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Urbanization and its Impact on Ambient Air Quality: A Case Study of Patna Municipal Area

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1. Introduction:

Ambient air quality means the concentration of pollutants suspended in outdoor air. Urban air quality is a big concerned because the large number of people resides in the big cities. Environmental pollution is a common problem in both develop and developing countries. (Ghosh et al 2005). Every year large quantities of toxins waste are discharge into the environment from production of goods, burning of fossils fuels, industries and domestic activities. Sulphur dioxide Nitrogen dioxide and Particulate Matter (PM10 and PM2.5) are regarded as major air pollutants in India (Agarwal and Singh 2000). The man-made activities such as combustion of fossil fuels and use of nitrogen fertilizers are the leading producer of hydrocarbons, carbon dioxide and nitrogen oxide, which finally inter into the environment. The increase concentration of the air pollutants adversely affects the living organisms and also the heat budget of the lower atmosphere (Anusha Pawar et al). Air pollution being a serious threat has led to over 3.7 million premature deaths because of outdoor air pollution and 3.8 million premature deaths because of household air pollution (WHO). Worldwide in 2016 the urban population is mainly exposed to high level of air pollutions increasing metals as well as fine and ultrafine particles from the vehicle emission (Sharma et al 2006). Due to rapid urbanization and our growing needs majority of regions in India especially state capitals have become major centers for commerce and industries. These activities are leading to unplanned growth and hence impose notable adverse impacts on the local and regional air quality (Bihar State Disaster Management Authority Safar 2018). Uncontrolled urbanization skating constructions activities, transportation activities, fossil fuel, combustions in industries, vehicles engines emissions, domestic burning biofuels, disposal practice including open biomass burning, poor road conditions, wind-blown dust from unpaved road side are some of the major pollution source which can be easily located in Patna city. (Sources EMIT) Various health hazardous pollutant enter into the atmosphere including PM10 PM. 2.5, NO2 and SO2, Carbon Di Oxide etcetera which can cause an adverse effect on the human body. These pollutants exceed certain level and shows some negative impact on human health specially children and elder people suffer more by this various infectious pollutant. Patna is the second largest city in the East India after the metropolitan city of Kolkata. In the recent years Patna has recorded the highest level of PM 10 and PM 2.5 concentrations which exceed the NAAQS standard limit. The CPCB report 2012 shows that Patna is the most polluted city in India after Delhi, the survey calculating the PM 2.5 in the state capitals. (Source: CPCB 2012) Ambient air to be 149 ug/m3 in 2016 in 2015 level of PM 10 in Patna was 355 ug/m3 that is three and half time higher than the prescribe limit of 100 m3. The occurrence of high number is due to higher vehicle and industrial emissions and construction activities in the City. (Bihar pollution control board 2018 report)

2. Aim and Objectives of the Research:

1. The primary purpose of this study is to assess the ambient air quality on the basis of PM 10, PM 2.5, SO2 and NO2 in the festival and non-festival season.
2. To analyze the impact of ambient air quality and recommend some measures to improve the air quality of the study area.

3. Methodology:

For the present research paper secondary data has been collected on the basis of temporal basis from 2020 to 2022. In this time period the pollutant of PM 2.5, PM 10, SO2 and NO2 is monetarized. The data is obtained from Bihar pollution control board and Central Pollution Control Board. There are two monitoring sites which is taken on the basis of activities i.e. Commercial and Residential.

Table 1: Details of site and period of monitoring

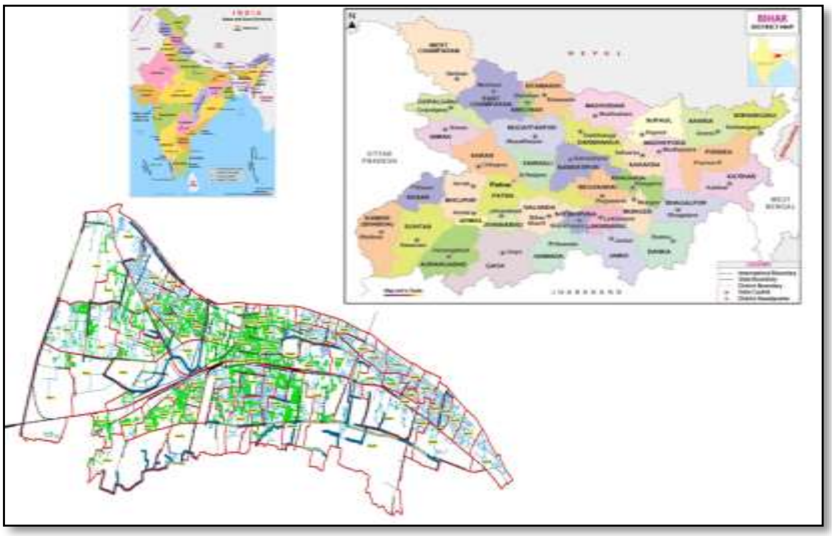
S.No.	Site Name	Period	Type	Latitude	Longitude
1	Taramandal (Maurya Lok Complex)	2020-22	Commercial cum Tri Junction	25.609^0N	$85'.1343^0$E
2	BIT Mesra, Samanpura	2020-22	Residential cum Educational	25.595^0N	85.086^0E

Table 1 shows the details of site and period of monitoring current status of ambient air quality in the City. The main objective was to generate the robust database on the concentration of hazardous pollutants PM 10, PM 2.5, NO2 SO2 in the air. For measuring the air quality of the particular place an AQI index is coined which is easily understood by the common man this is based on the international norms. The AQI categories is based on ambient concentrations value of air pollutants and their impact on health is known as health break points. Higher numbers of AQI index shows the greater risk and the lower number shows the lowest risk of the health associated with air quality.

4. Study Area:

Patna city is a saucer shaped, situated on the southern bank of river ganga's the township is based on thick fluvial sediments deposited by rivers and its tributaries. The climate of the Patna city is tropical humid type in the summer and monsoon season. Chilly winter nights and foggy or sunny days from October to February. The annual rainfall of 1109.8 mm is received through Southern West monsoon between the periods of June to September in the City.

Map 1: Location of Patna Municipal Area



5. Air quality index (AQI):

The AQI is a scale designed to indicate the air quality around us in terms of its effect on an individual health. AQI primarily community a unit less number divided in to several ranges as 0-50,51-100,101-200,201-300,301-400 and 401-500+and classified as levels of pollutants as good, satisfactory, moderate, poor, very poor and severe respectively. The higher in the number the greater is the health risk associated with air quality. The AQI and its corresponding breakpoints design for Indian cities are listed in table 2 and the health effect shows in table 3 respectively.

Table 2: AQI and its corresponding breakpoints

AQI Category (Range)	PM 10	PM 2.5	NO2	SO2
Good (0-50)	0-50	0-30	0-40	0-40
Satisfactory (51-100)	51-100	31-60	41-80	41-80
Moderate (101-200)	101-250	61-90	81-180	81-380
Poor (201-300)	251-350	91-120	181-280	381-800
Very Poor (301-400)	351-430	121-250	281-400	801-1600
Severe (401-500)	430+	250+	400+	1600+

Source: Beig et al. MoES Technical Scientific Report, 2010 and CPCB, 2014

Table 3: AQI and its health effect shows

Air Quality Index (AQI)	Associated Health Impact
Good (0-50)	Minimal Impact
Satisfactory (51-100)	May cause minor breathing discomfort to sensitive people
Moderate (101-200)	May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease.
Poor (201-300)	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease with short exposure.
Very Poor (301-400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart disease.
Severe (401-Above)	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity.

6. Result and discussion:

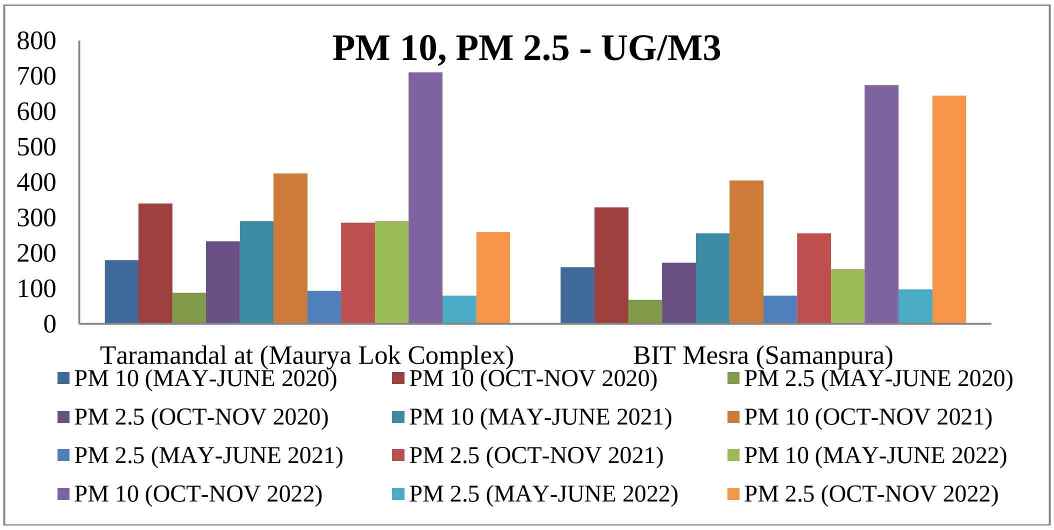
Patna is most populous and polluted city of Bihar there are so many commercial and industrial activities performed in the City. The table 4 shows their average concentration values of pollutants for monitoring period at each location of Patna city.

Table 4: Average concentration values of pollutants

Location	PM 10	PM 2.5	NO2	SO2
Taramandal (Maurya Lok Compex)	340.24 (festive season) 190 (summer)	294 (festive season) 202 (summer)	148.22 (festive season) 182 (summer)	15.03 (festive season) 10.3 (summer)
BIT Mesra, Samanpura	281.20 (festive season)	254 (festive season)	54 (festive season)	12.4 (festive season)

Data is in unit of ug/m3

a. PM 10 and PM2.5

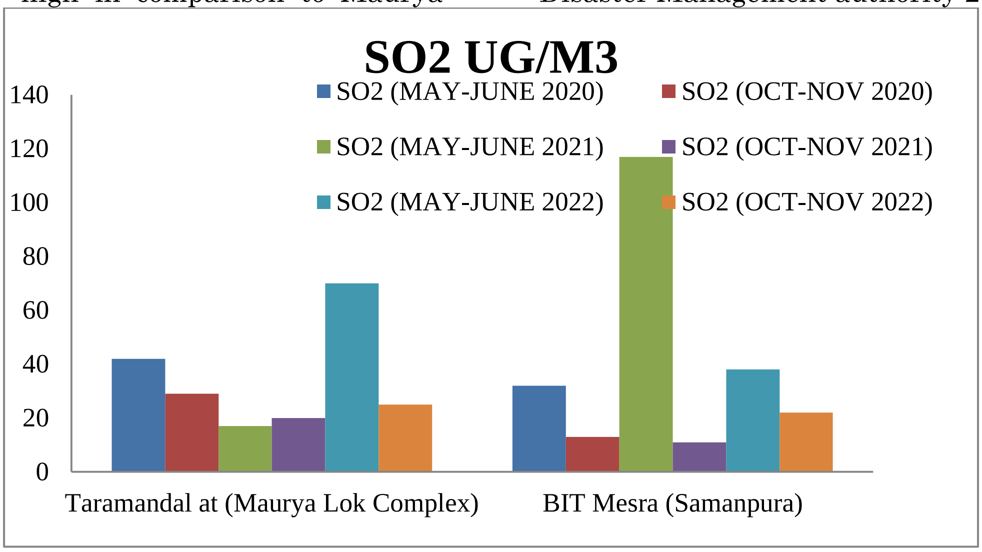


Status of the ambient air quality in the City. The data is collected from secondary sources between 2020 to 2022. The Taramandal site is located near Maurya complex which is a commercial hub of the Patna. The second site is located at Samanpura near BIT Mesra which is one of the residential site as well as educational center. Every year between 2020 to2022 in the festive period of Diwali at Maury complex the average value of PM 10 is 340.24 and value of PM 2.5 is 294 the NO2 is 148.22 and SO2 is 15.03 but when we saw the pollutants in summer season PM10 is 190 and value of PM 2.5 is 202, NO2 is quiet high i.e.182 and SO2 is 10.3 respectively. The variation was observed in this season because of burning of firecrackers and burning of paddy extract in the field during the winter season. In the year 2020 and 2021 the level of pollutant is recorded low respectively because of lockdown.

In the year 2020 the region of Samanpura near BIT Mesra the level of pollutants during festive season is respectively high in comparison to Maurya complex i.e. PM 10 is 281.20, PM 2.5 is 254 the NO2 is 54 and SO2 is 12.4 the PM 2.5 and PM 10 is quite high from the Maurya complex because this is a residential site as well as an outer area of Patna where there are some kind of forest is available. The level of pollutants is low because of COVID-19 also. In the non-festival season i.e. during May -June the concentration of pollutants is normal in range. i.e. PM 10 is 148, PM 2.5 is 51 and SO2 is 5.6. The data between 2017 and 2019 is not available because of not establishing the monitoring site at that time.(Bihar pollution control board 2018,SAFAR report).

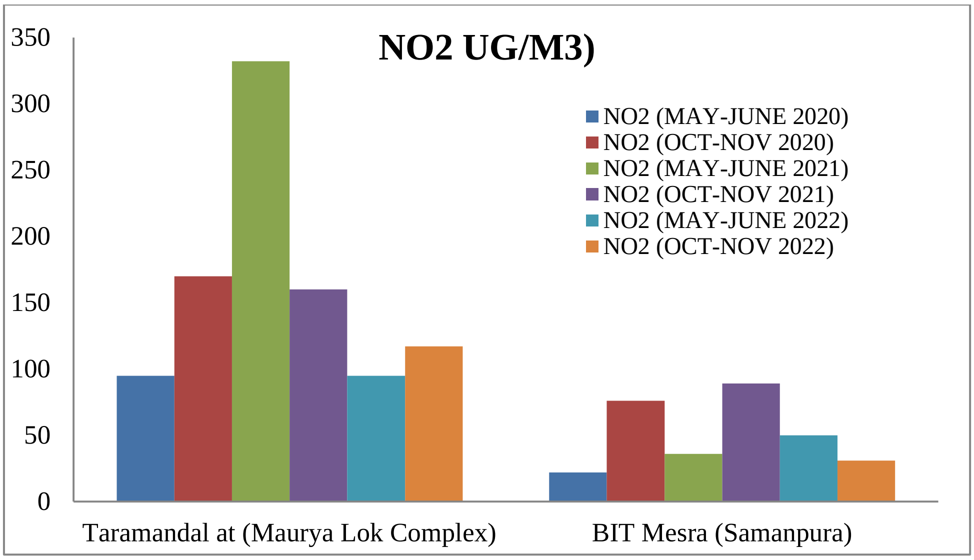
b. Sulfur dioxide SO2:

In the Taramandal area (Maurya complex) the highest level of SO2 is 25 ug/m3 and near BIT Mesra the SO2 range is 15 ug/m3 in the festival season but on the non - festival season the rate is respectively low. All the values are almost similar to the NAAQS limit which is 20 ug/m3or30.53ppb. AQI category for all the location is in "Moderate" range. (source: Bihar State Disaster Management authority 2018.)



c. Nitrogen dioxide NO2

During the month of October and November the NO2 level in the festive session is well higher the NAAQS limit of 30 ug/m3 at all monitoring location. In Maurya complex near Taramandal the level of NO2 is 45 ug/m3 the lowest level concentration and the higher level is 332ug/m3 in the month of May between 2020 to 2022. In the festive session of November October, the highest level of NO2 is 160ug/m3 and the lowest is 49ug/m3. In the station of Sammanpura BIT Mesra the lowest level of NO2 is 5.8 and highest level is 50ug/m3in the season of May –June 2020 to 2022.In the month of October i.e. festive session, the highest level of NO2 is 89 and the lowest is 14ug/m3.



d. Effect on health

The increase level of pollutant has adverse effect on human health. All pollutants accumulated through inhalation process to the human being. The pollutant is responsible for cardiovascular and respiratory diseases such as asthma, bronchitis and reproductive development increase risk of premature birth and even mortality and morbidity rate. (source: Ahmad Atiq 2015).

In the present study the concentration of PM 10 And PM 2.5 is above the prescribed limit. While NO2 is higher the permissible limit of NAAQS. Whereas the concentration of pollutants causes' severe disease like lung cancer.no2 is mainly exposed by vehicular traffic congestions (source: MoEF 2019)

7. Recommendations

Technology is required for improving the air quality of any places for this a long term measures must be taken, in general we can say that rapid industrializations, emissions from vehicles, construction activities, dust from unpaved road and cooking for domestic purposes are some of the major pollution source in Patna. This research paper shows that some adverse effect of deteriorated air quality which is discussed in this section.

1. Proper maintenance of vehicle is necessary.
2. Green the paved road and unpaved road.
3. Proper maintenance of traffic congestions so that emission of pollutant must be reduced.
4. Emissions from constructions activities can be minimized by adopting best practices such as stabilizing completed part with vegetation stabilizing earth works with stone soil geo textile use of water spray and dust separations create regions to prevent dust compact disturbed soil.
5. Technology advancement to improve Indian technology is the key handle fossil fuel emissions and it is high time that we continue to strive forever own new and better technology to minimize emissions from any type of fuel.
6. Improve public transport and use green fuel such as CNG, electricity in this sector.
7. For domestic purpose use clean and green energy. (source clean the air for children the impact of air pollutions on children October 2016 UNICEF).

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GIS-based spatial multi-criteria approach for characterization and sustainable development of the Wainganga River Basin, Central India

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Abstract

The present investigation highlights the importance of the Digital Elevation Model (DEM) and satellite images for assessment of drainage and extraction of their relative parameters for a water management plan with respect to their sustainability in the Wainganga River Basin (WRB). Some vital characteristics like topography, watershed, and hydrological parameters of the Wainganga River Basin (WRB) in Central India are evaluated using Remote Sensing (RS) data and geographic information system (GIS) applications. The WRB has a catchment area of 49949.68 km2 and a length of 638.91 km of the major stream. Under the umbrella of the topographical study of the Wainganga River Basin (WRB), the total mountain area is 10.56%, the plateau region acquires 33.92% and the plain region covers 55.51%. While, the area height break-up indicates that, the 2.77% of the area is above the altitude of 880 m, 28.51% of the area is the range between 480m - 281m, on the other hand, largest 46.61% of the area is below 280 m height. The Wainganga River flows with 26 tributaries out of them 14 are on left while 12 are on its right bank. The climate of the basin is characterized by hot summer from March to May followed by a rainy season from June to September. The post-monsoon season is also observed from the month of October. The annual mean rainfall ranges between1000 mm to 1400 mm. This study, along with geospatial technology will further help to better understand the circumstances of geographical features and their processes like soil erosion, drainage management, and potential soil conditions for effective planning and managing.

Keywords: Wainganga River Basin, DEM, Topography, Watershed Area, River Hydrology etc.

1. Introduction

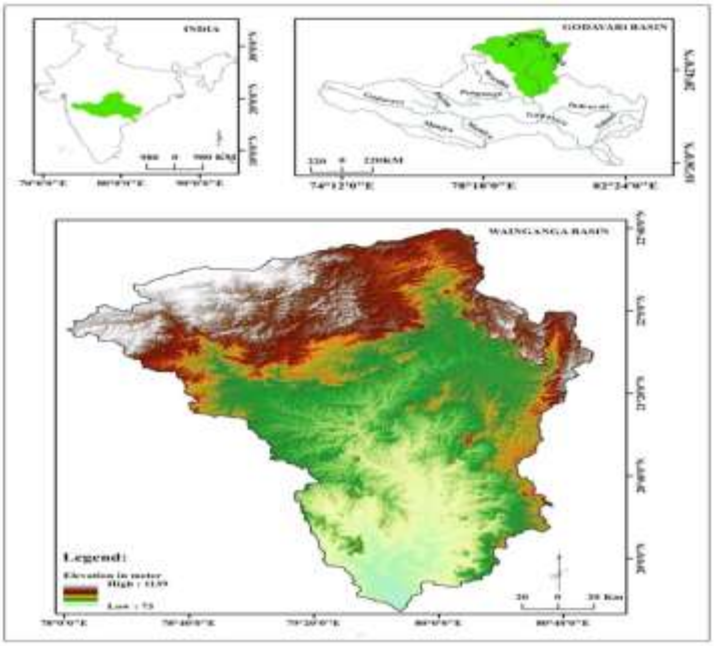
Watershed is defined as an area that drains water into a river or other body of water and considered as a major ingredient in managing water resources. To execute planning management strategies related to water resources the relevant systems in the watershed must be applied. Modeling has become one of the most powerful tools for watershed management during the last decades (Yadav et al. 2020; Srinivas et al. 2018; Zhang et al. 2016; Ahmad and Pandey 2018; Aslam et al. 2020; Rajasekhar et al. 2020; Pathare and Pathare 2020; Nassim and Munjed 2008; Sinha et al. 2012). A drainage basin is an area of land where precipitation collects and drains off into a common outlet, such as into a river, bay, or other body of water. Other some similar terms used interchangeably with drainage basin are catchment area, catchment basin, drainage area, river basin, and water basin (Xu et al. 2020; Walega et al. 2016; Rajasekhar et al. 2019; Yadav et al. 2016; Kamis et al. 2018; Farran and Elfeki 2020; Rogers 1982; Kudnar 2020; Kudnar and Rajashekhar 2020; Alcamo et al. 2007; Yang et al. 2016).

The present study is focused on the analysis of the Topography, Watershed, and Hydrological investigation of the Wainganga River with the help of geospatial technology. To achieve this goal researcher has prepared different thematic layers by using Geographical Information System (GIS) with the aid of ArcGIS software, which includes Physical Map, Contour Map, Digital

Elevation Map, Geological Map, Watershed Map, Land use Map, and Average Annual mean rainfall. The assessment of various morphological and hydrological parameters of the Wainganga Basin in India by applying geoprocessing methods such as the ARC map module in ARC GIS 9.3 and ERDAS imagine 9.2., all parameters were computed mathematically to analyses the characteristics of different morphological and hydrological parameters for sustainable development and planning of the river basin.

2. Study Area

The Wainganga River rises at an elevation of 640.0 m near village Partabpur (21°57'N & 79°34'E) about 20 Km from the town of Satpura plateau and flows in a wide half-circle, bending and winding among the spurs of the hills from the west to the east of the Seoni District of Madhya Pradesh.. The WRB total area of 49949.48 sq. km., while the Latitude extension- 19°30'N to 22°30 N' & Longitude extension- 79°00'E to 80°30 E'. The total length of the Wainganga River is 638.91 km, of which 270.2 km lies in Madhya Pradesh. The river travels 32 km along the border between Madhya Pradesh and Maharashtra, while the remaining 336.17 km lies in Maharashtra (Kudnar 2015 a, b, 2017; Paranjpye 2013).



Map No. 1 Wainganga Study Area

3. Methodology

The topographical data is obtained from a one-inch topographic map of Survey of India (1:63360 or 1:250000) with the help of toposheets No. 55J, 55K, 55N, 55O, 55P,56M, 64B, 64C, 64D, 65A. Using these sheets we have carried out various classification and analysis which includes sorting of data, digitization of various layers, preparation of maps, statistical analysis, and other GIS/RS techniques. Using WGS 84 datum, Universal Transverse Mercator (UTM) help of SOI topographic maps were georeferenced zone 44N projection in ArcGIS desktop 9.3. In this study, the Wainganga River Basin was delineated and the drainage network was extracted using Cartosat-DEM (1 arcsec) superimposed with SOI toposheets, GPS location, river hydrology including rainfall distribution, run-off are calculated by statistical methods, like as, Mann Kendall Trend Test (sometimes called the M-K test and Modify Mann Kendall Trend Test called the MMK test). After completion of DEM, the flow direction was calculated for each pixel, to generate a drainage network, the flow accumulation was taken into account, based on the flow direction of each cell. Thus GIS-based analysis of topography, watershed, and hydrological parameters has been calculated for the sustainable development of the Wainganga River Basin.

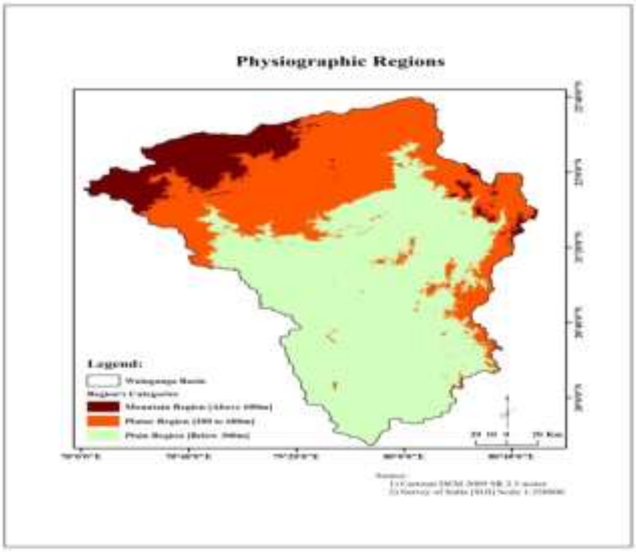
4. Results and discussions:

4.1. Physiographical Regions Area

The Wainganga basin's total calculated Mountain Region is in 10.56% and it is expanded in 5276.01 area sq.km. In mountain areas including the south part of Mandala district, Chhindwara and Seoni District occupies the southeastern portion of the Satpura Range and the upper valley of the Wainganga River. **4.2.**

4.2. The Wainganga River Basin Catchment Area

The Wainganga has the main 26 tributaries, of which 14 are on its left bank and 12 are on the right bank. Among these rivers, left Bank Rivers are Sagar, Nahar, Deo, Son joins the Wainganga in Madhya Pradesh as it flows through Seoni and Balaghat district. While, Bagh, Chulband, Gadhavi, Satti, Tipagsrhi, Khobragarhi, Pal, Kathani, Phuar and Pohar join the Wainganga in Maharashtra as it flows through Gondia, Bhandara and Gadchiroli district. Furthermore, Bagh (at Birsola, 283m above MSL), Chandan and Bawanthadi (at Bapera, 275 m above MSL) join the Wainganga on the borders of Madhya Pradesh and Maharashtra. Right bank rivers which are 12 in number are named Hira, Pench, Kanhan, Chandan, Bawanthadi, Sur, Ambi, Mari, Haman, Pathari, Mal, and Andhari. These rivers join the Wainganga in Madhya Pradesh as it flows through Betul, Chhidwarah, Seoni district, and Maharashtra as it flows through Nagpur, Bhandara, Chandrapur districts (Gosain and Rao 2004; Kudnar 2018, 2019)



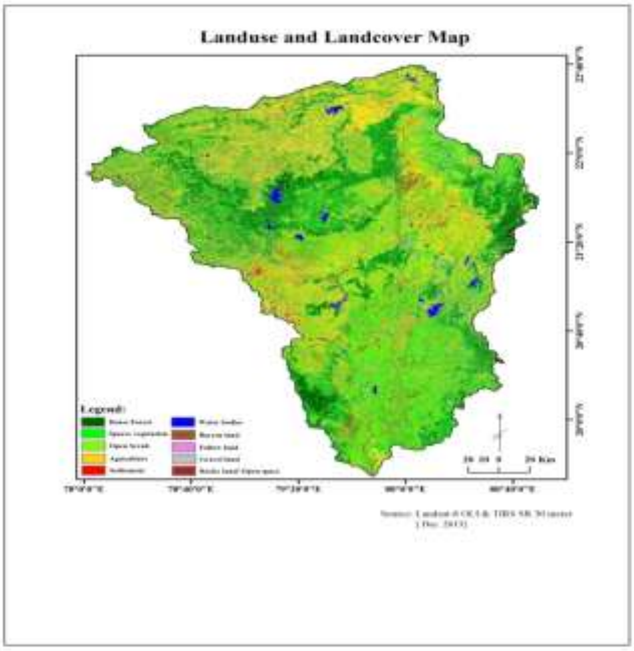
Map No.2 Physiographical Regions

Map No. 3 Wainganga River Sub-Basin

Table1. Wainganga River Basin Watershed Area

Sr. No.	River Basin	Area (Sq. km)	Sr. No.	River Basin	Area (Sq. km)
1	Ambi	830.37	15	Maru	727.90
2	Andhari	1223.88	16	Nahar	877.37

3	Bagh	2938.72	17	Pal	276.23
4	Bawanthadi	2161.79	18	Pathari	514.29
5	Chandan	1145.29	19	Pench	4717.86
6	Chulbund	2537.22	20	Phuar	429.91
7	Deo	840.32	21	Pohar	874.55
8	Gadhavi	1557.23	22	Sagar	1065.46
9	Haman	2078.26	23	Satti	830.85
10	Hira	1017.77	24	Son	1428.96
11	Kanhan	7640.26	25	Sur	1004.24
12	Kathani	932.73	26	Tipagsrhi	796.49
13	Khobragarhi	200.52	27	Wainganga	11160.66
14	Mal	140.39			
Grand Total					**49949.48**



Map No. 4 Land Use map of Wainganga sub-basin

Table 2 The Land use pattern of the Wainganga sub-basin

Sr. No.	Land use/ Land Cover Category	Area (sq. km.)	Total Geographical Area (%)
1	Dense Forest	8018.55	16.05
2	Sparce Vegetation	9994.97	20.01
3	Open Scrub	12995.75	26.01
4	Agriculture	8876.70	17.77
5	Settlement	897.19	1.80
6	Water Bodies	809.10	1.62
7	Barren Land	4318.96	8.65
8	Fallow Land	2676.20	5.36
9	Gravel Land	171.09	0.34
10	Rocky Land/ Open Space	1190.96	2.38
Grand Total		**49949.48**	**100**

4.3. Land use Pattern

The major land use categories in the Wainganga River's basin include buildup land (1.80%) and agricultural land (17.77) that comprises of generally Kharif, rabi, and double-crop system in the region. Forest cover (62.07%) comprises of Dense Forest (16.05%), Space vegetation (20.01%), Open Scrub (26.01%) and recent plantations (Table 2). Deciduous or Dense forest largely spreads out in the region in the east of the all Wainganga river basin area. Water Bodies (1.62%), Barren Land (8.65%), Fallow Land (5.36%), Gravel Land (0.34%), Rocky Land, or Open Space (2.38%) can also be found in the region (Fig. 6).

4.4 Hydrology

The areas receiving 75% dependable precipitation below 600 mm is classified as Drought prone for irrigation purposes as per Central Water Commission (CWC) New Delhi guidelines and accordingly, the Wainganga sub-basin is not drought-prone. The isohyets of 1500 mm pass the river parallel where the Dam-toe Power Station is proposed. Gridded rainfall data of 0.5×0.5° and 1× 1 resolution was analyzed to study long term temporal and spatial trends on annual (Fig. 7) and seasonal scales in the Wainganga river basin located in Central India during 1901- 2013.

4.5 Water Resources Development and Management Plan

4.5.1. Plan for development of Agriculture

Agriculture helps to meet the basic needs of humans and their civilization by providing food, medicine, recreation clothing, and shelters. Agriculture and allied activities are the main sources of livelihood for the communities in the Wainganga basin. We have compiled an inclusive database that includes information on the Wainganga River sub-basin agriculture land-use area, the net sown area is 1927.27 thousand hectares and the Gross cropped area is 2450.41 thousand hectares. The soil quality aspects in the study area to classify soil depth, soil chemical, and physical properties, soil types and series, soil erosion, irritability class, pH, etc.

4.5.2 Soil Depth

The soil depth in the Wainganga region ranges from deep soils with 150 cm to shallow soils with a depth of less than 20 cm. The region with deep soils can be found in the riverine and flood plain areas of Wainganga. The less than 50 cm. (Shallow) in the Wainganga river sub-basin is 2825.08 ha, moderately deep (50-100 cm) 795.42 ha. and Deep soils area 1308.89 ha., They are under extensive cultivation and are concentrated in the districts of Balaghat, Nagpur, Bhandara, Gondia, and the riverine areas in Gadchiroli. The jhudpi (shrubby) jungles of Gadchiroli region can be found in these alluvial plains. Shallow soils can be found in the hilly regions of Ramtek, Umred, Gaikhuri Range in Bhandara, forests of Nagzira and Gadchiroli.

4.5.3 Preparation of a Comprehensive Irrigation Management Plan

The Wainganga basin is relatively water abundant, the annual range of temperature is quite large and the region experiences extremely hot and dry days, which increases evaporation losses. Hence we have included appropriate techniques in the irrigation management plan to avoid and overcome such situations. I assume various new and old irrigation practices such as the volumetric and controlled release of water at different sources e.g. wells, canals, tanks, etc. and the use of gravity-based, siphon-based and energy-based systems (pumps, etc.); micro-irrigation techniques like drips, sprinklers and shed nets with foggers/moisturizers; variety and combination of shaping, profiling, rows, and furrows, creating meanders in order to maintain the appropriate soil moisture levels in the root zone areas; sub-soil piping system, optimal volumes of water for different crops in different soil categories. Upon completion of this detailed assessment, appropriate techniques will be suggested, depending upon the soil type and structure.

4.5.4 Groundwater Availability, Development and Management Plan

We studied surface water availability and water demand in the basin. The Wainganga basin is known to be endowed with geological conditions suitable for groundwater percolation and the rainfall is trapped in its aquifers. According to the legal provisions in Maharashtra states, groundwater is a privately held resource and is perhaps the most accessible source of water to remote communities. However, this also creates conditions for overexploitation, and not surprisingly two of the 80 watersheds in the Wainganga basin were found to be critically water-deficient according to the book on Groundwater Resources of Maharashtra (GSDA, 2007). A team of groundwater experts is there preparing a comprehensive plan which comprises an assessment of the groundwater reserves in the region, groundwater-based drinking water supply systems for remote villages, and a plan for the community-led aquifer management system. It will also include a book on the improvement of groundwater quality through aquifer management (Kadam et al. 2020).

4.5.5 Improvement of Traditional Water Systems

There are over 43,000 traditional tanks in the Wainganga region, and as stated earlier most of the tanks are in a state of neglect. Most of the smaller tanks have not been identified as traditional tanks by the Water Resource Department. Hence, a study is underway to identify, enlist, and record the status of all the traditional water systems within the Wainganga watershed area. Schemes like incentives for restoration of tanks, renovation of tanks, springs, canals, etc. are being proposed. Classification of tanks according to different uses like domestic water use, animals, gardening, agriculture, fisheries, recreation, and tourism, etc. is also being made.

4.5.6 Plan for water for Energy

There are many thermal power plants in and around the Wainganga catchment area, and new power plants are proposed (e.g. Adani Thermal Power plant is proposed at Tirora (Gondia) with the capacity of 10,000 megawatts). Accordingly, an assessment is being carried to determine the energy requirements of the basin, identifying areas that have not received conventional energy supply and the total energy production from the Wainganga region.

4.5.7 Tourism Plan

Water-based tourism is a major thrust area for livelihood development in the region since the region offers unique locales such as the 'Ghats' at Pauni, Markanda Temple in Gadchiroli, and the numerous small and large traditional tanks, etc. on the banks of the river. Besides this, the three Wild Life Sanctuaries in the Wainganga basin are also popular tourist destinations. Navigation and fishing in the Wainganga River, trailing along the Kathani River, etc. also provide unique opportunities for tourism in the region. 'Wainganga Yatra' is also a tourism option that has been suggested by the 'Abhyas Gats'. One such Wainganga Yatra has been planned in November 2012. Seeing the potential of tourism in the Wainganga basin, the community groups are therefore developing a 'Wainganga Water and Forest Tourism Package' that builds on the strengths and uniqueness of the region.

5. Conclusion

According to the topographical study of the Wainganga river basin, it can be divided into three major reliefs that are mountains, Plateaus, and Plains. It comprises a 10.56% mountain area, 33.92% plateau region and the plains region covers 55.51%. The watershed area analysis concludes that the watershed area is about 49949.48 sq. km with 26 tributaries, while the climatic investigation shows that the basin is characterized by hot summer from March to May followed by a rainy season from June to September. The average annual rainfall range varies from 1000 mm to 1400 mm. These topographical, watershed and hydrological parameters are playing a pivotal role in water management of the Wainganga River Basin. These parameters may also provide a rational platform for converting water resources for creating irrigation facilities. These parameters may also be used for various applied purposes like constructing dams, canals, forest management, barren land management, horticulture development, eco-tourism, and sustainable agriculture. For the planning and development of watersheds, it not feasible to carry out the same strategy over the entire basin it must diverse according to the nature of water shade. The result of this research work may be helpful for watershed planners and managers towards implementing various water and soil conservation measures in the region. It may also be concluded that with GIS and statistical techniques very holistic approach for the watershed management plan, sustainable natural resources management, and conservation.

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Recent Trends in Geography and Environmental Study

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Abstract
In the previous decades, research literature modifies in major height of volume with an unbelievable current yearly growth of millions of new notifications. As scholar gets ever more universal and new nations and organizations, either from educational or associate environment, to achieve with their share, it is usual to guide this mix propaganda and understand its importance. We present a study on a current trend which are more crucial in the geography.it helps us to show more clear study for next generation to focus on the scientific look in the geography department. As we know that geography pervades universe and without geography, we cannot make progress. If we want to compare with universal destination then it is must to adopt new and current trends in the field of geography and environmental study. Now a days all universal trying their best in the geography to make it beneficial in the lives of human. Recent trends in geography's tools and techniques show a future in which students, scholars, researchers, farmers, business people, official and policy makers will traverse a world of shared dimensional data and information from their work stations. They will request analyses from a rich menu of options, select the geographic area and spatial scale of analysis, and display their results in web and multimedia formats that are unexpected today.

Keywords: Trends, pervades, notifications, propaganda, explore.

Introduction –

Trends means temporal observations that allow us to understand the pattern on particular period.it helps us to learn the concept related to geography within stipulated area and period and also tells us what should be important in future generation. The outdated trends and current trends cooperate to make new field in the particular subject and it held also in geography. We also observe that in all subjects new or current trends make these subjects growth in the universe. It we want to make the subjects universalize; it is necessary to learn all these current trends thoroughly. In presents era these are lacks of trends emerging related to geography and environment e.g., the use of GIS and GPS has become important. We can search any type of location of weather, earthquakes, flood and many more disaster. So, maps are made by using GIS software system and have proved to be more accurate. We use lots of tools and technique using mathematical modelling and computer models in applied geography has increased. In recent era weather prediction also depends on GPS and GIS system.

Review of literature-

In present paper written overview of related topic and other sources are taken from different sources e.g. scholarly journal articles , books, government reports , web-sites etc. it provides us the different information , summary and evaluation of related topic , in present paper as researcher I collect the information from different scholar related to current trend whose writing is available and also refer government document, various paper , web sites etc. different critics write on the present topics and mention their views, merits , demerits etc. as a researcher review helps us to focus details on the given topic and throw light on topic more clearly and accurately

Data-

It is process to focus light on two different areas regarding to subject. here I select different previous trends and current trends related to geography and environment e.g., for map reading in past era we use traditional method but in current trends map reading become very accurate and praise. There are many more examples related to geography. in past era watering, harvesting, population tabulation, pollution, weather, mapping, nature, location, geomorphology, climate soil etc. to study all these topics we use traditional method as researcher but now a days in current trends we use new method for study all this topic so it helps researcher to focus all these topics accurately.

Methodology-

For present paper I prefer observation of method for the purpose I refer different published papers in the previous era. So present paper helps me to make difference between same concepts how it become clear and precise one. It makes paper focus on the strategy and help in to future researcher make their study properly.

Result-

present theme of paper demonstrates us that current trends in geography helps to understand the importance for student, researcher, scholar to universalize the subject and also it helps human to make progress as well as show direction what to do and not. As we know environment is key for human being as well as animals, birds, and plant species so we can'tniggled the importance of current trends in geography and environment. It focus how to live our life with environment.How a day's total universe facing the problem of climate change. But it we learn which factors are must for these type of problem then we have to verify all these concepts in geography otherwise we can't face all these problems properly so these type of research paper help to show proper way to all universe.

Conclusion-

In presents papers we discuss about the current trends and environment. In the paper we conclude that current current trends in geography are very important they helps student,scholors,researcher,humans and accurately they helps to contribute and make the subject universal current trends helps us to mingle between previous and current and current concepts how old concepts are waste the time and we cannot get accurate result related to geography as we know there are various branches of geography and all branches need current trends to make the subject world wise they helps students, researchers what is needful which criteria should be follow to make our study beneficial for all kind of living and non-living things so in conclusion we can say that current trends are key for geography and environment the latest example of covid-19 prove how current trends are very important for the world.

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A Geographical Analysis of Major Tourist Centres and Identification of Pilgrimage Tourist Circuits in North Ahmednagar District.

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Introduction

According to the report of the World Tourism Organization (WTO) June 1991, Tourism is the world's largest industry and major contributor to global development. India is on 54th rank in the Travel and Tourism Development Index (India Tourism Statistic 2022). Travel is the activity associated with arrival and departure at the time of Pleasure, Prosperity, Holidays and Leisure. (R.B.Chavda 2019). According to the definition given by the United Nations Organization (1937) "Tourism covers the social activities of people who go away from their permanent residence for 24 hours and more". Now in the present era lifestyle is changing rapidly, therefore the development of the tourism sector is very fast. Due to a fast lifestyle, people have little time for leisure and relaxation. Generally, people travel for several purposes or objectives. There are many types of tourism according to tourist purposes. i.e. Entertaining tourism, Environmental tourism, Health tourism, Adventure tourism, Religious tourism, Rural tourism, Historical tourism, Educational Tourism etc. (R.B.Chavda 2019). Tourism is now the largest industry in the world by virtually any economic measure including gross output, employment, capital investment and tax contribution. Tourism can create a significant importance in the income and living standards of the people of the region or locality. (Sujatha Annie Kurian 2012). Tourism is one of the industries with the strongest effect on the economy because it helps in the development of other sectors, it provides job opportunities in different tourism sectors like accommodation, hoteling, transportation, entertainment, and other. Ahmednagar district has a lot of potential in the tourism sector due to great diversity. Therefore, Ahmednagar has vast and huge potential of different historical, natural, religious and socio-cultural backgrounds. (Mr.Nikam S.M. 2016). The essential parameters for the success of the tourism industry is the development of the tourist circuits and destinations to attract domestic and international tourists. (Ar.Chetan Sachdeva 2020). This paper aims to study and highlight tourist centres in Ahmednagar district, classification of tourist centres and identification of possible pilgrimage tourist circuits in north Ahmednagar district.

Aim and Objectives of Research

The major objectives of the study are as follows:

1) To study the tourist centres of interest in Ahmednagar district.
2) To classify tourist centers in Ahmednagar district.
3) To highlight pilgrimage tourist centers and identify possible pilgrimage tourist circuits in north Ahmednagar district.

Database and Research Methodology

The study is based on the primary and secondary data collected from the visits to tourist centres with the help of Photographs, interviews of tourists, pilgrims, households etc. Secondary data was collected from reference books, booklets, daily newspapers, periodicals, magazines, research reports, internet, various online sources, thesis, district census handbook 2011,2022, the reports from tourism departments, forest departments, Ahmednagar district Gazetteer etc.

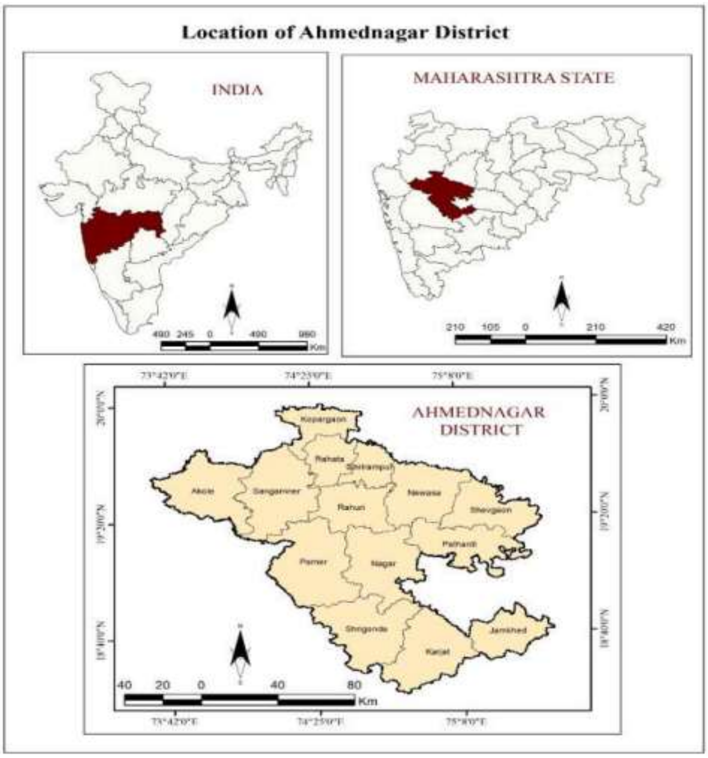
Study Area

Ahmednagar district is located between $18^{0}2'$ north to $19^{0}9'$ north latitude and

79⁰9' east to 75⁰ 5' east longitude. The district has geographical area of 17,048.00 km^2. (District census Handbook 2011) Ahmednagar district is the largest district in Maharashtra, bounded by Pune district, Nasik district, Aurangabad district, Beed district, Osmanabad district, Solapur district and Thane district. General elevation is 752 meters above mean sea level. Ahmednagar district is situated partly in the upper Godavari basin and partly in Bhīma basin. The district has Sahyadri, Baleshwar, Harishchandra, Kalsubai Ranges and Adula hills. Average rainfall receives 575.8 m.m. The mean daily Maximum temperature is 39^0centigrade and mean daily minimum temperature is 11.7^0 centigrade.

Ahmednagar district has 14 talukas. These are Kopergaon, Akola, Sangamner, Shrirampur, Rahata, Rahuri, Newasa, Shevgaon, Pathardi, Ahmednagar, Parner, Shrigonda, Karjat, and Jamkhed. Ahmednagar city is the administrative headquarter of the district. There are 1584 Villages, 19 towns with total population 45, 43,159 and Density of population is 266 persons per sq. km. (District census Handbook 2011).

Map:1: Location of Ahmednagar District



1. **Classification of Tourist centres in Ahmednagar District**

India is one of the nations with a strong potential and fastest growing tourism destinations in the world, which contributes 6.8% GDP, 7.7% total employment generated and provides foreign exchange of US$18.13 billion (IBEF 2016). Maharashtra attracts tourists from other Indian states and foreign countries. The area for study is Ahmednagar district with great potential for tourism. There is a lot of diversity in Ahmednagar district in the nature of tourist centres. The district has great and vast tourism potential of different natural, historical, religious, and socio-cultural backgrounds (Mr.Nikam S.M. 2016). There are different types of tourist centres like Natural/ geographical tourist centres, religious, historical, agro based, hill stations, caves, tombs, museums, monuments etc. For the convenience of this study researchers have classified tourist centres in five categories.

1) Religious tourism centers
2) Historical tourism centers
3) Natural Tourism centers
4) Cultural or Heritage tourism centers
5) Agro Tourism

Table: 1: Classification of Tourist Centers in Ahmednagar District

Types of Tourism	Tourist Attraction/ Destination	Taluka
Religious Tourist Centers	Shirdi	Rahata
	Shani Shinganapur	Newasa
	Siddhatek	Karjat
	Mohatadevi, Vruddheshwr , Madhi and Bhagawangad	Pathardi
	Deogad, Paiss Khamb (Newasa) , Siddheshwar Temple and Pravarasangam	Newasa
	Avhane	Shevgaon
	Jangali Maharaj Ashram and Janardan Seami Ashram (Maungiri Maharaj)	Kopargaon
	Agasti Rishi Ashram, Bhairav Gad	Akola
	Vishal Ganpati, Agadgaon, Dongargan, Avtar Meher Bab Samadhi, Meharabad, Arangaon and Gorakshnath Gad	Nagar
	Haregaon, Kamalpur (Domegram)	Shrirampur
	Shrigonda (Temple of Shaikh Mahamad maharaj)	Shrigonda
	Mahadev Temple and Mallikarjun Temple, karjat	Karjat
Types of Tourism	**Tourist Attraction/ Destination**	**Taluka**
Historical tourism centers	Ahmednagar Fort, Cavalry Tank Museum, Historical Museum, Chand Bibi Mahal, Alamgir Museum Farya Bagh and Manjarsumba gad	Nagar
	Patta Fort	Akole
	Bhalavani (Mahadaji Shinde wada), Palshi (gadhi)	Parner
	Raghobadada Wada	Kopargaon
	Kharda Fort and Chondhi	Jamkhed
Natural Tourism centers	Bhandardara Dam	Akole
	Mula Dam	Rahuri
	Randhafall, Ratangad, Harishchandragad, Kalsubai Peak, Ghatghar,	Akole

	Samrad Valley, Tahakari	
	Pemgiri	Sangamner
	Nighoj Pot holes, Wadgav Darya (Lavansthambha), Takali Dhokeshwar Caves	Parner
	Rehekuri – Black buck Sanctuary	Karjat

Types of Tourism	Tourist Attraction/ Destination	Taluka
Cultural or Heritage tourism centers	Sai Heritage Village, Shirdi Old Shirdi –Babas Geritage Village	Rahata
	Dhokeshwar Caves, Takali Dhokeshwar	Parner
Agro Tourism	Mahatma Phule, krishi Vidyapith, Rahuri	Rahuri
	Bhenda	Newasa
	Saiban and Hiware Bazar (Water shade Management and Adarsh Gav)	Nagar
	Ralegan Sidhhi (Water shade Management and Adarsh Gav)	Parner

2. Developed Religious Tourism Centers in North Ahmednagar District: -

There is a lot of diversity in north Ahmednagar district from a religious point of view. This district is known as a religious tourist district which is famous for some temples. These religious centers have huge potential for tourism development, but some of them are not well known for domestic as well as foreign tourists.

i) Shirdi:-

Shirdi, a town in Ahmednagar district is one of the famous religious sites for visitors from the 19^{th} century. The location of Shirdi is $19^{0}77'$ North Latitude and $74^{0}48'$ East Longitude. The Average height from sea level is 480 meters. The average rainfall in Shirdi recorded is 50 cm. Maximum temperature is recorded 20^{0} C. to 40^{0} C. and minimum temperature recorded 8^{0} C.
to 34^{0} C. in the winter season. This center is in Rahata tehsil, famous for Shri Sai baba. Most of the tourists visit Shirdi in huge numbers. Sai Baba temple is one of the richest temples in India. Saibaba Devasthan trust (Saibaba sansthan) is one of the major trusts. Shirdi is 83 km. from Ahmednagar and 15 km. from Kopargaon. Saibaba lived in shree kshetra Shirdi from 1838 to 1918. At the age of 16 to 17 years' baba arrived at Shirdi till his passing away. Shirdi village is developed because of Shri Sai Baba.

ii) Shani Shinganapur: -

Shani Shinganapur is one of the most famous places in Ahmednagar district. This village is located in Newasa tehsil. It is about 35 km. from Ahmednagar. It is situated only 6 km. far from Aurangabad – Pune state highway No. 60. The location of Shani Shinganapur is $19^{0}24'$ North Latitude and $74^{0}49'$ East longitude. This tourist center is 522 meters high from mean sea level. The Mula and Pravara Rivers are the main rivers in this area. The average rainfall in Shani Shinganapur recorded is 565 mm. Maximum temperature is recorded 40^{0} C. and minimum temperature recorded 9^{0} C. in winter season. Shri kshetra Shini Shinganapur is a very holy place. A unique aspect of this place is that there is no temple. There is only a simple platform on which stands the swaymbhu idol in black stone. Shinganapur is also famous for the fact that houses in this village are without doors, only a barrier to enter a house which keeps out stray animals. People believe that nobody dares to take a risk to steal anything because they are punished by lord Shanidev.

iii) Shree Kshetra Deogad:

Devgad is famous for the holy temple of lord Dattatrya. It is a well-known and bountiful place which attracts pilgrims and tourists. This tourist center is 480 meters high from mean sea level. The average rainfall in Devgad recorded is 60 cm. Maximum temperature is recorded 40^0 C. and minimum temperature recorded 10^0 C. in winter season. Sant shri Kisangiri Baba is founder of shri kshetra Deogad. Kisangiri baba was born in the village Bodhegaon tehsil Newasa on 13th September 1907. Baba believed that "Service to Man Being is Service to God". On 6th March 1983 Baba left his disciple alone and passed away.

iv) Pais Khamb and Sant Dnyaneshwar Temple Newasa:-

Shree Kshetra Nevasa is a spiritual university of Maharashtra in Nevasa taluka of Ahmednagar district in Maharashtra which conveys the heritage of ancient Indian culture and religious culture. The location of Newasa is $19^0$32' North Latitude and $74^0$56' East longitude. This tourist center is 480 meters high from mean sea level. The average rainfall in Devgad recorded is 55 cm. Maximum temperature is recorded 42^0 C. and minimum temperature recorded 90 C. in winter season.

In 1290 Saint dictated Dnyaneshwari at the age of 15 in the year 1290 Shake 1212 in this holy land and written by shri Sachchitanand Baba. Saint *Dnyaneshwar* leaned against the pillar while composing his great work Dnyaneshwari. This pillar is called a Paiss Khamb. This Paiss Khamb is buried in the ground under a flat roof, which is about 33 x 36 feet, it stands about 4.5 feet out of the ground. Saint Dnyaneshwar give "pasaydan" for the wellbeing of all the human beings of this world at this place.

V) Belhekarwadi – Renukamata Darbar :-

Shri Kshtra Belhekarwadi is well known for the glass temple of Mata Renuka. The location of Renuka Darbar is $19^0$23' North Latitude and $74^0$50' East longitude. This tourist center is 478 meters high from mean sea level. The average rainfall in Devgad recorded is 50 cm. Maximum temperature is recorded 38^0 C. and minimum temperature recorded 10^0 C. in winter season. This religious tourist center is situated 4 km. from Sonai and 60 km from Shirdi. It is situated only 12 km. far from Aurangabad – Pune state highway No. 60. Swami Shri Krishnaji Joshi was a natural devotee of Renukamata, Mahuragad living in Belhekarwadi with his wife Seema. Seamiji and Seemaji always visited village Mahurgad and prayed Renukamata by heart. One day as usual they are at Mahurgad. At that time Rnukamata blessed them and told them, ' You need not come here: I am; I am coming with you to your village.' From that day Swami decided to stay in the farm. He came back to his farm at village Belhekarwadi and stayed in the farm and started praying to Renukamata. He constructed a Yadnya Mandap in 1954. He started a construction of temple of Renukamata in 1971 and completed in 1991. Internal side of the temple is decorated by pieces of glass. Mosaic glass is very attractive. There is an idol of Renukamata.

There are Lord Krishna temple, Shri Dattatrya temple, Sraswati temple, Lord Vittha temple, Saptayogini and Swami Mharaj temple. These temples are in the area of the main temple. (Mr. Ghule S.R. 2013). These are the famous and developed tourist centers but the rest of the tourist centers are underdeveloped. Some religious tourist centers have a lot of potential. The potential for development amomong the following tourist centers is as follows, Kshri kshetr Taharabad, Shriram Mandir And Dudheshwar Mandit Shrirampur, Janardan Swami Maharaj (Maungiri Maharaj) Kopargaon, Kamalpur (Domegram), Agasti Rishi Ashram, Akole, Pravara sangam, puntamba, Domegaram ect. These religious tourist centers are not so popular.

3. Circuit Tourism:

Circuit tourism is a form of tourism in which a tourist starts from a tourist destination and visits at least three spots which are not too distant from each other. The circuit should have a distinct entry and exit point. Circuit tourism is normally conducted when the destinations require equal tourist recognition. Circuit tourism provides equal development to all the destinations in its circuit. It also provides equal importance to all destinations. (Antony Simon 2021) It's an important factor for the

development of multiple tourist destinations simultaneously. Circuit tourism also helps to provide more recognition to the less-visited tourist destination. With the help of a circuit. Tourism tourist spots could be easily recognized with fewer investments. Circuit tourism is normally cantered to a specific destination or monument or place and built around it. The most commonly found form of this tourism is for holy pilgrimages. Cities with historical or cultural or business importance (Antony Simon 2021). "A Tourist Circuit is defined as a route on which at least three major tourist destinations are located such that none of these are in the same town, village or city at the same time they are not separated by a long distance It should have well defined entry and exit points A tourist who
enters at the entry point should get motivated to visit all the places identified on the circuit" (Chowdhury, A.L. (2011).

Circuit tourism is typified by the short length of stay at each destination on the circuit, pre-planned itinerary and regional and local clustering of attractions (Chowdhury, 2011). Circuit tourism depends, for its existence, on the identification, development, and promotion of tourist circuits. Circuits can be developed either within a country (intra-border) or between two or more countries (cross-border). Circuit tourism needs careful planning in the smallest detail. It will also require development of a proper support system at various locations along the circuit route; and provides an opportunity to involve local people in the tourism development process.

4. Pilgrimage Tourism:

The term "Pilgrimage" has its origin in the Latin word 'Peregrines' which means a 'stranger' or 'wanderer'. It is also defined as a Spiritual odyssey. Its chief purpose is to gather religious merits (Punya) and absolve own sins (Pap) as well as to involve the blessings of the particular deity enshrined in the religious place. (Sinha Amita, 1994).

Pilgrimage a journey resulting from religious causes, externally to a holy site, and internally for spiritual purpose and internal understanding is one of the religious and cultural phenomena most common to human society throughout the world.

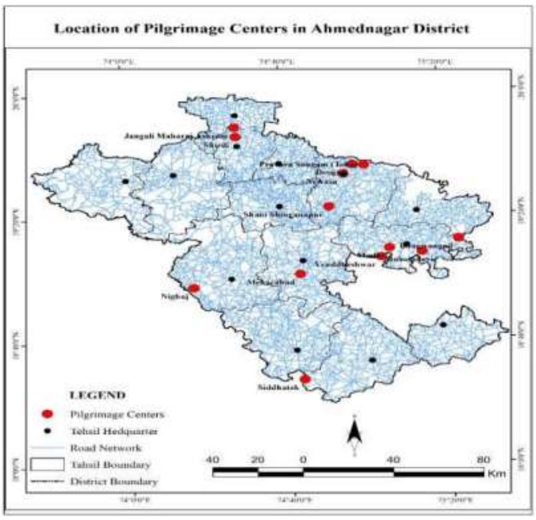
Pilgrimage refers to a journey that is motivated by religion or spirituality and plays a significant role in almost all world religions. The nature of religious tourism could be defined according to the World Tourism Organization (WTO, 1985) as the movement of persons due to essentially cultural motivations as study travels to festivals and another artistic events, visits to places and monuments, travels to explore the nature, the art, the folklore and the pilgrimages'.

5. Identification of Pilgrimage Tourist Circuits in North Ahmednagar district.

The creation of the route tourism process identified by Lourens (2007) involves the selection of routes based on the target market and its criteria, the audit of tourism goods in the specified region, the scrutiny of tourism properties and the identification of specific sales characteristics. In the next step, the product mix is established by designation marketing organization (DMO), a simple strategy to guide work plans and finally, route branding. (Ar. Chetan Sachdeva (2020).

Interstate Circuits can be developed based on various themes of effective transportation connectivity. When a circuit is around pilgrimage tourist centers the circuit is considered as a Pilgrimage tourist circuit. The destination in such a circuit will be of Pilgrimage or religious importance. The circuit is to be taken up and will be identified on the basis of popularity of destination and distance in between them. While selecting the circuit, the potential of the places should be considered. Till date circuit tourism in India is conducted between different cities of different states or different districts (Antony Simon 2021).

Map: 2: Pilgrimage Centers in Ahmednagar District



Map:3 Pilgrim Circuit in N. Ahmednagar District.

North Ahmednagar district is well known for popular religious tourist centers. As circuit tourism is not initiated till date, the tourists visiting the Ahmednagar district normally miss a few destinations, lot of guests coming who are most likely to take a tour to get the feel and culture of the city. So circuit tourism is the best way of getting them as close as to the Indian culture, history and beauty. It's an important factor for the development of multiple tourist destinations simultaneously. Circuit tourism also helps to provide more recognition to the less- visited tourist destinations. With the help of circuits, tourist spots could be easily recognized with fewer investments. Amongst the tourism circuits development in north Ahmednagar district have great potential. It consists of pilgrimage tourist centers like Shirdi, Shani Shinganpur, Newasa, and Deogad.

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Spatial and Temporal change in crop combination in Amravati district of Maharashtra

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Abstract

A study of crop combination constitutes an important aspect of agricultural geography and it also provides a good basis for agricultural regionalization. Crop combination is the analysis of the total percentage of area occupied by the different crops in a given region in that particular agricultural year. The crops are generally grown in combination and it is rarely seen that a particular crop occupies a position of total isolation; other crops in a given area unit at a given point of time. The distribution maps of individual crops are interesting and useful for planners, but it is even more important to view the integrated assemblage of the various crops grown in an area unit. For a comprehensive and clear understanding of the agricultural mosaic of an agro-climatic region and for the planning and development of its agriculture, a systematic study of crop combination is of great significance. In the present paper, author has made attempts to demarcate the crop combination region of the Amravati district of Maharashtra state for the year 2010-11 to 2021-22. Amravati district occupies the western part of the Vidharbha region of Maharashtra. Administratively the district is divided into fourteen tahsils. Agriculture is the main occupation of the district. Physiographical the region is divided into two regions Melghat hill region and the plain region. Fourteen crops have been considered for crop combinations of the region. Among these are Jawar, Wheat, Rice, Bajra, Cotton, Gram, Maize, Soyabeen, etc. are the main crops of the region. By computing the crop combination of the Amravati district it has been found that there are three to four crop combinations for the year 2010-11 and 2021-22. It has also been observed that the change in the cropping pattern of the region.

Keywords: crop combination, agriculture regionalization, total percent of area, area unit, agriculture mosaic.

Introduction

Crops are generally grown in combinations (Weaver, 1954). The study of crop combination of any region has gained importance in geographical study. It gives us the relative position of crops on the regional scale. The concept of crop combination is a scientific device to study the existing relationship of crops in association with each other and land utilization (Comred, 1979). Crops are commonly grown in combination and it is hardly that a specific crop occupies a position of total isolation from other crops in a given area. The pattern of crop combination gives spatial prevalence of certain crops or combination resulting in the emergence of crop regions (Todkari 2012). Crop combination study in geography is fruitful in several ways; firstly, it provides an ample understanding of an individual crop. Secondly, the combination is in itself an integrative reality, and finally crop combination regions are essential for the construction of a more complex structure of vivid agricultural regions. The study of crop combination thus forms an integral part of agricultural geography and such study is significantly helpful for regional agricultural planning. For the point of view of the importance of crop combination outher has find out crop combination of Amravati district.

2 Location of Study Area:-

Locational extends of the study area are between $21^{0}30'$ to $21^{0}50'$ north latitude and $76^{0}35'$ to $78^{0}27'$ east longitude. The total geographical area of the Amravati district is 12212 sq. km. 75% of the area of the district is covered by Deccan Trap while 25% area is covered by Purna alluvium. It is located in the Vidharbha region on the northeastern side of the State of Maharashtra. It is bounded by the Khandwa and Betul districts of Madhya Pradesh State on the north and by the Maharashtra districts of Nagpur on the northeast, Wardha on the east, Yavatmal on the south, Washim on the southwest, and Akola and Buldhana districts on the west. The district is divided into fourtheen tehsils viz., Amravati, Morshi, Warud, Tiwsa, Chandur Railway, Nandgaon kh., Bhatkuli, Daryapur, Anjangaon surji, Dharni, Chikaldhara, Achalpur, and Chandur Bazar. Amravati district has a monsoon climate is characterized by a hot summer and general dryness throughout the year except during the southwest monsoon season. The average annual rainfall in this district ranges from 700 to 900 mm. It receives 85 to 95% of the year from June to September.

A major part of the district comes under Purna-Tapi and Wardha River basins. Agriculture is the main occupation of the population of the study region.

3 Methodology

This research paper is based on secondary data collected from the socio-economic abstract of the Amravati district of the year 2010-11 and 2021-22. All crops of the district are arranged and ranked in the hierarchy order and applied crop combination method of Weaver for finding the crop combination of the district. Maps are created with the help of ArcGIS 10.5 software.

Weaver's Crop Combination Method

Weaver was the first Geographer who used (1954) statistical technique to express the crop combination of the Middle West USA. In this process, Weaver attempted to delineate agricultural regions of the Middle West in the United States and computed the percentage of total harvested cropland occupied by each crop that held as much as one percent of the 184 total cultivated lands in each of the 1081 counties. In this work, Weaver calculated the deviation of the real percentage of crops (occupying one percent of the cropped area) for all the possible combinations in the component areal units

against a theoretical standard. The theoretical curve for the standard measurement was employed as follows.

Monoculture = 100 % of the total harvested cropland in one crop.

Two crop combination = 50 % in each of the two crops.

Three crop combination = 33.3 % in each of the three crops.

Four crop combination = 25 % in each of the four crops.

For the determination of the minimum deviation the standard deviation method was used: Where d is the difference between the actual crop percentages in a given areal unit and the appropriate percentage in the theoretical curve and n is the number of crops in a given combination. As Weaver pointed out, the relative, not absolute value being significant, square roots were not extracted so, the actual formula used as follows. d= Σd2/n

4 Result and Discussion

4.1 crop combination 2010-2011

In one agriculture year, singal crop is not cultivated, there is a combination of crops. The combination of the crops depends on the agroclimatic condition and socio-economic factors and need nutrient enhancement of soil. In the year 2010-11 except Dharni tehsil all other tehsils of the Amravati district have three and four crop combinations. Out of the fourteenth tehsils ,ten tehsils had cotton as the first crop it means that cotton is a dominant crop of the district. There is no substitute cash crop available to cotton and as well as soil and agroclimatic condition are favorable to this crop also. If we observe tehsil wise crop combination of year 2010-11 it shows that Daryapur is a monoculture crop combination and the crop of this tehsil is cotton. Two crop combination tehsils are Chikhaldra, Achalpur, Morshi, Nandgoan Kh., and Chikhaldara. Except Chikhaldara all other tehsils cotton is the dominant crop Tur and Munge and Jawer crops are shown in combination of cotton in this crop combination.Chikhaldara tehsil is a hilly area and land holding is very small as well as traditional farming is practiced so cotton is not shown in this area. In three crop combination tehsils are Anjangoan Surgi, Warud, Tiwsa and Amravati and the combination of the crop in this tehsils are cotton, Jawar and Wheat,cotton jawar and Tur and cotton Jawar and Gram. Four crop combination tahsils are Chandur Bazar, Bhatkuli and Dhamangoan and crops are Cotton,Tur Wheat, and Gram. In Dharni tehsil seven crop combination is found and the reason is that it is forest and Trible area so the crop combination is increased.

Amravati District crop combination 2010-11

Sr. No	District	Monoculture	2-crop combination	3-crop combination	4-crop combination	5-crop combination	6-crop combination	Crop combination
1	Dharni	6435.41	1174.72	944.14	612.20	465.04	470.88	6
2	Chikhaldara	8342.49	2096.07	2492.30				2
3	Anjangoan Surgi	3299.01	437.95	434.71	854.17			3
4	Achalpur	3291.32	85.82	93.33				2
5	Chandur Bazar	5636.22	1980.06	953.57	504.51	521.32		4
6	Morshi	1961.16	769.35	1172.05				2
7	Warud	3458.35	901.90	864.72	973.46			3
8	Tiwsa	4320.69	1484.89	774.43	807.83			3
9	Amravati	4486.23	1438.21	794.46	904.33			3
10	Bhatkuli	6778.62	2178.38	1160.28	846.66	1627.52		4
11	Daryapur	2860.06	593.72	582.68	580.84	562.69		5
12	Nandgoan khand.	1895.60	805.92	1650.41				2
13	Chandur Riy	289.37	4688.34					1
14	Dhamangoan	7051.59	2579.34	1535.75	1027.09	1462.10		4
	Total	3829.20	1183.61	760.65	254.50	740.92		4

4.2 crop combination 2021-2022

In the year 2021-22 out of fourteen tehsils, eight tehsils are two crop combinations. In this crop combination Bhatkuli, Nandgoan khandeswar, Chandur Railway and Dhamangon first crop is Soyabeen and the second crop is Gram and in Morshi Warud and Daryapur cotton first crop and Gram is the second crop. In Dharni two crop combination are Gram and Corn. In three crop combination tehsils are Anjangoan surgi and Chandur Bazar and crops combination is Cotton, Soyabeen and Gram. In four crop combination is found in Achalpur tehsil and crops combination is Cotton, Soyabeen, Gram and Tur. Chikhaldra is hilly area and land holding is small and subsistence farming is practice n this area so that in this tehsil nine crop combination is found. All for whole district three crop combination and crops are Cotton Soyabeen and Gram.

4.2 crop combination 2021-2022

In the year 2021-22 out of fourteen tehsils, eight tehsils are two crop combinations. In this crop combination Bhatkuli, Nandgoan khandeswar, Chandur Railway and Dhamangon first crop is Soyabeen and the second crop is Gram and in Morshi Warud and Daryapur cotton first crop and Gram is the second crop. In Dharni two crop combination are Gram and Corn. In three crop combination tehsils are Anjangoan surgi and Chandur Bazar and crops combination is Cotton, Soyabeen and Gram. In four crop combination is found in Achalpur tehsil and crops combination is Cotton, Soyabeen, Gram and Tur. Chikhaldra is hilly area and land holding is small and subsistence farming is practice n this area so that in this tehsil nine crop combination is found. All for whole district three crop combination and crops are Cotton Soyabeen and Gram.

Amravati District crop 2021-22

Sr. No	District	1-crop Combination	2-crop combination	3 crop combination	4 crop combination	5 crop combination	6 crop combination	7 crop combination	8 Crop combenation	9 Crop combenation	Crop combenation
1	Dharni	2219.40	292.07	358.72							2
2	Chikhaldara	4624.10	1287.01	495.55	480.51	413.99	337.57	305.63	299.93	299.06	9
3	Anjangoan Surgi	4018.47	418.79	28.11	381.58						3
4	Achalpur	4865.98	1324.04	405.76	267.37	282.28					4
5	Chandu r Bazar	3781.45	605.01	162.95	208.57						3
6	Morshi	1306.29	373.41	405.25							2
7	Warud	2228.29	368.96	696.33							2
8	Tiwsa	3659.68	306.92	31.56	652.04						3
9	Amravati	2468.92	387.80	528.66	652.04						3
10	Bhatkuli	602.72	664.72	1183.40							2
11	Daryapur	1229.61	176.77	1098.56							2
12	Nandgoan	1225.20	741.25	1186.26							2

	khand.										
13	Chand ur Riy	2223 .75	193.0 2	401.51							2
14	Dhama ngoan	1791 .45	150.6 2	345.49							2
	Total	4196 .68	437.2 2	34.20	387.44						3

As compared the crop combination of year 2010-11 with the year 2021-22. In year 2021-22 Soyabeen get a dominant place in all crop combination as per the year 2010-11.Due to labour problem farmars choose the combination of Soyabeen and Gram in place of cotton.

Conclusion

After the analysis of crop combination of year 2010-11 and 2021-22 following conclusion are farmulated

1)Dharni and Chikhaldara is hilly and forest area of the region so agriculture in this area is subsistence type of farming so the crop combination in these thasils are increased.

2) In the year 2010-11 Cottan is main cash crop of the region but in year 2021-22 Soyabeen emerged as a substitute crop for Cotton.

3) Chandur Bazar, Amravati, Bhtkuli, Daryapur thasils come under the Purna river basin, and Warud, Morshi, and Tiwsa tahsils under Wardha river basin and soil of this two basin is suitable for Soyabeen and Gram and Cotton crops But the farmers select two or three crops combination as par there Land holding, nurtures requirement of the soil, highest returns in farming.

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Spatial analysis of rainfall data using geospatial technology in Satara District, Maharashtra.

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Abstract
Understanding rainfall patterns is crucial for comprehending hydrological systems. Using spatial interpolation techniques, hydrological modeling is performed to study the hydrological process, which is essential to the management of water resources. The present study deals with the rainfall characteristics of Satara district, Maharashtra. Annual rainfall data collected and analyzed for the last 21 years from 2001-2021. The annual rainfall data was obtained from the Maharain website, department of Agriculture, Government of Maharashtra (GoM). Rainfall data analysis is done using geospatial technology like a geographical information system (GIS). A GIS is used to visualize the spatial pattern of rainfall across an entire district. The spatial distribution of rainfall was studied with the help of the interpolation technique i.e. Inverse Distance Weighting (IDW) and respective maps were prepared in ArcGIS 10.2 software. The annual rainfall was divided into seven categories from very low rainfall (below 500 MM) to very high rainfall (3000 MM and above) for the preparation of maps. Physiography plays important role in rainfall distribution overall district. The rainfall map shows very high rainfall in the Western part of the district mainly the western ghat region (Mahabaleshwar, Wai, Jaoli, Satara, and Patan taluka), and comparatively very low rainfall in the eastern part of the district (Man, Khatav, and Phaltan Taluka) which is drought-prone region in Satara District.

Keywords: Precipitation, Rainfall analysis, GIS, Interpolation.

Introduction

Both spatial and temporal patterns of water availability are affected by rainfall. Climate change is leading to changes in rainfall patterns worldwide, so hydrological processes have become increasingly important in water resource management. Understanding the distribution of rainfall is essential to understanding hydrological processes. Rainfall interpolation is a key parameter of hydrological modeling.

In addition to its amount, frequency, and intensity, rainfall has many different characteristics that vary from place to place, from day to day, month to month, and also from year to year. The climate of the Satara districts is characterized by hot and dry summer and generally dry and cold during the winter. In general, rainfall decreases from the west toward the east during the southwest monsoon in the study area. The rainfall map shows very high rainfall in the Western part of the district mainly the western ghat region (Mahabaleshwar, Wai, Jaoli, Satara, and Patan taluka), and comparatively very low rainfall in the eastern part of the district (Man, Khatav, and Phaltan Taluka) which is a drought-prone region in Satara District.

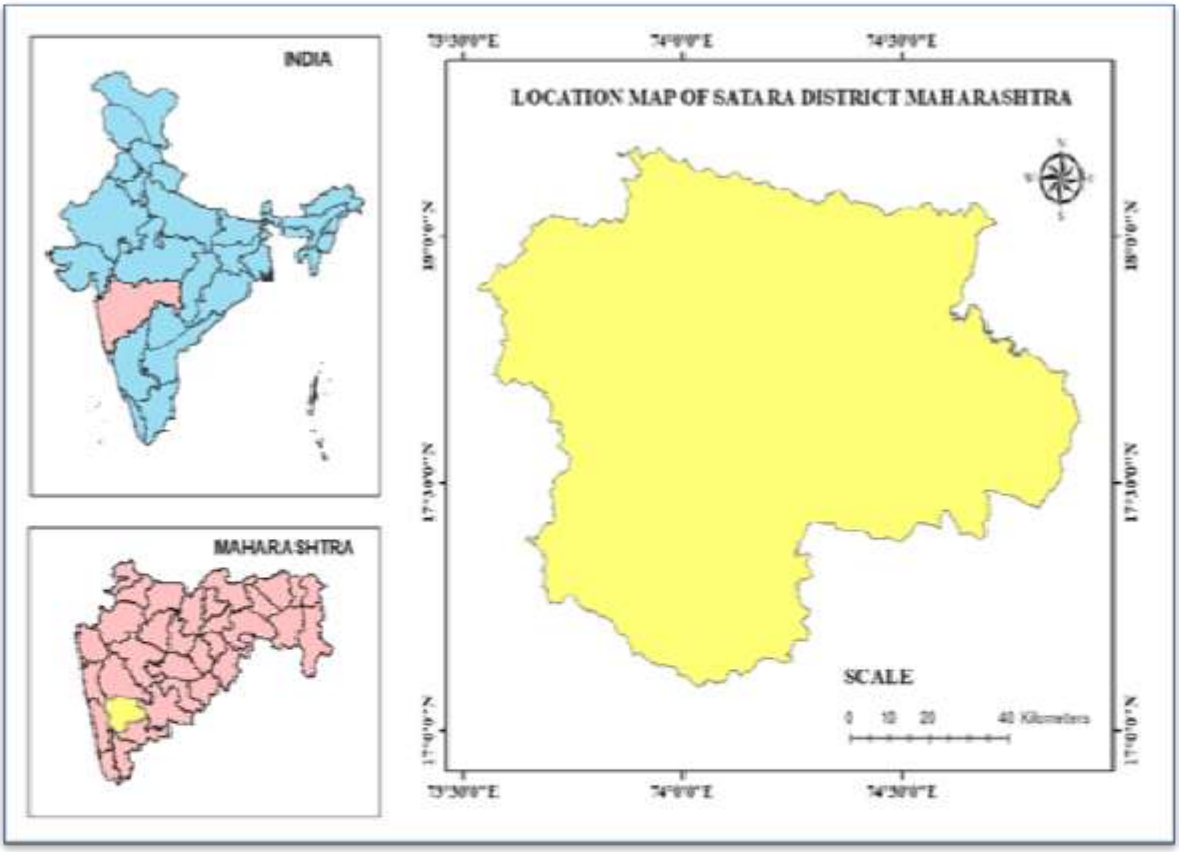
The GIS is an effective tool for mapping spatial distribution and its trend. The GIS has been used worldwide by a number of researchers for spatial mapping. Vennila (2007) studied the rainfall variation in the Vattamalaikarai sub-basin Tamilnadu. Rathod and Aruchamy (2010) have done a study on spatial analysis of rainfall variation in the Coimbatore District of Tamilnadu using the GIS tool. Similarly, the present study is made to understand the spatial variation of different data series such as annual rainfall for the Satara District. Balasubramanian et.al. (2020) studied long-term spatial and temporal rainfall trend analysis using GIS and statistical methods in the Lower Bhavani basin, Tamil Nadu, India using IDW method. Durgasrilakshmi et.al. (2022) also used IDW method for spatial analysis of rainfall for Hydrabad municipal corporation area. Srividhya (2017) have done deals the rainfall characteristics of the Ambuliyar watershed, which includes the spatial distribution and its variability through different seasons.

Studyarea

Satara is one of the districts of Maharashtra state of India is situated in the Western portion of Maharashtra (Figure 1) and the geographical extent of Satara is 10480 sq.km. (Latitudinal extension 17^0N to 18^015'N and longitudinal extension 73^030'E to 75^0E). It had eleven Talukas and four revenue divisions for administrative purposes (1721 revenue villages). The region experiences a good climate overall. The summer season follows the winter season, which runs from December until roughly the middle of February. The southwest monsoon season lasts from June to September, while the post-monsoon season lasts from October to November. In the district, the mean lowest temperature is 14.40 C and the mean maximum temperature is 36.80 C.

The examination of rainfall reveals that the district's average annual rainfall ranges from 473 to roughly 6209 mm. Rainfall is lowest in the district's eastern portion, increases toward the west, and peaks around Mahabaleshwar and the western ghat region of the Sahyadri range. The study also shows that the eastern portion of the district, which includes nearly the entire Khandala, Phaltan, Khatav, and Man talukas as well as a portion of the Koregaon and Karad talukas, can be classified as a "drought prone area" because it experienced drought for more than 20% of the years.

Figure 1 Location map of Satara District (Maharashtra).



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Materials And Method

Data: For the period 2001 to 2021, annual rainfall data for eleven rain-gauge stations from the Agriculture Department of Maharashtra website www.mahaagri.gov.in (Agriculture Department, Government of Maharashtra) are collected and processed using Excel sheets in accordance with the pre-requisites for the acquisition of an interpretative area map. A version of Arc GIS 10.2 was used for creating, managing, and generating maps.

Methodology:

For the preparation of rainfall maps, the annual rainfall data is collected (from 2001 to 2021). The rainfall data is collected from the eleven rain gauge stations (Table 1). There are many point-interpolation methods as well as non-interpolation methods for displaying point values. The IDW interpolation method is used for mapping in this research paper. There are various steps taking place in this process. Annual average rainfall maps for the period of 21 years are generated. The base map was prepared from the Survey of India Topographic sheets a 1:50,000 scale (Topographic sheets numbers 47F/12, 47F/16, 47G/9, 47G/10, 47G/11, 47G/13, 47G/14, 47G/15, 47G/16, 47J/4, 47J/8, 47J/12, 47K/1, 47K/2, 47K/3, 47K/4, 47K/5, 47K/6, 47K/7, 47K/8, 47K/9, 47K/10, 47K/11,47K/13, 47K/14 and, 47K/15).

Figure 2 Rain gauge stations in Satara District (Maharashtra).

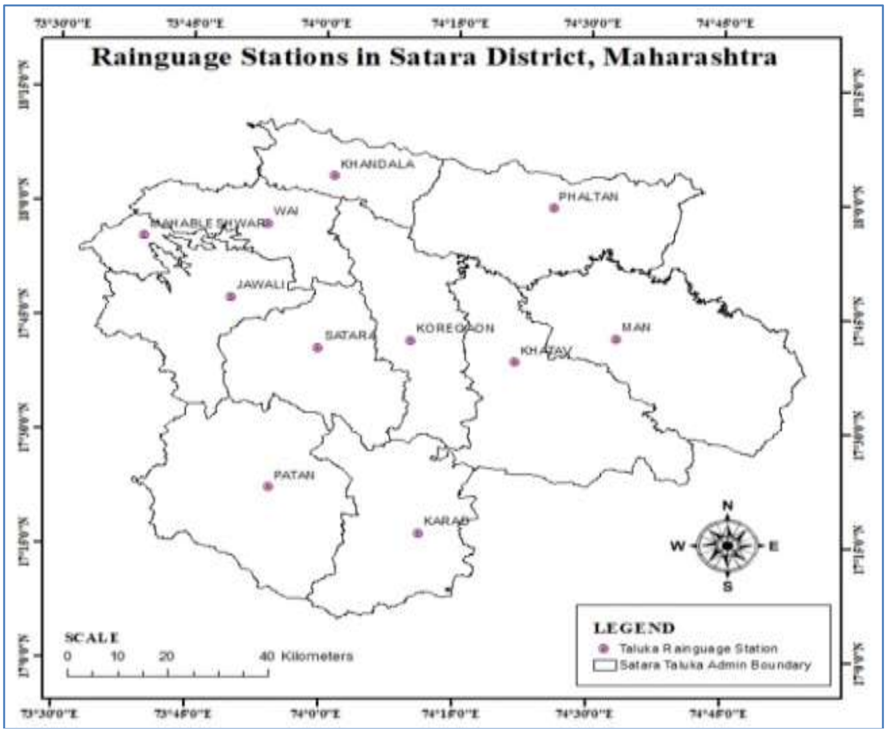


Table 1 Rain Gauge Stations in Study Area.

Sr.No.	Taluka	Latitude	Longitude
1	Khandala	18.05772	74.0181
2	Phaltan	17.99069	74.43118
3	Wai	17.95154	73.89354
4	Mahableshwar	17.92269	73.66096
5	Jawali	17.79029	73.82672
6	Man	17.70545	74.5511
7	Koregaon	17.6989	74.16489
8	Satara	17.68116	73.99166
9	Khatav	17.65331	74.36184
10	Patan	17.37455	73.90116
11	Karad	17.27643	74.18397

Results And Discussion

Physiography plays important role in rainfall distribution overall district. The spatial distribution of rainfall was studied with the help of the interpolation technique i.e. Inverse Distance Weighting (IDW) and respective maps were prepared in ArcGIS 10.2 software. The annual rainfall was divided into seven categories from very low rainfall (below 500 MM) to very high rainfall (3000 MM and above) for the preparation of maps. The rainfall map shows spatial distribution of rainfall overall district. It shows very high rainfall in the Western part of the district mainly the western ghat region (Mahabaleshwar, Wai, Jaoli, Satara, and Patan taluka), and comparatively very low rainfall in the eastern part of the district (Man, Khatav, and Phaltan Taluka) which is drought-prone region in Satara District. The spatial analysis of rainfall mapping based on annual data carried out from eleven rain gauge stations in Satara district. Spatial analysis of rainfall from year 2001 to 2021 shown in figure 3. Table 2 shows highlighted cells indicated below normal rainfall.

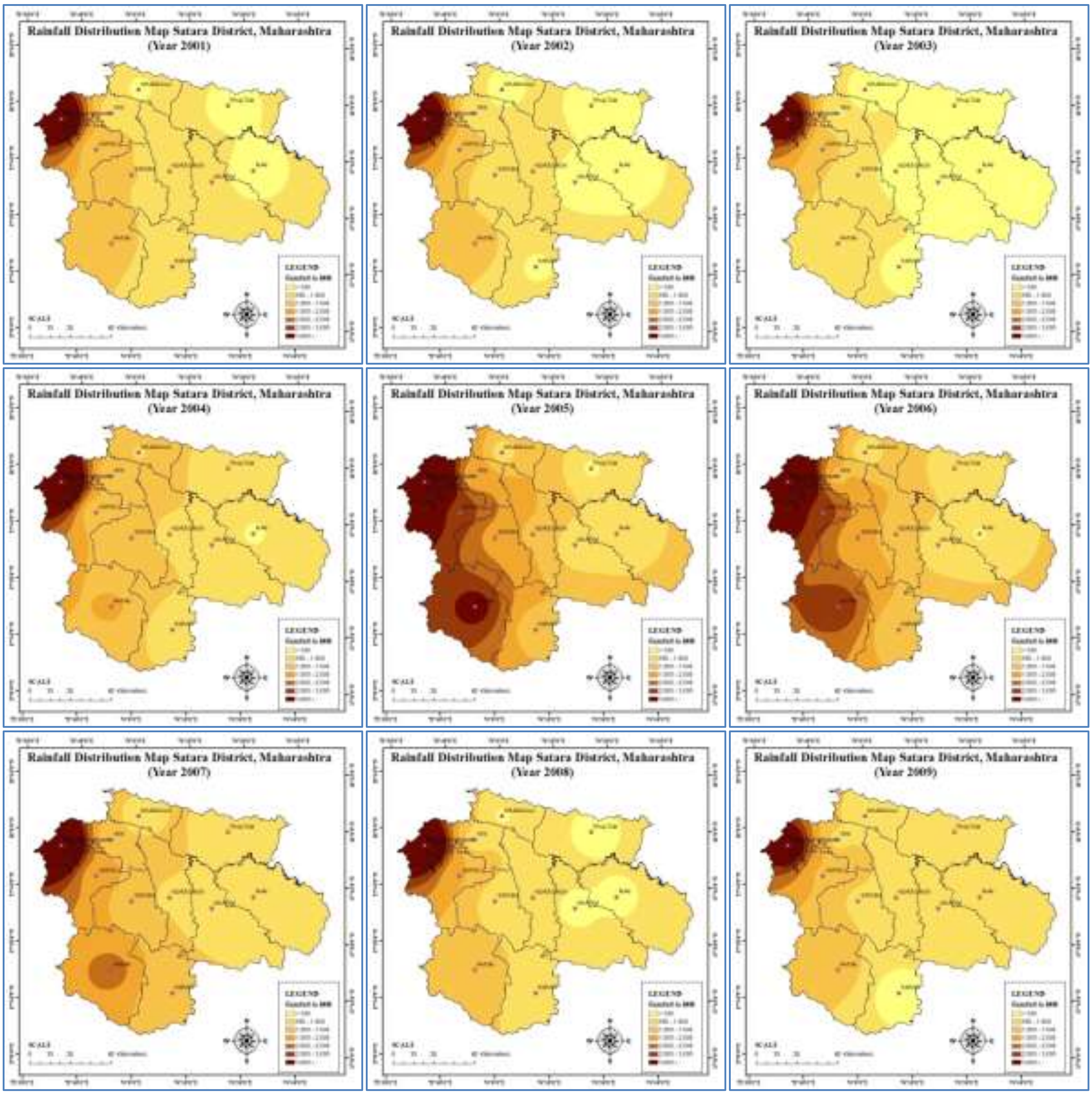
According to last 21-years of rainfall analysis, maximum rainfall is shown in the year 2005, 2006, and, 2019 in Satara district. The lowest rainfall is frequently recorded in Man, Khatav, and, Phaltan Taluka While highest rainfall recorded on the western ghat region of Satara district, such as Mahabaleshwar, Wai, Patan, and Jawali taluka (received more than 1500 mmrainfall). On the east side of the district, such as Man, Khatav, Phaltan,and Khandala, received the least rainfall (less than 1000 mm) see figure 3.

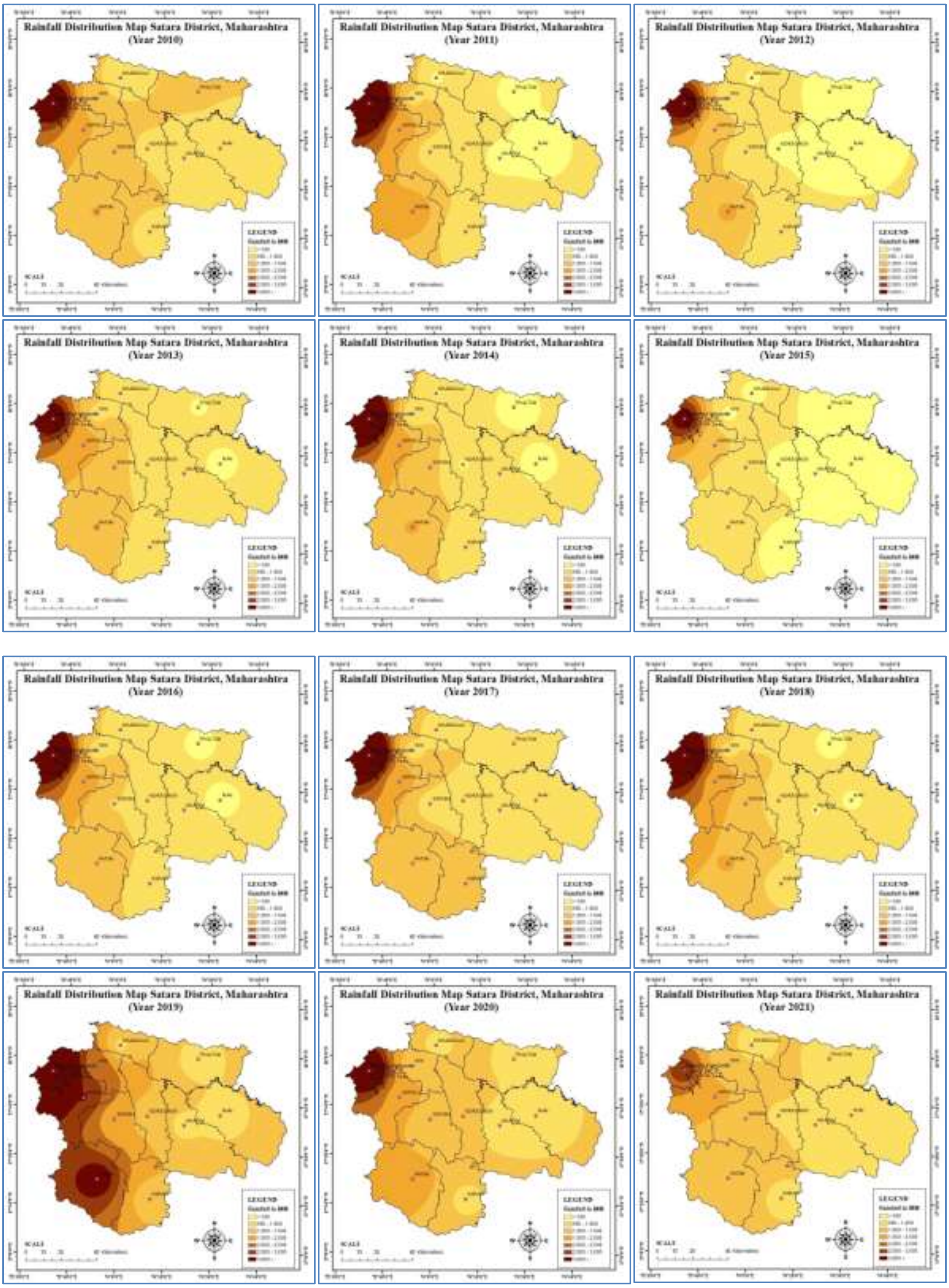
Table 2 Annual Rainfall in mm for the study area

SR NO.	1	2	3	4	5	6	7	8	9	10	11
Tahsils	Satara	Jawali	Koregaon	Karad	Patan	Phaltan	Man	Khatav	Wai	Mahableshwar	Khandala
AVERAGE RAINFALL (mm)	1026.00	1690.17	707.28	722.66	1711.31	506.45	471.93	563.87	933.52	5517.51	568.64
2001	1010.8	1126.3	559.8	523.2	1203.4	332.4	337	501.8	703.5	5159.6	380
2002	621.5	1325.4	507.4	441	1223.6	317.3	336	342.6	515	5005.4	224.8
2003	553.4	1147	318.6	404.8	972.9	89.7	98.6	181.4	468.4	4395.6	217.1
2004	1032.4	1058.6	879.8	704.3	1554.6	631.4	436.5	824.7	1042.5	6374.6	971.8
2005	1821.5	2720.1	1395.6	1184.5	3289.7	449.5	542.8	605.8	1537.1	8639.5	778.4
2006	1530.4	2676.2	1258	997.3	2902.6	588.6	472.6	632.1	1334.7	8403.1	664.1
2007	1196.7	1675.9	855.8	1007.4	2208.2	695	549.2	549.1	987.1	6245.1	648.5
2008	722.5	1502	537.4	807.9	1251	339	433.1	374.2	797	5660.4	439.8
2009	909.1	1448.1	761.1	131	1179.1	835	787	779.7	905.2	4203	562.8
2010	1011.2	1530.1	904.2	872.8	1511.2	1028.4	761.5	814.6	1029	4244	562.3
2011	777.6	1737.2	497.4	593.6	1804	342.2	225.8	373.1	873.2	6456.8	433.8
2012	686	1258.8	360.6	550.6	1574.4	267.1	269	273.4	650.1	3908.7	451
2013	1182.8	1787	596	569.	1510.3	469	407.	574.	881.	3812	633.2

				5			2	9	4		
2014	1034.2	1638.2	470.1	663.1	1525.5	300.7	383.2	552.2	674	5650.9	485.7
2015	582.1	1175.4	360.7	317.4	826.1	317.9	302.6	376	402.7	3449.7	418
2016	981.4	1661.7	564.9	688.5	1493	395.6	396.4	499.1	812.4	5583.7	540.1
2017	779.2	1673.7	578.6	1009.4	1430	789.6	681.2	883.7	798	5732.2	734.4
2018	1382.5	1815.5	539.8	889	1517.5	380.5	462.6	482.2	835.5	6226.9	500.8
2019	1642.6	3012	1127.6	1182	3433.2	711.9	730	851.1	2203.9	6787.5	904.3
2020	1062.1	1834.2	1072.1	915.9	1815.8	848.2	826.3	805.7	1219.6	4411.4	821.8
2021	1064.28	1720.75	945.83	928.42	1411.45	913	851	819.65	1065	2812	814

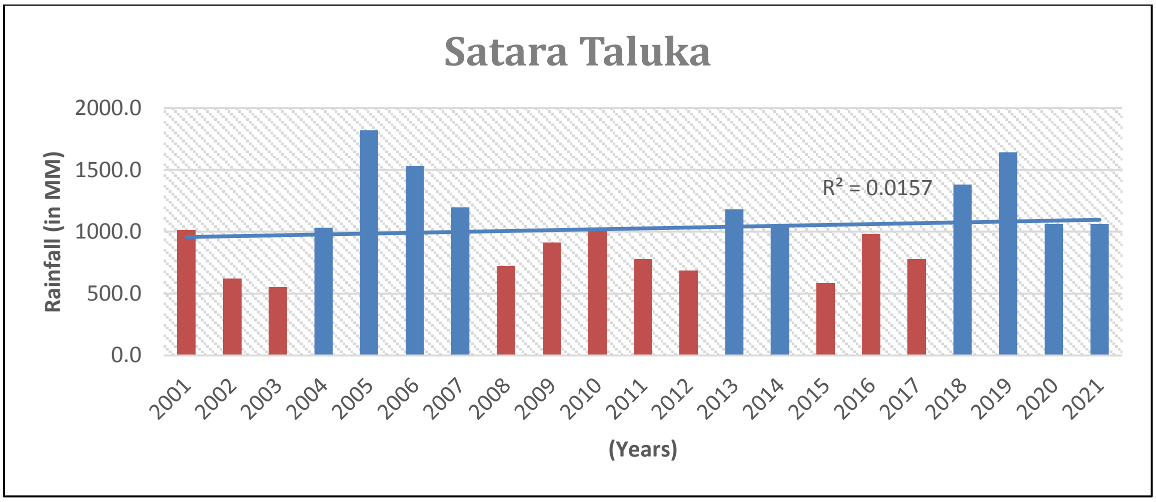
Figure 3 Spatial distribution of rainfall in Satara District (Maharashtra) from 2001 to 2021.

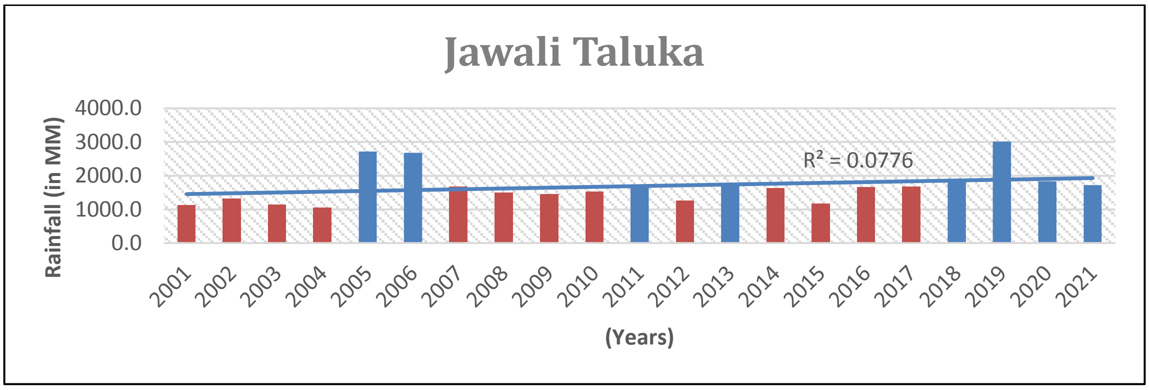


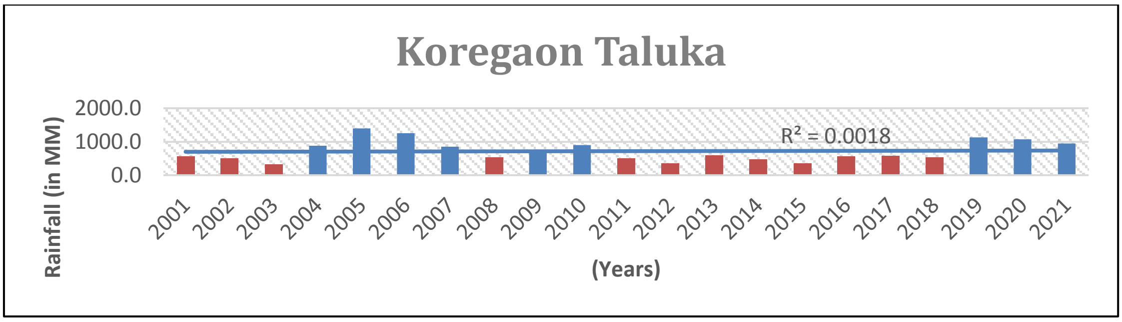


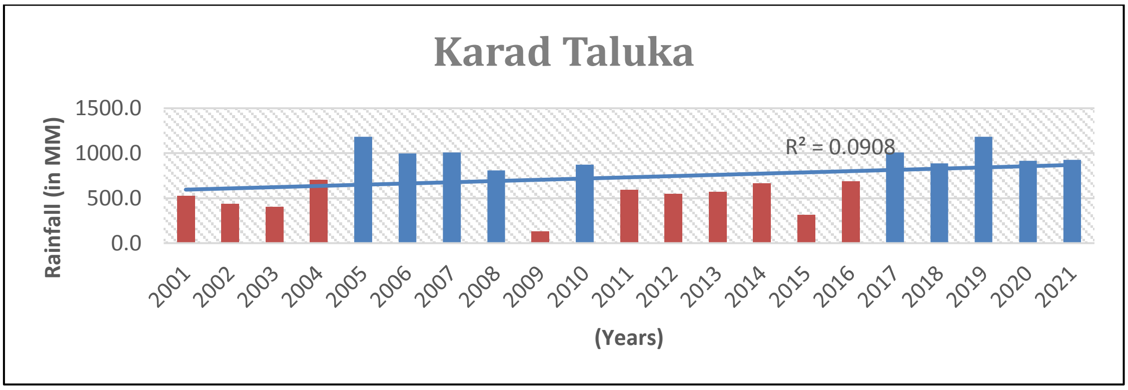
Linear regression analysis has been done in Excel which uses the method of least squares to find a line of best fits the points. The trend line of yearly average from 2001-2021 for the eleven stations have been produced. Out of eleven stations negative / decline trend has been shown in the Mahabaleshwar Taluka and rest shows positive trends (shown in Figure 4).

Figure 3 Trend analyses in Satara District (Maharashtra) from 2001 to 2021.









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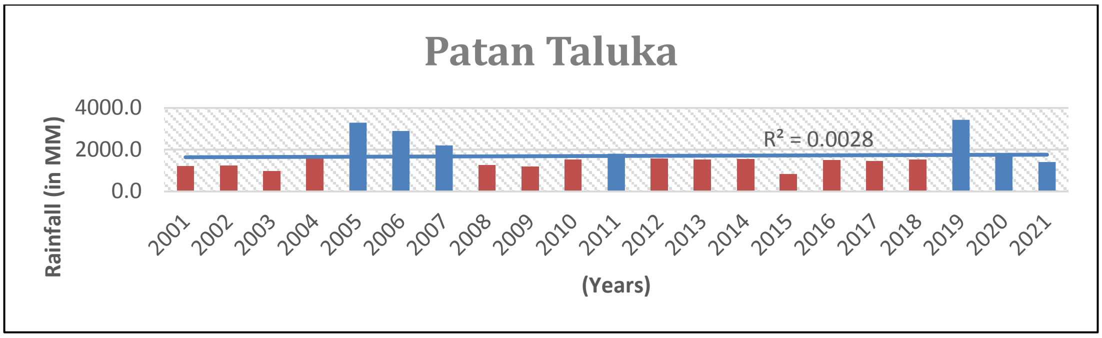
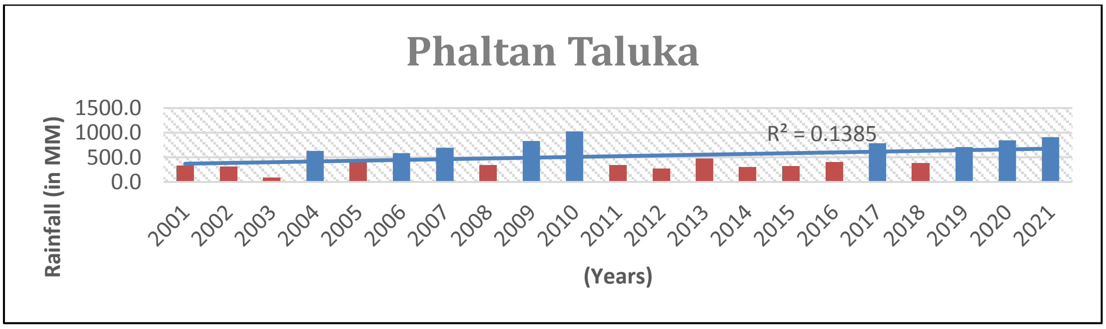
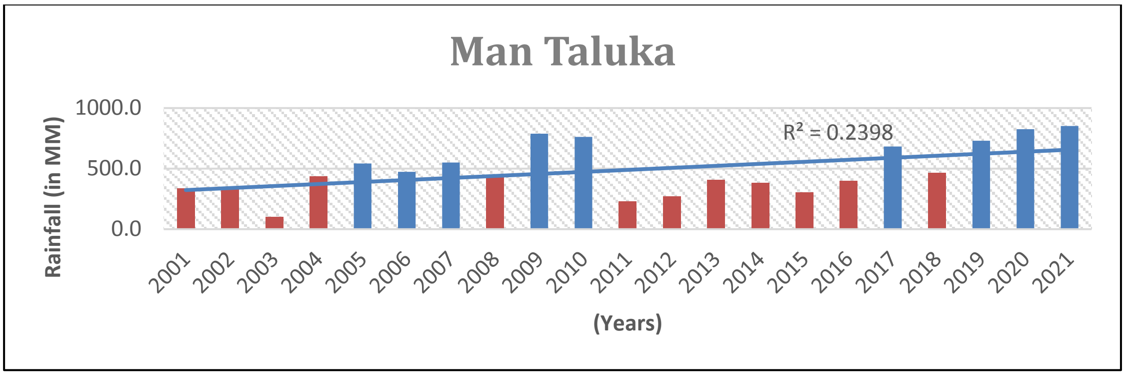
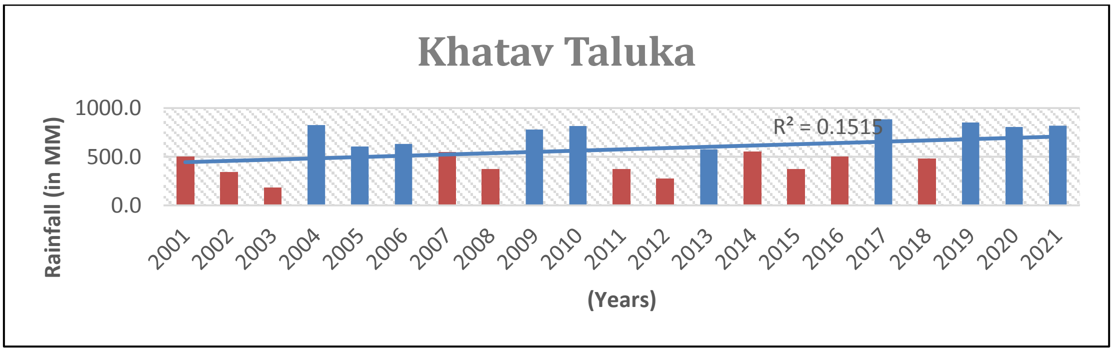
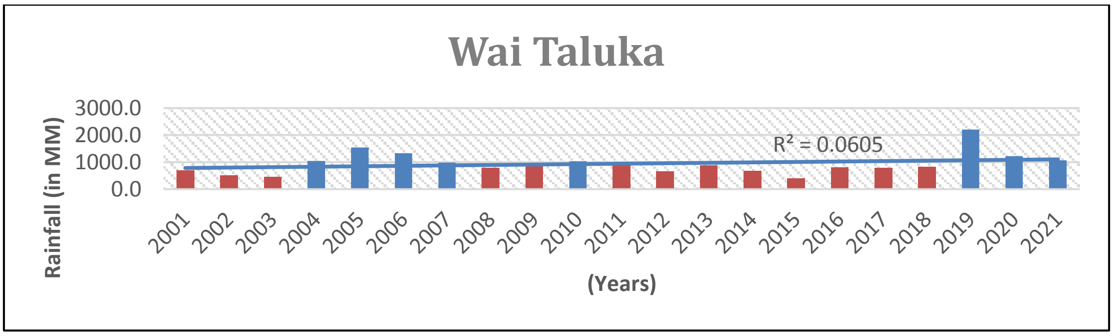
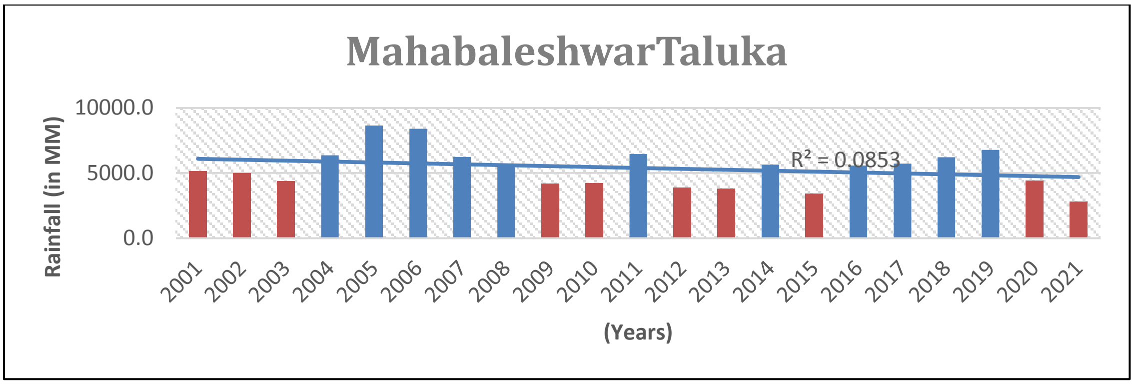

Patan Taluka
Rainfall (in MM)
4000.0
2000.0
0.0
R² = 0.0028
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
(Years)

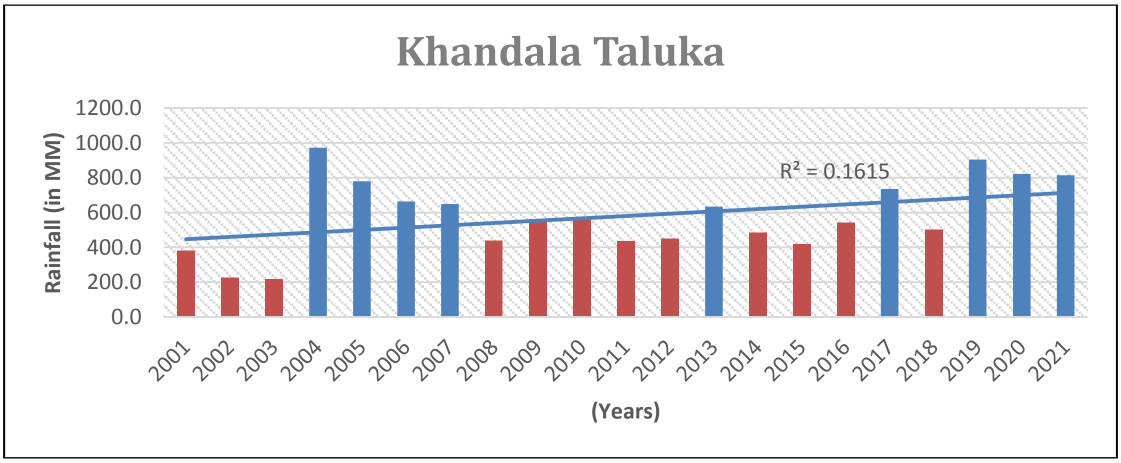

Phaltan Taluka
Rainfall (in MM)
1500.0
1000.0
500.0
0.0
R² = 0.1385
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
(Years)


Man Taluka
Rainfall (in MM)
1000.0
500.0
0.0
R² = 0.2398
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
(Years)


Khatav Taluka
Rainfall (in MM)
1000.0
500.0
0.0
R² = 0.1515
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
(Years)


Wai Taluka
Rainfall (in MM)
3000.0
2000.0
1000.0
0.0
R² = 0.0605
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
(Years)





Conclusion

In ArcGIS 10.2 software interpolation tool (IDW) useful in mapping the spatial distribution of rainfall data. Rainfall map preparation helps to identify the spatial variation of rainfall across different parts of the Satara district and to identify areas with high and low rainfall. GIS helps in modeling these spatial variations into an effortlessly interpretable frame which can be put into utilization for other related purposes. The aim of present study was analysis of annual rainfall for the study area using GIS. The trend line showed both positive and negative trend. The negative trend was found in Mahabaleshwar which shows minor decrease in rainfall through years 2001 to 2021.The annual rainfall was calculated for 21 years and the year 2005, 2006, and, 2019 received maximum rainfall.

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Land use land cover Change analysis using geospatial technique a study of Jalgaon city and part of city surrounding Area

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Abstract:-

The land use is a use of land by human the classification. It is very useful for the regional planning. The present study illustrates the spatio-temporal change of land use. The images of the study area were categorized into five different classes namely agriculture, vegetation built-up and water body. The results indicate that during the last five years built-up land have been increasing in trend while agriculture have decreasing in trend The paper highlights the importance of digital change detection techniques for natural and man-med locational changes of the Jalgaon city and part of surrounding area.

Introduction:-

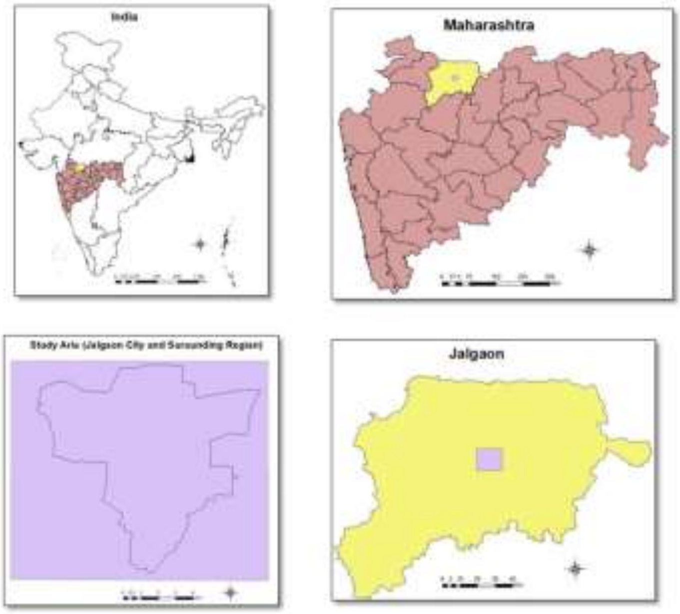
Digital change detection techniques by using multi-temporal satellite imagery helps in understanding land-use change. The present study illustrates the spatio-temporal change of land use and land cover of jalgaon city and city surrounding area. The land use defines as the utilization of accessible surface of the earth for a particular point in time and space. The Natural and man med factors like topography region ,soil type, climate ,drainage system , industrialization, transport connectivity medical facility these are affect on land use change of region in particular time and space and rainfall, temperature these are affect in land cover change of region in particular time and space. For the detection of change analysis there are need temporal remote sense images in this study use of five year distance for the detection of land use change of 2008 and 2018. Due to inappropriate planning and management, accelerated urban growth and tremendous loss in land, especially agriculture land, have become a great challenge for sustainable urban development in India, especially in developed urban area in the riverine as well as transport junction regions; therefore, there is an urgent need to effectively detect and monitor the land use changes and provide accurate and timely information for planning and management.

Classification of land use is a complicated task. Because many researchers or country are use many criteria and classes. There are main two type of classification Unsupervised Classification and supervised Classification in present study there are use Supervised classification in supervised classification, the identity and location of some of the land use / land cover types such as urban, cropland, forest, road network, water body etc. are known priori through a combination of field visits and study of existing maps. The analyst attempts to locate specific sites in the remotely sensed data that represents homogeneous land cover types. These areas are commonly referred as 'training sites' because the spectral characteristics of these areas are used to 'train' the classification algorithms for eventual land use / land cover mapping of the whole image. Multivariate statistical parameters (mean, standard deviation, covariance matrix, correlation matrix etc.) are calculated for each training site. Every pixel of both within and outside this training site is then evaluated and assigned to a class of which it has the highest likelihood of being a member

Study area: -

The study area is a Jalgaon city and part of surrounding village of Savkhede, kusumbe, Manyarkhede, Talarkhede, Bhambori, Asoda,. Tehsils of Jalgaon district

Jalgaon in Maharashtra state and is located between 20^0 93'to $21^0$04' North Latitude and $75^0$49' to $75^0$63' East Longitude The Study areas situated in Girna river basins and also located with transport junction on Mumbai-Delhi—Surat rail route and Surat Kolkata National highway no 6.



Map no.1 Location map

Objective: To identification of land use and land cover class and classification.

To estimation of area from classify image of same.

Methodology: -

The secondary data was collected with the help of the remote sensing resourcesat satellite LISS -III image of October 2008 and November 2018. To define the land use in the study area digital supervised categorization has been in the LISS-III images .the image was classified with the help of ERDAS Imagine and Arc GIS software of supervised classification techniques. The study area is extract using google earth using random selection.

Result and Discussion:-

According to the satellite image of October 2008 land-use land-cober of classified image in to three classes table no 1 they are Agriculture land (23.11%), Water body (5.32%), Built-Up area is (45.26%) and Vegetation cover (26.31%) and According to the satellite image of November 2018 land use of classified image in to three classes table no 2 they are Agriculture land (23.59%), Water body (5.32%), Built-Up area is (45.26%) and Vegetation cover (26.31%)

November 2018		
Class Name	Area(in sq. km)	Area in%
Agriculture	35.14	23.59
Water body	6.52	4.37
Built-Up	67.98	45.63
Vegetation	39.34	26.41
	148.98	100.00

October 2008		
Class Name	Area(in sq. km)	Area in%
Agriculture	34.70	23.11
Water body	7.99	5.32
Built-Up	67.96	45.26
Vegetation	39.50	26.31
	150.15	100.00

Table no1 Land use of October 2008

Change detection:-

The table no3 shows change detection of land-use land cover using image analysis with supervised classification land area have minor changes in urban area main focus land use changes in Built-up area it incises from October 2008- 45.26 % to November 2018- 45.63% in this decade within decade Agricultural area is increase from October 2008- 23.11 % to November 2018- 23.59%

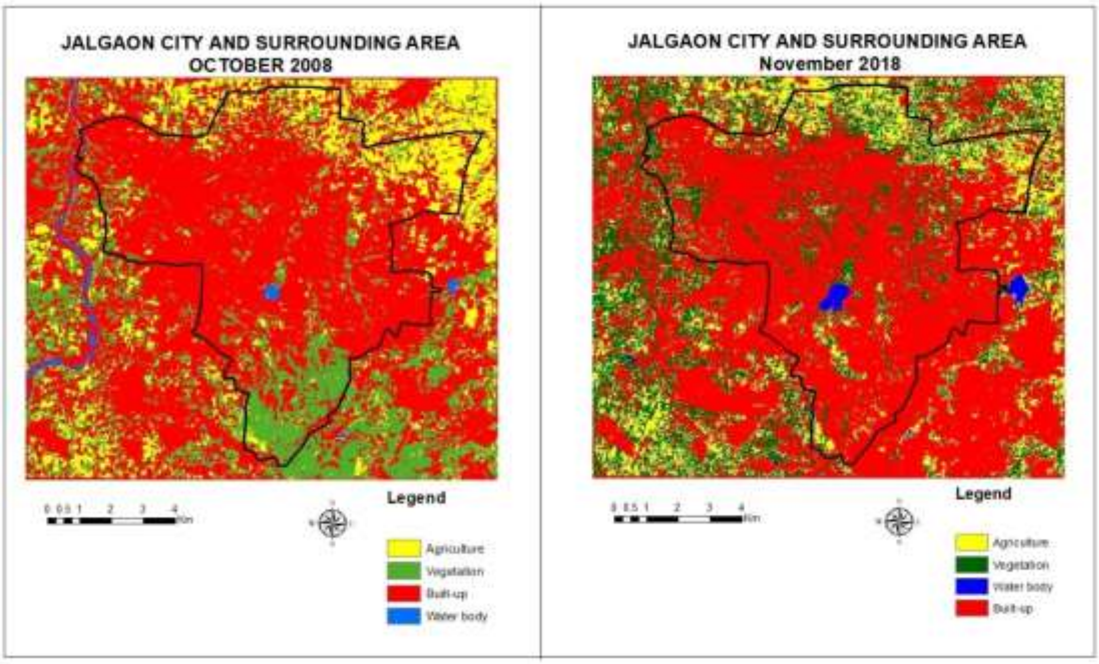
there is very high change with water body from October 2008- 5.32 % to November 2018- 4.37% and very moderate changes in Vegetation cover with October 2008- 26.31 % to November 2018- 26.41%.

No	Class	Area in %(October 2008)	Area in %(November 2018)
1	Agriculture	23.11	23.59
2	Water	5.32	4.37
3	Built-Up	45.26	45.63
4	Vegetation	26.31	26.41
	Total	100.00	100.00

Table no3 Land use of October 2008 and November 2018

Agriculture:-

The study area is located along the Girna river and transport junction on Mumbai-Delhi—Surat rail route and Surat Kolkata National highway in this area is very fertile soil hear most of the population is engage in agriculture of outer regain of city area some people engage in agro-base industries table no 3 and map no2 sows us agriculture area is slightly increase of 0.48% from 2008 to 2018 because the area belong to monsoon climatic region so the changes is only because of atmospheric changes in city surrounding area industrialization transport development and urbanization of city most of the area of agriculture is comes under the built-up so it's very impact on agriculture production



(Map no.2 land-use land-cover map of Jalgaon city and surrounding area October 2018 and November 2018)

Water:- In study area very less area is under the water body is October 2008- 5.32 % to November 2018- 4.37% here water body decries with 0.91% is only because of it is an atmospheric vernation less water in the Girna river.

Built-Up Area: - In the present study widely change in the urban area it increases towards the east west and south and of the city this is an very rapid growth of the city due to the increases of industries establish of educational institute in the west of city and medical facility and some social change of life-style people built a one bungalow for living in the study region built-up area increases with 0.37% within decade Jalgaon city it is an very highly grooving city of Maharashtra state and its nodal city of north Maharashtra **.**

Vegetation: - Vegetation Class is used as measures of biomass, amount of vegetative cover, and vegetation condition. The interaction of incident sunlight with green vegetation is strongly controlled by leaf pigments and leaf structure. The study area is located in monsoon low rainfall region after classify the both image October 2008 and November 2018 it observe that there is miner change in vegetation cover it increase with 0.10%.

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Synthesis and evaluation of antiproliferative activities of indole aza carbolines

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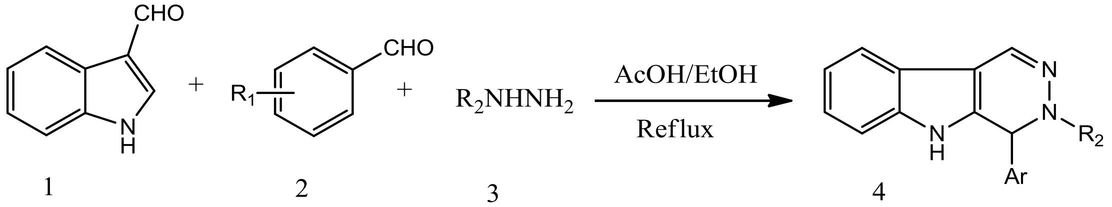
Introduction

Heterocycles form a largest class of organic molecules which are of immense importance biologically and industrially. Chemical and biological research poses a great challenge to synthesize and optimize highly efficient and economical synthetic routes to novel biologically active substances. Heterocycles dominated medicinal chemistry among which structurally decorated indole derivatives have been a topic of substantial research interest and continued to be one of the most active areas of heterocyclic chemistry, particularly due to their natural occurrence and pharmacological activities. A large number of indole derivatives are biologically active, lead compounds for drug development. Indole derivatives especially carbazoles,[1] α-and β-carbolines,[2,3] azaindoles[4] are of particular interest due to wide range of pharmacological activities such as anthelmintic[3], antiprotozoal,[4] antitumor,[5] cytotoxicity to tumor cell lines,[6] antihypertensive,[7] antimicrobial[8] serotonine antagonistic, antitumor agents,[9] antihistaminic, anxiolytic, and HIV-1 reverse transcriptase inhibitory activity.[10]
Considering the importance of indole alkaloids associated with various pharmacological activities, the objective planned was to develop new synthetic methods for indole containing scaffolds like azacarbolines. Literature survey revealed that these systems are less explored than β-carbolines and γ-carbolines with respect to biological activities as well as synthetic studies. All of these synthetic methods make the use of indole-2,3-dicarbonyls with alkyl hydrazines.

Methodology: Present work

1-Substituted-3-aza-β-carbolines **4** could be synthesized employing a multicomponent approach under mild reaction conditions (Scheme 1). Thus 3-formylindole 1, aromatic aldehyde 2 and alkyl hydrazine 3 were heated in aq. ethanol in presence of catalytic acetic acid for 4h to afford desired aza carbolines 4 in good to excellent yield without the use of N-protected indole-3 carbaldehyde.



Scheme 1: Multicomponent approach for aza β-carbolines of indole.

Results and discussion: i) Synthesis of aza carbolines

As shown in scheme 1 these three components were heated to reflux in ethanol in presence of catalytic acetic acid for 4 h (TLC check). The reaction was initiated in first 5 minutes with color change to pale reddish. After 4h, ethanol was stripped out under reduced pressure. The crude product was isolated by means of extraction with ether. Organic phase was washed 2/3 times with water, dried over anhydrous Na_2SO_4 and evaporated. After a short silica column chromatography, desired aza carboline was obtained in excellent yield and pure enough for spectral analysis. The versatility of the synthetic route was tested by varying aromatic aldehydes and phenyl or alkyl hydrazines (**Table 1**). All purified aza carbolines 4a-4k were analyzed by NMR and HRMS spectroscopy.

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Compound	R_1	R_2	%Yield	Compound	R_1	R_2	%Yield
4a	3-Me	Me	80	**4g**	H	H	91
4b	4-Me	Ph	82	**4h**	H	Ph	90
4c	4-OMe	Ph	91	**4i**	4-NO_2	H	95
4d	2-OMe	Ph	88	**4j**	H	H	88
4e	H	Et	85	**4k**	4-Cl	Ph	88
4f	H	Me	83	**4l**	3-Cl	Ph	84

Table 1. Preparation of a library of indole azacarbolines.

ii) Evaluation of antiproliferative activity

Compounds	% Cell of Viability HeLa cells				% of Cell Viability of normal cells
	48 h	72 h	92 h	IC_{50} values in µM	72 h
4a	26.2	15.9	12.18	6.86	94.2
4b	27.2	18.32	16.32	5.36	96.2
4c	27.2	18.32	16.32	5.26	96.2
4d	35.6	18.9	14.22	3.84	98.4
4e	17.3	16.7	12.24	7.84	96.6
4f	23.7	16.11	10.16	9.22	95.2
4g	28.7	18.11	13.18	6.34	89.9
4h	25.7	19.4	14.13	5.23	96.3
4i	23.7	16.4	13.13	30.4	97.3
4j	36.6	18.16	16.71	17.2	95.2
4k	36.1	18.2	15.14	17.3	96.4

Table 2. Antiproliferative activity of aza carbolines 4a-4k.

All synthesized indole azacarbolines **4a** to **4k** were selected for antiproliferative activity studies against HeLa and normal cell line (**Table 2**). Compound 4b, 4c, 4d and 4h showed higher antiproliferative activity against HeLa cell line with IC_{50} value of 5.36, 5.26 and 3.84 µM respectively. Of which compound 4d found to be the best candidate towards antiproliferative activity. Further structural modification in indole nucleus or aryl group may enhance the said activity and keeps this area of research unexplored.

Experimental :General Remarks

Chemicals and solvents received from commercial sources were used without further purification. ^{1}H NMR spectra and ^{13}C NMR spectra were recorded on Bruker (300 MHz, 400 MHz and 500 MHz) spectrometer. Coupling constants (J) are reported in hertz (Hz) and chemical shifts are reported in parts per million (δ). Melting points were determined using a Thomas Hoover capillary melting point apparatus and uncorrected. Column chromatography was performed using silica gel (100-200 mesh). Exact mass measurements were performed on Bruker impact HD Q-TOF analyzer in the ESI mode. IR spectra were recorded by a Shimadzu FT-IR 8400 Spectrometer.

Conclusion

Ten different derivatives (4a-4k) of 5,3-dialkyl substituted-3,5-dihydro-4*H*-pyridazino[4,5-b]indol-4-ones, were synthesized using simple MCR strategy All synthesized compounds were characterized by using spectral data and evaluated for their potential towards antiproliferative activity against HeLa and normal cell lines. Out of these, compounds 4d showed higher anti-proliferative activity against HeLa cell lines with IC_{50} value 3.84 µM.

Acknowledgment

Author is very grateful to the principal, Dr. R. J. Barnabas, Ahmednagar College, Ahmednagar for providing all lab facility.

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Rainfall Trend in Drought Prone Region of Ahmednagar District of Maharashtra in India: A Geographical Study

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Abstract:

In this paper the present study reveals the tehsil wise annual rainfall trend in Ahmednagar District of Maharashtra State during 1984 to 2018. The rainfall is one of the significant parameters among the climate for the development of society. They determine the scarcity of particular region. The rate of rainfall is varied in different region. The average annual rainfall in the Ahmednagar district varies from about 625.09 mm to 405.3; some area has been traditionally affected by drought. The large area of the district comes under the agriculture due to large population depend on agricultural for employment. This study focusses on the nine (out of total 14) tahsils in Ahmednagar district which is particularly sensitive to drought Karjat, Jamkhed, Shrirampur, Sangamner, Shrigonda, Newasa, Shevgaon, Parner tahsils. The aim of this research to understand trends of rainfall Ahmednagar district. In a study on tahsil wise trend analysis nine tahsils had decreasing trend in annual rainfall. Among two tahsils showing increasing trend, Akole tahsil shows highest rainfall trend. Remaining three tahsil had the same direction of trend in annual rainfall and seasonal scale.

Keywords: Drought Prone, Annual Rainfall, Rainfall Variability, Trend

Introduction:

To meet the various water demands of agriculture, industry, irrigation, hydroelectric power generation, and other human activities in district water budget is important factor. More than 70 per cent of the population in India is engaged in agricultural activities. Indian economy is completely depending on monsoon. The development of crops in any year is closely related to behaviour of monsoon. The most of part of India receive 90 to 95 per cent rain from south-west monsoon. Rainfall is huge affecting on agriculture activity of man. The Ahmednagar district comes under western Maharashtra region which is known as rain shadow zone. The Maharashtra State has Suffering drought frequently because of monsoon behaviour. The highest rainfall receives in western part of the Ahmednagar district in Akole tahsil. The rainfall generally decreases toward east and south east part of the Ahmednagar district. The government of Maharashtra and Central government of India declared total nine tahsil of Ahmednagar district are comes under drought prone area. This attempt has been made 1984 to 2018 annual rainfall tabulation and use help of mean, standard deviation, and variation of rainfall in Ahmednagar district.

Study Area:

The Ahmednagar district is one of the crucial districts of the Maharashtra state. Ahmednagar is the largest district of Maharashtra state. Near about 17418 Sq. Km area is covered by Ahmednagar district. The geographical extension of Ahmednagar district is 18° 2' N to19° 9'N latitude and 73° 9' E to 75° 5' E longitude. This district has comprised by fourteen tehsils. According to the 2011 census the population of Ahmednagar is 4,543,159.

Objectives:

The objectives of the present study are:

1. To study the average annual rainfall during the year 1984 to 2018.
2. To find out trends of rainfall and coefficient of variations.

Data Base and Methodology:

The present study is based on the rainfall data which collected from Indian Metrological Department for 35 years. The data has been collected from 1984 to 2018. The trend of rainfall is calculated and represent by mean, Standard Deviation, and Coefficient of Variation in percentage of rainfall in Ahmednagar District. The result of these analysis shows with the help of chart, graph method. For the data analysis following formula has been used.

Where, mean = Mean of Rainfall
S.D. = Standard Deviation of Rainfall
C.V. = Coefficient of variability of Rainfall

Annual Rainfall Distribution:

Rainfall is a vital factor, considered by impacts the agricultural economy of the district. It also determines the cropping pattern, performance of various cultural and agricultural practices.

Table 1.1 Average Annual Rainfall in Ahmednagar District 1984 to 2018 (in mm)

Tehsil Year	Akole	Sangmner	Shrirampur	Kopargaon	Rahuri	Newasa	Rahata
1984	374	204	350	518	427	407	0
1985	184	204	392	300	301	302	0
1986	244	260	335	319	242	375	0
1987	296	306	582	460	533	488	0
1988	734	461	546	575	725	583	0
1989	444	558	585	594	524	593	0
1990	503	445	752	499	788	786	0
1991	544	450	401	296	466	395	0
1992	404.5	342	456	418	407	380	0
1993	636.3	435	566	408	548	447	0
1994	509.8	416.6	463.9	440.2	455	531.3	0
1995	374	290	508	321	642	664	0
1996	620	566	611	537	555	623	0
1997	587	402	312	290	345	312	0
1998	814.5	489	819	582	585	681	0
1999	403	348	315	384	581	461	0
2000	439	528	354	428	587	516	525
2001	473	337	341	360	358	312	413
2002	445	459	391	366	302	305	385
2003	489	380	313	280	299	219	249
2004	1074	570	485	428	509	508	490
2005	1080	518	396	541	465	479	588
2006	1090	576	557	745	777	629	690
2007	913	478	587	583	656	391	523
2008	1006	487	401	503	651	591	385
2009	549	329	333	485	551	456	337
2010	829	572	644	853	866	860	814
2011	500	240	455	636	589	474	395
2012	648	496.2	402	408	513	502.5	548
2013	767	378.3	413.3	504	501.4	489.4	690.4
2014	733	391.7	273	491	321.9	337	327.5
2015	847.6	385.5	383.8	374	381	457	367.8
2016	1030.1	495.5	616.8	480.1	540.5	615.7	494
2017	1265	580.3	793.5	519.8	622.1	786.5	712.9
2018	962.5	302.2	382.7	381.1	239.5	331.5	303.4
Total	**21878**	**14680.3**	**15470.8**	**16307.2**	**17196.4**	**15943.9**	**7701**
Mean	**625.09**	**419.43**	**442.02**	**465.92**	**491.32**	**455.54**	**405.31**
S.D.	**278.63**	**110.28**	**142.85**	**127.67**	**153.51**	**143.48**	**282.97**
CV in %	**44.57**	**26.29**	**32.32**	**27.40**	**34.24**	**31.50**	**69.81**

Source- Indian Meteorological Department

Tehsil Year	Shevgaon	Pathardi	Parner	Shrigonda	Karjat	Jamkhed	Nagar
1984	309	351	575	496	532	727.0	497
1985	247.0	824	714	359	456	540	400
1986	422	318	313	460	637	872	498
1987	596	714	472	497	432	296	827
1988	824	807	738	531	689	1040	772
1989	730	701	713	610	864	920	914
1990	697	716	630	614	597	523	446
1991	391	485	442	438	391	480	950
1992	369	434.5	551	521.6	352	603.2	572
1993	519	720	696	496	651	823	655
1994	584.6	571.6	486.9	359	493	583.3	531.1
1995	363	533	259	460	498	570	372
1996	782	932	656	497	514	922	710
1997	226	448	361	531	328	427	347
1998	780	1095	702	610	920	1070	730
1999	366	360	245	571	405	409	479
2000	531	471	456	392	400	661	580
2001	349	332	384	352	495	333	380
2002	449	502	438	334	436	561	394
2003	320	476	190	87	281	460	199
2004	715	595	695	527	565	570	518
2005	491	464	451	524	606	484	634
2006	798	703	751	843	746	505	906
2007	631	450	488	388	401	675	628
2008	648	473	625	388	763	848	715
2009	563	633	620	464	710	499	615
2010	791	824	932	604	729	710	770
2011	374	741	614	368	413	326	712
2012	224.8	276	250	248.5	245	258	345
2013	563.3	668	622	544	676	777	682
2014	429	379	414	176	343.7	268	464.8
2015	406.8	441.2	434.2	394.3	330.9	437.2	415.5
2016	698.7	686.9	437	523	631.7	844	576.6
2017	640.5	611	589.5	606.2	813.2	869.9	726.7
2018	292.3	288	235.2	203.1	264.9	377.5	261.7
Total	**16041**	**20024.2**	**18179.8**	**14716.7**	**18153.4**	**20842.1**	**21222.4**
Mean	**458.31**	**572.12**	**519.42**	**420.47**	**518.6**	**595.48**	**606.35**
S.D.	**180.69**	**194.13**	**176.96**	**133.85**	**180.54**	**226.93**	**237.02**
C.V. in %	**39.45**	**33.93**	**34.07**	**31.83**	**34.81**	**38.11**	**39.09**

Source- Indian Meteorological Department

Shrigonda, Karjat they are receiving low rainfall and the rate of rainfall is increases towards the west around the area of Akola tehsil. The study also determines that entire eastern, north eastern, south and south eastern parts of the district comprising almost entire Shevgaon, Rahata, Newasa, Rahuri, Kopargaon, Shirampur, Sangamner, Shrigonda, Karjat which experienced droughts for more than 20% of the years can be categorized as "Drought Area". The average rainfall data for the period (1984-2018) are presented in Table-1. The mean annual rainfall for Ahmednagar district is 683.22 mm. The highest rainfall recorded in Akola 625.09 mm, Nagar 606.35 mm, Jamkhed 595.0 mm and Pathardi572.12 mm. Parner, Karjat, Rahuri, Kopargaon, Shevgaon, Newasa have medium rainfall which is 519.42, 518.60, 491.32, 465.92, 458.31, 455.54 respectively and rainfall rapidly decreases towards the Shrirampur 442.02 mm, Shrigonda 420.47, Sangamner 419.43, and Rahata 405.31.

The Coefficient of variation is 69.81 percent Rahata, 44.57 per cent Akole, 39.45 percent Shevgaon tehsil, 39.09 per cent Nagar tahsil and results comes to Parner, Karjat, Rahuri, Kopargaon, Newasa, Sangamner, Shrirampur, Shrigonda, Pathardi and Jamkhed tahsils respectively 34.07, 34.81, 31.24, 27.40, 31.50, 26.29, 32.32, 31.83, 33.93 38.11 per cent.

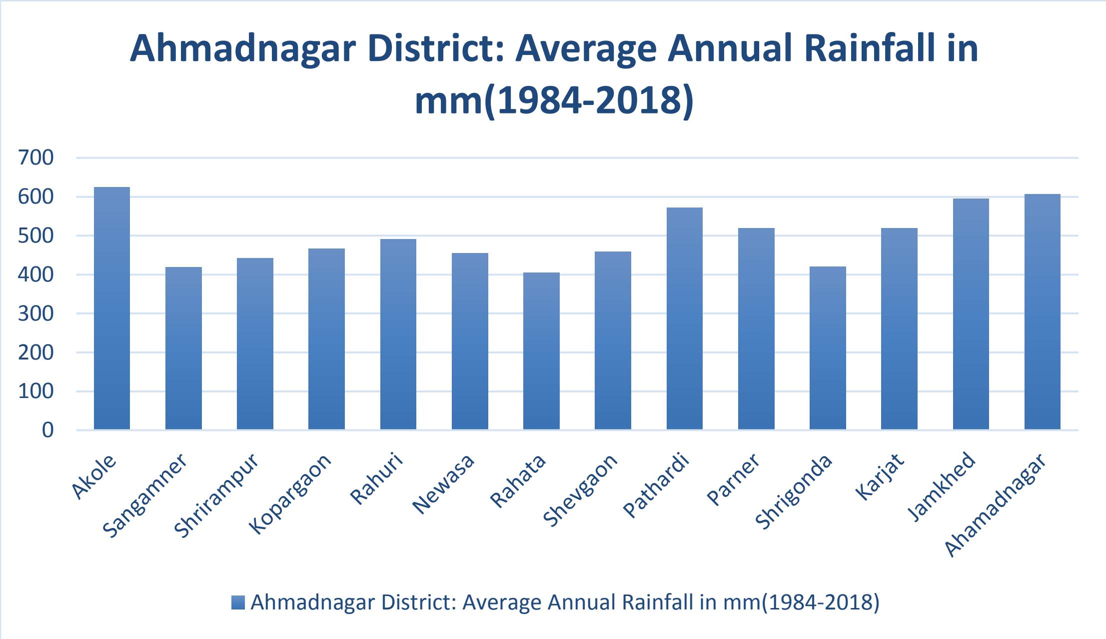

Fig.1 Average Annual Rainfall in Ahmadnagar District (1984-2018)

Table No 1 and Fig. No. 1 shows that the Akole tehsil recorded highest average rainfall during the 35 years. Nagar, Jamkhed, Pathardi, Parner, Karjat, normal rainfall recorded in during the time. Then Kopergaon, Shevgaon, Rahuri recorded medium rainfall. Rahata, Shigonda, Sangamner and Shrirampur tahsils show the less amount of rainfall during the1984 to 2018 years. The results of some tahsils are mainly depending on physiographical condition and local level climatic condition.

Rainfall Trend in Ahmednagar District of the Drought Prone Region:

The data obtained on the average annual rainfall Ahmednagar district for the period in Four decade viz. 1984 to 2018 were analysed by simple tabular method. The proportion were estimated for each of the below years to know the variation in the rainfall of the Ahmednagar district for period under the study. As the result of the rainfall variability in the Ahmednagar district. During the period 1984-2018, the difference of the actual average rainfall and trend of the rainfall in Ahmednagar district of eastern part of the drought prone region. This means that the trend is negative. The deficit of the drinking water, reducing level of water, food shortage, shortage of grain for cattle, effects on agriculture, population emigrated searching of water another district.

Conclusion:

The study has presented a detailed analysis of rainfall variability and trend of rainfall in the drought prone area of the Ahmednagar district. By using 35 years recoded of rainfall in fourteen tahsils, the study examined the spatial and temporal variation of rainfall on the Ahmednagar district. The main conclusion of the study is summarized below.

Annual rainfall in the Ahmednagar district varies from about 625.09 mm in Akole to 405.31and 420.47 Rahata, Shrigonda respectively.

Trend analysis of annual average rainfall indicators shows to fluctuations in 35 years. During the period of 1985, 1986, 1997, 1999, 2001, 2003, 2012, 2014, and 2018 shows decreasing trends in drought prone region. In 1989, 1990, 1996, 1998, 2006, 2010,2016, 2017 shows pattern of increasing trends in heavy rainfall in the study region.

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Implementation Of Rainwater Harvesting System (Rwh) In College Campus; A Case Study Of New Arts, Commerce & Science College, Parner (2017-2021)

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Abstract

Considering the Drought prone regions like Ahmednagar district; The extremity of droughts has its long-term effects on the Agricultural sector as well as Domestic use of water. Therefore, the Rainwater Harvesting techniques can act as a life saviour in the state of water scarcity in drought prone areas. The present study aims to implement and analyze the Rainwater Harvesting system in campus of New Arts, Commerce & Science College, Parner. This study is mainly based on Primary data, although some secondary data is also used from various trusted sources. Various Computer techniques are used to calculate Statistical parameters such as Average and GIS techniques are used to prepare the maps and represent the findings.

In the present study, the data reveals that Rain water from roof of buildings is collected through network of PVC pipes and is used for refilling of bore-wells as well as storing in the water tanks for further usage in the campus. The excavation pits around the casing pipes of bore well are specifically designed and implemented. Runoff coefficients according to different land surfaces are worked out. About 1 Crore 53 lakh liters of rainwater is harvested per annum. Therefore, in the past five years (2017-2021); the total runoff of 7 Crore 66 lakh liters of Rainwater is harvested. The farmers, peoples and other institutes can implement this technique to make a sustainable growth of this nation and help in replenishing the ground water level.

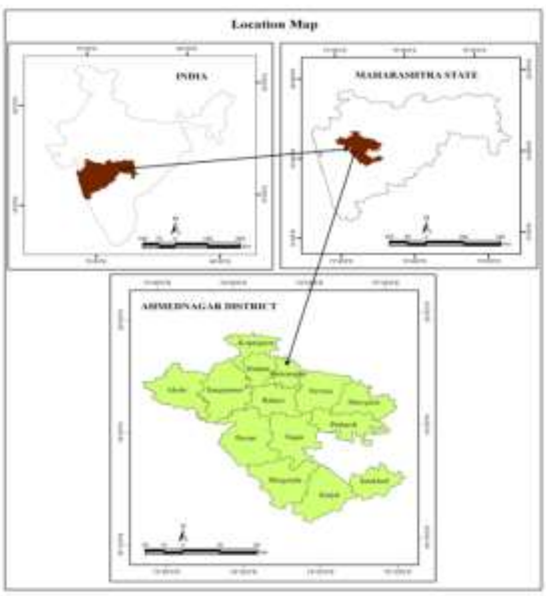
Keywords: Water Scarcity, Excavation pits, Rainwater Harvesting, GIS, Sustainable growth etc.

1. Introduction:

"Ahmednagar district is one of the drought-prone regions in Maharashtra state." (IPCC, 2007) [3]

The extremity of droughts has its long-term effects on the Agricultural sector as it does not allow the capital formation and hence farmers become a vulnerable community. Therefore, the Rainwater Harvesting techniques can act as a life saviour in the state of water scarcity in drought prone areas. Many initiatives have been introduced to conserve the scarce water resources in India. One of the methods introduced to utilize the rainwater effectively is Rainwater Harvesting technique (RWH).

Therefore, the present study entitled "Rainwater Harvesting System (RWH) in college campus; A Case Study of New Arts, Commerce & Science College, Parner" is undertaken.



2. Study Area:

The College campus of New Arts, Commerce & Science College, Parner from Ahmednagar District is selected as the study area in the state of Maharashtra.

The district is spread between $18^{0}10'$ to $20^{0}00'$ North Latitude and $73^{0}30'$ to $75^{0}37'$ East Longitude. [1] (Figure 1). The total geographical area of the district is 17048 sq. km. having 14 tehsils. [2] The district lies in the rain shadow zone of the western ghat. The distribution of the rainfall is very uneven and average annual rainfall received is 583.5 mm. About 75% of the annual rainfall is received during the southwest monsoon season. The precise location of college campus is shown using a red dot in Location map (Figure 1).

3. Objective:

The present study's main objective is to implement and analyze the Rainwater Harvesting system in campus of New Arts, Commerce & Science College, Parner.

4. Database and Methodology:

The present study is based on both Primary and Secondary data. The primary data is collected through Field survey & Personal interviews from the college campus and surrounding area. The required data and information about various Runoff coefficients and other related information etc. is collected from trusted secondary sources of information. The detailed database and Methodology is presented in the Flowchart (Figure 2).

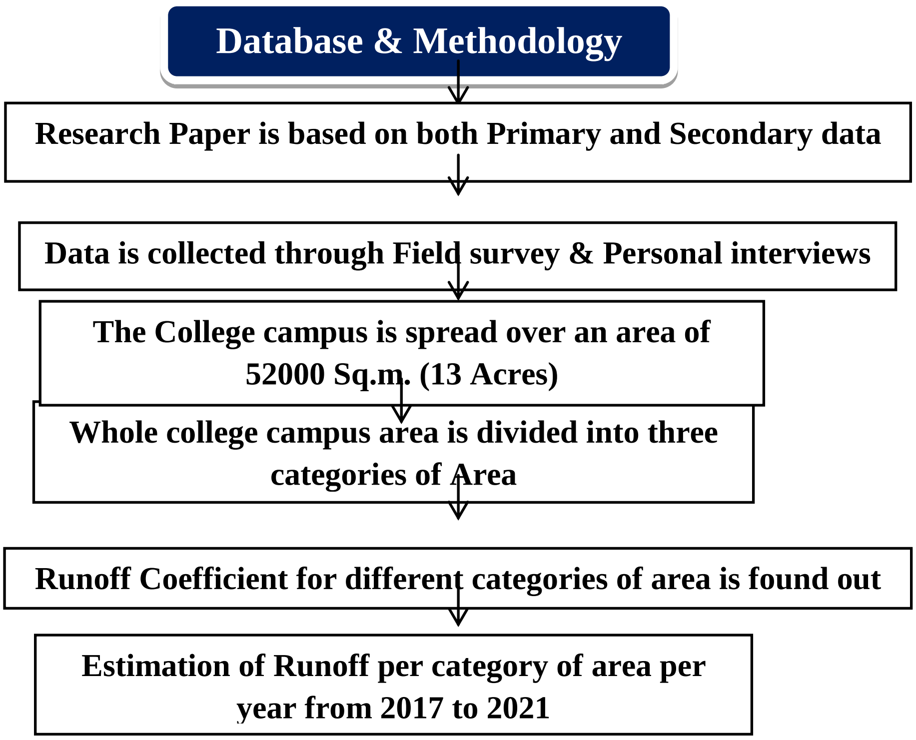


Figure No. 2: Flowchart for database and Methodology

As per the Rainfall data available from the last five years from 2017 to 2021; the Runoff is estimated using the empirical equation.

Results and Discussion: The total amount of water that is received in the form of rainfall over an area is called the rain water endowment of that area. Out of this, the amount that can be effectively harvested is called rain water harvesting potential. Runoff depends upon the area and type of catchment over which it falls as well as surface features. Runoff can be generated from both paved and unpaved catchment areas. Paved surfaces have a greater capacity of retaining water on the surface and runoff from unpaved surface is less in comparison to paved surface. In all calculations for runoff estimation, runoff coefficient is used to account for losses due to spillage, leakage, infiltrations catchment surface wetting and evaporation, which will ultimately result into reduced runoff. Runoff coefficient for any catchment is the ratio of the volume of excess runoff of a surface to the total volume of rainfall falling on the surface. The runoff coefficients for various surfaces is given in table (Table 1). The figure (Figure 2) shows the layout of the PVC pipe network implemented in the college campus.

Table 1: Runoff coefficients for various surfaces

Sr. No.	Type of catchment	Coefficients
	Roof Catchments	
1	Tiles	0.8 - 0.9
2	Corrugated metal sheets	0.7 - 0.9
	Ground surface covering	
3	Concrete	0.6 - 0.8
4	Brick pavement	0.5 - 0.6
	Untreated ground catchments	
5	Soil on slopes less than 10%	0.0 - 0.3
6	Rocky natural catchments	0.2 - 0.5

*(**Source:** Pacey, Amold and Cullis, Adrian 1989, Rain water Harvesting. The collection of rainfall and runoff in rural areas, Intermediate Technology Publications, London Pp: 55)*

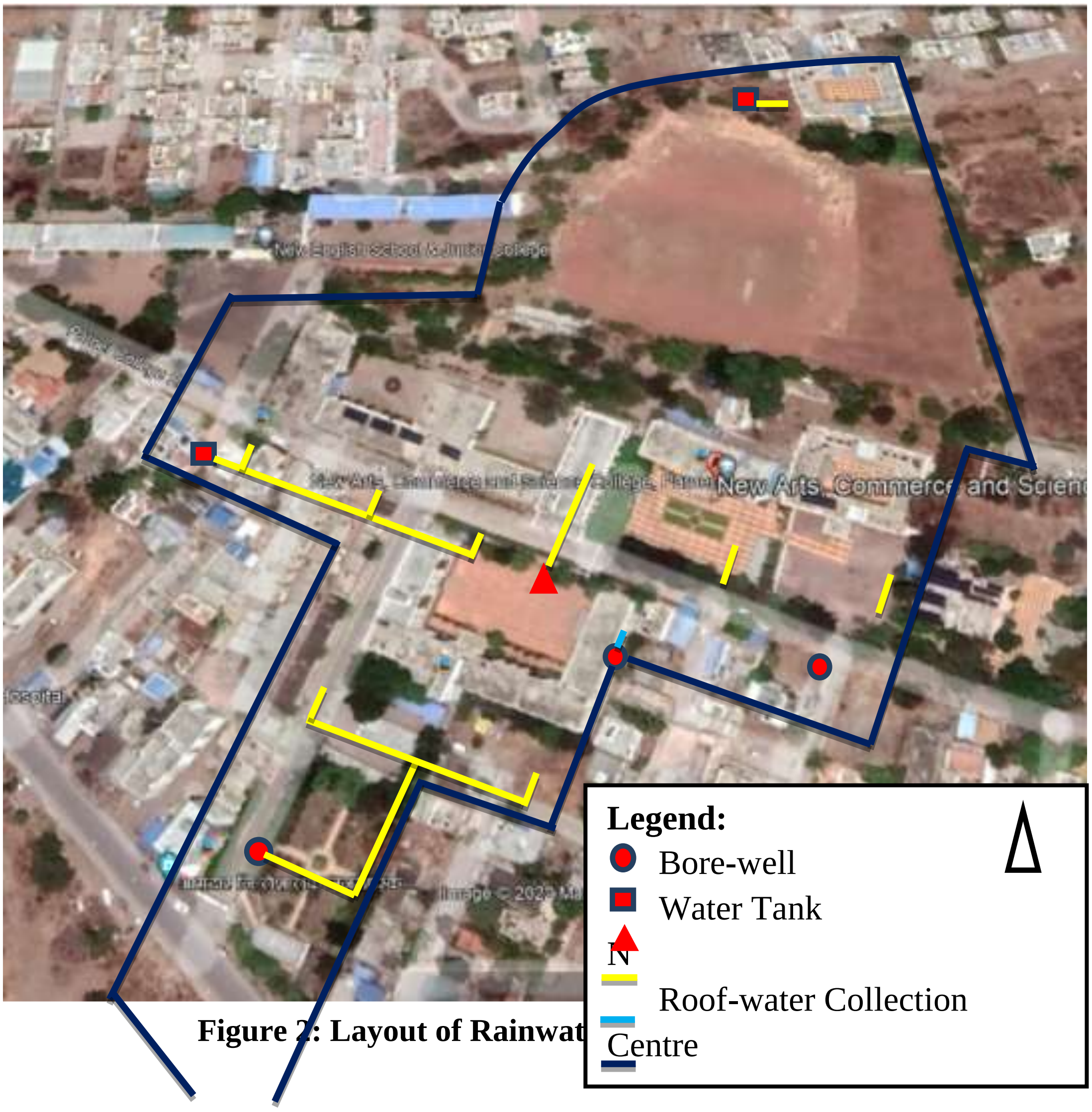


Figure 2: Layout of Rainwat

Based on the above table 1, the water harvesting potential of college site could be estimated using the following equation:

Rain Water harvesting potential = Average Annual Rainfall (R) x area of catchment (A) x Runoff co-efficient (C)

$$\text{RWH Potential} = R\,(m) \times [(A_1 \times C_1) + (A_2 \times C_2) + (A_3 \times C_3)]$$

Where,

A_1 = Area of Roof Catchments (Concrete)
A_2 = Area of Ground surface covering (Paver Blocks/Concrete/Brick Pavement)
A_3 = Area of Untreated ground catchments (Open Space/Garden etc.)
C_1 = Runoff Coefficient for Roof Catchments (Concrete)
C_2 = Runoff Coefficient for Ground surface covering (Paver Blocks/Concrete/Brick Pavement)
C_3 = Runoff Coefficient for ground catchments (Open Space/Garden etc.)

The detailed college campus area considered under various categories is given below;

- **A_1 = Roof Area of Administrative Building + Arts, Commerce and Library Building + Ladies Hostel + Science Building + B. Voc. Building + Boys Hostel**
- **A_2 = Roads + Area under Paver blocks**
- **A_3 = Playground + Garden + Remaining area**

This area can be seen from the top view in the figure 2.

From Table 1, The Coefficient of Runoff can be estimated as; **C_1=0.85, C_2=0.7, C_3=0.15**. The estimation of average annual runoff through RWH is illustrated in the following table (Table 2).

Table 2: Estimation of Average annual runoff through RWH

Sr. No.	Year	Area (sq. m.)			Average Annual Rainfall (m)	Annual Rainwater Runoff (Cu. m.)
		Roof Catchments (A_1)	Ground surface covering (A_2)	Untreated ground catchments (A_3)		
1	2021	6391	8486	37123	0.99628	**16878**
2	2020	6391	8486	37123	1.20762	**18512**
3	2019	6123	8486	37391	1.06523	**17846**
4	2018	6123	8486	37391	0.46934	**7863**
5	2017	5139	8486	38375	0.96504	**15503**
Average Annual Runoff						**76602/5 = 15320**

(Note: Total Area under college campus is 52000 Sq.m. (13 Acres))

Rain water from roof of building is collected with PVC pipes and is used for refilling of bore-wells as well as storing in the water tanks for further usage in the campus. Annually **1 Crore 53 lakh liters** of rainwater is harvested per annum. Therefore, in the past five years the total runoff of **7 Crore 66 lakh liters** of Rainwater is harvested.

Conclusion:

Rainwater harvesting has helped to replenish ground water of college campus and surrounding areas. The other farmers, peoples, institutes can implement this technique to make a sustainable growth of this nation. Annually **1 Crore 53 lakh liters** of rainwater is harvested per annum. In the past five years the total runoff of **7 Crore 66 lakh liters** of Rainwater is harvested. This water helps to water plants and trees in gardens, college campus. This water is also used for construction purpose as well. Thus rain water harvesting has helped to save run - off water to meet different needs of college campus. It has also helped in increasing ground water level.

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Conservation strategies of ethnomedicinally important *Isodon nilgherricus* Benth H. Hara and *Plectranthus canninus* Roth

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Abstract:
The present Study was aimed to determine that *Plectranthus canninus* Roth (Synonym *Plectranthus spicatus* Benth) and *Isodon nilgherricus* Benth H. Hara Basionym -*Plectranthus nilgherricus* Benth. is an essential plants in Indian system of medicine. *Plectranthus canninus* Roth found in Coimbator and in Africa too where the leaves of this plants are chewed to relieve toothache. *Isodon nilgherricus* Benth is an rare, aromatic plant indigenous in Nilgiri region, Ooty and in Africa. In Tamil Nadu, Kurumba tribes especially in Nilgiri region the leaf paste of this plant is used against gum disorder and toothache. These are grown with the help of seeds and stem cuttings , saplings were successfully grown in Ahmednagar area as well in Panchagani Table Land in Maharashtra. This experimental study provides an initial information of conservation practices of Plectranthus species in different geographical region and variety in drought prone area too with proper artificial enviornement.

Keywords: Ethnomedicine, Isodon nilgherricus, Plectranthus canninus, Plectranthus Conservation, Nilgiri

Introduction-
In the whole world most of the plants are used as a source of medicine by traditional herbal healers. Despite of it some plants show the pharmacological activity and other indigenous medicine. Many countries rich in traditional medicinal knowledge have been conducting ethnobotanical survey of medicinal plants. Ethnobotanical knowledge is passed from generation to generation either within families or various families. The socio-economic benefits arising from such resources are tremendous (Van der Maeson et al 1996). Traditional medicine is known as indigenous medicine or folk medicine and it consist of knowledge system that developed over generation to generation within various societies before the era of modern medicine. Plants are the chief source of the drugs containing phytochemicals which are used in herbal medicines. Ethnobotanical studies that explore and help to preserve knowledge are therefore urgently needed before traditional folklores are lost forever (Choudhary,1998).
In India, the genus Plectranthus is found in the Western Ghats, Himalaya region, the Southern Ghats and Nilgiri hills. The Nilgiri district also called 'The Nilgiris' is a hill area of 2452.50sq.km. located between 10-38-11-49 North latitude and between 76.0 and 77.15 East longitude, part of Nilgiris being in the Nilgiri Biosphere Reserve (NBR) in the Western Ghats which is one of the 'biodiversity hot spots of the world. (D.Puravankara and G.V.Gopal 2012).The NBR is known for its rich biodiversity (Daniels 1992).
Plectranthus canninus Roth (synonyms : *Coleus spicatus* Benth) and *Isodon nilgherricus* Benth (Synonyms : *Plectranthus nilgherricus*) belongs to the Labiatae family and both are an essential plants in the Indian system of medicine. It is perennial fleshy herb, which grows in arid places, on rocky ground among bushes. The information was collected from those people regarding the Plectranthus and its socio-economic importance. The region is dominated by ethnic tribes, Irulars . Traditionally, the plant is used as stimulant, in the treatment of tooth and gum disorder.(Edward J. 2013) and according literature this plant is known as natural cat repellent.
In Tamil Nadu, Kurumba Tribes especially in Nilgiri region *Isodon nilgherricus* Benth is

used against gum disorder and toothache and leaf paste is applied on the wound directly (Erny Sabrina 2014).

According to the Tamil Nadu forest department website, 6 tribal communities. Toda ,Kota,Kurumbas,Irulur,Paniyan and Kattunayakan habe been identified as Primitive Tribal communities. Interestingly all these six tribes are native to the Nilgiris. The purpose of this study was to observe the successful seed propagation, seedling germination and adaptation of southern plants on western ghat region.

Material and methods-

Study area - Naduvattam of Nilgiri Hills in Ooty, Maruthmalai hills in Coimbatore

Isodon nilgherricus Benth was collected from Naduvattam location from Ooty, officially known as Udagamandalam also known as Ootacamund, is a town and municipality in the Nilgiris District of the Indian state of Tamilnadu. It is located 86km north of Coimbatore and 128 km south of Mysore and is the headquarter of the Nilgiris district. It is a popular hill station located in the Nilgiri Hills. Being located at quite a high altitude the climate of Ooty remains cool and temperature almost all through the year. The average yearly rainfall is 121 centimeters. The latitude is 11.08 to 11.37N and 76.27E to 77.4E. It has mostly moist, dry, evergreen and shola tropical forests. The soil textures of the study areas could be classified as red loamy soil.

Maruthamalai hills are located near Coimbatore,15km away. The altitude is 426.72m MSL, 11.04E of longitude and 76.93N latitude. It has moist dry deciduous type of forest and the soil texture of this area is red loamy soil. *Plectranthus canninus* Roth (Synonym *Plectranthus spicatus* Benth) was collected from these hills.

The plants have grown in two seasons to development under encouraging circumstances Saplings were made in pots with the help of seed propagation techniques. Various numbers of seeds were sown in different pots in same environmental conditions at Ahmednagar area and in the same year in monsoon season seeds were propagated at Panchagani Table Land, in 10 X 10 feet and results were observed.

Panchgani Table Land is one of the table tops in Panchagani,(19km east of Mahabaleshwar) Maharashtra state. It is at 4,500 ft above sea level, is the highest point in Panchagani. It is a vast expanse of flat laterite rock surrounded by hills. The soil texture is very colourful layers of clay and sandy soils. This study area was selected for the experimentation of *Isodon nilgherricus* Benth.

The present experimental study were also carried out in Ahmednagar district . It extends between 18.20 and 19.59N latitudes and 73.40 to 75,43 east longitudes located in part in the upper Godavari basin. The district is very dense in shape and length of 200km a width of 210km. There are hilly off-shoots of Sahyadris in the western part of the district with the soil texture of medium black soil and deep black soil. It is the region of Maharashtra well known with a very little rainfall with extreme winters and extreme hot summers.

Results and Discussion: The conservation of *Isodon nilgherricus* Benth was tried with using various strategies. The results of the best practices are depicted in the following tables.

Table 1: Percentage of seedling grown under Pot Culture strategy

Sr. No.	No. of Seeds Sown	No of seedlings grown	Percentage
1	24	19	79.16%
2	20	17	85%
3	16	14	87.5%
4	10	09	90%
5	06	06	100%

Table 2: Percentage of Seedling grown under field condition at Mahabaleshwar (10X10 feet)

Sr. No.	No. of seeds sown	No. of seedlings grown	Percentage
1	100	75	75%
2	80	55	68.75%
3	60	50	83.33%
4	40	35	87.5%

5	20	20	100%

Table 3: Average vegetative growth of Seedlings grown under Pot Culture.

Sr. No.	Number of Seedlings	Number of Root	No. of Branches
1	19	0.2cm	4
2	17	0.4cm	5
3	14	0.6cm	6
4	09	0.8cm	7
5	06	0.9cm	8

Table 4: Average vegetative growth of Seedlings grown under field condition.

Sr. No.	Height	No. of Branches
1	4.1	08
2	4.2	11
3	4.5	12
4	4.8	12
5	5.0	15

The seeds were collected from Nilgiri Hills of South India. They were sown in various environmental condition under pot culture strategy and field conditions. The results are depicted in tabular form in various tables. In the pot culture method of conservation (Table 1) it was observed that if the number of seeds sown in limited given area the growth of plants is significant and natural. The results are 100% with satisfactorily growth. In this case it was found that the competition for water and mineral absorption is negligible. These plants were transplanted to field condition. Similarly the field experiment was carried out simultaneously in the same season. The criteria of seed sowing was applied same as per pot culture. The seeds were sown at the Table land of Panchgani, Mahabaleshwar. The number of seeds was increased from 20 to 100 (Table 2). The field area was 10 x 10 feet. Such 5 plots were selected for sowing of seeds. It was observed that as the number of seeds sown in a defined area, there was competition amongst the growing plants for minerals and water. Even the number of seedlings grown was only 75%. It was also observed that the sowing of seeds should be sparingly.

Plectranthus canninus Roth plants were grown with the help of seeds and stem cuttings too.

The vegetative growth parameters were also measured; the results obtained were also significant. The height of plants was also of limited where the number of plants was more.

Conclusion

The present experimental study of conservation concluded that the number of seeds sown sparingly showed better growth in pot culture as well as field experiment. *Plectranthus coetsa* plant shows a better growth with the seeds and stem cuttings too in drought prone areas of Ahemdnagar with proper artificial environment. Besides the large scale of Maharshatra and th different geographical scale the Plectranthus species collected from Nilgiri region can be successfully grown and conserved in Western Ghat and in Ahmednagar region.

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Study Of Urban Fringe In Pimpri Chinchwad City

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Abstract:
Pimpri Chinchwad city is one of the largest urban centers in terms of area coverage and population size and Cities in Maharashtra are experiencing the highest growth rate. The City is experiencing massive Urbanization on account of a rapid population increase caused by natural growth and mass migration from rural to urban areas in search of better living and employment opportunities and also due to merger of several villages as a result of spatial expansion of the city from time to time. The rural-urban fringe area stands for the spatial extension between a city and a rural area. Looking into the complex structure of transformation, the delineation of rural-urban fringe areas becomes very important. This area is a dynamic spatial zone caused by the effect of the process of urbanization at the outer limit of the city, and beyond the municipal or any other administrative boundary of a city. This occupies an important place in the field of urban geography, because it forms a complex identity of physical expansion of urban area and social, cultural, economic and environmental transforming conditions over a period of time. This paper is based on the works carried out by researcher to study dynamic nature of rural urban fringe area of Pimpri Chinchwad. This study tried to assess and monitor the spatio temporal dynamics of PCMC urban area.

Keywords: Urban Fringe, Delineation, Transformation, Urbanization, Dynamic nature

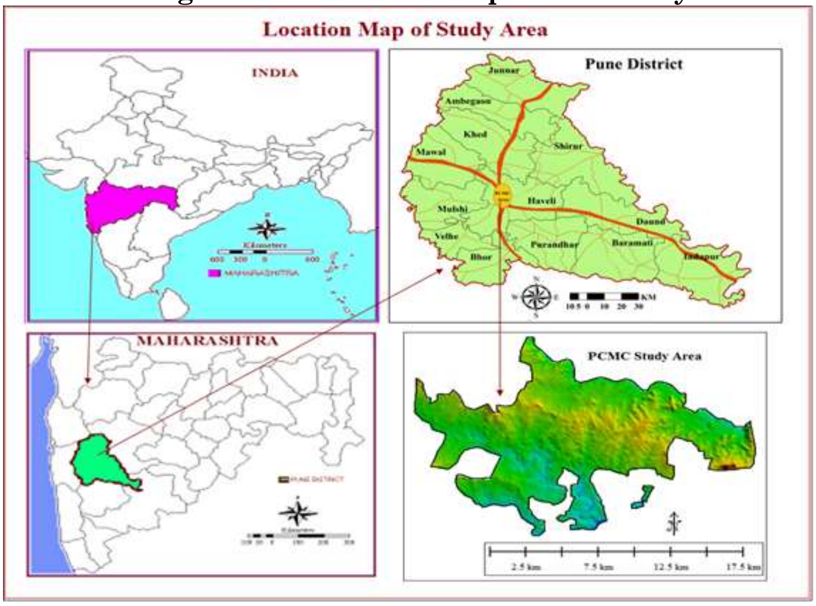
Introduction:

Rural-Urban fringe is an important concept in settlement geography. An urban boundary is a boundary area outside the appropriate urban area where rural and urban land uses intermix. (Dr. Jyostna Pandey, Rural-Urban Fringe in Indian Cities). It is the area where the city meets the countryside. It is an area of changing from agricultural land uses to urban uses (Models in geography). Properly located in the area of urban influence the edge is reflected in a variety of land uses including residential areas occupied by middle-income commuters working in the city center. Over time the edges of the fringe change from the rural to the larger cities. Urbanization occurs within the municipal boundary of a rural-urban fringe area. There are some distinct characteristics of rural urban area like garden centers, sewage works, vegetables and flowers fields, airports, social amenities, transport, etc. It means it is neither truly urban nor truly rural area. Some major characteristics are Encroachment of residential and industrial estate. This is the area into which the city is physically expanding.

Study Area:

Pimpri Chinchwad is located in one of the biggest industrial belts in Asia and particularly in India having a geographical area 171.59 sq. km. Pimpri Chinchwad lays between 18o 25’ to 18 o 42’ North latitude and 73 o 42’ to 73 o 57’ East longitude it covers 171.59 sq. km. Pimpri - Chinchwad has grown from an area of 86.01 sq. km. in 1982 to 170.52 sq. km in 1997 i.e. it has increased by 84.51 sq. km in the last 30 years. In 1982, the area of old PCMC was 86.01 sq. km. which increased to 170.52 sq. km. in 2011, with the inclusion of 18 villages. (pcmcindia.gov.in)It is rapidly growing city towards the metro due to the growth of IT industries. Rate of urbanization in PCMC area is very high. Growth rate of this area between 1991 and 2007 was 62.17%, it was doubled in comparison of Pune district. Within these 20 years this city has rapidly grown along with its fringe area, e.g. Bhosari Hinjewadi, Chakan, Dehu etc. Hence the study of the urban fringe of PCMC area is an attraction for researchers. Study of the growth of urban areas, its causes, planning of development, its problems, etc. is the need of time.

Fig. No. 1. Location Map of the Study Area



Aims and Objectives:

1. To study existing land use, land cover in Pimpri Chinchwad Municipal corporations fringe area.
2. To examine the characteristics of dynamic nature of urban fringe in PCMC area.
3. To evaluate various utility services of PCMC area.
4. To study economic activities in fringe area of PCMC.

Methodology:

The entire study is based on the collection of data both primary and secondary which has applied in this study. Review of literature related to the delineation of rural-urban fringe. Primary sources include visit and observation, interview, to conduct a sample survey a questionnaire has been prepared and filled up by various respondents, and secondary sources, were data published on PCMC authorized websites and SOI map, which can provide some basic information of the study area, other reference books, the analysis of information data, the source of unpublished data, etc. Data collection and Interpretation of data. Fieldwork gives a scientific and systematic view of observation.

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Physiography:

The city is located at about 18 ° 37 'North latitude and 73 ° 48' longitude east along its twin Pune in the north and northwest on the height of 530 to 570m above the sea level. The PCMC site is located on the east side of the Western Ghats and is approximately 560 m. The centers of the twin towns are about ten to 15 km apart. Three rivers Pavana, Mula and Indrayani flow through the area. The Pavana River is a major source of water in the PCMC region. The Pavana Dam, located 35 km from Pimpri Chinchwad, is the city's water source. Bed rock found throughout the city deccan trap basalt. Stone is the only commercially available mineral in the area.

Climate:

Climate of the Pimpri Chinchwad is influence by the prevalence of western breeze, the general climate in the area is healthy and moderate. The climate condition prevailing in the area is tropical type of climate. Pimpri-Chinchwad experiences three distinct seasons; summer, monsoon, and winter.Maximum temperatures range in summer from 35 to 40°C (95 to 102°F). The evening sea breeze from west- northwest keeps the city cool during summer nights. For the coldest month of December the temperature ranges from 30°C to 12°C. Average temperatures ranging from 20 to 28°C (68 to 82°F).

Demographic profile of study area:

Population:

Table no.1 showing the population statues of PCMC from 1971 to 2011. According to 2011 Census of India, Pimpri-Chinchwad had a population of 1,729,692. The sex ratio was 833 females per 1000 males. About 13% of the population was under six years of age with a sex ratio of 875 females per 1000 males. Around 8% of the city's population lives in slums. Pimpri-Chinchwad has an average literacy rate of 89.22% (92.41% males; 85.37% females), higher than the national average of 74.04%.

Table No. 1 Population Growth in Pimpri Chinchwad Region

Census	Population
1971	98,572
1981	251,769
1991	520,639
2001	1,006,417
2011	1,727,692

(Source: Census of India 2011)

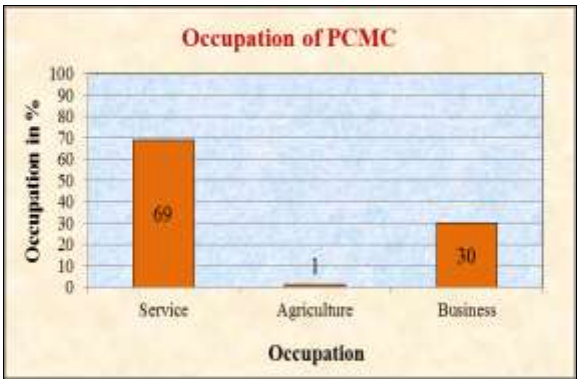
Analysis of data:

Introduction: This analysis done with the help of collected information by questionnaire from the fringe areas of PCMC area which shows various changes in land use patterns, land prices, residential structure buildup area and pattern, educational facilities, transportation, utility services, in study area, due to migration from nearby rural areas is increasing day by day. The population living in PCMC Fringe area is remarkably increased from last twenty years; it means migration from other area to PCMC from last two decades is high due to rapid industrialization. Study of this area show people living in PCMC area from the last 20 years. from last decade there is rate of immigration is increased which resulted to increase the diameter of PCMC fringe area.

1. Occupation:

In the graphical representation in figure no.2 shows the composition of occupational structure in the fringe is reveals the changing dimensions of economic structure of fringe area. Speedy growth of industrial sector in study area, industries, Tata motors, Bajaj Ltd, Alfa Laval, Thermax, as well as newly developed IT sector in Talawade, Hinjewadi, Tarawade, and various small industries in Bhosari, Chakan supply employment to population living in peripheral area and central area, hence maximum population works in industrial sector 69% people are engaged in this sector in various jobs, 30% businessman. Only 1% people are practiced agriculture in outskirt area it means that growth of urban area is expanding its boundary of fringe area in Sangwade, Talawade Mamurdi, Rawet, Tathwade, Punawale, and Moshi Chakan etc.

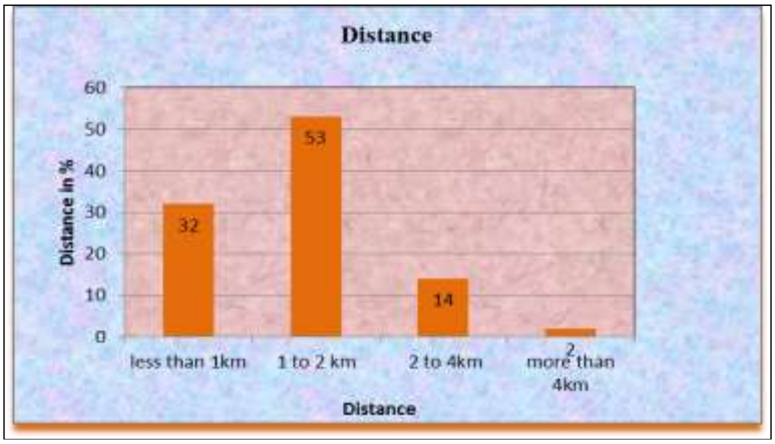
Fig.No.2



Market Place:

According to data in graph no. 3, development of amenities are in developing condition. All types of markets are available in main the city Pimpri and Chinchwad area but as we go towards outskirt area Tathwade, Moshi, Talawade, Punawale, distance of market place, Mall, vegetable market, sweet marts are long distance from the residential area. In outskirt area depending on the development of area for only 32% population have main market place under 1km, 53% population have 1to 2 km distance, but still one percent population have their market place far from there residential area which indicates there is only residential is developed but other utility services are in developing condition.

Fig. No.3



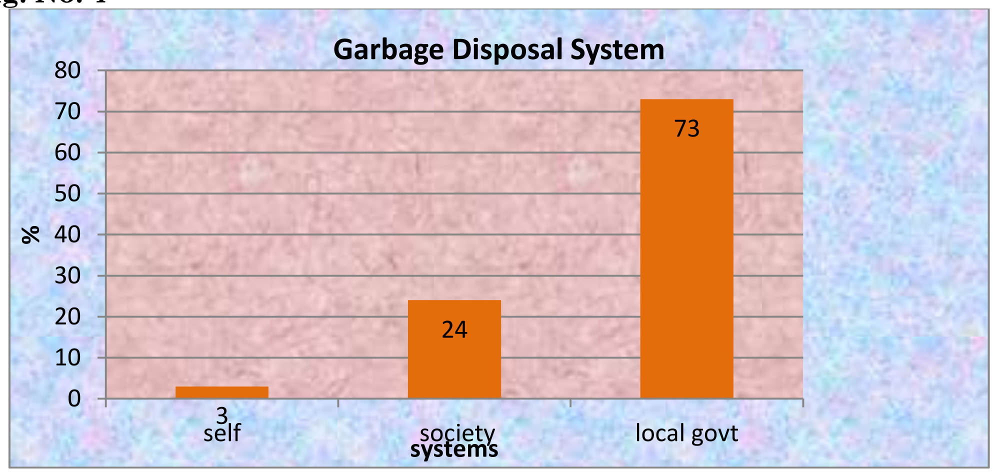
Source: based on collected data

3.

Garbage Disposal system:

Due to rapid increase in population growth of industries, there is huge garbage is also generated from residential societies as well as industries and hospitals etc. Civic body collect the garbage from these areas every day and dumped it at dumping site then dispose the solid wet and dry waste maximally by using land fill method, making compost. There is good waste management in central area, Pimpri, Chinchwad, Akurdi, Pradhikan area of PCMC. In various new residential societies have own wet garbage management system, they processed wet garbage in society premises for example societies in Wakad, Pimple Gurav has process their wet garbge and make compost this type of system followed by 24%. People living in far from city area in periphery region dump their garbage one place from which civic body collect the waste but these are very less only 3%. Maximum means 73% waste collected by municipal corporation every by using special transport vehicles and process it properly.

Fig. No. 4



Source: Based on collected data

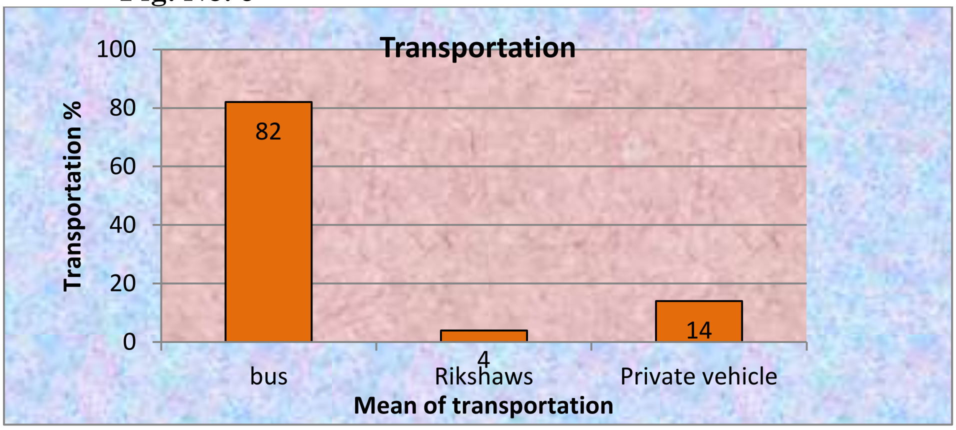
4.

Transportation facilities, Public and Private:

Population of PCMC city is growing rapidly which is shown in graph no. 4. There is good transport network found in center areas of PCMC city bus, BRT bus connectivity and road network is good. People living in outskirt areas travel every for job in main city area, industrial areas, there is good connectivity in some areas of PMPML Bus service because more than 82% population use public transportation. Only 4% people use rickshaws. 14% Population use their own or private vehicles for transportation this indicates developing or limited public transportation condition in some periphery area like Punawale, Moshi, Jadhavwadi, Rawet, Kiwale. But maximum area is connected by city bus and speedy BRT transport bus, for example rainbow bus service connects Kalewadi, Rahatani, pimple Gurav & Saudagar, etc. But newly developed outskirt areas are less developed and they are connected by private transportation.

Change in the lifestyle of the people in fringe area and transport facilities also change which indicates economic development of the PCMC and its Periphery area. Around 50% population use two-wheeler like motorcycle and scooter and own cars and only two percent people use other source of transportation. This shows transformation of area from less economic development to developed region.

Fig. No. 5



Source: Based on collected data

5.

Government Facilities and Utility service:

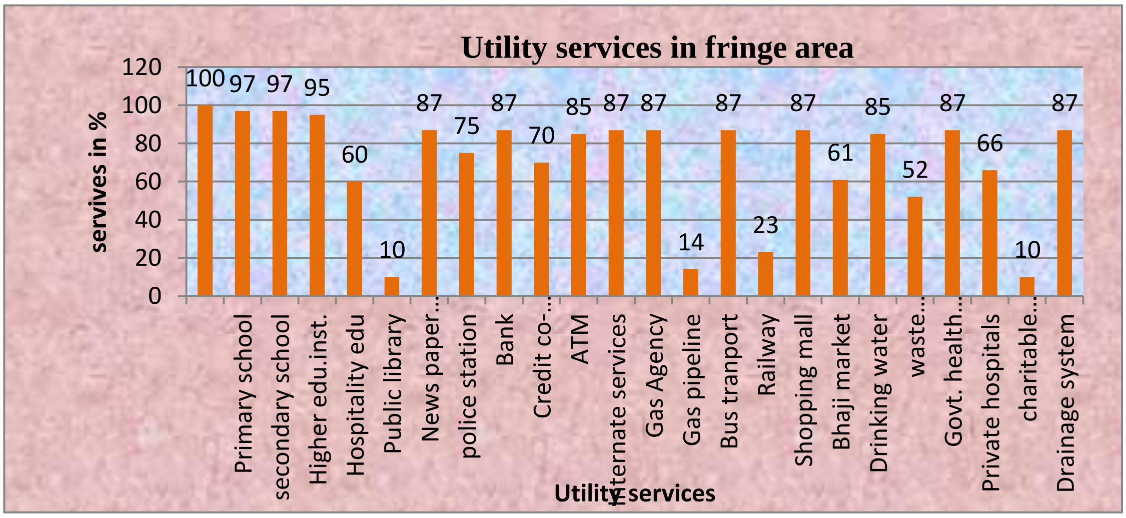
Population of PCMC city is growing and demand for various facilities like utility services is increasing day by day. PCMC providing all amenities as per requirement. People living in the fringe area are not completely satisfied with the facilities provided by the local government, because only 54% people said that they are happy with facilities but this data is below 27% and 19% people said that they can't say anything about facilities and its satisfaction.

For Pimpri Chinchwad Municipal Corporation (PCMC), Pavana dam is a major source of drinking water. In all the area of PCMC city as well as merged villages in PCMC water is supplied regularly by PCMC Municipal Corporation's Rawet pumping station, very people living in far away at boundary area of city used tube well and well for water The development of socio-economic status and residential infrastructure as well as urban utility facilities reflects the quality of life of the people living in that area. Table no 2. And its graphical representation shows utility services are essential for fulfill the human needs. In developed urban areas, these services are available on large scale, and the population residing over their lives a very luxurious. In study area all types of civic amenities are available. There are good, wide road and sufficient government and private transportation available in addition to all type of education facilities. Nevertheless, management and hospitality management, multispecialty hospitals, public libraries are more required in the fringe area. In study area there are only 10% hospital are there, 60% hospitality education institutes, 10% public libraries, 14% gas pipeline connection which indicates less development these services People living in the study area are aware of best quality amenities like An Automated teller machine (ATM), Hotels, shopping malls, gas pipelines, waste management system, quality education hence all these services and amenities are developing more and more in this region.

Table No. 2. Utility services in PCMC fringe area

Sr. No.	Utility services	Services in %
1	Preprimary school	100
2	Primary school	97
3	Secondary school	97
4	Higher education institute	95
5	Hospitality education	60
6	Public library	10
7	Newspaper centers	87
8	Police station	75
9	Bank	87
10	Credit co-operative society	70
11	ATM	85
12	Internet services	87
13	Gas Agency	87
14	Gas pipeline	14
15	Bus transport	87
16	Railway	23
17	Shopping mall	87
18	Bhaji market	61
19	Drinking water	85
20	Waste management	52
21	Govt. health centre	75
22	Private hospitals	66
23	Charitable hospital	10
24	Drainage system	87

Figure No. 5 Based on collected data



6.

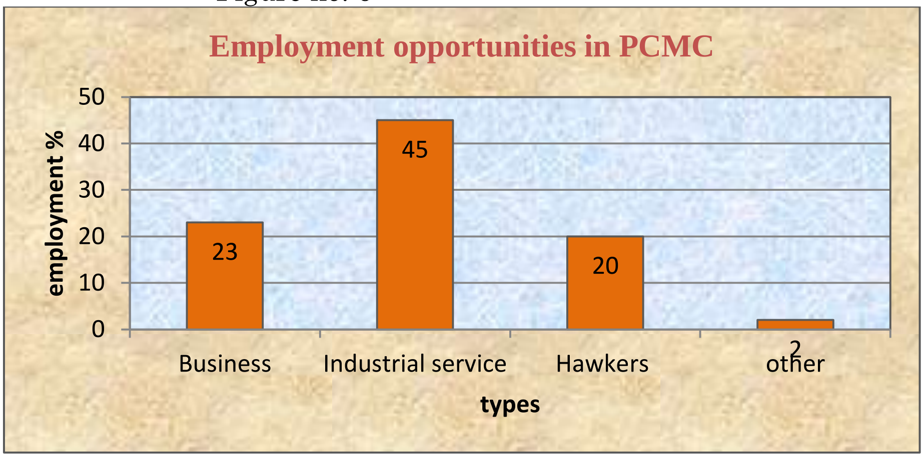
Change in residential infrastructure and Lifestyle of the people:

The pace of urbanization, development, industrialization, road network growth in residential areas is the major factors attributable for the change in pattern of residential infrastructure. Residential houses in the study area changing their pattern and types like modern houses, bungalows, two, three stored buildings found in inner fringe area. However in areas like Hinjewadi, Dehugaon, Talawade, Moshi, tathawade, Rawet etc. Multistoried building with all amenities is developing now and rate of land is also gradually increasing day by day as per the requirement of high skilled industrial servant. Amenities of the area is also developed between 2005and 2011. This changing scenario of fringe area indicates dynamic nature of the fringe area.

With change in employment pattern, infrastructural pattern and amenities, a big change in lifestyle of population is also take place. Young people adopt modern life style like use of self-transportation, taking higher education with professional skill, becomes economically independent. In study area, education pattern changed from traditional to professional as required by industrial and business sector. People working in Multinational companies and IT industries have high earnings and prefer high living standard and comfort life with high amenities. Ten to fifteen year before maximum people living as lower middleclass life style because their earnings were less and high amenities and comfort was not affordable (See figure no 6 and 7), 2009-10 high salary job from IT sector attract maximum people towards high living standard which indicates people living in study area changing their attitude toward their social and economic life education and try to make it more comfort.

With change in employment pattern, infrastructural pattern and amenities, a big change in lifestyle of population is also take place. Young people adopt modern life style like of self-transportation, taking higher education with professional skill, becomes economically higher class.

Figure no. 6



Source: based on collected data

Conclusion:

The outskirts of rural cities are the most dynamic area between the city and the rural area. The strength of the edges can be achieved by looking at the changes in the city and vice versa. Changes in the suburbs of rural cities depend on the performance and size of the city. The shape of the hem band varies depending on the city, depending on the physical, cultural and economic conditions of the city. The work of the growth and nature of the rural urban fringe around the Pimpri Chinchwad city fringe is not easily defined geographical area than one that begins and ends at certain distance from the city Centre. It is transitional area where dominant functional use of land is not clearing as agricultural or urban economic. Our cities are growing and expanding very fast beyond their municipal boundaries with the surrounded area. This is continuous process of changing or replacing rural area to urban area which we said transitional characteristics of urban fringe area. This fringe area is continuously changing its nature of economic activities and social characteristic. PCMC is fast growing industrial city due to expansion of industrial sector as well as immigration of population. from 1991 to 2010, the population increased gradually. After 2011 maximum expansion of residential area increased around the Centre which brought change in structure of buildings (buildup), change the standard of living of people from lower middle class to upper middle class. This phenomenon has influence on fast social and economic life of people. Price of land is increased, facilities increased, civic amenities like education, water facilities, waste management system, also well-developed. Transport facilities private vehicles like cars, two wheelers remarkably used by people. Municipal bus transportation developed and maximum places of fringe area, as well as connects by bus BRT to city Centre.

Rapid economic change in fringe area is sole of the modifying the educational and social structure. Growth of higher and skill-based learning institution in fringe area is indicator of good educational facilities in fringe area. This helps to increased social status, living status of people living in fringe area. People who are living from long time in PCMC area experienced a gradual changing fringe area by their life style, job variations, structure of residential area like newly developed Prabhakaran or planned residential areas transformation of slum residence by JNNURM. Fringe region of PCMC core centers and outskirts areas are well connected by road transportation wide and good unfractured, bridges for reducing traffic is main characteristics of transportation of fringe area. This provides speedy transport facility to people living in this area only outer fringe area has limited transport facilities by PCMC government, indicating this region changing and expanding gradually.

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A GEOGRAPHICAL AND SOCIO-ECONOMIC ANALYSIS OF IMMIGRANT TO AHMEDNAGAR CITY FROM RAJASTHAN

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Introduction:

Migration a spatio-temporal process that evolves over space and time—involves the continual reshaping of place as persons move between various origins and destinations. Geographers are especially interested in the process because of the interconnections and spatial linkages that are formed when people move. The numbers of flows and channels that are created as a result of migration have risen dramatically in the past two centuries, and the result is the constant transformation both of sending and receiving areas. The patterns, causes, and consequences of migration are innumerable and include complicated, multiscale economic, political, cultural, and demographic effects, all of which are studied by geographers. Migration is the movement of people from one place to another. Migration happens for a range of reasons. These can be economic, social, political or environmental. Push and pull factors drive migration. People can either choose to move ("voluntary migration") or be forced to move ("involuntary migration"). Migrations have occurred throughout the past, beginning with the movements of the first human groups from their origins in East Africa to their current homes throughout the world. Migration occurs in a variety of ways: Migration can occur between continents, within a continent, or within a single country. Migration can even occur when people move out of the city and into the country. The most important thing about migration to remember is that it occurs when groups of people move for the same reason. People move for many reasons. To decide, they think about what is good or bad about staying or moving.

The Study Area: For the present study Ahmednagar city has been selected as a study region. The choice of the study region is not arbitrary. It has been selected due to specific reasons. It is a peculiar region with distinct physical setting and socio-economic conditions. It also shows variation in population distribution and characteristics. It is one of the district of Maharashtra states, Ahmednagar city, the head-quarters of the district is located between 19° 01' 11" North to 19° 09' 4.7" North Latitude and 74°40' 37" East to 74° 46' 8" East longitudes. The height of city is 656.54 meters from mean sea level; a contour of 660 meter surrounds the city. Ahmednagar city is situated in the central part of the Deccan plateau, in the upper 'Sina' basin on the eastern flank of Harishchandra hill ranges. It experiences semi-arid climatic condition with mild winters and hot summers. It receives about 650 mm rainfall annually. Entire Ahmednagar district come under the category of "Drought prone Area". According to 2011 census population of Ahmednagar in 2011 is 350,859; of which male and female are 178,899 and 171,960 respectively.

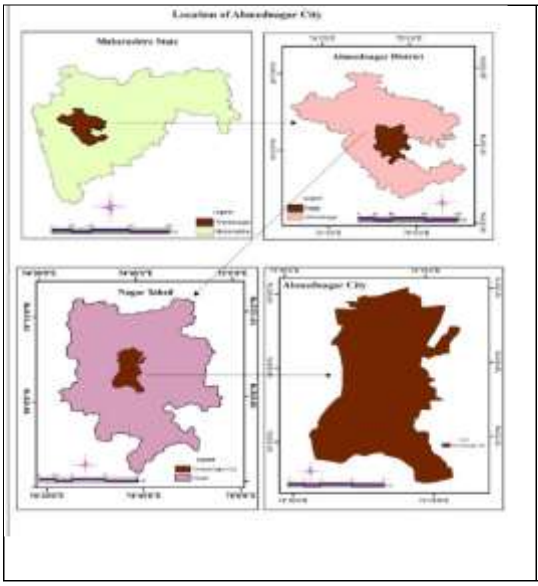

Fig. 1.1:- Location Map of Study area

Fig. 1.2:- Map of the study area in Rajasthan

Result of Analysis

For the present study we have selected those districts from which people are immigrated into the Ahmednagar City. From Rajasthan state maximum migrant families which were came from Nagaur (60) district after that Sikar (24) district and Bikaner (9). Only 2 families came from Hanumangarh which is located close to Punjab border and hence people prefer to settle over there.

Sr. No	District	No. of Families Migrated to A'nagar (1974-2022)
1	Churu	8
2	Sikar	24
3	Nagaur	60
4	Bikaner	9
5	Barmer	4
6	Jodhpur	4
7	Pali	9
8	Hanumangarh	2
	Total	**120**

Table 1.1 Number of migrant families of Rajasthan state.

Decade	Number of Migrated families
1971-1980	2
1981-1990	6
1991-2000	45
2001-2010	40
2011-2019	27
	120

Table 1.2 Number Decade wise migrated families.

Above table shows the decadal wise flow of the migrant in the Ahmednagar city. The maximum number of people is came in the 1991-2000 decade (45) after that 2001-2010decade (40). In the decade of 2011-2019 (27) families are come in the ahmednagar city

Bikaner District:-

Bikaner District is a situated of the state of Rajasthan in western India. The historic city of Bikaner is the district headquarters. It has 8 tehsil. The district is bounded by Ganganagar District to the north, Hanumangarh District to the northeast, Churu District to the east, Nagaur District to the southeast, Jodhpur District to the south, Jaisalmer District to the southwest, and

Punjab Province of Pakistan to the northwest. The driving distance between Ahmednagar to Bikaner is 1,244 km.In Bikaner district maximum number of migrate families are from Hiyadesar (03) village in Nokha tehsil. After that Panchoo and Kisnasar having respectively (1, 1) people from these village are angagrd in food industry (preparation of Namkin or others). From Bikaner-Deshnokh 1 migrant family is come in search of better opportunities of in Ahmednagar city.

Barmer District:-

Barmer District is a district in Rajasthan state of India. It is located in the western part of Rajasthan state forming a part of the Thar Desert. Barmer is located in the western part of the state forming a part of the Thar Desert. The district borders Jaisalmer district in the north, Jalore district in the south, Pali district and Jodhpur district in the east, and Pakistan in the west.The total area of the district is 28,387 square kilometre(10,960 sq mi). After Jaisalmer district and Bikaner.it is the third largest district of Rajasthan. It is also the fifth largest district in the country.In Barmer district there are only two villages of Sheo tehsil from where migrant are come in to Ahmednagar city. Thoombali village have maximum number of migrate family is (02) and Arang having (02) migrant family are come in search of better opportunities of in Ahmednagar city

Churu district:-

Churu is a district of the Indian state of Rajasthan in northern India. The town of Churu is the administrative headquarters of the district. Churu lies in the Jangladesh region of northern Rajasthan and shares boundaries with the Hanumangarh District to the north, the Haryana state to the east, the Jhunjhunun and Sikar districts to the southeast, the Nagaur District to the south, and the Bikaner District to the west. From Churu district maximum number of migrated families is from Rajgarh tehail Rabari bas village (06). After that Ranasar village in Churu tehil having (02) families are come in search of better opportunities of in Ahmednagar city.

Jodhpur District:-

Jodhpur District is a district in the State of Rajasthan in western India. The city of Jodhpur is the administrative headquarters of the district. As of the 2011 census, Jodhpur district population is 3685681it is the second highest populated district of Rajasthan (out of 33), after Jaipur district. From Jodhpur district maximum number of migrated families is from Barli (2) and Salori village (02) Families are come in search of better opportunities of in Ahmednagar city

Nagaur District:-

Nagaur District is one of the 33 districts of the state of Rajasthan in western India. Area of the district is 17,718 km2. The city of Nagaur is the district headquarters. Nagaur District is situated between 26°25' & 27°40' North Latitude & 73°.10' & 75°.15' East Longitude. The driving distance between Ahmednagar to Nagaur 1097 Km. In Nagaur district there are 10 tehsils among these tehsil Nagaur tehsil having the highest population (5, 24,926) and highest literacy rate is in Nawa tehsil (57.52%). After that Nawa tehsil (4, 04,910) stand second, Didwana tehsil (3, 97,003) is third.

Nagaur district have maximum number of migrant from the Rajasthan to the Ahmednagar city. Nagaur is the urban place but still people use to migrate. This trend shows the disparities between two regions. From nagaur tehsil 60, Merta tehsil 05, Degana tehsil 06 and Jayal tehsil 03 families are come to Ahmednagar. People from this region engaged in food industry (preparation of Namkin or others) in ahmednagar city.

Pali District is a district of the state of Rajasthan in western India. The town of Pali is the district headquarters. The Aravalli Range forms the eastern boundary of the district; the southern boundary ends at Bamnera village in Sumerpur Tehsil. A zone of foothills lays to the west, through which run the many tributaries of the Luni River.The western portion of the district includes the alluvial plain of the Luni. It is boundedby eight districts, Nagaur District to the north, Ajmer District to the northeast, Rajsamand District to the east, Udaipur District to the southeast, Sirohi District to the southwest, Jalore District and Barmer District to the west, and Jodhpur District to the northwest. Distance between Ahmednagar to Pali is 1003 Km. by road. In Pali district maximum number of migrate is from Mada (03) village in Desuri tehsil. After that Daylanakalan having (03), Dayalpura (01), Shivpura (02) families are migrated to

Ahmednagar city. People from this region are engaged in furniture making.

Sikar district:-

Sikar district is a district of the Indian state Rajasthan in northern India. The city of Sikar is the administrative headquarters of the district. The district is located in the north-eastern part of the state of Rajasthan. It is bounded on the north by Jhunjhunu district, in the north-west by Churu district, in the south-west by Nagaur district and in the south-east by Jaipur district. It also touches Mahendragarh district of Haryana on its north-east corner.The district has an area of 7742.44 km2; Distance between Sikar to Ahmednagar is 1152 km by road along and a population of 26, 77,737 (2011 census). Sikar, Churu district and Jhunjhunu district's comprise the Shekhawati region of Rajasthan. The old name of Sikar was "Veer Bhan Ka Bas" In Sikar district there are 6 tehsils among these six tehsil Sikar tehsil having the highest population (6, 44,183) and also having the highest literacy rate (62.9%). After that Sri Madhopur tehsil (5, 83,328) stand second, Dantaramgarh tehsil (4, 23,314) is third. After Nagaur,Sikar District is have maximum number of migrant families in the Ahmednagar. From Dantaramgarh 12, Sikar 05, Fatehpur 06 families are migrated in Ahmednagar city.

Hanumangarh district:-

Hanumangarh district is a district in the state of Rajasthan in India. The city of Hanumangarh is the district headquarters and its largest city. The district is located in the extreme north of Rajasthan. It has an area of 12,645 km2, the driving distance between Hanumangarh to Ahmednagar is 1425 km. a population of 1,779,650 (2011 census) and a population density of 184 persons/km2. It is bounded on the north by Punjab state, on the east by Haryana state, on the south by Churu District of Rajasthan, and on the west by Ganganagar District of Rajasthan. The major work of the district is farming; major crops include rice, millet, cotton, sonamukhi (senna), wheat, and vegetables. It has been the food basket of Rajasthan along with Shri Ganga Nagar, and with best agricultural land this is the 31st district of Rajasthan. From Hanumangarh district very few people migrate in to the Ahmednagar. Mainly from Purabsar vilaage of Rawatar tehsil. The main reason why less people is migrate is the because of distance. They migrate Panjab state instead of Ahmednagar Maharashtra.

Sr.no.	District name	District population	Migrant Families
1	Churu	2,367,745, 8	8
2	Sikar	2,421,914 24	24
3	Nagaur	2,367,745 60	60
4	Bikaner	3,309,234 9	9
5	Barmer	26,77,737 4	4
6	Jodhpur	1,779,650 4	4
7	Pali	2,038,533 9	9
8	Hanumangarh	3,685,681 2	2

Table 1.3 District wise numbers of migrant families.

Above table shows Jodhpur district has highest population among all districts. The second highest population is of Nagaur district and Barmer stood third. Whereas highest migration is found in Nagaur, second highest in Sikar district and Bikaner rank third.

Causes of Migration in all 8 districts

Poverty is the main cause of the migration mainly in Bikaner and because it is the most backward district of the Rajasthan state

Very less Job opportunities.

Lack of higher education mainly in Hanumangarh.

Crop failure due to the unpredictable nature some times because of flood and some time because of drought, people use to migrant.

Area	Migrant Families
Hanuman nagar	09
Vinayaknagar	36
Savedi	19

Kedgaon	04
Sarasnagar	16
Daund Road	02
Bhosaleakada	04
Premdan hudco	05
BistabagChowk	03
Pipeline Road	06
Jhopdi Canteen	04
Mg road	02
Railway Station	10
Total	**120**

Table 1.4 Migrant families are staying in following area of Ahmednagar City

The above table shows the maximum number of migrate families is situated in Vinayak nagar (36) in Ahmednagar. In this region they have their colony. After Vinayak nagar, Savedi is the favorite location because of Savedi is the one of the main urban center of Ahmednagar city and it good for their business purpose.

Sr.No	Business	Total Families
1	Carpenter	32
2	Travel Agent	1
3	Watchmen	2
4	Marbal Thekedar	16
5	Nurse	1
6	Transport	2
7	Teacher	3
8	Mithai Shop	8
9	Marbal Factory	4
10	Furniture	7
11	Cloth Shop	14
12	Shoes Shop	6
13	Grocery Shop	5
14	Army	3
15	Company	5
16	Factory	3
17	Doctor	1
18	Coolie	1
19	Building Labour	5
20	Painter	1
	Total	120

Table 1.5 various types of people's working fields.

Sr. no.	District Name	Calculated value	Table Value	
			0.05	0.01
1	Nagaur	5.36	2.57	4.03
2	Sikar	27.84	2.05	2.77
3	Bikaner	74.92	2.00	2.66
4	Pali	74.92	2.00	2.66

Table 1.6 District wise Statistical analysis.

For the present study descriptive statistical methods have been use for analysis. After applying student's 't' test the result shows that for Nagaur district the calculated value is 5.36 and table value of 0.05 is 2.57 and for 0.01 is 4.03. It means calculated value is greater than table value so H1 hypothesis is accepted. So there is significant relationship between population mean and sample mean. For Sikar district the calculated value is 27.84 and table value of 0.05 is 2.05 and for 0.01 is 2.77 it means calculated value is greater than table value so H1 hypothesis is accepted. So there is significant relationship between population mean and sample mean. For Bikaner district the calculated value is 74.92 and table value of 0.05 is 2.00 and for 0.01 is 2.66. It means calculated value is greater than table value so H1 hypothesis is accepted. So there is significant relationship between population mean and sample mean. For Pali district the calculated value is 74.92 and table value of 0.05 is 2.00 and for 0.01 is 2.66. It means calculated value is greater than table value so H1 hypothesis is accepted. So there is significant relationship between population mean and sample mean.

CONCLUSION

This study derives that migration is a function of push and pull factors that is in rural areas increasing of population did not have job facilities, reasonable income, and basic amenities. The pull factors of better job facilities, good salary, and more income, medical and educational facilities are attracting the rural people to move to the cities like Ahmednagar city. The push factors of no job facilities, low salary, less income, drought, less medical and educational facilities are the push factors of the rural people from rural to urban migration. People from all districts which are came in search of better opportunities in Ahmednagar city, Surveyed sample shows that all of these families are all most successful in all there selected occupations. The economic conditions of families are upgraded during last few decades.

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Prioritization of Sub-Watersheds in Semi Arid Region: A Case Study of Shevgaon and Pathardi Tahsils in Maharashtra

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Abstract:

Watershed management is an important in today's environment. Prioritization of sub-watershed plays an important role in watershed management studies. It shows the requirement of watershed study to go for the green growth of the region. Physical and social factors are also play an important role in identifying the sub-watershed for Prioritization. The present research is throwing a focus on how morphometric parameters in association with GIS analysis will help in identifying the ranking of sub-watersheds for further development with the help of suggested watershed structures. Shevgaon and Pathardi tahsils are known for drought prone tahsils of Ahmednagar district in Maharashtra. These tahsils comes under the semi-arid region. Sub-watershed prioritization is necessary for proper planning and management of natural resources for sustainable development of the study area. Scarcity of rainfall and increasing population pressure on the land as well as water resources. Hence, researcher has selected Shevgaon and Pathardi tahsils for sub-watershed prioritization. There are seven sub-watersheds selected from two tahsils for present research work. Morphometric analysis of all these sub-watersheds is taken into consideration for this research. The largest sub-watershed is Erdha sub-watershed which is located in Karanji circle of Pathardi tahsil, having an area of 145.06 km^2 and smallest sub-watershed is Erandgaon sub-watershed in Shevgaon tahsil, having an area of 40.143 Km^2. The drainage density of sub-watersheds varies between 1.83 to 2.80 p/km^2 it indicates coarser drainage structure. Lowest drainage density value is found in Chapadgaon sub-watershed which is 1.83 p/km^2 and highest drainage density value is found in Chandani watershed which is 2.80 p/km^2. The elongation ratio varies from 0.32 to 0.70. It indicates that all sub-watersheds have elongated shape. The high value of circularity ratio of Erandgaon watershed which is 0.64.

The compound parameter values are calculated for selected sub-watersheds. Lowest compound parameter value is given the highest priority and highest compound parameter value is given the lowest priority. In this research Erandgaon sub-watershed has a lowest compound parameter value which is 2.99 and Chandani sub-watershed has a highest compound parameter value which is 5.38. Prioritization is done on three levels depending on the result such as high, moderate and low priority groups.

Key words: Watershed, Morphometric Analysis, Compound Parameters Value, Prioritization.

Introduction:

Prioritization of sub-watershed plays an important role in watershed management studies. It shows the requirement of watershed to give a treatment for the green growth of the region and conservation of the sub-watersheds. Prioritization of sub-watersheds for soil and water conservation is conducted recently in several areas. Ranking of different sub-watersheds according to morphometric analysis using Remote sensing and GIS techniques. The prioritization concept is found to be very helpful for understanding the morphology and fluvial characteristics of individual watersheds and accordingly design efficient water harvesting structures.

Remote sensing and GIS techniques are the most important and powerful tools for watershed development, management and prioritization of sub-watersheds for soil and water conservation. The quantitative analysis of drainage basins is also considered as basic technique for watershed characterization and geomorphometric analysis of drainage basins and stream network. The present research is throwing a focus on how morphometric parameters in association with GIS analysis will help in identifying the ranking of sub-watersheds for further development with the help of suggested watershed structures. Shevgaon and Pathardi tahsils are known for drought prone tahsils of Ahmednagar district in Maharashtra. These tahsils comes under the semi-arid region. Sub-watershed prioritization is necessary for proper planning and management of natural resources for sustainable development of the study area. Scarcity of rainfall and increasing population pressure on the land as well as water resources. Hence, researcher has selected Shevgaon and Pathardi tahsils for sub-watershed prioritization. There are seven sub-watersheds selected from two tahsils for present research work.

Aims and Objectives:

The main aim of the study is to find out prioritization of sub-watershed and suggest type of structures for their particular sites based on morphometric and local geomorphic characteristics of the area.

1. To study the LULC analysis of Shevgaon-Pathardi tahsils.
2. To study the morphometric analysis of all selected sub-watersheds.
3. To find out compound parameter values of each sub-watersheds for prioritization.

Study Area:

The study area is located in Shevgaon and Pathardi tahsils of Ahmednagar district in Maharashtra. The study area lies between 18° 58' 43'' North to 19° 33' 45'' North latitudes and 74° 51' 30'' East and 75° 32' 32'' East longitudes (Figure 1). Total study area is 2,301.8 km^2. Which is divided into two tahsils, Shevgaon tahsil is covered 1,092.7 km^2 area which is 47% of the total area and Pathardi tahsil is covered 1,209.1 km^2 area which is 53% of the total area.

Seven sub-watersheds are selected for the present research work, namely, Kasichi sub-watershed (SWS-1) Chapadgaon sub-watershed (SWS-2) and Erandgaon sub-watershed (SWS-3) from Shevgaon tahsil and Tarak sub-watershed (SWS-4) Chandani sub-watershed, (SWS-5) and Erdha sub-watershed (SWS-6) from Pathardi tahsil. Domeshwar sub-watershed (SWS-7) is a common watershed in both the tahsils.

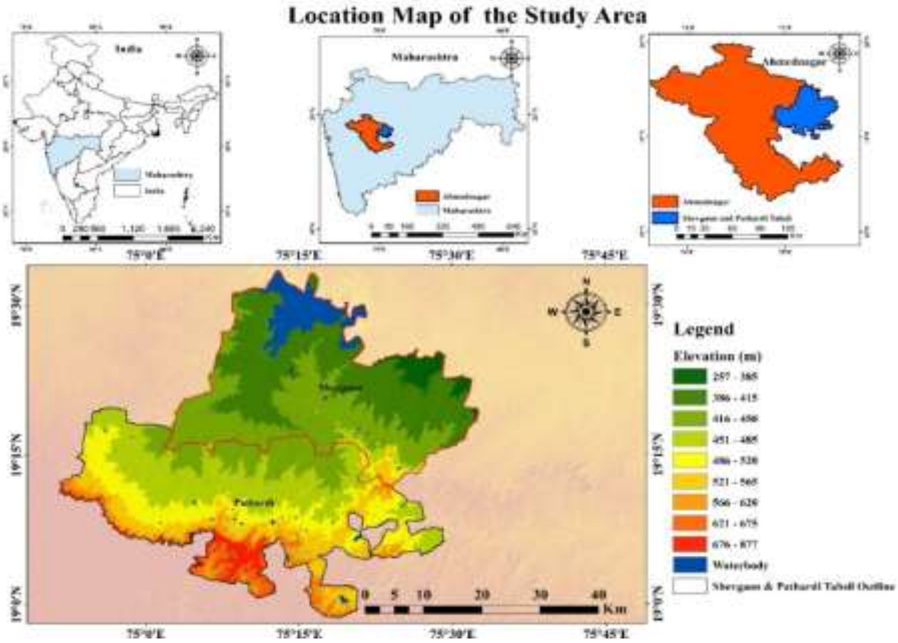


Figure - 1: Location Map of the Study Area

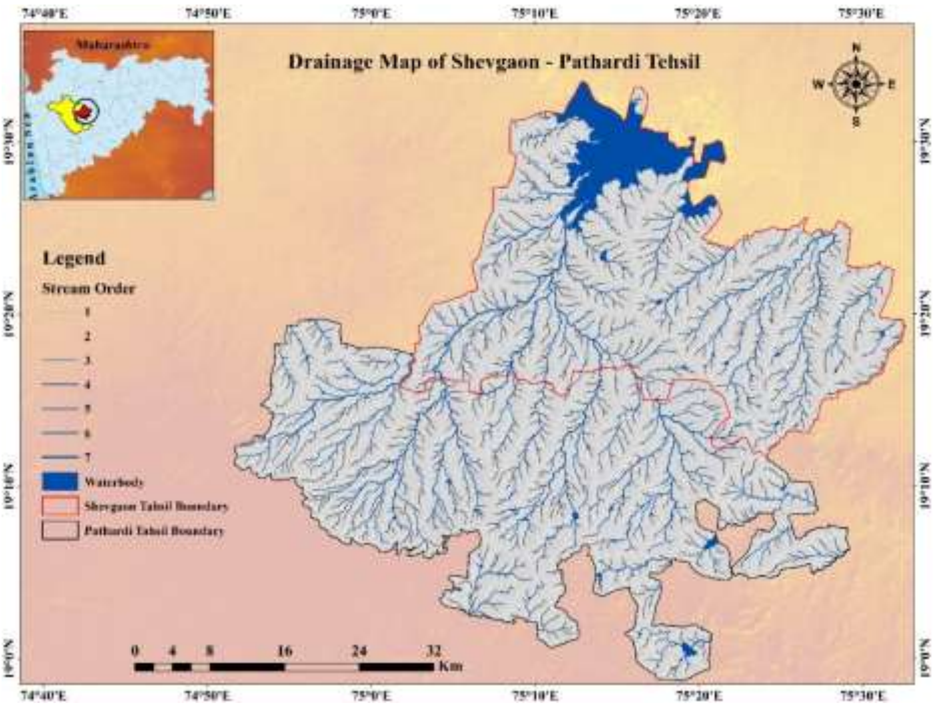


Figure - 2: Drainage of Shevgaon -Pathardi Tahsil

Review of Literature:

Choudhari P. P., Nigam Gaurav K., Singh Sudhir Kumar and Thakur Sapana (2018): analysed Morphometric based prioritization of watershed for groundwater potential of Mula river basin, Maharashtra, India. Authors were used SRTM DEM for calculate morphometric parameters. Five watersheds were selected for prioritization in Mula basin. Farhan Y. and Anaba O. (2016): studied a Remote Sensing and GIS Approach for Prioritization of Wadi Shueib Mini-Watersheds (Central Jordan) Based on Morphometric and Soil Erosion susceptibility

Analysis. Prabhakar A. K., Singh K. K., Lohani A. K. and Chandniha S. K. (2019): focused on study of Champua watershed for management of resources by using morphometric analysis and satellite imagery of upper Baitarni river basin in Odisha state in India. He used two different types of methods of analysis which involves morphometric and land use land cover.

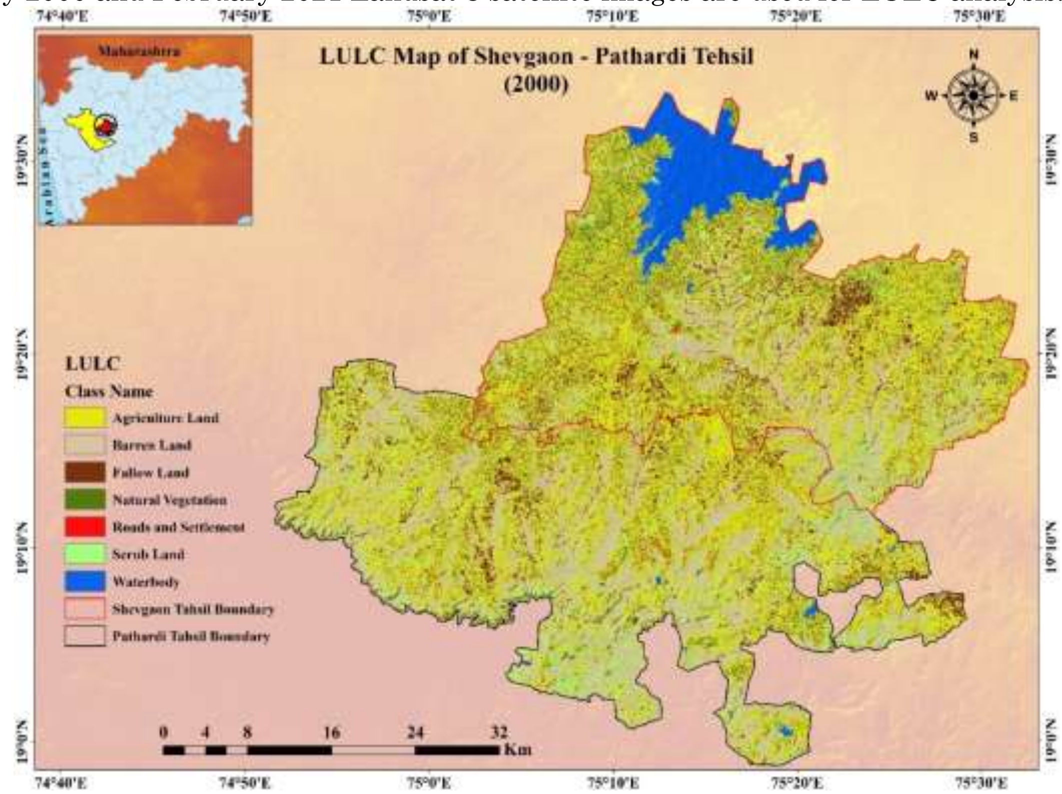
Swarnakar P. and Channabasappa K. (2022): carried out quantitative morphometric assessment of Bhima lower sub-basin using Remote Sensing and GIS. For his study authors were used digital elevation model Cartosat - 1 satellite data with 2.5 m PAN resolution at 16-bit radiometric resolution and 1 arcsec spatial resolution and Strahler's method udes for stream ordering and calculated morphometric parameters. Zende A., Nagrajan R. and Atal K. R. (2013): studied prioritization of sub-watersheds in semi-arid region, western Maharashtra, India using Geographical Information System. He used morphometry based prioritization method and calculate compound parameters. For this study he has selected Yerala river basin in Satara and Sangli district in Maharashtra.

Methodology:

Topographical maps with scale 1:50,000 (20 m contour interval) of Shevgaon and Pathardi tahsils were obtained from Survey of India. The toposheets were scanned and georeferenced using GIS softwares. Seven sub watersheds were selected from both tahsil. Digitized all watersheds and prepare drainage network and stream order was assigned following the stream ordering system developed by Strahler. Basic morphometric parameters were measured and calculated all seven watersheds using GIS softwares and mathematical equations elaborated by Horton, Strahler, Schumm and miller. On the basis of morphometric analysis compound values were calculated for prioritization. Ranking of all watersheds and prepared prioritization map. Land use land cover were carried out of both tahsils for change detection analysis.

Land Use Land Cover Analysis:

February 2000 and February 2021 Landsat 8 satellite images are used for LULC analysis.



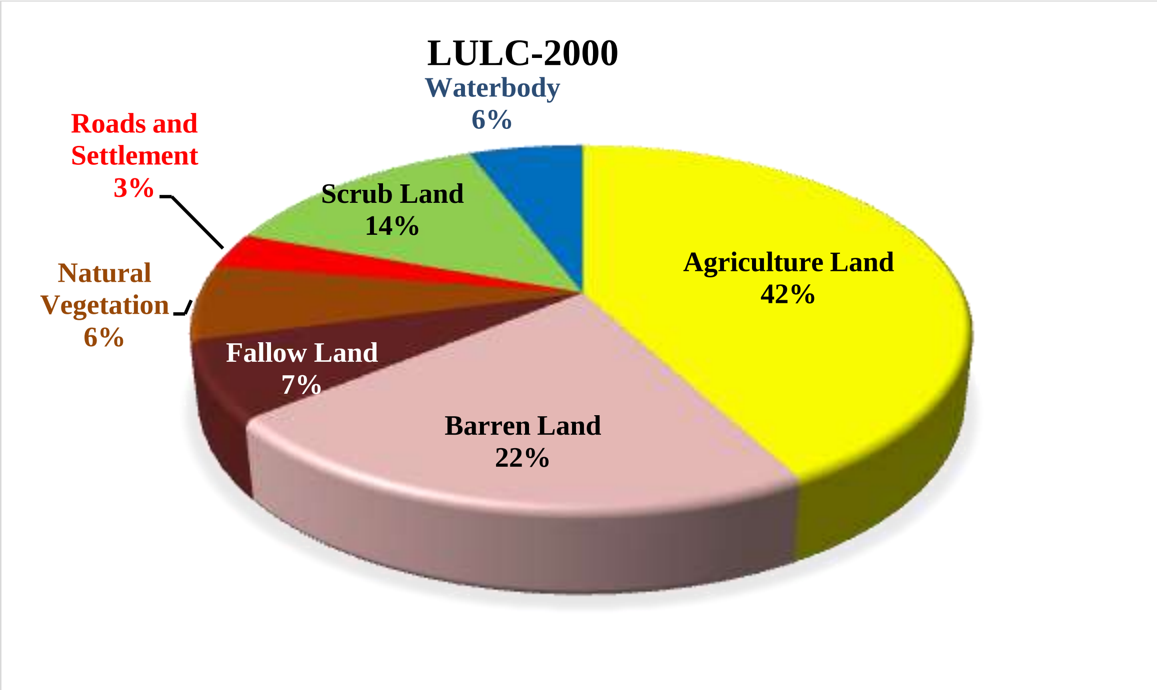
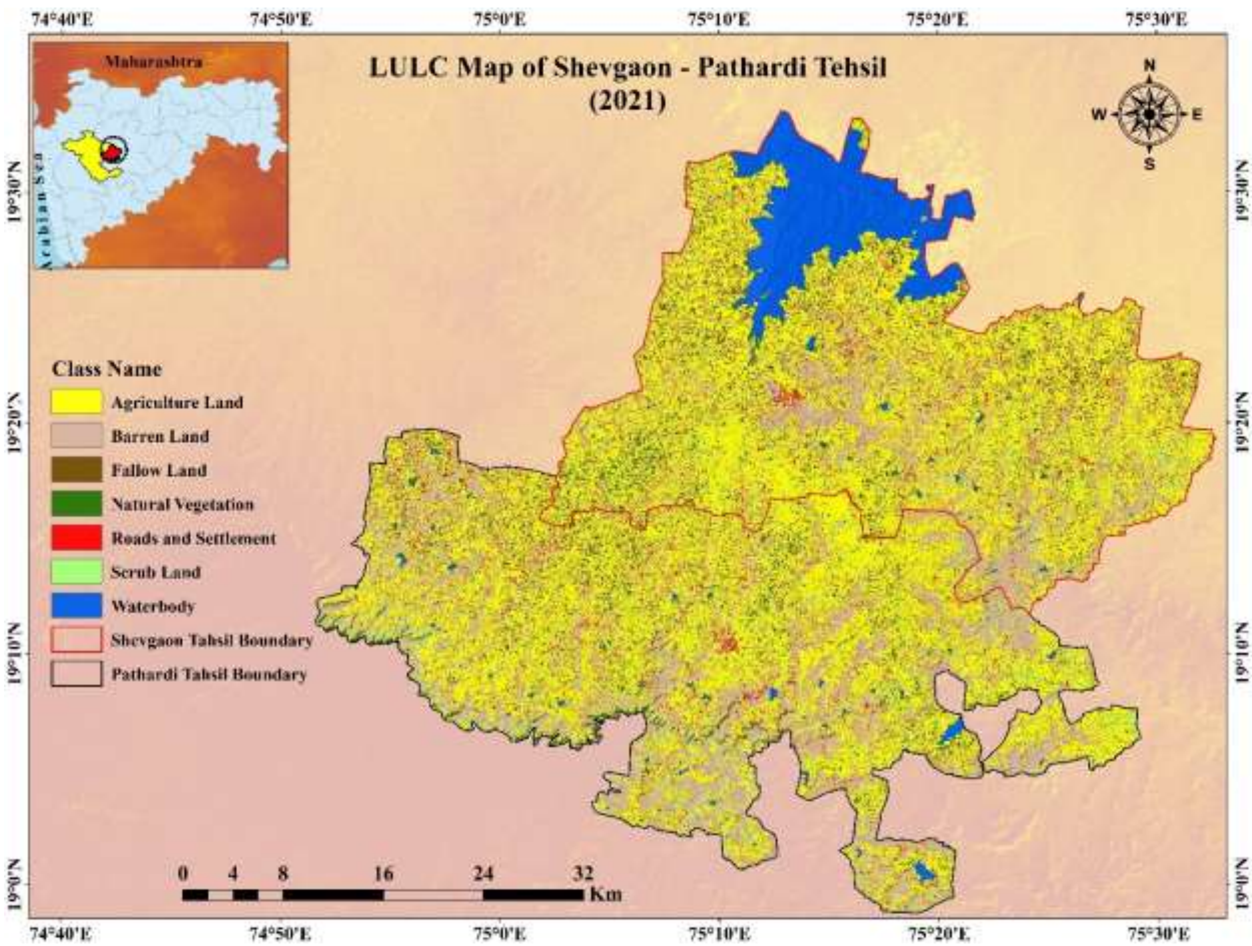


Figure 3: LULC of Shevgaon – Pathardi Tahsil in 2000



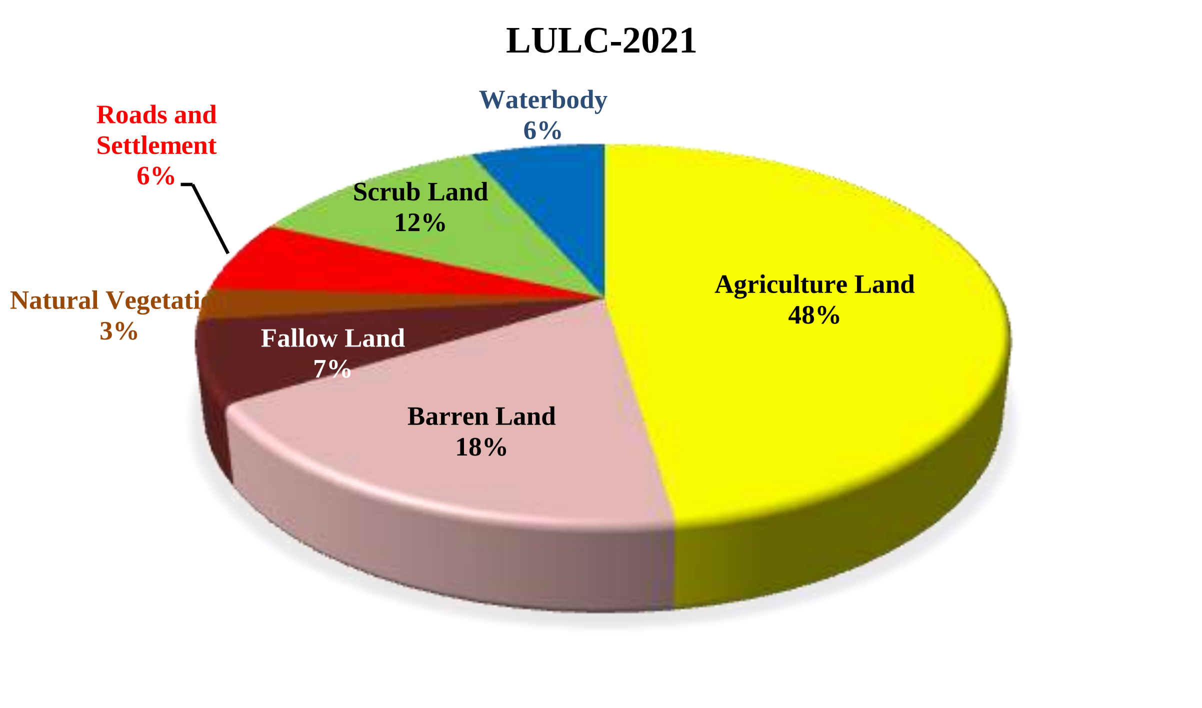


Figure 4: LULC of Shevgaon – Pathardi Tahsil in 2021

Table 1: Change in Land Use Land Cover from 2000 to 2021

Name of the Classes	2000	2021	Change in Land Use Land Cover
	Area in %	Area in %	
Agriculture Land	42.2	47.7	5.5
Barren Land	21.9	18.5	-3.3
Fallow Land	6.9	6.9	0.1
Natural Vegetation	6.6	2.7	-4.0
Roads and Settlement	3.1	6.1	3.0
Scrub Land	13.7	11.6	-2.0
Waterbody	5.7	6.4	0.7

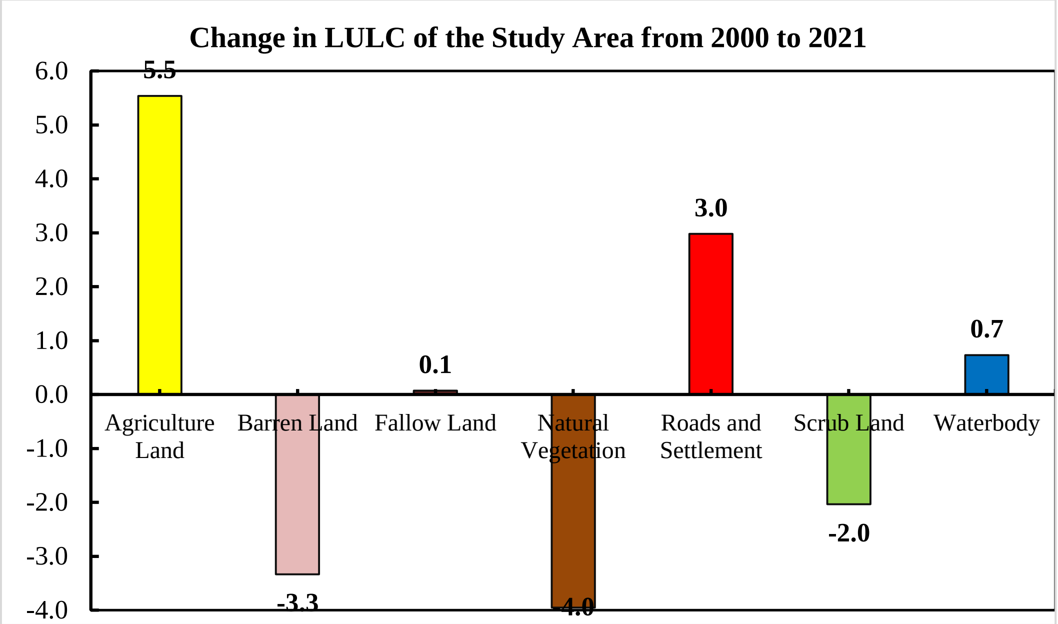


Figure 5: Change in LULC of the Study Area from 2000 to 2021

The LULC change analysis is carried out using remote sensing cloud free satellite images (Landsat 8) during February 2000 and February 2021. Data downloaded from the US Geological survey https://earthexplorer.usgs.gov website. The unsupervised classification has been carried out for LULC change detection in Shevgaon-Pathardi tahsil. The study area is classified into seven distinct classes as agriculture land, barren land, fallow land, natural vegetation, roads and settlement, scrub land and waterbody. Agriculture land is increased only 5.5%, waterbody is increased only 0.7%, fallow land increased in negligible percentage (0.1%), roads and settlements are also increased while barren land decreased 3.3%, natural vegetation is decreased 4.0 % and scrub land also decreased. Requirement of area under agriculture sector is increase for developing countries. Therefore, prioritization of sub-watersheds from the study area is useful. For management point of view, the conservation practices and measures are required in the study area.

Table 2: Methods of Calculating Morphometric Parameters

Morphometric Parameters	**Methods**	**References**
Linear		
Stream order (μ)	Hierarchical order	Strahler, 1964
Stream length (Lμ)	Length of the stream	Horton, 1945
Mean stream length (Lsm)	Lsm= Lμ/Nμ	Horton, 1945
Stream length ratio (Rl)	Rl= Lμ/ Lμ -1	Horton, 1945
Bifurcation ratio (Rb)	Rb = Nμ/ Nμ+1	Schumn, 1956

Relief		
Basin relief (Bh)	Vertical distance between the lowest and highest points of watershed	Schumn, 1956
Relief ratio (Rh)	Rh = Bh/Lb	Schumn, 1956
Ruggedness Number (Rn)	Rn = Bh x Dd	Schumn, 1956
Arial		
Drainage density (Dd)	Dd=L/A	Horton, 1945
Stream frequency (Fs)	Fs=N/A	Horton, 1945
Textural ratio (T)	T= N1/P	Horton, 1945
Form Factor (Rf)	$Rf=A(Lb)^2$	Horton, 1945
Circularity ratio (Rc)	$Rc=4\pi A/P^2$	Miller, 1953
Elongation Ration (Re)	$Re=2\sqrt{(A/\pi)}/Lb$	Schumn, 1956

Table 3: Drainage Network Analysis of all Selected Sub-Watersheds

Sub Watershed		Stream Numbers							Stream Length						Length Ratio				
		1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	Total	1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	2/1	3/2	4/3	5/4	6/5
SWS 1	Kasichi Watershed	230	52	12	03	01	-	**298**	140.606	48.378	26.763	7.909	23.728	-	0.34	0.55	0.0002	3.0	-
SWS 2	Chapadgaon Watershed	91	19	04	02	01	-	**117**	54.561	20.416	7.796	10.076	8.172	-	0.37	0.38	1.29	0.81	-
SWS 3	Erandgaon Watershed	93	24	07	02	01	-	**127**	43.852	20.264	15.056	5.128	4.631	-	0.46	0.74	0.34	0.90	-
SWS 4	Tarak Watershed	200	48	12	04	01	-	**265**	108.305	36.451	25.516	18.771	9.262	-	0.33	0.70	0.74	0.49	-
SWS 5	Chandani Watershed	465	108	29	07	02	01	**612**	201.310	89.300	40.160	21.130	26.610	9.850	0.44	0.44	0.53	1.25	0.37
SWS 6	Erdha Watershed	351	69	15	05	01	-	**441**	213.828	74.471	39.965	33.816	12.999	-	0.0003	0.53	0.84	0.38	-
SWS 7	Domeshwar watershed	167	38	06	02	01	-	**214**	95.410	37.019	8.257	11.228	16.886	-	0.38	0.22	1.35	1.50	-

Table 4: Morphometric Parameters of All Selected Sub-Watersheds

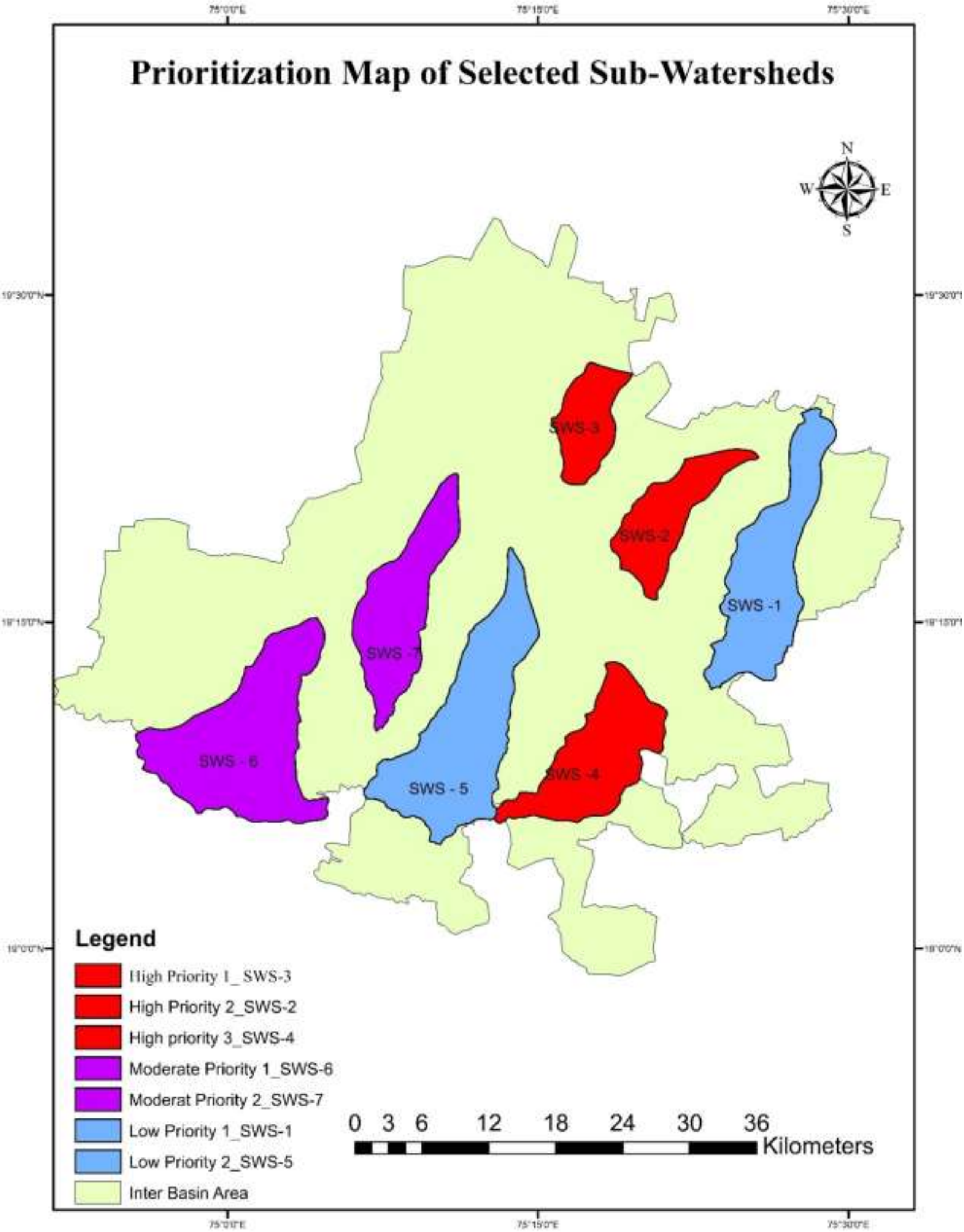
Sub Watersheds		Area (km^2)	Perimeter	Stream Frequency (Per/ km^2)	Basin Length (km)	Drainage Density (Per/ km^2)	Drainage Texture	Form Factor	Elongation ratio	Circularity ratio	Mean Bifurcation ratio
SWS 1	Kasichi Watershed	105.730	62.395	2.80	36.0	2.32	4.77	0.082	0.32	0.34	3.93
SWS 2	Chapadgaon Watershed	55.201	39.547	2.11	14.46	1.83	2.95	0.26	0.58	0.44	3.38
SWS 3	Erandgaon Watershed	40.143	28.144	3.16	10.720	2.22	4.51	0.35	0.67	0.64	3.19
SWS 4	Tarak Watershed	87.047	48.605	3.04	17.230	2.27	5.45	0.29	0.61	0.46	3.79
SWS 5	Chandani Watershed	138.46	66.026	4.42	25.816	2.80	9.26	0.20	0.51	0.39	3.53
SWS 6	Erdha Watershed	145.06	62.25	3.04	19.414	2.58	7.08	0.38	0.70	0.47	4.42
SWS 7	Domeshwar watershed	83.756	50.965	2.55	22.77	2.01	4.20	0.16	0.45	0.40	3.93

Table 5: Calculation of Compound value and Prioritized rank for all Selected Sub-Watersheds

Sub Watersheds		Mean Bifurcation Ratio R_b	Drainage Density D_d	Stream Frequency F_u	Basin Length (km) Lo	Form Factor Rf	Elongation ratio Re	Circularity ratio Cc	Compound Value	Prioritized Rank	Priority
SWS 1	Kasichi Watershed (Bodhegaon)	3.93	2.32	2.80	25.42	0.082	0.32	0.34	5.03	6	Low
SWS 2	Chapadgaon Watershed) (Chapadgao)	3.38	1.83	2.11	14.46	0.26	0.58	0.44	3.29	2	High
SWS 3	Erandgaon Watershed (Erandgao)	3.19	2.22	3.16	10.720	0.35	0.67	0.64	2.99	1	High
SWS 4	Tarak Watershed (Yeli)	3.79	2.27	3.04	17.230	0.29	0.61	0.46	3.95	3	High
SWS 5	Chandani Watershed (Pathardi)	3.53	2.80	4.42	25.816	0.20	0.51	0.39	5.38	7	Low
SWS 6	Erdha Watershed (Karanji)	4.42	2.58	3.04	19.414	0.38	0.70	0.47	4.43	4	Moderate
SWS 7	Domeshwar watershed (Awhane Budrukh)	3.93	2.01	2.55	22.77	0.16	0.45	0.40	4.61	5	Moderate

Classification

1) High Priority (Below 4.00)
2) Moderate Priority (4.00 to 5.00)
3) Low Priority (Above 5.00)



Conclusion:

Morphometric analysis of all these sub-watersheds is taken into consideration for this research. The largest sub-watershed is Erdha sub-watershed which is located in Karanji circle of Pathardi tahsil, having an area of 145.06 km2 and smallest sub-watershed is Erandgaon sub-watershed in Shevgaon tahsil, having an area of 40.143 km2. The drainage density of sub-watersheds varies between 1.83 to 2.80 p/km2 it indicates coarser drainage structure. Lowest drainage density value is found in Chapadgaon sub-watershed which is 1.83 p/km2 and highest drainage density value is found in Chandani watershed which is 2.80 p/km2. The elongation ratio varies from 0.32 to 0.70. It indicates that all sub-watersheds have elongated shape. The high value of circularity ratio of Erandgaon watershed which is 0.64. On the basis of morphometric analysis compound parameter values are calculated for selected sub-watersheds prioritization. Lowest compound parameter value is given the highest priority and highest compound parameter value is given the lowest priority. In this research Erandgaon sub-watershed has a lowest compound parameter value found which is 2.99. While Chandani sub-watershed has a highest compound parameter value which is 5.38. Compound parameter values are depended on the drainage structure, drainage density, length of the watershed, stream order, number of streams, mean bifurcation ratio.

Prioritization is done on three levels depending on the result such as high, moderate and low priority groups. In this study high priority assign to Erandgaon, Chapadgaon and Tarak sub watersheds, because of local geomorphic condition is affected on these watersheds. Scarcity of rainfall, slope, length of the watershed is very low. Moderate priority assigns to the Erdha sub-watershed and Domeshwar sub – watershed. Lastly, low priority is given to Kashichi sub- watershed and Chandani watershed. Prioritization of sub watersheds is helpful in scientific planning, mitigation and management of the natural resources.

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Use of Geo-Spatial Techniques in Analysing Morphometric Parameters: A Case Study of River Sina

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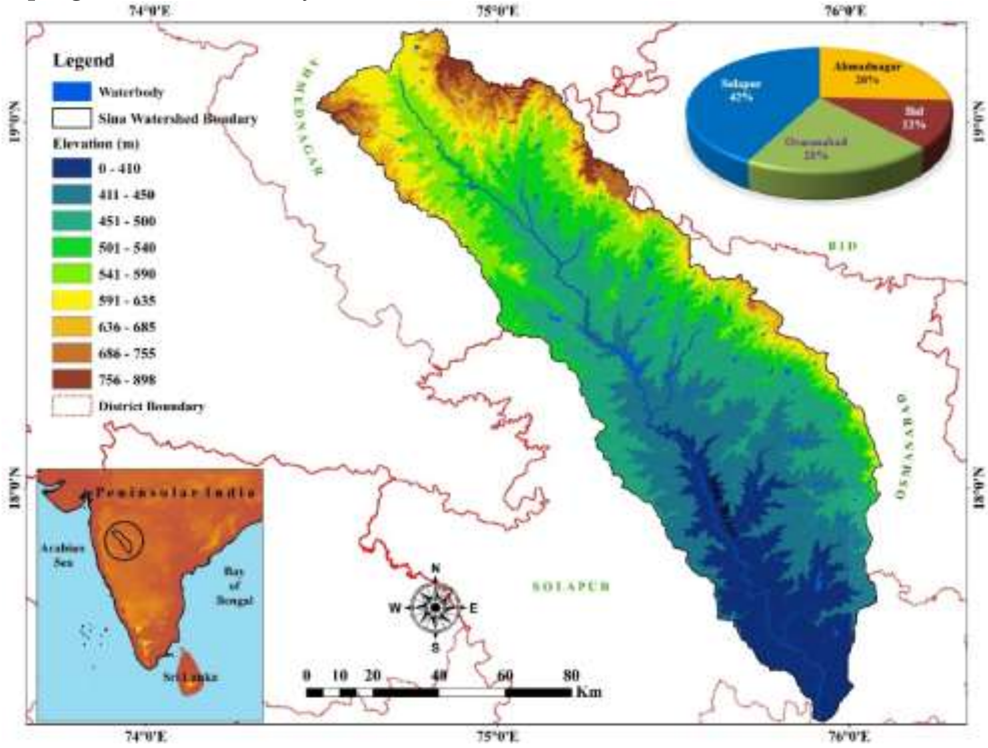
Introduction

Morphometry is the measurement and mathematical analysis of the configuration of the earth's surface, shape and dimension of its landforms (Clarke 1996; Agarwal 1998; Reddy et al. 2002). The morphometric analysis is completely successful by measurement of linear, aerial, relief, gradient of channel network and contributing ground slope of the basin (Nautiyal 1994; Nag and Chakraborty, 2003; Magesh et al. 2012).A broadly accepted principle of morphometry is that drainage basin morphology reflects various geological and geomorphological processes over time, as specified by several morphometric research (Horton 1945; Strahler 1952; Muller 1968; Oguchi 1997). It is well recognized that the effect of drainage morphometry is much noteworthy in realizing the landform processes, physical properties of soil and erosional characteristics. Drainage lines of an area describes the prevailing three-dimensional geometry of the region and also aid in understanding its evolutional process (Singh, 1980). Drainage provides a basic to understand initial gradient, variation in rock resistance, structural control, geological and geomorphologic history of the drainage basin or watershed (Rai et al. 2014). Several drainage parameters like stream order, basin area and perimeter, length of drainage channel, density of drainage, etc. are involved in evaluating the morphometry of the drainage. Quantitative analysis of drainage is significant part of watershed for hydrological investigations, management of basin and assessment of environment. In this paper an attempt has been made to study the morphometric aspects of Sina Basin by using RS and GIS tools. The linear parameters of morphometry like stream order, stream length, length ratio, bifurcation ratio, etc. basin geometry parameters like basin length, basin area, basin perimeter etc are studied. Stream frequency, drainage density, infiltration number, relief ratio, gradient ratio, etc are some of the drainage texture and relief characteristics studied as well.

Study area

Sina River makes the boundary between Ahmednagar district on one side and Ashti Tehsil ofBeed district on another side. The major left tributary of Bhima River is marked by Sina River. In Sina river earth fill Sina dam is found near Nimgaon Gangurda in Karjat taluka of Ahmednagar district. Sina river starts near Ahmednagar city which has two main sources one near Jeur at an 16km to the northeast side and another one near Jamgaon at a distance of 20km to west side of Ahmednagar city. It joins the Bhima River in Solapur District. The total study area of Sina river basin counts for about 12377.25431 sq.km. 42% of the total area of Sina basin falls in Solapur district, 26% in Ahmednagar district and 20% and 12% in Osmanabad and Beed district respectively. Latitudinal extent of Sina river basin is from 18° 73'to 19° 26' and longitudinal extent is from 74° 48' to 74° 94'. Sina River originates from the Balaghat hill range surrounding the Ahmednagar town. There is scarcity of rainfall due to which this region is considered as drought-prone region of Maharashtra state. Fig 1.1 shows the location map of the study area. Sina Basin occupies most part of the Ashti Tahsil of the district and is 600 meters from mean sea level. The slope of the basin is in South- East direction. The river basin consist of several valleys of small streams draining in southwards direction. It is an area having slope from south to west direction lying in Balaghat tableland, which has intensely dissected flat, topped inter fluent hills generally sloping downward away from the Balaghat scarp.



Location Map of Study Area

Morphometric Analysis

Morphometric analysis of a basin describes characteristics of basin based on quantitative evaluation of different parameters. Parameters are allocated according to their dimensional aspects; linear aspects, areal aspects, and relief aspects. Morphometric parameters such as relief, shape, and length also influence basin discharge patterns strongly through their varying effects on lag time (Gregory and Walling, 1973). The arrangement of streams in a drainage system constitutes the drainage pattern, which in turn reflects mainly structural or lithologic controls of the underlying rocks (Eesterbrooks, 1969). The methods of Horton (1945), Strahler (1952), Schumm (1956) are used for linear aspects studies, for areal aspects study using Horton (1945), Miller (1953) and Schumm (1956) technique, and the technique applies to relief aspects are Schumm (1956). The following calculation and evaluation have shown the descriptions regarding the basin characteristics.

Linear morphometric parameters

Linear aspects give the information about one-dimensional parameter like Stream Order, Stream Number, Bifurcation Ratio, Stream Length, and Sinuosity Index. This indicates channel patterns of the drainage network with the topological characteristics of the stream segments and analysis are based on open links of the stream network.

Stream order (U) it is defined as a measure of the position of a stream in the hierarchy of tributaries (Leopold, Wolman, & Miller, 1964). For the analysis modified Horton's law (Strahler law) has been followed because of its simplicity. The smallest, un-branched fingertip streams are designated as 1st order, the confluence of two 1st order channels give a channels segments of 2nd order, two 2nd order streams join to form a segment of 3rd order and so on. While designating stream order between two channels of different order then the higher-order is maintained. The observation shows that Sina river has up to 7th order tributaries where 1st, 2nd, 3rd, 4th, 5th, 6th and 7th stream are 14568, 3116, 604, 121, 28, 6 and 1 respectively in numbers (Table 1).

The total number of stream segments are 18444. The drainage patterns of stream network indicate dendritic type that develop where the river channel follows the slope of the terrain. According to the Horton, the number of stream segments of successively lower orders in a given basin tend to form a geometric series beginning with the single segment of the highest order and increasing according to the constant ratio. The relation gives a negative linear pattern when plotted in the logarithmic and Arithmetic scale in Y-axis and X-axis respectively

Stream length (Lu)

Stream length indicates the behaviour of surface runoff on the basin which has a significant role in the drainage basin system. The stream with longer lengths is normally indicative of flatter gradient whereas the smaller length is characteristics of areas with larger slopes and finer textures. The total length of stream segments is maximum in first order stream and decreases as stream order increases. (Table 1

Stream order	Nu	Lu	Lu/Nu	Lur	Lur-r	Lur*Lur-r	Luwm
I	14568	9245.07	0.63				
II	3116	4410.11	1.42	2.23	13655.8	30452.96	
III	604	2206.96	3.65	2.58	6617.07	17083.28	
IV	121	1125.06	9.30	2.54	3332.02	8478.92	**2.41**
V	28	491.62	17.56	1.89	1616.68	3052.85	
VI	6	201.66	33.61	1.91	693.28	1327.11	
VII	1	233.27	233.27	6.94	434.93	3018.63	
Total	18444	17914.38		18.10	26349.79	63413.746	
Mean				2.34			

Table 1 shows stream length and stream length ratio

Bifurcation ratio (Rb)

Bifurcation ratio is related to the branching pattern of a drainage network. It is defined as the ratio between the total numbers of stream segments of one order to that of the next higher-order in a drainage basin (Schumm, 1956). Strahler (1957) demonstrated that the bifurcation ratio shows a small range of variation for different regions or different environmental conditions, except where the geology dominates. It is observed that Rb is not the same from one order to its next order. The mean Rb of the entire basin is 4.76. According to Kale and Gupta (2001), the bifurcation ratio ranging between 3 and 5 indicate the natural drainage system within a homogenous rock. The lower value of bifurcation ratio are characteristics of the watershed which have flat or rolling watersheds while the higher values of bifurcation ratio indicate strong structural control on the drainage pattern and have well-dissected drainage basins). The higher bifurcation ratio leads to less chances of risk of flooding (Eze & Efiong, 2010).

Stream order	Nu	Rb	Nu-r	Rb*Nu-r	Rbwm
I	14568				
II	3116	4.7	17684	82676.67	
III	604	5.2	3720	19191.26	**4.76**
IV	121	5.0	725	3619.01	
V	28	4.3	149	643.89	
VI	6	4.7	34	158.67	
VII	1	6.0	7	42.00	
Total	**18444**	**29.81**	**22319**	**106331.50**	4.76417
Mean		5			

Table 2 shows stream order, stream number and bifurcation ratio

Sinuosity index (SI)

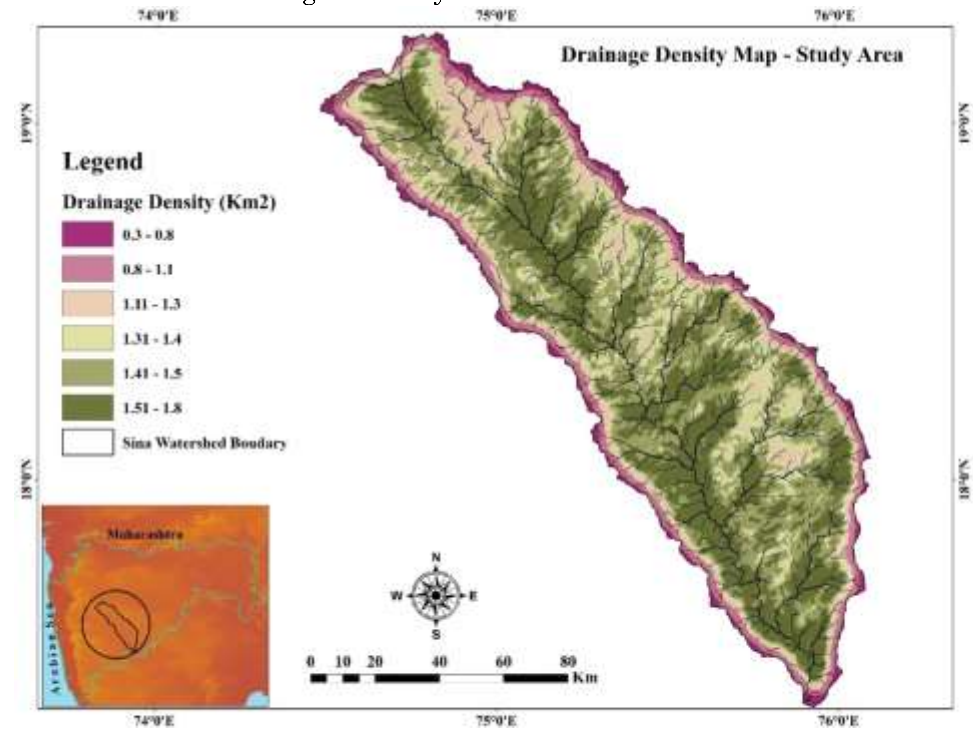
Schumm (1956) explains it as a factor to define a river deviation from the expected straight path. The meander ratio or sinuosity index is the ratio of actual length along a meandering river to the straight distance between the end points. In the study area, SI of the 7th order stream is calculated which is known as the trunk stream segment that has the highest order. For a straight river course this ratio is equal to unity. A ratio varying from 1 to 1.5 defines the river course as sinuous and from 1.5 to 4 as meandering. The SI value of the 7th order is 1.14 in the study area. So, the course of a stream is sinuous which in-between straight and meandering typology of basin is.

Areal morphometric parameters

Areal aspects deal with two-dimensional parameters like basin shape and area, drainage density, drainage texture, stream frequency, elongation ratio, circularity ratio, and form factor. The area of the basin is defined as the total area flowing to a given outlet, or pour point upon a horizontal plane contributing to cumulate of all orders of a basin which are delineated by ridgelines which are called water divides. Perimeter is the length of the outline of a basin that can be plot and calculate in the GIS software. The area and perimeters of the basin are found to be 12377.25 km² and 695.80.96 km respectively

Drainage density (Dd)

It is the ratio of total channel segment length cumulated for all orders within a basin to the basin area. It is expressed in terms of Km/Km². The drainage density is an expression of the closeness of spacing of channels (Horton, 1932). Drainage density is suggested that the low drainage density indicates the basin is a highly permeable subsoil and thick vegetative cover (Nag & Chakraborty, 2003). High drainage density is the result of weak or impermeable subsurface material, sparse vegetation, and mountainous relief. Low drainage density leads to coarse drainage texture while high drainage density leads to fine drainage texture. Drainage texture is a measure of relative channel spacing in a fluvial-dissected terrain, which is influenced by climate, rainfall, vegetation, lithology, soil type, infiltration capacity, and stage of development (Smith, 1950). In the study area, drainage density is 1.45 km/km² which indicates, low drainage texture and steeply sloping mountainous terrain with variation in vegetation coverage.



Stream frequency (Fs)

The stream frequency (Fs) of a basin may be defined as the total number of stream segments within the basin per unit area (Horton, 1945). Stream frequency exhibits a positive correlation with drainage density in the watershed indicating an increment in stream population with respect to increase in drainage density. Climatic character, vegetation coverage, rock and soil types, rainfall intensity, infiltration capacity, relief, run-off intensity, permeability terrain, slope has played vital role in controlling the drainage frequency and density. The Fs for the basin is 1.5,which indicates lower drainage density and stream frequency in a basin.(Kale & Gupta, 2001).

Texture ratio (T)

Texture ratio is an important factor in the drainage morphometric analysis which is depending on the underlying lithology, infiltration capacity, and relief aspect of the terrain (Schumm, 1956). The texture ratio is expressed as the ratio between the first order streams and the perimeter of the basin. The texture ratio in the study area is 1.8 km-1.

Form factor (Rf)

Form factor (Rf) is defined as the dimensionless ratio of the basin area to the square of the basin length. This factor indicates the flow intensity of a basin of a defined area (Horton, 1932). The value of form factor would always be less than 0.754 (the value indicating to a perfectly circular watershed). The smaller the value of the form factor,the more elongated will be the basin whereas the higher values corresponding to the circular basin. Basins with high form factors experience larger peak flows of shorter duration, whereas elongated watersheds with low form factors experience flatter peak flows of longer duration. The Rf value for the study area is 0.20, which is more towards the circular shape of the basin rather than elongated.

Elongation ratio (Re)

Elongation ratio (Re) is defined as the ratio of the diameter of a circle of the same area as the drainage basin and the maximum length of the basin (Schumm, 1956). Schumm's ratio shows values between 0.6 and 1.0 over a wide variety of climatic and geologic types. The varying index of elongation ratio can be classified as; circular (0.9-0.10), oval (0.8-0.9), less elongated (0.7-0.8), elongated (0.5-0.7), and more elongated (< 0.5). A circular basin is more efficient in the discharge of runoff than an elongated basin (Singh and Singh, 1997). The value ranges from 0.6 to 0.8 for regions of high relief and the values close to 1.0 have very low relief with circular shape (Magesh et al., 2013). The Re of the study area is 1.2 that indicates less elongated, steep to steeply slope and high relief.

Circulatory ratio (Rc)

Circulatory Ratio is defined as the ratio of the area of a basin to the area of the circle having the same circumference as the perimeter of the basin (Miller, 1953). The value of the ratio is equal to unity when the basin shape is a perfect circle and is range 0.4– 0.5 when the basin shape is strongly elongated and highly permeable homogeneous geologic materials. Rc is influenced by the frequency of stream, slope, relief geologic structure, climate and land use/landcover of the basin. The Rc value of the basin is 0.34 indicating elongated shape, low discharge of runoff, and high permeability of the subsoil conditions. Rc is a dimensionless number. Its low, medium, and high values are indicative of the youth, mature, and old stages of the life cycle of the tributary basins (Rafiq et al., 2013).

Length of overland flow (Lg)

The Length of Overland Flow (Lg) is defined as the length of water over the ground before it gets concentrated into mainstream which affect hydrologic and physiographic development of the drainage basin (Horton, 1945). Lg is significantly affected by infiltration (exfiltration) and percolation through the soil, both varying in time and space (Schmid, 1997). The high Lg value indicates that the rainwater had to travel a relatively longer distance before getting concentrated into stream channels (Chitra et al., 2011). The value for the length of overland flow in this study is 0.40 km which shows lower distance runoff in the study area. Constant channel maintenance(C) Schumm (1956) has used the inverse of the drainage density having the dimension of length as a property termed constant of channel maintenance. This constant, in units of square feet per foot, has the dimension of length and therefore increases in magnitude as the scale of the land-form unit increases.

Basin relief (Bh)

The basin relief (Bh) is defined as the difference in elevation between the highest and the lowest points on the valley floor of a basin. Relief is measured by subtracting the elevation of the mouth of the basin from the highest point within the basin. It is an important factor in understanding the denudational characteristics of the basin and plays a significant role in landform development, drainage development, surface and subsurface water flow, permeability, and erosional properties of the terrain. In the study, Bh is obtained as 5120.17m. So, the high relief value of basin indicates the gravity of water flow, low infiltration, and high runoff conditions (Magesh, Jitheshlal, & Chandrasekar, 2013). Relief ratio (Rh) Relief ratio is defined as the ratio between the total relief of a basin i.e., elevation difference of lowest and highest points of a basin, and the longest dimension of the basin parallel to the principal drainage line (Schumm, 1956). It is a dimensionless ratio. The high values of Rh indicate steep slope and high relief and vice-versa. Run-off is generally faster in steeper basins, producing more peaked basin discharges and greater erosive power (Palaka & Sankar, 2016). The value of Rh in the basin is 0.19 indicating high relief and high slope. The result is also visually interpreted and calculated by using Google earth and a topographical map of 1:50,000. Ruggedness number (Rn) Rn is the product of maximum basin relief (Bh) and drainage density (Dd), where both parameters are in the same unit. It is a measure of surface unevenness (Selvan, Ahmad, & Rashid, 2011).

An extremely high value of ruggedness number occurs when both variables are large and the slope is steep (Strahler, 1956). The value of ruggedness number in the present basin is 20.5 which has a steep slope and suggests more prone to soil erosion. Hypsometric curve a hypsometric curve is a graphical representation showing on the abscissa the basin areas situated above various altitudes. If necessary, the basin areas can be given as %ages of the total. The hypsometric curve has also been termed the drainage-basin relief graph (Zävoianu, 1985). It reveals a degree of dissection and stage of erosion. The more mature the river the hypsometric curve is more concave. From the curve, we can know which part of the river basin is more or less eroded or denuded in comparison to other parts. The hypsometric curve below is almost 'S' shaped with concave upward shaped for higher elevation points, whereas convex upward for the lower elevation points. The curve indicates landform with elevation between 1872.27m to 5000m has equilibrium mature stage and above 5000m has an in-equilibrium young stage. Which is based on the model proposed by Ritter and his company in 2002. (Martinez, Ramírez, Steinich, & Tuxpan, 2017).

Conclusion

- The measurement of linear, areal and relief aspects based on DEM generated from contour and spot height are really useful to identify physical and meteorological characteristics of the particular basin area. In this study, it is observed that the value indicated by bifurcation ratio, elongation ratio, drainage density, stream frequency, length of overland, relief ratio and hypsometric curve.
- The River Sina basin is 7th order stream has steep to very steep sloping mountainous terrain. Variation in vegetation coverage, rock and soil types highlights the ecological importance of the basin area which comprises of several plant and animal species and their relation with physical surroundings.
- Drainage pattern depends on the topography and geology of the land. The pattern of the drainage is dendritic in the study area. Many contributing streams joined together into the tributaries of the main river at acute angle and pattern mainly develop where the river channel follows the slope of the terrain. Basin with 'S' shaped curve indicates landform with varying stage that of both equilibrium mature stage and in-equilibrium young stage. The length of overland flow denotes high infiltration and percolation characteristics of soil. Drainage basin has less elongated shape experiencing peak flows of shorter duration with lower distance runoff. So, GIS has proved to be an effective and efficient tool for computation and analysis of various morphometric parameters of the basin.
- The mean bifurcation ratio of River Sina is 4.76 so it shows that the region is neither hilly nor dissected.
- The total number of stream are 18444. Regression Equation and coefficient of co-relation is calculated, on basis of calculation there is positive relationship between mean stream length and stream order. Mean stream length increases with stream order.
- The sinuosity index of the stream is 1.5 is shows the characteristics of plateau area.
- Circularity index 0.3 shows highly elongated shape of the basin.
- Drainage texture value for Sina river basin is 2.65 which falls in coarse texture Drainage basin.

Morphometric analysis of river Sina will be useful to provide flood control planning information to all the cities which are along the Sina River.

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Geographical Study of Fertilizer Consumption in Solapur District of Maharashtra

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Abstract :

Fertilizer is the important inputs for achieving high productivity India's impressive growth in food production has been principally due to widespread use of HYV seeds-fertilizer-water technology. Fertilizer is associated with an assured water supply either through rain or irrigation, plant-nutrients, consisting of major secondary and micro-elements have certain specific functions to perform in the plant and should be available in a balanced manner otherwise the full benefits of each or all of them . The forms chemical as well as physical in which nutrients are to be applied to the soil determine not only their availability but also the use efficiency of fertilizers containing them. The fertilizer doses are based on field experiments and depend on crop variety, water availability and soil characteristics. In addition, organic manures and compost derived from plant residues and agricultural wastes and by products may provide plant nutrients. There are at least sixteen chemical elements, which are essential for the growth and development of all crops. Out of these, carbon (C), hydrogen (H) , Oxygen (O) are obtained by plants (Crops) through air and water and the rest through soils. Fertilizer is land saving as well as labor saving input .The period during the last 20 years has witnessed considerable increase in the use of fertilizers as the key factor for increasing agricultural production. This phenomenon in irrigated parts of the region. The present study spatial variations in consumption of fertilizer have been analyzed. The Secondary data obtained from the record maintained by zilla perished and Agricultural development office of the region.It is observed that there is an increasing trend in the consumption of fertilizer in the region. The Consumption of fertilizer has been increased from 3.13kg/hect to19.43 kg/hect due to substantial development of irrigation. The data thus obtained were analyzed with the help of formula which was employed by jadhav & Shinde to calculate concentration index value of fertilizer consumption per unit area.North Solapur, Barshi and Akkalkot have lowest consumption of fertilizer.Pandharpur and Malshriras tehsils were high fertilizer consumption due to the Development of Irrigation facilities

Keywords - Agricultural Development, Fertilizer consumption, Tehsils

Introduction:

Fertilizer is regarded as an important component of Green Revolution. India's impressive growth in food production has been principally due to widespread use of HYV seeds-fertilizer-water technology. Fertilizer is the important inputs for achieving high productivity, which is associated with an assured water supply either through rain or irrigation, plant-nutrients, consisting of major secondary and micro-elements have certain specific functions to perform in the plant and should be available in a balanced manner. The fertilizer doses are based on field experiments and depend on crop variety, water availability and soil characteristics. The fertilizer doses are based on field experiments and depend on crop variety, water availability and soil characteristics. In addition, organic manures and compost derived from plant residues and agricultural wastes and by products may provide plant nutrients. . Fertilizer is land saving as well as labor saving input and its land quality argumenting character has attracted much attention. The research paper is based on Secondary sources of data collected. Research paper is examined the spatial pattern of Fertilizer Consumption on Agriculture in Solapur district

Study Area: -

Solapur district area under present investigation lies entirely in the Bhima Sina-

Man river basins of Krishna river system of South Maharashtra. The district is bounded by 17^{o} 10' North and 18^{o} 32' North latitudes and 74^{o} 42' East and 76^{o} 15' East longitudes. The district is fairly well defined to its west as well as its east by the inward looking scarps of Phaltan range and Osmanabad plateau respectively. The adjoining districts are Sangli to its south west, Satara to its west, Pune to its north-west, Ahmadnagar to its north, Bhir and Osmanabad to its east and Bijpur district of Karnataka state to its south. Broadly the Physiography of the district may be grouped into three parts i.e. 1) The Hills and Ghats height between (750-850) meters II) The Foot hills (650-750) meters. III) The Plains and Plateau (below 500-600) meters. The soils vary from deep medium black alluvial of the river tracts and further to poor gray soils in the east. The region is drained by Bhima River and its tributaries Nira, Man, Sina, Bhogavati etc. The Bhima River on Ujjani irrigation project is a major irrigation project in solapur district. The district has a total area of 14886 Kms^2 and population of **4317756** persons as per 2011 census which constitute purposes; the district is divided into eleven tehsils (Fig.No.1) e.g. North Solapur, Barshi Akkalkot, South Solapur, Mohol Managalwedha, Pandharpur, Sangola, Malshiras, Karmala and Madna.The Solapur district is located in Southern Maharashtra. Its latitudinal

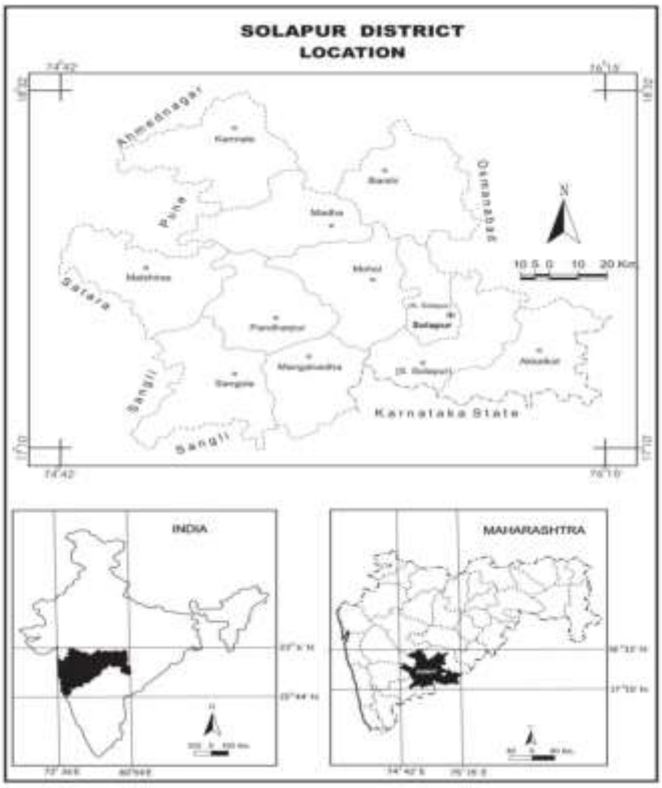

Fig. 1.1

extent is from 17˚ 10′ north to 18˚ 32′North and longitudinal is 74˚ 42′ east to 76˚ 15′ east. The average annual rainfall in the district is 584.3 mm. The region has predominantly a drought prone area of South Maharashtra.

Objectives:

In the present study an attempt has been made to examine the spatial pattern of Fertilizer Consumption on Agriculture and to identify the regional variations to the Fertilizer Consumption on Agriculture of the region.

Database and Methodology: The study also intends to examine the relationship between irrigation and fertilizer use crop yields. Primary as well as secondary data has been used. The primary data have been generated from sample village and farm level data have been collected from field survey through schedule method .The secondary data obtained from the records maintained by zilla Parishad and Agricultural development office of Solapur district. The spatial analysis therefore has been attempted here at tehsil level for the year 2020. The data were abstracted for the present analysis, from the published records of zilla Parishad of Solapur District. The data thus obtained were analyzed with the help of formula which was employed by M.G. Jadhav and S.D. Shinde (1979) to calculate concentration index values of fertilizer consumption per unit area the formula has been slightly modified here as –

$$Ife = \frac{Tf}{Df} \times 100$$

Where.

Ife = Index of fertilizer consumption

Tf =for hect./ kg fertilizer consumption in the tehsil

Df – per hect/kg fertilizer consumption in the region (district)

Regional Pattern of Fertilizer Consumption:

Spatial pattern of fertilizer consumption in Solapur district, the tehsils can be grouped under three zones based on fertilizer consumption but they have been grouped under three broad categories

A) Region of Low Consumption - (below 75 kg /hectare)

It includes 3 tehsils of Northern Eastern and extreme western parts of the districts covering the parts of North Solapur, Barshi and Akkalkot tehsils. The lowest consumption of A fertilizer with 65.4 kg/hect, of cultivated area is confined to Akkalkot, Barshi 69.2 kg/hect and Akkalkot 73.0 kg/hect tehsils. The lack of irrigation facilities and the poor financial conditions of subsistence farmer's low purchasing power of farmers and too much dependence of. Agriculture on uncertain rainfall has all discouraged large scale application of fertilizers in this zone

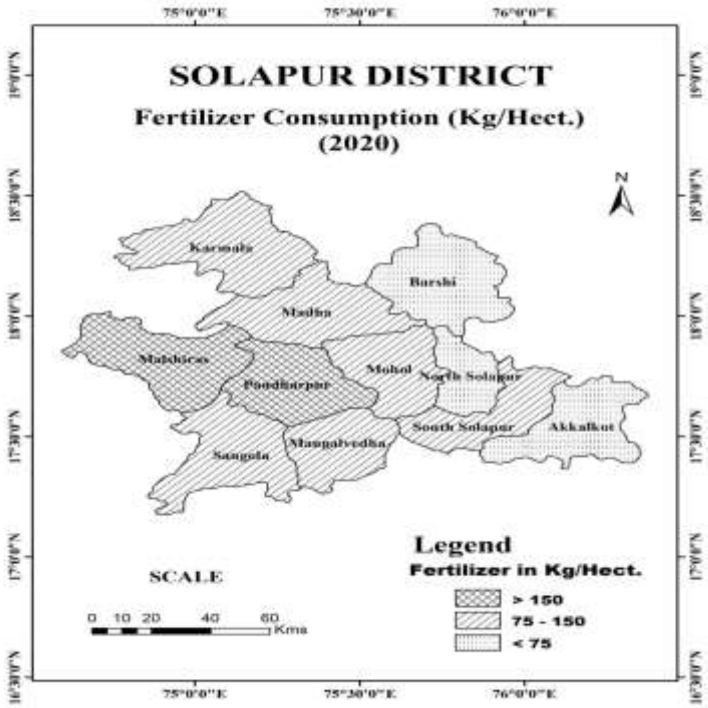

Fig. No. 1.2

B) Region of Moderate Consumption – (Between 75 to 150 kg/hectare)

The tehsils namely South Solapur, Karmala, Madha, Sangola and Mohol represent moderate level of consumption. The index values of these tehsils are South Solapur (77.6), Karmala (86.9), Madha (87.2), Sangola (103) and Mohol (104) respectively. These tehsils are endowed with the relative developments in irrigation, mainly the range of 500 mm and 600 mm annually rainfall. The inadequate conditions of soil moisture of this zone have restricted the use of fertilizers. Besides in this part of co-operative sector has been playing vital role for promoting fertilizers. So the farmers are well aware about the use of fertilizers leading to moderate level of consumption.

C) Region of High Consumption. (Above 150 kg/hect)

It includes 2 tehsils located along the Bhima River viz Pandhrpur, Malshiras tehsils (Fig.1.2) .The highest fertilizer consumption has been recorded in Malshiras tehsils which is 308 kg /hect and Pandharpur (151.5) kg/hect. This zone has been characterized by perennial water for irrigation tehsils fertile alluvial soils dominance of sugarcane cultivation location of sugar factories and close network of village level co-operative societies. Besides these the farmers of irrigated tract are socially and economically capable to adopt new technology. As a result of these this zone possesses high and very high level of fertilizer consumption.

Conclusion: - Addition of plant nutrients in the form of fertilizer constitutes an essential step in agricultural production. Because of the narrow land man ratio, the only hopeful means supplying needs of agricultural produce would be by raising productivity level. One of the important inputs for achieving this objective is the fertilizer. The region has witnessed an increasing trend in consumption level of different types of fertilizers during the last 20 years i.e. from 3.13 kg/hect. To 19.43 kg/hect. (488.49 per cent) as the region has attained substantial development in the irrigation mainly from lifts wells, tube wells and canal.It is observed that there are regional variations in the consumption of fertilizer. The tehsils located along the Bhima river viz Pandharpur, and Malshiras tehsils have recorded high fertilizer consumption i.e. above 150 kg/hect. Their zone has been characterized by perennial irrigation black fertile alluvial soils and dominance of sugarcane cultivation. As a result this zone possess as high level of fertilizer consumption. The low level of fertilizer consumption (below 75 kg/hect.) is observed in northern and eastern parts of the district covering parts of North Solapur, Barshi and Akkalkot tehsils. The lack of irrigation facilities and too much dependence of agriculture on monsoon rainfall have restricted large scale application of fertilizer.

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A Geographical Analysis Of Occupational Structure In Shevgaon Tehsil Of Ahmednagar District Maharashtra State

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Abstract

Since the creation of living creatures on earth till date human being is the only animal who has developed scientific approach based on his intellectual skills. Humans have played a vital role in any changes or evolution in the world. Even the seemingly impossible things have been achieved due to the continuous efforts of human beings, it has created a society that loves and believes in karma. The research study of demographic characteristics has become an important topic due to the importance and efforts given by leading researchers including the world's most populous countries. The exploratory study and research of demographic characteristics provides direction to play a revolutionary role in many fields. In the census of any place the working population is enumerated mainly in two groups namely main workers and marginal workers. For almost all types of occupation-based population, these two groups are divided according to the working population and the work obtained. Important aspects of the occupational composition of the population are hidden not only in the economic context, but also in the geographic point of view and acquired skills. The area selected for the present research is Shevgaon Tehsil of Ahmednagar District of Maharashtra. The present research focuses on the revenue circle, which is important for the link between the 'circle' i.e., the village and the tehsil. In this research analysis, the working population is considered in two major categories namely main workers and marginal workers and further divided into agricultural laborer's, cultivators, household industry workers and other workers. Analysis of the present research shows that the share of workers mainly in household industries and other workers is less than the district share. Compared to the district, there are more cultivators and the share of agricultural laborers and smallholder farmers and other workers is relatively less. Microsoft Excel and SPSS software were used to analyze the statistical data. Also, GIS (ArcMap-10.2) platform has been used to create maps and Microsoft Excel has been used to create graphs to show the results of the analysis in the present research.

Keywords: Occupational Structure, Working Population, Main Worker, Marginal Worker, SPSS, GIS.

1. Introduction:

The occupational composition of the population of any region is an important factor in human resource assessment. The proportion of people gainfully employed in economic activities and the share of various occupational groups in total employment play an important role in development planning. Workers can be defined as those who participate in the process of any economic production, whether physical or mental [4]. The work includes not only actual work but also operative supervision and direction of work. In this turn the workers are generally shown as total main labor and marginal labour. Population census data is the main source of data for the present study. Any occupation is a very important social attribute of that population. Occupational composition appears to play an important role in the diversity of studies related to economic development and the level of social inequality in the study area. Since occupation reflects an individual's position in a technical segment of the workforce, it is considered a central determinant of current and future economic opportunities in modern society [8].

2. Aims and Objectives:

The main aim of the study is to understand the spatial pattern of occupational structure in Shevgaon tehsil.

1. To identify the spatial structure of work participation rate in Shevgaon Tehsil.
2. To assess and analyze various occupational structures in Shevgaon Tehsil

3. Source of Data:

To fulfill the objectives of the present study, secondary data has been collected from various sources related to the study area.

1. Ahmednagar District Census Handbook of 2001 and 2011.
2. Ahmednagar District Gazetteer.
3. Study Area Map prepared based on SOI Toposheet.

4. Methodology:

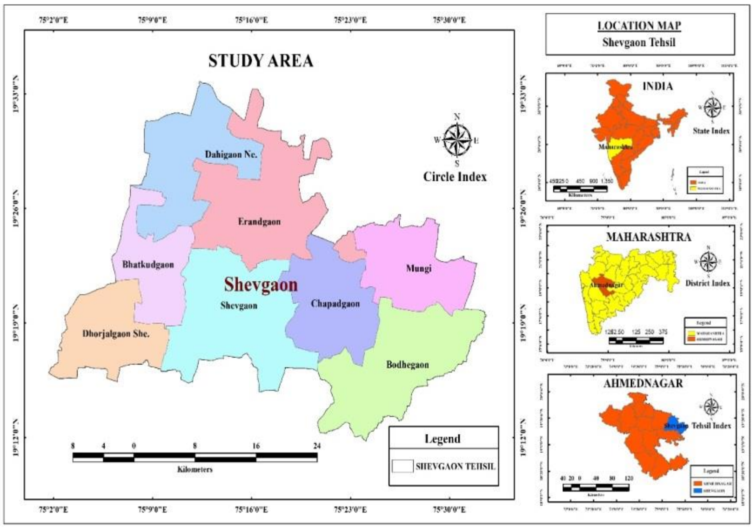
Based on the topographical map provided by Survey of India department, the base map of the tehsil has been prepared according to the 'Revenue Circles' with the help of GIS software ArcMap-10.2. Compiled occupational data of Population Census from Ahmednagar District Census Handbook 2011. This information was analysed statistically with the help of Microsoft Excel and SPSS software. The statistics are then displayed through choropleth map with the help of GIS software ArcMap-10.2 and cartographic techniques with geographical context.

5. Location of the Study Area:

Shevgaon tehsil is located in easternmost side of Ahmednagar district and is part of the basin of river Godavari on the Maharashtra plateau. It extends between 19°11'N and 19°33'N latitude and 75°01'E and 75°32'E longitude. The tehsil is irregular in size, about 46 km long and 55 km wide. Shevgaon is one of the 14 tehsils of Ahmednagar district and is the sixth largest tehsil by size. The area of the tehsil is 1081 sq. km. In terms of revenue, the tehsil is divided into eight revenue circles. The total number of villages in the tehsil is 112. According to the 2011 census, there was no any urban center in the tehsil, but in recent times Shevgaon, the village headquartered in the tehsil, has been accorded the status of a Nagar Parishad, making Shevgaon the only city in the tehsil. Ahmednagar city is 67 km west of Shevgaon tehsil and Aurangabad city is 78 km north. Shevgaon tehsil has a subtropical climate with moderate temperatures. The average minimum temperature in the tehsil is 18°C and maximum temperature is 29°C is commonly recorded. The average rainfall in Shevgaon tehsil is 636 mm. As per 2011 census, the population of the tehsil is 245714, of which 125837 are males and 119877 are females. Out of the total population of the tehsil 51.12% of the population is working population and 48.88% is dependent population. Dependent population mainly consists of senile population as well as juvenile population. The background of the tehsil is entirely rural and marginally urban; As a result, the proportion of dependent population is also high.

Fig. No.1

Location Map



6. Results and Discussion:

In the present analysis I have included all aspects of occupational structures found in Shevgaon tehsil to study the differences between main workers and marginal workers in the study area.

6.1.Total Workers:

The work participation rate is defined as the proportion of total workers i.e., Main and Marginal workers to total population. When work participation increases, the economy of a particular region also increases [6]. According to 2011 census the work partition rate of Shevgaon tehsil is 51.12 percent which is more than the work partition rate of the district (48.53%). Shevgaon tehsil has a high rate of participation in work. However, overall work participation varies from circle to circle. Considering the circle wise distribution of total workers in Shevgaon Tehsil viz., Dhorjalgaon She. (56.54%), Chapadgaon (55.55%), Bhatkudgaon (54.16%), Mungi (53.99%), Bodhegaon (53.40%), Erandgaon (53.04%), Dahigaon Ne. (48.15%) and Shevgaon (44.64%). According to the census definition, if individuals are employed for six months or more in a year, such working population is considered as main worker and population with less than six months of employment is considered as marginal worker. They will be studied in detail based on the following points.

Table No.1, **Distribution of Main Workers in Shevgaon Tehsil (%)**

Sr. No.	Name of Circle	Total Workers (%)	Main Workers (%)	Cultivators (%)	Agricultural Laboure's	Household Industry Workers	Other Workers
1	Bhatkudgaon	54.16	93.40	56.99	30.91	01.22	10.88
2	Bodhegaon	53.40	92.43	55.69	30.65	01.17	12.50
3	Chapadgaon	55.55	92.63	63.87	28.19	01.70	06.24
4	Dahigaon Ne.	48.15	93.53	46.64	38.98	00.92	13.46
5	Dhorjalgaon She.	56.54	92.60	57.16	32.87	01.56	08.41
6	Erandgaon	53.04	95.69	59.02	29.42	02.69	08.87
7	Mungi	53.99	93.11	60.49	32.94	01.00	05.56
8	Shevgaon	44.64	95.08	37.83	27.16	02.21	32.79
Tehsil Total		**51.12**	**93.70**	**52.63**	**30.71**	**01.64**	**15.02**

Source: *Compiled by Researcher from 2011 census data, Ahmednagar District.*

6.2.Total Main Workers:

According to the census definition, a person is considered a main worker or full-time worker if they have worked for at least six months or more. However, the participation rate of main workers varies from circle to circle. 93.70% of the total workforce in Shevgaon Tehsil is the main labor population engaged in various economic based activities including agriculture and farm labour. It is worth noting that Shevgaon Tehsil has a higher rate of participation of main workers than any other occupational structure. Revenue Circle wise distribution of main workers in Shevgaon tehsil such as, Erandgaon (95.69%), Shevgaon (95.08%), Dahigaon Ne. (93.53%), Bhatkudgaon (93.40%), Mungi (93.11%), Chapadgaon (92.63%), Dhorjalgaon She. (92.60%) and Bodhegaon (92.43%). The total main workers are divided into four categories. The four main occupational structure groups taken up for the present study are Cultivators, Agricultural Laborers, Household Industrial Workers and Other Workers.

Fig. No.2

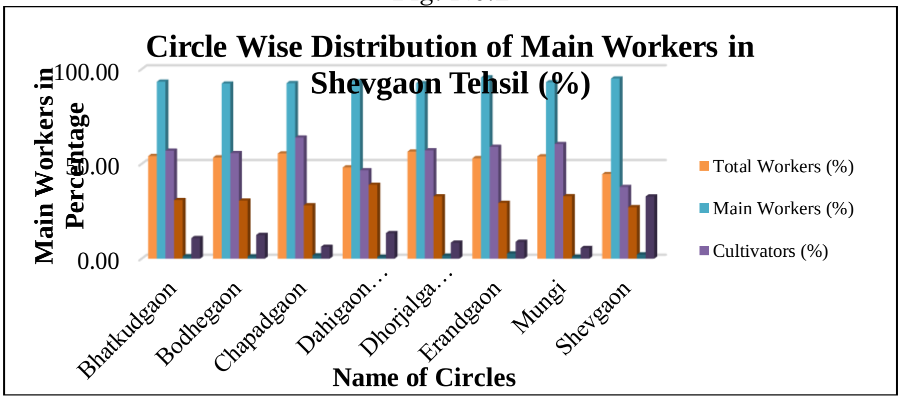


Table No.2

Distribution of Marginal Workers in Shevgaon Tehsil (%)

Kamble Kishor Dasharath, Ugale Vilas Rachandra

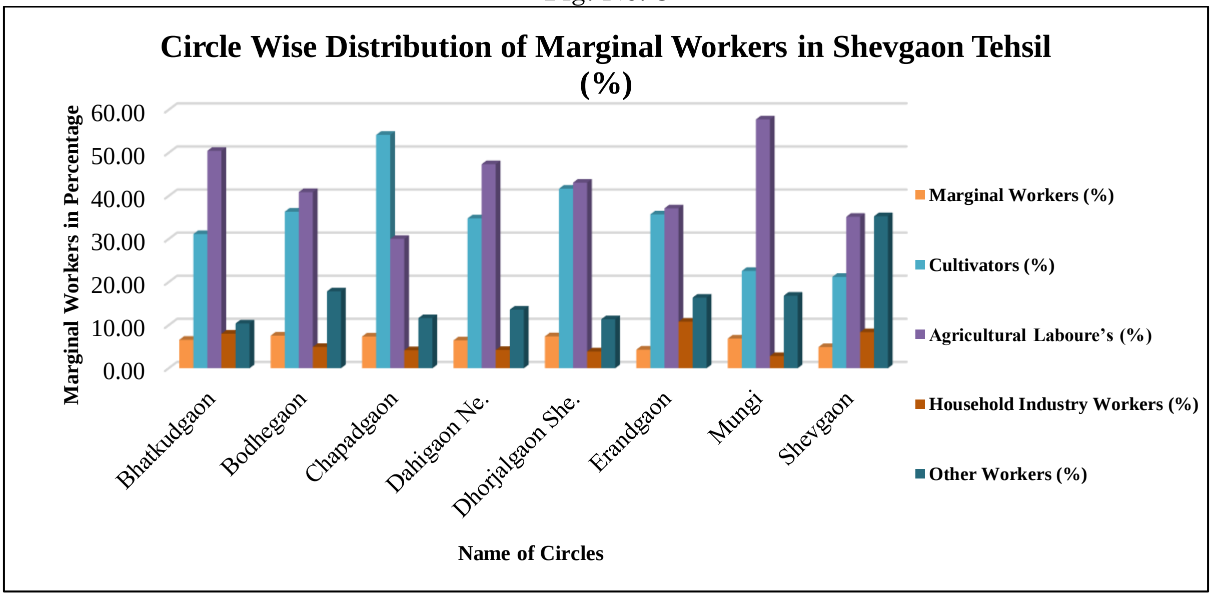
Sr. No.	Name of Circle	Marginal Workers (%)	Cultivators (%)	Agricultural Laboure's	Household Industry Workers	Other Workers
1	**Bhatkudgaon**	06.60	31.14	50.46	08.02	10.38
2	**Bodhegaon**	07.57	36.34	40.88	04.94	17.84
3	**Chapadgaon**	07.37	54.17	30.02	04.17	11.63
4	**Dahigaon Ne.**	06.47	34.79	47.37	04.24	13.61
5	**Dhorjalgaon She.**	07.40	41.67	43.07	03.90	11.36
6	**Erandgaon**	04.31	35.71	37.11	10.80	16.38
7	**Mungi**	06.89	22.58	57.76	02.82	16.83
8	**Shevgaon**	04.92	21.20	35.15	08.37	35.29
	Tehsil Total	**06.30**	**34.19**	**41.97**	**05.75**	**18.10**

Source: *Compiled by Researcher from 2011 census data, Ahmednagar District.*

As per the census definition, a person has worked less than six months in a year, he is considered as a marginal worker. Out of the total working population in the Shevgaon tehsil, 6.30 percent of the population belongs to the marginal workers group, which is less than the district (7.49%). Though, the work participation rate of marginal workers varies circle to circle, with 6.30% marginal workers of the total work force in Shevgaon tehsil engaged in various economic activities, including Cultivator, Agricultural Labors, Household Industry Workers and Other Workers. In Shevgaon tehsil, the work participation of marginal workers in all occupations is very low. Circle wise distribution of marginal workers in Shevgaon Tehsil viz.

Bodhegaon (7.57%), Dhorjalgaon She. (7.40%), Chapadgaon (7.37%), Mungi (6.89%), Bhatkudgaon (6.60%), Dahigaon Ne. (6.47%), Shevgaon (4.92%) and Erandgaon (4.31%). The four marginal occupational structure groups taken up for the present study are Cultivators, Agricultural Laborers, Household Industrial Workers and Other Workers.

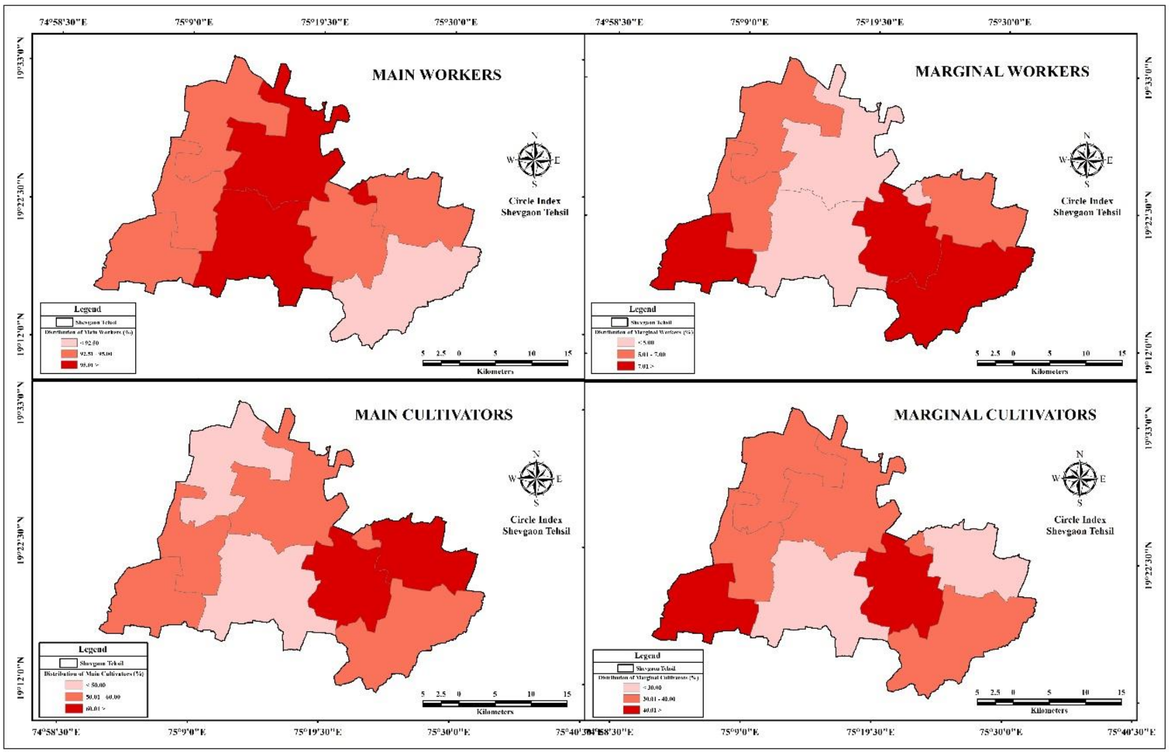
Fig. No. 3



6.3.Cultivators:

A person is considered to be a farmer if he/she is engaged in the cultivation of land that he owns or leases for money from the government or private individuals or institutions [KCC]. The average share of main cultivators in the total working force is about 52.63% in the Shevgaon tehsil. Similarly, the average share of marginal cultivators in the total marginal workers is about 34.19% in the tehsil. The number of main cultivators in Ahmednagar district 47.51% is less than tehsil and the number of marginal cultivators in the district 37.39% is more than the Shevgaon tehsil. Circle wise distribution of main cultivators in Shevgaon tehsil shows higher work participation in Chapadgaon circle (63.87%) which is clearly shown in fig. 2, then Mungi Circle (60.49%), Erandgaon Circle (59.02%), Dhorjalgaon She. Circle (57.16%), Bhatkudgaon Circle (56.99%), Bodhegaon Circle (55.69%), Dahigaon Ne. Circle (46.64%), and Shevgaon Circle (37.83%). Circle wise distribution of marginal cultivators in the Shevgaon tehsil such as, Chapadgaon Circle recorded higher work participation (54.17%), then Dhorjalgaon She. Circle (41.67%), Bodhegaon Circle (36.34%), Erandgaon Circle (35.71%), Dahigaon Ne. Circle (34.79%), Bhatkudgaon Circle (31.14%), Mungi Circle (22.58%) and Shevgaon Circle (21.20%).

Fig. No. 4



6.4.Agricultural Labouré:

A person who works as a laborer or shareholder on another person's land is considered an agricultural laborer. He/she only works on someone else's land for wages. A farm laborer has no right or contract over the land he/she works on. In general, for the entire tehsil the proportion of workers engaged as main agricultural laborers is 30.71%, while the proportion of labor engaged as marginal agricultural laborers is 41.97%. Considering the share of agricultural labor in Ahmednagar district, main agricultural labor is 24.61% and marginal agricultural labor is 34.60% which is lower than Shevgaon tehsil. It indicates that the major Agro-based activities in the Shevgaon tehsil are Dahigaon Ne. Circle (38.98%), Mungi Circle (32.94%) and Dhorjalgaon She. Circle (32.87%). Bhatkudgaon Circle (30.91%), Bodhegaon Circle (30.65%), Erandgaon Circle (29.42%) have moderate share. Chapadgaon Circle (28.19%) and Shevgaon Circle (27.16%) are the lowest. It also indicates that Mungi Circle (57.76%) and Bhatkudgaon Circle (50.46%), have minor Agro-based activities in the tehsil. Dahigaon Ne. Circle (47.37%), Dhorjalgaon She. Circle (43.07%) and Bodhegaon Circle (40.88%) have moderate share. Erandgaon Circle (37.11%), Shevgaon Circle (35.15%) and Chapadgaon Circle (30.02%) are the lowest share.

6.5.Household Industrial Workers:

The proportion of workers engaged in household industries is the lowest in the occupational composition of the Shevgaon tehsil. The average share of main house hold industry workers in Shevgaon tehsil is 1.64%, while Ahmednagar district has an average of 2.33% as per census data. The average share of marginal household industry workers in Shevgaon tehsil is 5.75%, while the average share of marginal household industry workers in the district is 5.85%. The main household industry worker is high in Erandgaon Circle (2.69%) and Shevgaon Circle (2.21%). They have a medium main household industry worker in Chapadgaon Circle (1.70%), Dhorjalgaon She. Circle (1.56%) and Bhatkudgaon Circle (1.22%). The lowest share of main household industry worker is noticed Bodhegaon Circle (1.17%), Mungi Circle (1.00%) and Dahigaon Ne. Circle (0.92%). Similarly, the marginal household industry worker is high in Erandgaon Circle (10.80%), Shevgaon Circle (8.37%) and Bhatkudgaon Circle (8.02%). The medium marginal household industry worker in Bodhegaon Circle (4.94%), Dahigaon Ne. Circle (4.24%) and Chapadgaon Circle (4.17%). The lowest share of marginal household industry worker is noticed in Dhorjalgaon She. Circle (3.90%) and Mungi Circle (2.82%).

Fig. No. 5

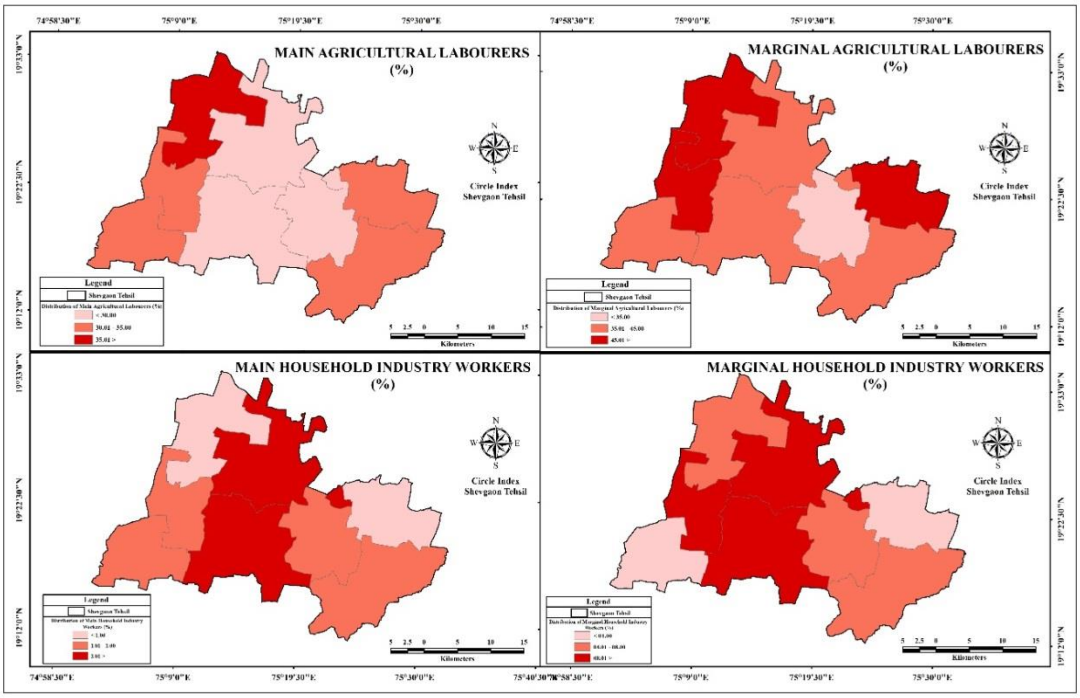
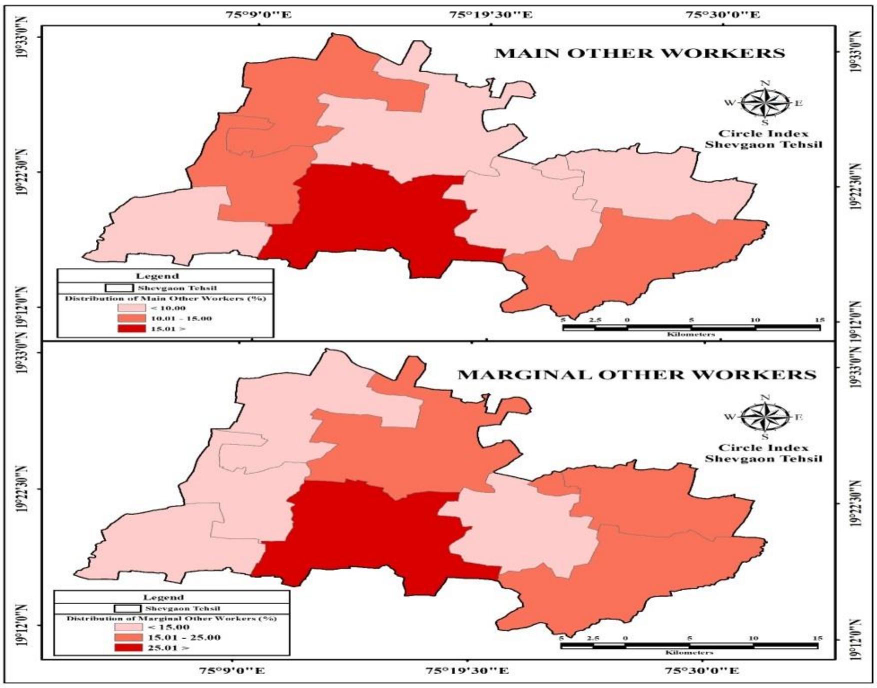


Fig. No. 6



6.6.Other Worker:

Other workers in the study area include only those engaged in trade and commerce, transport, administrative storage activities. This type of work is prevalent mainly in urban and semi-urban areas, the average share of main other working class is about 15.02% for the tehsil, which is lower than the district average of 25.55%. Similarly, the average share of marginal other working class is about 18.10% for the tehsil, which is lower than the district average of 32.86%. People in the main other worker categories are more concentrated in Shevgaon Circle (32.79%), Dahigaon Ne. Circle (13.46%) and Bodhegaon Circle (12.50%) and marginal other workers concentrated in Bhatkudgaon Circle (10.88%), Erandgaon Circle (8.87%) and Dhorjalgaon She. Circle (8.41%). The lowest share of main other workers category is noticed in Chapadgaon Circle (6.24%) and Mungi Circle (5.56%).

7. Conclusion:

The main working population of the Shevgaon tehsil is higher than the Ahmednagar district average, while the marginal working population is less. Total main workers constitute 93.70% and marginal workers 6.30%, the main workers are more to the Ahmednagar district average and the marginal workers are less. The average share of cultivators is 52.63% for main cultivators and 34.19% for marginal cultivators which is higher than the district average. Because Shevgaon tehsil has a completely rural background. The average share of main agricultural labor and minor agricultural labor in the study area is about 30.71% and 41.97% respectively which is lower than Ahmednagar district average. The average share of main household industry workers in Shevgaon tehsil is 1.64% and the average share of minor household industry workers is 5.75%. And the participation rate of other workers is 15.02% and 18.10% respectively. In Ahmednagar district, the proportion of household industry workers and other workers is relatively less than Shevgaon tehsil average. Analysis of this type of occupational structure will give a clear picture of the sector and help the government to take necessary steps to initiate primary, secondary and tertiary activities wherever possible. Like ArcMap-10.2 GIS software, Microsoft Excel and SPSS software plays a key role in providing solutions to this type of analysis.

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Agriculture Productivity of Junnar Tahsil of Pune District, Maharashtra

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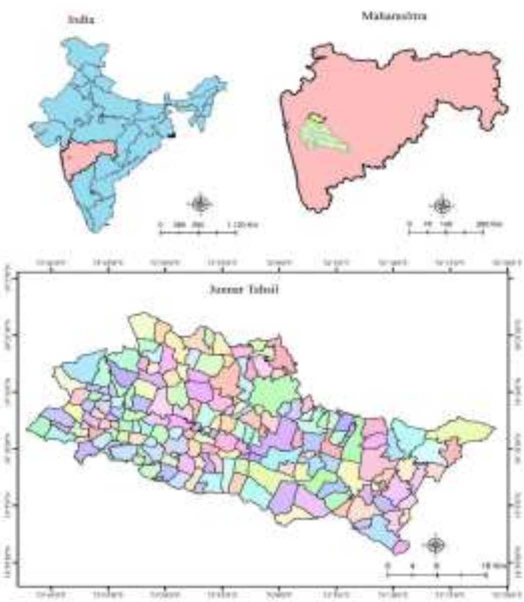
Abstract

Agriculture accounts for one-fifth of India's gross domestic product and considered as economic lifeline of India and will continue to be agriculture. However, regional differences in productivity and development in agriculture need more research. Agriculture productivity of Junnar tahsil is calculated with the help of Kendall's method for the year 1995, 2005 and 2015 using Agriculture Census data and District Socioeconomic Abstract. The Junnar tahsil is northernmost tahsil of the Pune district and characterized by diverse physiography and climatic condition which causes variation in agriculture productivity. The research shows that agricultural production has changed over time.

Keyword: Agriculture Productivity, Junnar Tahsil, Kendall's Agriculture Productivity.

Introduction

Agricultural productivity is influenced by a variety of factors including physical factors such as relief, altitude, climate, and soil, socioeconomic factors such as holding size, tenancy system, population occupational structure, literacy level, and technical factors such as irrigation, chemical fertilizers, high yielding varieties of seeds, and mechanization. Due to this Spatial-temporal variance in agricultural output, all of the aforementioned components are extremely variable and dynamic both in space and time (Munir, 1995). Several researchers have characterized agricultural production using their particular perspectives and disciplines. According to their goals, geographers, agronomists, agriculturalists, and economists have interpreted it in various ways. Agricultural productivity is defined as "output per unit of input" or "output per unit of land area" in agricultural geography. Agricultural productivity, according to Mohammad, N. (1992), is defined as "the ratio of output to input in respect to land, capital, and total resources engaged in agriculture." It is a dynamic notion that encompasses effective management of existing natural and human resources, technological innovation, and agricultural production organizational setup.



Study Area:

Junnar, the northernmost tahsil of the Pune district, is situated between 19° 08' 52.72" N and 19° 21'26.62" N latitude and 73° 40' 18.07" E to 74°18'54.27" E longitude, having an area of 1383 square kilometers, at an average elevation of 838 meters above mean sea level. Tahsil measures 62.31 km east-west and 29.19 km north-south. This roughly oblate/rectangular-shaped tahsil is ranked 3rd in terms of area and literacy, and 4th in terms of population and sex ratio. As per Census 2011, there are 1 town and 183 villages within Junnar tahsil. Junnar Municipal Council is the headquarter of the tahsil. The boundaries of the tehsil stretch in the Survey of India toposheet number 47E/11, 47E/12, 47E/15, 47E/16, 47I/3. 47I/4 and 47I/8.

Methodology

The ranking coefficient method of M.G. Kendall (1939) is more dependable and simpler to use for determining the agricultural production of any region. Kendall introduced this technique for assessing agricultural efficiency that is based on production per unit area and designed a system of Ranking Coefficients to measure the effectiveness of agricultural practices. In the article titled 'The Geographical Distribution of Crop Production in England' (1939), Kendall used this method to assess the distribution of agriculture production. Kendall breaks down the process is into three phases, the recorded units are ranked in order of output per hectare for each of the selected crops, (b) the ranks obtained by each unit for the selected crops are added, and (c) the sum of the ranks obtained by each unit for the selected crops is divided by the number of crops selected, resulting in the ranking coefficient. Kendall used the following formula to obtain the agriculture productivity

$$Ranking\ Coefficient\ Index = \frac{R1 + R2 + R3 + R4 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + Rn}{n}$$

Where,
R = Ranking of the yield of individual crop
n = Number of crops.

The area with the higher yield per unit area will have a low-ranking coefficient index value, suggesting high productivity, in simple words, the area which ranked one in every crop list, would have maximum production. But in the areal unit which has a low ranking would have a ranking coefficient equal to the number of units evaluated, indicating the lowest agricultural production (Gambire, 2000). This technique has a set of shortcomings, in this method, the yield of the unit area of land has no weightage, instead, the Kendall ranking coefficient index confides on rankings, which serves as the reference point to the calculation of the index (Muni, 1989). Another drawback of this method is it unable to compare the areal unit on the basis of the yield per unit area, thus the difference between the low yield and high yielding areal units cannot be compared.

In the present research, the agriculture productivity of the villages of the Junnar tahsil was calculated for the years 1995, 2005, and 2015. For this purpose, the average yield for the selected ten crops per hectare was collected for these villages and ranked according to the production basis on the yields of crops. On the basis of Kendall's ranking coefficient index, the villages are divided into five groups on the basis of the index value.

Data Base

The agriculture productivity of the Junnar tahsil is calculated on the basis of the Agriculture Census Data, District Socioeconomic Abstract, and Village level Agriculture Data for the year 1995, 2005 and 2015.

Result

Kendall's Ranking Coefficient Index: 1995

The agriculture productivity of the Junnar Tahsil is calculated for the year 1995, ranking the crops on the basis of the average yield. According to Kendall's ranking coefficient index 10.50 percent of the villages shows very high productivity, the villages namely Dholwad, Otur, Narayangaon, Tikekarwadi, Umbraj, Udapur, Ozar, Hivare Dhalewadi Tarfe Haveli, Dingore, Kombadwadi, Tajewadi, Pimpalwandi, Vadaj, Kalwadi, etc. shows very high productivity, while 38.12 percent of the villages shows high proctivity,17.68 percent of the total villages shows medium productivity, 12.71 percent villages shows low productivity and 16.57 villages shows very lowproductivity.

Table 1: Kendall's Coefficient Index-1995			
Ranking Coefficient Index	**Category**	**No of Villages**	**Percentag e**
Below 6.5	Very High	19	10.50
6.5-15	High	69	38.12
15-25	Medium	32	17.68
25-30	Low	23	12.71
Above 30	Very Low	30	16.57

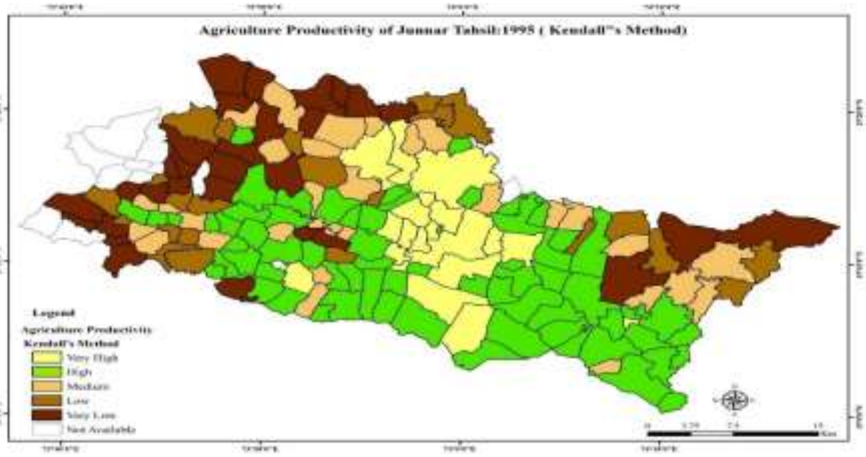


Figure 2: Agriculture Productivity Based on Kendall's Method (1995)

Kendall's Ranking Coefficient Index: 2005

Table 3: Kendall's Ranking Coefficient Index: 2005			
Ranking Coefficient Index	**Category**	**No of Villages**	**Percentage**
Below 6.5	Very High	22	12.15
6.5-15	High	75	41.44
15-25	Medium	34	18.78
25-30	Low	16	8.84
Above 30	Very Low	26	14.36

The agricultural productivity of the Junnar Tahsil is calculated for the year. According to Kendall's ranking coefficient index, twenty-two villages, about 12.15 percent of the total villages of the tahsil had very high productivity, seventy-five villages, about 41.44 percent of the total villages had high productivity, while thirty-four villages, about 18.78 percent villages had medium productivity. About 8.84 percent, sixteen villages of the Junnar tahsil had low agriculture productivity and twenty-six villages. 14.36 percent of the total villages had very low agriculture productivity in the year 2005. The agriculture productivity in the Junnar tahsil has shown a positive change from 1995 to 2005.

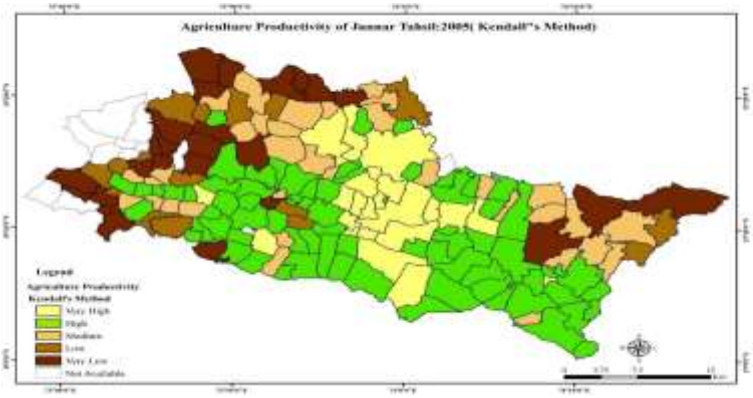


Figure 3: Agriculture Productivity of Junnar Tahsil: 2005

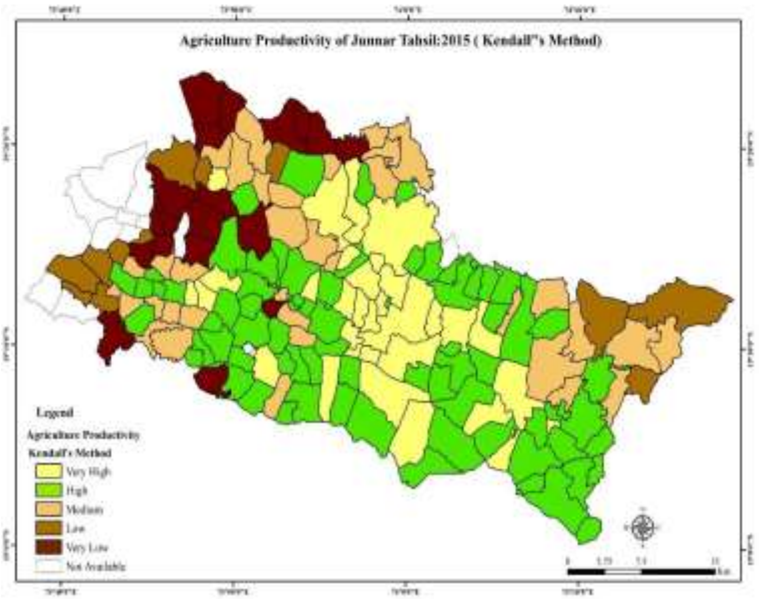
Kendall's Ranking Coefficient Index 2015.

Kendall's agriculture productivity index was calculated for the Junnar tahsil for the year 2015. According to the Kendall's ranking coefficient index, thirty-one villages of the tahsil, about 17.13 percent had very high productivity, seventy-nine villages of the tahsil, nearly 43.65 percent of the total villages had high agriculture productivity. Whereas, thirty-five villages, about 19.34 percent of the villages of the total villages of the tahsil had medium agriculture productivity. While, twelve villages, about 6.63 percent of the total villages of the tahsil had low agriculture productivity and sixteen villages, nearly 8.84 percent of the total villages had very low agriculture productivity. Eight villages of the tahsil are there for which the data of yield per hectare is not available.

Table 5-3: Kendall's Ranking Coefficient Index: 2015

Ranking Coefficient Index	Category	No of Villages	Percentage
Below 6.5	Very High	31	17.13
6.5-15	High	79	43.65
15-25	Medium	35	19.34
25-30	Low	12	6.63
Above 30	Very Low	16	8.84

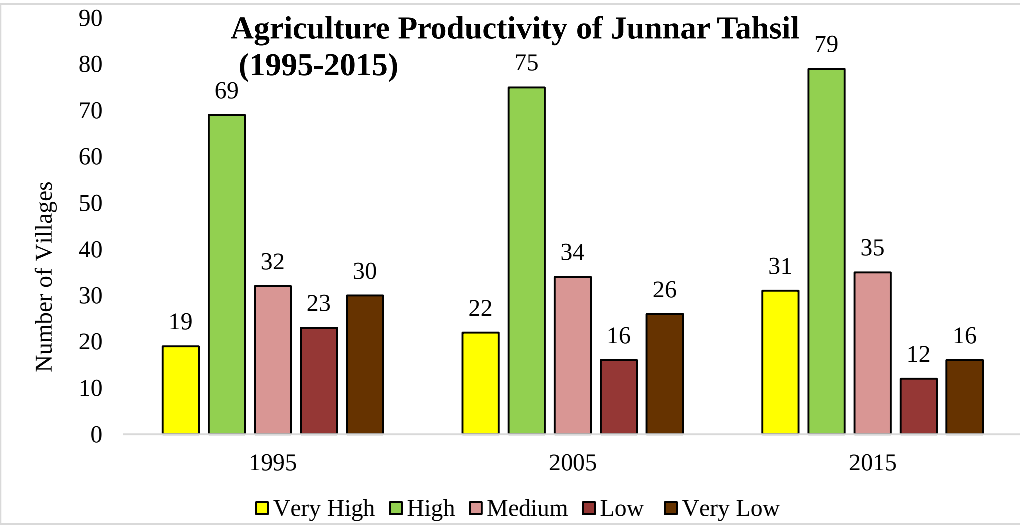
Figure 4: Agriculture Productivity of Junnar Tahsil:2015



Dr.Sharad Baban Kaphale, Dr.Jyotiram C. More

Conclusion

Junnar tahsil is an important agricultural region of the Pune district, the tahsil has dynamic physiography, climate, and bio-environment, Kendall's Ranking Coefficient Index was used to calculate the agriculture productivity of the Junnar tahsil from 1995 to 2015. As per the index value of the villages, the number of villages in the tahsil with very high agriculture productivity, increased from 19 in the year 1995 to 31 in the year 2015, pointing to a substantial increase of 63.15 percent of the growth in the number of villages with very high agriculture productivity. The villages with high productivity were 69 in the year 1995 which in the year 2015, increased to 79, highlighting the growth of 14.49 percent in the number of villages with high agriculture productivity. The villages with medium agriculture productivity were 32 in the year 1995 which increased to 35 in the year 2015, indicating a growth of 9.37 percent in the number of villages with medium agriculture productivity. During 1995-2015 the villages with low and very low agriculture productivity showed a decline, the number of villages with low and very low in the year 1995 were 23 and 30 respectively, which in the year 2015 were 12 and 16, which indicate a considerable decrease in the villages with low and very low agriculture productivity. Overall, the Kendall's ranking coefficient index value indicates increase in overall agriculture productivity of the Junnar tahsil.
Over the period number of villages with high and very high productivity, has increased while the villages with medium, low and very low agriculture Productivity decreased considerably which owes to availability of markets, connectivity and transport facilities, use of HYV and fertilizers, availability of irrigation facilities.



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Medical Geography: Natural Environment & Health

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Abstract
Environment means different things to different people. For traditional geographers environment means natural environment, sociologists stress on social environment, while anthropologists see environment in cultural terms. Medical geography treats environment as a composite milieu within which human beings live and work. It includes the natural as well as the social, cultural and economic environment. The main aim of this study is to discuss the natural environment and its relation to health. In the present study it is found that the diseases are not necessarily endemic to tropical climates. Many communicable diseases were present in the temperate climates too and millions of people did die of those diseases. In real life, we cannot expect everyone to follow all the laws of healthy living. People to break the rules of the game and subjects their body to various kinds of stresses and strains.

Keywords : Medical Geography, Natural Environment, Health

Introduction

Environment means different things to different people. For traditional geographers environment means natural environment, sociologists stress on social environment, while anthropologists see environment in cultural terms. In economics, environment means the economic conditions in which man lives and works. Each discipline defines environment in its own way. Medical geography treats environment as a composite milieu within which human beings live and work. It includes the natural as well as the social, cultural and economic environment.

Objective

In this paper the main objective is to discuss the natural environment and its relation to health.

Discussion

Natural environment includes factors like relief, soils, climate, flora and fauna in all their details. Man-environment relationship has always been a major concern of geography and geographers. In the eighteenth and nineteenth centauries, a large number of monographs were brought out giving details of human activities in various natural regions of the world. They were based on visible and apparent relationship between man and environment: causal analysis on scientific lines was rare, it not absent.

Climate is defined as the average weather reckoned in months, years and decades. It can also be defined as the combined effect of mutual interaction between Sun's radiation, atmosphere, oceans and the lithosphere on the biotic phenomenon including man. Its chief elements are temperature, air pressure, winds, humidity and precipitation. It runs in latitudinal bands following the inclination of the Sunrays to the surface of the earth but can be modified by local conditions such as relief, attitude, distribution of land and water. Climate has a great impact on human activities, the style of life and the capacity to work. It is the main determinant of plant coverage and animal life. Despite great strides made in artificial irrigation, food production is still controlled by the climate conditions.

Climate and Health

There is close relationship between climate and diseases. Certain diseases are seasonal. Dehydration and cholera are common during hot summers, malarial fever during rainy season and cough, cold and bronchitis during winters. Of the other season-specific diseases, the most common ones are infantile paralysis, dysentery, chickenpox, common cold and heat stroke. Humidity in the air is low; the delicate membranes of the nose, throat and other respiratory tracts are adversely affected making people fall easy prey to common cold. Arthritis, rheumatism and goat patients suffer more in winters and rainy seasons. Air and water pollution, particularly in urban areas, gives rise to a number of diseases that were so rare in the past. Asthma is no longer confined to aged persons; it is becoming common among the children. Mental cases are also on the increase and so are the cases of hepatitis and lung infection of various kinds.

Close relationship between climate and health can be felt by one and all but the degree of causality is debatable. Does climate impact human body to such an extent that man loses his biological stamina and some of his ability to control the environment and whether the kinds, numbers and varieties of external aggressors upon his organism are greater in the tropics than in the temperate climates or these and other questions are of such a complicated nature that they can not be answered satisfactorily without deeper and cross-cultural studies.

Climate and Human Physiology

The influence of climate on human physiology is enormous. Part of it is direct in terms of comfort and discomfort. We feel in different climatic regions and in terms of resources that we spent toward off its unwanted consequences. Several studies point to a close relationship between climate and physical and mental agility. The environmental determinists relied very heavily on the apparent evidence of people living in the warm and humid climates being slow and less energetic, energy differences between the races living in temperate and warm climates. The man in the tropics has lower oxygen consumption, lower blood pressure and a lower capacity to meet emergencies than the inhabitants of the temperate zones.

The best climates appear to be those, which are marked by a good balance between heat loss and heat gain by human body. Too hot and too cold climates are, therefore, not considered to be comfortable. Human body, however, can adjust to such differences to a great extent man has always used his technological resources to counter balance climate extremes.

Climate and Nutrition

In predominantly agricultural countries like India, food intake is determined by what is locally and regionally produced and what is produced is very much dependent on climatic conditions. If the rains are good, people have access to more and greater variety of foods. When drought and floods come, people suffer from shortage of food. Many of have been able to get over this problem by import of food from surplus countries. Agricultural societies being economically underdeveloped have to depend on their own resources. People die of hunger and many others suffer from deficiency and other diseases. Climate plays a very significant role in food production, particularly in countries like India where agriculture is still 'a gamble in monsoon'. Climate has both indirect and direct effects on agriculture. It is a major factor in soil formation, distribution of flora and fauna, domestication of plants and animals and agricultural management in general. Areas with heavy rainfall are subjected to soil erosion, flooding and leaching. These are also the areas where plant and animal pests and diseases abound. In moist climates the quality of animal is poor while the cost of maintaining them is high. The yield of milk per animal is low. There is a general shortage of animal proteins in the diet.

Conclusion

The conclusions of the type mentioned above may not be based on cross-climatic and cross-cultural observations and studies as such they may not conclusively prove as to which of the several climatic elements really influence health, in what circumstances, how and in what measure. But the fact that working capacity of man is greatly influenced by temperature and humidity in particular cannot be defined. Humid climates of the tropics reduce man's capacity for both physical and mental work.

Diseases are not necessarily endemic to tropical climates. Many communicable diseases were present in the temperate climates too and millions of people did die of those diseases. In real life, we cannot expect everyone to follow all the laws of healthy living. People to break the rules of the game and subjects their body to various kinds of stresses and strains.

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Impact Of Irrigation On Agricultural Development In Ahmednagar District Of Maharashtra State

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Abstract

Irrigation is essential input of agriculture development. It is most of the successful green revolution areas in India also admit high irrigation intensity areas, since enough and on time moisture supply is a sine-qua-non in the new agriculture its success is linked very closely with the development of irrigation. The problem of agricultural productivity can be solved by adopting a new irrigation system for agriculture. The provision of irrigation facilities makes a great difference in agricultural production in a region. If agriculture is continuously supplied with water, agriculture can transform and expand. Without irrigation very few can be expected from extensive cultivation. Besides, irrigation helps greatly in raising the yield of the land. In the foregoing analysis, an evaluation of the aspects of irrigation in the Ahmednagar district has been made in detail in order to understand the role and impact of irrigation in the development of agriculture and its efficiency. Microsoft Excel, SPSS was used to analyze the data on Irrigation Intensity in related to Net Irrigated area and net shown areas. Software like GIS Arc Map- 10.4 has used to create the maps.

Keywords: Agriculture Land Use, Net Irrigated Area, Net shown Area, Source of Irrigation, Agricultural productivity, Irrigation intensity.

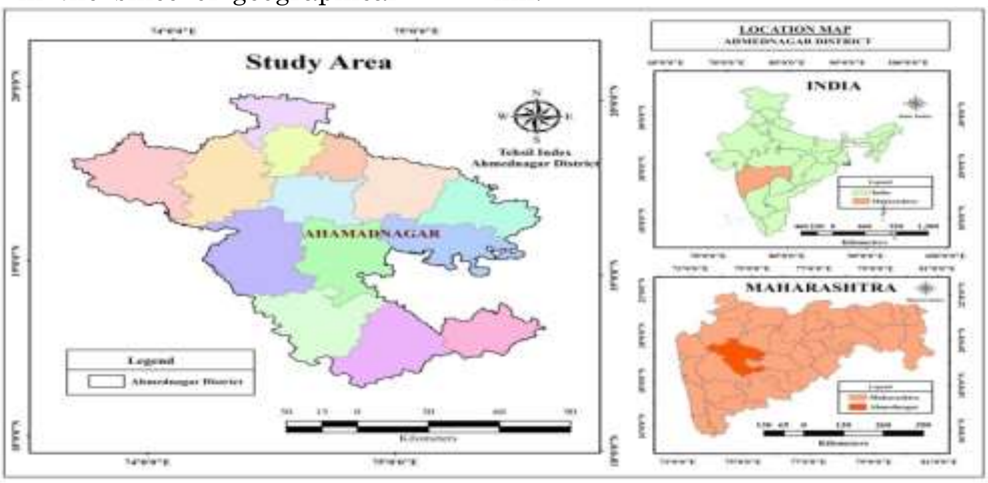
I. Introduction

Historically Irrigation is an age-old art. Many civilizations have followed the development of irrigation. Mostly men who are well-informed about irrigation are certain of its perpetuity, as it is intelligently practiced. Others think that a civilization based on agriculture under irrigation is to intend to decline sooner are later with the disappearance of water resources. Civilizations have evolved on irrigated lands; they have also decayed and disintegrated in irrigated regions. Most ancient civilizations were destroyed due to the lack of political and community stability, necessary for sustainable agriculture that relied on irrigated agriculture. The duration of civilization depends on many factors, of which permanently profitable agriculture is the most important. This paper discusses some of the principles and practices important for sustainable and profitable irrigated agriculture. In regions where the rainfall is less than fifteen centimeters, agriculture without irrigation is economically unprofitable. The increasing water demand of for agriculture can be met by intensive and extensive utilization of the available water resources. Thus, one of the major purposes of inquiry into the available water resources is to define the regional pattern of their quality, quantity, and utilization. In fact, there are three sources of water available to a man, that is surface water, groundwater, and ocean water.

Thus, surface water in the form of streams, rivers, and lakes is the most important source used for irrigation purposes. The uses of irrigation are conditioned by several variables. While low rainfall and its variable nature are essential the development of artificial means of moisture supply, the increasing use of fertilizers, and to some extent of improved variety of seeds make timely needs of water prerequisite. There is little wonder that most of the successful green revolution regions in India are of high-intensity irrigation, adequate and timely moisture supply is a sin-qua-non in the new agriculture, and its success is linked closely with the development of irrigation. The problem of low agricultural productivity can be tackled by improving farm facilities and irrigation facilities. Irrigation disparity accounts for a substantial amount of variation in agricultural output between regions. If a constant supply of water is ensured, the transformation and expansion of agriculture can take place. Without irrigation very little can be expected from extensive cultivation. Besides, irrigation helps greatly in raising the yield of the land. This aspect is more significant in the case of the Ahmednagar district. In the foregoing analysis, an evaluation of the aspects of irrigation in the Ahmednagar district has been made in detail, in order to understand the role and impact of irrigation in the development of agriculture.

Ii. Study Area

Ahmednagar district has been selected for present research study. The district is first in the since of geographical area (17048 sq. km.) in the state of Maharashtra. It is situated between 18° 20´ and 19° 59´ north latitudes and 73° 40´ to 75° 43´ east longitudes (Map.1). Administratively, Ahmednagar district consists of fourteen tehsils. The district is very dense in shape and length of 200 km. a width of 210 km. This study region is divided into there are three physical divisions namely, first Sahyadri moutons ranges, second Plateau and third plains area. The Godavari, Bhima River is the main rivers in this district with the major tributaries are Paravara, Mula, Sina, Dhora, Kukdi etc. The average annual rainfalls is 566 mm. and mean daily maximum temperatures is 39°C and mean daily minimum temperature is 11° C. In study region 71.10 percent area under cultivation area out of them 32.40 percent is irrigated and 67.60 percent rain fed or rain shadow area. The population of the Ahmadnagar district according to the 2011cesus is 4543159 with about 51.57% as male and 48.43 % as female population. The density of population was 266 persons per sq. km.



Iii. Aim And Objectives

The objective of this study is to demarcate the spatial and temporal distribution of irrigation and its impact on tehsil wise development agriculture in the study region. . The second objective is to locate the areas logging in irrigation facilities and the causes thereof.

Iv. Data Base And Methodology

The entire work is based on secondary data, in the present study. The secondary data concerning the Census Handbook of Ahmednagar District, Socio-economic Abstract of Ahmednagar District and Statistical Abstract of Ahmednagar district. The obtained data for irrigation has been converted into percentage values for better understanding. The gathered data were then processed with the help of a map, Choropleth technique of mapping was used to describe the spatial variation clearly.

V. Discussion

Irrigation facility varies from one tehsil to another tehsil in Ahmednagar District. As per the figure made available by Bureau of Economics and Statistics, the district has a geographical area of 170 48 sq.km. The total net shown area of the district during 2012-13 is 1255868 hectares and net irrigated area is 221499 hectares. During2002-2003, the net sown area was 1214000 hectares and 436000 hectares of land under irrigation. The net irrigated area has decreased to 214501hectares during study period. The decrease in net irrigated area over a decade is not uniform in all the tehsil of the district have decreased their land under irrigation. However, the decrease in the net irrigated area in the district is a negative feature for the agricultural development. In the year 2012-13, the annual average rainfall has decreased, so the area under net irrigation has also decreased.

Vi. Well Irrigation

Groundwater is major irrigation system in the district since ancient times. The Available wells ground water is used in various ways such as agriculture, domestic use and industrial use. The resource of groundwater is valuable in drought prone areas. Provides protective irrigation during long dry periods. Good potable water from dug well can be useful for drinking purpose throughout the year. The irrigation commission and Fact finding committee (1973) have suggested conjunctive use of groundwater for irrigation. However, this policy coupled with technological progress has been responsible for increase in number of wells especially after 1980. This has been responsible for lowering of ground water. Drying up dug well has put forth a need of supply of drinking water through tanks. In the year 2012-13 AD, the number of well increased to 167261, water is being supplied through these wells. The tehsil wise distribution of wells and irrigated area is given in the table (Table 1). The highest proportion of wells was observed in Nagar tehsil (15.21%) followed by Parner tehsil (13.01%). In 2012–13 the 1, 19,359 hect areas was under well irrigation in the district. The teble no. 1, shows that the highest area under well irrigation is observed in Nagar tehsil (15.21%) followed by Parner (13.01%) and Jamkhed (10.21%). This shows that, out of total geographical area, 16.90% areas have been irrigated through wells and surface water.

Vii. Surface Irrigation

Surface is another major irrigation system in the district (Table- 1). During 2012-2013 the area under Surface irrigation was 1, 02,140 hect (46.11 percent). The net increase of area under surface irrigation is 10352hectares. The Nevasa tehsil has observed highest 32,409 hect (31.73%) surface irrigation in the district. The Pathardi, Jamkhed and Nagar tehsils have not observed surface irrigation. Other sources of the irrigation in the district are percolation tanks, farm ponds and lift irrigation schemes. In central and southern part of the district the ground water potential is generally low and it is particularly observed under scarcity zone. The depth of groundwater has decreased to 300 to 400 feet as observed in the field study. This is a long term disaster as groundwater depletes. As groundwater is accumulated water in centuries in the past, this source should be conserved for future generation as per basic principle of sustainability.

Table-1: Tehsil wise Source wise Area Irrigated in Ahmednagar District-2012-13 (Area in Ha. And Percentage)

Sr. No.	Tehsils	Surface	% of Surface	Wells	% of Wells	Net Irrigated area	% of Net Irrigated area
1	Akola	3512	3.44	5193	4.35	8705	3.93
2	Sangamner	11770	11.52	7226	6.05	18996	8.56
3	Kopargaon	12492	12.23	00	0.00	12492	5.64
4	Rahata	5910	5.79	5292	4.43	11202	5.06
5	Shrirampur	4437	4.34	5623	4.71	10060	4.54
6	Nevasa	32409	31.73	11887	9.49	44296	20.00
	Shevgaon	2750	2.69	7221	6.05	9971	4.50
8	Pathardi	00	00	11828	9.91	11828	5.34
9	Nagar	00	00	17598	15.21	17598	7.95
10	Rahuri	12701	12.43	4704	3.94	17405	7.86
11	Parner	6159	6.03	15523	13.01	21682	9.79
12	Shrigonda	7075	6.93	7019	5.88	14094	6.36
13	Karjat	2925	2.86	8063	6.76	10988	4.96
14	Jamkhed	00	0.00	12182	10.21	12182	5.50
	Total	**102140**	**100**	**119359**	**100**	**221499**	**100**

Source- Socio Economic Abstracts Ahmednagar District- 2020-21 Compiled by author.

Intensity of Irrigation:

The intensity of irrigation in any region is controlled by various factors such as the source of irrigation, types of crops grown, cropping season, quantity and quality of water supply, and density of the network of water channels, etc. The benefits of irrigation intensity are reflected in cropping patterns, land productivity, land use efficiency, and cultivation practices. In an agricultural region other things being equal, the intensity of irrigation will increase with a decrease in rainfall and vice-versa. The intensity of irrigation will always remain low and negligible in rain-fed areas. The intensity of irrigation is worked out by using the following formula-

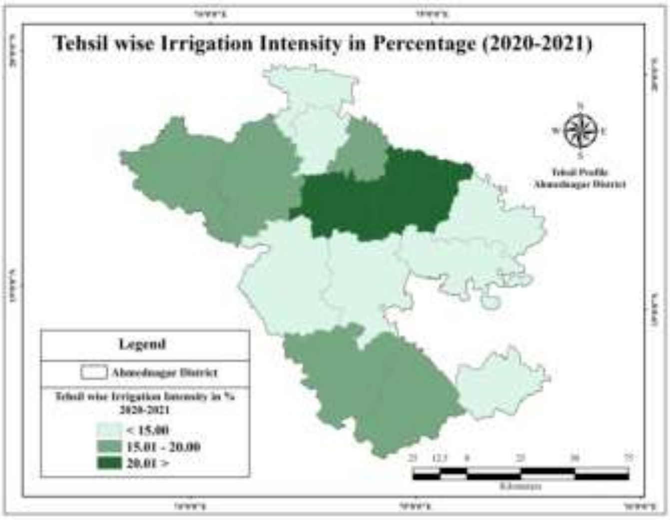
$$\textbf{Intensity of Irrigation} = \frac{\text{Net irrigated Area}}{\text{Net sown Area}} \times 100$$

Table -2: Intensity of Irrigation, 2012-13

Sr.No.	Tehsils	NIA(hect)	NSA (hect)	Irrigation Intensity %
1	Akola	8705	54426	15.99
2	Sangamner	18996	104104	18.25
3	Kopargaon	12492	86641	14.42
4	Rahata	11202	96579	11.60
5	Shrirampur	10060	66216	15.19
6	Nevasa	44296	138271	32.03
7	Shevgaon	9971	70450	14.15
8	Pathardi	11828	80903	14.62
9	Nagar	17598	124964	14.08
10	Rahuri	17405	58289	24.71
11	Parner	21682	154913	14.00
12	Shrigonda	14094	89854	15.68
13	Karjat	10988	71123	15.45
14	Jamkhed	12182	86135	14.14
	Total	**221499**	**1255868**	17.96

Source- Socio Economic Abstracts Ahmednagar District- 2020-21

Irrigation intensity is the use of more water to cultivate different types of crops on the same land or more crops in one year or agricultural season. In areas where water is supplied by assured water supply like river canals, monoculture crops like sugarcane can be emphasized, which need more than a year period. In such a situation, the intensity of irrigation does not arise. The intensity of irrigation, therefore, refers to cultivating more crops in a year such as rice, groundnut, Sunflower, etc. In such a situation, it is interesting to underline that these crops may consume less water tha Therefore, the intensity of agriculture will support farmers' localized interests such as subsistence needs of food crops, animal needs like fodder, and use of animal products like dung for biomass fertilizer production, milk production, meat production, the leather of the animals, etc., Therefore the high index of intensity of irrigation in a region can definitely show the agriculture development in an Indian context. The intensity of irrigation is not uniform in the Ahmednagar district. The district as a whole intensity value was 17.96 in 2012-13. The net increase in the intensity of irrigation is 1255868 hectares (Table- 2). sugar cane cultivation while the total number of crops grown will add to more income for the farmer and it may be suitable to farmers for diversified needs than that of sugar cane cultivation.



Considering that the ground water table is decreasing over the years, it is very necessary to take and implement the following measures to restore the water table and to protect the ground water potential for future exploitation.

1) Desilting existing tanks to enhance groundwater recharge.

2) Artificial recharge to store natural groundwater storage capacity increase by difference groundwater storage methods like, check dams, subsurface, dykes, gully, plugging etc. wherever possible .

3) Using new irrigation methods to conserve of groundwater for the future like drip irrigation, and sprinkler irrigation.

4) use of surface and groundwater Critical shortages of underground water due to limited natural recharge, small surface storage capacity and overuse have stimulated efforts to recharge groundwater reservoirs with surface water.

Thus, it provides water to seep into the underground reservoirs. Flow of streams, sewage and industrial water may also be utilized for recharging these reservoirs. Full conservation of available water supply requires and integrated use of surface and underground water and storage facilities. Crops cultivation to a large extents and rearing livestock depend upon the resources of their immediate environment. Therefore, land owners and cultivators will have to select appropriate and adaptable crops to the existing physical environment. Since agriculture is directly related to physical environment variations, this in turn also affects agricultural land use. Thus, agriculture is not only an economic activity, but also a form of applied ecology. The crop production potentiality of an area always depends primarily on the prevailing climatic and soil conditions.

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Decadal Changes in Literacy Rate of Jalgaon District of Maharashtra

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Abstract:-

Literacy rate defines the percentage of the population of a given age group that can read and write. Literacy is the ability to read, write, speak and listen in a way that allows us to communicate effectively and understand the world. Higher literacy rates are associated with healthier populations, lower crime, greater economic growth, and higher employment rates. For an individual, literacy is the foundational skill needed to acquire advanced skills. These in turn provide higher wages and more employment in labor markets.

The literacy rate of Jalgaon district is increasing from 2001 to 2022. The decadal literacy rate has increased to 64.66%, 68.37% and 74.31% respectively during 2001 to 2022. The gap between male and female literacy rates is rapidly decreasing in Jalgaon district.

Key words:- Decade, Literacy, Population, Variation etc.

Introduction:-

Literacy rate defines the percentage of the population of a given age group that can read and write. Literacy is the ability to read, write, speak and listen in a way that allows us to communicate effectively and understand the world. The adult literacy rate is the percentage of people aged 15 and over who can read and write with understanding of a short simple statement about their daily lives. The adult literacy rate corresponds to those aged 15 years and above, the youth literacy rate to those aged 15 to 24 years and the elderly to those aged 65 years and above. Higher literacy rates are associated with healthier populations, lower crime, greater economic growth, and higher employment rates. For an individual, literacy is the foundational skill needed to acquire advanced skills. These in turn provide higher wages and more employment in labor markets.

Literacy rate of Jalgaon district is changing decade wise during 2001 to 2022. Over the decades, there is a changing trend of literacy of the population in comparison to total population in Jalgaon district. Tahsil wise variation in literacy rate of Jalgaon district is observed and it is going to increase over the decades. In 2001 census, total population of Jalgaon district was 3682629 and literate population was 2381394.

The percentage of literate population was 64.66%. In 2011 census, total population of Jalgaon district was 4229917 and literate population was 2891882 which was 68.37%. It means that there is an increase of 3.71% in the literacy rate as compared to 2001. As per the 2022 survey data, the literate percentage is 74.31%, which is an increase of 5.94% in Jalgaon district.

Hypothesis:-

The hypothesis of this research work is assumed as **"Literacy rate of Jalgaon district is increase in decades".**

Objectives:-

The following objectives have been set for this research work-

1. Find the literacy rate of Jalgaon district during 2001 to 2022.
2. Find out the decadal changes in the literacy rate of the population in Jalgaon district.

3. Find the difference between male and female literacy rate.
4. Find out the high and low literacy area of the district.

Importance of the study:-

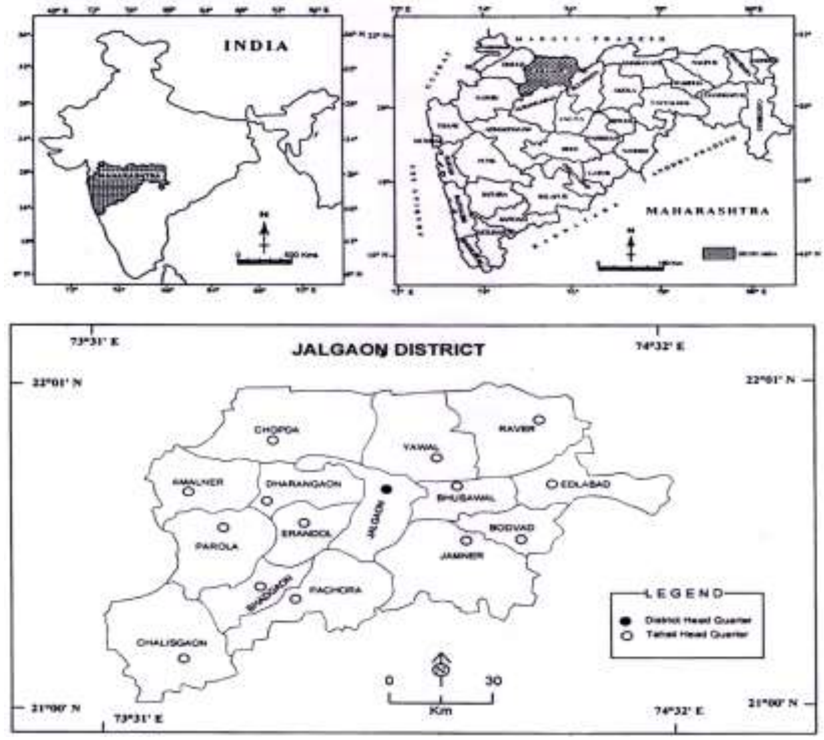
In the study of population, population structure plays a major role in planning, development, construction of infrastructure and health facilities. The literacy rate is the main driving factor of the cultural composition of the population. Educated population is the efficient resource of the country. With the help of the cultural composition of the population, the government and grassroots planners can plan for the development of Jalgaon district as well as India.

Selection and Demarcation of study Area:-

‘A region is an area of land that has common features. These features can be natural, such as climate or landscape. They can also be artificial, such as language or religion’ (*National Geographic Society*).

The selection of Jalgaon district for the present study is not arbitrary. Jalgaon district is one of them in the state of Maharashtra. Nowadays this district is facing some demographic problems. Jalgaon district is situated on the northern upper part of the Deccan Plateau in the Tapi river basin.

Map No. 1
Location of Jalgaon district



Jalgaon District extends between 21^{0} 00’ to 22^{0}01’ North Latitude and 73^{0} 31’ to 74^{0} 32’ East Longitude. The length of Jalgaon district is 120 km. from east to west and 110 kms. North to South directions. The total area of Jalgaon district is 11765 sq km. There are 15 tahsils in Jalgaon district.

Research Methodology and Data Base of the Study:-

Find out the change in population structure in the last ten years taking 2001 as the base year of population and 2011 census as the base year and 2022 is the survey data comparison and result search year. I have used primary and secondary data for this study.

Four villages in each tahsil are selected for field work through random sampling. During this process primary data is collected by questionnaire and personal interview. Secondary data is collected from published and unpublished literature and census.

Devendra Anantramji Maski , Dr. Sanjay Devidas Bhaise

Table no. 01
Literacy Rate of Jalgaon District 2001 to 2022

Sr. No.	Tahsil	No. Of Literate-2001				No. Of Literate-2011				No. Of Literate-2022			
		Total Population	Persons	Males	Females	Total Population	Persons	Males	Females	Total Population	Persons	Male	Female
1	Chopda	271863	158872	94942	63930	312815	196453	111711	84742	207	166	92	74
2	Yawal	248596	163492	94874	68618	272242	186027	103826	82201	218	141	83	58
3	Raver	285236	179945	105859	74086	312082	210727	117930	92797	214	130	71	59
4	Muktai Nagar	137753	83264	50027	33237	163444	106295	60686	45609	231	186	97	89
5	Bodwad	79126	49149	29556	19593	91799	63656	36092	27564	222	154	81	73
6	Bhusawal	325527	244110	137092	107018	359461	275479	148567	126912	195	150	79	71
7	Jalgaon	553725	392084	222870	169214	676041	501884	275750	226134	263	181	94	87
8	Erandol	148114	88400	52420	35980	166521	106997	61375	45622	192	148	83	65
9	Dharangaon	155272	100184	59231	40953	173447	117219	66751	50468	209	150	82	68
10	Amalner	267872	170302	100352	69950	287849	200290	112299	87991	231	163	89	74
11	Parola	169919	103559	61413	42146	196863	129129	74394	54735	163	129	72	57
12	Bhadgaon	142168	90158	52735	37423	162889	108374	61860	46514	163	132	72	60
13	Chalisgaon	356808	227996	136104	91892	414879	272655	157134	115521	156	108	57	51
14	Pachora	251907	158579	94857	63722	289628	190649	109621	81028	185	153	82	71
15	Jamner	223050	171300	104546	66754	349957	226048	131227	94821	199	174	98	76
	District Total	3682690	2381394	1396878	984516	4229917	2891882	1629223	1262659	3048	2265	1232	1033

Source:- Census of India 2001, 2011 & Surveyed data 2022

Above table is presenting the literacy rate data of Jalgaon district during 2001 and 2022. This table shows the population literacy compared to total population of Jalgaon district. Tahsil wise variation in literacy rate of Jalgaon district is observed and it is going to increase over the decades.

Fig. no. 01
Literacy Rate of Jalgaon District 2001 to 2022

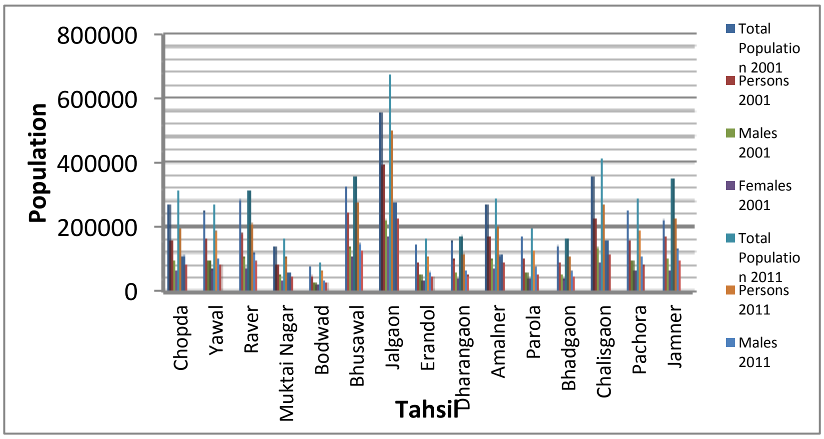


Fig. no. 01 is presenting the literacy rate of Jalgaon district during 2001 and 2011. Tahsil wise literacy rate of the population of Jalgaon district is going to increase in these two decades. According to the data of 2001 and 2011, there has been an increase in the literacy rate in 2011 as compared to 2001. Male and female literacy rates have also increased in these decades. In Jalgaon district some tahsils have high literacy rate and some tahsils have low literacy rate. There is a large variation in the literacy rate among the more populated tahsils.

The northern side tahsils like Chopda, Yawal and Raver have almost same variation in literacy rate. There is variation in literacy rate in southern tahsils like Jamner, Chalisgaon and Pachora. These tahsils are facing geographical abstraction in infrastructure of educational facilities. Because the education centers are far away from the original residence of the rural people. Secondly, the economic status and social structure also affect the literacy rate. The female literacy rate is less than the male literacy rate in rural and urban areas of the district.

Table no. 02

Percentages of Literate Population in Jalgaon District 2001-2022

Sr. No.	Tahsil	% Of Literate-2001				% Of Literate-2011				% Of Literate-2022			
		Persons	Male	Female	Difference	Persons	Male	Female	Difference	Persons	Male	Female	Difference
1	Chopda	58.44	59.76	40.24	19.52	62.80	56.86	43.14	13.73	80.19	55.42	44.58	10.84
2	Yawal	65.77	58.03	41.97	16.06	68.33	55.81	44.19	11.62	64.68	58.87	41.13	17.73
3	Raver	63.09	58.83	41.17	17.66	67.52	55.96	44.04	11.93	60.75	54.62	45.38	9.23
4	Muktainagar	60.44	60.08	39.92	20.16	65.03	57.09	42.91	14.18	80.52	52.15	47.85	4.30
5	Bodwad	62.11	60.14	39.86	20.27	69.34	56.70	43.30	13.40	69.37	52.60	47.40	5.19
6	Bhusawal	74.99	56.16	43.84	12.32	76.64	53.93	46.07	7.86	76.92	52.67	47.33	5.33
7	Jalgaon	70.81	56.84	43.16	13.68	74.24	54.94	45.06	9.89	68.82	51.93	48.07	3.87
8	Erandol	59.68	59.30	40.70	18.60	64.25	57.36	42.64	14.72	77.08	56.08	43.92	12.16
9	Dharangaon	64.52	59.12	40.88	18.24	67.58	56.95	43.05	13.89	71.77	54.67	45.33	9.33
10	Amalner	63.58	58.93	41.07	17.85	69.58	56.07	43.93	12.14	70.56	54.60	45.40	9.20
11	Parola	60.95	59.30	40.70	18.60	65.59	57.61	42.39	15.22	79.14	55.81	44.19	11.63
12	Bhadgaon	63.42	58.49	41.51	16.98	66.53	57.08	42.92	14.16	80.98	54.55	45.45	9.09
13	Chalisgaon	63.90	59.70	40.30	19.39	65.72	57.63	42.37	15.26	69.23	52.78	47.22	5.56
14	Pachora	62.95	59.82	40.18	19.63	65.83	57.50	42.50	15.00	82.70	53.59	46.41	7.19
15	Jamner	76.80	61.03	38.97	22.06	64.59	58.05	41.95	16.11	87.44	56.32	43.68	12.64
	District Total	**64.66**	**58.66**	**41.34**	**17.32**	**68.37**	**56.34**	**43.66**	**12.68**	**74.31**	**54.39**	**45.61**	**8.79**

Source:- Calculated by researcher

As per table no. 02, 2001 the literacy rate of Jalgaon district was 64.66% and out of that the male and female literacy rate was 58.66 and 41.34% respectively. There was a difference of 17.32% in male and female literacy rate i.e. female literacy rate is 17.32% less than male literacy rate. In 2011, Jalgaon district had an average literacy rate of 68.37%. This means that the literacy rate has increased by 3.71% as compared to 2001 census. Male and female literacy rates were 56.34% and 43.66% respectively. Male literacy rate has increased by 2.32% in the decade of 2011. The difference between male and female literacy rate in 2011 is 12.68%. This means that the gap has decreased by 4.64% during this decade. As per the data collected by personal survey, the literacy rate has increased in 2022 and found to be 74.31% and out of that male literacy rate is 54.39% and female literacy rate is 45.61% in Jalgaon district and male and female literacy differ.

The rate is 8.79%. There is an increase in literacy rate to 5.34% in 2022. This means that the literacy rate has been increasing continuously for a decade and the gap between male and female literacy rate is going to reduce. This is a healthy sign for the development of present and future society. This is a good indication of the changing mindset of the society regarding women's education in this district.

Fig. no. 02

Literacy Rate of Jalgaon District 2001 to 2022

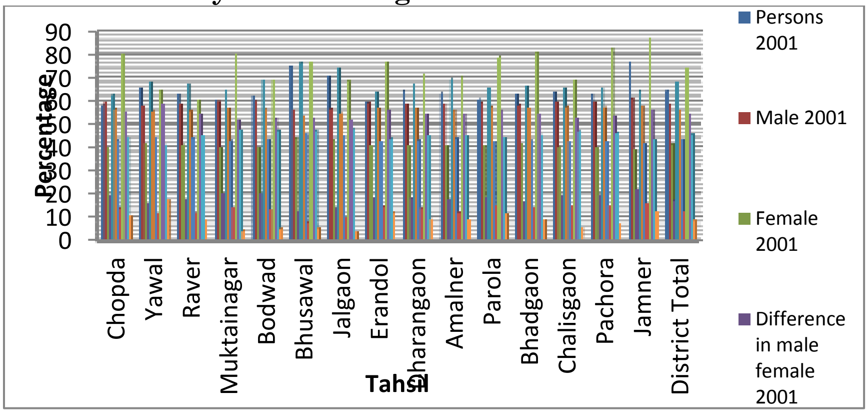


Fig. no. 02 is showing the percentage of literacy rate during 2001 to 2022 in Jalgaon district. The literacy rate of the population of Jalgaon district is increasing throughout the decades and the male and female literacy rate is increasing. This is the reason why the difference between male and female population is going to decrease in these decades.

Conclusion:-

The secondary data of 2001, 2011 census and 2022 survey data are showing a clear picture of the literacy rate of Jalgaon district. Jalgaon, Bhusawal and Jamner tahsils are highly literate but the variation in male and female literacy rate is high in these tahsils. The female literacy rate is very low in these tahsils of Jalgaon district. The difference between male and female literacy rate of Jalgaon district in 2022 is more in Chopda, Yawal, Erandol, Parola and Jamner tahsils.

Social structure and geographical phenomena are creating obstacles in women's education. Most of the families are not aware about the power of education. They are not sure about the social security of a girl alone outside the home. That's why most people want to have a girl child in the house and want to get education at the local level but the facility of higher education is not available at the local level. That's why women are doing their loss by getting higher education.

Most of the families try to avoid the responsibility of the mature girl and get their daughter married early. That's why the female literacy rate is low in the whole district.

There is a need to develop more educational facilities in the mountainous and hilly areas of the district. Social campaign is necessary to encourage people about strengthening education for women empowerment. It should make a positive impact and help increase the female literacy rate in Jalgaon district.

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An Assessment of Population Pressure on Land Recourses in Pune District of Maharashtra

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Abstract:

It has been witnessed that overpopulation and the high growth of Population have caused various problems in many parts of the world. Significant issues like hunger, pestilence and poverty are caused mainly by excessive population growth and overpopulation. Population growth has created a kind of strain on the natural resources of the land. In recent times, the impact of human population growth has been felt in agriculture, pastureland, and forests in the country. The pressure on land resources of the Population, when viewed in this context, needs to be consulted with changes in the pattern of land use. Due to heavy stress on the development of a large population, a large area was brought under cultivation. As a result, the area of forests and grasslands automatically decreased. In the Plateau regions of India, this picture of land use looks slightly different. In the plateau area, where fertile land and water supply are available, there is a heavy concentration of the Population. There is an excellent concentration of the Population in the Pune district where the people can sustain themselves because of the favorable economic activities

Key Words: Overpopulation, Population Pressure, Resources, Population Projection.

Introduction:

The rapid growth of Population is one of the biggest problems for many cities of India, such as Delhi, Kolkata, Chennai, Mumbai, and Pune (Sandu, 2018). The Population has been increasing rapidly in Pune District, especially in and around Pune City (Ohal, 2017). With a relatively high growth rate Population in a country like India, it is difficult to increase the production of crops and other necessary raw materials in order to meet the needs of the people (Nagarajan, 2005). The land resources are limited, and resources produced from them have not been increasing in line with the growth of the Population. Land resources are highly stable and have been continuously exploited by human beings in order to fulfill their needs. Thomas R. Malthus, an economist, postulated a highly systematic theory of population growth in his book called 'Essay on the Principle of Population'. Malthus was of the view that population growth was not in line with the capacity of the land to sustain overpopulation (Shrestha et al., 1999). When there are no checks, the Population grows geometrically, whereas the means of sustenance grow arithmetically (Hartmann, 2009).

The population growth, particularly in developing and undeveloped countries like India, has to be brought under control so as to fulfill the needs of the country's Population from the available land resources and also to maintain the minimum standard of living in the country. The demands for food, clothing, housing, sanitation, finished products, education etc. (Holden,1998). have increased in India, and all these factors are dependent on land that has been divided into small fragments. Hence, a large number of people have to be dependent on small areas of land, which means that every individual has a small portion of land per head (Ramotra, 2019). This has resulted in the problem of increasing population pressure on land resources, especially on housing facilities and utility services in Pune City. The major objective of the present chapter is to estimate the pressure of population growth on land by considering cultivated land per head in the Pune District of Maharashtra as well as to find sites suitable for urban development in the Pune District to moderate the increasing pressure of Population in Pune City and surrounding areas (Mundhe, 2014).

Study Region:

Study Area Pune district is located between 17º 54' N and 10º 24' N latitude and 73º 19' E and 75º 10' E longitude. The district has a geographical area of 15,642 km^2 having a population of 72,24,224. Pune district is bound by Ahmednagar district, Solapur district, Satara district, Raigad district, and Thane district. It is the second largest district in the state and covers 5.10 percent of the total geographical area of the state. The landscape of the Pune district is distributed triangularly in western Maharashtra at the foothills of the Sahyadri Mountains. Administratively the district is divided into 14 tehsils. These are Junnar, Ambegaon, Khed, Maval, Mulshi, Velhe, Bhor, Haveli, Purandar, Pune City, Indapur, Daund, Baramati, and Shirur. Pune city is the administrative headquarters of the district. There are around 1,866 villages in the district. The slope is towards the southeast. The study area has a basaltic base having step-like topography. In the west, there is Sahyadri basaltic mountain running north to south, and towards the east, the basaltic Deccan plateau, lying gentle slope towards east. In the Pune district, there are two municipal corporations, namely Pune and Pimpri Chinchvad and 18 town centers in district.

Objectives:

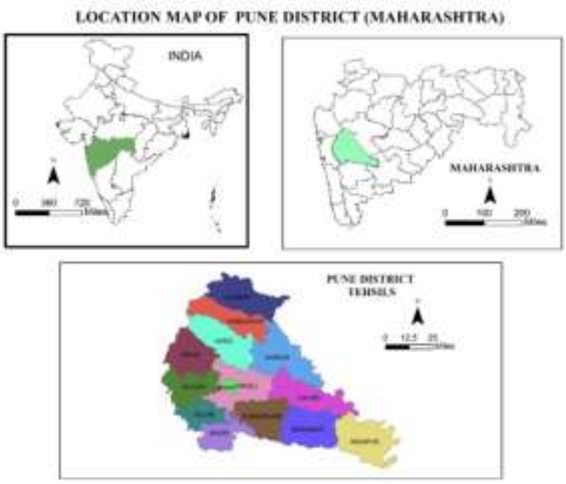
In the present paper, an analysis has been made to study the Population Pressure on Land Resources in Pune District. The aims and objectives of the present study are:

1. To study and analyze the population density in the Pune district.
2. To find out tehsil-wise population pressure on land in the Pune district.

Database and Methodology:

The present work is based on primary and secondary data pertaining to land records and Population. All relevant published and unpublished records have been considered. Primary data is collected through intensive fieldwork. The secondary data has been collected from the district census handbook, Gazetteer, district statistical abstracts, socio-economic abstracts, and records of villages. Projected population data for the year 2021 was used to estimate population pressure on land resources. Besides this, the required data and information has been collected from various books and journals.

Location Map of Pune District:



The analysis and interpretation of data has been done from the geographical point of view. The data has been processed in tabulation, percentage, index value done with help of computer software. The processes data has been put in the table forms, certain statistical methods and cartographic techniques has been applied to represent the data in the form of graph, maps, and diagrams. The processed data would be used for mapping and interpretation. GIS and Remote Sensing techniques are used for map presentation.

Result & Discussion:

In order to assess the pressure of Population on land in any region, information on population density and cultivatable land for agriculture in that region are required. Population statistics for 2011 have been released by India's Census Department. Hence it is possible to estimate the population pressure on land resources in 2011. But as population data for 2021 is not available, so the Researcher has considered the projected Population. With available data of Population 2001 and 2011 census reports, Researcher has calculated the projected Population of 2021. Since there is no rapid change in the area under cultivatable land of agricultural, the data on cultivatable land of agricultural in 2011 has been taken into consideration. Therefore, the Researcher has used various statistical formulas to calculate the projected Population and the pressure of the Population on the land resource.

Projected Population for 2021:

The population projection method has been used for estimating the future Population (the year 2021) of Pune District at the Tehsil level and village/town level. In recent years, there has been an increasing demand for estimation of the future Population. This information is required by governments for socio-economic planning and also for demographic research for making an estimation of the size and composition of future market and labour force and analysing the pressure of

Population on resources. The following formula of geometric population growth has been used for estimating the future Population and projected Population shown in table no.1

$$P_n = P_1 * (1 + I_G/100)^n$$

P_n = Projected Population

P_1 = Present Population

I_G = Decadal Growth rate of Population (%)

n = number of decades

From Table 1 and Figure 1, it is observed that the population density is the highest in Pune City and Haveli Tehsils of Pune District, followed by Mawal Tehsil, which indicates the high level of pressure of Population on the land area. Velhe Tehsil has the lowest population density, which indicates that the population pressure on land is less in this Tehsil.

Figure 1: Cultivable Land Area in Pune District, 2011

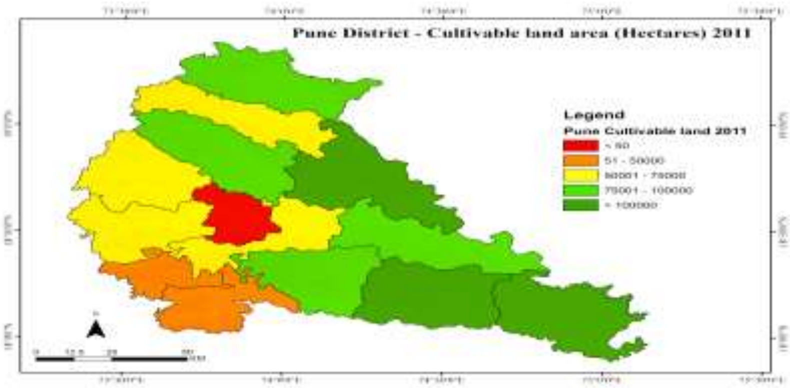


Figure 2: Pune District – Tehsil wise Projected Population Density (2021)

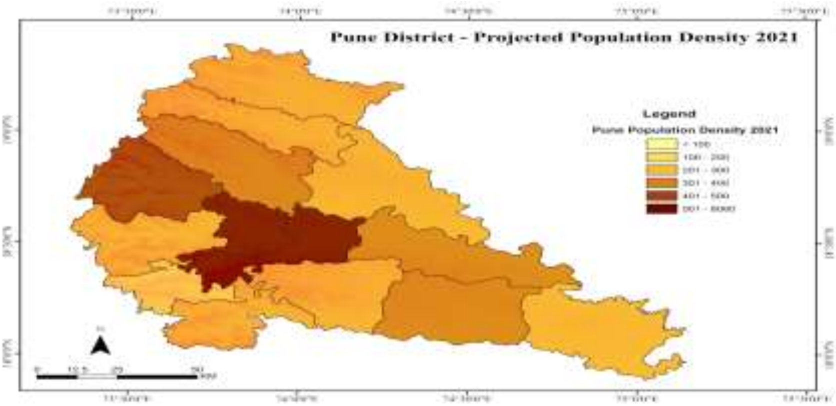


Figure no. 2 shows that the in year 2011, the land under cultivation in the Pune district was 10,23,828 hectares. In the Pune district, Shirur, Indapur, and Baramati Tehsils had a large area under cultivation (more than 1,00,000 hectares). The area under cultivation in Shirur is the highest (1,35,371.8 hectares) among all the Tehsils in Pune District. In the Pune district, Junnar, Daund, Khed, and Purandhar Tehsils had a considerable area under cultivation (75,000 to 1,00,000 hectares). Ambegaon, Haveli, Mulshi and Mawal Tehsils had relatively less area under cultivation (50,000 to 75,000 hectares). Bhor and Velhe Tehsils had less than 50,000 hectares of land area under cultivation. From Table 7.1, it is noticed that the average number of persons per hectare of the cultivable land area, i.e. the nutritional density during 2011, is the highest in Haveli Tehsil of Pune District followed by

Mawal and Khed, which indicates the high level of pressure of Population on the cultivable land area. Velhe Tehsil has the lowest nutritional density or an average number of persons per hectare of the cultivable land area during 2011, which indicates that the population pressure on cultivable land is less this Tehsil.

Population Pressure on Land in Pune District:

In order to measure the population pressure on cultivated land, the relative co-efficient of the Population has been computed by taking into the consideration 0.4-hectare land (Mendels, 1971; Ramaswamy, 1992; Shi et al., 2005), which is the minimum requirement of agricultural land to feed an individual as recommended by Great agriculturist Swaminathan (1974) in his book 'Limits of Growth'. The following formula has been used for the calculation of the population pressure index (Hammound, 1985, p. 32):

Formula

$$PPI = \frac{P_1 - P_2}{A}$$

Where,

'PPI' is the index of population pressure,

'P_1' is the population size capable of being supported by the resources in a given region or in a country,

'P_2' is the population size in that region and

'A' is a total agricultural area of the country

Table 1: Pune District – Tehsil wise Population Pressure Index (PPI) on land (2011)

Sr. No.	Tehsil	Cultivable land area (Hectares)	Population (2011)	ND 2011	PPI (2011)	Projected Population (2021)	ND 2021	PPI (2021)
1	Junnar	93900.4	399302	4.25	-1.75	431151	4.59	-2.09
2	Ambegaon	71325.47	235972	3.31	-0.81	260392	3.65	-1.15
3	Shirur	135371.8	385414	2.85	-0.35	478264	3.53	-1.03
4	Khed	86679.67	450116	5.19	-2.69	590315	6.81	-4.31
5	Mawal	52121.23	377559	7.24	-4.74	467253	8.96	-6.46
6	Mulshi	53601.45	171006	3.19	-0.69	229564	4.28	-1.78
7	Haveli	59486.33	2435581	40.94	-38.44	4384210	73.70	-71.20
8	Daund	93880.52	380496	4.05	-1.55	424084	4.51	-2.01
9	Purandhar	78239.23	235659	3.01	-0.51	248560	3.18	-0.68
10	Velhe	28793.08	54516	1.89	0.61	53191	1.85	0.65
11	Bhor	43563.34	186116	4.27	-1.77	201720	4.63	-2.13
12	Baramati	104454.3	429600	4.11	-1.61	494985	4.73	-2.24
13	Indapur	122411.4	383183	3.13	-0.63	421423	3.44	-0.94
Pune District		1023828.8	9429408	9.21	-6.71	12293544	12.00	-9.51

Source - Data calculated by Researcher

ND - Nutritional Density (persons per hectare of cultivable land area)

The population pressure index (PPI) in relation to the area under cultivation (in hectares) has been calculated Tehsil wise for understanding population pressure on Land in Pune District for the year 2011.

In 2011, Pune city had the maximum population pressure as it had the highest Population among all the Tehsils, and there is a small area of cultivable land in this Tehsil. From Table 7.1, it can be noticed that population pressure on land is relatively high in three Tehsils viz. Haveli (-38.44), Mawal (-4.74) and Khed (-2.69). The minimum requirement of agricultural land (0.4 hectares) available per head is not fulfilled (according to the negative population pressure index) in almost all the Tehsils of Pune District except Velhe Tehsil in 2011. Pune District has an overall population pressure index of -6.71 which indicates the high level of pressure of Population on land resources in Pune District. In 2011, only Velhe Tehsil in Pune District, having a population pressure index of 0.61, had been identified, fulfilling the minimum requirement of agricultural land (0.4 hectares) available per head of the Population.

Figure 3: Pune District – Tehsil wise Population Pressure Index (PPI) on land (2011)

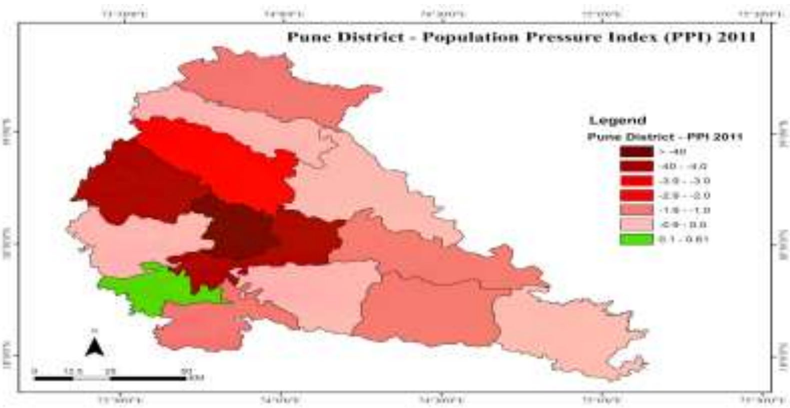
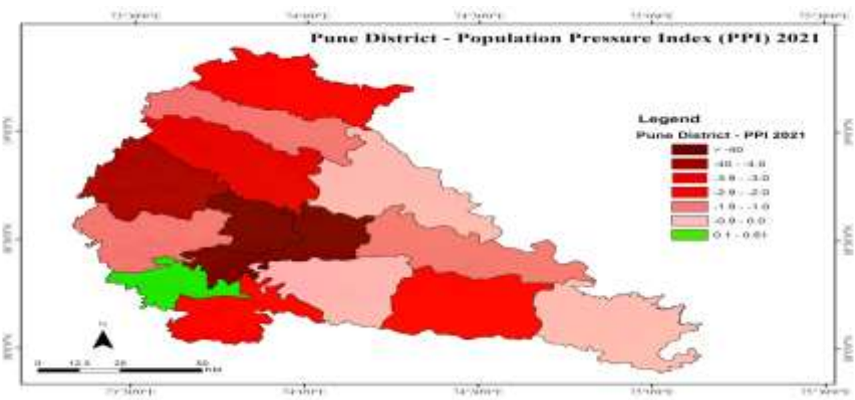


Figure 4: Pune District – Tehsil wise Population Pressure Index (PPI) on land (2021)



From Table 3, it is noticed the average number of persons per hectare of the cultivable land area i.e. the nutritional density during 2021, is the highest in Haveli Tehsil of Pune District, followed by Mawal and Khed, which indicates the high level of pressure of Population on the cultivable land area. Velhe Tehsil has the lowest nutritional density or an average number of persons per hectare of the cultivable land area during 2021, which indicates that the population pressure on cultivable land is less this Tehsil.

According to the projected Population and population pressure index for the year 2021, Pune city will have the maximum population pressure as it will have the highest Population among all the Tehsils, and there is significantly less cultivable land in this Tehsil. From Table 3, it can be seen that population pressure on land is increasing in almost all Tehsils except Velhe Tehsil as compared to 2011, and it is relatively high in three Tehsils viz. Haveli (-71.20), Mawal (-6.46) and Khed (-4.31). The minimum requirement of agricultural land (0.4 hectares) available per head will not be fulfilled (according to the negative population pressure index) in almost all the Tehsils of Pune District except Velhe Tehsil in 2021. Pune District's overall population pressure index has increased from -6.71 to -9.51, which shows the increasing pressure of Population on land resources in Pune District. In 2021, only Velhe Tehsil in Pune District, having a population pressure index of 0.65, will fulfil the minimum requirement of agricultural land (0.4 hectare) available per head of the Population.

Conclusion:

Population pressure on land resources in Pune district has been studied in this research. Several findings have emerged in this research. The population growth in Pune district is very fast. Urban population is increasing very rapidly in Pune district. Pune city and Haveli taluks in Pune district have the highest percentage of urban population. Pune city is 100 percent urbanized and there is no agricultural area at all. Haveli taluka has also seen a drastic decline in the agricultural sector. Industrial areas are developing rapidly in Maval, Khed, Junnar, Shirur, Mulshi and Baramati taluks of the district. These types of physical changes tend to alter the natural form of the land, leading to increased use of the land for man-made purposes. The total natural state of land in Pune district is being used more for human activities. Land use Land Cover Pattern has changed from naturally occurring forests, water, grasslands, and wastelands to manmade infrastructre. Due to the increased population, land use has increased for either construction or agriculture. In the future, the population of Pune district is going to increase like this. It is very important to maintain the balanced development of the environment. For this, it is necessary to maintain the existence of forests, water bodies, pastures, and waste lands etc. Areas under forests as well as lands suitable for agricultural cultivation should not be used for construction or physical resource development. Due to rapid urbanization in recent times, lands in Pune, Haveli, Maval, Khed tehsils are being used for building construction, roads, dams, industrial factories, and other man-made physical facilities development. In Pune district, the pressure on land due to population growth is much higher. In this research, the researcher has tried to study the pressure of population on land resource by tehsilwise. Land use planning has become a matter of necessity in Pune district in the future. This type of research will further stimulate the study of many factors like land use planning, urban development planning, industrial development planning.

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A Critical Study on the Problem of Slum and Housing: A CaseStudy of Bihar Sharif Municipality

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Introduction

A slum is a heavily populated urban informal settlements characterized by substandard housing and squalor. (Goswami and Manns 2013) While slums differ in size and other characteristics from country to country must lack reliable sanitation services, supply of clean water, reliable electricity, timely law enforcement and other basic services. (Srivastva A.1996) Slum residence vary from shanty houses to professionally built government recognized dwellings which deteriorate in due course of timedue ill maintenance. slum is defined as a household where in group of individuals living in a particular area which lacks, properly designed and constructed house that protects the resident from natural calamities, sufficient amount of spaceallotted to each member of the household available of safe drinking water proper sanitation conditions i.e. clean toilets and a proper drainage system and the ownership of the land. (UN Habitat2012) The major reason of development of the slum is rapid urbanization and economic growth occurring in an informal fashion where in the residents do not hold the legal rights to live in those areas. (census of India 2001) A Slum area is a compact of at least 300 populations or about 60 to 70 households of poorly built congested tenements in unhygienic environment usually with inadequate infrastructure and lacking in proper sanitary and drinking water facilities. (National Slum Policy)

Slum is a compact area of at least 20 slum like households satisfying the set criteria exist in unhygienic environment usually with inadequate infrastructure and lacking proper sanitations and drinking water facilities in the context of Bihar. Main characteristics of a slum are high overall household density at least 40 families per acre and predominantly cloud house single room houses co habitations by two or more families. Second quality of house and location third in a liquid asset of safe drinking water and improvedsanitations, less than 50% house has drinking water supply, less than 50% families having individual toilet or access to community toilet and having legal electric connections. (Slum policy of Bihar 2016) In Bihar more than 10% of total urban population, constituting 1.2 million people reside in its urban slums recognizing the need to frame a holistic sustainable and inclusive policy for informal settlement in the state. (Tiwari R.C 2012)

According to Bihar Slum Census (2016) In Biharsharif 21,281 people live in slum area in which 11037 of total population is male and 10244 is female. This is around 7.16% of total population of Biharsharif city. The appearance of slum maybe scene as a by - product in the process of urbanization in a developing country like India. (Goswami and Mans 2016). The growth of the slum has provoked increasing international interest and the United Nation. Sustainable Development Goals (SDGs) specify a target to address the 'Plight of slums' (UN, SDGs,2015). There are so many problems like physical, socio – culture, economic and environmental. There is low level of housing which is characterized by large population is called a slum. In this area there is some defined illegal occupations with over population in which basic facilities such as latrine, drinking water and health facilities are very much poor. The biggest problem of the Biharsharif is rapid urbanization and lack of resources. There are low level of amenities and inadequate sanitations due to which a variety of problems have to be faced in the settlements. Inferior goods are found in local shops apart from this there are alcoholic people and criminals. (Biharsharif Municipal Commission report 2012)

Aim and Objectives:

The present research focuses to examine the slum area in Bihar Sharif town and their associated problems. The following objectives have been made for the research.

(a) To study the socio - economic characteristics of the slum of Bihar Sharif City.

(b) To study the housing condition of the City.

(c) To study the living condition and services available in the slum area.

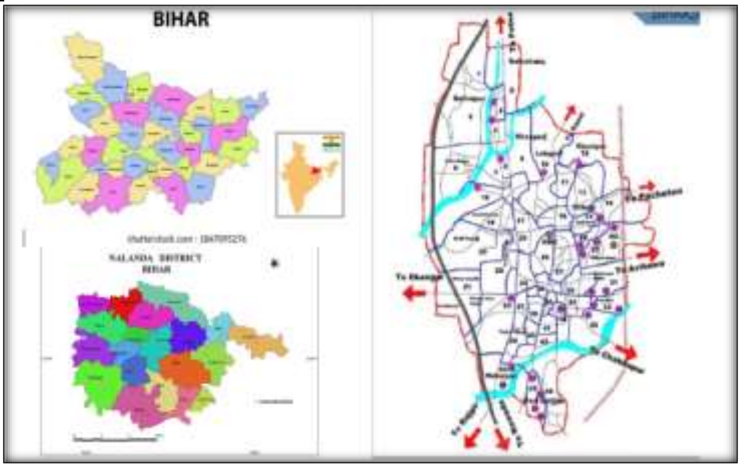
1. **Methodology of the research**

For the present study the data is collected from both primary and secondary respectively. The study used the primary data with the help of questionnaire and field survey, interview with the resident and for secondary data the researcher used municipality data and census of India 2011 which comprises number of household population and demographic characteristics beside that mapping of slum area through administrative ward is done by the GPS and Google map services.

2. **Location of slums**

The slum dwellings are scattered in the different localities of the city mainly in the outskirts portion of the city. Out of the total 46 wards in Bihar Sharif, presence of slums has been noted in most of the wards except ward number. 1, 13, 14, 16, 17, 20, 21, 22, 27, 35 and 46. There are total 38 slum settlements in the city. Maximum slum population has been noted in ward number 5.

Map 1: Location of Notified Slum in Bihar Sharif



3. **Slums in the City**

Table: 1: Slum details of Bihar Sharif in comparison with the city

Sr.no	Item	City	Slums
1	Total house hold	57534	3861
2	House hold size	7.3	7.9
3	Total population	297268	21281
4	Sex ratio	902	942

Source: Census 2011

Presence or absence of slums is an indicator of general quality of life or health of a city unfortunately. Slums have become an integral part of the urban landscape in almost all Indiancities and Bihar Sharif is no exceptions. The details of slum in Bihar Sharif as per 2011 census are mention in the table no.1. As per the Census 2001 the number of households and population living in the slum are 1,726 and 13,713 respectively. But in comparison to 2011 census it increases with 3861 and 21281 respectively. The total slum population is 7.16% of the total city population which is almost similar to the country slum population of 5.1%. Table 2.

Table 2: Slum detail as per recent study

particulars	Nos.
Total number of slums	33
Total population of slums	21281
Number of house hold in slums	3861

Source: BMC Survey 2011

4. **Slum identification**

According to the slum policy of Bihar (2016) the slum within the urban area have been based on:

1. Poor quality of housing
2. Absence of drainage facility
3. Non availability of sanitation facility
4. Absence of education facilities
5. Non accessibility to roads and pathways

5. Housing

The places which ensure access to a safe, secure, habitable and affordable home is known as housing. (UN Habitat) It is the basic need for human being specially for the poor. The problem of housing for the people is rapidly increase due to excessive urban population and constant migration of rural population to cities in search of job. It is causing insufferable strain on urban housing and basic services. There is a dreadful housing shortage in urban areas with demand and supply gap increasing day by day (HUDCO 2018). It is estimated that in 1991 Urban Housing shortage at 8.23 million and had expected the absolute shortage decline progressively to 6.57 million in 2001 and 4.64 million in 2011. (National building organization, NBO). Bihar has only 2.70 million urban housing unit with compare to all India total of 110.14 million. (a) residential 73.1% (b) non- residential 20.02% (c) vacant unit 6.2% by census 2011 (UN-Habitat 2016). Bihar has shortage of 1.19 million urban houses according to ministry of Housing and Urban Area 2012. Housing is a major role in facilitating urban development in Bihar which will see its urban population double between 2011 to 2031 National Housing Project has also recently be launched in the state but result of which still and clear. (SPUR report)

6. Socio Economic Characteristics in the Slum of Bihar Sharif

The slum localities are characterized by poor infrastructure conditions. Most of the dwellers have their own houses with or without any legal document. The basic amenities like bathroom, toilet, drinking water and electricity is not present in the slum area. Due to that they resolve to open defection. Almost all the slums have inadequate water supply and sewerage disposal problem, Waterlogging and other problems for the resident of slums area is arising due to poor waste disposal and sanitation facilities.

Table 3: Slum Characteristics of Bihar Sharif

Particulars.	Details
Poor availability of water supply	62% of slum settlements
Community toilet facility.	Only 19% of slum settlements
Open defection.	More than 80% of the slum settlements
Drainage facilities kaccha or pakka or both	Nearly 94% of slum settlements
Provision of electricity	Only 40% of slum settlements
Pakka internal roads	Nearly 52% of slum settlements
Government schools within slums	Nearly 44% of slum settlements

Source: Census Survey 2011

The slum sex ratio of Bihar Sharif is 942 the overall sex ratio of city is 915. The literacy rate of slum population in Bihar Sharif is 62.5% which is lower than the city literacy figure of 75.30%. There are variations between male and female literacy rates in slums. The work force participation rate of the slum population in Bihar Sharif was 57.4%, out of which the main workforce constitutes about 86.6%. There is a need for appropriate strategies to provide skill upgradations, development opportunities to enhance the capacity and improve the ability of the poor and the marginalized to earn better livelihoods.

The population residing in the slum areas mostly belongs to the schedule caste and other backward castes. Due to the history of many Muslim governors and presence of many religious places in the city, there is the large Muslim populations and similarly mini slum areas are also Muslim population dominated. The ethnic structure of the city in terms of presence of different communities is also visible in the slum areas. (Source: SPUR)

Table 4: Slum Characteristics of Bihar Sharif

Sr No.	Indicator	Perticular	Bihar Sharif City	Slums
1	Sex ratio		902	942
2	Literates	Total	205,691	10071
		Male	79,547	3585

		Female	56,144	2486
3	Total Workers	Total	63505	3886
		Male	50543	2887
		Female	12962	999
4	Main Workers	Total	55023	3480
		Male	45910	2725
		Female	9113	755

Source: Census Data2011

7. Housing Condition in Slum

To conduct the house hold survey, we used the household survey of slum area and collected primary data in which we got the information about house hold size, vacant house, type of house, category of the owner and their nature of job. From the survey we got the total number of households in Slum area i.e. 3861 which is 6.71 % of total house in Bihar Sharif (57534) the average household size is 7.3. From this survey we came to know that the people living here are mostly from Muslim community and back ward classes, who mainly do the work of picking up garbage, selling vegetables and doing labor work. Most of the woman work as a maid in other houses in the city. If we compare the hosing condition of the city it has been observed that house hold development is much higher than the slum area, city is observed 25% growth of house hold than the slum area. There is lack of basic amenities in the houses. Most of the houses is in dilapidated condition and about six and seven family member lived in single houses.

There is one other household survey was carried out in 2007 which shows that around half of the surveyed populations lives in either single or two three dwellings room. As the average household size is greater than 7, it clearly depicts that majority of the households in the city are at present living in overcrowded conditions. The absolute shortage of houses in Bihar Sharif is minimal only 3.16 households are homeless. (Source: Bihar slum policy).

Table 5: Status of the Census Houses

Particulars	Number
Livable	40,847
Good	25,718
Number of decaying houses	8,585
Vacant houses	5,569

Source: census2011

As per census 2001 there are 42,780 houses in Bihar Sharif municipal area out of which 40,927or occupied and 1,853 are vacant the occupancy rate is 95.67%. Out of the total occupied census houses under residential and residential come other use 78.49% are permanent structures, 19.14% are semi-permanent structures and less than 3% are under temporary services and temporary non- serviceable category

As per census 2001 there are 24,645 households in Bihar Sharif Municipal Area, however 23,594 occupied census houses are under residential or residential cum other use which impliesthat there is a shortage of 1,051 houses in Bihar Sharif. Only 4% households are homeless and it is indicative of good housing conditions.

Integrated Housing and Slum Development Program

The IHSDP scheme has been targeted for the urban poor and it is mandatory for them to review the existing living conditions of the identified slums on the basis of the seven-point charter under IHSDP. There is an attempt to improvise the deteriorated condition of the slum dwellers and make it more livable. This programmed come under JNNURM. There main aim is to provide affordable houses for the urban poor with the help of BSUP. (Source: Basic service for the urban poor)

Table 6 : Condition of Slum dwellers

Particulars.	Numbers
Total census houses.	42,780
Occupied	40,927
Residence	29433

Residence cum other use	1736
Hotel or guest houses	160
Hospital dispensary	215
School colleges	246
Shops offices	7096
Factory worksheet andworkshop	342
Worship place	340
Other Non-residential	1359

Source: Census2001

8. Services in slums

On the basis of primary survey with the help of interview of local residents it is found that the service level in the slum area is very poor. Most of the slum populations depends on the government water supply which is not properly distributed and maintained. The pipes are damaged and water is just flows on the road. As there is always scarcity of water supply, only few hand pump is installed in the area. Out of the 33 slums, only 10 slums have hand pump facilities. The remaining slums are depending on government supply and community taps. There is lack of sanitation in these slums areas which results in high open defection. About 40% of the slum population defecates in open due to absence of individual or community toilets. There are only 8 community toilets in the slum area in the city. Around 44% of the people in the slum localities have either no houses or kutcha houses the slum area do not have proper access to infrastructures facilities. Solid waste of the slum is disposed in Nala drains or openly on roads. This leads to flooding during the monsoon and causes health effect. Table 7

About 36.4% of the roads in the slum are kutcha and are in very bad conditions and needimmediate attentions. These slums have very poor water draining facilities. Out of the existingdrains in the slums 75% are open and are always choked due to solid waste dump in these drains. On the other hand, the road and drainage system of the city is quite better than the slum area, in Biharsharif 40% of drain is closed and 60% of house is in pucca condition. This comparison shows that the slum area is neglected by the municipal commission and need special attention for proper development of the city.

Table 7: Service Levels in Slum in Bihar Sharif

Particulars	**Percentage**
Houses	
Kutcha	45.2%
Pucca	23.3%
Semi Pucca	31.5%
Drains	
Open	74.2%
Closed	25.8%
Road	
Kutcha	36.4%
Pucca	63.6%

9. Key issues

Based on the current research there are some problems are being identified. The number of slum settlements in Bihar Sharif is very high these slums have degraded in the recent past due to lack of basic amenities such as water and toilets etc. Rapid growth of population creates unemployment, health issues, lack of infrastructure, social problems and Environmental problem. The increasing pressure on resources by urbanization and urban sprawl, different types of challenges are being faced. The condition of the slum is worse than the past.

10. Recommendations for Slum Improvement

The following are the strategies and recommendations for slum improvement-

1. Strengthen the capacity of support agencies like municipal administrations to provide the better services.
2. Adequate residential facilities should be provided to each family.
3. Accommodation should be environment friendly and convenient.

4. Provide clean drinking water for slum resident and uninterrupted electricity so they can upgrade their life style.
5. Proper construction of drainage and maintenance of sanitation system must be watched by competent authority.
6. Provide technical and financial assistant for innovative enterprises to improve local productivity and generate wages and employments.
7. Pollutions and environment issue should be on priority means with the help of NGOs and governmental organization.

11. Conclusion

Bihar Sharif is the biggest city of the district that's why the rural population migrate to the cityand create chaos. Constant population expansion and rural urban migrations are the primary causes of the environmental and socio economic issue in slums, which will make urbanization a significant challenge in the future. it is very important that the policies and programs of the municipality and government should be like that the gap between the slum and the town can be removed. Bihar Sharif has expanded haphazardly and cause various problems. During the field survey it was found that the slumpeople had migrated from the previous location to current location for the employment. The condition of streets, road and drains is not satisfactory. The house hold size and socio economic status is not up to mark. Disposal of garbage and house hold waste is not properly maintained.

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Tourism Potential in Nashik City

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Abstract

If tourism is strategically organized, it may significantly contribute to sustainable development, economic growth, and social welfare. Addressing these problems, making the most of India's diverse destination resources, and maximizing the country's financial investment in improving its tourism infrastructure have all been priorities in the country during the last decade. This article develops a straightforward framework for estimating a region's tourist-drawing power when specifics are lacking. In this investigation, the "Weighted Sum Method" was used, which is a well-liked method for making decisions based on several factors. The approach picks socio-physical characteristics to quantify using ranking and scaling methods. The cost of tourism infrastructure has been minimized by the use of a clustering idea. In the present study the tourism potential for the Nashik City has been assessed. Remarkable historic precincts are the major feature of the area. Individual hotspots and clusters have been used to calculate the tourist potential. Important caveats to this work have been highlighted, and suggestions for further research have been made.

Introduction

Tourism potential, in its simplest form, is a location's likelihood of attracting and accommodating visitors who are interested in the site's accessibility, resource quality, interpretive opportunities, etc. (Anderson, 2007). According to Kuskov and Dzhaladyn (2006), tourism potential is "the sum of natural, cultural, historical, and socio-economic foundation for the organization of tourist activity in the given location." In addition, Bassey (2015) defined tourism potential as a community's or location's stockpile of resources with the potential to be converted into tourist attractions or end goods. However, tourist potential should not be understood exclusively from a resource-based viewpoint; operational factors are essential contributions to the concerns regarding tourism potential. This is consistent with the focus placed by Bassey (2015) on the amenities, services, and infrastructure that tourism destinations need to be ready for guests.

Given that "destinations might be very dynamic in size, from an entire country... to a hamlet," the phrase "destination appeal" refers to the tourist potential of historic sites (UNWTO., 2007). A destination may be anything from a large-scale tourist attraction like a museum to a small-scale historical site like an ancient hamlet. Both supply and demand factors contribute to a location's overall allure. Formica (2000) underlined the difference between the two perspectives: "The supply view is based on the quantity and quality of available attractions at destination. Demand forecasts are sensitive to visitors' impressions and inclinations about the destination. By classifying supply-side aspects as competitiveness and demand-side ones as attractiveness, Buhalis (2001) further distinguished the two viewpoints. As "the entire tourist appeal of a site is contingent upon the link between actual resources (natural, cultural, historical, etc.) and the perceived worth of such resources" (Formica, 2000), Vengesayi (2003) reiterated this perspective of destinations from both sides. The word "potential" is used instead of "attractiveness" in this research because it more accurately describes the judgment made at the very beginning of tourist development rather than the more generalized and universal assessment made at later stages.

The potential of a location or its associated resources must be understood before the location can be successfully marketed as a tourist destination. It's beneficial for planning, marketing, investing, and management, just to name a few of the many linked topics that may be better understood with this information in hand. As a result, a plethora of reports assessing the tourist potential of different locations and assets have been compiled. This research has been dominated by the model of du Cros (2001), which combines concerns about the physical robustness of heritage into the assessment of potential, in parallel to the commercial attractiveness of cultural assets. In the paradigm, robusticity and cultural relevance comprise one dimension, while commercial attractiveness and product design represent another. The evaluation findings are shown graphically as a matrix, with heritage sites divided into nine categories based on their commercial attractiveness and capacity to handle more tourism.

Du Cros's (2001) flawed two-dimensional model. Because the two aspects are incompatible with one another, heritage assets tend to be grouped together in the graphical display of assessment findings without creating a hierarchy (McKercher &Ho, 2006). Lacking such results as a ranking of re-sources or assets raises questions about the model's efficacy. McKercher and Ho (2006) were able to reassemble a four-dimension framework (henceforth referred to as the McKercher framework) that links to the cultural, physical, product, and experience values of assets by deconstructing the du Cros model. As noted by McKercher and Ho (2006) and Sanchez Rivero, Sanchez Martn, and Rengifo Gallego (2016), the qualitative aspect of evaluation has not altered despite efforts to utilize an ordinal scale to designate sub-indicators of the fourfold values. What this means is that the flaws inherent in the du Cros model have been carried over into the four-value framework.

This study aims to develop a new model for auditing the tourism potential of tourism sites. Applying the model to heritage site evaluation generates a hierarchy of sites, which would be helpful for comparing sites in terms of their potential for tourism development. A quantitative method is required to obtain a hierarchy of heritage sites based on levels of potential. Quantitative methods have been widely used for site evaluations for various developments, such as environmental conservation (Matin et al., 2016) and agriculture development (Kolios, Read, & Ioannou, 2016). In addition to conducting site evaluations, studies have assessed sites for different forms of tourism development, such as eco, agro, adventure site development. Quantitative methods have been used to evaluate heritage sites (e.g., Al Mamun & Mitra, 2012; Malik & Bhat, 2015), and the quantified results are helpful for comparing the tourism potential of sites in a given area.

Two popular theoretical frameworks, du Cros and McKercher Various approaches have been used in previous research to assess the potential of resources or sites for tourism. Du Cros's (2001) concept is widely used; it has two parts, heritage conservation and heritage commercialization (also known as heritage management and tourist development). Some have attempted to conceptualize the former component via the idea of robusticity. Cultural heritage sites may be placed on a three-dimensional grid according to their robustness and commercial attractiveness. The matrix positions allow us to categories heritage sites into four groups: those with high market appeal and relative high robusticity, those with high market appeal but low robusticity, those with moderate market appeal and relatively high robusticity, and those with low market appeal regardless of robusticity. The value of the du Cros matrix is most apparent in its ability to combine the two most important components of heritage—preservation and commercialization. For sustainability reasons, Bucurescu (2013) argues that assessments of the tourism potential of heritage sites should not be limited to market appeal, but rather should be carried out while taking into account the factor of robusticity, or the ability to accommodate negative impacts derived from increased levels of visitation. Studies of tourist potential have made extensive use of the du Cros model. Stamenkovic and Jaksic (2013) made no adjustments to the duCros model as they used it to do an evaluation of a historic downtown. The approach was used by Li and Lo (2004) to assess the potential for tourism in Hong Kong's New Territories, which are populated by people with just one surname. The research validated the model's efficacy but critiqued the matrix for its absence of community concerns in the robusticity component and its nebulous treatment of "product design requirements" in the market appeal dimension. Despite its widespread use for evaluating cultural assets, the du Cros model has only been applied to natural heritage by a select few studies, and even those that did so used somewhat altered sub-indicators (Bjeljac et al., 2012). The McKercher framework is a considerable extension of the du Cros model; it is comprised of four dimensions: cultural, physical, product, and experience value. Physical importance, robustness, development demands, market appeal, and L. Yan et al. / Tourism Management 63 (2017) 355e365356 other elements in the du Cros model were broken down to produce these dimensions. In other words, the du Cros model served as the basis for developing the vast majority of the four-dimensional indicators. The McKercher framework was created for evaluating lesser-known Hong Kong historic assets. Nine public museums in Hangzhou, China's cultural capital, had their tourist potential assessed using a model with two new criteria added to it: marketing and leadership (Sheng & Lo, 2010). The experiential value of cultural assets was the primary topic of a research on Chinese heritage assets in an Australian city (Laing, Wheeler, Reeves, & Frost, 2014), which used the McKercher framework. The literature provides a variety of tools for evaluating a resource's potential as a tourist attraction. The literature provides a variety of tools for evaluating a resource's potential as a tourist attraction. i.e., Strengths, weaknesses, opportunities, and threats (SWOT) analysis, Descriptive analysis, Item response theory model, Stakeholders' assessment, Weighted sum model and the demand-side perspective.

Study Area

Nashik city is capital of Nashik District situated in the northwest of Maharashtra state, at 19°54'40" N to 20°05'08" N latitude and at 73°41'08" E longitude to 73°54'22" E longitude. The total geographical area of Nashik Municipal Corporation is 259.10 sq. km. The administrative divisions of NMC are divided into 06 divisions and 61 general wards. The Nashik Municipal Corporation is India's 29th and 5th largest urban agglomeration of the Maharashtra; and third largest urban agglomeration of North Maharashtra. Nashik has a unique personality of its own attribute to its mythological, historical, social and cultural importance. (Revised Development Plan NMC,2016). The city's history may be traced back to the Ramayana. There are many allusions to the city in both epics and Vedas. Since ancient times, the city has grown up along the river's banks, as a religious site. However today it is a flourishing industrial centre as well as an educational centre. Its mythological, historical, social and cultural value gives a unique personality to the Nashik city. It is popularly known as 'Grape City' and is one of the four cities in India that hosts the massive Sinhastha Kumbh Mela once in twelve years. The Nashik city is the third most industrialized city of the Maharashtra State after Mumbai & Pune and signifies as one of the rapidly growing urban agglomeration of Maharashtra. The scenic beautiful surroundings and cool and pleasant climate make the Nashik city a centre of attraction.

Description of the Study Sites of the Nashik City

Panchvati

Panchvati is a spiritual, religious, and mythological location, situated on the left bank of the Godavari River, in the northern part of Nashik Municipal Corporation, tehsil: Nashik and District Nashik.

Muktidham

Muktidham is a temple and dharmshala located in Nashik about 8 km from the city centre in the Nashik Road region. Muktidham temple, which is constructed entirely of flawless marble from Makrana, Rajasthan, is one of the most popular tourist attractions in Nashik, the temple was built by a local industrialist Mr. J.D. Chauhan-Bytco in the year 1971. The literal meaning of the word Muktidham in Hindu religion is place where u can get 'Moksha' (release from the cycle of rebirth impelled by the law of karma). It is privately owned and administered by a trust, and it was established and maintained as a result of a charitable contribution.

Kalaram Mandir

The Kalaram temple is an ancient Hindu shrine dedicated to Lord Rama that can be found in the Panchavati section of Nashik City's Panchavati district. It is one of the most prominent Hindu shrines in the city and state, and it is dedicated to Lord Rama. The temple gets its name from a statue of Lord Rama that is painted in a dark shade of purple. The goddess Sita and Lakshman also have accompanied sculptures in this temple.

Pandav Leni/Trirashmi Leni

Pandav Leni or Trirashmi Leni or Nashik Leni is a group of twenty-four rock carved caves located on hill at the outskirts of Nashik city on Trirashmi hills. According to the Archaeological Survey of India Caves carved between the first and third centuries BCE, with additional sculptures added until the sixth century. The cave area carved on the northern frontage of Trirashmi hills protects them from the sun and rains from the southwest, therefore most of the carved art and many lengthy and significant inscriptions have survived 1500-2000 years intact. All of the caverns are intricately carved and handcrafted works of art.

Sita Gufa

The Sita Gufa (also Sita Gumpha and Sita Gupha) is a sacred site in Hinduism that plays a significant role in the Ramayana, the foundational epic of Hindu mythology. Basically, it means "Cave of Sita," the name of Rama's (the Ramayana's protagonist and heir presumptive to the kingdom of Ayodhya) wife. Rama is banished to the forests for 14 years, and he ends up spending a good portion of that time at Panchavati, which is today a part of Nashik, Maharashtra. Ravana, the wicked king of Lanka, is supposed to have abducted Sita here, from the Cave of Sita.

Methodology

Questionnaire Survey

To make an assessment for the tourism potential of the Nashik city, an extensive questionnaire survey was conducted. The questionnaire was designed in such a manner which will help to collect various information regarding the tourism potential of the Nashik City. The questionnaire was helpful to collect various indicator.

Measurement

This research produced a scale for measuring tourist potential based on two indicators: resource values and development status. The aesthetic value, historical value, awareness level, ambiance or setting, complementarity with nearby attractions, value for money, and authenticity were the seven criteria used to evaluate resources (Li & Lo, 2004; McCercher & Ho, 2006; Yeung, 2012). Accessibility or transportation, proximity to other attractions, tourist facilities, on-site interpretation, visitor information, time spent at the destination (McKercher & Ho, 2006), and on-site catering services (Sanchez Rivero et al., 2016) were used to gauge the second indicator, development state. The Discussion section explains the thinking behind the measurement's creation. Every supplementary metric was graded on an ordinal scale. Some of the supplementary indicators used the scale of five values from low to high, as provided by McKercher and Ho (2006). Although additional classifications were employed, the order of low to high or negative to positive remained consistent. Each category was given a numeric value between 0.2 and 1.0 for the coding process. The lowest number was 0.2, followed by 0.4, 0.6, 0.8, and 1. (the highest value). After then, both the authors and the respondents rated the indicators and the sub-indicators. Depending on how crucial they were to the industry's growth, the sub-indicators were given a score between one and seven.

Weights of indicators and sub-indicators

This research made the supposition that a higher-ranked sub-indicator had a greater impact on the total value. In other words, each rank needs a weight that reflects its position in the hierarchy of ranks (Al Mamun & Mitra, 2012). Following is the formula used to determine the weighted value for each position:

$$\boldsymbol{R_i} = (\boldsymbol{MAXi}) + \boldsymbol{1} - \boldsymbol{i}) \sum \boldsymbol{I}$$

Where I is the ordinal number of ranks.

The weighted values of the seven rankings were obtained with formula (1). (Table 1). While determining how much weight to provide to each sub-indicator, we took everyone's input into account. More precise results from weight calculations would result from this. The weights of the sub-indicators were determined using the following formula.

$$\boldsymbol{W_{ji} = \sum(C_{ji} * R_i)/N}$$

where N is the total number of observations, I is the ordinal number of sub-indicators, C I is the count of occurrence of the i-th rank for a particular sub-indicator, and j is a constant that refers to a specific indicator. Indictor weights were assigned by the authors.

The indicator of resource values came in first, followed by the indicator of development status, because of the importance of resources to the tourist industry's growth. Resource value was given a weight of 0.67 and development state weight of 0.33 in the computations described above.

Estimation of Composite Potential values

$$V = \sum W_{ji} \, (W_{ji} * S_{ji})$$

where Sji represents the average value of the jth sub-indicator.

Data collection

The data collection was done using questionnaire survey conducted between January 2018 to March 2019 consisting peak and peak off season. A total number of 682 questionnaire were collected from the tourist places in the Nashik city. The frequent visits were arranged in the tourist places of the Nashik city to record the response of the tourist using questionnaire. In the responder's male accounted for 67 percent and 33 females, the 52 percent were between age of 30-40, followed by age group between 20-30 i.e., 19 percent, below 20 years for 15 percent, and rest for 14 percent. Of total responders 72 percent were married and 28 percent were unmarried. 81 percent were out station tourists were 19 percent were local tourists. 91 percent of responders have used personal vehicles to reach tourist places while 9 percent have used public transport.

Item	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**Weight**
Historical value	165	99	58	58	34	19	15	8	0.199
Customs and Traditions	142	101	85	65	24	23	19	11	0.192
Aesthetic Value	128	99	82	74	52	41	33	25	0.150
Ambience	113	108	96	50	45	22	10	5	0.138
Adjacent Attractions	105	85	76	54	41	29	15	10	0.115
Attitude towards tourist	92	75	62	52	37	27	23	19	0.109
Value for Money	74	63	52	47	41	34	29	20	0.109
Total Value									**1.0**

Item	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**Weight**
Accessibility	140	84	69	49	29	16	13	7	0.172
Transport	121	86	72	55	25	20	16	9	0.167

Facilities	109	84	70	63	44	35	28	21	0.151
Information Center	96	92	82	43	38	19	9	4	0.147
Amenities	89	72	65	46	35	25	13	9	0.134
Eateries and Accommodation	78	64	53	44	31	23	20	16	0.126
Proximity to Other Attractions	63	54	44	40	35	29	25	17	0.106
Total Value									**1.0**

Item	**Panchvati**			**Kalaram Mandir**			**Muktidham**			**Pandav Leni**			**Sita Gufa**		
Accessibility	**Mean**	**SD**	**Alpha**	**Mean**	**SD**	**Alpha**	**Mean**	**SD**	**Alpha**	**Mean**	**SD**	**Alpha**	**Mean**	**SD**	**Alpha**
Adjacent Attractions	0.885	0.193	0.85	0.868	0.189	0.83	0.842	0.184	0.81	0.876	0.191	0.84	0.797	0.174	0.77
Aesthetic Value	0.756	0.117	0.84	0.742	0.115	0.82	0.719	0.111	0.80	0.748	0.116	0.83	0.680	0.105	0.76
Ambience	0.396	0.151	0.85	0.388	0.148	0.83	0.377	0.144	0.81	0.392	0.149	0.84	0.356	0.136	0.77
Amenities	0.582	0.212	0.86	0.571	0.208	0.84	0.554	0.202	0.82	0.576	0.210	0.85	0.524	0.191	0.77
Attitude towards tourist	0.657	0.224	0.82	0.645	0.220	0.80	0.625	0.213	0.78	0.650	0.222	0.81	0.591	0.202	0.74
Customs and Traditions	0.854	0.258	0.81	0.838	0.253	0.79	0.813	0.246	0.77	0.845	0.255	0.80	0.769	0.232	0.73
Eateries and Accommodation	0.642	0.114	0.83	0.630	0.112	0.81	0.611	0.108	0.79	0.636	0.113	0.82	0.578	0.103	0.75
Facilities	0.584	0.228	0.84	0.573	0.224	0.82	0.556	0.217	0.80	0.578	0.226	0.83	0.526	0.205	0.76
Historical value	0.664	0.217	0.83	0.651	0.213	0.81	0.632	0.206	0.79	0.657	0.215	0.82	0.598	0.195	0.75
Information Center	0.284	0.182	0.83	0.279	0.179	0.81	0.270	0.173	0.79	0.281	0.180	0.82	0.256	0.164	0.75
Proximity to Other Attractions	0.951	0.199	0.81	0.933	0.195	0.79	0.905	0.189	0.77	0.941	0.197	0.80	0.856	0.179	0.73
Transport	0.528	0.201	0.79	0.518	0.197	0.77	0.502	0.191	0.75	0.523	0.199	0.78	0.475	0.181	0.71
Value for Money	0.329	0.185	0.81	0.323	0.181	0.79	0.313	0.176	0.77	0.326	0.183	0.80	0.296	0.167	0.73

Item	**Panchvati**	**Kalaram Mandir**	**Muktidham**	**Pandav Leni**	**Sita Gufa**
Resource Value	**0.698**	**0.741**	**0.885**	**0.484**	**0.558**
Development State	**0.685**	**0.447**	**0.329**	**0.511**	**0.624**
	1.383	**1.188**	**1.214**	**0.995**	**1.182**

Result

After adding up how each sub-indicator fared, we utilized formula (2) to determine their relative importance. In Table 3, you'll find the final outcomes. According to the data in the table, the most valuable resource is its historical significance, followed by its authenticity (the degree to which it adheres to the established norms of the genre). A pleasing appearance and atmosphere are somewhat important. These three elements—market awareness, complementarity with neighboring attractions, and value for time and money—were ranked as the least important. Accessibility was the most important aspect of the development state set, followed by the quality of tourist facilities, the quality of on-site explanation, the quality of tourist information, the quality of catering, and the capacity to retain visitors. On average, their weights will decrease as you go down the list. Comparable to the prior item of complementarity with nearby attractions, proximity to other attractions was deemed to be of least relevance in terms of resource value. Participants felt that the historic attraction and associated amenities were more crucial to tourist growth, whereas the proximity of a heritage site to other attractions was less of a concern. A mean score analysis was performed on the two groups of sub indicators, which measured resource values and the level of development, separately. Table 4 displays the obtained outcomes. All items have Cronbach's alpha values over 0.70.

Discussion

A majority of the mean ratings for the second historic site in the table were higher than those for the first. However, there are still some shared and divergent features to consider in this circumstance. Among the variables comprising the resource value set, the mean ratings for historical significance, authenticity, and aesthetic value were considerably higher for both heritage sites. Mathematical outcomes won't have any trouble understanding and using the tourist potential evaluation methodology. The weighted sum approach, which involves two separate steps, is straightforward. The quantitative aspect of the methodology makes it sound for evaluating and comparing regional historic assets. Sites would be classified as either having low potential (< 0.4), medium potential (0.4 >0.7), high potential (0.7 > 1) and very high potential (> 1.0) based on the potential value findings. Nashik is an ancient city where many ancient temples and monuments are present combine with the present structures. The approach might be used to assess a large number of historic sites, therefore providing a holistic comprehension of their tourist development potential.

This knowledge would be useful in setting priorities for developing and marketing these regional ordinary historic sites, which are appealing to new visitors who want genuine heritage experiences despite the sites' relatively small size and low profile (Timothy, 2014). Planning hinges on a thorough examination of the tourism potential of heritage sites in a region (du Cros, 2001), and development of those sites with higher potential would be helpful to better meet the needs of the tourist market. In order to make sure that local or provincial governments deploy their limited financial resources to the places with relatively high potential, a comprehensive evaluation of tourist resources is necessary (Kou & Wu, 2013). The higher rankings were received for Panchvati, followed by Muktidham, Kalaram Mandir and Sita Gufa. All the values of tourism potential are above 1.0 indicating very high potential for tourism potential in the Nashik City.

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A Case Study of Socio-economic status of Schedule Caste under Sub Plan Schemes in Nashik District, Maharashtra

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Abstract:
The schedule caste is officially designated group of people among the most disadvantages socio economics group in India. It's known as depressed class in the period of British. According to 2011 data distribution of schedule caste (SC) populations found in Punjab it is also 32 percentage of total population. According to 2011 census data populations of Schedule Caste is 16.6 percentage. After the Independence of India the schedule caste given reservation. The present paper focus on sub plan for schedule caste SCSP. In this paper use the census data for find out the social and economical status of Schedule Caste in Nashik District, Maharashtra. Maharashtra state second largest population state in India. According to 2011 Census populations of Maharashtra more than 11 crore 25 lakh 74 thousand. This paper Express the sub plan and socio economic conditions of scheduled tribes in Nashik District Maharashtra its populations is 11.8 percentage.

Introduction:

The word 'Caste' has been derived from the Portuguese term 'Casta' meaning race, family or lineage. M.N. Srinivasan defined 'caste' as heredity usually localized group, having a traditional association with an occupational and particular position in the local hierarchy of castes.

Prevalence of 'Caste System' in Indian Hindu society is one of the most discriminatory forms of social stratification Scheduled castes (SC) are Sub-communities within the framework of the Hindu caste system and they are considered to be of low status in society. According to the Constitution order, 1950 lists, there are 1108 castes across 29 States in its first schedule in India.

As per 2011 census of India, there are around 201.38 million SCS comprising of 103.53 males and 97.84 million females in India. The proportion of SCs in relation to the total population is 16.64% where 8.55% and 8.08% belong to male and female categories respectively.

Background of SCSP:

The Government of India in the Ministry of Social Justice and Empowerment is implementing a "Central Sector Scheme of Special Central Assistance (SCA) to Scheduled Castes Sub Plan (SCSP)"since 1980 for the development of Scheduled Castes who form the major chunk of the country's population living below the poverty line. Strategy of the SCSP for the Scheduled Castes (SCs) was introduced in the Sixth Plan for channelizing the funds to the SC categories of people to avail their due share of plan benefits and outlays. The strategy of SCSP envisages channelizing the flow of outlays and benefits from all the sectors of development in the Annual Plans of States/UTs and Central Ministries at least in proportion to their population both in physical and financial terms. Special Central Assistance (SCA) to Scheduled Castes Sub Plan (SCSP) is a central scheme under which 100% grant is given to the States/UTs as an additive to their Scheduled Castes Sub Plan (SCSP). The Scheduled Castes persons living below the Poverty line are the target groups of SCSP.

The main objective of the Scheme is to give a thrust to family oriented schemes of economic development of SCS below the poverty line, by providing resources for filling the critical gaps. Since the schemes/programmes for SCs may be depending upon the local occupational pattern and the economic activities available, the Sates/UTs have been given full flexibility in utilizing SCA with the only condition that it should be utilized in conjunction with SCP and other resources available from other sources such as various Corporations, financial institution etc.

Objectives of the scheme:

1. The main objective of the scheme is to increase the income of the target population (SC) by way of various income generating schemes, skill development by educating/training in various sectors, entrepreneurship and infrastructure development.
2. To reduce the poverty among the target population and bring them above the poverty lines.

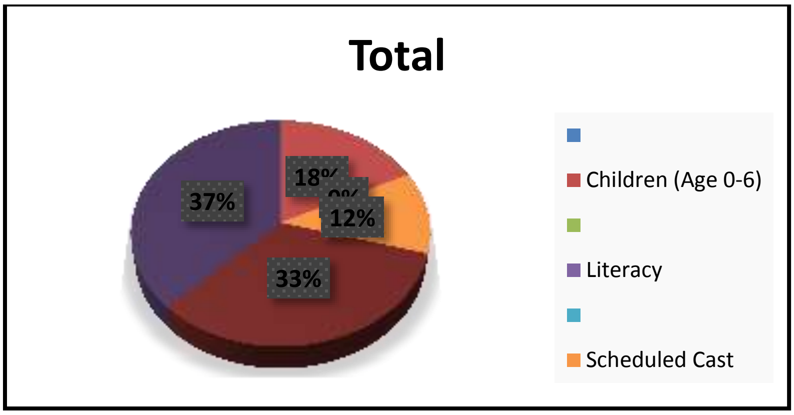
Scheduled Castes status in Maharashtra:

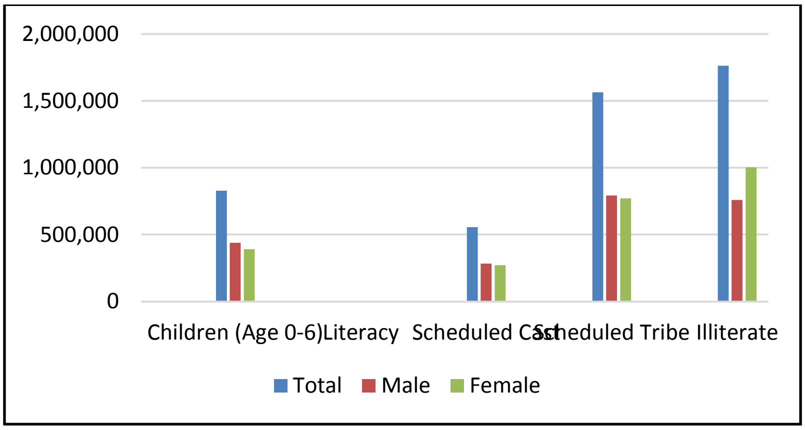
The total population of Maharashtra, as per the 2001 Census, is 96,878,627. Of this, 10.2% are Scheduled Castes (SCs). The SC population of the state constitutes 5.9% of the country's SC population. Fifty-nine (59) SCs have been notified in Maharashtra under the Scheduled Castes and Scheduled Tribes Orders (Amendment) Act, 1976. Only one SC, Kaikadi has been notified in the state with an area restriction. The growth rate of SC population in the decade 1991-2001 at 12.8% has been considerably lower if compared to the overall growth rate of 22.7% of the state population.

Among the numerically major SCs, Mang have recorded the highest growth rate of 21.2%, followed by Bhambi (16.1%) and Mahar (10.9%) the lowest growth rate (6.2%) is registered among Bhang at the 2001 Census. Population- Size and Distribution. O of 59 SCS, Mahar, Mang, Bhambi and Bhangi together constitute 92% of the SC population of the state. Mahar numerically the largest SC with a population of 5,678,912 constituting 57.5% of the SC population of the state. They are followed by Mang 2,003,996 (20.3%), Bhambi 1,234,874 (12.5%) and Bhangi 186,776 (1.9%), Twenty-eight (28) SCs have returned population below 1000 at the 2001 Census. Of the total SC population, 61.7%are residing in rural area. Mang have the highest (66.9%) rural population, followed by Mahar (65.5%). On the other hand Bhangi, the fourth largest SC of the state is highly urbanized, having 92.7% urban population followed by Bhambi (49.1 %).

Nashik district of Maharashtra has total population of 6,107,187 as per the Census 2011. Out of which 3,157,186 are males while 2,950,001 are females. In 2011 there were total 1,222,887 families residing in Nashik district. The total literacy rate of Nashik district is 82.31%. The male literacy rate is 75.94% and the female literacy rate is 66.03% in Nashik district. In Nashik district out of total population, 2,763,328 were engaged in work activities. 91.3% of workers describe their work as Main Work (Employment or Earning more than 6 Months) while 8.7% were involved in Marginal activity providing livelihood for less than 6 months. Of 2,763,328 workers engaged in Main Work, 900,810 were cultivators (owner or co-owner) while 644,052 were Agricultural labourer. As per the Population Census 2011 data, following are some quick facts

Particulars	**Total**	**Male**	**Female**
Children (Age 0-6)	827,935	438,050	389,885
Literacy	82.31%	75.94%	66.03%
Scheduled Cast	554,687	282,213	272,474
Scheduled Tribe	1,564,369	792,547	771,822
Illiterate	1,761,821	759,648	1,002,173





Schedule Caste (SC) constitutes 9.1% of total population in Nashik district of Maharashtra comprising 554,687 in total where 282,213 are male and 272,474 are females. Farmers belongs to the SC are minimum land holding population in Maharashtra. Most of the farmers are working in their own farm or they work on daily wage basis. Socio-economic status of the family is poor and struggling hard in the farm and do drudgery works. About Nashik district are appended below.

Conclusion:

In present paper writer attempt to explain what is the socio-economic status of scheduled cast under sub plan scheme in Nashik District, Maharashtra. For this Article writer Chase the Handbook of Nashik District. 2010, and with these data and Apply the statistical Techniques for the finding result. Main objective of these paper increase the of the target population it means scheduled Cast population- and reduced the poverty of these group population as well as in the paper find out what is the states of scheduled cast status in Maharashtra. Apply the graphical tools for present the various data at last finding of these research paper Socio-economic status of those family is poor and straggling.

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Assessment of Child Malnutrition Status: A Study of Tribal Population in Nashik District (Maharashtra)

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Abstract:

The present paper is an attempt to evaluate malnutrition among children in tribal areas. For this purpose, 210 tribal children from the 0-5 age group have been selected from villages in Nashik District. The authors use data from the Primary Survey 2022 to present age-specific patterns of child mortality among the tribal population. The analysis shows four clear findings. First, a disproportionately high number of child deaths are concentrated among the tribal population, especially in the 0-5 age group and in those tehsils where there is a high concentration of the tribal population. Second, the gap in mortality between tribal children and the rest really appears after the age of one. In fact, before the age of one, tribal children faced more or less similar odds of dying as other children. However, these odds will significantly reverse later. This calls for a shift in attention from infant mortality or in general under-five mortality to factors that cause a wedge between tribal children and the rest between the ages of one and five. Third, the analysis goes contrary to the conventional narrative of poverty being the primary factor driving differences in mortality outcomes. Fourth, poverty and malnutrition exacerbate the risk of infants and children contracting various infection diseases like diarrhea and pneumonia, and heighten the probability of death, particularly among children with low birth weight. There is a close relationship between malnutrition and child death. In Nashik district, 24 percent of children die per 1000 live births before five years of age.

Key words: Mortality, Malnutrition, Tribal, Age group 0-5, Children

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Introduction:

The aim of this paper is to examine the extent of malnutrition among tribal children in Nashik district. Thirty years ago, the world made a commitment to protect and fulfil children's rights as enshrined in the Convention on the Rights of the Child. Among the most fundamental of these rights is the right of every child to survive (United Nations, 1989). While substantial progress in child survival has been made since then, the failure to fully meet that commitment reverberates today for millions of children: In 2018 alone, 5.3 million children died before reaching their fifth birthday. Globally, out of the total children aged under-five years, almost 165 million were stunted (height for age) and 52 million were wasted (weight for height). The prevalence of underweight has decreased from 26.5 percent to 17.6 percent in 1990-2015 (De Onis M, 2004). The United Nations International Children's Emergency Fund (UNICEF) world-level estimates for wasting were 7.5 percent. Malnutrition is a major cause of child mortality and is widely recognized as a public health problem in developing countries including India. India has a very high burden of childhood stunting as 61 million (37 percent) of the 165 million stunted children aged under five years globally are Indian children (De Onis M, (2012). Approximately 43 percent of children are underweight (weight for age); one, out of every five children is wasted, and almost half of the children are stunted. Under the Millennium Development Goal -1 (MDG-1), one of the key indicators was to reduce the proportion of malnourished children through the reduction in poverty and hunger and to halve the prevalence of underweight children by 2015. Goal 2 of Sustainable Development Goals (SDGs) aims to end hunger and all forms of malnutrition by 2030. Nearly, almost half of all deaths in children of age under 5 are attributable to under nutrition, resulting in an unnecessary loss of around 3 million young lives worldwide every year (UNICEF, 2018).

Various factors are responsible for malnutrition; different authors have addressed the issues of Malnutrition of Children. Found that the proportions of children having low birth weight are at higher risk among women who are not educated. Nutrition status has been found to be positively associated with infant feeding practices. It is found that children who take exclusive breastfeeding have fewer chances of malnutrition (Rathaur VK, 2018). The optimal use of nutritious food feeding is healthy for child growth and development (Chaudhary SR, 2018). Infectious diseases like diarrhea, pneumonia, and measles increase the risk of mortality among those children who are stunted, underweight and wasted children (Black RE, 2013). Practices of personal hygiene and sanitation are fundamental to avoid stunting among children and are useful for the growth and development of children (Rah, 2015). The prevalence of malnutrition was found to be high among the tribal population due to their poor condition. Parents working in agriculture, and non-agricultural areas similarly who are below the poverty line and having Antyodya card and no schooling these are factors that lead to high malnutrition among the children (Kamath SM, 2017). Evidence suggests that the level of stunted children has declined from 52 percent in 1992–93 to 38 percent by 2015-16 but the prevalence of wasted had increased from 17 percent to 28 percent during this period, as reported in National Family Health Survey (NFHS 4). Moreover, in 2016, India accounted for 62 million stunted children, 40 percent of the global share of stunting in Maharashtra (UNICEF, 2018).

Over the last few years report of death of tribal children due to malnutrition has been pouring in the Maharashtra state. This has become a recurring phenomenon despite the governmental and NGOs effort to eradicate the problem. For instance, deaths of tribal children in Melghat, Dharni block of Amravati district, the tribal areas of Chandrapur, Yavatmal, Thane, Amravati, Nashik and Gadchiroli in recent years have created a cause of concern (Sonowal C.J, 2010).

While considering the above aspects, we decided to conduct a study on the prevalence of malnutrition in different tribal tehsils of Nashik district and what socio-demographic and economic factors are responsible for it. The current study also aims to explain the factors contributing to child malnutrition in the study area. The contributing factors that clarify this childhood malnutrition are most glaring in comparative and nationally representative ways and may support policymakers in their endeavours to diminish it. Very few studies have emphasized the mounting childhood under nutrition in different countries including India. To our knowledge, there exists no available literature explaining the child malnutrition in Nashik district.

Study Area:

Nashik district is a tribal dominated district in Maharashtra state. It is one of the growing districts despite uneven topography and dynamic nature. It is located in the north-west of Maharashtra state. The study region extends from 19^0 33' to 20^0 52' North latitudes and 73^0 16' to 74^0 56' East longitudes (Fig. No.1). The study region spreads over 15530 square kilometres, and ranks fifth in Maharashtra state, accounting for 5.04 percent area. The population of Nashik district is 6,107,187 as per Census 2011. Nashik is the 4th most populous district out of the total 35 districts in Maharashtra and it is the 11th most populous district in India.

Fig. 1: Study Area

Objective of the Study:

The present study aims to assess the health status of tribal children in tribal communities. Therefore, following objectives have been considered for this study.

i. To assess child malnutrition status of target population.

Data Sources and Methodology:

On the basis of information on occurrence of malnutrition cases among the tribal children, seven tribal tehsils, namely Igatpuri, Trimbakeshwar, Peth, Surgana, Dindori, Kalwan and Baglan of Nashik district were selected for the study.

Out of seven tehsils, the tribal villages, where the tribal population is 100 percent, have been taken into consideration. Twenty-one tribal villages were chosen for sample collection. For the study, various villages in tehsils such as hills, plains, Riverside, roadside, forest, and so on are chosen. Villages with households with children from 0 to 5 years of age were preferred for the study of malnutrition. 210 children were assessed for this study. A personal meeting and interview method were also adopted for getting socio-economic information from the head of the family.

From each of these selected villages, ten families were selected for in-depth studies. The criteria for selecting such families were based on the presence of less than 5 years old children and expectant mothers and also the presence of malnourished children as revealed by the local Anganwadi workers' records. It is worth mentioning that the level of malnourishment was based on Anganwadi workers' data. Some of those data were cross-examined and were found to be similar to our assessment. Therefore, extensive measurements were not carried out. The prevalence of malnourishment was universally accepted. Consequently, the influencing factors were studied in detail to get a conclusion on the issue.

The selected households were surveyed using random sampling survey method schedules. The schedules included space for demographic data like age, sex, education, occupation, seasonal migration, age at marriage, land holding pattern etc. Anthropometric indices like weight for age and weight for heights, etc. were considered for determination of stages and status of malnutrition among the children. Based on preliminary data collected with the help of household survey schedules, some families were selected for intensive case studies and interviews. Observations based on certain criteria were carried out to gain insight into the problems defined for the study.

Height and weight measurements were recorded following the standard techniques. The weight was measured using Salter's scale with light clothing and without shoes. Zero error was checked and adjusted before measurements. The height of the child was recorded with the help of non-stretchable measuring tape. The new WHO Child

Growth Standards for children under 5 years (2006) were used as reference for median. Nutritional status of children were assessed according to weight for age, height for age, weight for height and BMI for age and sex by Standard Deviation classification recommended by WHO. Children below -2 SD of the reference median on any of these indices were considered as undernourished and termed as underweight, stunted and wasted respectively. Children below -3 SD were considered to be severely undernourished. All the children whose weights were more than 85th percentiles (BMI) for the age and sex were considered as overweight and more than 95th percentiles (BMI) for the age and sex were considered obese.

The Z - Score Method has been applied to find out tribal child malnutrition status among scheduled tribes in the study area.

To calculate the tribal child malnutrition status, the Z-score values of different parameters (as per the WHO guidelines) have been computed using the following formula. Score value of the parameter X for the ith tahsil =

$$\boldsymbol{Z} = \frac{Xi - \bar{X}}{STDX} X10$$

Whereas;

Xi =X parameter of ith tahsil

Ẋ = Mean value of X tahsils

STD= Standard Deviation of X Parameter

The z-score (more commonly referred to as a standard score) is a very useful statistic because it; Allows us to calculate the probability of a score occurring within our normal distribution, Enables us to compare two scores that are from different normal distributions and Z-scores are a way to compare results from a test to a 'normal' population. Results from tests or surveys have thousands of possible results and units. However, those results can often seem meaningless (Deviant, 2010).

Results:

Table No. 1 and Fig. No. 2, 3 and 4 shows the malnutrition status among the tribal children in study region of Nashik district. As shown in Table No.1 and Fig. No.2, 60 children (28.5 percent) children lie in Moderate Acute Malnutrition grade (severely underweight)(-2SD). In the study region MAM tribal children are found in the Kalwan and Dindori tehsils. This Moderate Acute Malnutrition is known as MAM. Children in this group are more vulnerable to illness and have increase threat of death or they could move to next severe acute malnutrition (SAM) where risk of death is higher. 62 children (29.5 percent) lie in Mild Malnutrition Grade (underweight) (-1SD) where they are close to normal growth but far from adequate weight. In the study region MMG tribal children are found in the Igatpuri and Trimbakeshwar tehsils. Require weight for the age group 0 to 5 to obtain normal growth ranges between 2.56 kg to 14.8 Kg but unfortunately only 90 children (42.8 percent) out of 210 children fall in this Normal growth group (not underweight).

The data presented in Table No.1 and Fig. No.2 shows that, height (wasting) of tribal children. Out of 210 sample 14.3 percent (30) children were found in -3SD group which indicates (severely wasted) Severe Acute Malnutrition (SAM). In the study region SAM tribal children are found in the Igatpuri tehsil. 58 percent (122) children are in -2SD category which reflects (wasted) Moderate Acute Malnutrition (MAM).In the study region MAM tribal children are found in the Kalwan, Dindori, Peint and Trimbakeshwar tehsils. Only Surgana and Baglan tehsils 27.6 percent (58) children were found normal according to their height for age.

Table No. 1 : Malnutrition status of tribal children in study region of Nashik district (Z score in percent)

Sr. No.	Tahsil Name	Under weight	Wasting	Stunning
1	Baglan	14.84	14.58	14.91
2	Dindori	12.23	13.61	12.34
3	Igatpuri	12.64	12.22	12.62
4	Kalwan	12.51	14.05	12.46
5	Peint	15.76	14.01	16.58
6	Surgana	17.99	17.31	16.81

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7	Trimbakeshwar	14.02	14.21	14.29
Total		**100**	**100**	**100**

Source: Computed by Researcher

Findings in Table no.1 and Fig. No. 4 reveal that the 30 (14.4 percent) Children fell in -3SD category (severely stunning) Severe Acute Malnutrition (SAM).In the study region SAM tribal children are found in the Dindori tehsil.92 (43.8percent) children come in -2SD category (stunning) Moderate Acute Malnutrition (MAM).In the study region SAM tribal children are found in the Igatpuri, Trimbakeshwar and Kalwan tehsils. The 90 (42.8percent) children shows normally nourishment.

Table No. 2 and Fig. No. 5 reveal that the 28.57 percent children in study area were observed as Severe Malnutrition grade. In the study region Severe Malnutrition tribal children are found in the Igatpuri and Dindori tehsils.29.52 percent children in study area were observed as Poor Malnutrition grade. In the study region Poor Malnutrition tribal children are found in the Kalwan and Trimbakeshwar tehsils. Overall nutritional status depicts that only 41.90 percent children have Neutral grade.

As per the above results, tribal child malnutrition was found to be statistically significant. The higher proportion of malnutrition was also seen among children whose mothers were illiterate as compared to those with educated mothers.

Table No. 2 : Malnutrition status of tribal children in study region of Nashik district (Under weight, wasting and stunning)

Malnutrition Status	Z score in percent
Sever	28.57
Poor	29.52
Neutral	41.90
Total	**100**

Source : Computed by Researcher

Fig. No. 2 : Malnutrition status (underweight) of tribal children

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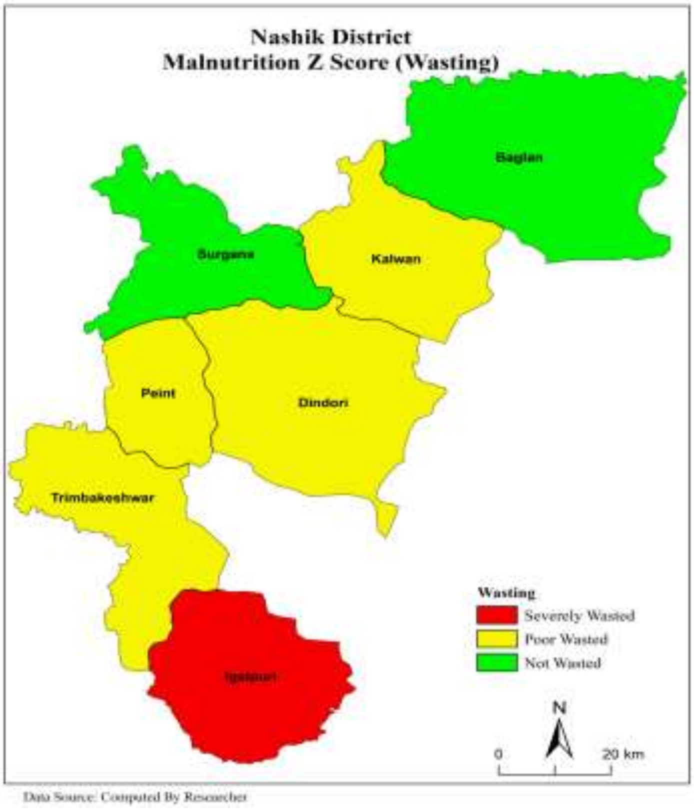

Fig. No. 3 : Malnutrition status (wasting) of tribal children

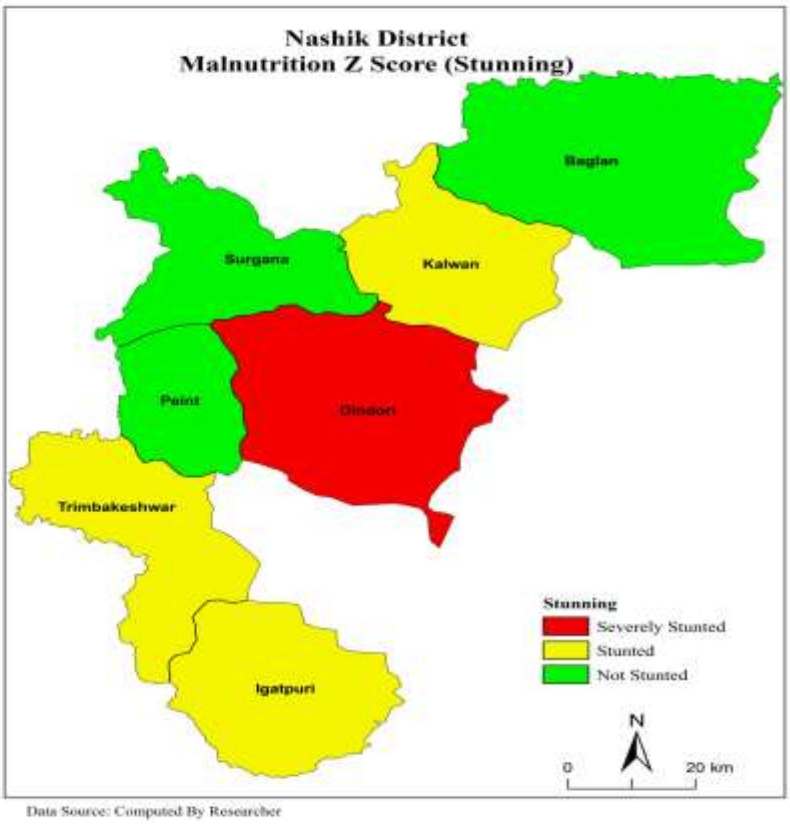

Fig. No. 4: Malnutrition status (stunning) of tribal children

Fig. No. 5 : Malnutrition status of tribal children

Malnutrition has chronically remained a major public health problem among tribal child population in study region of Nashik district. Nutritional status among children below five years is betterin other eight tehsils than study regions (seven tehsils) of Nashik district because of all demographic and socioeconomic indicators are better than the study regions of Nashik district. The study, in general, revealed that malnutrition is an important public health problem where the prevalence of underweight, wasting and stunning was 14.33, 14.30 and 14.29percent, respectively. Place of residence, household, economic status, woman's employment and woman's age are important determinants of nutrition among women. We found that under nutritionist heavily concentrated among tribal region. Socio-economic status like limited access to health services, household food insecurity and the likelihood of poor environmental conditions such as access to clean water, sanitation, and hygiene increase the likelihood of illness. Women of low economic status have the highest prevalence of under-nutrition, which may be due to food insecurity in these households that negatively impacts the nutritional status of women as well as child. It was also observed that educational status of the mother positively affected the nutritional status of children. Educated mothers are more aware of their child's health and have a superior shot of utilizing the health services as compared to the illiterate ones. This study, also revealed that underweight was significant lyhigher among children whose mothers were illiterate compared with children whose mothers had secondary and higher education. Mothers education level was associated with progressively effective management of limited household resources, lower fertility, improved health promoting behaviour, better utilization of health-care services, and child- caring practices.

The present study also found an association between food restrictions and special food fed and malnutrition among the tribal children. A higher percentage of sweets and chocolate consumption among the tribal children was observed among malnourished children as compared to normal children. The higher risk of malnutrition among tribal children who ate more sweets or chocolate might be due to the lack of intake of nutritious food which is required for growth of the child.

Conclusion

In the present study the prevalence of underweight, wasting and stunning was found to be14.33, 14.30 and 14.29percent, respectively. Malnutrition was found to be higher among the children of illiterate parents; children belonged to Scheduled Tribes, born with low birth weight, having higher birth order, more number of siblings, those with incomplete immunization status and inappropriate feeding practices.

Recommendation

Maternal education had significant effect on child's nutritional status. So, there is a strong need for their formal and informal education regarding available services for their children and make those services acceptable too. The compromised nutritional status of the mother is a direct determinant in producing a low birth weight baby, thus encouraging the improvement in the nutritional status of women during ANC period is essential. Faulty feeding practices worsens the nutritional status of children. Therefore, mothers need to be educated regarding the benefits of exclusive breast feeding during initial 6 months of life

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A Case Study of Water Audit in Padmashri Vikhe Patil College, Pravaranagar, Tal-Rahata, Dist-Ahmednagar (MS)

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Abstract

Water audit is an important part environmental audit which is carried with the inspection and observation of work directed inside the organizations whose movement can make risk to the health of inhabitants and environment. The National assessment and accreditation council (NAAC) take a genuine note of this aspect while assessing the educational institute. Water audit is performed in the college with various phases of water such as sources, supply, utilization, disposal etc. On location perception and talk with the most authorized and issue related staff was taken up to get the information. Bore wells and canal beside the village satisfy the all necessities of institute while prerequisite of staff colonies is fulfill by grampanchayat supply.

Institutional water is consumed by the laboratories (20-25%), Gardens (30-35%), Bathrooms (15-20%), boys hostel (15-20%), girls hostel (25-30%), drinking water (40-45%) and sports ground and other (5-10%). The seepage in the old construction, reutilization of water and unavailability of rain water harvesting are the destinations of change in institute. Concluded that, institute has own and necessity based source and supply of water then again locales of improvement was likewise observed.

Keywords : Water audit, Water utilization, Water Pollution, Water conservation.

Introduction

Water is basic forever. From the time that primeval species ventured from the oceans to live ashore. Chemically, it is transparent, colorless, tasteless compound of hydrogen and oxygen (H2O). Water is additionally found in strong state as ice and gaseous state as vapors (Popkin et al., 2010 and Linton, 2010). All living beings, including humans require water for their survival. Therefore, guaranteeing that sufficient supplies of water are accessible is fundamental for person. A typical clarification is that despite the fact that there is a considerable measure of water on earth, just around 2.5% is fresh water, and in light of the fact that the majority of water is put away as icy masses or profound ground water just a little measure of water is effortlessly available (Oki and Kanae, 2006). The more prominent part of this fresh water (68.7%) is as ice and perpetual snow cover in the Antarctic, the Arctic, and in the mountainous regions. Next, 29.9% exists as fresh groundwater. Only 0.26% of the total amounts of fresh waters on the Earth are concentrated in lakes, reservoirs and river systems where they are most effortlessly open for economic needs and totally imperative for water biological systems (Shiklomanov, 1998).

Industries, educational and research institution, commercial complexes and many other government and non-government organizations utilize water for their different purposes. Its needful utilization, supply and disposal are directly related to wastage and health of nearby flora and fauna as well as effect in the environment. Therefore periodic monitoring the water status of such organizations is very important. Keeping in this mind checkup of water situation of Padmashri Vikhe Patil College was done. The water audit includes incorporates examination of water assets, its supply, utilization, status and purity of drinking water, disposal and conservation of water and so forth.

Study Sites

Padmashri Vikhe Patil College At-Pravaranagar (Senior PVP) is one of the most featured educational institute of Maharashtra come into existence on June 1971. Land of more than 36 acres. 5 hectare buildup area. The college has 147 teaching and 259 non-teaching staff. In the academic year 2018-19 a total of 2953 students are pursuing education in the college. The College is located in rural area in Ahmednagar district of Maharashtra and has been catering to the educational needs for the boys and girls of surrounding 44 villages.

Methodology

Survey- The survey site includes laboratories of Environmental Science, botany, zoology, microbiology, chemistry and biotechnology, botanical and other gardens, boys &girl's hostel, mess, canteen, bathrooms, water coolers (RO system), playground and auditorium. The auditor was also visited to staff colonies. Survey includes on site observation and discussion with charge staff and officers.

Results and Discussion

In view of the above study the results of the water audit is abridged here with different subheads–

Water Resource and Supply

The PVP has resource of water to supply the entire college. The organization asset incorporates four bore well (19°34'53.71"N to 74°28'33.11"E), (19°34'37.89"N to 74°28'27.84"E), (19°34'56.16"N to 74°28'34.32 "E) and (19°34'53.81"N to 74°28'29.61"E). Institutional water supply includes laboratories, gardens, lawns, boy's & girl's hostel, mess, girls common room, bathrooms, Drinking water, poly-house, botanical garden and so on.

The 4 bore wells are arranged from morning 06 am to 10 am (04hr) fulfill the 70-75% institutional requirement while 1 bore well situated near PG building, 1 near girls hostel, 1 near boys hostel and other 1 is situated in front of multipurpose hall which is scheduled for 03hr fulfill the 20-25% prerequisite.

PVP Senior college is facilitated with drinking water with Reverse Osmosis (RO) .The drinking water facility is accessible in the accompanying areas Administration Office (19°34'50.5"N to 74°28'26.62" E), Department of Environmental Science (19°34'51.3"N to 74°28'29.1"E),Department of Chemistry (19°34'50.9"N to 74°28'30.2" E), Department of Zoology (19°34'50.6"N to 74°28'33.0" E), Department of Botany (19°34'50.9"N to 74°28'29.2" E), Department of Biotechnology (19°34'50.86"N to 74°28'33.27"E), Department of Dairy Science (19°34'48.6"N to 74°28'33.65"E), Department of Microbiology (19°34'49.4"N to 74°28'33.3"E), Poly house (19°34'49.2"N to 74°28'31.9"E), Circle tank (19°34'53.0"N to 74°28'28.8"E), Botanical Garden (19°34'49.4"N to 74°28'32.0"E), Principal Bungalow (19°34'54.3"N to 74°28'27.2"E), Canteen (19°34'55.1"N to 74°28'25.5"E), Mess (19°34'55.8"N to 74°28'27.9"E), Drinking Water Cooler in Girls Hostel (19°34'55.8"N to 74°28'27.9"E) ,Girl's Hostel (19°34'59.8"N to 74°28'28.03"E) , Playground (19°34'56.2"N to 74°28'27.2"E), Boy's Hostel (19°34'55.9"N to 74°28'31.9"E), PG Building (19°34'53.7"N to 74°28'32.5"E), Toilet (19°34'53.5"N to 74°28'30.4"E) , Campus Drinking Water (19°34'53.0"N to 74°28'28.6"E).

Water Consumption

For the most part institutional water is devoured by laboratory (30-35%) which includes laboratory of Environmental science (18 liter/day), Chemistry (238.2 liter/day), Zoology (117 liter/day), Botany (57 liter/day), Biotechnology (72.8 liter/day), and Microbiology (50 liter/day). Including botanical garden consume (500 liter/day) of total followed by Bathrooms (3200 liter/day), Boys hostel (6700 liter/day), Girls Hostel (7260 liter/day), Mess (1184 liter/day), Girls and Boys Canteen (2400 liter/day), Drinking Water (6718 liter/day), Principal Bungalow (6500 liter/day), Poly House (222.7 liter/day) and Sports Ground and other (5-10%). Pandit and Magan (2015) comparably assessed the water utilization amid green audit of Arts, Science and Commerce College, Manmad. The authors reported garden, laboratory and canteen were the most water expending destinations of college. Comparable finding was likewise found in present overview.

Waste Water Disposal and Water Conservation

The waste water is treated and use for garden area. Water releases from Girls, Boys Bathroom and only few overflow tanks and waste water utilizes in Lawns and Garden area in garden irrigation.

Improvement Sites

As the main building is excessively old so water harvesting is need in the coming construction and furthermore to the old building. Reutilization and reusing is extremely constrained.

Conclusion

The water audit is not only necessary to NAAC evaluation but more to care the environment. The educational institute utilizes water, energy, chemicals, gases, metal equipments and sometime radioactive and carcinogens. Their proper utilization is always necessary because it may harmful to the people surrounding and environment. Water is very essential because it is utilizes in laboratories, canteens, gardens, hostels etc. The college utilizes water from own sources. Its utilization was found as per the need. Maximum water is utilizes in laboratories, washrooms, gardens etc. The pipelines and tanks were maintained periodically. But it is needed to make an effective plan for water recycling, wastage from outflow and rain water harvesting.

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Estimated Water Demand and Rooftop Rain Water Harvesting Potential of Dahiwadi College Campus in Man Tahsil of Satara District (Maharashtra)

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Abstract:

Dahiwadi College campus is located in drought-prone area of Satara district, where the average annual rainfall is 500 mm. Dahiwadi College is situated in 6 acres of campus area and 4957.18 sq. meter area of roof surface. The total population of college is 4,386 comprising of students and the staff, administrative staff and the daily visitors to the campus. The present study is entirely based on the primary as well as the secondary data. Runoff Coefficient and Annual rainwater harvesting potential (ARHP) is measured by using Pecey, Amold and Cullis, Adrian (1989) formula.

The present paper intends to measure water demand and supply gap and the rooftop rain water harvesting potential in the College campus during 2020-21. Results obtained from the present study show that 8772 liter drinking water is required per capita per day. Rooftop rainwater harvesting potential is 18,18,844 liters. So, there is a need of conservation of this precious resource. Thus, it is suggested that Rooftop rain water harvesting practice is more applicable in various colleges located in drought prone areas of Maharashtra and India.

Key Words: Rainwater Harvesting, , Potential, Drought-prone, Conservation, Resource.

1. Introduction

Rain water harvesting is the process of collecting and storing water for future productive use. Rooftop rain water harvesting is one of the technique through which rain water is captured from the roof catchments and stored in reservoirs. Geographically this method is highly useful in drought-prone, hilly and coastal areas. Water is a one of the most important resource for survival of human being as much as food, air etc, but very few attentions are paid for its economical use and conservation. As we know day by day increasing pressure of population on water resources leads to over pumping of ground water, the water table is going down abnormally, so there is a need of conservation of this precious resource.

2. The Study Region

For the purpose of present investigation campus of Dahiwadi College Dahiwadi located in Man tahsil of Satara district of Maharashtra has been undertaken. It lies between 17^0 40'54" north latitude and $74^0$37'47" east longitude. Dahiwadi College campus is located in drought-prone area of Satara district, where the average annual rainfall is 500 mm.

Dahiwadi College comprises of 6 acres of campus area with 78797.95 sq. ft. built up area and 4957.18 sq. meter area of roof surface. The population of college is about 4386 including students, teaching and non-teaching staff and daily college visitors. College has 712 sq. meters area of fruit garden and 1550 sq. meter area of botanical garden. At present, college has built-up 4 underground reservoirs having 1,70,000 liters of capacity.

DAHIWADI COLLEGE DAHIWADI

LOCATION MAP

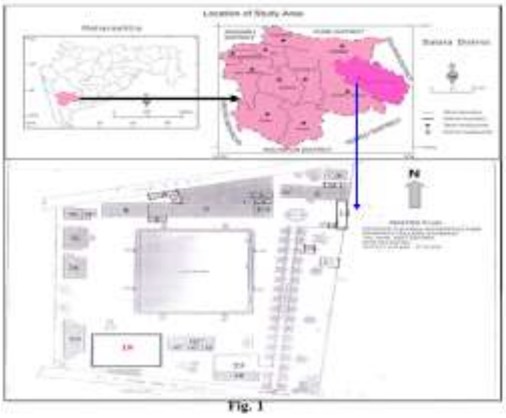

Fig. 1

3. Objective

1. To find out the present status of water requirement and supply gap.
2. To measure the rooftop rainwater harvesting potential in the Dahiwadi College campus during 2020-21.

4. Data Source and Methodology

The present study is entirely based on primary and secondary data. Primary data collected directly form field survey in which type of roof surface, area of roof, average of daily water supply to college campus, depth and number of boar wells, daily persons visited to college etc. and secondary data regarding strength of students and staff, Built-up area collected from college records, Socio – Economic Review and District Statistical Abstract of Satara, District Gazetteer etc. Rooftop rainwater harvesting innovative method is used for this study. The per capita daily water requirement is calculated as number of persons x 2 liters. The daily, annual and dry day's water requirement has been calculated in liters. Runoff Coefficient and Annual rainwater harvesting potential of the study region is measured by using formula given by Pecey, Amold and Cullis, Adrian (1989) as follows.

Annual Rainwater Harvesting Potential (ARHP) = R x AC x RC

R - Rainfall (in metre), AC - Area of catchment (in square metre),
RC - Runoff coefficient.

5. Water Requirement and Supply Gap

There are number of estimates in the world belonging to the water requirement for human being, for drinking and also for domestic purpose. According to World Health Organization, it is estimated that average 2.5 liter daily water intakes per capita per day required. According to U.S. Environmental Protection Agency average daily water intake 2.0 liters per capita per day is required. National Academy of Sciences also estimated daily 2.0 liters water requirement for per person. For the present study water requirement 2.0 liters per person per day is taken into consideration. The total population of the college is 4386 including all students, all teaching and non-teaching staff and daily visitors. Analysis revealed that 8,772 liters water required for daily and 32, 01,780 liters for annually for drinking purpose. Estimated daily domestic water demand of the college is about 10,500 liters and annual demand is about 38, 32,500 liters. Estimated daily drinking and domestic water requirement is 19,272 liters and 70, 34,280 liters annual.

It is observed that average 12,000 litres daily and 4380000 liters annually ground water extracted from 3 bore wells in the college campus for the purpose of drinking and domestic use. Drinking water demand is totally fulfilled through ground water extraction but for the domestic water demand and supply gap is about -547500 liters per annum. Present investigation shows the total demand and supply gap is -7272 liters daily and -2654280 liters annually (Table 1). It has also been increased from 8,000 to 12,000 liters per day in every summer season leads to severe problem of water scarcity in the summer season. College has fulfilling been total water demand and especially domestic water demand through providing water tankers in every summer season.

Table- 1 Projected Water Demand and Supply of Dahivadi College (2020-21)

Total Population of the College (Students + Staff + Guests)		Estimated water requirement (Drinking + Domestic) Liters per day		Estimated ground water extracted and supply in liters (through 3 bore wells)		Estimated water demand and supply gap in liters	
Daily	Annual	Daily	Annual	Daily	Annual	Daily	Annual
1	2	3	4	5	6	5 - 3	6 - 4
4386	1600890	19272	7034280	12000	4380000	-7272	-2654280

Source: Field survey, 2020-21

6. Rooftop Rain Water Harvesting in Dahiwadi College Campus

6.1 Roof Surface Area and Annual Rain Water Harvesting Potential

As many as 20 buildings surveyed in Dahiwadi college campus. Out of which 10 buildings of concrete rooftop having (52.78 per cent) 2616.60 sq. m. rooftop area and estimated annual rooftop rain water potential is (48.75 per cent) 886751 liters. Its collection efficiency is 70 % (0.7 coefficient), which is second the largest efficiency in the college campus. Roof surface of metal sheets observed for 09 buildings comprised with about (46.38 per cent) 2299.27 sq. m. area and estimated annual capacity of (50.56 per cent) 919700 liters which is second largest with respect to roof surface area and largest with respect to rain water harvesting potential of the college. Its collection efficiency is 80 % (0.8 coefficients).

Table- 2 Type of Roof Surface and Annual Rainwater Harvesting Potential (ARHP)

Sr. No.	Type of Roof Surface	No. of Buildings	Total area in sq. meters	Total Area in %	Total (ARHP) in liters	Total (ARHP) in %
1	Concrete rooftop	10	2616.6	52.78	8,86,751	48.75
2	Corrugated metal sheets	09	2299.27	46.38	9,19,700	50.56
3	Brick pavement	01	41.31	0.25	12,390	0.68
4	Total	20	4957.18	100	18,18,844	100

Source: Field Survey, 2020-21

Remaining a single construction of brick pavement shows very less proportion (0.25 per cent) 41.31 sq.m area of roof surface and estimated annual rain water harvesting potential is 12,390 liters (0.68 per cent) and also efficiency is very less i.e. 50 % (0.5 coefficient), hence this roof surface is not much useful for rain water harvesting (Table-2). Both the concrete and metal sheets type of roof surfaces highly suitable for rooftop rainwater harvesting purpose because of its collection efficiency is 70-80 per cent. Therefore, rooftop rain water harvesting method is more applied for both types of roof surface buildings in the college campus.

6.2 Water Demand and Rooftop Rain Water Harvesting Potential

Dahiwadi college campus has a huge potential of rain water harvesting. It is estimated that, 1818844 liters water made available throughout the year. Annual drinking water demand of the college is about 3201780 liters. In this way annually 56.80 per cent requirement of drinking water can be meet from Rooftop RWH in the entire college campus. In the dry days drinking water demand is about 2482476 liters which is 73.26 per cent completed through rain water harvesting. Annual domestic water demand of the college is about 38377500 liters. Annually 47.45 per cent requirement of domestic water can be meeting from Rooftop RWH.

In dry days (243 days) domestic water demand is about 2971500 liters out of which 77.53 per cent completed through the rooftop RWH, it shows that in dry days domestic water demand is also extensively fulfilled by using harvested water. Total drinking and domestic water demand of the college is 7034280 liters out of which 25.85 per cent total water demand completed annually. Dry day's water demand is less than annual demand i.e. 5453976 liters out of which estimated that 33.34 per cent water demand are completed through rain water harvesting.

Thus, it is proved that by using rooftop rainwater harvesting method water scarcity in the college campus can be minimized up to some extent and water collected can be used for drinking and domestic purpose.

6.3 Annual Rooftop Rain Water Harvesting Potential

I. Very High Potential (Roof Area 500 sq. m. & above)

There is positive correlation between roof surface area and rain water harvesting potential. At present Indoor Sport Complex building having highest potential of rooftop rain water harvesting in the college campus. Indoor Sport Complex building has 864 sq. m. roof surface area, which is highest as compared to other campus buildings also because of metal sheet roof surface its collection efficiency is 80% per cent. So its estimated rooftop rainwater harvesting potential is 345600 liters per year.

Another Wing - 'B' Building having roof surface area is 700.3 sq. m. and estimated annual rain water potential is 245105 liters & second largest harvesting potential in the college campus. Two buildings total annual estimated rooftop rainwater harvesting potential is 32.5 per cent out of overall existing potential of the college.

II. High Potential (Roof Area 300 – 500 sq. m.)

The MCVC and Canteen building on the college campus show 425 sq. m area of metal sheet roof surface having 80 per cent collection ability, because of this estimated rain water harvesting potential to be 170000 liters. Auditorium and Ladies hostel building shows 350.9 sq. m. and 322.5 sq. m. area of roof surface having concrete surface so, its water collection capacity 70 per cent. Both buildings show high potential of rooftop rain water harvesting i.e. 122815 liters, 112875 liters respectively per year. Another important Golden Jubilee building has recently been constructed, which indicates 392.92 sq. m. concrete roof surface area with 108470 liters of potential annually. All these 4 building are felt in high potential and suitable for rooftop rain water harvesting.

Source: Field Survey 2020-21

Table-3 Building-Wise Annual Rooftop Rainwater Harvesting Potential

Building No.	Building Name	Rooftop Area in sq. meter	Coefficients	Annual Rooftop Rainwater Harvesting Potential	
				Cu. m.	Liters
1	Indoor Sport Complex	864	0.8	345.6	345600
2	Wing - 'B' Building	700.3	0.7	245.105	245105
3	MCVC Building and Canteen	425	0.8	170	170000
4	Auditorium	350.9	0.7	122.815	122815
5	Chemistry & Zoology Laboratory	296.96	0.8	118.784	118784
6	Wing - 'C' Building	284.09	0.8	113.636	113636
7	Ladies Hostel	322.5	0.7	112.875	112875
8	Golden Jubilee Building	309.91	0.7	108.47	108470
9	Wing - 'A', Principal Cabin & Office	284.61	0.7	99.61	99610
10	Library	219.04	0.7	76.66	76660
11	Car & Motor Cycle Parking	186.12	0.8	74.44	74440
12	Gents and Ladies Toilet	166.44	0.7	58.254	58254
13	Bicycle Parking	93.06	0.8	37.224	37224
14	Principals Quarter	99.31	0.7	34.7585	34758.5
15	Boys Common Room	73.2	0.8	29.28	29280
16	Chemistry Apart Stores	44.2	0.8	17.68	17680
17	Botany Research Laboratory	42.5	0.7	14.875	14875
18	Staff Toilet	38.08	0.7	13.328	13328
19	Ladies Common Room	32.64	0.8	13.056	13056
20	Vermiculture	41.31	0.6	12.393	12393
Total		4957.18		1818.844	1818844

III. Medium Potential (Roof Area 100 – 300 sq. m.)

There are 6 buildings viz. Chemistry & Zoology Laboratory, Wing - 'A', Principal Cabin & Office, Wing - 'C' Building, Library, Car & Motor Cycle Parking and Gents and Ladies Toilet building shows medium potential of rain water harvesting. Roof surface of all these buildings made by metal sheets or concrete roof contains 70-80 per cent rain water collection potential. Chemistry and Zoology Laboratory acquired 296.96 sq. m. area having 118784 literts annual potential. Secondly Wing - 'A', Principal Cabin & Office building comprised with 284.61 sq. m area of roof surface and estimated annual potential is 99610 liters. Wing - 'C' Building covered 284.09 sq. m. area of roof surface and proposed potential is 113636 liters per year. Library of the college is acquired 219.04 sq. m., Car & Motor Cycle Parking acquired 186.12 sq. m. area and Gents and Ladies Toilet building acquired 166.44 sq. m. roof areas having 76660 liters, 58,254 liters, 74440 liters and 58254 liters respectively annual rain water harvesting capacity.

IV. Low Potential (Roof Area below 100 sq. m.)

Remaining 08 buildings shows less rain water harvesting potential. Due to below 100 sq. m. roof surface area of all buildings. Buildings such as Principals Quarter, Bicycle Parking, Boys Common Room, Botany Research Laboratory, Chemistry Apart Stores, VermicSulture, Staff Toilet, and Ladies Common Room etc. are not much use full for rain water harvesting.

7. Conclusion

The present study shows the total water demand and supply gap is -7272 liters daily and -2654280 liters annually. It has also been increased from 8,000 to 12,000 liters per day in every summer season which leads to severe problem of water scarcity in the college campus. Both concrete and metal sheets type of roof surfaces in the college is more suitable for rainwater harvesting because of its collection efficiency is 70 per cent. Estimated annual rooftop rain water potential of these roof surfaces is about 48.75 per cent and 50.56 per cent respectively. Rooftop rainwater harvesting estimated annual potential is about 1818844 liters and it can mitigate 56.80 per cent water requirement of drinking and 47.45 per cent of domestic demand annually. If the college has used harvested water in dry days only then 77.53 per cent of drinking water demand or domestic water demand fulfilled. The total water demand of the college is about 7034280 liters out of which annually 25.85 per cent and in dry days 33.34 per cent completed through Rooftop RWH method.

Highest rooftop rain water harvesting potential is exist in Indoor Sport Complex and Wing - 'B' Buildings. High potential exist in buildings such as MCVC and Canteen building , Auditorium and Ladies hostel and Golden Jubilee building also medium but good potential was found in as many as 6 buildings like Chemistry & Zoology Laboratory, Wing - 'A', Principal Cabin & Office, Wing - 'C' Building, Library, Car & Motor Cycle Parking and Gents and Ladies Toilet buildings in the college campus. Thus, the Rooftop rain water harvesting would be a good solution for drinking and domestic water sustainability of the college in some extent. Results obtained from the present study suggested that Rooftop rain water harvesting method is more applicable on college campus located in drought prone-zones of Maharashtra.

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Flower Farmer's Awareness of The Floriculture In Solapur District

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Abstract
There are numerous flower and plant kinds that are grown for their economic benefit. The demand for floriculture products on a global scale is rising quickly. Many countries, especially the developed ones, import flowers to meet domestic demand. Commercial floriculture is a relatively recent occurrence in India. Maharashtra is home to the majority of floriculture producers in India. With a significant emphasis on direct marketing, market research, supply chains, and transportation, among other things, India's exports of floriculture could rise globally. The study focuses on the floriculture sector with particular reference to the Solapur District in order to ascertain the trade potentials of plants from the climatically rich region of Solapur, Maharashtra.
Floriculture, also referred to as flower farming, is the practise of growing colourful, ornamental plants for use in gardens and floristry. It is a very promising and rapidly growing industry in India. It has developed into a prosperous industry with greater profit potential than other agricultural products. Numerous Indian enterprises now see floriculture as a potential sector due to the increased importance of flowers in Indian culture, the blending of eastern and western lifestyles, the rise in living standards, and the expanding flower export market. In recent decades, there has been a marked global increase in the demand for flowers. Growing market demand and product value have attracted an increasing number of people. The paper makes an effort to survey the current and potential of floriculture production in the Solapur District as well as the steps that should be taken to improve this valuable industry.

Keywords: Floriculture, Flower Farmer, Awareness, Industry.

Introduction

The potential for producing profitable self-employment within small and marginal farmers as well as earning foreign exchange is enormous in the field of floriculture. Global attention is being drawn to floriculture as a result of changes in people's lifestyles, environmental concerns, purposeful initiatives to go green, and more consumer power. Numerous options exist to utilise the potential of ornamentals due to their natural value and extensive biodiversity.

A new generation of producers is emerging who will use contemporary technology to maximise output, provide high-quality products for customer acceptance, and command a higher price. In comparison to other agri-horticultural crops, it has emerged as a lucrative career with a significantly larger potential for profits.

Modern businessmen are investing in the floriculture sector due to the aesthetic value of flowers and decorative plants, their usage in social gatherings, general satisfaction from working with them, and high earning potential. Due to recent changes in lifestyle and urbanisation, floriculture has flourished as a profitable industry. The market for cut flowers and loose flowers has grown significantly, and research on floriculture will concentrate on the shifting market conditions, rising demand, and anticipated future needs. It is a powerful method for understanding the floricultural sector and evaluating its success in terms of the economics, environment, and society.

Research Objective

The study's purpose is to better understanding of sustainability in floriculture, and awareness of flower farming in flower growers.

1. To inform the flower growers about the benefits of floriculture.
2. Encouraging them to invest in the floriculture market.
3. Understanding the current situation.
3. Only roses and marigolds will be considered for export in the research work.

Study Area

Solapur is a district in the Maharashtra state of India. Solapur is where the district offices are located. The Bhima and Seena basins completely enclose it, and it is located close to the state's southernmost tip.

The district as a whole is drained by the Bhima River. According to the 2011 census, the total population of the Solapur district was 43,15,527. Its geographical area is around 14,895 square kilometres, and it is divided into 11 tahsils (Barakade and Sule, 2011). It ranks fourth in Maharashtra's 36 districts in terms of area (4.88%) and seventh in terms of population (4.51 percent). The district receives an average of 584.3 mm of rain annually as a result of the study area's placement in a rain shadow.

Focus Of The Study

1. The scope of the research is limited to Solapur district.
2. The survey includes responses from flower growers only.
3. Only roses and marigolds will be considered for export in the research work.

Data Collection / Source Of Data

Primary Data: All prospective respondents in the Solapur District would be surveyed to obtain the primary data. Primary data is information that is obtained for the first time and is not derived from any previously collected information.

Secondary Data

Secondary data is information that has been obtained from previously published sources for purposes other than the current investigation. The secondary information was acquired from publications that are open to the public, committee and business reports, etc.

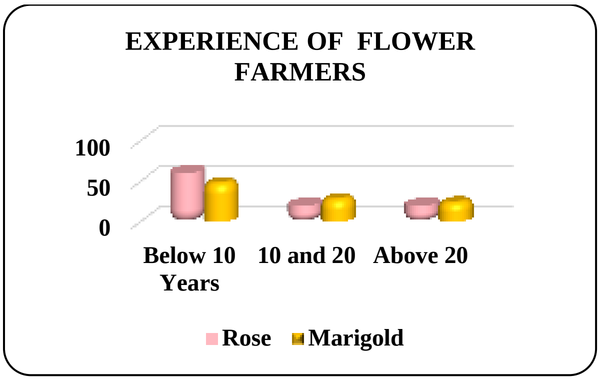
Sample Design

Respondent Type	No of Respondents		Total
	Rose	Marigold	
Flower cultivators	25	25	50

Data Analysis

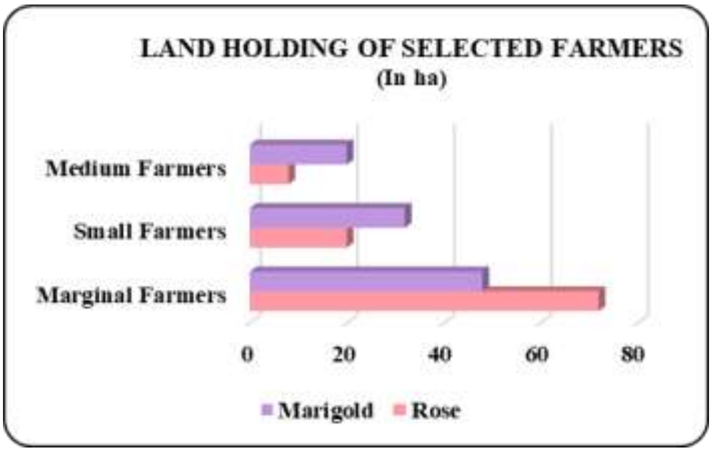
The following methods are used reach with the respondents: In-person interviews used in surveys.

Sr. No.	Respondent Type	No of Respondents		
	Experience in flower market	Rose	Marigold	Total
1	Below 10 Years	15 (60)	12 (48)	27(54)
2	10 and 20	5 (20)	7 (28)	12(24)
3	Above 20	5 (20)	6 (24)	11(22)
	Total	25	25	50



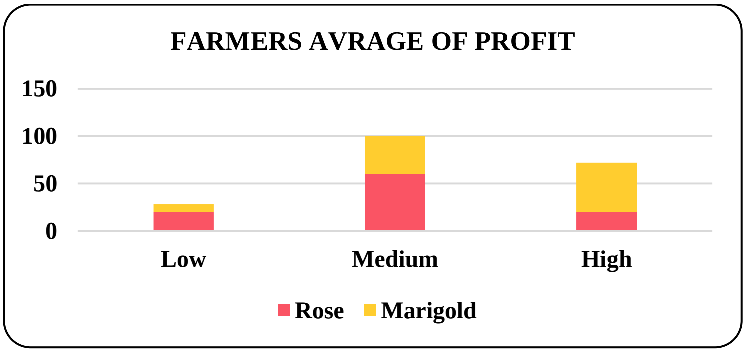
It is observed that in the above table some of the Rose and Marigold flower cultivators are experienced below ten year experience of flower cultivation.

Sr.No.	Respondent Type	No of Respondents		
	Land Holding	Rose	Marigold	Total
1	Marginal Farmers	18 (72)	12 (48)	30 (60)
2	Small Farmers	5 (20)	8 (32)	13 (26)
3	Medium Farmers	2 (8)	5 (20)	7 (14)
	Total	25	25	50



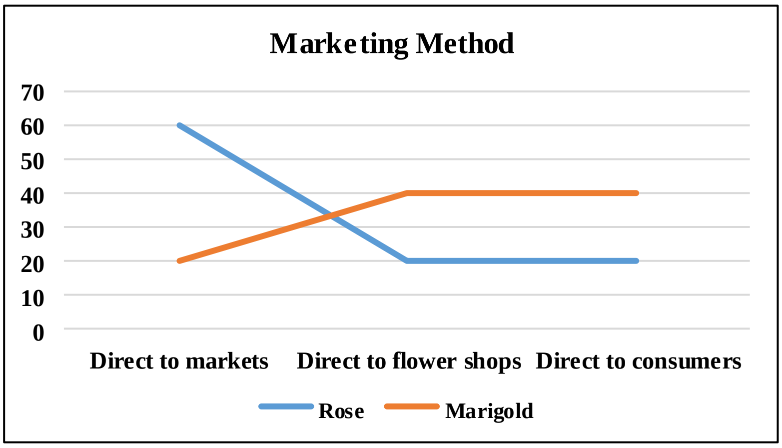
It is detected that in the above table more or less of the Rose and Marigold flower cultivators are under the land holders are marginal farmers of flower cultivation.

Sr. No.	Respondent Type	No of Respondents		
	Farmers Average of Profit	Rose	Marigold	Total
1	Low	5(20)	2(8)	7(14)
2	Average	15(60)	10(40)	25(50)
3	High	5(20)	13(52)	18(36)
	Total	25	25	50



It is identified that in the above table average of the profit of the Rose and Marigold flower cultivators are medium and high.

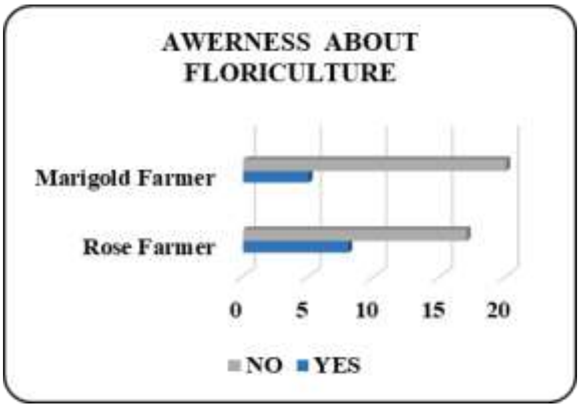
Sr. No.	Respondent Type	No of Respondents		
	Marketing Method	Rose	Marigold	Total
1	Direct to markets	15(60)	5(20)	20(40)
2	Direct to flower shops	5(60)	10(40)	15(30)
3	Direct to consumers	5(20)	10(40)	15(30)
	Total	25	25	50



It is recognized that in the above table sale for marketing method of the Rose and Marigold flower cultivators are three ways: direct to markets, direct to flower shop, direct to consumer.

Are you aware of the floriculture market's potential?

Sr. No.	No of Respondents		
		Rose Farmer	Marigold Farmer
1	YES	8	5
2	NO	17	20
	Total	25	25



It is observed that most of the flower cultivators are unaware of Current floriculture Markets

Suggestions

Governmental organizations should arrange practical workshops and training sessions.

There are no policy initiatives that could improve the flower business and lead to an economically appealing segment of agriculture in Solapur because no work has been done on the production of various varieties of flowers.

To improve cultivation practises and make the best use of suggested inputs in floriculture, a research wing needs to be established. This would improve flower yield in general while costing less overall. The income of farmers would rise as a result, and surplus produce would be available for export.

A successful extension programme serves as a link between academic inquiry and practical application. Therefore, it is necessary to start a well-equipped extension service programme to provide producers of flowers with useful instructions on flower growing, quality maintenance, reducing loss during harvest, and extending flower storage life. Additionally, this service ought to be able to inspire other farmers to take part in this kind of crop diversification at the farm level.

When cultivating flowers requires a lot of labour, the government has the opportunity to develop a policy framework that would help the industry improve from where it is now. As a result, extra labour might be used productively in various aspects of the production and marketing of the flower industry.

Conclusion

Flower growers' awareness of the flower industry and market can improve their understanding of the trade environment. Risk tolerance will be improved and flower farmers will learn international trade by making small financial investment decisions. The primary reasons for the drop in yield per hectare are unusual weather rains and weather variations, a lack of technology, farmers' lack of competence, and poor planting supplies.

Due to different agro-climatic zones and unique production techniques, floriculture has experienced significant commercialization as opposed to subsistence farming. The production has increased globally.

The floriculture sector of the state currently faces a number of commercial constraints that must be overcome via careful planning and coordinated development efforts at all levels. However, the floriculture sector in Maharashtra as well as Solapur district has a very high potential from a technical standpoint. Utilizing this potential will help the state's socioeconomic situation. Additionally, because it is a significant export, it can significantly increase the country's overall foreign exchange earnings.

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Prioritization of Kamlang River Watershed Through Morphometric and Land Use/Cover Parameters using Quantitative Analysis

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Abstract

Considering the relationship and importance of water and how watershed plays a dominant role in transporting water and landforms development, it is very significant to study a watershed as it is an ideal unit for management of natural resources like land and water for mitigation of the impact of human activities and natural disaster for achieving sustainable development. Remote sensing (RS) and Geographic Information System (GIS) techniques help planners in decision making and hence became a popular tools for such kinds of studies. Morphometric parameters (linear and shape) with land use land cover parameters were used for assigning ranks based on which prioritization and ranking were made for all the sub-watersheds of Kamlang River Watershed. Different categories of priority from high to low rank were assigned depending on the parameters and lastly, the compound value (Cp) of all the sub-watershed was calculated. Higher Cp was of low priority, lower Cp was of higher priority. The study demonstrates the presence of high priority in the sub-watershed of SW64 and SW65 on the bases of morphometric studies. Whereas based on land use land cover more numbers of sub-watersheds are in the high priority range for example SW1, SW6, SW8, SW12, etc. The combined result of morphometric and land use/cover analysis, however, gives a different result i.e. only SW65 is in the high priority zone. This means the sub-watershed of SW65 is more prone to erosion due to its morphometry and land use land cover type. Therefore the implementation of soil and water conservation measures for this sub-watershed is necessary.

Keywords: GIS & RS, Prioritization, Land Use/ Land Cover, Morphometric.

Introduction

A watershed is a hydrologic unit often used as a physical-biological unit and a socioeconomic-political unit for the planning and management of watershed resources (Kenneth N. Brooks, Peter F. Ffolliott, Joseph A.Magner, 2012). It combines with other watersheds to form a network of Rivers and streams that progressively drain into large water areas. Watersheds are usually separated from other watersheds by naturally elevated areas.

Moreover, the drained Water is not only influenced by rainfall kinetics, but also by land characteristics and vegetation cover. Apart from rainfall, soil, vegetation, and slope, the quantitative hydro-morphological characteristics, i.e., basin shape and stream network, also decide the stream flow hydrographs, run-off volume, run-off intensity, and peak flow. Therefore the study of the morphometry of a watershed is very important it not only evaluates the quantitative hydro-morphometric feature of a basin of modeling run-off but also the sediment yield from the drainage basin. Using the watershed as the basic unit in the morphometric analysis is the most logical choice because all hydrologic and geomorphic processes occur within the watershed

Morphometry is the measurement and mathematical analysis of the configuration of the earth's surface, shape, and dimension of its landforms (Clarke, 1966). The method of quantitative analysis of drainage basins was developed by (Harton, 1945), and modified by (Strahler, 1964). According to Strahler's quantitative analysis, the drainage system is an important aspect of the characteristics of the watershed. Land and water resources are limited and their improper utilization without any conservation is the prime cause of the deterioration of the watershed. In this, the context of the watershed is gaining importance in natural resources management and conservation.

Remote sensing and Geographical Information system (GIS) provides a sophisticated tool to convert heterogeneous spatial information into a unified, well-structured database for handling large quantities of spatially varied data at the micro-level as well as at the basin scale. one of the major advantages of GIS is its capability to overlay multi-thematic data, which could be used in hydrological models or integrated land-use planning.

Human activities like cutting of trees, traditional 'Jhum' cultivation (shifting cultivation), and natural hazards such as floods, erosion, and Stormy weather resulting in the uprooting of a large number of shallow-rooted standing trees, etc have virtually destroyed the virgin tropical vegetation and the natural environment of Kamlang River watershed area. To manage natural resources like land and water for mitigation of the impact of natural disasters for achieving sustainable development in the study area a quantitative analysis for prioritization of watershed through morphometric and land use land cover parameters is used for the study area.

Study Area

In the northeastern extreme of Arunachal Pradesh, lies the 'Lohit' District. The study area of the Kamlang River basin is one of the important Rivers that flow in the Lohit District and joins its tributaries to form a watershed. It flows through the Kamlang Wildlife Sanctuary which is named after the Kamlang River. It rises from Galo in Wakro and flows in an east-westerly direction to finally meet the Lohit River. The topography of the basin is complex, including mountains, hills, alluvial plains, water bodies, etc., and is located between 27°50' to 27°49' North latitudes, and 96°14' to 96°42' East longitudes. Glow lake is a famous lake that lies in the Kamlang watershed at an altitude of around 5,000 feet.

Kamlang watershed lies in the seismic zone subjected to frequent tremors. Earthquakes have been reported in 1897, 1930, and 1950 (Centre for Natural Disaster Management, Assam Administrative Staff College). The soil characteristic of the River deposits contains sand, clay, and other finer matter of silt. Floods largely attribute to the formation of alluvium in the lower valley region. Past earthquakes have also contributed to soil formation (Gazetteer of India, Arunachal Pradesh, Lohit District, 1978). At the foothills, the summer months are extremely hot ranging from June to August while the valley provides a pleasant, cool, and humid climate. The temperature at times rises to 41.11°C, while in winter it goes as low as 5°C. Pre-monsoon thunderstorms are common, followed by regular southwest monsoons commencing from June and lasting up to mid-October. The winter prevails from late October to November. Precipitation is also received in the form of snow in the higher altitudes. The vegetation may be broadly classified into tropical, temperate, and alpine forests. The tropical wet evergreen forest is present in the foothills and lower reaches of the watershed, whereas alpine vegetation is expected to dominate in the upper reaches of "Daphabhum peak" just bordering Namdapha National Park.

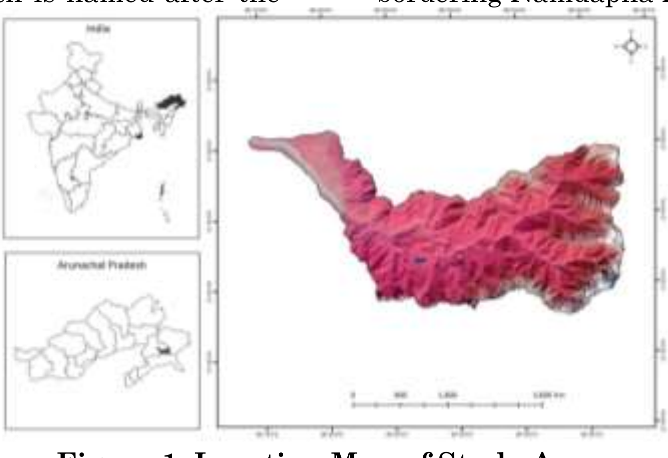

Figure 1: Location Map of Study Area

The terrain of the Kamlang watershed is largely mountainous with a steep to moderate hill range of Himalayan formations. Towards the North, the mountains are clad with perpetual snow, with an altitude ranging from 610m to 5182m. Towards the southwestern portion of the watershed, it gradually changes in the plan area. Numerous springs and Rivers originate from the mountain reaches and join the Kamlang River. Most of the Kamlang watershed area is inaccessible because of the topography however, the vast stretches of valley support luxuriant tropical evergreen forest, providing an amazing landscape.

Data used and Methodology

Ancillary data

Survey of India Toposheet map at 1:50,000 scale

Satellite data

IRS Cartosat 1 Orthoimage of 2.5m resolution

IRS Resourcesat 2 LISS III image 23.5m

SRTM GDEM (Global Digital Elevation Map) - 30m resolution

Methodology

The Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) data of 30m resolution was used to identify the watershed boundary of the Kamlang River basin using hydrology tools in ArcGIS environment. Streams were delineated using Survey of India (SOI) Topographic maps with a scale of 1:50000 by georeferencing and digitizing in Arc GIS 10.5 environments. In addition, the IRS Resourcesat 2 LISS III and SRTM data were utilized to find out the modification and alteration in the drainage network. Stream orders were assigned following the stream ordering system developed by Strahler for further morphometric studies.

Catchments are divided into eighty sub-watersheds (SW_1 to SW_80) based on the topographic division using SRTM DEM (30m resolution), followed by the streams as shown in figure 2. The drainage network related to each of the eighty sub-watershed was measured and calculated using GIS software, and the mathematical equation elaborated by Horton (1945), Strahler (1964), Schumm (1956), and Miller (1945) is given in table 1.

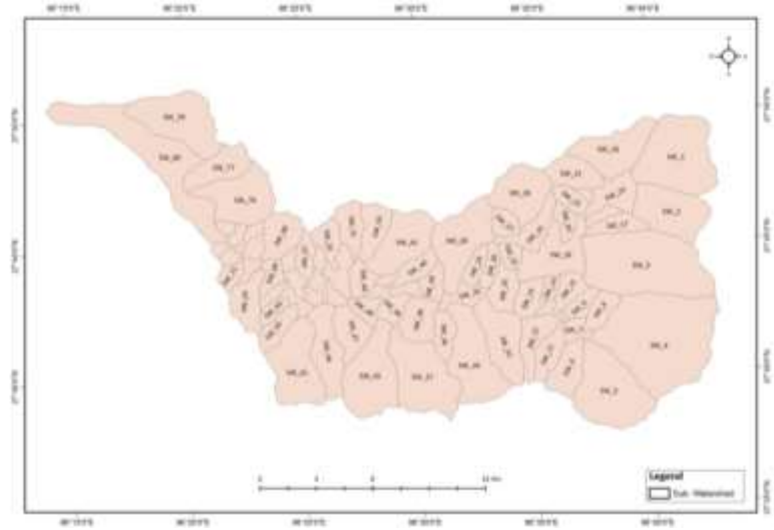

Figure 2: Kamlang watershed and its sub-watersheds

Morphometric parameters like stream order, stream length, bifurcation ratio, drainage density, stream frequency, circulatory ratio, elongated ratio, form factor, drainage texture, and compactness coefficient were calculated for each sub-watershed.

The linear parameters such as drainage density, stream frequency, bifurcation ratio, and drainage texture have a direct relationship with erodibility. Hence prioritization of sub-watershed, the highest value of linear parameters was rated rank 1st, the second highest value rated as rank 2nd, and so on, and the least value was rated last in rank. Shape Parameters such as elongation ratio, compactness coefficient, circularity ratio, and basin shape and form factor have an inverse relationship with erodibility lower the value more is the probability. Thus the lowest value of shape parameters was rated as rank 1st, the next lower value was retained as rank 2nd and so on and the highest value was rated last in rank. Hence, the ranking of the sub-watershed has been determined by assigning the highest priority/rank based on the highest value in the case of the linear parameter and the lowest value in the case of shape parameters. Compound value (Cp) by adding the ranking value of each of the 80 sub-watershed was separately calculated for all parameters of both linear and shape. This compound value based on average value was assigned the highest and lowest priority, the sub-watershed having the least average was assigned the highest priority, the next higher value was assigned second priority, and so on.

Land use/cover of the study area was obtained by using LISS III imagery of 23.5-meter resolution and Cartosat I Orthoimage of 2.5m resolution with the help of visual image interpretation techniques and data interpretation keys such as tone, texture, shape, location, association, pattern, etc. Ancillary information like elevation and landforms followed by data from ground truthing was used to check the accuracy of the interpretation.

Results and Discussion

Table 1: Formula for calculating Morphometric Perimeters

S.No	Morphometric Parameter	Formula	Reference
1	Stream order	Hierarchical order	Strahler 1964
2	Stream length (Lu)	Length of the Stream (km)	Horton 1945
3	Stream Length ratio (RI)	Rl= Lu/Lu-1 Where, Lu= Total number of stream segments of order 'U', Lu-1=Stream length of next lower order.	Strahler (1964)
4	Mean Stream Length (Lum)	Lsm= Lu / Nu Where, Lu=Total Stream length of order 'U', Nu= Stream length of next higher stream order.	Strahler (1964)
5	Bifurcation Ratio (Rb)	Rb = Nu / Nu+1 Where Nu=Total Number of stream segments of order 'U', Nu+1= Number of segments of the next higher order.	Schumn (1956)
6	Drainage Density (Dd)	Dd=Lu /A where Dd=drainage density, Lu=total stream length of all orders, A=area of the basin(km^2)	Horton 1945
7	Drainage texture (Dt)	T=Nu/P where Nu=total no. of streams of all orders, P=basin perimeter, km	Horton 1945
8	Elongation ratio (Re)	Re=2√A /π/Lb where Re = elongation ratio , A= area of the basin, km^2 ,π =π value i.e., 3.141 , Lb =basin length	Miller
9	Compactness coefficient (Cc)	Cc =0.2821 P/A 0.5 where Cc=Compactness coefficient, A=Area of the basin, km^2 P=basin perimeter, km	Horton 1945

Stream Order

Stream order is the method of assigning a numeric order to links in a stream network (Das et.al. 2012). This ordering was done using the method proposed by Strahler (1964) and as the method suggests the number of stream segments in the Kamlang River watershed decreases with an increase in the stream order as shown in Table 2. The Kamlang watershed is a 6th order drainage sub-basin with River Kamlang being on the 6^{th} order.

Table 2: Stream order and distribution of stream segments.

Stream Order	Number of segments	Percentage of total Streams segments
1st	1600	79.52
2nd	314	15.61
3rd	75	3.73
4th	17	0.84
5th	5	0.25
6th	1	0.05
Total	2012	100.00

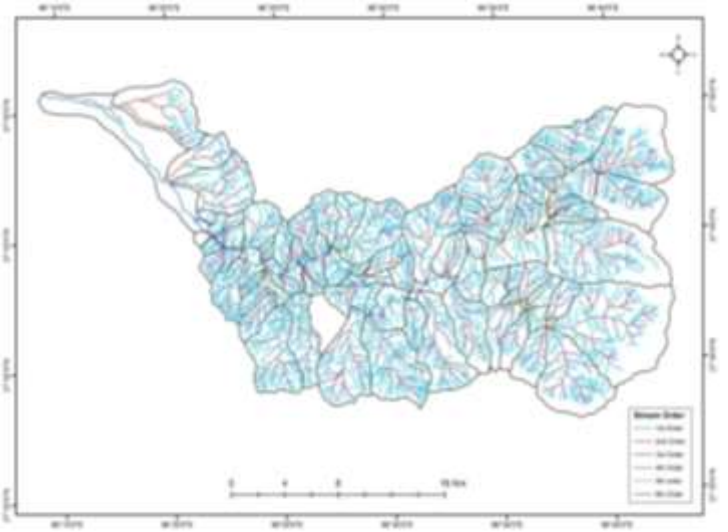

Figure 3: Drainage showing the stream orders of sub-watershed

Stream Length

The stream length measures the length of the stream in each order and is calculated by adding the total length of all streams in a particular order by the number of streams in that order. It increases exponentially with increasing stream order.

Kamlang watershed has a total stream length of 2653.03 km. As stated in the law of stream lengths (Horton 1945) the average length of streams of each of the different orders in a drainage basin tends closely to approximate a direct geometric series in which the first term is the average length of streams of the first order. Therefore the length of the 6th order stream of the study area is 14 km which is the highest of all 5th order the second largest and so on. The 1st order streams are the shortest compared to the streams of other orders. This change may indicate the flowing of streams from high altitudes, lithological variation, and moderately steep slopes (Singh and Singh, 1997).

Bifurcation ratio (Rb)

It is a dimensionless number denoting the ratio between the number of streams of one order and those of the next higher order in a drainage network. According to Horton (1945), the bifurcation ratio varies from a minimum of 2 in "flat or rolling drainage basins" to 3 to 4 in "mountainous or highly dissected drainage basins"; it is a parameter used in the equation giving the number of streams in a basin.

The bifurcation ratio of the Kamlang River watershed shows a wide variation where the sub-watershed number SW_65 has the maximum (Rb = 4.93) while the sub-watershed SW_79 has the minimum (Rb = 0). The SW_79 has the lowest bifurcation ratio due to the absence of sub-streams and also indicates the characteristics of structurally less disturbed watersheds without any distortion in drainage patterns (Nag 1998). Maximum numbers of sub-watersheds bifurcation ratio (Rb) values are ranging from 0.75 to 4.9 which mean that the drainage of the Kamlang River basin is characteristically influenced by the geological structure of mountainous or highly dissected drainage basins.

Drainage Density (Dd)

Drainage density is defined as the total length of streams of all orders per drainage area. Kamlang River watershed drainage density ranges from 1.66 km2 to 14.63 km2. Around 67 sub-watershed have low density and is below 10 km2 while, there are 13 sub-watershed with high drainage density, highest being 14.63 which is very high comparing to the rest of the sub-watershed. Density factor varies from climate, rock type, relief, infiltration rate, vegetation cover, and landscape evolution processes. The area with very resistant or permeable subsoil material, low relief, and dense vegetation results in low drainage whereas, whereas weak or impermeable subsurface material, mountainous relief, and sparse vegetation results in high drainage density (Nag. 1998).The drainage density of all the sub-watershed is given in Table 3 in detail.

Drainage texture (Dt)

The texture of drainage refers to the relative spacing of a total number of stream segments of a given length per unit area (Horton 1945). The study shows that there are five sub-watersheds with drainage texture below 2 indicating a very coarse texture, around thirty-one sub-watersheds, have coarse drainage texture, other thirty-one sub-watersheds have moderate, seven have fine and five have very fine drainage texture. The five sub-watersheds with very fine drainage textures are the ones where runoff is more. Detail drainage texture of the Kamlang River basin and its sub-watershed is given in Table 3.

Stream frequency (Fs)

Stream frequency is the count of all stream segments per unit area of a basin. In Kamlang river watersheds, sub-watersheds with more area under dense forest have low drainage frequency compared to those with agricultural land. It shows a positive correlation with the drainage density value, with increasing drainage density value. The lower stream frequency of maximum numbers of sub-watershed relates to low runoff in comparison to those where the stream frequency is high. The stream frequencies of all the sub-watersheds are mentioned in Table 5.

Table 3: Values of drainage density, drainage texture and bifurcation ratio.

Sub Watershed	Perimeter (km2)	Drainage Density	Drainage Texture	Bifurcation Ratios					Mean R
				Rb1	**Rb2**	**Rb3**	**Rb4**	**Rb5**	
SW_1	19.87	2.55	3.72	4.46	6.50	2.00	0.00	0.00	4.32
SW_2	16.17	2.79	3.65	4.60	5.00	2.00	0.00	0.00	3.87
SW_3	25.67	2.55	3.97	5.13	5.33	3.00	0.00	0.00	4.49
SW_4	27.78	2.05	3.35	4.44	3.20	5.00	0.00	0.00	4.21
SW_5	19.77	2.81	3.90	3.87	5.00	3.00	0.00	0.00	3.96
SW_6	12.00	2.52	2.17	7.33	3.00	0.00	0.00	0.00	5.17
SW_7	8.35	16.55	1.56	9.00	1.00	1.00	1.00	0.00	3.00
SW_8	9.14	2.70	1.20	10.00	0.00	0.00	0.00	0.00	10.00
SW_9	7.89	2.48	1.27	8.00	1.00	0.00	0.00	0.00	4.50
SW_10	7.69	23.43	1.43	1.50	0.00	4.00	0.00	0.00	2.75
SW_11	11.04	2.47	1.36	6.00	2.00	0.00	0.00	0.00	4.00
SW_12	14.12	2.30	0.99	3.33	3.00	0.00	0.00	0.00	3.17
SW_13	9.61	6.82	1.46	3.33	3.00	0.00	0.00	0.00	3.17
SW_14	5.68	3.29	1.41	7.00	0.00	0.00	0.00	0.00	7.00
SW_15	8.70	2.91	1.84	6.50	2.00	0.00	0.00	0.00	4.25
SW_16	21.36	5.22	1.92	5.80	1.25	2.00	2.00	0.00	2.76
SW_17	11.09	4.93	2.34	3.80	2.50	0.00	0.00	0.00	3.15
SW_18	7.20	4.23	1.11	2.50	2.00	0.00	0.00	0.00	2.25
SW_19	14.51	7.34	2.27	3.67	3.00	1.00	2.00	0.00	2.42
SW_20	17.58	3.87	3.58	5.78	9.00	1.00	0.00	0.00	5.26
SW_21	11.58	3.29	2.94	4.50	6.00	0.00	0.00	0.00	5.25
SW_22	4.09	3.83	0.98	3.00	0.00	0.00	0.00	0.00	3.00
SW_23	7.49	4.43	2.40	16.00	1.00	0.00	0.00	0.00	8.50
SW_24	7.88	3.92	2.16	7.00	2.00	0.00	0.00	0.00	4.50
SW_25	14.79	3.96	1.89	7.00	1.00	3.00	0.00	0.00	3.67
SW_26	15.03	3.63	3.73	5.50	2.67	3.00	0.00	0.00	3.72
SW_27	7.09	4.15	2.40	4.33	3.00	0.00	0.00	0.00	3.67
SW_28	18.89	3.36	4.02	5.00	4.00	3.00	0.00	0.00	4.00
SW_29	7.77	1.87	0.51	3.00	0.00	0.00	0.00	0.00	3.00
SW_30	8.09	2.64	0.99	7.00	0.00	0.00	0.00	0.00	7.00
SW_31	6.39	1.97	1.10	6.00	0.00	0.00	0.00	0.00	6.00
SW_32	10.62	14.76	1.79	4.33	3.00	0.00	1.00	1.00	2.33
SW_33	16.76	2.95	2.92	8.20	2.50	2.00	0.00	0.00	4.23
SW_34	21.01	3.02	2.71	3.23	13.00	1.00	0.00	0.00	5.74
SW_35	11.44	18.54	1.14	3.50	2.00	0.50	0.00	0.00	2.00
SW_36	9.39	4.11	2.45	10.00	2.00	0.00	0.00	0.00	6.00
SW_37	20.44	3.72	4.16	5.15	3.25	4.00	0.00	0.00	4.13
SW_38	11.02	9.76	2.99	4.40	1.67	0.00	2.00	0.00	2.69
SW_39	8.32	3.75	1.56	5.00	2.00	0.00	0.00	0.00	3.50

SW_40	9.76	4.38	1.74	4.33	3.00	0.00	0.00	0.00	3.67
SW_41	15.9	3.95	4.46	4.58	6.00	2.00	1.00	0.00	3.40
SW_42	4.7	3.88	1.29	5.00	0.00	0.00	0.00	0.00	5.00
SW_43	7.2	5.01	1.24	6.00	1.00	1.00	0.00	0.00	2.67
SW_44	12.0	15.65	2.16	20.00	1.00	0.33	0.00	0.00	7.11
SW_45	18.9	3.20	3.17	5.22	3.00	1.00	0.00	0.00	3.07
SW_46	17.4	4.05	3.10	6.43	7.00	1.00	0.00	0.00	4.81
SW_47	12.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SW_48	7.9	2.95	2.03	2.75	4.00	0.00	0.00	0.00	3.38
SW_49	8.3	18.68	2.52	7.50	1.00	0.00	0.00	0.00	4.25
SW_50	11.5	3.42	2.44	4.40	5.00	0.00	0.00	0.00	4.70
SW_51	11.2	3.93	2.40	5.25	2.00	0.00	0.00	0.00	3.63
SW_52	9.9	4.71	2.73	4.00	5.00	1.00	0.00	0.00	3.33
SW_53	12.0	15.47	2.34	3.17	6.00	1.00	0.00	0.00	3.39
SW_54	5.9	3.77	1.35	2.50	2.00	0.00	0.00	0.00	2.25
SW_55	7.0	29.73	1.29	3.00	0.00	2.00	0.00	0.00	2.50
SW_56	4.9	3.30	1.02	3.00	1.00	0.00	0.00	0.00	2.00
SW_57	8.7	3.68	1.84	6.50	2.00	0.00	0.00	0.00	4.25
SW_58	7.2	29.44	2.22	3.33	3.00	1.00	0.00	1.00	2.44
SW_59	4.8	3.14	0.84	3.00	0.00	0.00	0.00	0.00	3.00
SW_60	10.1	8.90	1.49	3.33	0.00	0.00	0.00	0.00	3.33
SW_61	18.6	3.78	4.63	6.36	2.75	4.00	0.00	0.00	4.37
SW_62	9.8	4.03	2.85	4.40	5.00	0.00	0.00	0.00	4.70
SW_63	6.7	4.44	2.37	6.50	2.00	0.00	0.00	0.00	4.25
SW_64	6.1	5.96	2.31	12.00	1.00	0.00	0.00	0.00	6.50
SW_65	12.9	4.45	3.96	8.80	5.00	1.00	0.00	0.00	4.93
SW_66	9.2	17.88	1.31	8.00	1.00	1.00	0.00	0.00	3.33
SW_67	5.1	5.95	1.77	3.00	2.00	0.00	0.00	0.00	2.50
SW_68	11.2	3.15	2.41	7.67	3.00	0.00	0.00	0.00	5.33
SW_69	5.8	2.44	0.69	3.00	0.00	0.00	0.00	0.00	3.00
SW_70	6.4	66.26	2.33	3.00	3.00	0.50	0.00	0.00	2.17
SW_71	6.9	4.34	2.45	1.83	0.00	0.00	0.00	0.00	1.83
SW_72	5.1	43.93	2.75	1.60	5.00	0.00	0.00	0.00	2.20
SW_73	7.2	3.50	0.56	3.00	0.00	0.00	0.00	0.00	3.00
SW_74	5.3	2.86	0.57	2.00	0.00	0.00	0.00	0.00	2.00
SW_75	4.2	2.93	0.72	2.00	0.00	0.00	0.00	0.00	2.00
SW_76	18.6	2.71	2.74	5.13	8.00	1.00	0.00	0.00	4.71
SW_77	13.7	2.07	1.24	4.33	3.00	0.00	0.00	0.00	3.67
SW_78	19.6	2.08	1.43	3.17	3.00	2.00	0.00	0.00	2.72
SW_79	4.0	47.88	0.25	0.00	0.00	0.00	0.00	0.00	0.00
SW_80	40.6	2.03	0.12	0.00	1.00	0.50	2.00	0.00	1.17

Elongation ratio (Re)

Elongation ratio is the ratio between the diameter of a circle of the same area as the drainage and the maximum length of the basin (Schumm, 1956). The elongated ratio of the sub-watershed of the Kamlang River basin ranges from 0.4 to 1 indicating the presence of all types of the basin as mentioned in Table 4. However, a circular basin is more efficient in runoff discharge than an elongated basin (Singh and Singh, 1977). Values near 1.0 are the characteristics of the region of very low relief, while values in the range of 0.6 to 0.8 usually occur in the area of high relief and steep ground slope (Strahler 1964).

Table 4: Elongated ratio and its inference

Basin	Re
Circular	>0.9
Oval	0.8-0.9
Less elongated	0.7-0.8
Elongated	0.5-0.7
More elongated	<0.5

Compactness coefficient (Cc)

It is also known as the Gravelius index (GI). According to Gravelius, the compactness coefficient of a watershed is the ratio of the perimeter of the watershed to the circumference of the circle area, which equals the area of the watershed. The Cc is independent of the size of the watershed and dependent only on a slope.

The value of Cc of more than 1.0 indicates that the sub-watersheds have more deviated from the circular nature. Sub-watershed with lower values denotes more elongation of the basin and less erosion, while higher values indicate less elongation and high erosion. The Cc of the sub-watershed is given in Table 4. 55 sub-watersheds have Cc value of more than 1 indicating more erosion than the rest of the sub-watersheds.

Table 5: Morphometric parametes of Kamlang River watershed.

Sub-Watershed	Area (km^2)	Stream Frequency (km/km^2)	Basin Length (km/km^2)	Form Factor	Elongation Ratio	Circularity Ratio	Compactness constant
SW_1	24.75	2.99	39.28	0.63	0.90	0.79	0.45
SW_2	15.35	3.84	29.49	0.52	0.81	0.74	0.59
SW_3	35.80	2.85	109.37	0.33	0.65	0.68	0.40
SW_4	44.90	2.07	74.83	0.60	0.87	0.73	0.35
SW_5	22.66	3.40	46.73	0.48	0.79	0.73	0.49
SW_6	7.32	3.55	19.56	0.37	0.69	0.64	0.93
SW_7	2.61	4.99	5.30	0.49	0.79	0.47	1.81
SW_8	4.38	2.51	12.17	0.36	0.68	0.66	1.18
SW_9	3.05	3.28	8.67	0.35	0.67	0.62	1.46
SW_10	1.45	7.59	4.66	0.31	0.63	0.31	3.00
SW_11	5.45	2.75	20.82	0.26	0.58	0.56	1.14
SW_12	6.74	2.08	25.98	0.26	0.57	0.42	1.18
SW_13	4.72	2.96	9.70	0.49	0.79	0.64	1.15
SW_14	1.85	4.32	3.99	0.46	0.77	0.72	1.73
SW_15	4.09	3.91	10.20	0.40	0.71	0.68	1.20
SW_16	13.13	3.12	23.91	0.55	0.84	0.36	0.92
SW_17	4.49	5.79	23.55	0.19	0.49	0.46	1.39
SW_18	1.77	4.53	7.05	0.25	0.57	0.43	2.30
SW_19	7.07	4.67	20.97	0.34	0.66	0.42	1.16
SW_20	13.69	4.60	27.77	0.49	0.79	0.56	0.72
SW_21	7.19	4.73	16.07	0.45	0.75	0.67	0.91
SW_22	0.79	5.04	3.22	0.25	0.56	0.60	2.91
SW_23	3.28	5.49	9.02	0.36	0.68	0.73	1.29
SW_24	3.04	5.60	11.18	0.27	0.59	0.62	1.46
SW_25	6.17	4.54	23.04	0.27	0.58	0.35	1.35
SW_26	12.60	4.44	22.86	0.55	0.84	0.70	0.67
SW_27	3.37	5.05	7.16	0.47	0.77	0.84	1.19
SW_28	16.72	4.55	55.23	0.30	0.62	0.59	0.64
SW_29	3.16	1.27	11.17	0.28	0.60	0.66	1.39
SW_30	2.92	2.74	11.96	0.24	0.56	0.56	1.56
SW_31	2.53	2.77	5.57	0.45	0.76	0.78	1.43
SW_32	5.67	3.35	6.45	0.88	1.06	0.63	1.06
SW_33	12.96	3.78	46.79	0.28	0.59	0.58	0.73
SW_34	18.15	3.14	56.33	0.32	0.64	0.52	0.65
SW_35	3.67	3.55	16.92	0.22	0.53	0.35	1.76
SW_36	4.44	5.18	14.90	0.30	0.62	0.63	1.19
SW_37	20.37	4.17	62.90	0.32	0.64	0.61	0.57
SW_38	7.02	4.70	11.03	0.64	0.90	0.73	0.89
SW_39	3.45	3.76	9.41	0.37	0.68	0.63	1.36
SW_40	4.37	3.89	15.00	0.29	0.61	0.58	1.26
SW_41	13.51	5.26	40.86	0.33	0.65	0.67	0.67

SW_42	1.01	5.97	4.30	0.23	0.55	0.58	2.61
SW_43	1.88	4.78	6.08	0.31	0.63	0.45	2.17
SW_44	4.68	5.56	11.26	0.42	0.73	0.41	1.45
SW_45	18.60	3.23	50.33	0.37	0.69	0.65	0.57
SW_46	11.14	4.85	49.91	0.22	0.53	0.46	0.88
SW_47	7.18	0.00	14.64	0.49	0.79	0.60	0.96
SW_48	3.22	4.98	4.30	0.75	0.98	0.65	1.38
SW_49	3.81	5.52	5.90	0.64	0.91	0.69	1.23
SW_50	6.38	4.39	19.23	0.33	0.65	0.61	1.02
SW_51	5.70	4.73	17.35	0.33	0.65	0.57	1.11
SW_52	4.50	6.00	12.46	0.36	0.68	0.58	1.24
SW_53	4.56	6.14	5.22	0.87	1.05	0.40	1.48
SW_54	1.62	4.95	4.79	0.34	0.66	0.58	2.06
SW_55	1.80	4.99	2.52	0.72	0.96	0.46	2.19
SW_56	1.25	3.99	4.56	0.27	0.59	0.65	2.21
SW_57	3.64	4.39	14.56	0.25	0.56	0.60	1.35
SW_58	2.06	7.76	4.04	0.51	0.81	0.50	1.97
SW_59	1.27	3.15	3.24	0.39	0.71	0.70	2.12
SW_60	2.27	6.62	9.07	0.25	0.56	0.28	2.51
SW_61	17.01	5.05	38.95	0.44	0.75	0.62	0.62
SW_62	4.59	6.10	17.12	0.27	0.58	0.60	1.21
SW_63	2.36	6.79	7.70	0.31	0.62	0.65	1.61
SW_64	1.46	9.57	6.70	0.22	0.53	0.50	2.34
SW_65	7.23	7.05	30.29	0.24	0.55	0.55	1.01
SW_66	3.20	3.75	3.70	0.86	1.05	0.48	1.62
SW_67	1.34	6.69	4.39	0.31	0.62	0.66	2.13
SW_68	7.55	3.58	17.10	0.44	0.75	0.76	0.84
SW_69	2.06	1.94	5.21	0.40	0.71	0.76	1.59
SW_70	1.63	9.20	6.09	0.27	0.58	0.50	2.22
SW_71	2.69	6.32	8.18	0.33	0.65	0.70	1.46
SW_72	1.37	10.25	1.80	0.76	0.98	0.66	2.10
SW_73	1.74	2.30	8.67	0.20	0.51	0.43	2.32
SW_74	1.42	2.11	3.47	0.41	0.72	0.64	2.10
SW_75	1.09	2.74	2.35	0.47	0.77	0.79	2.15
SW_76	15.55	3.28	38.80	0.40	0.71	0.57	0.67
SW_77	8.74	1.95	28.97	0.30	0.62	0.59	0.88
SW_78	18.60	1.51	55.07	0.34	0.66	0.61	0.59
SW_79	0.99	1.01	1.95	0.51	0.80	0.77	2.29
SW_80	29.79	0.17	273.78	0.11	0.37	0.23	0.77

Land use/ Land cover Analysis

Land Use / Land Cover generally refers to the categorization or classification of human activities and natural elements on the landscape within a specific time frame based on established scientific and statistical methods of analysis of appropriate source materials. 76.92 percent of the total land of the Kamlang River watershed is covered with forest and only very few percent of the land is used for other uses. Table 5 shows a detailed land use land cover of the sub-watersheds.

Table 5: Land use/ Land cover distribution of Kamlang River basin.

Classes	Area (Km2)	Percentage
Forest	459.67	76.92
Wastelands	83.11	13.91
Snow	31.66	5.30
Water Bodies	14.94	2.50
Agricultural Land	6.77	1.13
Built-Up	1.48	.026
Total	597.63	100

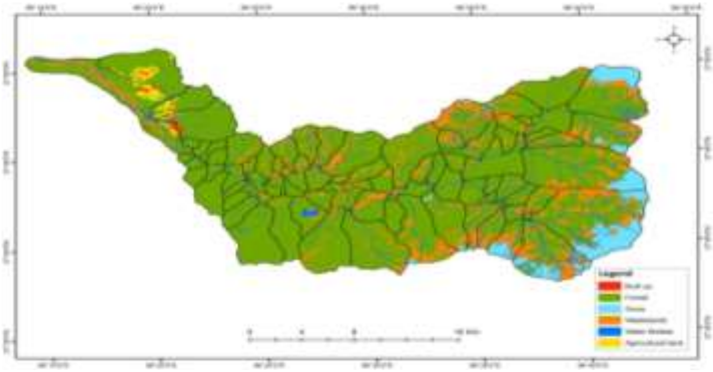

Figure 4: Land use/ Land cover map of kamlang River basin.

Prioritization of sub-watershed

Based on Morphometric parameters both linear parameters and shape parameters ranking of each subwatershed from SW_1 to SW_80 is done for categorizing them into a high priority to low priority. Linear parameters have a direct relationship to erodibility, therefore, drainage density, stream frequency, bifurcation ratio, and drainage texture with a higher value are ranked higher, and lower are ranked low. Shape parameters, however, have an inverse relationship to erodibilty, therefore, elongation ratio, compactness coefficient, circularity ratio, and form factor are ranked inversely, higher values are ranked low and lower values are ranked high. The rank value of each sub-watershed was added to get a compound value (Cp). Higher compound values of the sub-watershed are assigned low priority in comparison to the lower compound value which is of high priority. Lastly, three is developed to categorize the sub-watershed into high priority, medium priority, and low priority.

The study demonstrates that the sub-watershed of SW46, SW64, and SW65 are highest ranking in priority than the others which means this sub-watershed is more prone to erosion. Where else 34 numbers of sub-watersheds are under medium priority ranking and 42 numbers of sub-watersheds are under low priority ranking.

Drainage patterns of stream network from the sub-watershed have been observed mainly parallel type indicating a hilly catchment. It is further observed that maximum frequency is seen in the case of 1st order stream and it decreases as the stream order increases. However, SW_47 is the sub-watershed that has no River streams on it because of the altitude and the presence of Glow Lake it is isolated from the rest of the watershed.

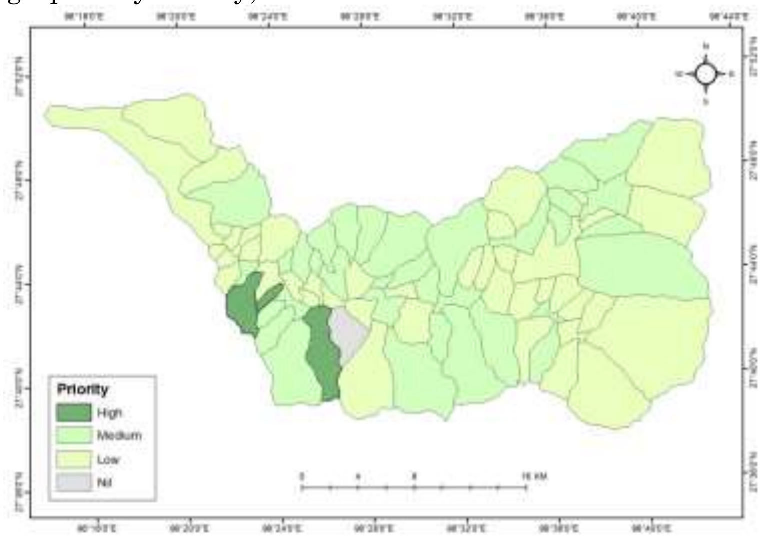

Figure 5: Prioritized map of sub-watershed based on morphometric parameter

Prioritization of Land use / Land covers

prioritization of the sub-watersheds using the land use land cover parameter was carried out by calculating the total area of land use land cover classes under each sub-watershed, where ranking is assigned according to the total area and their relation to erosion. Land use land cover classes such as built-up, agricultural land, snow, and wasteland have a direct relation to erosion, therefore, higher ranks are assigned to the area with the highest value. Similarly higher the area under forest cover class lower the erodiblity so an area with low forest cover was ranked higher than the area with high forest cover. These values were added to calculate the compound value of the sub-watershed, where a higher compound value means the sub-watershed is in lower priority ranking and a lower compound value means the sub-watershed is in higher priority ranking.

Sub-watershed like SW1, SW6, SW8, SW12, SW19, SW20, SW24, SW30, SW34, SW35, SW36, SW48, SW52, SW53, SW54, SW56, SW65, SW62, SW63 are in high priority ranking due to the presence of more area under agriculture, built-up, wasteland and snow which directly interacts to erodibilty, 48 sub-watershed are in medium priority ranking and 42 numbers of sub-watershed are in the low priority ranking this is because this subwatershed are most enclosed with moderate to thick forest.

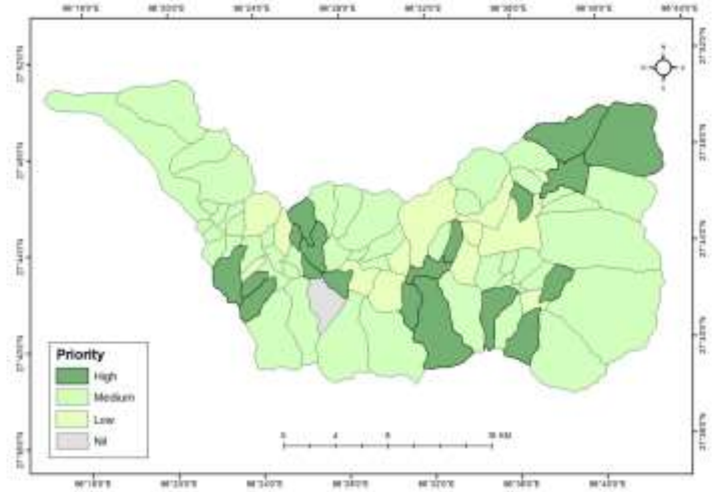

Figure 6: Prioritized map of sub-watershed based on LULC parameters

Prioritization of watershed and Land use / Land covers combined

To find out common sub-watersheds which are in higher priority in both morphometric and land use land cover, results were correlated to understand their relationship. However, the combined result of morphometric and land use/cover analysis shows that only SW65 is in the high priority zone and needs utmost attention with conservation measures than the rest of the sub-watersheds. There is very little or no correlation among the rest of the sub-watershed.

Conclusion

Kamlang River watershed has mountainous topography and some of the areas are covered in snow-clad peaks, it also receives heavy rainfall and wind during the rainy seasons hence using the conventional method of study is difficult in this area. Using remote sensing and GIS techniques, therefore, becomes more suitable to study the morphometry of this watershed. Prioritizing the sub-watersheds with a Quantitative morphometric approach integrated with land use land cover analysis helped in identifying the sub-watershed with are of higher priority which means sub-watersheds with high priority can be taken up for implementation of soil and water conservation measures.

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Bison Sanctuary in Kolhapur District of Maharashtra: A Geographical Perspective

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Abstract

Radhanagari Wildlife Sanctuary is situated in greenly ranges of Sahaydri of Western Ghat in Kolhapur District. Previously jungle of Radhanagri was specially used as favorite hunting spot by the king of Kolhapur Chhatrapati Shahu Maharaj. In the year 1958 this game reserve including places from south and west including Panlet, Olvan, Gaganbawada and Mouje Taliye making altogether 19.61 Sq. Km of an area was declared as Sanctuary for bison and recognized as Dajipur Bison Sanctuary (Reserve Forest). After that by taking into account the importance of diversified forests and occurrence of distinguished wild animals, the Government of Maharashtra and the Revenue Department of forest tried to develop and secure these places by law. Therefore by the Government rule no. WLP 1085 CR/581/V.F.5/ dated 16/09/1985 the jungles of the catchments zone of 'Laxmi Lake' Radhanagari and 'Rajarshi Shahu Sagar' Kalammawadi dam declared as Radhanagri Wild life Sanctuary . Now this Radhanagari Wildlife Sanctuary is famous exclusively for Gaur the Bison and other wild animals. In India it is well recognized. As a result of expansion of Radhanagri Wildlife Sanctuary, even wild animals in Karnataka State are frequently migrating to the Radhanagri Sanctuary. Especially wild Tuskers and Bison are frequently migrating in the forest of Radhanagri. According to 2004 wild life census, there was considerable population of Bison from 395 to 610. The study of Radhanagri Wildlife Sanctuary in that respect is very important. Present paper explains the environmental importance of wildlife in Kolhapur district.

Keyword: Western Ghats, Indian Bison, Wildlife Sanctuary, Reserve Forest etc.

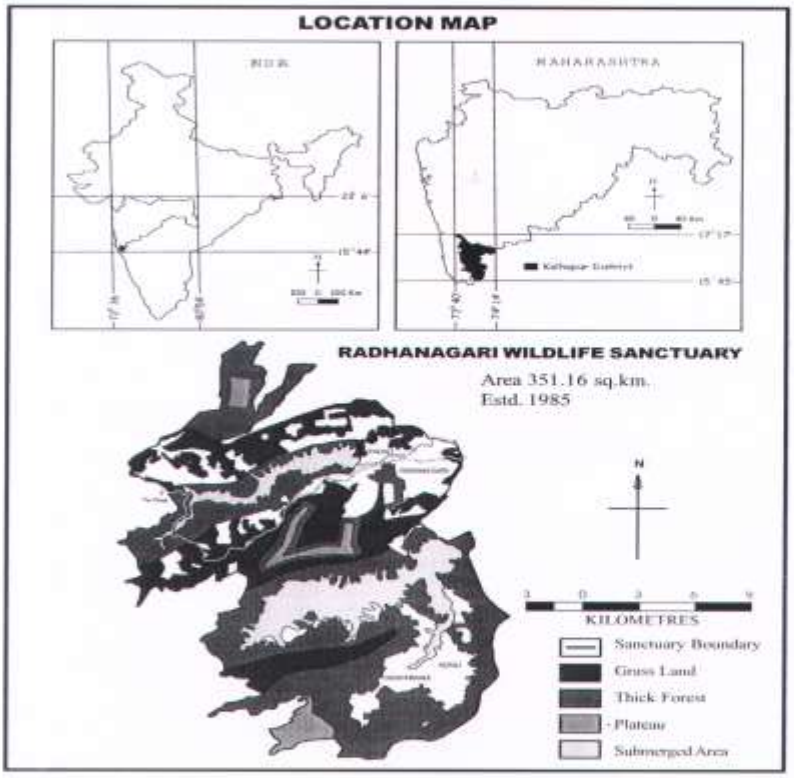
Introduction

As a result of expansion of Radhanagri Wildlife Sanctuary, even wild animals in Karnataka State are frequently migrating to the Radhanagri Sanctuary. Especially wild Tuskers and Bison are frequently migrating in the forest of Radhanagri. According to 2004 wild life census, there was considerable population of Bison from 395 to 610. The study of Radhanagri Wildlife Sanctuary in that respect is very important. The versatile Geographical Environment of Radhanagri Wildlife Sanctuary which includes surface structure, soil, climate, plant and animal diversity which has tremendous scope to look into. In addition the study of Natural Resources i.e. Water, minerals, Flora and Fauna is also having a large scope. In global and national respect management and planning of wild life, plants, soil and forest with its conservation for the development of Radhanagri Sanctuary is very important.

Location And Extension Of The Study Area:

The present paper is restricted to Radhanagri Wildlife Sanctuary which occupies southern and western parts of Radhanagri and Gaganbawada Tahsil in Kolhapur District. Radhanagri Wildlife Sanctuary is 95 km from Kolhapur. Radhanagri Sanctuary is well known among the 35 Sanctuaries in Maharashtra. This is also recognized as Dajipur Reserve Forest. Radhanagri Sanctuary has a slight dumbbell shape and extended in the Bhogavati and Dudhganga basin. It has east – west stretch of about 23 km and north – south is about 31 km. There are two ranges namely Radhanagri (WL) and Dajipur (WL) covering 18336.41 hectare and 9898.29 hectare respectively. Altogether it covers 28234.70 hectare which is 351.16 Sq. Km. according to

the area occupied by the forest it is 23147.50 hectare by Reserve Forest, 4728.59 hectare area is occupied by Protected Forest whereas 358.61 hectare area is occupied by Un-classed Forest.
The area under study lies between 16^0 10' to 16^0 30' North Latitudes and 73^0 52' to 74^0 14' East Longitude, located in the catchments area of Bhogavati and Dudhganga basin. Annual rainfall is about 2500 mm to 5000 mm. Height from the mean sea level is in-between 550 m to 1000 m. (Map: 1)



(Map: 1)

Selection Of Topic:
The selection of the topic is based on the following considerations:
1)Radhanagri Wildlife Sanctuary is situated in greenly ranges of Sahyadri of Western Ghat which is famous for Bison and other wild animals.
2) In the study region, there is an impact of physiographic on Flora and Fauna.
3) For the preservation of the forest some master plan is needed.

Objectives Of The Research:
In view of the above following specific objectives are mainly focused in ongoing study.
To look into the faunal diversity (Wildlife: Animals, Birds, Reptiles etc.) by observations and records.
2) To find the scope of management and planning which is related to soil, forest, and wildlife conservation.
3) To explore and identify the problems resulting from the natural and human interaction with the environment of Radhanagri Wildlife Sanctuary.

Methodology, Database And Sources:
In this study, the biodiversity in respect of plants and animal is considered. Therefore this study is based on exhaustive field survey in this respect the study is conducted as described below:
A field study has been planned with the help of aerial photographs, maps, Google Earth images and records. The observation of plants and animals has been conducted during field work with the use of GPS device.

Database and Sources:
The proposed work is based on primary as well as secondary data.
1) Primary Sources of Data: The primary data has been collected through field work, observation, discussion during field work.
2) Secondary Sources of Data: The secondary data is collected from published records of the Government like Conservator (Wildlife) Division, Kolhapur, Assistant Conservator (Wildlife) Radhanagri Sanctuary, Radhanagri, Ranger (Wildlife)

Dajipur, Ranger (Wildlife) Radhanagri.

It also includes published and unpublished reports and abstracts, journals, books, soil reports and available literature on sanctuaries and forest news bulletin etc.

Socio-Economic Review of Kolhapur District, Statistical abstracts, Census of India, District hand book, Gazetteer of Maharashtra State, Kolhapur district Gazetteer, data regarding weather parameters (Rainfall, Humidity and Temperature) collected from India Meteorological Department (IMD) regional station Kolhapur, Geological and soil data will be collected from the records of the Geological Survey of India (GSI) Department of Geology and mines, Government of Maharashtra State, the Agricultural Department, Groundwater Survey and Development Agency (GSDA) Government of Maharashtra, Remote sensing imageries, Google Earth imageries, Toposheets are the chief tools used for further study.

In the above context and keeping in a view understanding the physiographical characteristics, the Remote Sensing imageries have also been used in conjunction with Geomorphic and Environmental factors obtained from field survey to analyze, detect, by mapping of existing status of plants and animals.

Significance Of The Research Work:

Near about 200 sanctuaries, National Parks and other miscellaneous natural areas have been established in the country to provide protection to wildlife of different categories and to conserve diversified plant species. Sanctuaries having natural habitat provide maximum protection and optimum living conditions to the plants and animals including avifauna (birds) and reptiles. No killing or possession of wild animals is allowed in the sanctuaries except the written permission by the concern authority.

The wildlife action plan was started at national level in 1983 in India with the basic objective to chalk out and due implementation of strategies, programs and projects for the conservation of existing and future wildlife in the protected areas which is increased from the existing 3 to 4% of geographical areas of the country.

Radhanagri Wildlife Sanctuary is one of the important wildlife sanctuaries in India which established in 1985 by the Government of Maharashtra with moderate area under reserve forest i.e. 351.16 Sq. km exclusively for bison. Owing to the location in western ghat this sanctuary has national and global importance in respect to the biological diversity. Therefore there is a wide scope of study the region through conservation and protection point of view.

The data drawn during fieldwork is correlated and verified with existing Biodiversity studies of plants and animals which also give a concrete idea about the integrity between physiography and environmental conditions and biodiversity on the basis of which management and conservation of plants and animals can be checked out. In the context of biodiversity it is very important to conserve such delicate and vulnerable ecosystems to maintain the balance of the biosphere.

Conclusions

In the present paper all concerned objectives are well recognized. The main objective of the present study is to recognize biodiversity of the area by identifying and demarcating the flora and fauna.

Keeping in broad view of the biodiversity of the Radhanagri Wildlife Sanctuary, the following conclusions have been made.

1. In case of plants it is obvious that at the places where water availability is more are having more growth of vegitation e.g. most of the vally floors are nothing but the water supplying channels of the rivers, and tributaries. These channels provide good and suitable habitat for the plant species. Dangs or dense forest patches are another such habitats where the growth of big trees, shrubs, climbers is flourished. The shrubs like Bhoma, Shendri, Jangli, Limbu, Pendri, Karvi are most common species.The places with less water availabity particularly bare rocky lands, plateau tops and some hill slopes are deprived of vigorous growth of vegitation, only some seasonal shrubs and herbs with good growth of grass and weeds are seen.
2. Growth of flora and habitat of fauna has also revealed the impact of physiography. Topographically the region has undulating surface. The plateau tops are with vigorous growth of grasses and stunted vegetation like Jansenella griffithiana, Pogostemon deccanensis, smithia, Uricularia, Eriocaulon, Burmania colestis, Cyprus compressus

are common especially in rainy season. It really a spectacular experience to see the flowirng of such plants in mid rainy season. By vertue of deposition of weathred soil on flank slopes of the hills and plaesus the vigorous growth of species lilke kalvan , jambha , shisvi seen on the slopes. Plain areas and valley floor are shown good growth of all kinds of trees forming mix woods with Jamun, Mango, Anjani, Hirda, Surangi and Par Jambul. Zulumb is a common species of plants at altitude under 700 m above mean sea level. Haldiya and Pandhara boke are dominated over 700 mts.

3. The Bison is the flagship species of this sanctuary along with the presence of Tiger, Panther, Sloth Bear, Giant Squirrel, Mouse Deer, and Barking Deer etc. Based on the data of population estimation and observation by the fieldwork, the pattern of distribution of various major animals in the protected area is arrived. Panther are found throughout the protected area, Tiger is found in Geezekada, Nanivale, Surangee and Waghche Pani, Shelapche Pathar, Bamaber area only. Bison, Sambar, Barking eDeer, Wildboar, Mouse Deer are found throughout the protected area in varying degrees. Sloth Bear is found in Geezekada, Nidankhan, Kaladang, Waghbamabar area of rocky broken country where they can get shelter in the form of caves and dens. Bison and Sambar are essentially animals of hilly area. Barking Deer prefers hilly and wooded country where dens undergrowth is available. Mouse Deer prefers grass covered rocky hill site. Giant Squirrel is found in Surangee area, Patacha dang and Kala dang. If we see the biodiversity gradient of the sanctuary, it is found that the core areas have more faunal habitat and it is less towards the flanks of the sanctuary.

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Crop Diversification in Ahmednagar District (MH)

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Abstract

In Ahmednagar district found variety of crops like rice, Jawar, wheat, Bajara, maize, sugarcane, cotton, pulses and oilseeds and recently horticultural crops. Indian horticulture sector contributes about 33% to the agriculture Gross Value Added (GVA) making very significant contribution to the Indian economy. Apart from ensuring nutritional security of the nation, it provides alternate rural employment opportunities, diversification in farm activities, and enhanced income to farmers. India is currently producing about 320.48 million tons of horticulture produce which has surpassed the food grain production, that too from much less area (25.66 million Ha. for horticulture against 127.6 M. ha. for food grains). Productivity of horticulture crops is much higher compared to productivity of food grains (12.49 tonnes/ha against 2.23 tonnes/ha.). India has emerged as world leader in the production of a variety of fruits like mango, banana, guava, papaya, sapota, pomegranate, Lime & aonla and is the second largest producer of fruits and vegetables. Besides, India has maintained its dominance in the production of spices, coconut and cashewnut. Among the new crops, kiwi, gherkins, kinnow, date palm and oil palm have been successfully introduced for commercial cultivation in the country. Ahmednagar district has significant production of horticulture and around 312879 hectare (2021) areas under the cultivation of fruit, vegetables, and flowers in horticulture.

Keywords: Horticulture, Crop diversification.

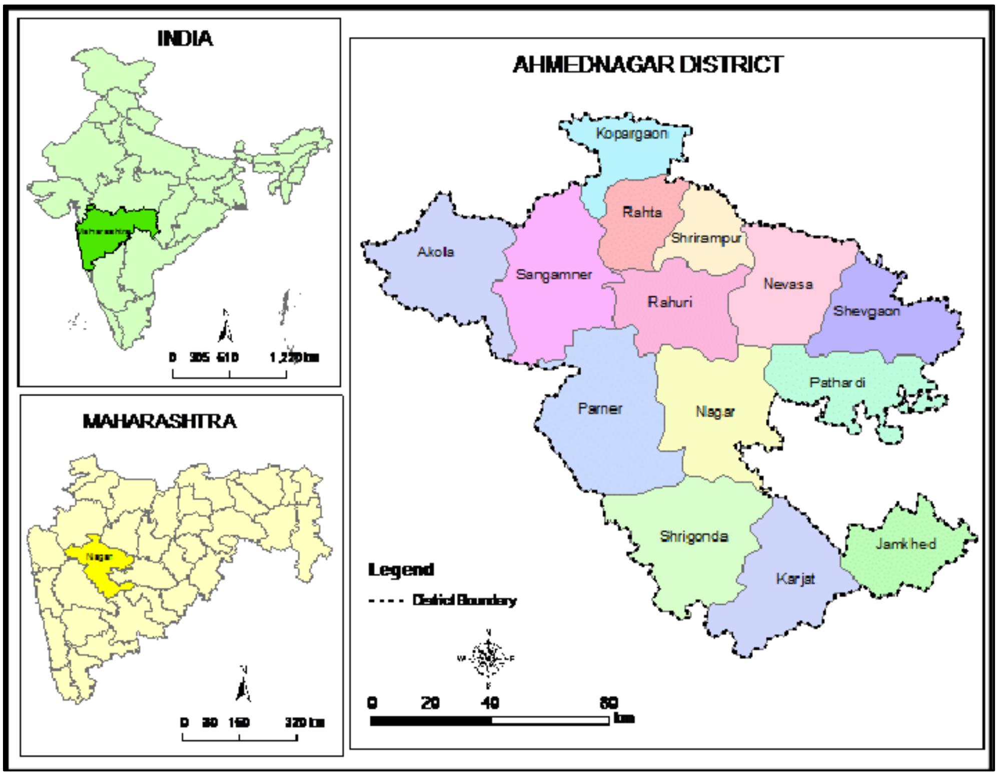
Objectives:

1. To study in Crop diversification in the study area (2020-21).
2. To study causes of Crop diversification in the study area.

1. Introduction:

Ahmednagar is the largest district of Maharashtra State with geographical area of 17418k.m. which is 5.66% of area of Maharashtra State. Out of total areas 391.5 sq. k. m. is urban area and remaining 16,656.5 sq. k. m. is rural area. Ahmednagar is centrally located in western Maharashtra. In Ahmednagar district there were 14 blocks or tehsils, 1,581 villages and 1,308 gram sabhas. The Ahmednagar district is laid between 18^0, 2' to 19^0, 9' North latitude and 73^0, 9'to 75^0.5' East longitude, and is bounded on the north by Nasik district, on the north east by Aurangabad district, in the east by Beed and Osmanabad, on the south by Solapur and in the south west by Thane and Pune district. The region has irregular shape and has 200 kilometers a length and width of 210 kilometers on 17,048 square kilometers area and having a population of 4,543,159 persons in 2011 accounting 5.5 percent area of Maharashtra state. In study region density was 266 persons per sq. kilometer. The sex ratio was 939 females per thousand males; literacy was 79.05 percent accounting urban literacy (87.57 percent) and rural literacy (76.89 percent). The growth of population from 2001 to 20011 was 12.44 percent. The study region has 46.48 percent cultivators, 22.28 percent agricultural labours and remaining 31.24 percent workers engaged other than agriculture sector. According to physiographical set up, study region is divided into three regions, namely, Sahyadri hill ranges, namely, Kalsubai, Adula, Baleshwar and Harishchandragad, Plateau and plains drained by Godavari and Bhima rivers. Average rainfall receives 575.8 mm. The mean daily maximum temperature is 39° centigrade's and means daily minimum temperature is 11.7° centigrade. The deep black soil, medium black soil, gray soil and red soil appear in study region. 71.10 percent area is found under cultivation and irrigation accounts 32.40 percent. The major crops, namely, Jawar, wheat, Bajara, maize, sugarcane, cotton, pulses and oilseeds and recently horticultural crops are cultivated in study region.

Sr.no.	Taluka	Rice	Wheat	Jawar	Bajara	onion	Total %	No.of crops	ICD
1.	Akole	99.79	-	-	-	-	99.79	1	99.79
2.	Sangamner	-	-	-	17.50	-	17.50	1	17.50
3.	Kopergaon	-	-	-	-	-	-	-	-
4.	Rahata	-	-	-	-	-	-	-	-
5.	Shrirampur	-	-	-	-	-	-	-	-
6.	Newasa	-	-	-	-	-	-	-	-
7.	Shevgaon	-	10.28	-	-	-	10.28	1	10.28
8.	Pathardi	-	10.60	-	11.97	-	22.97	2	11.48
9.	Nagar	-	-	14.82	-	10.40	25.22	3	12.61
10.	Rahuri	-	-	-	-	-	-	-	-
11.	Parner	-	-	17.50	20.76	19.11	57.37	3	19.12
12.	Shrigonda	-	-	11.66	10.79	15.42	37.87	3	12.62
13.	Karjat,	-	-	19.57	11.69	-	31.26	2	15.63
14.	Jamkhed,	-	-	15.65	-	-	15.65	1	15.65



Mr. Kiran Kundlik Sasane, Dr. Sanjay Sangale

Methodology:
The present study with the help of Secondary Sources.

3. Crop diversification (Jasbir Singh Method):

$$\text{Index of Crop Diversification} = \frac{\%\text{ of total croped area under 'n' crops}}{\text{Number of 'n' crops}}$$

Crop Diversification in Ahmednagar District: 2020-21

Socio-Economic Abstract Ahmednagar District

Where,

'n' crops are those crops that individually occupied 10% or more of the cultivated area in

Crop Diversification Index

Conclusion

Based on index values, the blocks have been grouped into

High diversification - Table shows that the Areas of high diversification were observed in Nagar, Parner, Shrigonda were in 3 crops

Medium diversification- Medium diversification was observed in Pathardi, Karjat tehsil cropped 2 crops.

Low diversification-Whereas area of low diversification were found in Akole, Sangamner, Shevgaon, Jamkhed tehsil are cropped only 1 crop.

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Analysis of cropping pattern in ghod irrigation project of pune district in western Maharashtra

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Abstract :-

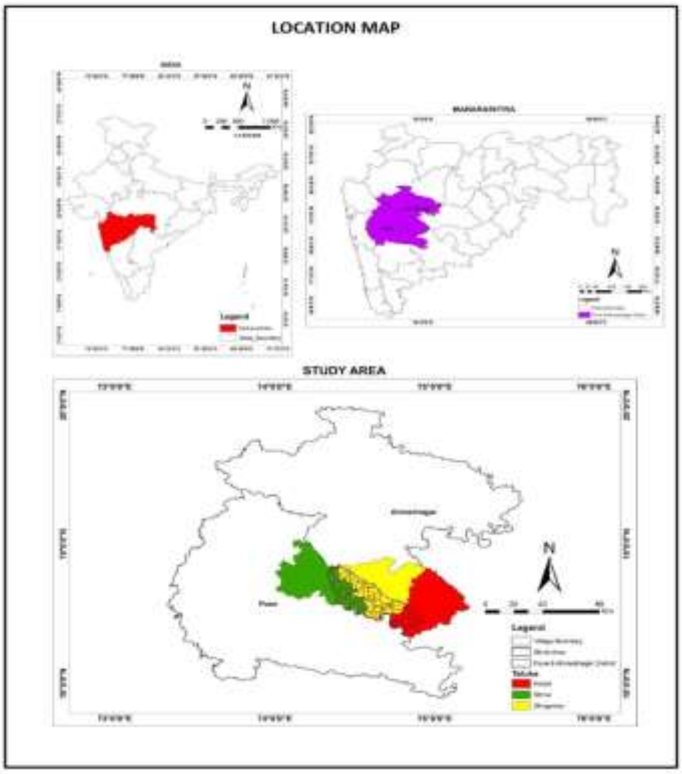
Agriculture plays an extremely important role in the Indian economy 64% of the total population of India is dependent on direct agriculture Indian Agriculture After independence, construction of large and medium-sized dams was emphasized to increase irrigation facilities, but 45% of the water released from the dams through canals is wasted before it reaches the fields, 17% of the water is wasted before it reaches the crops, resulting in a total wastage of 62% of the water .Agriculture productivity is high in irrigated area it is more than ten time as compere to Dry area The Shrigonda, Karjet of Ahmadnager District and shirur of pune District is selected for the present study .this area lies in drought prone zone of western Maharashtra so irrigation control the agriculture development therefore it's important to study the cropping pattern in ghod irrigation project commend area of Pune and Ahmadnagar district .the present study is based on distribution of varies crop and crop production in different period .

Introduction :-

"Water is the elixir of life" Due to the water in the dam, despite the low rainfall in the shrigonda ,karjet taluka of ahmadnagar district and shirur of une district , a large area is irrigated through the canal. Due to this, the crop pattern of the region is changing. Therefore, the economic and social situation in this region is changing, if the dam is not filled to its full capacity, it has a large effect on the benefit area. Agriculture plays an extremely important role in the Indian economy 64% of the total population of India is dependent on direct agriculture Indian Agriculture Tea Coffee Spices Mangoes Grapes Cashews Tobacco Cotton etc. Agricultural commodities are exported from India Irrigation schemes are important for the development of agriculture in the drought prone regions of Maharashtra About the total area under cultivation in the state of Maharashtra is about 18% of the area is under irrigation After independence, construction of large and medium-sized dams was emphasized to increase irrigation facilities, but 45% of the water released from the dams through canals is wasted before it reaches the fields, 17% of the water is wasted before it reaches the crops, resulting in a total wastage of 62% of the water. It is necessary to do and it is necessary to use modern irrigation methods such as drip irrigation, frost irrigation in agriculture. Drought can be considered as an effect of rainfall, temperature, wind, sunlight, soil texture, soil moisture etc. The result of the interaction of these variables is an unfavourable balance between available soil moisture and evapotranspiration. Drought is a natural part of the climate, although it can be mistakenly considered a rare and random event. Drought differs from aridity, which is limited to regions of low rainfall; It can occur in any climate zone, but its characteristics vary considerably from one region to another. Drought is a lack of precipitation over an extended period of time, usually for a season or longer in ecological regions where water is scarce. Droughts are classified as climatic, agricultural, hydrological and socio-economic as suggested by India Meteorological Department. Drought is defined as less than normal rainfall during a particular period. Also, if there is no availability of water in the soil for the growth of crops and fodder, it is called agricultural drought. Drought is primarily an agricultural phenomenon that refers to conditions where plants respond to specific levels of moisture that affect plant growth and crop yields. As a result of the usual hydro-meteorological variability, drought occurs in the pre-monsoon season when potential evapotranspiration exceeds available moisture due to rainfall uncertainty, while prolonged dry periods in the post-monsoon season lead to drought. Also due to sudden rise in temperature and non-availability of rainfall, evaporation increases resulting in drought conditions. Definitions of drought have been proposed by many scholars. "Drought" is a "dry weather term" (Tannehill, 1947).Carter (1955)

2. Location of the study area

Geographical location of the study area is 18°30' to 18°45'N latitude and 74°15'. It lies in 75°00'E longitude. The height of the region ranges from 494 to 634 meters and the entire region is included in the Deccan Plateau. According to the geographical position of Maharashtra, this region is in western Maharashtra. The area of this division is 143000 hectares. Shrigonda and Karjat ta of the study area are bordered by Jamkhed to the east, Parner to the north, Daund to the south and Khed to the east of Shirur tehsil. But for the study, 59377.23 hectares of Srigonda taluka, 35484.11 hectares of Karjat taluka and 48138.95 hectares of Shirur taluka of Pune district under Ghod right canal have been selected for the study. The Shrigonda and Karjet of the Ahmadnagar District and shirur of the pune District Selected for the present study the Shrigonda and Karjet tehsil located in the south ahmadnagar and shirur is north east of pune district. the headquarters of the tehsil Shrigonda ,Karjet and shirur is 70 km from District



3.

Objectives:-

1. To study the changing cropping pattern from different period of time
2. To study the relation of irrigation and crop production
3. To study the agriculture practices and its impact on economic development
4. Database Methodology:-

The present study is based on changing cropping pattern of Shrigonda ,Karjet and shirur tehsil ghod dam constructed in 1965 and most of this area is covered in non-agriculture and Arable agriculture after ghod irrigation agriculture development and cropping pattern change and as the amount of pump irrigation has increased farmer have reduce crop under cereals and increase production of onion, sugarcane and fruit orchards after electrics motor and pipelines the area of irrigation increased .this study is based on village cropping data collected by tehsil agriculture office. Total area under cultivation and net sown area change after 2000-2001 we have use GIS technique to show crop distribution and its relation to irrigation

5.Cropping pattern

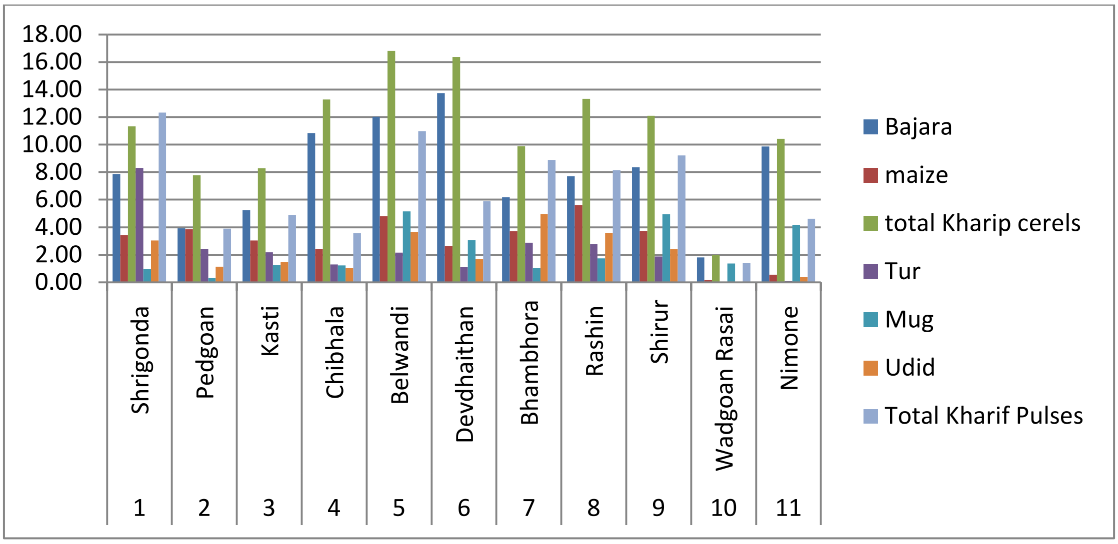
The proportion of irrigated area is higher during Kharif and Rabi period which is 84% of totalarea Only 4.8% of the area is under annual irrigation. However, high ground water levels in the canal area have led to an increase in agricultural income.the study region is under the rain shadow or drought prone area of Maharashtra. The amount of average rain fall was 985.8 mm in year 2018. the study region received low to moderate rain fall.so irrigation facilities is important for agriculture development. irrigation system is used to increase production, 60 to 65% water is saved and production is increased by one and a half to two times. Farmers should make efficient use of modern technology in disaster situations. The use of drip irrigation, sprinkler irrigation, etc. to meet the water requirement for agriculture increases productivity and water saving. This increases the productivity of agriculture. Importance and contribution of irrigation in agricultural productivity: The population is increasing day by day. The area available to the growing population for food is not enough. So you want maximum production in less area. There is a difference in productivity as there is not even rain in all places. In such cases, there is no alternative but irrigation to increase the productivity of agriculture. , it is indicated that when the irrigation system develops. Then the employment opportunities also increase. Because with the help of irrigation we can get 2 or 3 crops in 12 months. Irrigation also improves the soil surface and hence the production capacity also starts increasing. And we will reduce the suicide rate of farmers which is increasing everywhere. Water supply to the area available in short time due to lack of electricity: In rural areas the load shedding of electricity is 12 to 14 hours so the farmer gets only 10 to 12 hours for water supply. It is not possible to supply water to the gold field during that period. So if we use sprinkler or drip irrigation at such a time, we can overcome the problem of electricity. Water can be supplied to agriculture in less time and with less water. Therefore, soil moisture is not lost. Her quality remains good. Will remain in the safe. Farmers should use irrigation to meet their water needs. Farmers who have wells. They should buy irrigation kits not only to save the crop in drought conditions. So in the next 10 to 12 years it will be to increase the area under irrigation. Due to the reduction of soil erosion, the cycle of nature as well as the use of mulch can evaporate the moisture in the soil and the distance between two layers of water can be reduced by 80 to 90%. 20 to 29% water saving for mulching. Nearly soybean husk. Or use plastic film. Covering the remaining part of the crop increases the amount of organic carbon in the soil. It also creates a nutritious environment.

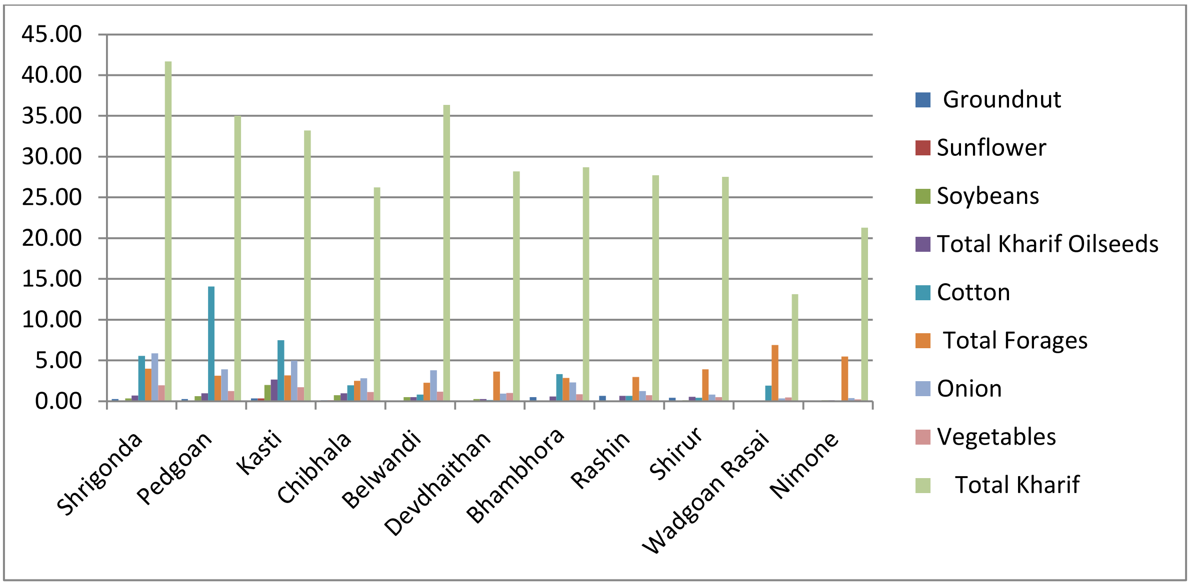
Sr.no	Mahasul M	Bajara	maize	total Khari	Tur	Mug	Udid
1.00	Shrigonda	7.87	3.44	11.32	8.30	0.97	3.05
2.00	Pedgoan	3.91	3.86	7.77	2.43	0.32	1.14
3.00	Kasti	5.24	3.04	8.28	2.18	1.26	1.47
4.00	Chibhala	10.85	2.43	13.28	1.30	1.22	1.04
5.00	Belwandi	12.02	4.79	16.81	2.15	5.15	3.68

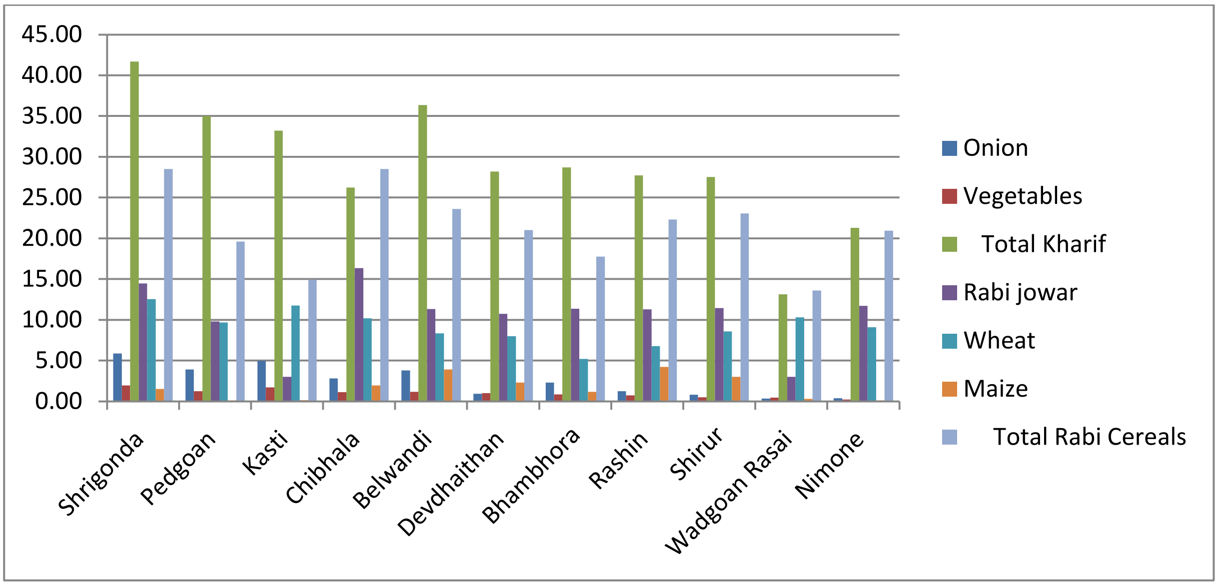
6.00	Devdhaith	a 13.73	2.64	16.37	1.12	3.07	1.69	
7.00	Bhambhor	6.18	3.71	9.89	2.87	1.04	4.97	
8.00	Rashin	7.71	5.61	13.32	2.79	1.74	3.61	
9.00	Shirur	8.36	3.75	12.10	1.88	4.94	2.40	
10.00	Wadgoan	R 1.82	0.19	2.01	0.02	1.37	0.03	
11.00	Nimone	9.86	0.55	10.41	0.08	4.18	0.36	
Mahasul M	Total Khari	Total Khar	Groundnu	Sunflower	Soybeans	Total Khari	Cotton	Total Fora
Shrigonda	12.32	23.64	0.28	0.08	0.33	0.68	5.58	3.98
Pedgoan	3.89	11.67	0.28	0.05	0.62	0.96	14.08	3.14
Kasti	4.91	13.19	0.33	0.34	2.01	2.67	7.48	3.18
Chibhala	3.57	16.85	0.13	0.11	0.74	0.98	1.96	2.50
Belwandi	10.97	27.78	0.00	0.00	0.51	0.51	0.83	2.27
Devdhaith	5.89	22.26	0.00	0.00	0.28	0.28	0.13	3.63
Bhambhor	8.88	18.77	0.50	0.06	0.03	0.60	3.32	2.84
Rashin	8.14	21.46	0.65	0.01	0.00	0.65	0.65	2.96
Shirur	9.22	21.33	0.43	0.01	0.11	0.55	0.44	3.90
Wadgoan	1.42	3.42	0.02	0.01	0.06	0.09	1.90	6.91
Nimone	4.63	15.04	0.00	0.01	0.12	0.13	0.03	5.47

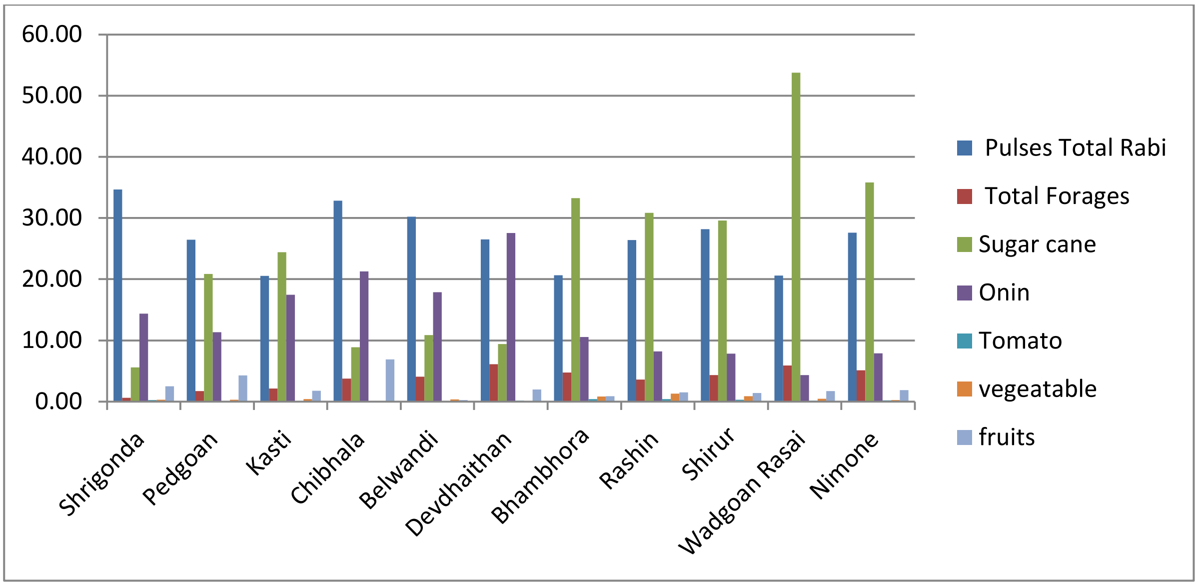
Mahasul M	Onion	Vegetables	Total Kha	Rabi jowar	Wheat	Maize	Total Rabbi	Total Rabi
Shrigonda	5.89	1.93	41.71	14.45	12.55	1.51	28.51	6.13
Pedgoan	3.93	1.25	35.01	9.81	9.69	0.11	19.61	6.83
Kasti	4.97	1.72	33.20	3.01	11.77	0.16	14.93	5.60
Chibhala	2.81	1.15	26.25	16.36	10.18	1.97	28.52	4.31
Belwandi	3.79	1.17	36.35	11.33	8.35	3.92	23.60	6.63
Devdhaith	0.92	0.99	28.21	10.73	7.99	2.31	21.03	5.49
Bhambhor	2.29	0.87	28.68	11.37	5.23	1.18	17.77	2.85
Rashin	1.25	0.73	27.70	11.31	6.78	4.21	22.30	4.11
Shirur	0.83	0.49	27.54	11.46	8.59	3.01	23.05	5.13
Wadgoan	0.34	0.46	13.13	3.01	10.29	0.31	13.62	6.99
Nimone	0.40	0.23	21.30	11.74	9.10	0.10	20.93	6.68
Mahasul M	Pulses Tot	Total Fora	Sugar cane	Onin	Tomato	vegeatable	fruits	total Rabbi
Shrigonda	34.64	0.61	5.57	14.39	0.25	0.32	2.51	58.29
Pedgoan	26.43	1.71	20.88	11.35	0.01	0.31	4.29	64.99
Kasti	20.53	2.13	24.42	17.44	0.08	0.43	1.74	66.80
Chibhala	32.83	3.77	8.90	21.30	0.00	0.04	6.91	73.75
Belwandi	30.23	4.07	10.87	17.90	0.00	0.33	0.25	63.65
Devdhaith	26.52	6.10	9.39	27.57	0.15	0.10	1.98	71.79
Bhambh	20.62	4.76	33.25	10.57	0.38	0.81	0.88	71.32

or								
Rashin	26.41	3.60	30.86	8.20	0.40	1.31	1.51	72.30
Shirur	28.19	4.32	29.58	7.83	0.29	0.87	1.38	72.46
Wadgoan	20.61	5.88	53.76	4.31	0.12	0.46	1.73	86.87
Nimone	27.61	5.10	35.80	7.90	0.20	0.23	1.86	78.70









Finding:-

Above graph show Predominance of food crops such as jowar, Bajara, wheat, maize etc. is observed in the rain shadow region of Maharashtra, but despite the area selected for the study falling in the rain shadow region, but as result of irrigation various types of crops are found in this region. Through the study it was observed that onion area is 5.89 % in Shrigonda revenue circle and lowest in Vadgaon and Nimone revenue circle .40%.

Bajra ,maize, toor mug udid crops are 12.2, 4.79, 16.81, 2.15, 5.15, 3.68 respectively in Chimbla revenue circle while Vadgaon revenue circle has the lowest percentage of food grains crop is less than 2 % as this area is served by two means of irrigation namely river and canal. Sugarcane is the highest in this place. In all the revenue circles, the amount of oilseed crops is less than 1 % and the amount of orchards is increasing day by day.

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*P*hysical and Chemical Properties *of Water in Rahuri Tahsil of* Ahmednagar District (M.S.)

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Abstract

Water quality assessment of Rahuri tahsil in Ahmednagar district has done in Maharashtra State, India. This paper aims to study the physical and chemical properties of water of Rahuri and its surrounding area. The physical parameters included Temperature, Total dissolved solids and electrical conductivity. The chemical parameters included pH, total hardness, calcium hardness, magnesium hardness, Phenolphthalein alkalinity, total alkalinity. Ionic parameters like chloride, phosphate, sulphate, calcium, magnesium, sodium, potassium, iron, chromium and manganese. Also, the biological parameters studied standard plate count and most probable number.

Keywords: Physico-Chemical Parameters, Permissible Limit, Chemical Standards of Drinking Water.

Introduction

Water is the most precious resource because the life of animals and plants depends on it. Most industries also require water for various applications, so the global economy depends on it. Springs are the places where ground water is discharged at specific locations on the earth and they vary dramatically as to the type of water they discharge. Many of the springs are the result of long cracks or joints in sedimentary rock. (Young, 2007) Hot springs are defined as springs where the temperature of water lies significantly above the mean of annual air temperature of that region. (Thompson, 2003 and Young, 2007) Hot ground water can be used to drive turbines and generate electricity, or it can be used directly to heat homes and other buildings. Energy extracted from the Earth's heat is called geothermal energy. (Thompson and Turk, 2005)

Water is one of the abundantly available substances in nature. It is essential constituent of all animal and plants material and forms about 75% of matter of earth crust. It has been argued previously that geochemical energy-yields may be a key determinant of microbial community structure and diversity in thermal environments (Amend and Shock, 2001) Rainfall, an important and largest source of water, other sources are surface water and sub-surface water or ground water. (Sharma B.K., 2001)Water is mostly important for industrial and municipal purposes. In addition to the direct consumption of water at homes and farms, there are many indirect ways in which water affects our daily life.

The physical, chemical and biological composition of water is influenced to a great extent by different factors including climate, geomorphology and geology. Also the physical variables which include temperature and turbidity; chemical variables in that non-toxic variables such as pH, total dissolved salts, salinity, conductivity, ions, nutrients, organic matter and dissolved gases and toxic variables like biocides and trace metals. The objectives of the present work are to analysis and discuss the suitability of water for drinking and sanitation.

Study Area

The Rahuri Tehsil in Ahmednagar district of Maharashtra has been selected for the present investigation work. The tehsil comprises of 95 villages and two urban centers spread over an area of 1, 00,898 hectares. The geographical extension of the study area is form 19°15' N to 19°34' North latitude and 74°23' E to74°50'

East Longitude. The Rahuri tehsil lies in the rain shadow zone of the Western Ghats in Mula and Pravara basin.

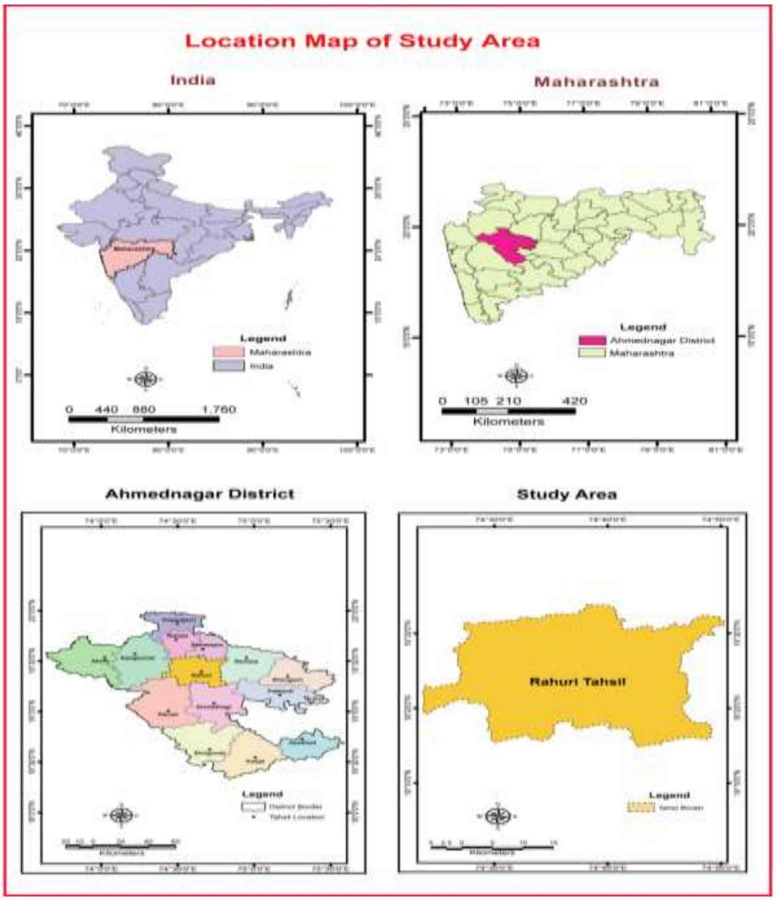

Figure: Location Map of Study Area

Sampling Methods

The water quality parameters estimated by the standard methods given by APHA (1998). For the present investigation groundwater samples were collected every month during the study year from June 2013 to May 2014 from 32 different sampling stations of Rahuri tehsil. The water samples collected from the Rahuri Tahsil and taken inpre-cleaned polyethylene bottle. Water temperature recorded immediately on the site by mercury thermometer. TDS of water samples measured using gravimetric method. Dissolved oxygen was estimated by the method of Winkler method. EC values of the water sample under investigation were measured using Digital Conductivity meter. The pH value of water sample measured by using Digital pH meter.

The total hardness of the water sample was determined by complex metric titration with EDTA using Erichrome black T as an indicator. The calcium hardness and calcium of the water sample were determined by complex metric titration with EDTA using Murexide as an indicator. Phenolphthalein and Total alkalinities of the water samples were determined by titrating with H_2SO_4 using phenolphthalein and methyl orange as indicators.

Result and Discussion

A total of 32 samples were collected from 32 villages of Rahuri tehsil of Ahmednagar. Among these villages, 4% drinking water samples from two locations contain 1 mg/l of fluoride, 96% of the samples contain fluoride 0.5 mg/l. The results indicate that the fluoride content in all the sampling stations was found within the permissible levels as per WHO standards.

- **Hydrogen Ion Concentration (pH)**

The average of pH noted from 32 villages of Rahuri tehsil. Water sample is 8.77as maximum and minimum 5.1 was observed.

- **Electrical conductivity (EC)**

The average of Electrical conductivity recorded from 32 villages of Rahuri tahsil. Of it water sample is 4.53 uS/cm as maximum and 0.16 uS/cm as minimum recorded.

- **Total Dissolved Solids (TDS)**

The average total dissolved solids observed from 32 villages of Rahuri tehsil. From water sample are 690 mg/L as maximum in pre-monsoon and 110 mg/L as minimum in post monsoon. Total dissolved solids are above the permissible limiting 500 mg/L recommended by WHO.

Asrari et al. (2008) measured the TDS minimum 50mg/L and maximum 3575 mg/L from Kor River, Iran. The amount of TDS related with increasing dissolved ions.

Temperature

The water temperature noted from 32 villages of Rahuri tehsil, it 28.5^{o}C in pre-monsoon as maximum and 27^{o}C in post-monsoon season. Jaybhaye et al. (2008), reported water temperature ranged from 22.5-32.5^{0}C from Kayadhu river, near Hingoli during January-December 2004.

Dissolved Oxygen

The average dissolved oxygen obtained from 32 villages of Rahuri tehsil of water sample is 0.9 mg/L maximum and 0.2 mg/L minimum with the mean value of 0.49 mg/L.

Yannawar VB and Bhosale AB (2013), achieved value of dissolved oxygen varied from 2.0, 1.12, 1.8 and 1.64 in S1, S2, S3 and S4 respectively from the selected sites. The lower dissolved oxygen due to organic contamination near sources to water.

Hardness

The average hardness obtained from 32 villages of Rahuri tehsil of water sample is 310 mg/L maximum and 80 mg/L minimum with the mean value of 80 mg/L.

Singh et al. (2005), found hardness level as 243 mg/L, 180 mg/L and 149 mg/L during June 1999 from the wells, springs and the rivers respectively in Udhampur, Jammu and Kashmir. Also they found hardness 194 mg/L, 179 mg/L and 146 mg/L in October 1999 from same water sampling sites.

Calcium

The value of calcium observed from 32 villages of Rahuri tehsil of water samples are 198 mg/L maximum and 5.6 mg/L minimum in pre and post-monsoon respectively. The mean calcium hardness was 33.1 mg/L.

Vijayakumar et al. (2005), observed calcium ranged from 8.60 – 94.10 mg/L 75.25 – 124 mg/L in surface and sub-surface water of Bhadra River respectively.

Phenolphthalein Alkalinity (PA)

The phenolphthalein alkalinity of 32 villages of Rahuri tehsil of water sample is below detectable limit in pre-monsoon and 1885 mg/L maximum and minimum 267 mg/L. Average value of phenolphthalein alkalinity 596.9 mg/L.

Approximately of the aquatic characteristics stay lower the accepted edge in the post-monsoon period and some are upstairs the acceptable limits in pre-monsoon season. This might be due to dilution of water by raining. Simmular remarks are observed by Yannawar et al. (2013).

Conclusion

On the basis of above discussion, it is concluded that the water quality assessment of Rahuri Tehsil in Ahmednagar district in Maharashtra. It reveals that although the situation is not worst but it has to be maintained. Some of the water characteristics are below the permissible limit in the post-monsoon season and some are above the permissible limits in pre-monsoon season. This may be due to dilution of water by raining. Complete study showed that the water is more polluted in pre-monsoon as compared to post-monsoon.

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Educational Status of Schedule Caste and Schedule Tribes a Comparative Study of Nashik District in Maharashtra

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Abstract:

India having a high tribal population country. In which near about 8.6 percentage tribal population, as well as scheduled cast population. India considers it impossible to cross the education between the Scheduled tribe and Scheduled cast communities. The both community faces a lot of problems due to its unprotected and deprived status, with numerous aspects in which education is one of the important issues that makes them more unprotected and deprived.

Tribal community and scheduled cast community wellbeing over a span of time is in a state of on-going dialogue and deliberation. Tribal educational problems, poor physical facilities, expensive schooling, lack of teaching staff etc. These are the basic challenges in tribal area in specific, tribal societies in overall and primeval tribal groups are particularly unprotected and deprive about education. They still may not have the requisite access to basic education services. Secondary data is collected on various aspects education system data collected from Nashik district handbook2009-10. The current paper aims to illustrate the different aspects of the tribal education and development program available in the study areas.

Key Words-*Tribes, Education Status, Health Program.*

Introduction:

Education system in India- opportunities and challenges for improvements, the Indian education system is at a four stage, the first is lower primary (age 06 to 10), second stage upper primary (11 to 12), high (13 to 15) and last higher secondary (17 to 18). They emphasised the need to develop education facilities, especially for the unprotected, scheduled cast and scheduled tribes are socially and culturally poorer and also living in remote area. They belong in agricultural economy and generalised backwardness under below poverty. This is due to their poor education, and is a source of suffering and a result of it. Inequality of the education system and the radical insecurity of the masses are the main barriers to good health. Illiteracy of tribal society the potential to learn, what is the education productivity, revenue and investment in education, leading to low quality life and thereby continuing poverty. Scheduled cast and scheduled tribes has no basic educational services and a greater number of tribal residents living below the poverty line. For their safety, there's an immediate need to work on them. Given the budgetary provision of public money rating for their schooling in belated to wipe out the race due to perfectly poor physical facilities, expansive schooling and lack of teaching staff existing in the whole tribal areas due to in accessibility of timely quality education and government funded quality educational program.

Study Region:

Nashik district consist of 15 tehsils, namely Malegoan, Nandgaon, Nashik, Niphad, Peint, Baglan, Sinnar, Surgana, Trimbakeshwar, Chandwad, Devala, Dindori, Igatpuri, Kalwan, and Yeola. The main Sahyadrian range runs across north to south on the western portion of this district.Selbari range approximately forms the boundary between Nashik and Dhule districts. Nashik is located at an altitude of 600 meter above mean sea level. The study mainly emphasises to focus on tribal tehsils of Kalwan (20º29'25" N latitude and 74º01'35" E longitude),Dindori (20º12'00" N latitude and 73º49'59" E longitude), Peint (20º15'30" N latitude and 73º30'11" E longitudes), Surgana (20º34'12" N latitude and 73º37'12" E longitude) and Trimbakeshwar (19º55'56" N latitude and 73º31'51" E longitudes) in Nashik district.

Objectives:

1. Find out the availability and adequacy of education system in study areas.
2. To search cause analysis of education status in scheduled cast and scheduled tribe.
3. To develop and improve the framework of educational policy for scheduled cast and scheduled tribe.

Methodology and Data Analysis:

The Nashik District is taken as a unit to determine the level of education level in the field of research. Tehsil has a Schedule cast (SC) and Schedule Tribe (ST) population known as a tribal tehsil for more than 50% of its total population. The present research paper is based on a secondary data source. Secondary data is collected from the Handbook of Nashik District Census(2010) Data has been analysed on the basis of population norms and make tabulation with graph and diagrams, map cartography and digitisation of tribal educational status availability with in their areas are also examined.

Table – 1: Population Data

Sr. No.	Tahsils	Backward Population						Backward population Percentage of total population	
		Scheduled Cast			Scheduled Tribes			Scheduled Cast	Scheduled Tribes
		Total	Male	Female	Total	Male	Female		
1	Surgana	909	453	456	137602	68969	68633	0.63	94.81
2	Kalwan	5803	2998	2805	108955	54464	54491	3.50	65.79
3	Devala	11914	6134	5780	21354	10894	10460	9.17	16.43
4	Baglan	17178	8730	8448	107288	54488	52800	5.52	34.45
5	Malegav	41592	21157	20435	65769	33392	32377	5.27	8.33
6	Nandgav	32498	16603	15895	26997	13846	13151	13.75	11.42
7	Chadwad	18883	9654	9229	36945	18632	18313	9.20	18.01
8	Dindori	16187	8299	7888	139033	70526	68507	6.11	52.52
9	Peth	796	429	367	89926	45007	44919	0.82	92.92

10	Trimbak	7399	3789	3610	106315	53432	52883	5.42	77.93
11	Nashik	165399	84809	80590	131132	67857	63275	12.56	7.95
12	Egatpuri	20904	10687	10217	86370	43675	42695	9.16	37.85
13	Sinnar	20477	10413	10064	35456	17946	17510	7.01	12.14
14	Nifad	44067	22716	21351	79751	40351	39400	10.02	18.13
15	Yeola	22510	11473	11037	21378	10792	10586	9.56	9.08
Total		**426516**	**218344**	**20812**	**119421**	**604271**	**590000**	**8.54**	**23.92**

Source - Handbook of Nashik District Census (2010)

Population is an important factor in the development process. Population is considered to be a kind of resource and hence it is highlighted factor in integral development process. Since the number of tribal is relatively high in Nashik district, this paper has taken the secondary data to study the educational status of tribal community. We are taken total population of 15 talukas of Nashik district; the highest percentage of Scheduled Caste is found in Nandgaon which is 13.75% and the lowest percentage is found in Surgana – 0.63%. Peth, surgana and kalwan talukas having below 5 percentage population of scheduled cast. Deola, Baglan, Malegaon, Chandwad, Trimbark Igatpuri, Sinnar and Yewla talukas there are between 5 to 10 percent SCs population. more than 10% are Nashik, Niphad and Nandgaon talukas. Similarly, more than 90% of Scheduled Tribes are population found in Surgana and Peth two talukas and above 60% in Kalwan and trambak talukas. While more than 50% people are found in Didori. Malegaon, Yewla and Nashik taluks have less percentage of Scheduled Tribes.

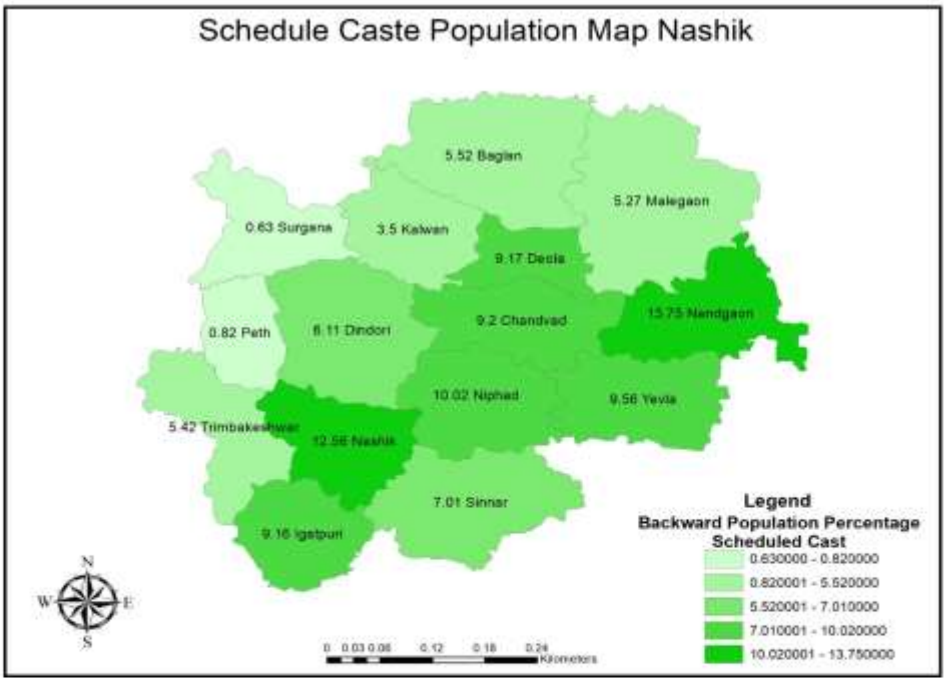

Figure -2: Schedule Cast Population Map of Nashik District

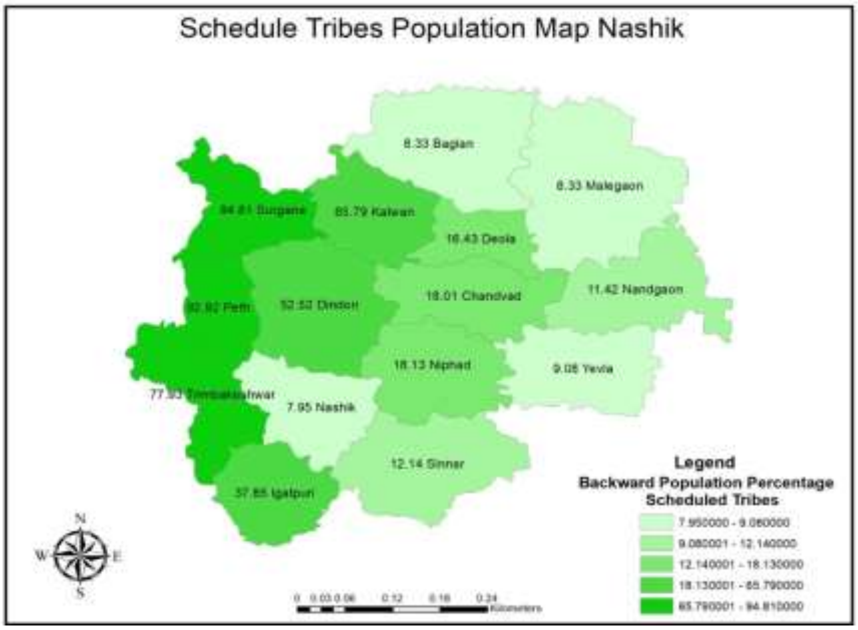

Figure -3: Schedule Tribes Population Map of Nashik District

Concept of Education:

Education is essential for a bright future for all of us. We can achieve a lot in life by using this machine of education. The level of education increases the social and family respect of people and helps in creating a distinct identity. The period of education is a socially and personally important time for everyone. Education provides the ability to overcome major family, social and national and international problems. That is why in today's no one can ignore the importance of education in life.Schedule caste and Scheduled Tribes community are socially and economically backward and for this situations one responsible causes are lack of education so nowadays many government schemes are being run to make education accessible to Schedule caste and Scheduled Tribes people. In rural areas people are being made aware of the importance of education. Awareness is being created about education by showing advertisement through media like TV, Radio, and Newspaper etc. But in recent study area cause of remote area these type facilitates not apply effectively.Due to the caste system, the people of light castes had no right to education, but after the independence many social workers and intellectuals worked to bring about change in the society. The government also helped in this work. People belonging to poor, tribal and dalit classes got help in education through reservation. Education is essential for Schedule caste and Scheduled Tribes community a bright future for all of us. If apply the Modern education system and free primary education for these community plays an important role in education development process. So that the student can complete his education even with less money. Apart from this, monthly and annual scholarships are also given by the government to Schedule caste and Scheduled Tribes students.

Table -2: Educational Status of Scheduled Cast

Particular	Primary	Secondary	Higher Secondary
Male	87604	40496	4783
Female	5590	4108	271
Total	93194	44604	5054

Source - Handbook of Nashik District Census (2010)

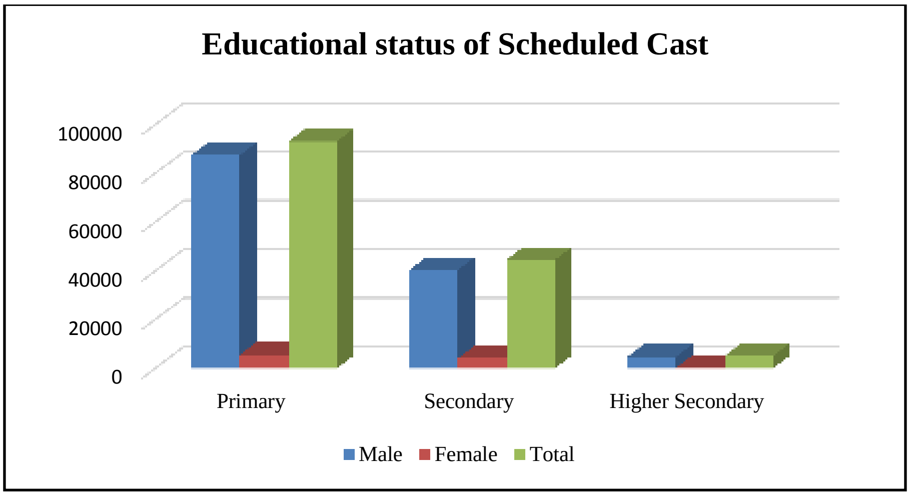

Figure - 4: Educational Status of Scheduled Cast

The above table shows the level of education in the Scheduled Caste category and the related information is taken from the Handbook of Nashik district census 2010. According to this, the male population and the female population and the total population are taken. The number of boys receiving primary education was 87604 and the number of girls was 5590. Similarly, the number of boys in secondary education was 40496 and girls were only 4108. And in higher secondary education the number of boys was 4783 and the number of girls was only 271. On comparative study of the above statistics, we find that females are less educated than boys in the Scheduled Caste community.

Table -3: Educational Status of Scheduled Tribe

Particular	Primary	Secondary	Higher Secondary
Male	251044	78083	12441
Female	6173	2857	674
Total	257217	80930	13115

Source - Handbook of Nashik District Census (2010)

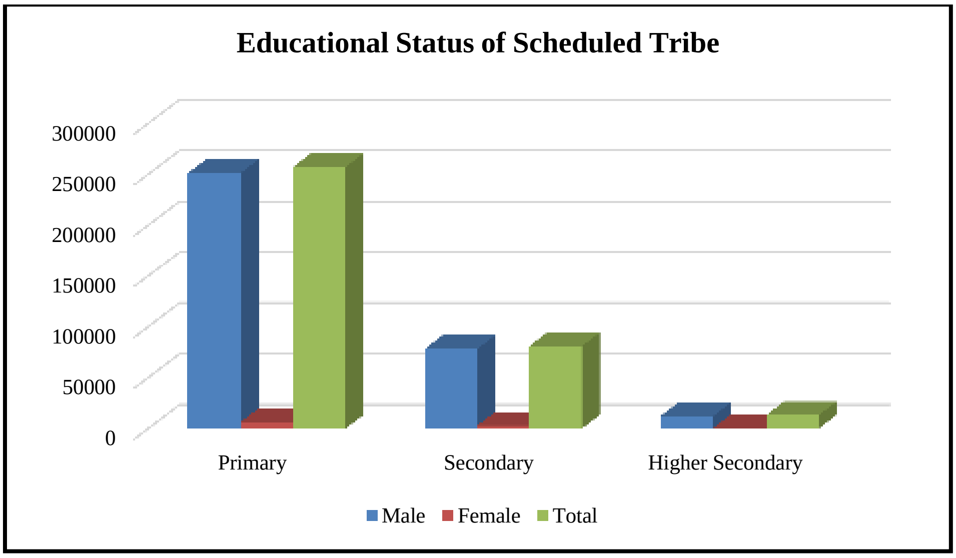

Figure - 5: Educational Status of Scheduled Tribe

The above table shows the level of education in the Scheduled Tribe category and the related information is taken from the Handbook of Nashik district census 2010.

According to this, the male population and the female population and the total population are taken. The number of boys receiving primary education was 251044 and the number of girls was 2857. Similarly, the number of boys in secondary education was 78083 and girls were only 4108. And in higher secondary education the number of boys was 12441 and the number of girls was only 674. On comparative study of the above statistics, we find that females are less educated than boys in the Scheduled tribe community.

Conclusion:

The present paper focus on the comparative study of between schedule caste and scheduled tribe about educational status. there are the main objective of this papers are find out the availability and the adequacy of education system in Nasik district with analyse the educational status between schedule caste and schedule tribes. Last objective of that how the developed the education system which are the policy helpful for the educational development of particular tribes. In which paper apply the statistical method for analysis. Use the digitisation system for represent the various data and graphical presentation for understanding the educational status in schedule caste and schedule tribes.

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Morphometric Analysis of River Basin: A Case Study of River Indrayani Using Geospatial Tools

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Introduction

Morphometric analysis is the measurement and mathematical evaluation of the earth"s surface, shape and dimension of its landform (Clarke 1996; Agrwal 1998; Obi Reddy et al. 2002) River and their related fluvial landforms are among the most widespread features of the earth's surface (Strahler, 1957) with diversified nature. The quantitative explanation of the basin morphometry involves the linear and areal features, the channel network gradient and contributing ground slope of the drainage basin. Basin morphometry involves evaluation of streams through the measurement of stream properties with the analysis of various drainage parameter i.e. stream order, bifurcation ratio, basin perimeter, stream length, basin area, drainage density, stream frequency, average slope, dissection index, texture ratio, circularity ratio etc. Analysis of these parameters are important to study the nature and behaviour of drainage basins. Hydrologic and geomorphic processes are the main factors responsible for formulation and development of morphometric parameter in drainage basin. Detailed study of morphometry helps in monitoring water and land resource and their management at the watershed level. The stream network within the catchment of a particular basin receives natural input of energy in the form of precipitation or sediments and has an output in the form of water and sediment discharge along the river channel. From the geomorphic point of view, the physical environment such as hill slope, river channel, stream network of the fluvial system is connected by fluvial processes which are active within the system.

The dynamics of fluvial processes within a drainage basin is controlled by geology, topography, hydrology, land use etc. in the upstream region and also in the downstream region in the form of sediment deposits and change in the base level of erosion. Remote sensing data using GIS techniques helps in identifying and interpreting such dynamic environment of river systems and its pattern of drainage and relief with their resultant landforms. Therefore, Geographical Information System and image processing technique have been adopted for identification of morphometric features and analysing their properties of Indrayani river basin of Maharashtra. The study demonstrates the fact that integrated remote sensing and GIS-based approach is more convenient, quick and appropriate than a conventional method for morpho-dynamic assessment of medium and large-scale watershed. The study seeks to utilise the interpretation capabilities of GIS to find out the relationship between the morphometric parameters at the catchment level. GIS provides an excellent means of storing, retrieving and analysing data at the river basin level to find out their association. It also provides a powerful mechanism not only to upgrade and monitor morphometric parameters but also to permit the spatial analysis of other associated resources database.

Objective

The main objective of this paper is to calculate the basin morphometry using a remote sensing and GIS technics using satellite data and analyse their influence on morphometric processes of Indrayani river basin.

Study area:

The Indrayani watershed having an area of 980 km2 covered from Valvan dam to mid of Bhima River. The study area, Indrayani river basin in Pune district is bounded by latitude of 19° 01' 40" N and 19° 12' 35" N and longitude 76° 36' 05" E and 76° 46' 15" E..

The Indrayani River originates in Kurvande near Lonavala, a hill station in the Sahyadri Mountains of Maharashtra. It is a tributary stream of Bhima river. Fed by rain, it flows east from there to meet the Bhima river. It flows a course mostly north of the city of Pune. There is a hydroelectric dam called Valvan Dam on the Indrayani at Kamshet. Indrayani catchment area receives heavy precipitation in the form of rainfall.

Data base	Data base detail	Source
Topographical sheets	47F/5, 47F/6 47F/9, 47F/10 47F/13, 47F/14. at 1:50,000 scale	Office of the Survey of India, western Zone, GDC, Pune Maharashtra.
Satellite data	Shuttle Radar topography Mission (SRTM)	NASA, USA, Archive –GLCF (https://earthdata.nasa.gov/learn/articles/nasa-shuttle-radar-topography-mission-srtm-version-30-global-1-arc-second-data-released-over-asia-and-australia)

Database and methodology

The database of the study includes satellite images and secondary sources. The base map has been prepared using Survey of India (SoI) topographical sheets at 1:50,000 scale. In the present paper, the slope map is prepared from Shuttle Radar Topography Mission (SRTM) data using ArcGIS software.. The details of database with sources are stated in Table 1. Some selected morphometric parameters of linear, areal and relief aspects are used for analysing the watershed. Table 2 shows the selected parameters and their mathematical equation with description. The data collected from the satellite and secondary sources are analyse using quantitative and computer aided techniques and prepared with thematic maps, tables, graphs using appropriate cartographic methods.

Result and discussion

Linear aspect

As per the drainage order scheme proposed by A. N. Strahler, (1964), The Indrayani basin has fifth order drainage network with 892 segments of streams, out of which 695segments are in the first order, 154 in the second order, 38in the third order, 4in the fourth. It is observed that the numbers of stream segments are maximum in case of Frist order stream and stream number decrease as order increases, thus it supports Hartons law of stream number. The regression line plotted on a semi-log graph, which indicate that the number of stream decrease as stream Oder increase. This relationship unfold the negative exponential function.

Stream Order	Stream Number (Su)	Stream Length(Lu)	Mean Stream Length	Stream Length Ratio	Bifurcation Ratio(Rb)
I	695	609.1	0.88	_	_
II	154	240.9	1.56	1.8	4.51
III	38	159.78	4.20	2.7	4.05
IV	4	53.95	13.49	3.2	9.50
V	1	89.07	89.07	6.6	4.00
	892	**1152.8**			

The numbers of stream segment from lower order to higher order i.e. 1, 2, 3, 4, 5, are 695, 154, 38, 4and 1 respectively. The head stream Indrayani is the fifth order stream. The coefficient of correlation (r) between stream order and a number of stream segments is 0.75, indicating highly negative correlation between them. Analysis of cumulative length of streams (L) shows that the existence of high stream length is due to structural complexity, high relief, and impermeable bedrock. Horton (1945) gave his law of stream length stated that the cumulative mean lengths of stream segment of each of the successive order in a basin tend closely to approximate a direct geometric series in which the first term is the mean length of streams of the first order. The regression line plotted on a semi-log graph tends to validate his law of stream lengths as the coefficient of correlation is 0.94. According to the law of stream length, the cumulative mean length of stream segment of successively higher order increase in the geometrical progression starting with the mean length of the first order segments with constant length ratio. The cumulative stream length of a given order is positively related to stream order. The cumulative mean stream length of Indrayani river network increases as 0.88, 1.56, 4.20, 13.49, 89.7, km from the lowest order to successive higher orders of 1, 2, 3, 4, and 5. The estimated correlation coefficient involving the cumulative mean length of stream and stream order of Indrayani basin is 0.1 i.e. highly positive correlation between them. The regression line fitted on the basis of the regression equation of positive exponential function model involving cumulative mean stream length and basin order of Indrayani river basin.

Morphometric parameters of Indrayani Basin

Name	le ng Bath si (k	Ba si n pe ri) k m m(	Drainage Order in (no)					N o. of Se strg eam	St re a m) le k m(	R eli ef rat
			1st	2nd	3rd	4th	5th			
Indrayani	89.0	208.5	695	154	38	4	1	892	1152.8	6.6

Areal aspect

The parameters considered for the present study to understand the areal aspects include basin area, basin shape, drainage density, stream frequency and constant of channel maintenance. Basin shape is a significant parameter to help in description and comparison of different forms of the drainage basin. An ideal drainage basin is dependent on the size and length of the head stream, basin perimeter, slope, basin relief, geological structure, and lithological characteristics etc. Most popular methods of computation of basin shape are form factor, circularity ratio, and elongation ratio. Indrayani basin have a lower value of elongation ratio 0.40 indicating elongated. In elongated shape time of concentration is more. Ranoff time is due to elongation shape. This is most important of the shape elongation Ratio is important to determine the flood and runoff characteristic. According to elongation Ratio flood management is easy in indrayani river basin. Circularity 0.29 is unfold the stream length, stream number affected by the topography, it may be rock, vegetation land cover, and relief .It indicates that the Indrayani low-lying area is elongated in shape. Bifurcation Ratio is useful to understand the branching pattern and its indicate number of stream, drainage density if RB value is more mean number of stream also more it indicates the surface runoff is high.

Drainage density of a river basin refers to the total number of stream length per unit area. The density of stream network has long been recognized as topographic characteristic of fundamental significance. It provides a link between forms attributes of a drainage basin in many ways and processes along the stream courses. The drainage density of Indrayani 1.16 km low drainage density and under dense vegetation cover and low relief. It is observed that the drainage density of the basin is not uniform throughout. The drainage density of entire Indrayani river basin has been categorised into extremely low drainage density (below 2 km km–2), moderate (2–4 km km–2) and high (above 4 km km–2). More than 14 % of the total area has low drainage density and 72 % of the total area falls in the category of medium drainage density; whereas only 12.59% of the total area has high drainage density. The Stream frequency of Indrayani is 0.90. Stream frequency refers to the number of streams per unit area. The quantitative analysis of stream frequency helps in classification of the drainage basin, prediction of processes particularly the length of overland flow, runoff, sedimentation, denudation etc. It also gives an idea about the geological structure, topographic controls, hydrological factors are paramount significant in the evolution of terrain characteristics of a drainage basin. While the ruggedness number of low-lying area of the basin is only 0.80 that assign low probability of erosive power of river.

Conclusion

It can be concluded that the detailed quantitative morphometric analysis empower to understand the relationships among the different aspect of the drainage pattern and their influence on landform processes, drainage, and soil erosion. Indrayani basin is a fifth order river basin and elongated in shape. The Indrayani river basin is characterised by low discharge of runoff with flow for longer duration. The catchment is also associated with low to medium drainage density with steep slopes. The relief aspects of the Indrayani basin prove that the catchment is characterised by highly structural complex terrain and vulnerable to soil erosion. As a result, the structure, slope and flow regime have a great implication on the processes of landform development. The morphometric parameters evaluated using geospatial tools helps to develop a better understanding on the nature of landforms and their processes, along with drainage pattern characteristics for watershed area planning and management.

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Global Warming and climate change in India

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Abstract

It is often observed that global warming and climate change are used interchangeably, but in reality both are applicable to different phenomena. Climate change can be defined as change in the climate that is in atmosphere, winds, air pressure etc. while speaking about global warming in simplest terms it is referred to rise in earth's temperature due to emission of greenhouse gasses. These greenhouse gasses include carbon dioxide, methane, nitrogen oxide and chlorofluorocarbons which are caused by burning of fossil fuels. Due to this, devastating effects like flooding, low productivity in agriculture, low vegetation etc. Scientists, researchers and environmentalists have expressed deep concerns over climate change. The central aim of the research paper is to understand the concept and factors relating to global warming and climate change. The researcher also analyzes how shifting from non-renewable energy resources to renewable energy resources such as solar, wind, hydro thermal, geothermal is beneficial for the planet. Utilizing renewable energy sources is one of the most effective ways to combat global warming. The research is based on existing documents such as newspapers, books, internet, articles etc.

Keywords- Global warming, climate change, Renewable energy

Introduction

The earth's climate system is thought to be changing as a result of the atmospheric buildup of trace gasses like carbon dioxide (CO_2) and methane (CH_4), which is mostly the result of anthropogenic activity like the combustion of fossil fuels. India has a reason to be concerned about climate change because a large population depends on climate-sensitive industries like agriculture, forestry, and fishery for a living. The Intergovernmental Panel on Climate Change (IPCC) stated in its fourth assessment report that "warming of the climate system is now unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global seal level."The severity of the country's livelihood problems has worsened as a result of the negative effects of climate change, which include a decrease in rainfall and an increase in temperature. The ecological and social systems, which are already under a great deal of stress as a result of the fast industrialization, urbanization, and economic growth, will be further stressed by climate change. One of the most significant worldwide environmental issues now confronting humanity is climate change, which has effects on things like freshwater availability, health, natural ecosystems, and food production. The earth's climate system has altered dramatically from pre-industrial times on a global and regional scale, according to the most recent scientific assessment. Additionally, research suggests that human activities are mostly to blame for the warming (of 0.1 oC each decade) that has been seen over the past 50 years.According to the Intergovernmental Panel on Climate Change, the average global temperature may rise by 1.4–5.8 oC by the year 2100. The global hydrological system, environment, sea level, food output, and associated systems are all predicted to be severely impacted by this unprecedented surge. The impact would be especially severe in the tropical regions, which are primarily developed nations like India. The Framework Convention on Climate Change (FCCC), established in 1992 as a result of the UN Conference on Environment and Development (UNCED) in Rio de Janeiro, laid the groundwork for the eventual stabilization of greenhouse gasses in the atmosphere while acknowledging shared but distinct responsibilities, individual capacities, and social and economic conditions.In 1994, the Convention went into effect. The 1997 Kyoto Protocol, which went into effect in 2005, reaffirmed the significance of stabilizing greenhouse gas concentrations in the atmosphere while adhering to the principles of sustainable development. According to the Protocol, developed nations participating in it must cut their emissions of six greenhouse gasses: carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, hydrofluorocarbons, and perfluorocarbons.

India's Demographic Characteristics According to the Census of India 2001, there were 286 million urban residents in India, or 27.80% of the country's 1.02 billion people. By 2012, it is expected that its population would reach 368 million. India has 5,161 cities and towns, and its urban population has significant water and sanitation stress. A World Bank assessment on India's water economy asserts that the country is rapidly running out of water, would be severely stressed by 2030, and anticipates that by 2050, demand will outpace supply. The need for water will inevitably increase in an environment where the economy is expanding quickly.Even if millions of tonnes of carbon dioxide are being continuously and undoubtedly released into the atmosphere from only a small number of nations or regions, this activity has the potential to have disastrous effects on the planet's climate, including the submerging of many islands and coastal regions due to rising sea levels, changes in cropping patterns, and decreased agricultural productivity. India is a sizable developing nation with a rural population of about 700 million people who directly rely on natural resources and climate-sensitive industries including water, biodiversity, mangroves, coastal zones, and grasslands for their survival and livelihood. Additionally, nomadic shepherds, woodland dwellers, and farmers who cultivate arid soil have relatively limited adaptation capacities.Although the Kyoto Protocol had symbolic significance, it is now commonly seen as a "failure" since it has neither started a worldwide emission reduction initiative nor promised needed additional decreases in greenhouse gas emissions. Even complete adherence to the Kyoto Protocol, as scientists have long warned, would not be enough to stop the climate from changing, yet the world has spent over 15 years crafting this failed strategy. The Kyoto Protocol's almost exclusive emphasis on mitigation works against the interests of the developing world. Only 25% of the world's population resides in affluent industrialized nations, but they are responsible for more than 70% of the world's CO_2 emissions due to their unsustainable spending patterns.The threat of climate change should worry india since it might have negative effects on the nation. The primary "categories" of climate change impacts include those on agriculture, sea level rise that submerges coastal communities, and an increase in the frequency of severe events that pose serious hazards to India. The impact of climate change on India is extensively covered in the article, with a focus on agriculture, water, health, forests, sea level, and risk events.Indian greenhouse effect Since the beginning of the industrial era, the concentration of greenhouse gasses in the atmosphere has increased, leading to climate change, which has become a severe worldwide environmental problem and a threat to humankind. The interconnections, trade-offs, and synergies between the many policy sectors concerned are being explored in a growing body of international literature. Climate change is increasingly acknowledged as one of the possible essential variables in sustainable development pathways. In India, estimates of inventories of anthropogenic greenhouse gas emissions started in 1991 on a small scale. These estimates were then expanded upon and corrected, and the first conclusive report for the base year 1990 was released in 1992. (Mitra, 1992).The UNFCCC has created a thorough inventory of the emissions from all energy sources, industrial operations, agricultural endeavors, land use, land use change, forestry, and waste management techniques in India (NATCOM 2004). The greenhouse gas inventory estimates submitted under the auspices of India's Initial National Communications are summarized in Table 1. Between 1990 and 2000, India's CO_2 equivalent emissions increased on average by 4.2% a year, according to the data (Table 2). On a sectoral basis, emissions from the industrial process industry are growing at the highest rate (21.3% annually), followed by emissions from the waste sector (7.3% annually). Almost little growth in emissions from agriculture has been seen, while the energy sector emissions have only increased by 4.4% annually.

Agriculture

The 65% of India's land area covered by rainfed agriculture, which is very climatically sensitive, produces approximately 25% of the country's GDP, employs the entire workforce, and generates 13.3% of all exports when combined with related businesses. According to a number of studies, despite a significant rise in the nation's production of food grains, climate change may cause some significant productivity losses for vital crops like wheat and rice. In the previous three to four decades, the rate of CO2 emission into the atmosphere has multiplied by 30. According to estimates, a 0.5 oC increase in winter temperature might result in a 0.45 tonne per hectare decrease in wheat output. In a recent World Bank analysis, the effects of climate change were examined in three drought-prone regions—Telangana, Maharashtra, and Orissa—as well as one flood-prone region. It was discovered that the following negative effects of climate change were likely: 1. Dry land farmers in Telangana might face a 20% decline in their revenue. 2. Sugarcane yields in Maharashtra may drop by 25–30% drastically.In the foreseeable future, flood hazards would rise as a result of melting glaciers. Water given by glaciers cannot be replaced in the long run, which might lead to unprecedented levels of water shortages. As a result of climate change, it is expected that droughts and floods would become more frequent. This will result in a significant crop loss and render big areas of fertile land unusable for farming. In conclusion, it will put food security in danger. Farmers may be losing a net income between 9% and 25% due to a 2 to 3.5 oC rise in temperature and a 7% to 25% change in precipitation, which might have a negative impact on the GDP by 1.8% to 3.4%.Food Safety By 2010, India's predicted total foodgrain demand is expected to exceed 250 mt. By 2010, it is anticipated that the gross arable area would rise from 191 to 215 mha, necessitating a roughly 150% increase in cropping intensity. The requirement for additional food in India can only be satisfied by increasing yield per unit of land, water, energy, and time, such as through precision farming, because land is a fixed resource for agriculture. Kavi Kumar and Parikh demonstrated that the effects of climate change on Indian agriculture would persist even with farm-level responses. It examined cross-sectional data on the susceptibility of Indian agriculture to the climate. The investigation at the field level revealed that although most farmers are aware of the phrase "climate change," their interpretation frequently overlaps with that of other phenomena. Impacts were observed to be much higher between the middle of the 1980s and the late 1990s. The study's findings support mounting evidence of declining agricultural output in India during the same time span. The effects estimated using climate projections specific to India show that impacts increased during the period from 1971 to 1985 and then increased again, possibly as a result of improved agricultural resilience in India during this time as well as due to regional variation in the climate projection.

Conclusion

To Sum Up The 21st century is predicted to see a significant rise in temperature and rainfall in scenarios with higher greenhouse gas concentrations. India's climate might increase by 2.33 to 4.78 oC in the event that CO2 concentration doubles. By 2040, it is expected that the yearly temperature would have risen by 0.7 to 1.0 oC compared to the 1980s. Over a substantial portion of the nation, the general number of rainy days is decreasing. While the number of rainy days may rise by 5 to 10 days close to the foothills of the Himalayas and in north-east India, this reduction is more pronounced in the western and central sections (by more than 15 days).The prospects for and effectiveness of climate policies will be influenced by the effects of climatic variability and change, climate policy responses, and related socioeconomic development. Missions, the rate and magnitude of climate change, climate change consequences, the power to adapt to those changes, and the capacity to counteract those changes will all be significantly impacted by the socioeconomic and technical aspects of various development routes. The well-being of people is anticipated to be impacted by climate change in a variety of ways, including capital, ecosystem, illness, and migration. Regardless of how important the issue is, it is unclear how to calculate the value using the condition of the economics. A significant change at least entails shifting from an agrarian to a non-agricultural economy and lowering reliance on agriculture.Since the majority of the labour force—roughly 70%—depends on the sector for both employment and a means of subsistence, it will free up the required labour and capital for the manufacturing and service sectors when it becomes more productive and secures food self-sufficiency. It is vital to demonstrate that India is far from being inert in the context of the present discussion about climate change and that significant steps in terms of laws, programmes, and projects are being implemented. Transferring technologies can hasten modernization efforts, while greater funding can hasten government efforts to conserve energy. However, strategies for reducing poverty must be given top attention.

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Development of Ecotourism- The Study of Pashan Lake, Pune

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DOI-10.5281/zenodo.7546900

Introduction -:

In view of promotion of eco-tourism, this study examines the potentiality and essentiality of eco-tourism at Pashan Lake. In this context, this study focuses on environmental, natural, cultural and socio economic condition of Pashan. This study integrates environmental dimension in tourism development issue, management concerns and conservation needs in order to develop a framework for eco-tourism. Eco-tourism is a catchy word for ecologically sound tourism or nature tourism. It can be summarized as a term of cultural and environmental ethics among travelers that contribute to the conservation and management of natural areas for long term leading to sustainable economic development.

The main feature of such tourism is that the person who practices eco-tourism has the opportunity of immersing himself/ herself in nature in a manner generally not available in the urban environment. Eco-tourism has been viewed as a new tourism strategy that balances development and economic gains by benefiting both nature and destination areas.

Study area -:

Tourists have increased in different parts of Pune. Though tourism activities are increasing, it seems very unsustainable and detrimental to the surrounding environment in the area under the study. The study area is Pashan Lake of Pune district. This particular area is chosen for its accessibility and falls as a heterogeneous geographical structure. The city of Pune (Maharashtra, India) is located 560m on the western margin of the Deccan Plateau, west of the Western Ghats mountain range. It has a tropical wet and dry climate. Pashan lake is located approximately 12km west of Pune city and is a century–old artificial lake. Pashan lake was created when the Ramnadi River (which has a watershed of approximately 108km square), was dammed. It has a surface area of approximately 625hat (PMC2012). From the 1960s to 1980s Pashan lake was a winter site for a great diversity of wet land birds. However by the late 1990s bird diversity at Pashan lake had plummeted. This prompted several restoration efforts.

Objective -:

The general objective of this study was to harmonize tourism and environment. The specific objective were

1) To identify physical infrastructure needed for tourism development.
2) To encourage local community participation and skill development.
3) To ensure the safety and security of tourist.

Methodology -:

Both qualitative as well as quantitative nature of data is used in this study. This study is based on primary data through field survey. This primary data was collected by direct interview, structured, questionnaire, observation and group discussion method.

Similarly the secondary data was also used for the studies. It was collected from published or unpublished written documents from individual experts. To generate primary data, the structured questionnaire, semi or unstructured interviews and field observations were applied. The sampled tourism activities covered fifteen present of the total selected on quota and simple random sampling basis structured questionnaire was used.

Different people from different walks of life were selected and asked a number of questions regarding the ecology, environment and eco-tourism at Pashan lake and its potentiality in the future as well as the people's perception about eco-tourism.

Conclusion -:

Result of the study suggests that there is great potentiality of eco-tourism and essentiality of environmental conservation in the area. To maintain the balance between present population's aspiration and the carrying capacity of natural environment, certain precautions and behavioral changes are needed.

Tourism is the most sensitive industry and requires awareness among the people for its prospects. In this context, it is an urgent need to conserve Pashan lake from pollution and encroachment of local citizens. Otherwise we may fail to hand over this natural gift to our future generation. Pashan lake is a potential destination for the tourists because of its unique characteristics like surrounding mountains with green forest, presence of a temple nearby, peace and tranquility etc.

The inferences might be valid to some extent regarding the area having similar geographical and environmental settings. Eco tourism is a response to the negative effect that mass tourism has had on culture and geography of countries. In reality eco-tourism is a culturally and environmentally sensitive travel that contributes to conservation and management of natural areas for sustainable economic development.

These restoration efforts are focused on improving the abiotic and biological integrity of the lake and included draining extracting silt and construction debris. Developing of the lake for birds and the planting of indigenous tree species is necessary.

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Temporal Changes in the Surrounding Areas of Wakad in the Proximity of Hinjewadi It Park

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Abstract

Pune has experienced rapid growth in the areas especially in the fringe of the city. This is mainly on account of the development of the Information Technology (IT) Parks. The tertiary sector has experienced a rapid growth especially during the last decade. The study area includes the suburban areas of Pimple Gurav, Pimple Nilakh, and Pimple Saudagar which are close to Wakad. These erstwhile villages were located adjacent to the Hinjewadi IT Park across the highway. Till the year 2001 these places were thinly populated. It is often argued that the process of economic liberalization and associated structural reform would accelerate rural–urban (RU) migration and boost the pace of urbanization. Linking of India with global economy would lead to massive inflow of foreign capital as also rise in indigenous investment resulting in an increase in employment opportunities within or around the existing urban centres [Kundu Amitabh (2001)]. By the year 2011 here has been a significant change in the land use particularly in the built up area. This paper attempts to study the changes in land use / land cover which has taken place in these suburban areas. The study of the land use changes in the urban areas can be done effectively with the help of remote sensing and GIS techniques. Using the digital image processing techniques, the satellite images are classified and land use / land cover is derived. The results show that the area under built-up land has increased by around 52.78% in the last 30 years. On the contrary, the land under agriculture, barren, pasture has decreased significantly.

Keywords: suburban area, land use / land cover, remote sensing, GIS,

Introduction

Today due to the process of urbanization cities are growing at an alarming rate .Rapid urban development and increasing land use changes due to increasing population and economic growth in selected landscapes is being witnessed of late in India and other developing countries [K.Madhvi Lata et al (2007)]. The continuing liberalization and economic reform programmes in India since 1991 have given an impact to the Indian economy particularly in the Information and Communication sector. Steps taken by the State to promote this sector includes the establishment of Information Technology Parks in different parts of the country. It is often argued that the process of economic liberalization and associated structural reform would accelerate rural–urban (RU) migration and boost the pace of urbanization. Linking of India with global economy would lead to massive inflow of foreign capital as also rise in indigenous investment resulting in an increase in employment opportunities within or around the existing urban centres [Kundu Amitabh (2001)].

The establishment of the Rajiv Gandhi Info-Tech Park at Hinjewadi and IT Parks in Kharadi and Talwade have resulted in the transformations of the area in the vicinity. These IT Parks are located in the fringe area due to certain advantages like of lower rent, educational hub etc. Peri-urban areas exist first beyond the city limits. Whilst, the word '*suburb*' describes a mainly mono-functional e.g. a residential area developed around or next to the urban center, a peri-urban area is more distant to the core city and tends to have higher land-use diversity (e.g. individual houses, agricultural land and leisure residences). Due to this fact, peri-urbanisation is often called rurbanisation.

The growth impulses which are a result of the IT sector have promoted unplanned growth as the areas are located outside the city limits. The various land uses which include traditional agriculture, horticulture, derelict farms, older villages, newer residential extensions, commerce, industry and services are intermingled in a random fashion which gives this distinctive quality of the peri-urban also known as the rururban area. The present study aims at studying the changes in there sub-urban areas which have experienced changes due to the development process which is associated with the IT Parks with the help of Geoinformatics. Geoinformatics is today extensively used for managing the rapidly growing information of our cities and villages [Lakshmi Kantakumar et al (2011)].

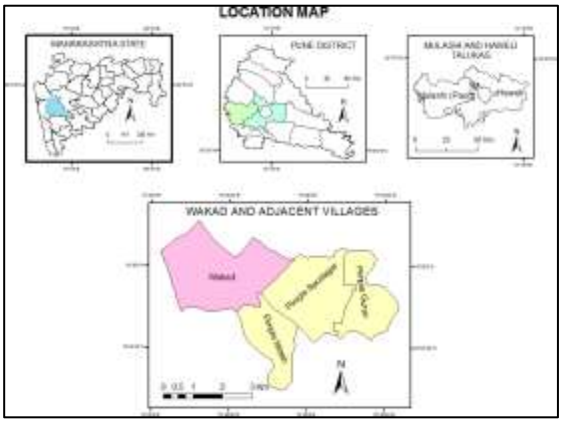
Aim And Objectives

The main aim of the study is to identify the changes in land use and land cover in the villages in sub-urban parts of the Pune city. To fulfill this aim the objectives are:

1. Classification of Satellite images (LANDSAT TM, ETM+ and LANDSAT8) for the study area for 1992, 2000, 2011and 2020
2. Evaluation of the change in the land use and land cover for these years using image processing techniques

Study Area

The study area is located to the east of Hinjewadi IT Park. The elevation of Hinjewadi is about 580m above mean sea level. Study area includes four villages namely, Pimple Gurav, Pimple Nilakh, Pimple Saudagar and Wakad. These settlements are located on north western side of Pune city along the left bank of River Mula and to the east of the Mumbai - Pune Highway. The study area covers1699.83 hectares (Figure 1 & 2).



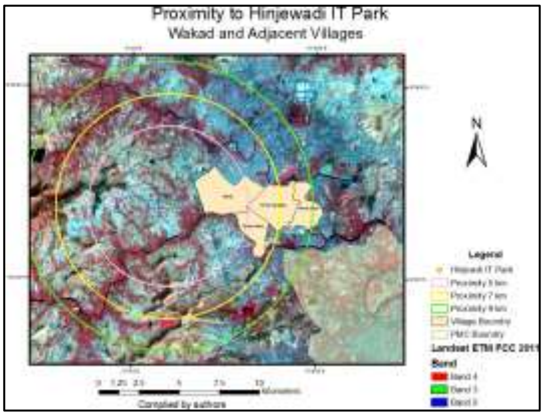


Fig. 1: Location Map: Wakad and Adjacent Villages Fig. 2: Proximity to Hinjewadi IT Park

Data And Methodology

The change in land use and land cover for the time period of 30 years is analyzed by using satellite images (LANDSAT TM and ETM LANDSAT 8) at 10 years of interval i.e. 1992, 2000, 2011 and 2020. The cloud-free LANDSAT images were downloaded from internet for the specified years which were corrected geometrically using the topographical maps. The village maps were procured from the office of land records, Pune. These village maps were then scanned, dereferenced using the topographical maps. Using the image processing software (ERDAS Imagine), the village area is extracted from the satellite images. For the present study, the LU LC classification was carried out using different classification techniques like Minimum distance to Mean, Parallelepiped, Maximum Likelihood (MXL) and Mahalonobis. Out of these classifiers MXL classifier gave better results with best accuracy and used for area calculations. The classes chosen were settlement, agricultural land, fallow land, barren land, water body and pasture land which were verified by the spectral seperability analysis and were then considered for further analysis. With the overall accuracy of 85%, the land use and land cover maps were prepared for these four years (figure 3). Since, there is a difference in the land use of the study area from 1992 and 2020, it was decided to go for GPS survey. That helped to understand the existing land use, land cover and the actual changes that took place in the study area from 1992 and 2020.

Results And Discussions

The Land use land cover classification has shown the following results for three decade.

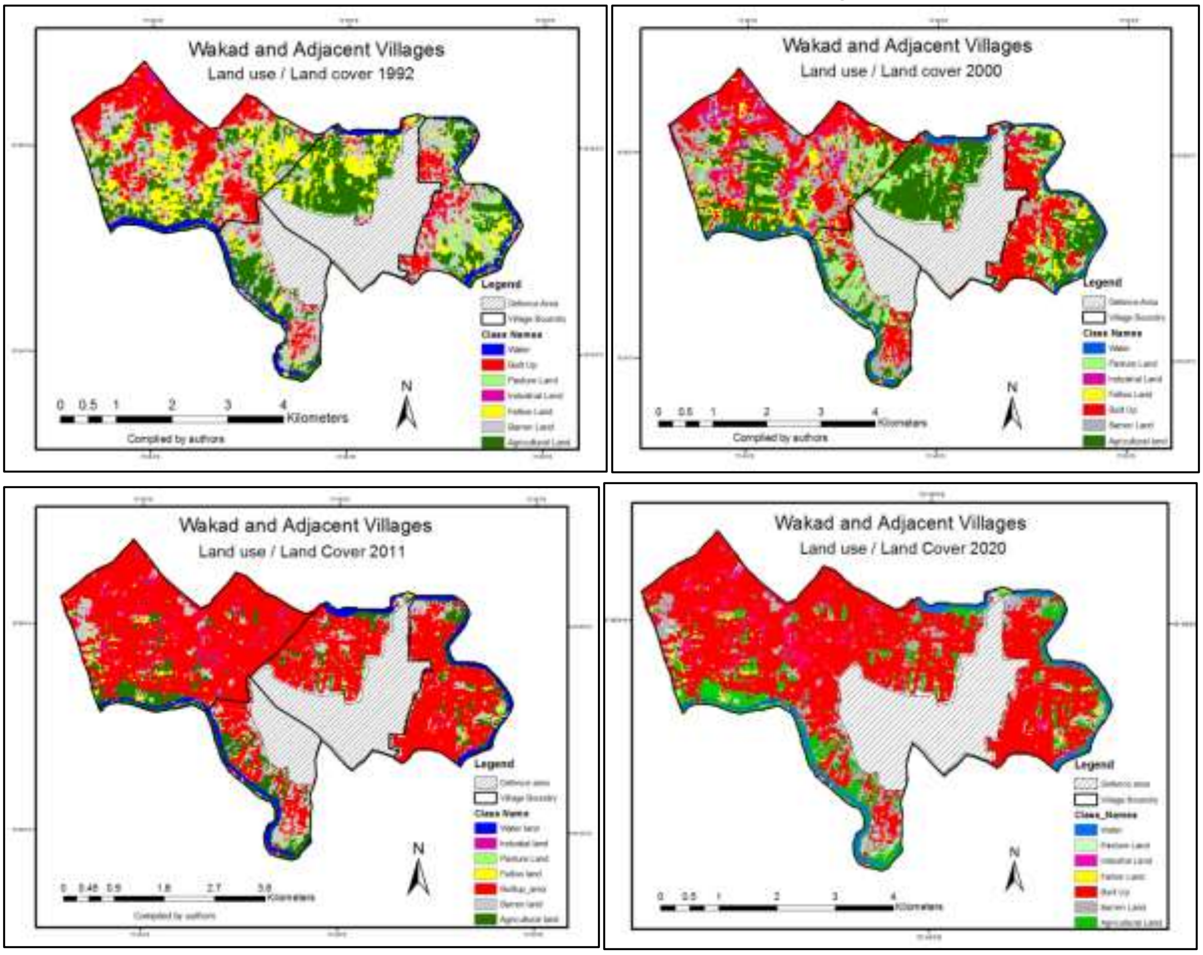


Fig. 3: Supervised classification of the study area years 1992, 2000, 2011 and 2020

The agricultural land has shown a very nominal rise from 1992 to 2000 and but by the year 2011 and 2020, there has been a sizeable decrease in the agricultural area. Fallow lands have shown a decline in the three decades along with barren land. This is due to the conversion of these lands for construction of buildings. There is a negligible change in the area under water. The major change which has taken place is in the built up area. This is due to the fact that the requirement of the residential and commercial functions experienced a considerable increase. The high income of the people employed in the IT industries led to the demand for residential areas in Wakad and its surroundings. Hence the built up land rose from 21.5 to 29.7 per cent from 1992 to 2000 and then it increased by more than three times the amount by the year 2011 when it rose to 65.2 per cent. Based on the LU/LC Classification, the following results were obtained (annexure)

Conclusions

Urban growth remains a major topic concerning GIS and Remote sensing application. RS and GIS have proved to be an effective means for extractive and processing varied resolution of spatial information for monitoring urban growth [Ian Masser (2001)].

1. The impact of IT Parks has triggered rapid urbanization in the areas of the proximity to them. Due to the basic support of tertiary activities, residential activity has experienced a very rapid growth in the region in proximity to IT Parks. Prior to 1991 these villages were uninhabited. After establishment of IT Park they provided land for urban expansion based on the multiple needs of the IT Parks.
2. The location of the area is as such close to Mumbai Bangalore Highway (NH4) and also to the near the boundary of PMC. This also

resulted in a phenomenal rise in built-up area especially during the decade of 2000 to 2011

Scope And Limitations

The sub-urban areas of the city of Pune are facing a lot of problems due to rapid urbanization. Some of these includes traffic congestion, increase in pollution level, sewage and waste disposal, water shortages etc. The urban sprawl is going on at a very rapid rate. This type of detailed land use study would help in to identify the problems with the help of geoinformatics. The planning of resources in the sub-urban areas is of utmost importance and hence such studies would help in the proper planning of these areas.

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Annexure

Land Use/Land Cover with TGA Change (%) of Wakad and Adjacent Villages (Ha)

Area under Land use and land cover (ha)								
Classes	**1992**	**% TGA**	**2000**	**% TGA**	**2011**	**% TGA**	**2020**	**% TGA**
Agricultural Land	428.62	25.24	431.01	25.38	221.94	13.07	71.94	4.235926
Fallow land	255.62	15.05	104.74	6.17	29.73	1.75	8.73	0.514034
Pasture land	77.81	4.58	218.48	12.86	27.21	1.6	7.21	0.424535
Barren Land	465.99	27.44	312.56	18.4	174.51	10.28	77.51	4.563895
Water	78.46	4.62	72.49	4.27	75.26	4.43	69.26	4.078124
Built up Land	364.86	21.48	504.9	29.73	1111.23	65.43	1401.23	82.50634
Industrial Land	26.97	1.59	54.15	3.19	58.45	3.44	62.45	3.677142
Total	1698.33	100	1698.33	100	1698.33	100	1698.33	100

Change						
Classes	**1992-2000**		**2000-2011**		**2011-2020**	
	Area (ha)	**% TGA**	**Area (ha)**	**% TGA**	**Area (ha)**	**% TGA**
Agricultural Land	2.39	0.14	-209.07	-12.31	-150	-8.83
Fallow land	-150.88	-8.88	-75.01	-4.42	-21	-1.24
Pasture land	140.67	8.28	-191.27	-11.26	-20	-1.18
Barren Land	-153.43	-9.03	-138.05	-8.13	-97	-5.72
Water	-5.97	-0.35	2.77	0.16	-6	-0.35
Built up Land	140.04	8.25	606.33	35.7	290	17.08
Industrial Land	27.18	1.6	4.3	0.25	4	0.24

(Source: compiled by authors)

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Geographical Analysis of Changing Land use and cropping pattern: A Case Study of Ahmednagar District (M.S.)

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Abstract:-

Agriculture is a base of all economic activity in the world. Indian agriculture gone through tremendous changes via physical, socio-economic and technological factors. These changes are also changing land use and cropping pattern from time to time. This means that, what is the land use and cropping pattern in the selected study area is governed by above said factors. Ahmednagar district is drought prone, so physical factors like rainfall affect the land use and cropping pattern. As per data available, general land use clearly indicates that except negative changes in area under forest, there are positive changes for agricultural development. Decrease in other than fallow; increase in non-agricultural and net sown area is good indicators for agricultural development. The change in cropping pattern is indicating that the farmers have changed their attitude from food crops to cash crops. The change in cropping pattern in particular span of time clearly indicates the changes that have taken place in the agricultural development.

Key Word:- Land use, Cropping pattern

Introduction:

Agriculture is not only growing of crops but also rearing of animals (Agriculture Geography, Majid Husain) India is basically an agricultural oriented country, the role of agriculture is very vast as it is the most important enterprise in Indian economy. Land use is an important aspect of geographic studies particularly relevant to agricultural geography. Cropping pattern is the proportion of area under various crops at a point of as it changes over space and time. The cropping patterns of a region are closely influenced by the geo-climatic, socio-economic, historical and political factors (Hussain, M. 1996) patterns of crop land use of a region are manifestation of combined influence of physical and human environment. Differences in attitude towards the rural land in the level of prosperity and technology have produced changes in emphasis. Their effects on both landscape and land use studies are likely to be far reaching (Coppock, 1968). Ahmednagar district is known as the draught prone region. Present studies focusing upon the land use and cropping pattern in Ahmednagar district. The relationship between cropping pattern and responsible geographical condition for it, is explaining in the present study.

Objective:

To find out changes in general land use and cropping pattern in the study area.

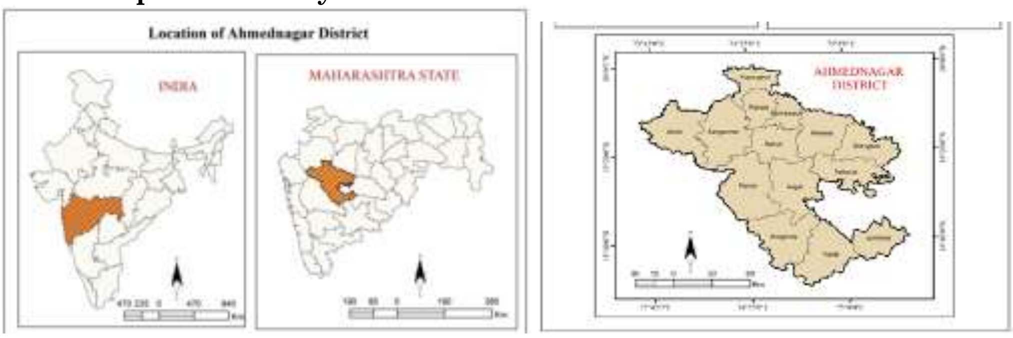
Data base and Methodology

The present research paper based on secondary source of data. Secondary data obtained from District 1990-91 and 2015-16 The study of land use and cropping pattern is based on quantitative information. Spatial and Temporal changes shown by pie diagram of 10 crops for the period -1990-91 and 2015-16.

Study area:- Ahmednagar is the largest district of Maharashtra State with geographical area of 17418k.m., which is 5.66% of area of Maharashtra State. Out of total areas 391.5 sq. k. m. is urban area and remaining 16,656.5 sq. k. m. is rural area. Ahmednagar is centrally located in western Maharashtra. In Ahmednagar district there were 14 blocks or talukas and 1,581 villages and 1,308 gram sabhas. The Ahmednagar

district is laid between 180, 2" to 190.9"North latitude and 730.9"to
750.5" East longitude, and is bounded on the north by Nasik district, on the north east by Aurangabad district, in the east by Beed and Osmanabad, on the south by Solapur and in the south west by Thane and Pune district.The region with irregular shape and has 200 kilometers a length and width of 210 kilometers on 17,048 square kilometers area and having population of 4040642 persons in 2011 accounting 5.5 percent area of Maharashtra state. In study region density was 237 persons per sq. kilometer. The sex ratio was 908 females per thousand males; literacy was 78.3 percent accounting urban literacy (84.7 percent)and rural literacy (72.9 percent). The growth of population from 1991 to 2001 was 19.80 percent. The study region has 46.48 percent cultivators, 22.28 percent agricultural labours and remaining 31.24 percent workers engaged other than agriculture sector.According to physiographical set up, study region is divided into three regions, namely, Sahyadri hill ranges, namely, Kalsubai, Adula, Baleshwar and Harishchandragad, Plateau and plains drained by Godavari and Bhima rivers. Average rainfall receives 575.8 mm. The mean daily maximum temperature is 39° centigrade'sand meansdaily minimum temperature is 11.7° centigrade. The deep black soil, medium black soil, gray soil and red soil appear in study region. 71.10 percent area is found under cultivation and irrigation accounts 32.40 percent. The major crops, namely, jowar, wheat, bajra, maize, sugarcane
, cotton, pulses and oilseeds and recently horticultural crops are cultivated in study region.

Location map of the study area.



Result and Discussion:

In this study the following categorization of land utilization has been made in different groups, these are

1. Area under Forest, 2. Area not available for Agriculture.
3. Other than fallow , 4. Fallow Land
5. Net Sown Area

The land use pattern and its change in the study period is presented in Figure No 1. The figures are computed for the years these are 1990-91 and 2015-16.

1. **Temporal changes in general land use: 1990-91 to 2015-16**

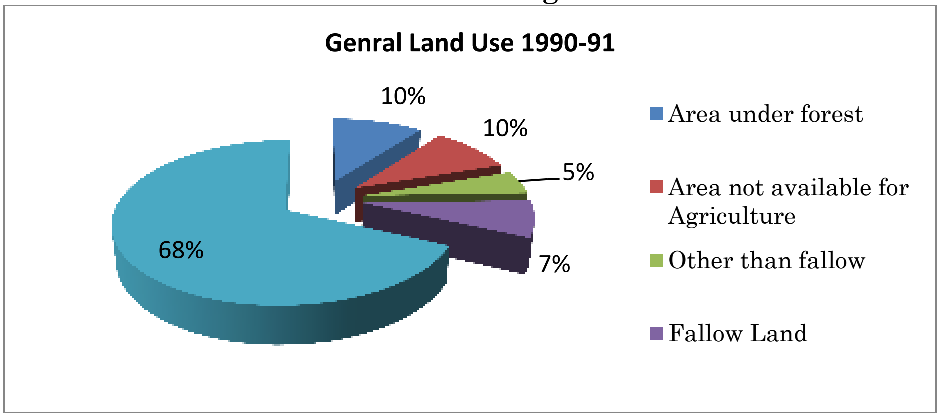
The general land utilize of any region undergoes the changes in any particular period of time is called as a temporal change. The temporal changes in land use pattern of Ahmednagar district have studied for the period of twenty-five years. The study period 1990-91 to 2015-16 find out the trends of changes in general land use and to discover the reasons of the changes. The main objective of this chapter is to emphasize the spatial- temporal changes in general land use categories are based on census classification. The temporal changes in general land use for Ahmednagar district is shows in Table No. 1 and Figure 2

Table No. 1-General Land Use

Sr.No.	**Type of land use**	**1990-91**		**2015-16**		**Change in %**
		Area in '00'Ha.	**Area in %**	**Area in '00'Ha.**	**Area in %**	
1	Area under forest	1756	10.32	1316	7.73	-2.59
2	Area not available for Agriculture	1607	09.44	1684	9.89	+0.45
3	Other than fallow	798	04.69	339	2.00	-2.59
4	Fallow Land	1256	07.38	1301	7.64	+0.26
5	Net Sown Area	11603	68.17	12380	72.74	+4.57
6	**Total Geographical Area**	**17020**	**100**	**17020**	**100**	**00**

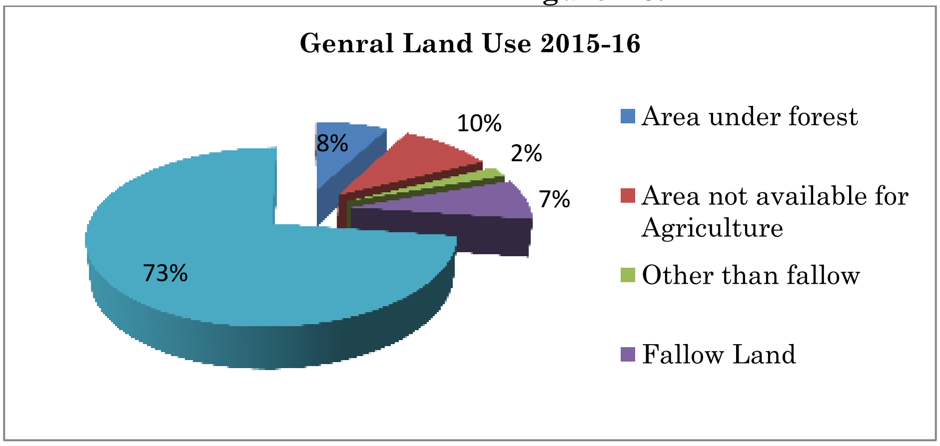
(Source: Socio-Economic Review and Statistical Abstract of Ahmednagar District- 1991-92, 2015, 16.)

Figure No.1



(Prepared on the basis of seconadry data by researcher)

Figure No.2



(Prepared on the basis of seconadry data by researcher)

1)

Area under forest

Forest land includes all land classified as a forest under any legal enactment dealing with forests or administered as forest, whether state owned or private, whether wooded or simply maintained as a woodland. The Table No.3.1 clearly indicates that there is a continuous decrease in the forest land. As per standard 33 percent area needed under forest cover to maintain environmental balance but in the district in 1990-91 there is only 10 percent area under forest which was further decreasing by 2.59 percent. This indicates alarming imbalance of environmental condition. Less green cover less rainfall because evapotranspiration through green leaves. Green leaves of plants provide additional source of humidity which is helpful to occurs rainfall.

2) Non Agricultural Area/ Area not available for agriculture

Non-agricultural area means land which is not available for cultivation under the existing circumstances. This type of land use represents the land under road and railway transportation, industrialization, play grounds, grave land and settlement etc. Non-agricultural area has shown the variation in the study period. The land under this category in 1990-91 was 160700 hectares which was 9.44 percent of the total geographical region. In 2015-16 it was a recorded as 168400 hectare which is 9.89 percent. It was increased by 0.45 percent. This indicates expansion of settlement, industrialisation, transport etc., due to increasing population.

3) Other than fallow

Other than fallow land is also well-known as cultivable waste land. These lands are certainly cultivable but at present lying of waste on account of number of causes. They can be counted underneath following heads intrusion by floods and corrosion, poor drainage, scarcity of water and distance from settlements etc. Land under cultivable waste in study region has 79800 hectares of the total geographical area of study region in 1990-91 It was 4.69 percent area of study area and 33900 hectares i.e. 2.00 percent in 2015-16. It was decreased by 2.59 percent. This indicates the area under fallow land comes under utilisation. It comes under cultivation land because of rural dwellers scattered in rural area because of land fragmentation. So land other than fallow was decreased.

4) Fallow Land

Fallow Land -The fallow land subdivided into three types.

a) Permanent fallow- means the land reserved uncultivated for the period of five years or extra period. It consist the land under permanent grazing land and land under various trees and bushes

b) Current fallow land means the land which were not sown at the occasion of crop reporting but were sown one or two years of left follow either in one season or one full year to improve the quality of the land.

c) Other fallow land means the land kept uncultivated two to five years due to some problems. Initially in 1990-91 the fallow land in Ahmednagar district was 125600 hectares accounting 7.38 percent and it was increased up to 130100 hectares accounting 7.61 percent of the total geographical area. Throughout the study period from 1990-91 to 2015-16 the fallow land has slightly increased by 0.26 percent of the total geographical area. Increasing in the proportion of fallow land is due to the purchase of land by the investors which are businessmen in city area. They are not doing agriculture so it becomes fallow land. Most of such fallow land found along the highways and roads.

5) Net Sown Area

The net sown area is the land which is being actually tilled for raising the crops. The temporal change in net sown area from 19901-91 to 2015-16 is shown in table no 3.1. In 1990-91 the net sown area was 1160300 hectares accounting 68.17 percent of the total geographical area. In 2015-16 it was recorded as 12380 hundred hectares which was nearly about 73 percent. In the study period from 1990-91 to 2015-16, it was increased by 4.57 percent.

Above discussion of general land use clearly indicates that except negative changes in area under forest, there are positive changes for agricultural development. Decrease in other than fallow; increase in non-agricultural and net sown area is good indicators for agricultural development.

4.2 Cropping Pattern of Ahmednagar District-1990-91 to 2015-16

The study of cropping pattern is based on quantitative information obtained from Socio-Economic Review and Statistical Abstract of Ahmednagar District- 1991-92 and 2015, 16. Here with data extracted regarding area under major crops grown in the district. The major crops grown in district were Jowar (Sorghum), Bajara, wheat, pulses, sugarcane and oilseeds It must be noted that the Jowar (Sorghum) is the traditionally dominant crop in the drought prone district like Ahmednagar. Its dominance as per areal strength still persists. During the year 1990-91, Jowar occupied 41.35 percent area to total gross cropped area which was 1249841 hectares. It is major cereal crop and mainly grown in *rabi* season in district. Bajra is the second ranking cereal crop is grown in *kharif* season in throughout the district. It occupied 25.79 percent area to total gross cropped area. Wheat occupied 5.47 percent area while cotton occupied 0.14 percent area to total cropped area. Oilseeds having a share of 5.31 percent. Sugarcane is cash crop having 6.34 percent area. During the year 2015-16 food crops namely Rice, Jowar, Bajra and Wheat occupied nearly about 43 percent area to total gross cropped area which is 1270585 hectares, while cash crops namely, cotton, oilseed and sugarcane occupied nearly about 22 percent area to total gross cropped area. Fodder crops occupied 4.81 percent area to total gross cropped area of district.

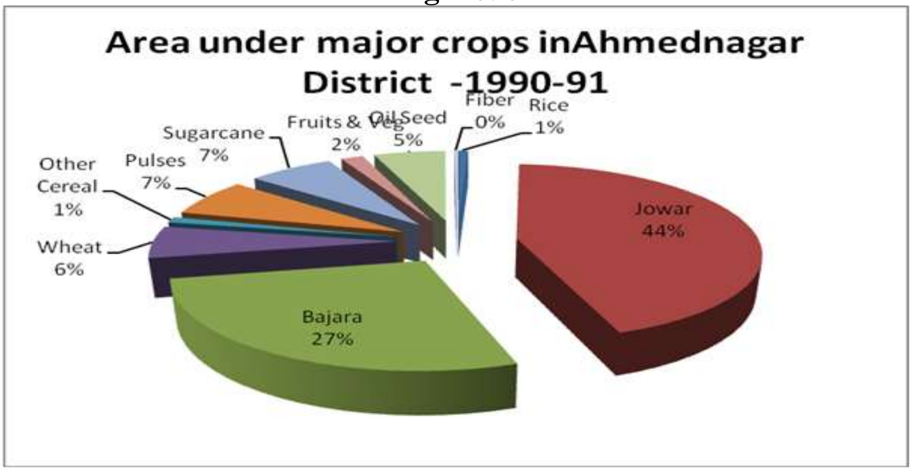
Table no. 4.2- Area under Major Crops and its Changes -1990-91 to 2015-16

Sr. no.	Major crops	Year and area in percentage		change in percentage
		1990-91	2015-16	
1	Rice	0.76	0.96	0.2
2	Jowar	43.46	39.01	-4.45

3	Bajara	27.52	7.53	-19.99
4	Wheat	5.75	9.53	3.78
5	Other Cereal	0.98	3.24	2.26
6	Pulses	6.83	10.25	3.42
7	Sugarcane	7.22	11.35	4.13
8	Fruits & Veg	1.73	5.37	3.64
9	Oil Seed	5.58	4.89	-0.69
10	Fiber	0.12	7.87	7.75

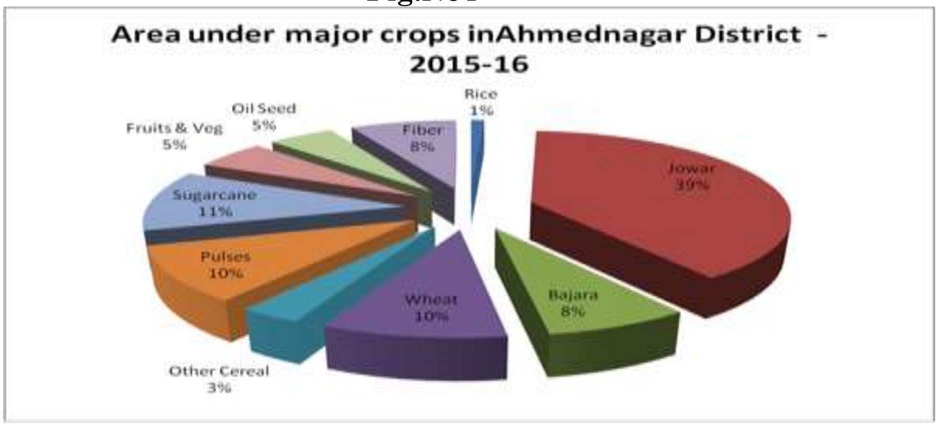
(Source: Socio-economic abstract, Ahmednagar district (1990-91 & 2015-16))

Fig No. 3



(Prepared on the basis of seconadry data by researcher)

Fig.No4



(Prepared on the basis of seconadry data by researcher)

Table 2 revealed the temporal changes in major crops areal strength in the study area. Area under Jowar and Bajara decreased by nearly about 26% in 2015-16. Other crop registered positive change in 2015-16. This change occurs due to various factors i.e. distribution and amount of rainfall, availability of irrigation facilities, farm credit and high yielding variety of seeds and market price of agricultural commodities, chemical and domestic fertilizer, labour coast and availability etc. The temporal pattern of volume change in area under crops registered significant positive change in sugarcane (3.82 percent), other cereals (1.9 percent), fruits, vegetables, condiments and spices (3.16 percent), cotton (6.91 percent), wheat (3.06 percent) and pulses (2.68) while significant negative change recorded in jowar (6.41 percent), bajra (19.05 percent) and oilseeds (0.93 percent).

Conclusion:

This change is indicating that the farmers have changed their attitude from food crops to cash crops. The change in cropping pattern in particular span of time clearly indicates the changes that have taken place in the agricultural development.

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Geographical Analysis Of The Age-Sex Composition In Ahmednagar District, Maharashtra"

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Abstract:

Main aim of the paper is to analyses the rural and urban Age-Sex Composition of Ahmednagar district from Geographical point of view. Required data collected from secondary sources such as Ahmednagar district Census Handbook and Ahmednagar District Socio-Economic Review of 2011. Among the study of demography, it is well known that one of the most fundamental characteristics of the population composition is its age-sex structure. Age composition gives us a broad idea of economic dependency in any population. Therefore, it is essential to note that the study of age-sex composition is important demographic aspect in the subjects of population geography, demography, economic and sociology. For demographic analysis, it is customary to classify in five-year age groups, such as 0-4, 5-9, 10-14, 15-19, and 20-24 and so on. Thus, age data classified in mutually exclusive age groups are used for an analysis of the age structure of any population, and are also useful for a wide variety of analytical purposes. Considering the age-sex ratio it may be broadly speaking that in terms of rural and urban area slow increasing trend of population observed from 0-24 age group and then above 24 age it is observed very steeply decreasing trend of population in Ahmednagar district. Highest percentage of male and female population found in the age group of 10-14 followed by 15-19 for rural area and it was 20-24 followed by 15-19 for urban area. It may be concluded that younger population is high and older population is very low in study area.

Key Words- Age-Sex Ratio, Age-Sex Pyramid, Rural, Urban Area.

Introduction:

Age and sex composition is an important aspect of demographic studies. Sex Ratio is the number of females per thousand males and number of males per thousand females. Age structure represents the proportion of population in each age group. Sex composition is the characteristics of sex ratio of the population of a defined geographical territory.Age composition are the characteristics of age structure of the population of a defined geographical territory. Age and Sex Composition of population is an important for analysis of other population attributes such as economic policies, planning for social service provision etc. It enables researchers and planners to analyze variations of socio-economic phenomena. Age composition portrays the trend of mortality, fertility, marital status, migration and helps in demographic analysis.

The data on the population by Age and Sex provides health administrators and demographers input for the planning and implementation of various developmental and health programs. Help in analyzing production and consumption pattern of various goods and services. Fertility, Mortality and Migration determines the age and sex structure of the population. The status of the women in the society greatly determines sex ratio. Decreasing trend of sex ratio in terms of total, rural and urban areas were observed in Ahmednagar district. Average Sex ratio is decreased from 1005 in 1901 to 939 in 2011. It was decreased from 1003 in 1901 to 938 in 2011 in rural area and it was decreased from 1021 in 1901 to 942 in 2011 for urban area.

1.1 The Study Area:

The Ahmednagar district has been selected for the study to present demographic research work. The map (s) 1 shows that location of the Ahmednagar district within Maharashtra. The district has irregular in shape and resembles a slanting cross with a length of 200 kms. and breath of 210 kms. It is surrounded by Nashik district to the north, Aurangabad district to the north-east, Beed district to the east, Osmanabad and Solapur district to the south, Pune district to the west and Thane district to the north-west. Ahmednagar district is the largest district of Maharashtra state in respect of area. It is situated partly in the upper Godavari basin and partly in the Bhima basin. The district occupying a somewhat central position in Maharashtra. Ahmednagar district extends between 18^0 2' North and 19^0 9' North latitudes and 73^0 9' East and 75^0 5' East longitudes.It covers an area of 1708 sq. kms. which is 5.54 per cent of the total Geographical area of Maharashtra state. The district consists 14 tahsil of Akole, Sangamner, Kopargaon, Shrirampur, Nevasa, Shevgaon, Pathardi, Nagar, Rahuri, Parner, Shrigonda, Karjat, Jamkhed and Rahata. It consists 1587 villages and 18 towns in which 11 statutory towns and 7 census towns. Urban population have been found in only 9 tahsil and remaining 5 tahsil totally as a rural in character.

Map-1

1.2 Objectives:

1. To examine average Age-Sex ratio of Ahmednagar district in 2011.
2. To analyze rural and urban Age-Sex ratio of Ahmednagar district in 2011
3. To analyze rural and urban Age sex-composition of Ahmednagar district in 2011.

1.3 Data Source And Methodology:

Generally data on Age and sex are collected in the censuses and surveys all over the world. The censuses are an important source of data on age and sex composition. A few international agencies such as UN publishes Demographic Yearbook which contains data regarding age and sex for different countries.

1.3.1 Sources Of Data On Age And Sex: Required data for Age and Sex ratio collected from secondary sources such as Ahmednagar district Census Handbook and Ahmednagar District Socio-Economic Review of 2011.

1.3.2 Methodology:

Measures To Analysis Of The Age-Sex Composition Of Population: There are number of measures used for an analysis of the age-sex composition are: percentage, average age (with the help of mean, median and mode) and a few other indices based on the distribution of persons in various age-groups. But out of them the age-sex composition of any population is most commonly and frequently studied by demographers and geographers with the help of a simple mathematical measure like the per cent distribution and an equally simple measure like the age pyramid. Therefore, the per cent distribution and the age-sex pyramid measures applied for present study of age-sex composition in Ahmednagar district.

1.4 Analysis Of Age-Sex Composition:

Basic graphical methods – Population Pyramid is a basic procedure for assessing the quality of census data on age and sex. Displays the size of population enumerated in each age group (or cohort) by sex. The base of the pyramid is mainly determined by the level of fertility in the population; while how fast it converges to peak is determined by previous levels of mortality and fertility. The levels of migration by age and sex also affect the shape of the pyramid.

1.5 Analysis of the Age-Sex Composition in Ahmednagar District (2011): Table -1 and fig.-1 shows the distribution of males and females' population of Ahmednagar district. It is given in five-year age group by residence and sex both in terms of absolute numbers and percentages. Respective table clearly reveals the age-sex distribution of population in terms of total, rural and urban areas. Population in five-year age-group illustrated with the help of 'age-sex population pyramids' by the fig. 1, 2 and 3 for total, rural and urban areas respectively.

1.6 Age-Sex Composition of Ahmednagar District: Table-1 shows that total population of Ahmednagar district was 4543159 in which 2342825 (51.57 per cent) males and 2200334 (48.43 per cent) females in 2011. It is evident from the respective table and fig.-1 that highest persons i.e., 444802 means 9.79 per cent included in 10 -14 age group in which 237754 (9.93 per cent) are males and 207048 (9.12 per cent) are females. Followed by 4,40,174 means 9.69 percent included in 20-24 age-group, 433199 means 9.54 per cent included in 15-19 age-group, 403465 means 8.88 per cent included in 5-9 age-group and 394258 means 8.68 per cent of population included in the age group of 0-4 years. The percentage of persons decreased from 9.79 per cent in age group of 10-14 to 1.06 per cent in age group of 75-79 years. Generally, it is observed that successively decreasing trend of percentage of persons from the age group of 10-14 years to 75-79.

Considering in terms of three broad age groups, 27.35 per cent population having (children under the working age) below 15 years age, 64.44 per cent persons are in the working age of 15 to 64 years and 8.21 per cent persons above the working age of 65 and above. It means that almost 64.44 per cent working population age group observed in this regard and around 35.56 per cent non-working population age group observed in study area.

It is evident from the table 5.19 and fig. 5.15 that highest percentage of males (10.15) and females (9.41) population contained in age group of 10-14 years. Followed by there are 9.93 per cent males and 9.12 per cent females' population contained in age group of 15-19 years and 9.73 per cent males and 9.65 percent females' population included in the age group of 20-24 years. Males and females' population decreased from 9.93 per cent and 9.12 per cent respectively in the age group of 15-19 years to 1.06 per cent and 1.13 per cent respectively in the age group of 75-79 years. Decreasing trend has been observed regarding percentage of males and females' population in Ahmednagar district. The percentage of the average population in the working age group (15-64 years) is 64.44 per cent and it is 63.84 per cent for males and 65.08 per cent for females. Non-working average population (age group 0-14 and 65 and above years) is 35.56 per cent and it was 36.16 per cent for males and 34.92 per cent for females.

1.7 Rural Age-Sex Composition of Ahmednagar District: Table-1 shows that total population of Ahmednagar district was 4543159 in which 3630542 (79.91 per cent) is rural in **Table-1:** Population in Five Year Age-Group by Residence and Sex of Ahmednagar District in 2011.

Sr. No.	Age-Group (Year)	Number	Number (N) and Percentage (%) of Population								
			Total			Rural			Urban		
		%	P	M	F	P	M	F	P	M	F
1	0-4	N	394258	212276	181982	320535	172934	147601	73723	39342	34381
		%	8.68	9.06	8.27	8.83	9.23	8.4	8.08	8.37	7.77
2	5-9	N	403465	217908	185557	324846	175534	149312	78619	42374	36245
		%	8.88	9.30	8.43	8.95	9.37	8.5	8.61	9.02	8.19
3	10-14	N	444802	237754	207048	359231	191788	167443	85571	45966	39605
		%	9.79	10.15	9.41	9.89	10.24	9.53	9.37	9.78	8.95
4	15-19	N	433199	232550	200649	345397	186250	159147	87802	46300	41502
		%	9.54	9.93	9.12	9.51	9.95	9.05	9.62	9.85	9.37
5	20-24	N	440174	227933	212241	345132	179614	165518	95042	48319	46723
		%	9.69	9.73	9.65	9.5	9.6	9.42	10.41	10.28	10.55
6	25-29	N	380662	195395	185267	296142	152470	143672	84520	42925	41595
		%	8.37	8.34	8.42	8.16	8.14	8.17	9.26	9.13	9.39
7	30-34	N	329685	165825	163860	257219	129195	128024	72466	36630	35836
		%	7.26	7.08	7.45	7.08	6.9	7.28	7.94	7.79	8.09
8	35-39	N	315851	157204	158647	248204	123508	124696	67647	33696	33951
		%	6.95	6.71	7.21	6.83	6.6	7.10	7.41	7.81	7.67

9	40-44	N	283292	144801	138491	223175	114361	108814	60117	30440	29677
		%	6.23	6.18	6.29	6.15	6.11	6.20	6.6	6.48	6.7
10	45-49	N	237417	122163	115254	186478	95747	90731	50939	26416	24523
		%	5.23	5.21	5.24	5.14	5.11	5.16	5.60	5.62	5.53
11	50-54	N	197150	101636	95514	155979	79645	76334	41171	21991	19180
		%	4.34	4.34	4.34	4.3	4.25	4.34	4.51	4.68	4.33
12	55-59	N	157098	78753	78345	125571	62238	63333	31527	16515	15012
		%	3.46	3.36	3.56	3.46	3.32	3.6	3.45	3.51	3.39
13	60-64	N	153129	69456	83673	126372	56787	69585	26757	12669	14088
		%	3.37	2.96	3.8	3.48	3.03	3.96	2.93	2.7	3.18
14	65-69	N	148526	68538	79988	125853	58141	67712	22673	10397	12276
		%	3.27	2.93	3.64	3.47	3.1	3.85	2.48	2.21	2.77
15	70-74	N	103388	51456	51932	88049	44274	43775	15339	7182	8157
		%	2.28	2.19	2.36	2.43	2.36	2.49	1.68	1.53	1.88
16	75-79	N	49618	24772	24846	41665	21016	20649	7953	3756	4197
		%	1.09	1.06	1.12	1.15	1.12	1.17	0.87	0.8	0.95
17	80>	N	56230	26401	29829	47748	22571	25177	8482	3830	4652
		%	1.24	1.13	1.36	1.32	1.21	1.43	0.93	0.82	1.05
18	Age Not Stated	N	15215	8004	7211	12946	6834	6112	2269	1170	1099
		%	0.33	0.34	0.33	0.36	0.36	0.35	0.25	0.25	0.25
Total Population		N	**4543159**	**2342825**	**2200334**	**3630542**	**1872907**	**17576635**	**912617**	**469918**	**442699**
			100.00	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Ahmednagar District Census Handbook 2011(Table C-14)

2011. It is evident from the respective table and fig.-2 that highest persons i.e., 359231 means 9.89 per cent included in 10 -14 age group in which 191788 (10.24 per cent) are males and

Fig. 1 : Age-Sex Pyramid of Ahmednagar District in 2011

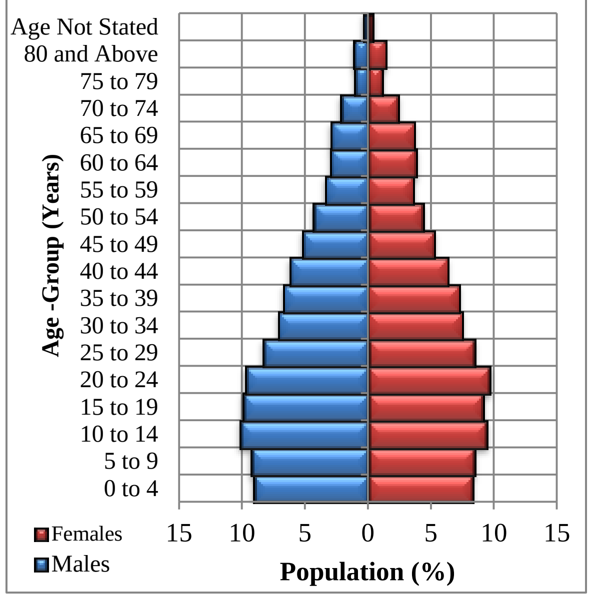
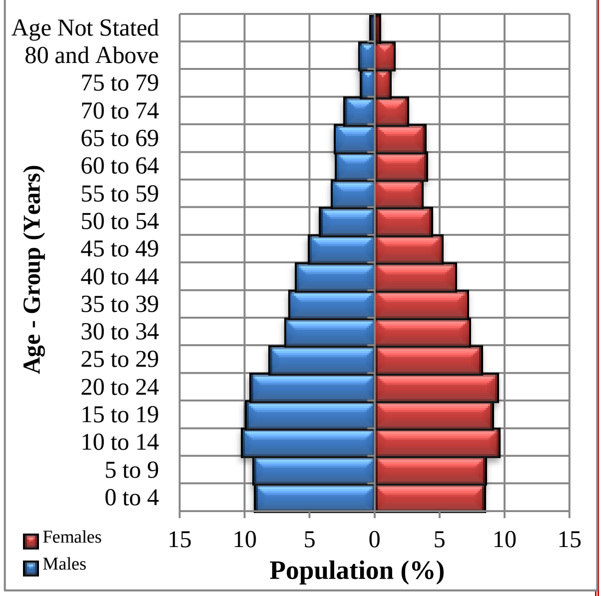


Fig. 2 : Rural Age-Sex Pyramid of Ahmednagar District in 2011

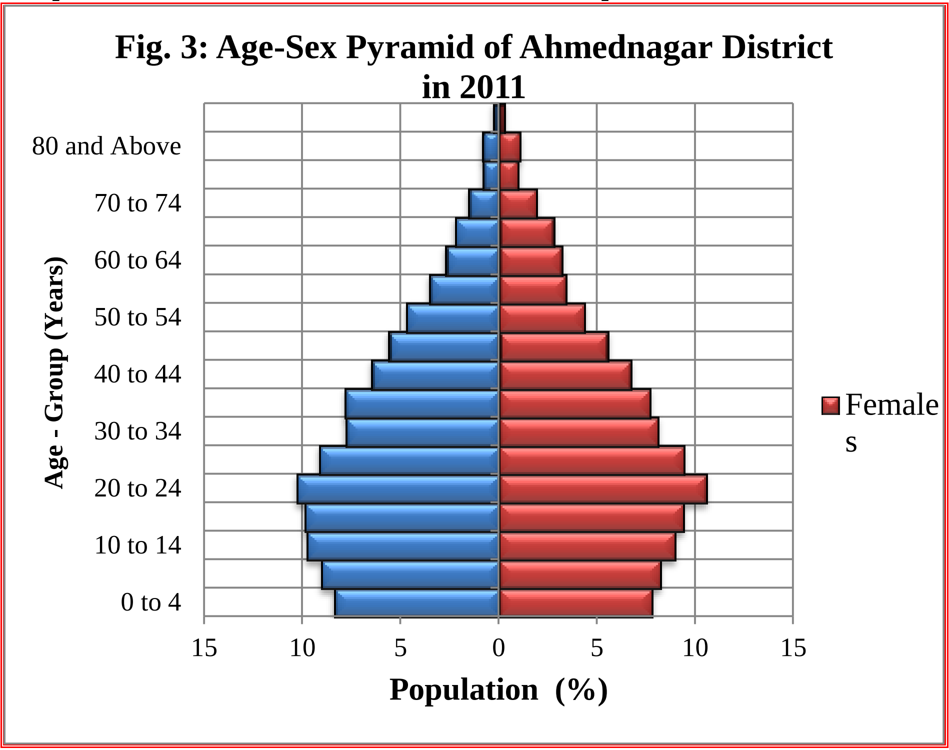


167443 (9.53 per cent) are females. Followed by 345397 people means 9.51 percent included in 15-19 age-group, 345132 persons means 9.50 per cent included in 20-24 age-groups, 324846 means 8.95 per cent included in 5-9 age-group and 320535 means 8.83 per cent of population included in the age group of 0-4 years. The percentage of persons from the age group of 10-14 to 75-79 years.

Considering in terms of three broad age groups, about 27.67 per cent population having (children under the working age) below 15 years age, 63.61 per cent persons are in the working age group of 15 to 64 years and 8.72 per cent persons above the working age of 65 and above. It means that almost 63.61 per cent working population and 36.39 per cent non-working population observed in study area. It is evident from the table -1 and fig.-2 that highest percentage of rural males (10.24) and females (9.53) population contained in age group of 10-14 years. Followed by there are 9.95 per cent males in the age group of 15-19 years, and

9.42 per cent females in age group of 20-24 years, 9.60 per cent for males in age group of 20-24 years and 9.05 per cent females in the age group of 15-19 years, 9.37 percent males and 8.5 per cent females in the 5-9 age group and 9.23 per cent males and 8.4 per cent females are included in the age group 0-4 years. Decreasing trend has been observed in 10-14 age group from 10.24 per cent for males and 9.53 per cent for females to 1.12 per cent for males and 1.17 per cent for females in age group of 75-79.

The percentage of the average rural population in the working age group (15-64 years) is 63.61 per cent and it is 63.01 per cent for males and 64.28 per cent for females. Non-working average population (age group 0-14 and 65 and above years) is 36.39 per cent and it was 36.99 per cent for males and 35.72 per cent for females.



1.8

Urban Age-Sex Composition of Ahmednagar District: Table-1 shows that total population of Ahmednagar district was 4543159 in which 912617(20.09 per cent) is urban in 2011. It is evident from the respective table and fig.-3 that highest persons i.e., 95042 means about 10.41 per cent included in 20 -24 age group in which 48319 (10.28 per cent) are males and 46723 (10.55 per cent) are females. Followed by 87802 means 9.62 per cent included in 15-19 age-group, 85571 persons means 9.37 per cent included in 10-14 age-group, 84520 means 9.26 per cent of population included in the age group of 25-29 years and 78616 persons means 8.61 per cent included in 5-9 age-group. The percentage of persons decreased from 10.41 per cent in age group of 20-24 to 8.08 per cent in 0-4 age group and 0.87 per cent in age group of 75-79 years. Generally, it is observed that percentage of population decreased successively from age group of 20-24 years to the lowest (0-14 age group) and highest (75-79 age groups). Fluctuations are occurred in percentage of persons included in various age-groups. Considering in terms of three broad age groups, about 26.06 per cent population having (children under the working age) below 15 years age, 67.73 per cent persons are in the working age group of 15 to 64 years and 6.21 per cent persons above the working age of 65 and above. It means that 67.73 per cent working population and 32.27 per cent non-working population observed in study area. It is evident from the table 1 and fig. 5.17 that highest percentage of males (10.28) and females (10.55) population contained in age group of 20-24 years. Followed by there are 9.85 per cent males in age group of 15-19 years and 9.39 per cent females' population contained in age group of

25-29 years, 9.78 per cent males and 8.95 percent females' population included in the age group of 10-14 years. Males and females' population decreased from 10.28 per cent and 10.55 per cent respectively in the age group of 20-24 years to 0.8 per cent and 0.95 per cent respectively in the age group of 75-79 years. Fluctuating and decreasing trend has been observed regarding percentage of males and females' population in Ahmednagar district. The percentage of the average urban population in the working age group (15-64 years) is 67.73 per cent and it is 67.85 per cent for males and 68.20 per cent for females. On-working average urban population (age group 0-14 and 65 and above years) is 32.27 per cent and it was 32.78 per cent for males and 31.81 per cent for females.

Conclusions:

Considering the age-sex ratio it may be summarized that in terms of rural and urban area, slow increasing trend of population observed from 0-24 age group and then above 24 ages it is observed very steeply decreasing trend of population in Ahmednagar district. Highest percentage of male and female population found in the age group of 10-14 followed by 15-19 for rural area and it was 20-24 followed by 15-19 for urban area. It may be concluded that younger population is high and older population is very low in study area.

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Automation in meliorated Forest Change Detection based on Landsat Satellites in the Upper Mutha basin, Pune District

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Abstract

Automation is a major key component in geospatial technologies. It provides ease while dealing with large-scale studies, and enhances yield precision in decision-making processes. Landsat satellites have proven the Earth's surface land monitoring strength. Forest Change Detection (FCD) is one of the monitoring elements with proficient precision. Normalized Difference Vegetation Index (NDVI) trad approach-based FCD has been calculated from Landsat – 5 Thematic Mapper (TM) 1992, Landsat – 7 Enhanced Thematic Mapper Plus (ETM+) 2002, and Landsat – 8 Optical Land Imager & Thermal Infrared Sensors (OLI & TIRS) 2013 respectively. Overall changes in the studied area indicate positive changes at 12.93% & 62.64%; no change at about 43.22% & 33.01%, and negative changes at 43.85% & 04.35% with 70.81 overall accuracies. NDVI-based FCD has limitations like non-eliminated reflectance errors leading to false-positive results therefore, multi-band Tasseled Cap Coefficient Transformation (TCCT)has been used for meliorated FCD. The new approach eliminated known errors and include the application of a Feature Manipulation Engine (FME) to automate FCD through the combination of Artificial Intelligence (AI) and Machin Learning (ML). About 49.03% & 55.05% of estimated land indicate stable vegetation, 35.61% & 24.78% positive change, and 15.37% & 20.17% negative change with a more prominent 88.20% overall accuracy. The second approach has proven meliorated FCD proficiency and effective applicability for sustainable forest management.

Keywords: *Automation, Forest Change Detection, Landsat, FME, AL & ML*

Introduction

Earth's surface (on the land, water bodies surface, etc.), and underneath water bodies are covered with various plant species. Plants have evolved from single cells and multi-cells gradually over a period of time and have the capability to grow illimitable extent in favorable conditions. An accumulation of plant species known as vegetation cover. A canopy of vegetation in nearly undefine areas on the land surface produce forest. The vegetation which is diverse in density, root types, root depth, height, leaf types, leaves colours, patterns, and trunk patterns makes it unique as a determinant factor in the form of forests. It is a community of living beings that are mitigating, interacting, and collaborating, etc. with the physical environment and has complexities with self-regenerating capacities. Forest covers approximately 30% Carlowicz (2012) to 31% Food and Agriculture Organization (FAO 2015) of the earth's surface Healey et al. (2008); Virk and King (2006); Bauer et al. (1994). Forest is a natural generator of organic carbon and it helps to hold control of global climate, and biodiversity it manages natural hazards like floods, landslides, soil erosion, etc. Since the evolution of plants, they become wildlife habitats naturally. Forest is an effective asset that regulates various cycles including atmospheric, nutrient, hydrological, etc., and conserves the adequate quality of air, freshwater, and soil, Sonawane and Bhagat (2017); Southworth (2004). Estimated natural forest land is nearly 33.36 million km² per World Resources Institute (WRI) to

39.88 million km² per World Conservation Monitoring Centre (WCMC) without marine forests Fettig et al. (2007); Sonawane and Bhagat (2017); Kumsap et al. (2005); Mishra et al. (2003); Forkuo and Frimpong (2012).

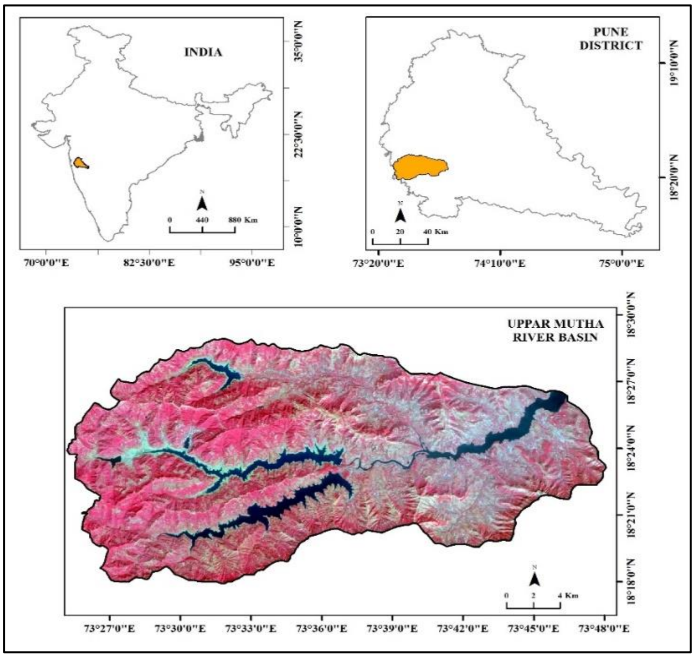
Even so, in the previous, some decades forest devastation and land appropriation increased rapidly globally Turker and Derenyi (2000). Forests are vanishing at an over-the-top and obstinately relentless rate. In 2021, the world lost 3.75 million hectares of tropical primary rainforest areas of critical importance for carbon storage and biodiversity per WRI (2022). The total forest cover in India is 7,13,78,900 hectares which is 21.71% and declined 1,58,200 hectares of the Total Geographical Area (TGA) ISFR (2022); FSI (2022) due to soil degradation, deforestation, imbalanced climatic conditions, desertification, continuous pressures of an exploding population and the subsequent domestic needs including food, fuel, fodder, timber as well as industrial demands and water stresses in drought conditions Sonawane and More (2022); Keenan et al. (1999). Notably, 17% of the rural population in India depends on forests to meet their domestic energy Drescher and Perera (2010). Many research scholars and analysts have reported that automation is a major key component in geospatial technologies Healey et al. (2008); Kennedy et al. (2009).

It helps cater to bast easily while dealing with large-scale studies and enhances yield precision in decision-making processes. Landsat satellites have proven the Earth's surface land monitoring strength. Forest Change Detection (FCD) is one of the monitoring elements with proficient precision Sonawane and More (2022). Reliable FCD analysis remains a challenging approach that can provide analytical data for forest degradation and conservation Pouliot et al. (2002); Coppin et al. (2004); Sommer et al. (2011); Schwilch et al. (2011); Bhagat (2012). Therefore, modified change detection technology was designed for this study based on field checks and statistical analyses to get a more precise analysis of forest changes Southworth, (2004). The Landsat-5 TM, Landsat-7 ETM+, and Landsat-8 OLI & TIRS datasets have been used for the detection of changes in forest cover in the study area. Two approaches have been adopted for this analysis: Approach I) Traditional NDVI based post-classification technique and Approach II) Improved multi-spectral post-classification technique Chandio and Matori (2011). Overall changes in the forest were detected using (Equation 1) traditional NDVI based post-classification techniques Fettig et al. (2007), whereas normalized indices and coefficients were used for the improved multi-spectral post-classification approach of change detection Sonawane and Bhagat (2017).

Study Area

The current study is executed in the study area Upper Mutha basin of the Pune district. Upper Mutha basin is situated (Figure 1) between latitude 18° 17' 53.01" to 18° 28' 45.33" N and longitude 73° 25' 03.57" to 73° 48' 2.98" E as per Survey of India (SOI) Toposheets scaled at 1:50000 i.e., 47 F/7, 47 F/11 and 47 F/15. The altitude varies from 500 to 1320 m Mean Sea Level (MSL). The Total Geographical Area (TGA) has covered 63,745.32 hectares. Geologically, this area is covered with basaltic lava as a part of the Deccan trap and formed by basaltic rock Gareeau et al. (2009) which prevents water to percolate.

The depth and water-holding capacity of soils in the region Zolekar and Bhagat (2015) vary according to variations in slopes. Geographically the study area has



covered the Sahyadri mountain range in the western region, loamy soil in the middle, and a plain area in the eastern region of the study area. The forest cover varies by height, slopes, soil quality, rainfall, etc. Foothill zones in Western parts show more dense forests than hilltops with thin soils. The area is irrigated/drained by the Mutha river and its tributaries. Average annual rainfall is 1208.5 mm as per the Indian Meteorology Department (IMD) characterized by hot in summer, dry and cold in winter, and rain during southwest monsoon seasons Sonawane and More (2022).

Data and Software

The FCD analyses are carried out based on statistical models Shalaby et al. (2006), remotely sensed satellite data Golmehr (2008) and extensive deep learning field validation, etc. Landsat series (Figure 2) satellite data i.e., Landsat-5 TM (04th Dec. 1992), Landsat-7 ETM+ (24th Dec. 2002), and Landsat-8 OLI & TIRS (14th Dec. 2013) downloaded from opensource USGS platform and been utilized in detection of forest cover changes. The verification of inferences has been completed using field-collected data. Google Earth Engin (© Google) historical images and Garmin's Global Positioning System (GPS) unit were utilized for ground checks. Area of Interest (AOI) processed through ArcGIS Pro (© Esri), ERDAS Imagin (© Hexagon), and FME software (© Safe). The automation process flow (Figure 18 and Figure 19) has been designed in the Bizagi Modeler (© Bizagi). Area shape has been generated in ArcGIS Pro, Raster operations such as subset, layer stack, ratio indices calculation, tasseled cap coefficient, etc. processed in ERDAS Imagine and end2end automation through ML like define algorithms, variety of mechanism, services integration, configuration validation, etc. has designed in the FME software Sonawane and More (2022). Statistical correlation techniques were executed using 'Karl Pearson techniques' Chen et al. (2001); Yang et al. (2014) using SPSS (© IBM) Zhang et al. (2002); Fastring and Griffith (2009), and last but not least the writing part has been taken care through Microsoft Office (© Microsoft) software.

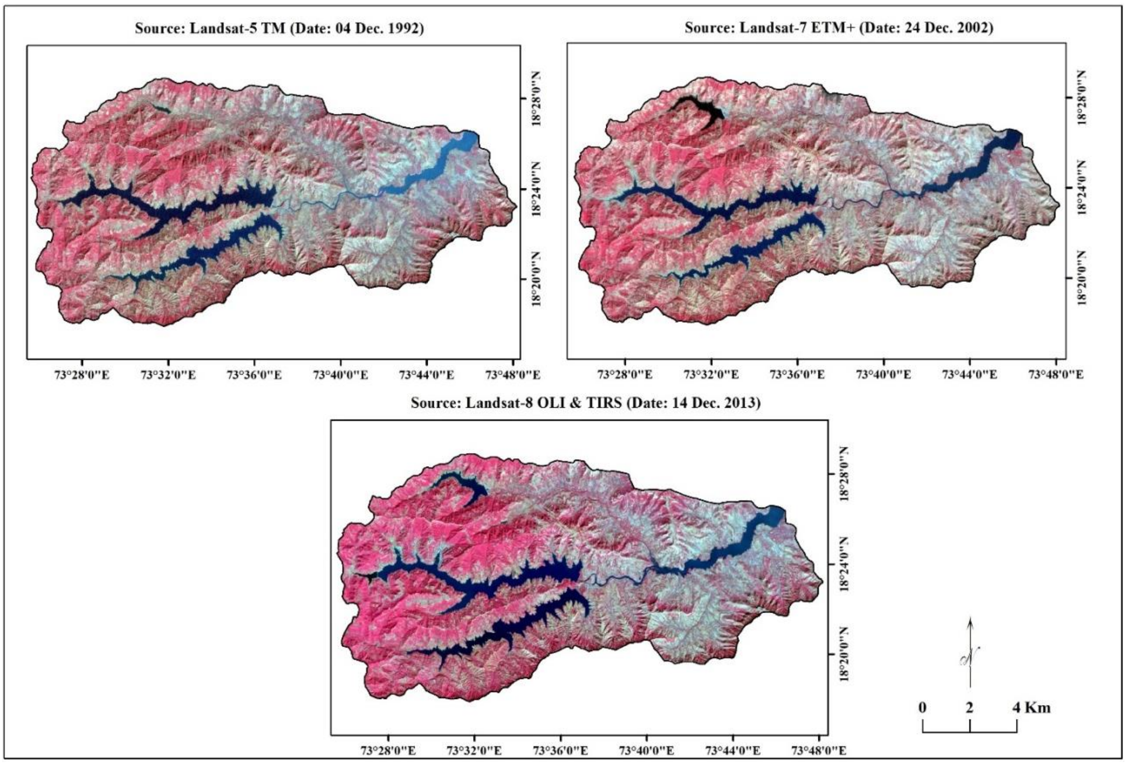


Figure 2: Landsat series False Colour Composite (FCC) imageries

Methodology and Approaches

Two major approaches are used to detect changes in forest cover: Approach I - Traditional NDVI based post-classification technique and Approach II - improved multi-spectral post-classification technique. An accuracy assessment was performed and the results of analyses were compared to check the applicability of the approaches. Statistical techniques were useful to inculcate robustness in the analysis for change detection Theiler and Perkins (2011). Automation in configuration, integration, and services collaboration has been set and tested accordingly Sonawane and More (2022).

The approach I - Traditional NDVI based post-classification technique

Since a long time, NDVI index widely used to detect vegetation cover on the land surface. Many research scholars extensively utilized this approach in various studies and land management Silleos et al. (2006). Therefore, NDVI (Equation 1) index has been calculated using band-3 (Red) and band-4 Near Infrared (NIR) for Landsat-5 TM, Landsat-7 ETM+ data, and band-4 (Red) and band-5 (Near Infrared) for Landsat-8 OLI & TIRS data (Figure 6).

$$\boldsymbol{NDVI} = \frac{(NIR-RED)}{(NIR+RED)} \quad (1)$$

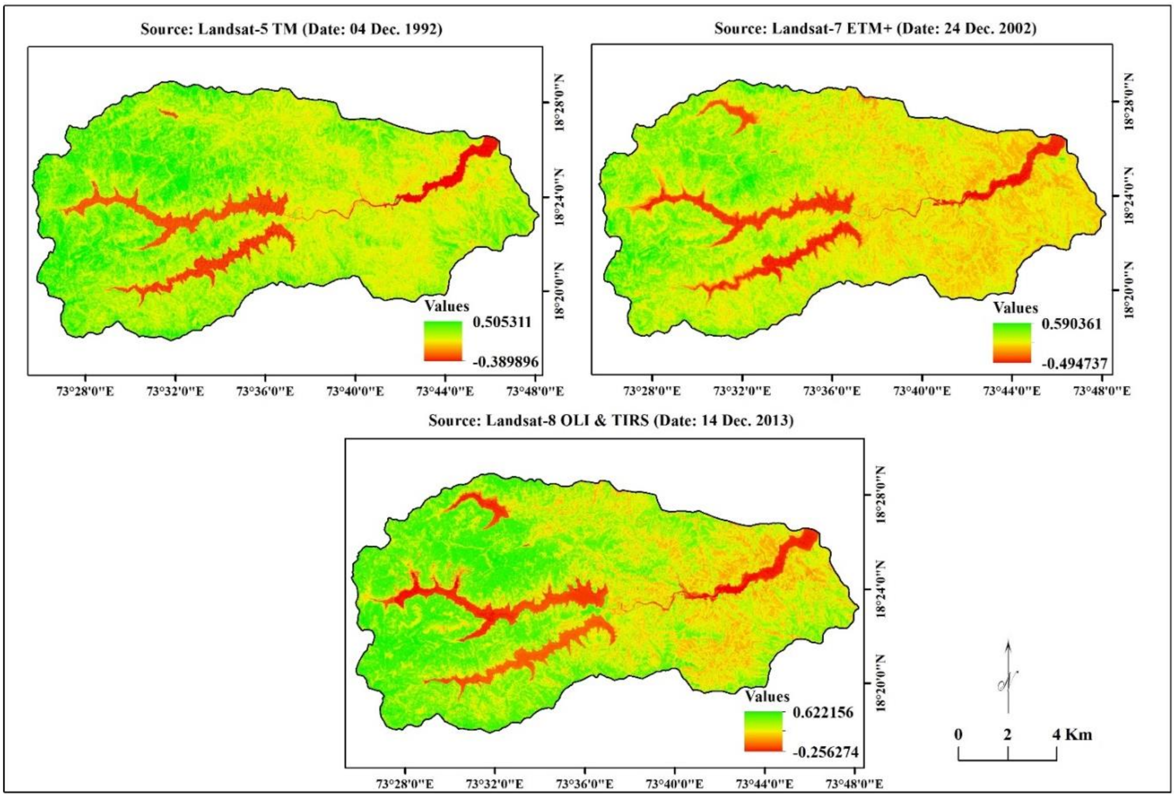


Figure 3: NDVI Index

Processed NDVI values lie between -1 to +1 based on the reflected Digital Number (DN) of band red and NIR. A maximum value near +1 represents dense vegetation and a minimum value of NDVI indicated low or absence of vegetation cover (Figure 3).

Table 1: NDVI domain classes of ground truth

Sr. No.	Classes	Landsat-5 TM 1992	Landsat-7 ETM+ 2002	Landsat-8 OLI & TIRS 2013
1	No vegetation	Below -0.15	Below -0.17	Below -0.16
2	Low to medium	-0.16 to -0.05	-0.17 to -0.03	-0.16 to -0.06
3	Medium	-0.05 to 0.03	-0.03 to 0.05	-0.06 to 0.04
4	Medium to dense	0.03 to 0.18	0.05 to 0.20	0.04 to 0.17
5	Dense to very dense	0.18 to 0.51	0.20 to 0.59	0.17 to 0.62

The processed output is broadly sorted into five (Table 1) i.e., no-vegetation, low to medium, medium, medium to dense, and dense to very dense, utilizing threshold celebrated in NDVI 1992, 2002, and 2013 images using sub-groping in Erdas. The maximum value (0.51 and 0.59) in the reference image (NDVI 1992 (t_1)) and (NDVI 2002 (t_2)) was detected for dense vegetation whereas the minimum value (-0.39 and -0.49) for rocky and barren land including water body. The targeted image (NDVI 2013 (t_3)) depicts the maximum value (0.62) for dense vegetation and the minimum (-0.26) for no vegetation.

Table 2: NDVI Classification (Area Hectare)

Sr. No.	Classes	L5-1992	% L5-1992	L7-2002	% L7-2002	L8-2013	% L8-2013
1	Water body	4423.59	6.94%	5968.64	9.36%	7322.13	11.49%
2	No-vegetation	6011.91	9.43%	16100.48	25.26%	7661.52	12.02%
3	Low to medium	15866.63	24.89%	15654.52	24.56%	10409.40	16.33%
4	Medium	20691.26	32.46%	16648.77	26.12%	13708.27	21.50%
5	Medium to dense	11690.33	18.34%	7888.14	12.37%	14026.66	22.00%
6	Dense to very dense	5061.35	7.94%	1484.58	2.33%	10616.94	16.66%
	Total	**63,745**	**100**	**63,745**	**100**	**63,745**	**100**

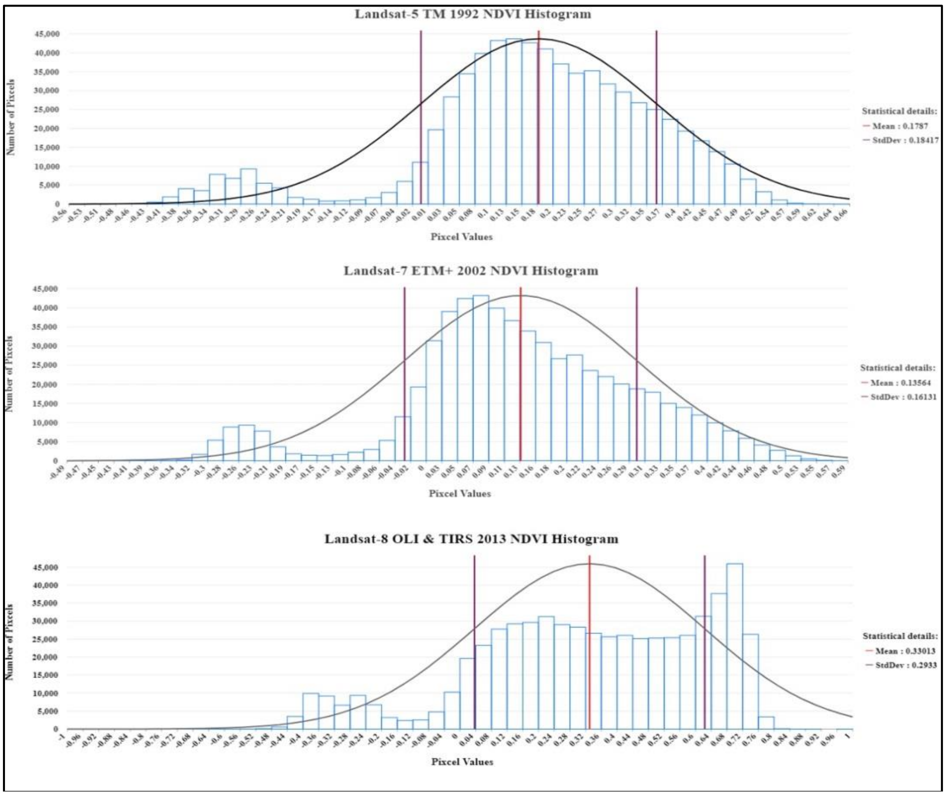


Figure 4: Histogram of NDVI values distribution

As per Adegoke and Carleton (2002) that the innovative hybrid image classification technique limit values of NDVI classes for change detection analysis of the forest. Therefore, images from 1992, 2002, and 2013 (Table 1) were determined based on insistent field validation using Google Earth Engine historical high-resolution images, GPS data, and FCC (Figure 2). A statistical representation of the histogram (Figure 4) depicting the change in calculated values of NDVI respectively.

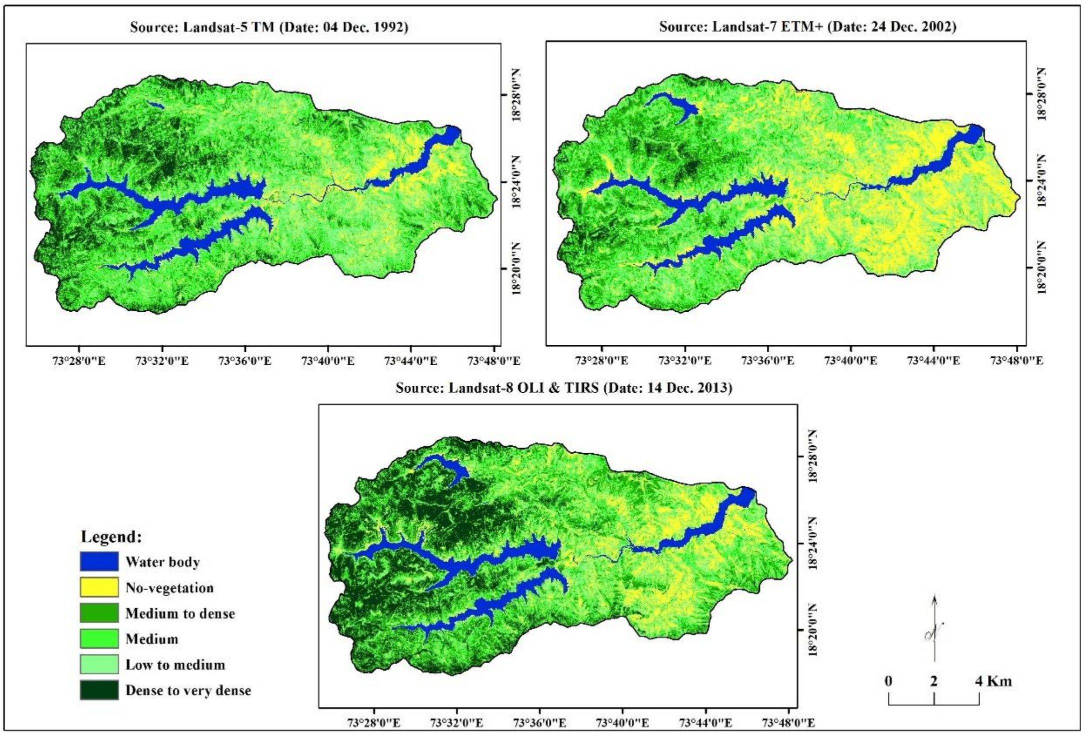


Figure 5: NDVI classified images

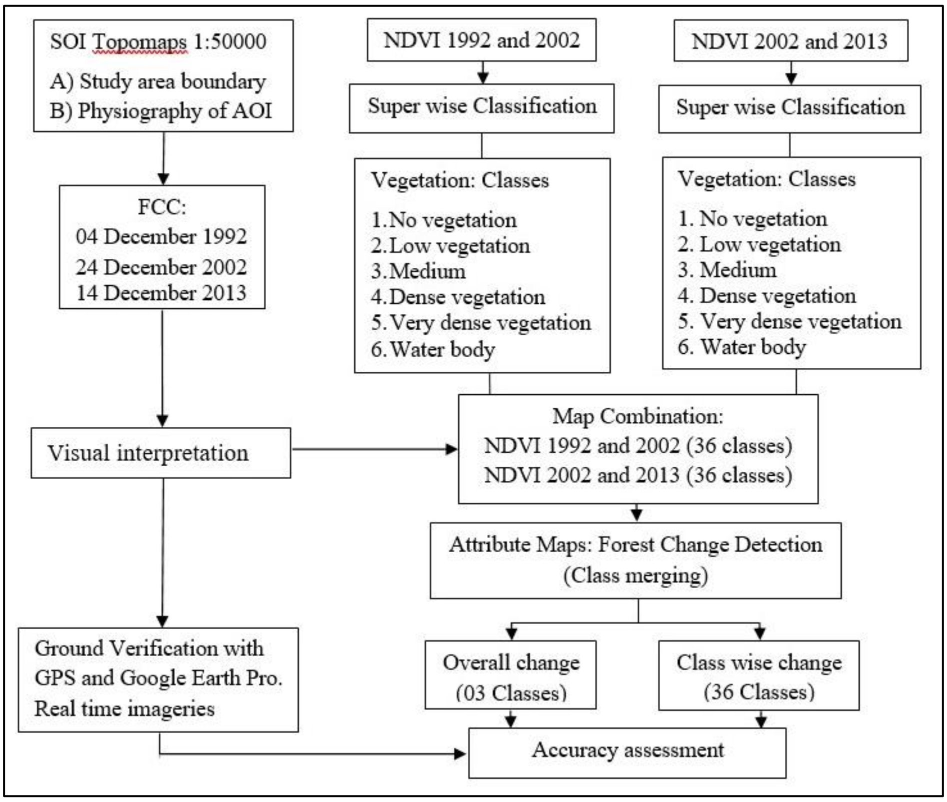


Figure 6: Approach -I Traditional NDVI based post-classification process flow

The deviation between vegetation land classes for the first 10 years i.e., in the reference NDVI 1992 (t_1) and targeted NDVI 2002 (t_2) images; in the next 11 years i.e., in the reference NDVI 2002 (t_2) and targeted NDVI 2013 (t_3) images based on the changes in the reflectance radiance known as forest change detection Weng et al. (2009). The difference in the reflectance radiance primarily happened due to divergence in weather, actual land classes transfer, the difference in sensing element calibration, error in Route Mean Square (RMS) at georeferenced data, soil moisture, etc.

Table 3: Combination of vegetation classes for overall change

Reference Classes	Targeted Classes					
	Water body	No-vegetation	Low to medium	Medium	Medium to dense	Dense to very dense
Water body	No Change	Positive Change	Positive Change	Positive Change	Positive Change	Positive Change
No-vegetation	Negative Change	No Change	Positive Change	Positive Change	Positive Change	Positive Change
Low to medium	Negative Change	Negative Change	No Change	Positive Change	Positive Change	Positive Change
Medium	Negative Change	Negative Change	Negative Change	No Change	Positive Change	Positive Change
Medium to dense	Negative Change	Negative Change	Negative Change	Negative Change	No Change	Positive Change
Dense to very dense	Negative Change	Negative Change	Negative Change	Negative Change	Negative Change	No Change

Table 4: Vegetation classes combination for class-wise change

Reference Classes	Targeted Classes					
	Water body	No-vegetation	Low to medium	Medium	Medium to dense	Dense to very dense
Water body	WBNoC	WBPNV	WBPL	WBPM	WBPD	WBPVD
No-vegetation	NVNWB	NVNoC	NVPL	NVPM	NVPD	NVPVD
Low to medium	LNWB	LNNV	LNoC	LPM	LPD	LPVD
Medium	MNWB	MNNV	MNL	MNoC	MPD	MPVD
Medium to dense	DNWB	DNNV	DNL	DNM	DNoC	DPVD
Dense to very dense	VDNWB	VDNNV	VDNL	VDNM	VDND	VDNoC

*Refer - Abbreviations or Table 5 and Table 12 for details.

In the approach one NDVI classified image i.e., t_1, t_2, and t_3 were compounded with a one-to-many relationship of each class in the ArcGIS Pro (Figure 5) combination method. The combination method yields 36 classes i.e., t_1 * t_2 and t_2 * t_3 classes. The overall change produced through three major classes viz. no-change, positive change, and negative change in forest cover (Table 2) applying 're-classification'. Overall change classes have further narrowed down at the micro level (Figure 7 and Figure 8) and forest cover changes detected at the micro-scale (Table 5). However, the accuracy assessment indicated that the overall accuracy was approximated at about 70.81%. This is a traditional forest change method used in many aspects from the micro level to the mass level nowadays Rozenstein and Karnieli (2011) without eliminating the false positive impacts. Therefore, a new approach has been tested based on statistical methods.

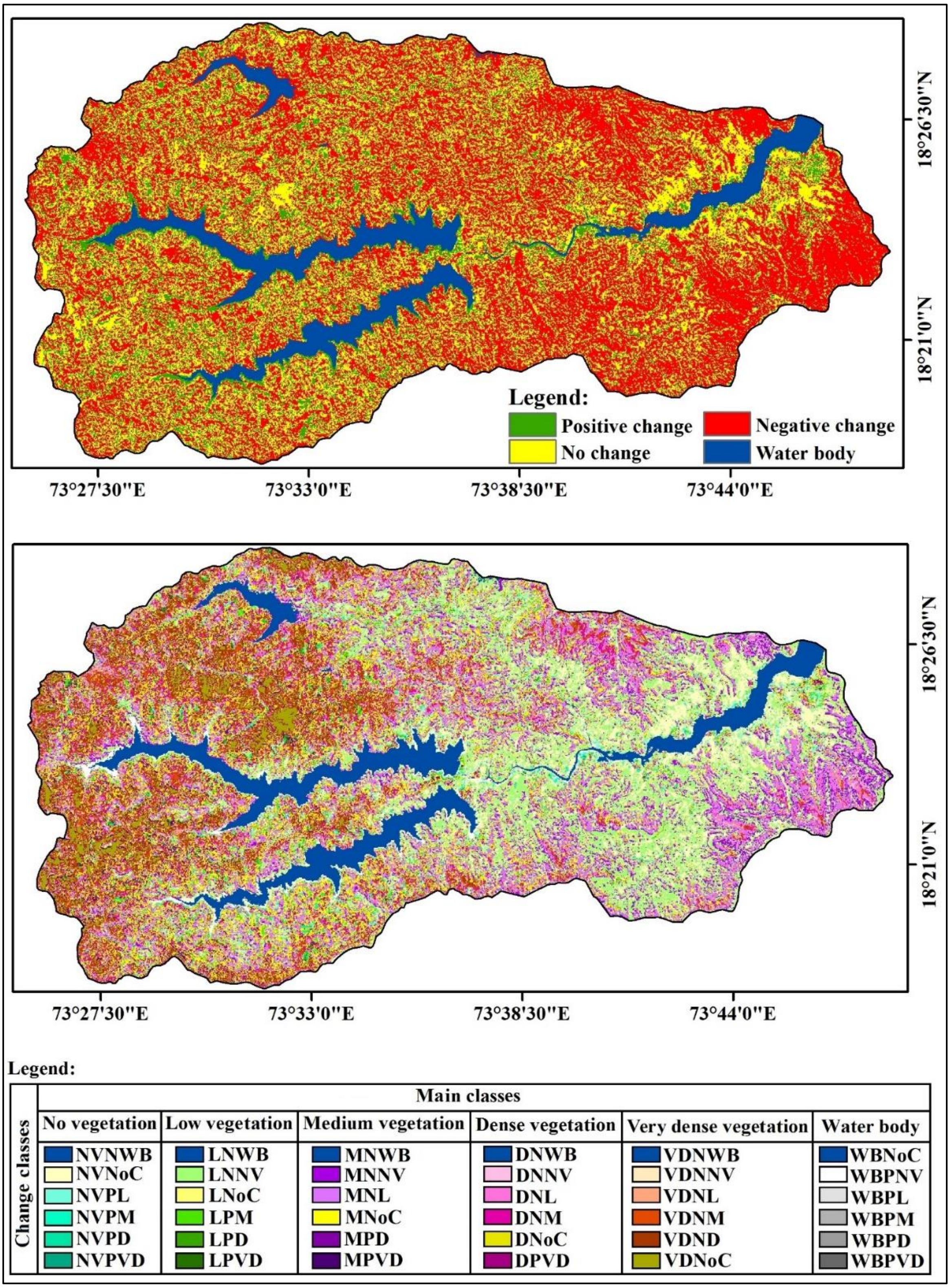


Figure 7: NDVI based FCD between 1992 and 2002 (Overall and Micro classes)

Approach II - Improved multi-spectral post-classification technique

There are various approaches available for land change detection analysis and they are successfully tested Weng et al. (2009); Cano et al. (2006); Pu et al. (2008). The improved multi-spectral change (Figure 11) derived from multiple steps i.e., a) Ground Reference Digital

Number (GRDN) sampling Lu et al. (2011), b) Statistical algorithms Chapelle et al. (2002), c) Multi-spectral indices normalization Singh (1989), d) Improved change detection Dhakal et al. (2002), and e) Accuracy assessment Turker and Derenyi (2000). Altogether this new approach has been named Mechanical Error Estimations Techniques (MEET).

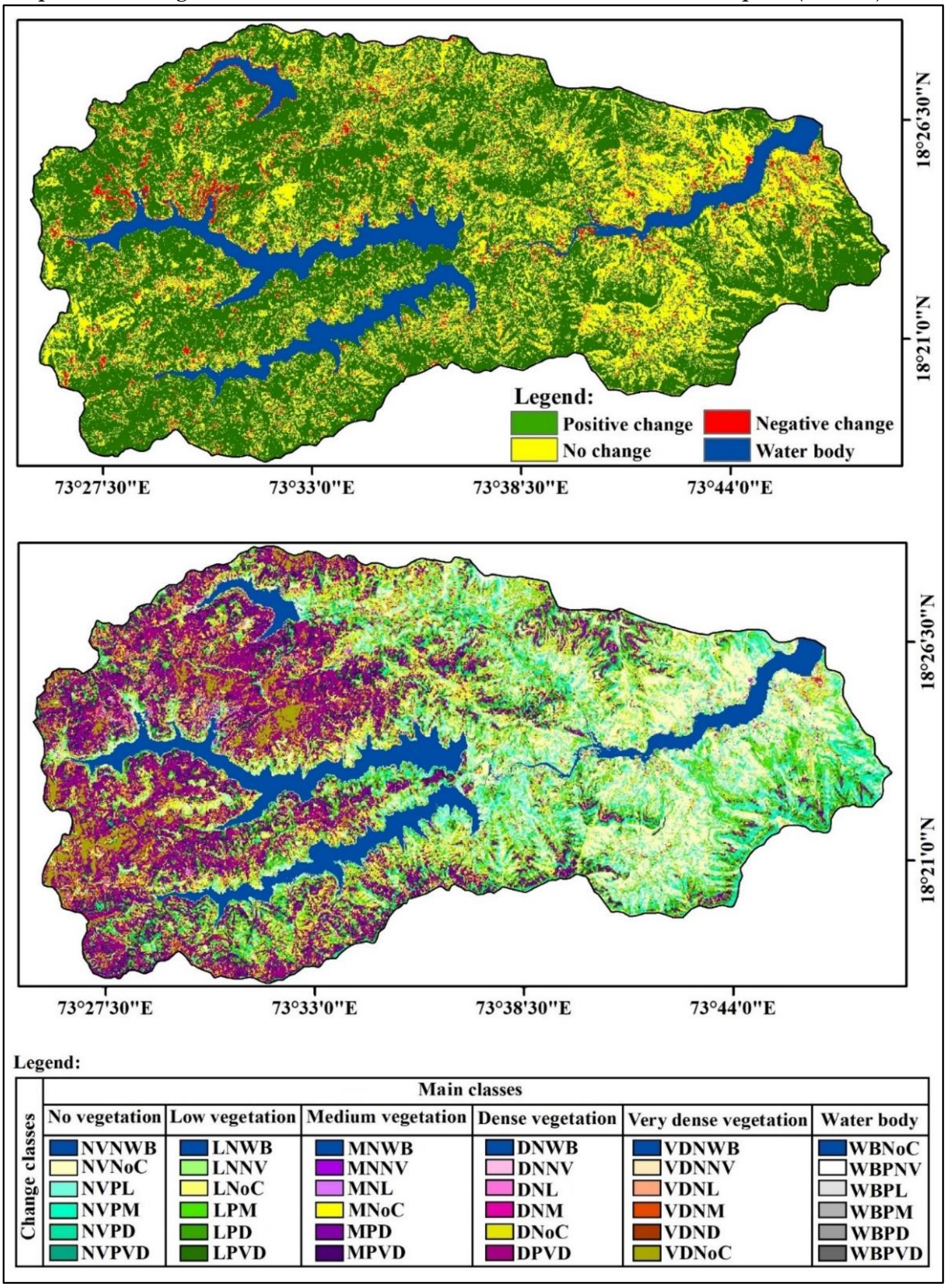


Figure 8: NDVI based FCD between 2002 and 2013 (Overall and Micro classes)

a)
Ground Reference Digital Number (GRDN) sampling

This sampling method has been designed to extract the unique DN (Figure 10) from the different objects of stable land surface e.g., desert lands, rocky lands, marshlands, barren lands, forests, snow covers, water bodies, etc. Statistical methods have been applied to the gathered data from individual band data, multi-spectral bands, coefficient, and ratio indices Felkar et al. (1981). The detection pattern of land changes appears differently due to variations in the object radiance and their surface reflectance Chen et al. (2012). A total of 200 unique samples have been collected from stable land of reference L-5 TM 1992 (t_1) image viz. barren land, rocky land, water bodies, and forest, etc. based on the GRDN (Figure 9) to normalize targeted images i.e., L-7 ETM+ 2002 (t_2) and L-8 OLI & TIRS 2013 (t_3). Land surface classes detected through this method are authentic and more precise Lu et al. (2011). Multi-spectral analysis has the potential to detect land classes using thresholds. Tasseled Cap Coefficient Transformations (TCCTs) reduce the atmospheric noise from the targeted images. The greenness index has been used to calculate forest cover of the study area Ghosh et al. (2010) using coefficients estimated by Crist et al. (1986) for L-5 TM, Huang et al. (2002) for L-7 ETM+, and Baig et al. (2014) for L-8 OLI & TIRS (Table 8). These transformations simply reduce the number of radiance noise density and provide high association in single response Silleos et al. (2006); Sonawane and Bhagat (2017).

$$\boldsymbol{Greenness}\ (\boldsymbol{TM}) = \sum((\text{Band1} * (-0.2728)) + (\text{Band2} * (-0.2174)) + (\text{Band3} * (-0.55080)) + (\text{Band4} * (0.7221)) + (\text{Band5} * (0.0733)) + (\text{Band7} * (-0.1648)) \quad (2)$$

$$\boldsymbol{Greenness}\ (\boldsymbol{ETM}+) = \sum((\text{Band1} * (-0.3344)) + (\text{Band2} * (-0.3544)) + (\text{Band3} * (-0.4556)) + (\text{Band4} * (0.6966)) + (\text{Band5} * (-0.0242)) + (\text{Band7} * (-0.2630)) \quad (3)$$

$$\boldsymbol{Greenness}\ (\boldsymbol{OLI\&TIRS}) = \sum((\text{Band1} * (-0.2941)) + (\text{Band2} * (-0.2430)) + (\text{Band3} * (-0.5424)) + (\text{Band4} * (0.7276)) + (\text{Band5} * (0.0713)) + (\text{Band7} * (-0.1608)) \quad (4)$$

Table 5: Micro Level Forest Change Detection Based on NDVI Classification (Area Hectare)

Overall Change	Micro Classes	NDVI 1992	NDVI 2002	NDVI 2013	1992 To 2002	2002 To 2013	% 1992 To 2002	% 2002 To 2013
Positive change	MPD	Medium	Medium to dense	Medium to dense	1898.84	7509.34	2.98%	11.78%
Positive change	LPD	Low to medium	Medium to dense	Medium to dense	466.21	2360.34	0.73%	3.70%
Positive change	LPM	Low to medium	Medium	Medium	2231.03	6926.31	3.50%	10.87%
No change	DNoC	Medium to dense	Medium to dense	Medium to dense	3956.86	1696.86	6.21%	2.66%
No change	MNoC	Medium	Medium	Medium	6961.87	3538.26	10.92%	5.55%
Negative change	DNM	Medium to dense	Medium	Medium	3941.82	348.66	6.18%	0.55%
Negative change	VDNM	Dense to very dense	Medium	Medium	1445.06	25.83	2.27%	0.04%
Positive change	NVPM	No-vegetation	Medium	Medium	519.4	2864.35	0.81%	4.49%
Positive change	NVPL	No-vegetation	Low to medium	Low to medium	1325.63	5816.17	2.08%	9.12%
Negative change	MNL	Medium	Low to medium	Low to medium	6579.72	501.3	10.32%	0.79%
Negative change	VDND	Dense to very dense	Medium to dense	Medium to dense	2373.59	72.63	3.72%	0.11%
Negative change	DNL	Medium to dense	Low to medium	Low to medium	1891.08	72.72	2.97%	0.11%
Positive change	DPVD	Medium to dense	Dense to very dense	Dense to very dense	421.48	6096.34	0.66%	9.56%
No change	LNoC	Low to medium	Low to medium	Low to medium	5610.88	4107.33	8.80%	6.44%
Positive change	NVPD	No-vegetation	Medium to dense	Medium to dense	154.99	1381.87	0.24%	2.17%
Negative change	VDNL	Dense to very dense	Low to medium	Low to medium	643.35	5.4	1.01%	0.01%
Positive	MPVD	Medium	Dense to very	Dense to very	209.44	3881.53	0.33%	6.09%

change			dense	dense				
Negative change	LNNV	Low to medium	No-vegetation	No-vegetation	6374.81	881.64	10.00%	1.38%
No change	VDNoC	Dense to very dense	Dense to very dense	Dense to very dense	2029.87	1375.2	3.18%	2.16%
Negative change	MNNV	Medium	No-vegetation	No-vegetation	3286.89	198	5.16%	0.31%
No change	NVNoC	No-vegetation	No-vegetation	No-vegetation	4594.33	6455.61	7.21%	10.13%
Negative change	DNNV	Medium to dense	No-vegetation	No-vegetation	504.72	39.78	0.79%	0.06%
Positive change	LPVD	Low to medium	Dense to very dense	Dense to very dense	98.54	1317.88	0.15%	2.07%
Negative change	VDNNV	Dense to very dense	No-vegetation	No-vegetation	182.02	2.43	0.29%	0.00%
Negative change	NVNWB	No-vegetation	Water body	Water body	213.57	536.94	0.34%	0.84%
Negative change	LNWB	Low to medium	Water body	Water body	179.73	61.02	0.28%	0.10%
Negative change	MNWB	Medium	Water body	Water body	97.84	20.34	0.15%	0.03%
Negative change	DNWB	Medium to dense	Water body	Water body	130.24	3.78	0.20%	0.01%
Positive change	WBPNV	Water body	No-vegetation	No-vegetation	469.17	484.06	0.74%	0.76%
No change	WBNoC	Water body	Water body	Water body	4398.22	3871.17	6.90%	6.07%
Negative change	VDNWB	Dense to very dense	Water body	Water body	104.77	0.09	0.16%	0.00%
Positive change	WBPM	Water body	Medium	Medium	78.25	37.86	0.12%	0.06%
Positive change	WBPL	Water body	Low to medium	Low to medium	88.65	806.48	0.14%	1.27%
Positive change	NVPVD	No-vegetation	Dense to very dense	Dense to very dense	88.08	445.54	0.14%	0.70%
Positive change	WBPD	Water body	Medium to dense	Medium to dense	103.78	1.62	0.16%	0.00%
Positive change	WBPVD	Water body	Dense to very dense	Dense to very dense	90.18	0.45	0.14%	0.00%
				Total	**63,745**	**63,745**	**100%**	**100%**

Basically, the estimated value of the stable land like waterbody absorbing maximum radiation and emitting a very small amount of energy Nemani et al. (1993) thus usually appears black body in the satellite image. Water appears blue-green or blue due to maximum reflectance of shorter wavelength and is viewed as dark because of reflectance of red and near-infrared depending on the amount of the suspended sediment in water Fletcher and Everitt (2007). Rocky land reflects the maximum amount of radiation as compared to barren land; hence it appears bright (Figure 10). Rocky lands are purely dry and rarely covered by thin grass and algae in wet seasons. However, rocky lands absorb a very low amount of visible as well as NIR waves and reflect maximum as compared to other classes Majed et al. (2011). Vegetation cover reflects the maximum amount of Near Infrared (NIR) and green bands, it is a good absorber of blue and red bands Jiany et al. (2008). Water bodies, deep forests, and rocky lands are stable objects and have extreme reflectance (minimum and maximum) in the region. The variations in reflectance recorded in satellite images have an influence on the accuracy of forest CD using post-classification Pu et al. (2008); Sonawane and Bhagat (2017). Calculated NDVI (1992) indicates a positive correlation with the estimated greenness (2002), NDVI (2002) with greenness (2002), and NDVI (2013) with greenness (2013). The correlation value has calculated 'r = 0.945', 'r = 0.746', and 'r = 751' respectively (Table 6). Graphical representation of Scatterplot (Figure 12) for NDVI (1992) with Greenness (2002) and NDVI (2002) with Greenness (2013) depicts clustered distribution of vegetation concerning stable land samples. Therefore, the greenness index is utilized for estimations of the dependent variable in the regression analysis. Estimated greenness indices are shows the maximum greenness

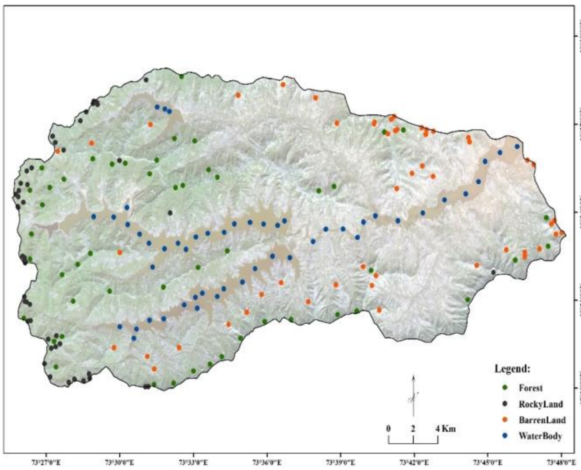


Figure 9: Ground Reference Digital Number's sample locations

b) Statistical algorithms

Usually on a wide range of scales the ratio index i.e., NDVI has applied to detect and segregate vegetation from other land classes due to the lesser number of the band (band 4 and band 3 for Landsat 5 & 7, then the band 5 and band 4 for Landsat 8 & 9) required for the analysis Fletcher and Everitt (2007). However, multispectral TCCTs based greenness (Equation 2, 3, and 4) respectively estimated by Crist et al. (1986); Huang et al. (2002); and '57.5311' calculated for t_1 in (1992), '79.4262' calculated for t_2 in (2002), and '136.046' calculated for t_1 in (2013). On the other hand, minimum greenness '-110.436' for the absence of vegetation i.e., shadow, rocky land, and water, etc. in t_1 (1992), '-24.5202' in t_2 in (2002), and '-90.0496' in t_3 (2013). Out of 200 total GRDN stable land samples about 25% samples were collected from rocky land, 25%from rocky land, 25%from forest covers 25% from barren land, and 25% from water bodies for further process (Figure 9).

Baig et al. (2014) (Table 8) have a more reliable and precise estimation of vegetation. Greenness values estimated for both images (t_1, t_2, and t_3) have positively correlated with NDVI. Therefore, greenness estimated for TM (t_1), ETM+ (t_2), and OLI & TIRS (t_3) data was used as a dependent variable for estimations corrected (Table 6) greenness values for (t_2) ad (t_3) (Figure 14). Theoretically, values estimated for the stable lands might be the same which is not possible in certain conditions at the time of image capturing Yarbrough et al. (2005). Therefore, the probable accuracy of FCD in the study area depicts less per Munyati (2004). In the next stage, these estimated values of greenness have normalized using values estimated for stable pixels Gill et al. (2012). The differences between estimated greenness values for stable pixels of TM (t_1), ETM+ (t_2), and OLI & TIRS (t_3) have been calculated and correlated with different bands i.e., DN values of band 4 (t_1), band 4 (t_2), band 4 (t_3) (Figure 13) have been estimated to find independent variables for estimation of the normalized dependent variable for t_2 and t_3 (Table 10).

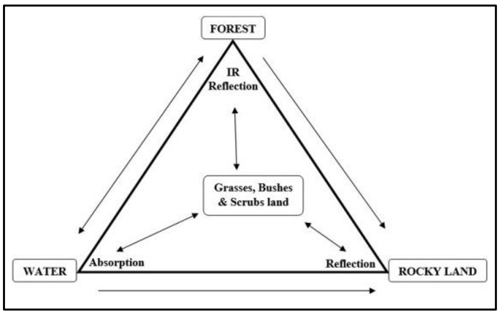


Figure 10: Ground Reference Digital Number (GRDN) triangle

Substantial correlation (Table 7) of computed difference between the greenness of (t_1) & (t_2) and (t_2) & (t_3), was estimated with DN values of band 4 (t_1), band 4 (t_2), band 4 (t_3) (Table 10). However, the strongest correlation was estimated for band 4 (t_1) and thus this band was utilized as an independent variable to estimate the pixel values of correction in (t_2) and (t_3) respectively in the regression analysis. A total of 200 samples were collected in terms of stable lands i.e., rocky land, water, forest land, barren land, etc. (Figure 9), and was used in the statistical algorithm analysis. Linear regression (Equation 5) provides mathematical capabilities Lawrence and Wrlght (2001); Cohen et al. (2003) to estimate the fit between two different multi-spectral images acquired at a different time for the same area per Sonawane and Bhagat (2017). Pixel values close to the regression line indicate the suitability of the model (Table 10).

$$\boldsymbol{Y} = a + b(x) \tag{5}$$

where,
'Y' is an estimated variable (dependent)
'a' and 'b' is constant (is intercept and is a rate of change in slope)
'x' is an independent variable

Many researchers have accounted for the most prominent change detection accuracy by using the regression approach. Jiany et al. (2008) described the three steps of radiometric normalization using stable land surface pixel values: (1) delineation of stable land based on near-infrared (NIR) bands; (2) DN for stable areas using regression models, and (3) the regression coefficients used for normalizing DN of the target images. In this study, the linear regression model shows (Figure 13) the fit R^2= 0.945 of differences in the greenness of t_1 and t_2 with band 4 of t_1 with high correlation (0.945) and R^2= 0.926 of differences in the greenness of t_2 and t_3 with band 4 of t_1 with high correlation (0.926) clustered distribution (Table 6, 7 and 10). The values closer to zero on the x-axis are for water bodies, the next cluster for forests, and far from barren and rocky lands.

c) Multi-spectral indices normalization

The reference image L-5 TM 1992 (t_1) NDVI maximum value was observed as '0.5053' for dense vegetation whereas the minimum value was '-0.3898' for low or no vegetation with 0.1787 mean and 0.1842 standard deviations. Next to this in the targeted image, L-7 ETM+ 2002 (t_2) NDVI, the maximum value was observed as '0.5904' for dense vegetation whereas the minimum value was '-0.4947' for low or no vegetation with 0.1356 mean and 0.1613 standard deviations, and at for the next targeted image, L-8 OLI & TIRS 2013 (t_3) NDVI maximum value was observed '0.6222' for dense vegetation whereas minimum value was '-0.2563' for low or no vegetation with 0.3301 mean and 0.2933 standard deviations (Table 1). These fluctuations in the stretch between -1 & +1 NDVI values concerning (t_1), (t_2), and (t_3) show the exaggeration in the targeted images as compared with the reference image. Hence, the regression model (equation 8) was formed to estimate the values of exaggeration in greenness (Ge) (Table 9) estimated for (Equation 6) target image (t_2) and (t_3) for normalization (Figure 14).

Table 6: Correlations between NDVI and Greenness

		Greenness (1992)	**Greenness (2002)**	**Greenness (2013)**
NDVI (1992)	Pearson Correlation	**.945****	.520**	.686**
	Sig. (2-tailed)	.000	.000	.000
	N	200	200	200
NDVI (2002)	Pearson Correlation	.830**	**.746****	.834**
	Sig. (2-tailed)	.000	.000	.000
	N	200	200	200
NDVI (2013)	Pearson Correlation	.804**	.560**	**.751****
	Sig. (2-tailed)	.000	.000	.000
	N	200	200	200

$$\boldsymbol{Get_2} = a + b(b4t_1) \tag{6}$$

where,
'Ge' is an estimated variable (t_2) Or (t_3)
'a' and 'b' is constant (is intercept '-15.529' and is a rate of change in slope '61.48')
'x' is an independent variable being 'band 4' of (t_1)

Eventually, the estimated greenness for target image (t_2) was normalized (Equation 7) for final FCD.

$$\boldsymbol{Nt_x} = Greeness\ 2002 - Get_2 \tag{7}$$

where,
'Nt_x' is normalized (t_2) Or (t_3)
Get_2 is estimated variable from (t_2) Or (t_3)

d)

Improved change detection

Before normalization, the reference image L-5 TM 1992 (t1) greenness maximum value was observed at '53.5711' for dense vegetation whereas the minimum value was '-110.4360' for low or no vegetation with '11.5750' mean and '14.5707' standard deviation. Next to this in targeted image L-7 ETM+ 2002 (t2) greenness maximum value was observed at '79.4262' for dense vegetation whereas the minimum value was '-24.5202' for low or no vegetation with '10.6481' mean and '13.3525' standard deviation, and at for the next targeted image L-8 OLI & TIRS 2013 (t3) greenness maximum value was observed '136.0460' for dense vegetation whereas minimum value was '-90.0496' for low or no vegetation with '16.9601' mean and '25.8266' standard deviation. Post statistical algorithmic method and estimations of exaggerated greenness normalization stage the final change detections between reference greenness of L-5 TM 1992 (t_1) and corrected greenness of targeted L-7 ETM+ 2002 (t_2) and L-8 OLI & TIRS 2013 (t_3) have been estimated (Figure 14) and processed for FCD. The reference greenness (t_1) and normalized (Nt_2) and (Nt_3) images were classified into six classes (Table 9) e.g., no-vegetation, low to medium, medium, medium to dense and dense to very dense, waterbodies respectively.

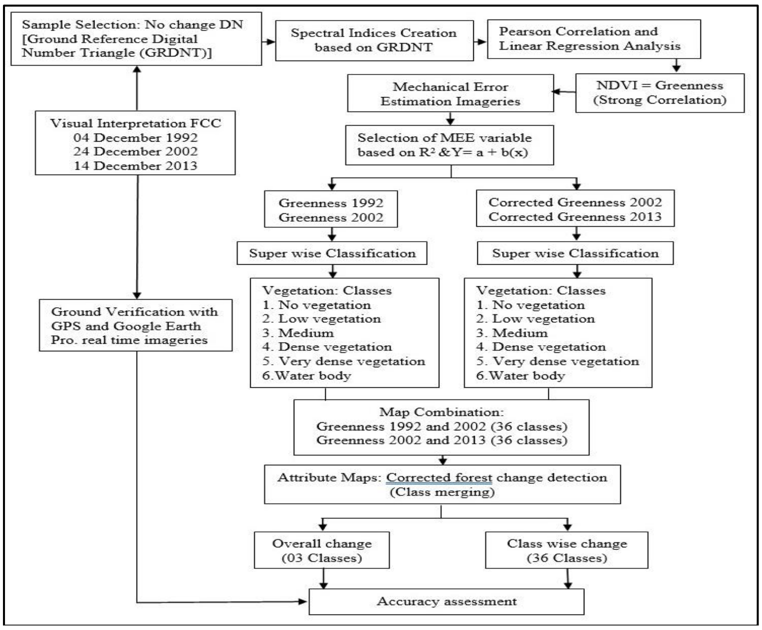


Figure 11: Approach -II Improved multi-spectral post-classification process flow

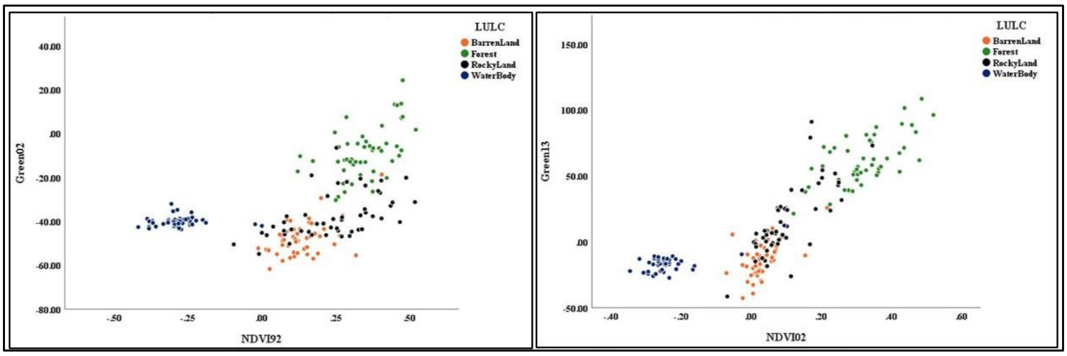


Figure 12: Correlation between NDVI and Greenness index

Finally, the supervised classified (6 classes each) greenness (Table 11) images (Figure 15) as reference L-5 TM 1992 (t_1), normalized L-7 ETM+ 2022 (t_2), and L-8 OLI & TIRS 2013 (t_3) as targeted images were compounded via one-to-many Relational Database Management System (RDBMS) operation for improved forest change detection approach. Two decades of change detection were calculated as the difference between 1992 to 2002 (Figure 16) and 2002 to 2013 (Figure 17) respectively. Each decadal FCD is categorized into two ways i.e., 1) Overall Change (High/ broad level) and Micro Change (Micro/ Low level), etc. Basically, 6 classes from each image have generated 36 classes when combined with two images of each decadal CD. These 36 classes merged based on the meaning full criterion viz. 'positive changes', 'no-changes', and 'negative changes', etc. for overall change. Further, each class-wise and micro-level change is also estimated to know the shifts from one class to another (Table 3 and Table 4) as 'positive change, no-change, and negative change.

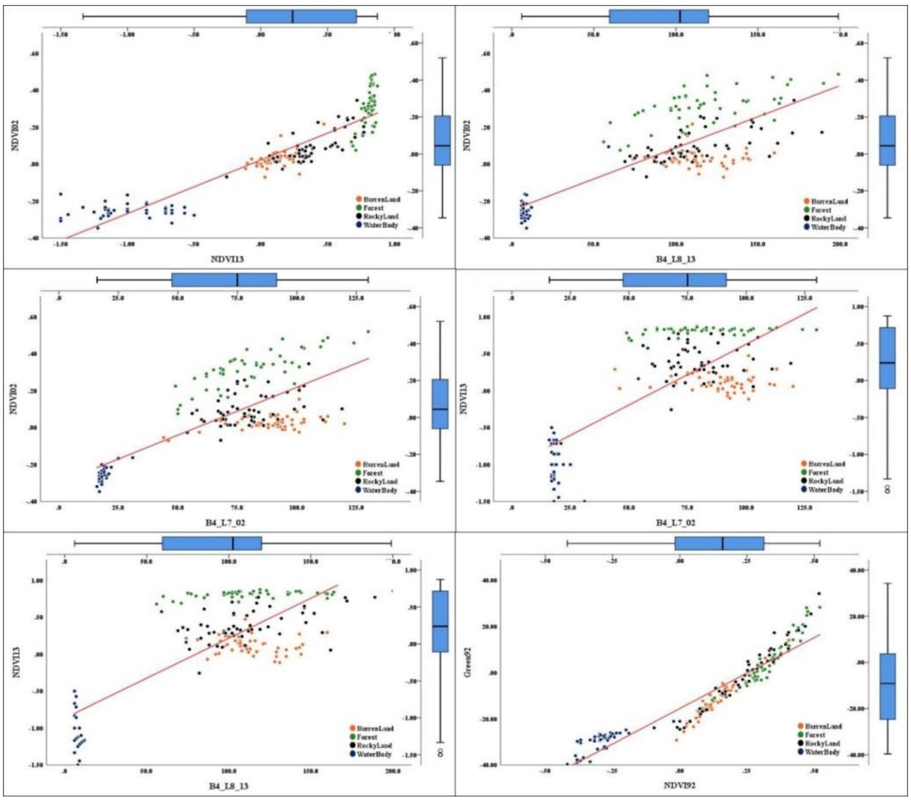


Figure 13: Regression analysis

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Result and Discussions

The forest change estimated with forest cover in the study area i.e., 63,745 hectares through two main approaches, the first one is 'Traditional NDVI based post-classification technique' and the second is 'Improved multi-spectral post-classification technique'. NDVI based classified maps prepared for (t_1), (t_2), and (t_3) were used for FCD (Figure 7 and Figure 8) in approach one (Table 5) and statistical analyses were executed for melioration in accuracy (Table 12) of improved multi-spectral post-classification FCD in second (Figure 16 and Figure 17).

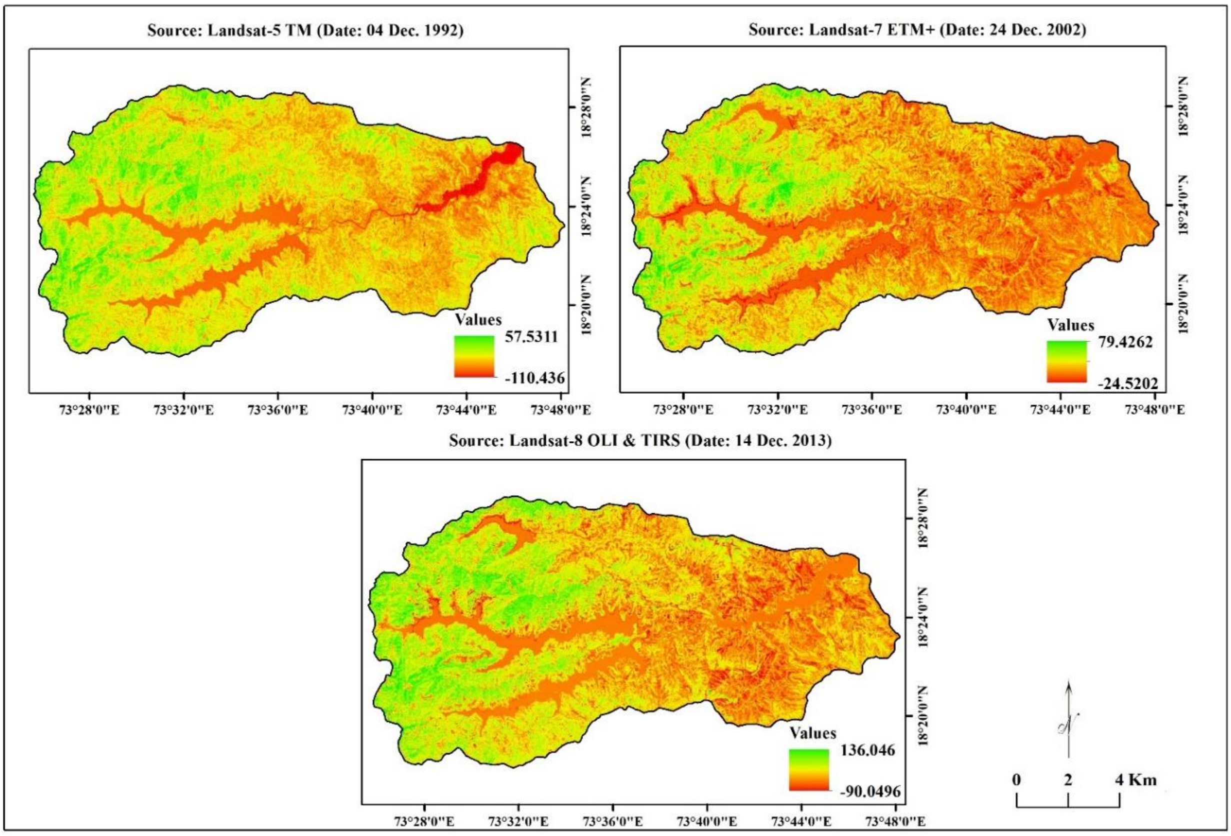
Table 7: Correlation of difference greenness with the selected criterion

		Band4_L5_1992	Band4_L7_2002	Band4_L8_2013
Difference greenness (1992-2002)	Pearson Correlation	**.945****	**.821****	**.757****
	Sig. (2-tailed)	.000	.000	.000
	N	200	200	200
Difference greenness (2002-2013)	Pearson Correlation	**.926****	**.827****	**.755****
	Sig. (2-tailed)	.000	.000	.000
	N	200	200	200

Approach-I Traditional NDVI based post-classification technique: The forest change in the study area between 1992 to 2002 and 2002 to 2013 has been detected based on the NDVI technique (Figure 6). Around, 8243.67 ha (13.93%) and 39930.14 ha (62.64%) of re-examined area depict forests with raising trends, about 27552.03 ha (43.22%) and 21044.43 ha (33.01%) area indicates no-changes, with declining trends and approximate 27949.21 ha (43.85%) and 2770.56 ha (4.35%) an area losing the forest (Table 15). Land class indicates the 'water body' coverage was 6.94% (t_1) it increases around 9.36% (t_2) and 11.49% (t_3). 'No-vegetation' excluding waterbodies and including barren land and rocky land was 9.43% (t_1) it increases by around 25.26% (t_2) and decreased by 12.02% (t_3). 'Low to medium' vegetation' class had an area of 24.89% (t_1) it slightly decreased around 24.56% (t_2) and then 11.49% (t_3). Class 'medium' vegetation was about 32.46% (t_1) it decreases to around 26.12% (t_2) and 21.50% (t_3). Class 'medium to dense' vegetation was about 18.34% (t_1) it decreases to around 12.37% (t_2) and increased to around 22.00% (t_3). Then the last class 'dense to very dense' was 7.94% (t_1) it decreases to around 2.33% (t_2) and increased to around 16.66% (t_3) (Table 2). However, these calculated values express inferred envision of changes within the classes therefore, dynamics (Figure 7 and Figure 8) of class-wise changes are also analyzed (Table 5). The accuracy of the assessment has been estimated at 70.81%, discussed in the next section (Table 13).

Table 8: Tasselled Cap Coefficients (Greenness) at satellite reflectance

Satellite	Sensor	Index	Blue (band-1)	Green (band-2)	Red (band-3)	NIR (band-4)	SWIR (band-5)	SWIR (band-7)	Reference
Landsat-5	TM	Greenness	-0.2728	-0.2174	-0.5508	0.7221	0.0733	-0.1648	Crist et al., 1986
Landsat-7	ETM+		-0.3344	-0.3544	-0.4556	0.6966	-0.0242	-0.263	Huang et al., 2002
Landsat-8	OIL & TIRS		−0.2941	−0.243	−0.5424	0.7276	0.0713	−0.1608	Baig et al., 2014



Approach-II Improved multi-spectral post-classification technique: The second approach has been designed based on the stable land class samples and a combination of statistical methodologies i.e., Karl Pearson's correlation (Table 7) and regression model analysis. It has been used to improve the effectiveness, precise decision, and perfectness in the performance of FCD (Figure 11). Multi-spectral band TCCT greenness (Table 11) application has been used to detect areas under forest. The exaggerated reflectance of the land surface and recorded in DN pixel value has been normalized from the estimated greenness (t_2) and (t_3) images (Equation 6 and Equation 7). The forest change in the study area between 1992 to 2002 and 2002 to 2013 has been detected based on the greenness technique. Around, 22699.02 ha (35.61%) and 15796.55 ha (24.78%) of the reviewed area indicate forests with positive change with declined trends, about 31250.96 ha (49.03%) and 35092.26 ha (55.05%) area indicates no-changes, with slightly increased trends and approximate 9794.86 ha (15.37%) and 12856.32 ha (20.17%) an area losing the forest (Table 15). This improved technique of FCD helps to reduce the exaggeration in estimations (Figure 16 and Figure 17). Class-wise changes were also estimated to understand the dimensions of changes in forest cover (Table 12).

Table 9: Greenness domain classes of ground truth

Sr. No.	Classes	Landsat-5 TM 1992	Landsat-7 ETM+ 2002	Landsat-8 OLI & TIRS 2013
1	No vegetation	Below -62	Below -62	Below -62
2	Low to medium	-62 to -46	-62 to -46	-62 to -46
3	Medium	-46 to -34	-46 to -34	-46 to -34
4	Medium to dense	-34 to -13	-34 to -13	-34 to -13
5	Dense to very dense	-13 to 58	-13 to 79	-13 to 136

Accuracy Assessment

It is very obvious and common in geospatial technology that without quality gets or quality assurance the analyzed data is useless for any research, planning, and management. Hence, the accuracy of detected changes in the forest was calculated as the producer's accuracy, the user's accuracy, and the overall accuracy. Rahman and Saha (2008) have suggested that the sample size should take a minimum of 30 samples for each class to estimate accuracy at 90%. Therefore, 200 samples well distributed within the classes were collected using GPS points and Google Earth Pro engine high-resolution images Sonawane and Bhagat (2017).

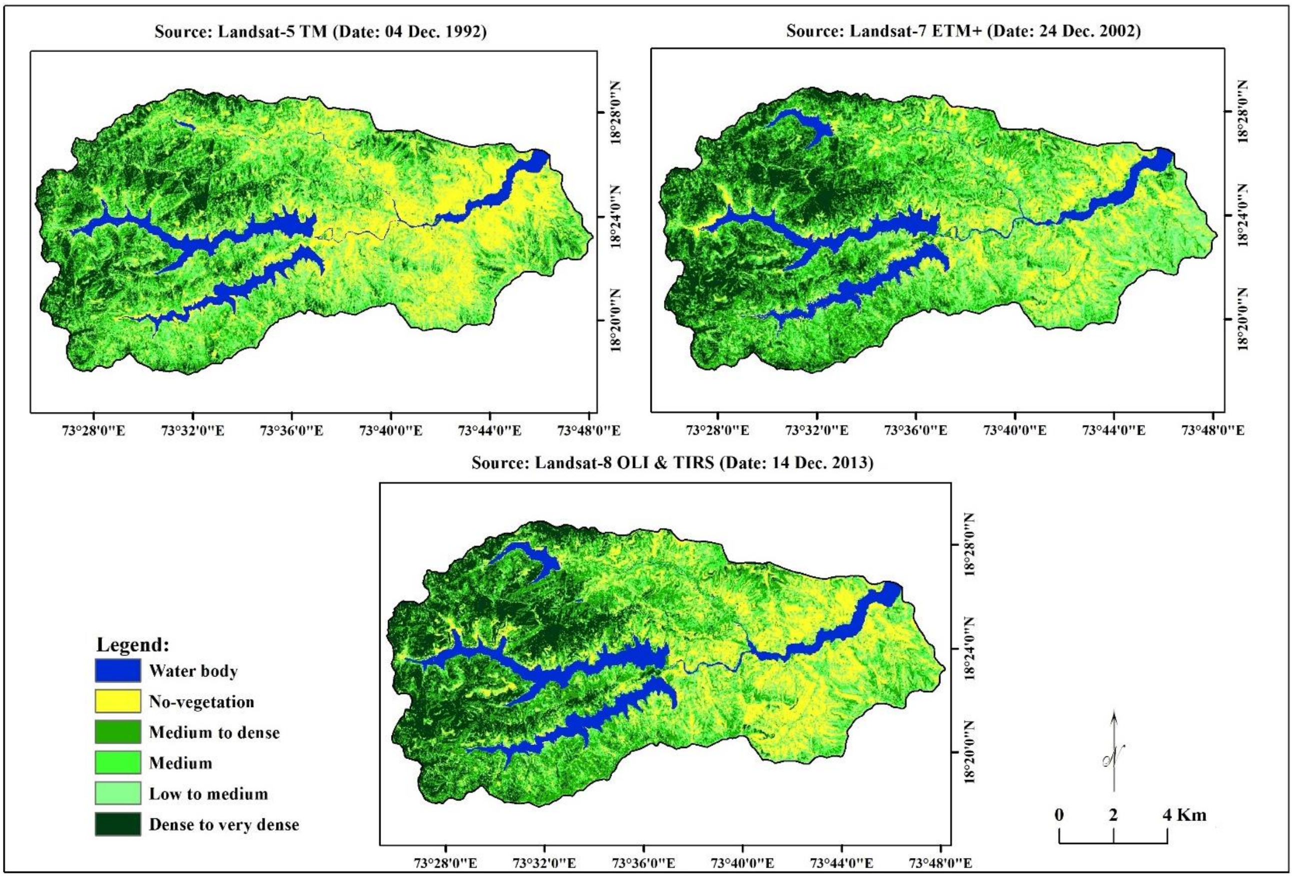


Figure 15: Distribution of forests depicted based on the greenness index

Table 10: Regression analysis of difference greenness with selected criterion

Y	X	Correlation (r)	a	b
Difference greenness (1992-2002)	Band4_L5_1992	0.945	-15.529	61.48
	Band4_L7_2002	0.821	-0.249	0.003
	Band4_L8_2013	0.757	-0.300	0.005
Difference greenness (2002-2013)	Band4_L5_1992	0.926	0.023	0.29
	Band4_L7_2002	0.827	-0.865	0.011
	Band4_L8_2013	0.755	-1.016	0.016

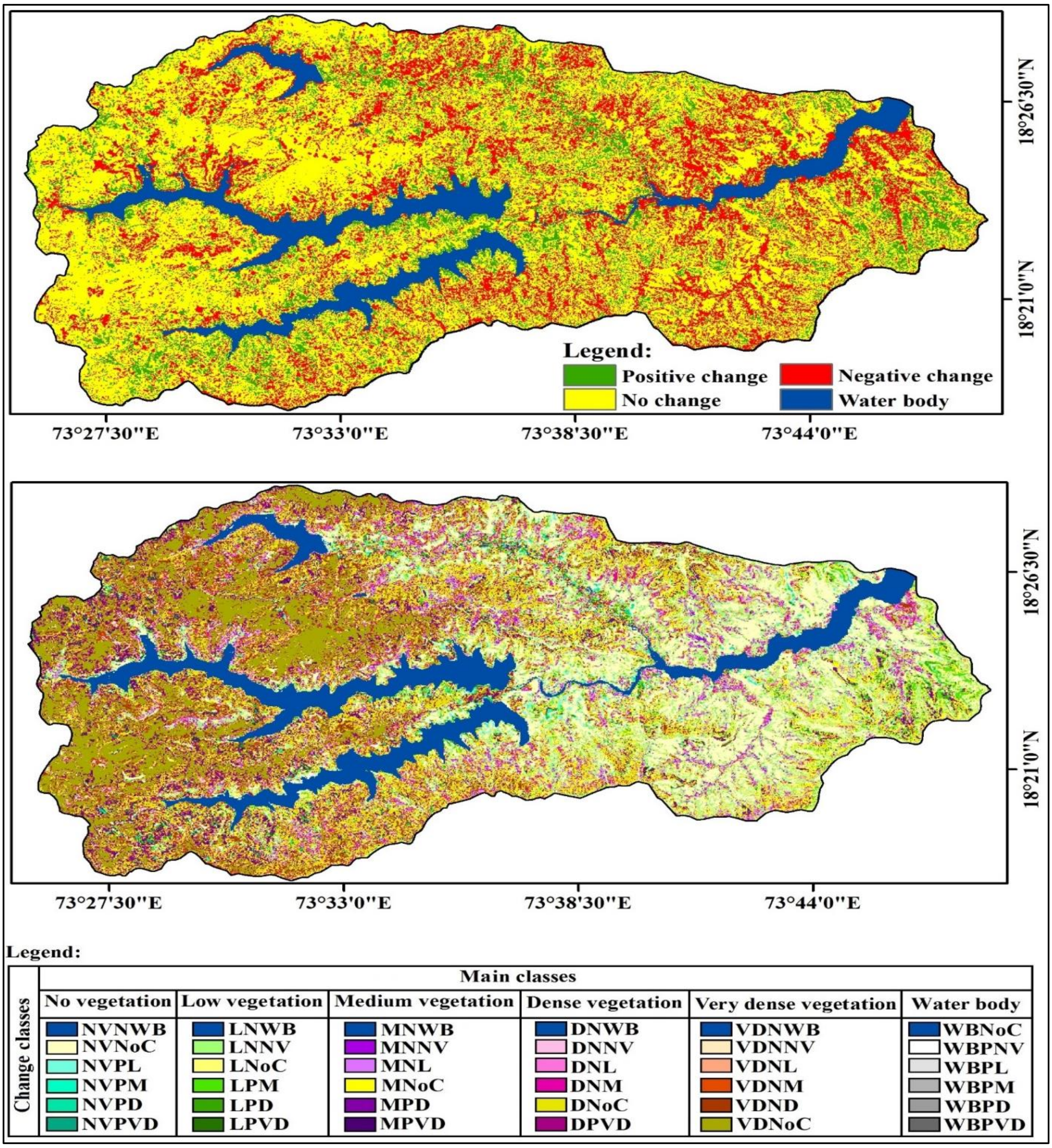


Figure 16: Greenness based FCD between 1992 and 2002 (Overall and Micro classes)

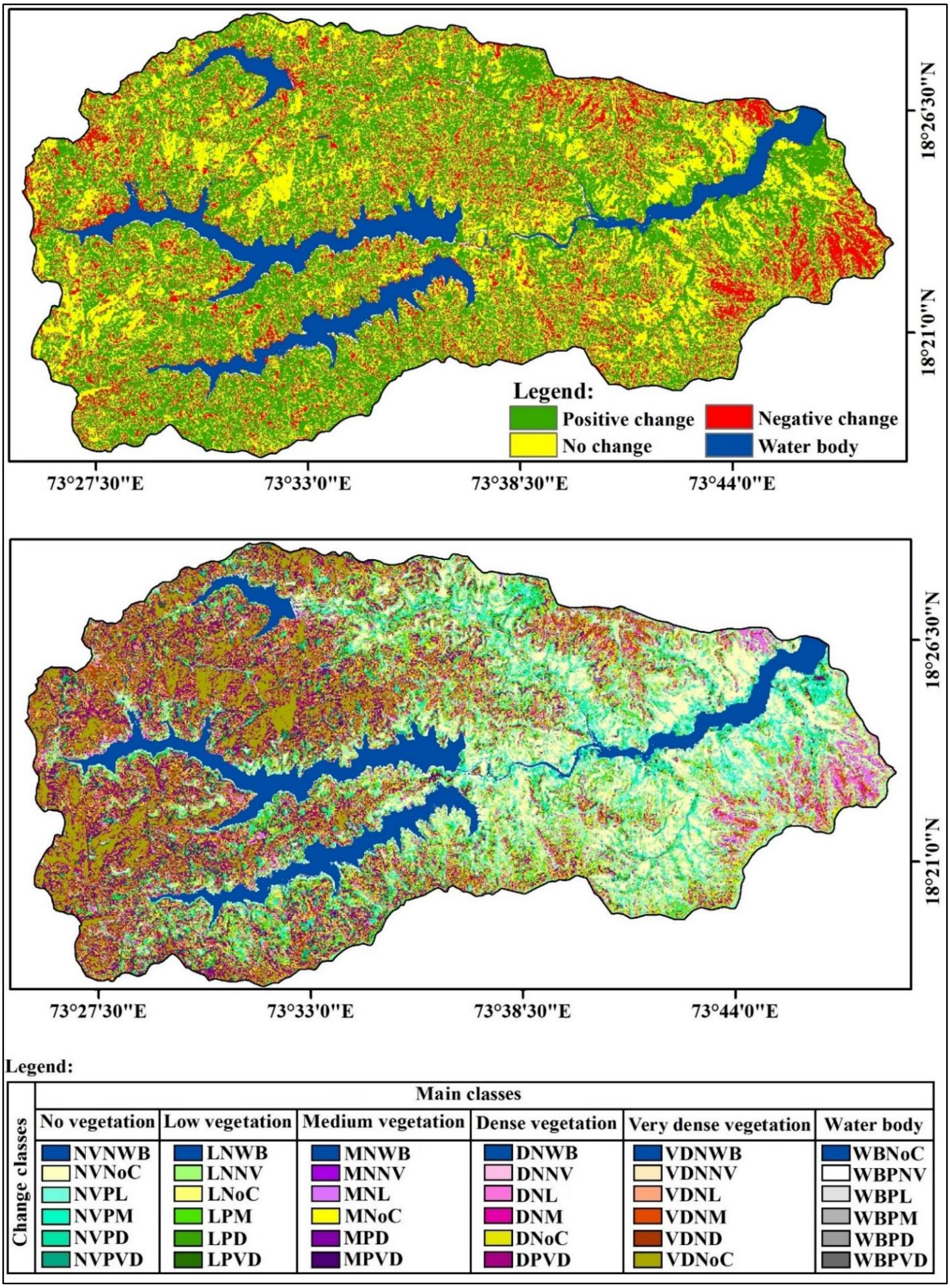


Figure 17: Greenness based FCD between 2002 and 2013 (Overall and Micro classes)

The overall accuracy of approach one was estimated at 70.81% (Table 13). The user's accuracy was calculated at around 55% for positively changed, 61% for no-changed and 77% for the negatively changed forest, and 87% for water bodies. Producer's accuracy was estimated at 64% for positive changes, 70% for no changes, 64% for negative changes, and 80% for water bodies. Here, class waterbody and negative change estimated higher accuracy whereas positive change depicts low accuracy.

Table 11: Greenness Classification (Area Hectare)

Sr. No.	Classes	L5-1992	L7-2002	L7-2002	% L7-2002	L8-2013	% L8-2013
1	Water body	4053.51	6.36%	5714.61	8.96%	7322.13	11.49%
2	No-vegetation	15728.58	24.67%	8127.00	12.75%	11759.85	18.45%
3	Low to medium	13161.61	20.65%	12404.63	19.46%	9573.86	15.02%
4	Medium	12770.52	20.03%	14980.99	23.50%	11096.66	17.41%
5	Medium to dense	11371.56	17.84%	13389.13	21.00%	13881.26	21.78%
6	Dense to very dense	6659.29	10.45%	9128.77	14.32%	10111.54	15.86%
		63,745	**100%**	**63,745**	**100%**	**63,745**	**100%**

The first approach accuracy assessment suggested that improvement is required in the change detection approach. Therefore, stable land classes and statistical-based improved FCD has been developed. The second approach has improved the accuracy of forest change detection to 88.20% (Table 14) with user's accuracy of about 82% for positive changes, 83% for no-change, 91% for negative changes, and 96% for water bodies whereas the producer's accuracy was calculated about 90% for positive changes, 93% for no-change, 84% for negative changes and 87% water bodies. Finally, the improved multi-spectral post-classification technique improves the accuracy of FCD. Both approaches are currently being utilized by many researchers, but the more common usage of NDVI gets priority due to less awareness, compromised quality, less processing time, etc.

Table 12: Micro Level Forest Change Detection Based on Greenness Classification (Area Hectare)

Overall change	Micro Classes	Greenness 1992	Greenness 2002	Greenness 2013	1992 To 2002	2002 To 2013	% 1992 To 2002	% 2002 To 2013
Positive change	MPVD	Medium	Dense to very dense	Dense to very dense	1125.63	1353.25	1.77%	2.12%
Positive change	LPVD	Low to medium	Dense to very dense	Dense to very dense	542.44	590.18	0.85%	0.93%
Positive change	NVPD	No-vegetation	Medium to dense	Medium to dense	1123.38	672	1.76%	1.05%
Positive change	DPVD	Medium to dense	Dense to very dense	Dense to very dense	3149.64	2635.56	4.94%	4.13%
Negative change	VDND	Dense to very dense	Medium to dense	Medium to dense	1329.12	1946.61	2.09%	3.05%
Positive change	MPD	Medium	Medium to dense	Medium to dense	3837.6	3584.71	6.02%	5.62%
No change	DNoC	Medium to dense	Medium to dense	Medium to dense	4881.61	6791.94	7.66%	10.65%
Positive change	LPD	Low to medium	Medium to dense	Medium to dense	2191.68	1482.13	3.44%	2.33%
Positive change	NVPM	No-vegetation	Medium	Medium	2406.96	496.2	3.78%	0.78%
Positive change	LPM	Low to medium	Medium	Medium	3347.64	2950.39	5.25%	4.63%
No change	MNoC	Medium	Medium	Medium	4105.18	4556.43	6.44%	7.15%
No change	VDNoC	Dense to very dense	Dense to very dense	Dense to very dense	5042.8	6668.01	7.91%	10.46%
Negative change	DNM	Medium to dense	Medium	Medium	1689.12	2168.64	2.65%	3.40%
Positive change	NVPVD	No-vegetation	Dense to very dense	Dense to very dense	226.17	218.36	0.35%	0.34%
Negative change	MNL	Medium	Low to medium	Low to medium	1904.85	2428.47	2.99%	3.81%
No change	LNoC	Low to medium	Low to medium	Low to medium	5289.32	3801.6	8.30%	5.96%

Positive change	NVPL	No-vegetation	Low to medium	Low to medium	4210.56	1742.14	6.61%	2.73%
Negative change	VDNM	Dense to very dense	Medium	Medium	378.63	210.78	0.59%	0.33%
Negative change	VDNL	Dense to very dense	Low to medium	Low to medium	236.44	85.32	0.37%	0.13%
Negative change	DNL	Medium to dense	Low to medium	Low to medium	784.98	508.05	1.23%	0.80%
Negative change	MNNV	Medium	No-vegetation	No-vegetation	548.91	945.54	0.86%	1.48%
No change	NVNoC	No-vegetation	No-vegetation	No-vegetation	6603.58	6528.78	10.36%	10.24%
Negative change	LNNV	Low to medium	No-vegetation	No-vegetation	1527.93	3866.67	2.40%	6.07%
Negative change	DNNV	Medium to dense	No-vegetation	No-vegetation	169.92	259.74	0.27%	0.41%
Negative change	VDNNV	Dense to very dense	No-vegetation	No-vegetation	126.82	81	0.20%	0.13%
Negative change	NVNWB	No-vegetation	Water body	Water body	583.02	1569.52	0.91%	2.46%
Negative change	LNWB	Low to medium	Water body	Water body	150.84	213.66	0.24%	0.34%
Negative change	MNWB	Medium	Water body	Water body	201.79	112.59	0.32%	0.18%
Negative change	DNWB	Medium to dense	Water body	Water body	54.93	25.2	0.09%	0.04%
Negative change	VDNWB	Dense to very dense	Water body	Water body	107.56	4.05	0.17%	0.01%
No change	WBNoC	Water body	Water body	Water body	5328.47	4109.94	8.36%	6.45%
Positive change	WBPD	Water body	Medium to dense	Medium to dense	12.42	316.87	0.02%	0.50%
Positive change	WBPM	Water body	Medium	Medium	40.23	114.22	0.06%	0.18%
Positive change	WBPL	Water body	Low to medium	Low to medium	57.15	108.28	0.09%	0.17%
Positive change	WBPNV	Water body	No-vegetation	No-vegetation	226.26	478.12	0.35%	0.75%
Positive change	WBPVD	Water body	Dense to very dense	Dense to very dense	201.26	120.18	0.32%	0.19%
				Total	**63,745**	**63,745**	**100%**	**100%**

Automation in FCD

Automation in geospatial technologies adds values like processing heavy and complex datasets with various logical algorithms in lesser time, reduction in throughput time, and improving yield in decision-making processes. Feature Manipulation Engine (FME) platform has capabilities to automate processes through the combination of Artificial Intelligence (AI) and Machin Learning (ML). Integration of different transformers together has performed improved FCD estimations on Landsat-5, Landsat-7, and Landsat-8 satellites (Figure 18 and Figure 19) Sonawane and More (2022).

Table 13: Approach-I Accuracy assessment error matrix

Classified Data	Reference Data					
	Positive change	No change	Negative change	Water	Row total	User's accuracy in %
Positive change	**18**	6	5	4	33	**55**
No change	6	**28**	7	5	46	**61**
Negative change	3	4	**27**	1	35	**77**
Water	1	2	3	**41**	47	**87**
Column total	28	40	42	51	**161**	
Producer's accuracy in %	**64**	**70**	**64**	**80**		**70.81%**

Table 14: Approach-II Accuracy assessment error matrix

Classified Data	Reference Data					
	Positive change	**No change**	**Negative change**	**Water**	**Row total**	**User's accuracy in %**
Positive change	**27**	1	2	3	33	**82**
No change	2	**38**	3	3	46	**83**
Negative change	0	2	**32**	1	35	**91**
Water	1	0	1	**45**	47	**96**
Column total	30	41	38	52	**161**	
Producer's accuracy in %	**90**	**93**	**84**	**87**		**88.20%**

Table 15: Overall Forest Change Detection Comparisons of both approaches (Area Hectare)

Overall change	Approach-I				Approach-II			
	1992 To 2002	**1992 To 2002 %**	**2002 To 2013**	**2002 To 2013 %**	**1992 To 2002**	**1992 To 2002 %**	**2002 To 2013**	**2002 To 2013 %**
Positive change	8243.67	12.93%	39930.14	62.64%	22699.02	35.61%	15796.55	24.78%
No change	27552.03	43.22%	21044.43	33.01%	31250.96	49.03%	35092.26	55.05%
Negative change	27949.21	43.85%	2770.56	4.35%	9794.86	15.37%	12856.32	20.17%
	63,745	**100%**	**63,745**	**100%**	**63,745**	**100%**	**63,745**	**100%**

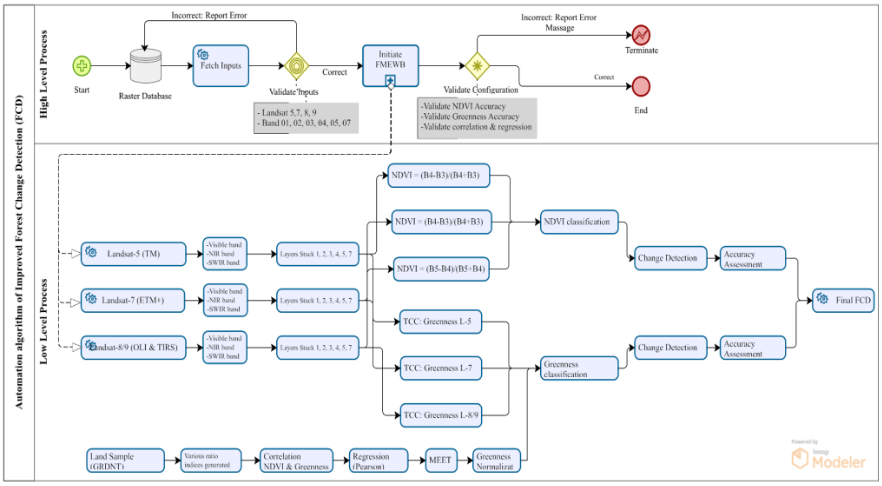


Figure 18: Forest Change Detection algorithmic detailed process flow

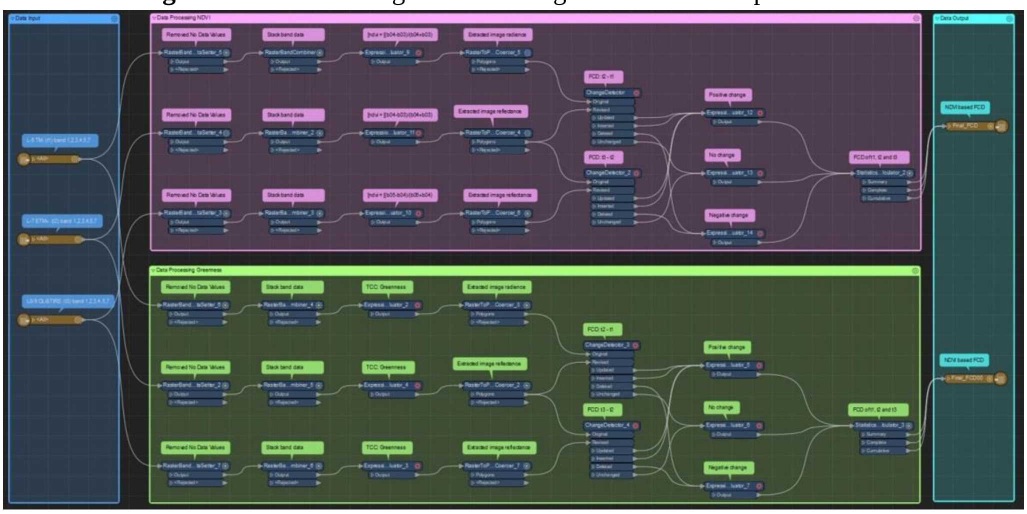


Figure 19: The actual FME workbench's algorithmic logic

Conclusion

The first approach of FCD shows around 13.93% and 62.64% of re-examined areas depict forests with raising trends, about 43.22%, and 33.01% areas indicate no changes, with declining trends, and approximately 43.85% and 4.35% are losing the forest (Table 15) in forest cover in the area (Figure 7 and Figure 8). On the other hand, the improved multi-spectral post-classification analysis estimates (Table 15) around, 22699.02 ha (35.61%) and 15796.55 ha (24.78%) of the reviewed area indicate forests with positive change with declined trends, about 31250.96 ha (49.03%) and 35092.26 ha (55.05%) area indicates no-changes, with slightly increased trends and approximate 9794.86 ha (15.37%) and 12856.32 ha (20.17%) an area losing the forest (Figure 16 and Figure 17). Therefore, it has been confirmed that the normalized greenness data using the statistical technique eliminated the exaggeration of reflectance recorded in satellite data and is useful to estimate more precisely FCD. There are some limitations with using open-source Landsat series data with 30 * 30 meter spatial resolution. Increasing the utilization of the improved FCD approach needs the bare minimum requirement of automation (Figure 18 and Figure 19). The proven methodology and proficiencies developed during this study can be utile by environmental planners, scholars, researchers, and management for change detection of forests for sustainable land management and development.

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Abbreviations

AI: Artificial Intelligence; **AOI:** Area of Interest; **DN:** Digital Numbers; **DNL:** Dense vegetation negatively changed to low vegetation; **DNM:** Dense vegetation negatively changed to medium vegetation; **DNNV:** Dense vegetation negatively changed to no-vegetation; **DNoC:** Dense vegetation with no-change; **DNWB:** Dense vegetation negatively changed to water body; **DPVD:** Dense vegetation positively changed to very dense vegetation; **ERDAS:** Earth Resource Data Analysis System; **ETM+:** Enhanced Thematic Mapper Plus; **FCC:** False Colour Composite; **FCD:** Forest Change Detection; **FME:** Feature Manipulation Engine; **FMO:** Food and Agriculture Organization; **FSI:** Forest Survey of India; **GPS:** Global Positioning System; **GRDN:** Ground Reference Digital Number; **ha:** Hectare; IBM: International Business Machin; **IMD:** Indian Meteorology Department; **ISFR:** India State of Forest Report; **LNNV:** Low vegetation negatively changed to no-vegetation; **LNoC:** Low vegetation with no-change; **LNWB:** Low vegetation negatively changed to water body; **LPD:** Low vegetation positively changed to dense vegetation; **LPM:** Low vegetation positively changed to medium vegetation; **LPVD:** Low vegetation positive changed to very dense vegetation; **MEET:** Mechanical Error Estimations Techniques; **ML:** Machin Learning; **MNL:** Medium vegetation negatively changed to low vegetation; **MNNV:** Medium vegetation negative changed to no-vegetation; **MNoC:** Medium vegetation with no-change; **MNWB:** Medium vegetation negative changed to water body; **MPD:** Medium vegetation positively changed to dense vegetation; **MPVD:** Medium vegetation positively changed to very dense vegetation; **MSL:** Mean Sea Level; **NDVI:** Normalized Difference Vegetation Index; **NIR:** Near Infrared; **NVNoC:** No vegetation with no-change; **NVNWB:** No vegetation negative changed to water body; **NVPD:** No-vegetation positively changed to dense vegetation; **NVPL:** No-vegetation positively changed to low vegetation; **NVPM:** No-vegetation positively changed to medium vegetation; **NVPVD:** No-vegetation positive changed to very dense vegetation; **OLI & TIRS:** Optical Land Imager & Thermal Infrared Sensors; **RDBMS:** Relational Database Management System; **RMS:** Route Mean Square; **SOI:** Survey of India; **SPSS:** Statistical Packages for the Social Sciences; **TCCT:** Tasselled Cap Coefficient Transformation; **TGA:** Total Geographical Area; **TM:** Thematic Mapper; **USGS:** United States of Geological Survey; **VDND:** Very dense vegetation negatively changed to dense vegetation; **VDNL:** Very dense vegetation negatively changed to low vegetation; **VDNM:** Very dense vegetation negatively changed to medium vegetation; **VDNNV:** Very dense vegetation negatively changed to no vegetation; **VDNoC:** Very dense vegetation with no-change; **VDNWB:** Very dense vegetation negative changed to water body; **WBNoC:** Water body with no-change; **WBPD:** Water body positively changed to dense vegetation; **WBPL:** Water body positively changed to low vegetation; **WBPM:** Water body positively changed to medium vegetation; **WBPNV:** Water body positively changed to no vegetation; **WBPVD:** Water body positively changed to very dense vegetation; **WCMC:** World Conservation Monitoring Centre; **WRI:** World Resources Institute

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Use of multi-criteria AHP technique for detection of potential sites for tourism in Anjarle Beach area of Ratnagiri District, Maharashtra (India)

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Abstract:

The multi-criteria decision-making AHP techniques was used to detect the potential sites for tourism in Anjarle Beach, Ratnagiri District, Maharashtra (India) based on beach scenic value (BSV) and beach scientific investigate value (BSIV). Ten criteria were selected for this analysis: coastal slope, adjacent land use and seas, and streams, beach morphology, landscape features, sand colour, sunrise and sunset views, water clarity, integrity and size pockets. AHP-OS software was used to calculate the pairwise comparison matrix and determine the weights for selected criteria and parameters. The calculated consistency ratio (CR) (0.08) indicates the acceptability the results. Beach morphology and adjacent land use show higher suitability for tourism activities, whereas beach water clarity and integrity show moderate suitability and other features are less suitable for tourism activities. The multi-criteria decision-making AHP techniques are suitable for the detection of suitable sites for tourism in coastal areas.

Keywords: Coastal tourism potential, scenic beauty, Analytical Hierarchy Processes, Pairwise comparison Matrix, Weights, Ranking.

1 Introduction

The identification of tourism potentials of coastal area needs detailed study of these physiographic and socioeconomic parameters (Ergin *et al.*, 2006; Phillips and House, 2009; Anfuso *et al.*, 2017; Mooser *et al.*, 2021). The share of tourism activities and service sector in GDP of India was 6.7% in 2018 (WTTC, 2019) and the tourism industry contributed 1.7 trillion USD to GDP of the world in 2019 (WTO, 2019). Tourism activities support the economy of any country, significantly assisting the people (Rio and Nunes, 2012; Botero *et al.*, 2014) and playing a significant role in the development of the rural economy (Bel *et al.*, 2014). Beaches at coastal lines are significant assets for tourism, create prospective appreciated financial assistance to a visitor and most important tourist destinations (Botero *et al.*, 2014; Stanchev *et al.*, 2015; Chen and Bau, 2016). The techniques like MCDM, AHP, Fuzzy-AHP (F-AHP) and Weighted Overlay Analysis are widely used techniques for assessment of potential for development of tourism activities. AHP advance techniques were applied for the identification of tourism potential within the research area. The majority of the researchers into the revision of tourism potential have used recent scientific GIS (Geographical Information System) base multi-criterion (MCE) method. These AHP and GIS techniques have been practiced via a variety of researchers in different physical areas of India. (Gaikwad and Bhagat 2018; Zolekar and Bhagat 2015). The GIS and RS technique using satellite images are used as an appropriate apparatus for identifying of tourism potential sites and its scenic beauty (Bunruamkaew and Murayama 2011,) Moreover, to Study evolution tourism potential, satellite image has been used by Murali *et al.* (2013).

Further, Analytical Hierarchy *Processes, techniques* widely used for *the tourism development sector* and its various *uses* like identification tourism potential sites, scenic beauty, tourism site suitability and so on. Analytical Hierarchy Processes determine the weight of influence into definite tourism potential use pairwise comparisons of *the parameters* as per research area importance to determine the rank and *criteria* for identification of tourism potential using *the OS AHP software*. Saaty (1990), was used the AHP technique can evaluate the complexities with their significant important. The present research mentions the process to the identification of tourism potential and its scenic beauty the standard physical sub-parameters of the Anjarle beach in Ratnagiri district in Maharashtra (India) by applying GIS-based geo processing system software ARC drawing component in ARC GIS 9.3 and Global Mapper (2013). The study area selected all standard criteria and sub-parameter of tourism potential were computed *statistics* to evaluate the uniqueness of different tourism potential parameter for research and progress of coastal tourism.

2. Study Area

The Anjarle beach is the part of coastal zone of Ratnagiri district (Maharashtra) along the Arabian sea extended between 17° 50′ 30″ and 17° 51′ 30″ N and 73° 05′ and 73° 06′ E ((Figure 1.1). The study area beach is an entire north-south narrow strip, low coastal land plain heightbelow 100 meters.

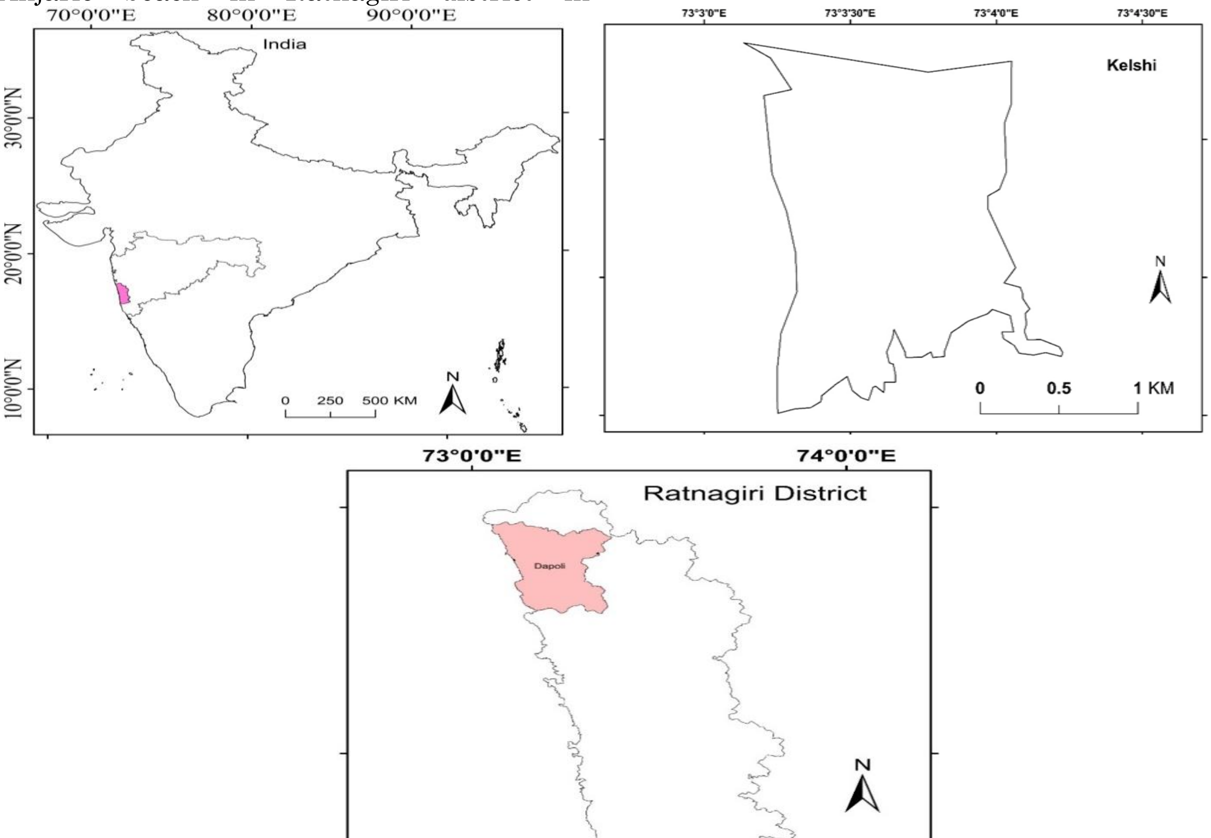


Figure1. Study area: Kelshi

Anjarle is along with Dapoli thasil its atmosphere of the research area is characterized as a result of warm summer from *the coastal area day* and night temperature variation is little change between 17^{0}c to 35^{0}c in March to May. Temperature ranges from 25 to 34ºC with an average of 31.3ºC. The average rainfall is 3118 mm in Sayhadri ranges. However, the rainfall along the coastline is between 2500 to 3200 mm. The laterite soil is suitable for the mango plantation observed in the region. Alluvial soil is observed in the foothill zones near to the coastline and useful for the coconut plantation. The fishery is one of the major occupations of the people in the region. The total population is 1394 with 672 males and 722 females. The population density is

250 persons/km2 with 89.09 % literacy. The sex ratio (1074 females/1000 males) is significantly more compared to the state of Maharashtra (922 females/1000 males). Anjarle creek, Jog river, *Kadyawarcha Ganpati* temple, Turtle festival, *Holi* festival, Ram Navami, are the main attraction of tourist.

3. Study area methodology

3.1 Data collection and software techniques

The identifications of study area location Ganpatipule beach were approved, using the Survey of India (SOI) toposheet (1:50000). The fieldwork was carried out in the direction of *gathering* the information adjacent beach physical landscape features and artificial features *between* the assist of global positioning system (GPS). The Google image data (Figure 2) *are* overloaded, process, and analyze in Arc GIS 9.3 and Global. Saaty (1977) introduced the AHP method and Saaty and Vargas (1991) to resolve the complex judgment -making problems. For that reason, present research AHP techniques have been used for the identification tourism potential with based coastal vulnerability index (CVI) taking equally physical (PVI) (Figure 3).

Table1 .Study area criteria, parameter and sources

Criteria	Parameter	Sources
Beach Scenic Value (BSV)	Beach morphology	Field visit, GPS data collection
	Landscape Features	Maharashtra Maritime Board
	Beach Sand colour	https://mahammb.maharashtra.gov.in
	Beach Sunrise and sunset view	Google Image
	Beach water clarity	
Beach Scientific investigate value (BSIV)	Size of the area	SOI (Survey of India)Toposheet
	Coastal slope (%)	1:50000
	Adjacent land use	Maharashtra Maritime Board
	Seas, lakes, streams	https://mahammb.maharashtra.gov.in
	Integrity	ASTER data
	Beach management	Google Image

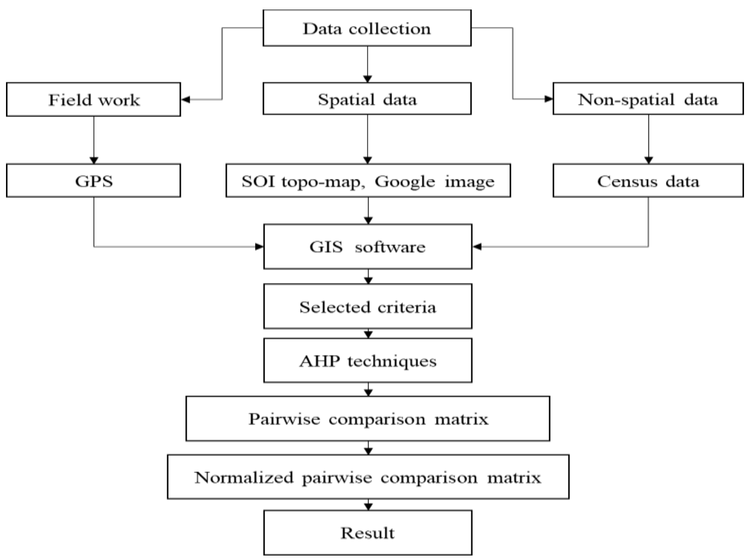


Figure 2. Methodology

3.2 Beach criteria and sub-parameters

Coastal morphological Physical characteristics are most significant for tourism planning, management and development. The physical criteria viz. beach morphology (BM), landscape features (LF), beach sand colour (BSC), beach sunrise and sunset view (BSV), and beach water clarity (BWC) size of the area (SA), coastal slope (%) (CS), adjacent land use (ALU), seas, lakes, streams (SLS), Integrity (I) for identification tourism potential and its scenic beauty.

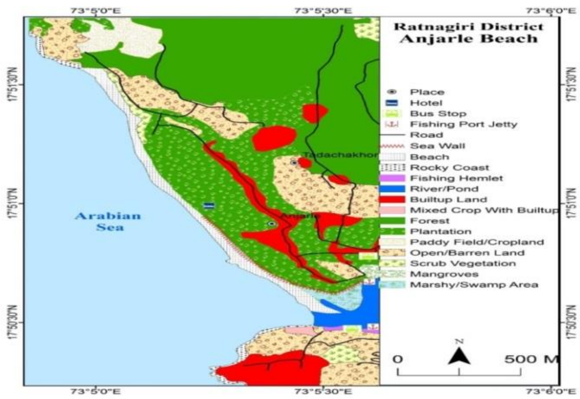
These parameters influence the potential of the morphological site. Therefore, these parameters are considered for detection tourism potential and its scenic beauty for tourism planning, management and development based on literature survey, field survey and local morphological condition of the beach. (Table 2).

Table 2. Study area criteria and sub-parameter used for identified the coastal tourism potential and scenic beauty.

Beach Scenic Value (BSV)	Details of Parameter / score	Low (1)	Moderate (2)	High (3)	Very High (4)
	Beach morphology	Rocky coast	Estuaries/ lagoons	Silt /Muddy	Open /barren land/ Sandy coasts / Rocky coast (Murali *et al.*2013)
	Landscape Features	single Landscape Features	2 or 3 Landscape Features	4 To 6 Landscape Features	More than 6 Landscape Features (Pralong and Reynard 2005)
	Beach Sand colour	Mud sand	Black sand	White sand	White and golden sand (researcher complied)
	Beach Sunrise and sunset view	Very Simple view	Simple View	Beautiful View	Ideal views (Navale *et al.*,2021)
	Beach water clarity	Turbid	Partially Turbid	Partially Transparent	Transparent (Navale *et al.*,2021)
Beach Scientific investigate value (BSIV)	Size of the area	>0.50 ha	0.75 ha- 0.50 ha	1 – 0.75 ha	>1 (Navale *et al.*,2021)
	Coastal slope (%)	>1	>0.2 and <1	>0.1 and <0.2	>0 and <0.1 (Navale *et al.*,2021)
	Adjacent land use	Forest /Shrubs	Agriculture	Marshy/ water	Built up (Navale *et al.*,2021)
	Seas, lakes, streams	Creeks	Shores of stream	Shores of lake	Sea cost (Navale *et al.*,2021)
	Integrity	fundamentally change	obviously change	a little change	Intact (Navale *et al.*,2021)

3.3 Analytical Hierarchy Process (AHP) methods

Prof. Thomas L. Saaty (1970) introduces the Analytical Hierarchy Process (AHP) method which is mostly used for solving composite problems connected to group judgment making. Several researchers have been used to AHP. Therefore, AHP has been used for identification of tourism potential and its scenic beauty in the present study. This method is processed following steps for identification of tourism potential criteria and sub parameter: (1) determination of ranks, (2) pairwise comparison matrixes, (3) normalization of pairwise comparison matrix, (4) calculation of weights and influence (Gaikwad and Bhagat, 2018; Navale and Bhagat, 2021, Navale and Bhagat, 2022).



(Sources: Maharashtra Maritime Board, 2017, https://mahammb.maharashtra.gov.in)

Figure 3. Anjarle coastal tourism potential

3.3.1 Determination of ranks

The scores were assigned to the criteria and sub-criteria from 1 to 4 i.e. low (1), Moderate (2), High (3) and Very high (4) (Table 1, 2 and 3) which is the prime score to indicate the potential site. *Further, researchers* in the field of tourism potential and scenic beauty have assigned scores to *the criteria* and parameter on the basis of coastal tourism potential site 1 to 9 (Table 4). The researcher has been assigned the score for sub- criterion and parameter (Table 5 and 6) and calculated *by* score or weight value of each *physical, i.e.* coastal slope (%)*,* size of *the area*, sea, lakes, streams, landscape features, integrity, beach water clarity, beach sunset sunrise view, adjacent land use, beach morphology. AHP-Online Systems –AHP-OS software used to determine and calculate the weights or score.

3.3.2 Pairwise Comparison Matrix (PCM)

Saaty (1983) has been suggested pairwise comparison matrix (PCM) to compute the weights for calculation of *the influence* of criterion to express the relative significant between each two criteria. The Field survey and literature analysis were used for arrangement of conclusion between two criteria and the pairwise comparison matrix (PCM) was arranged (Table 5 and 6). The pairwise comparison matrix (PCM) helps to identify the relationship between the criterion relative to the identification of tourism potential and its scenic beauty in the present study. The criterion principles in PCM were divided as a result of *the total* of the column to locate the cell values in normalized pairwise comparison matrix (Table 7 and 9) (Gaikwad and Bhagat*,* 2018; Murali *et al.* 2013; Navale and Bhagat, 2021,Navale *et al*.,2021)

3.3.3 Calculation of Weights and Influence)

The calculating normalized matrix of selected criterion and sub Parameter and find out each weight of criterion and sub Parameter (R. Mani Murali *et al*.2013) were used the following normalized matrix calculating equation 1 (Table 6 and 7).

$$Nm = \frac{Wc}{Sc}$$

Nm = Normalized Matrix.

Wc = Weight of each criterion.

Sc = Sum of each criterion

Further, the normalized matrix percentage weight of each criterion was calculating sum/final influence selected criterion and sub Parameter and dividing all the cell values from the sum of the respective columns in the pairwise comparison matrix used (Table 8 and 10) the following percentage weight calculating equation 2.

$$P_C^W = Sf_i/n * 100$$

P_C^W = Percentage weight of each criterion.

Sf_i = Sum/final influence.

n = Number of criterion/parameter

Table 3.Details of Anjarle beach characteristics and its score or value

Beach criteria	Parameter	Details of beach characteristics	Score
Beach Scenic Value (BSV)	Beach morphology	Open/ barren land beach, rocky coast	4
	Landscape features	2 or 3 Landscape Features	2
	Beach sand colour	Blackish	2
	Beach sunrise and sunset view	Very simple View	1
	Beach water clarity	Transparent	4
Beach Scientific investigate value (BSIV)	Size of area	0.75 ha- 1ha (0.7049h)	3
	Coastal slope (%)	>0.2 and < 1 Gradient (1.54) (0.9^0)	2
	Adjacent land use	Marshy/swamp land, mixed crop with built up, paddy field, mangroves ,scrub vegetation, social forestry, plantation, forest	4
	Seas, lakes, streams	River/Pond	2
	Integrity	Intact	4

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Table 4. Thomas L. Saaty 9 Point scale, 1977.

Strength of weight	Explanation
1	Equal importance
3	Moderate importance
5	strong importance
7	Very strong important
9	Absolutely strong important
2,4,6,8 Reciprocals	Intermediate values for inverse comparison

Table 5.Demarcated Physical Parameter score/value index for identification of coastal tourism Potential

Physical Parameter	Score/value	Physical Parameter	Score/value
Beach sunrise and sunset view	1	Size of area	3
Landscape features	2	Integrity	7
Beach sand colour	2	Beach water clarity	8
Coastal slope (%)	2	Adjacent land use	9
Seas, lakes, streams	3	Beach morphology	9

(Sources: Saaty (1977), 9 Point scale)

Table 6.Pairwise comparison matrix of physical parameter

	Beach sunrise and sunset view	Landscape features	Beach sand colour	Coastal slope (%)	Seas, lakes, streams	Size of area	Integrity	Beach water clarity	Adjacent land use	Beach morphology
Beach sunrise and sunset view	1	1	0.5	0.33	0.33	0.33	0.14	0.12	0.11	0.11
Landscape features	1	1	0.5	0.33	0.25	0.2	0.14	0.12	0.11	0.11
Beach sand colour	2	2	1	0.33	0.33	0.33	0.14	0.12	0.11	0.11
Coastal slope (%)	3	3	3	1	0.33	0.33	0.14	0.12	0.11	0.11
Seas, lakes, streams	3	4	3	3	1	0.33	0.14	0.12	0.11	0.11
Size of area	3	5	3	3	3	1	0.14	0.12	0.11	0.11
Integrity	7	7	7	7	7	7	1	0.5	0.5	0.11
Beach water clarity	8	8	8	8	8	8	2	1	0.5	0.33
Adjacent land use	9	9	9	9	9	9	2	2	1	0.5
Beach morphology	9	9	9	9	9	9	9	3	2	1
	46	49	44	40.99	38.24	35.52	14.84	7.22	4.66	2.6

Table 7.Normalized matrix of physical parameter

	Beach view	Landscape features	Beach sand colour	Coastal slope (%)	Seas, lakes, streams	Size of area	Integrity	Beach water clarity	Adjacent land use	Beach morphology	Sum/ Final Influence	% Weight	Rank
Beach view	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.04	0.17	1.71	10
Landscape features	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.04	0.17	1.66	9
Beach sand colour	0.04	0.04	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.04	0.22	2.25	8
Coastal slope (%)	0.07	0.06	0.07	0.02	0.01	0.01	0.01	0.02	0.02	0.04	0.33	3.29	7
Seas, lakes, streams	0.07	0.08	0.07	0.07	0.03	0.01	0.01	0.02	0.02	0.04	0.42	4.16	6
Size of area	0.07	0.10	0.07	0.07	0.08	0.03	0.01	0.02	0.02	0.04	0.51	5.07	5
Integrity	0.15	0.14	0.16	0.17	0.18	0.20	0.07	0.07	0.11	0.04	1.29	12.91	4
Beach water clarity	0.17	0.16	0.18	0.20	0.21	0.23	0.13	0.14	0.11	0.13	1.66	16.56	3
Adjacent land use	0.20	0.18	0.20	0.22	0.24	0.25	0.13	0.28	0.21	0.19	2.11	21.11	2
Beach morphology	0.20	0.18	0.20	0.22	0.24	0.25	0.61	0.42	0.43	0.38	3.13	31.28	1
	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	10.00	100.00	

Calculation of vulnerability index

3.4.1 Consistency Ratio:

Consistency ratio (CR) *was used* the scaling method and its priorities in hierarchical structures (Saaty 1977) (AHP). Basically consistency ratio (3) a result was calculated by consistency index value (CI) dividing the random index value (RI) as follows (Equation 3),

$$CR=CI/RI.$$

3.4.2 Consistency Index (CI) and Random Index (RI)

Here, the consistency index (CI) can be expressed as (Saaty 1977, 1983, 1990) (Equation 4),

$$CI= (\lambda max- n)/ (n-1),$$

$$CI= (11.28-10)/ (10-1),$$

$$CI= 0.14$$

Table 8. Showing values of Random index (Thomas L.Saaty.1977).

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.14	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Where

λ (Lambda) = Principal Eigen value of the matrix.

n = number of the matrix.

RI = the random index (Table 8)

3.4 .3Measure the evaluation of the consistency ratio

Saaty (1977) expressed that consistency ratio (CR) of a value of 0.10 or less is considered relevant or accepts its means that is a significant priority if consistency ratio (CR) of a value of > 0.10 or < 0.1 it's not relevant or rejects or error, its means not significant then calculating AHP sequence (Table 9) (Murali *et al.*2013).

Table 9. Measure the evaluation consistency ratio

CR $\leq$ 0.10	Relevant or accepted	Significant
CR > 0.10 / CR $\leq$ 0.1	Not relevant or rejected	Not significant

Computation of consistency ratio (CR) result

The geographical study of a selected site of Anjarle beach in Ratnagiri district, Maharashtra (India) were using multi-criteria the Analytical Hierarchy Processes (AHP) (Saaty1977) method for identifying the potential of coastal tourism and its scenic beauty. These are the resulting weights for the 10 major criteria based on pairwise comparisons and normalized matrix (Table 6 and 7). The following equations 3 were used for the calculating the physical computation of consistency ratio, CR=0.09, (equations 4) CI= 0.10 and RI (1.49) (Table.8).The researcher measures the evaluation of the consistency ratio (Thomas L. Saaty, 1977) *was* using the CR ≤ 0.10 (physical variables 0.09 ≤ 0.10) its *mean* physical variable consistency ratio is 0.09 is less than ≤ 0.10 (Table 9).Therefore the geographical study of a selected site of Anjarle beach in Ratnagiri District, Maharashtra (India) it's the potential of coastal tourism and scenic beauty is most relevant and significant. Therefore the Anjarle beach site has been more applicable and suitable for tourism planning and development.

Table 10. Computation of consistency ratio (CR)

Parameters	Physical variables
Λ max	11.28
n	10
CI	0.14
RI	1.49
CR	0.09

3.4. 4.

Physical vulnerability index (PVI)

The Physical vulnerability index (PVI) estimated and find out variables result. The physical criterion and sub-parameter value PVI is the base of priority rank. These physical variables are showing the priority rank, first, three priority ranks are beach morphology (BM) (1), adjacent land use (ALU) (3), beach water clarity (BWC)(3), integrity (4),size of area(SA) (5), sea lake, stream (SLS) (6), coastal slope(CS) (7),beach sand colour(BSC) (8), landscape features(LF)(9) and beach view(BV) (10) along the coastline(Table11).

Table 11. Physical vulnerability index (PVI)

Physical criterion and sub parameter										
Sr .No.	1	2	3	4	5	6	7	8	9	10
Parameter	BM	ALU	BWC	I	SA	SLS	CS	BSC	LF	BV
Physical index	31.28	21.11	16.56	12.91	5.07	4.16	3.29	2.55	1.66	1.71
Priority rank	1	2	3	4	5	6	7	8	10	9

4.0.

Results

The estimated tourism potentiality map classified into four categories: 1) very high tourism potentials, 2) high tourism potentials, 3) moderate tourism potentials, and 4) less tourism potentials as follows:

4.4.1. Low Tourism potential:

The beach view (BV), landscape features (LF), variables have the low tourism potential for tourism development and management. Therefore the government level and local level planning and management are most important in this tourism sector.

4.4.2. Moderate Tourism potential:

The size of area in this class are not capable to beach carrying capacity of various tourism activities. Therefore, tourist visitor's intensity and pollution were coming into these categories. Its means infrastructures facilities and tourism, coastal action plan policy implementation needed.

4.4.3. High Tourism potential:

The mangrove vegetation, coconut orchards, natural beauty of the seacoasts are major tourist attraction points in this region.

The moderate elevation with moderate slope (5-25°) are more suitable for different the tourism activities in this region. The researcher and academicians are visiting this area for the study of flora and fauna with botanical and medicinal approaches, river channel analysis, geomorphology, geology, soil analysis, marine studies, etc. The Ganesh festival, turtle festival, mango festivals, fishing festivals, *holi* festival, food festivals, jayanti festivals as well as regional traditions, arts, etc. are attractions of urban people visiting this region.

4.4.4. Very High Tourism potential:

The white sandy beaches at seacoast, golden sand, sand dunes, lagoons, aerial view of sea beaches, mangrove vegetation, scenic beauty, biodiversity, orchards of coconut and mangoes, clean and safety seacoasts are major tourists' attractions in the region. The beach morphology of Anjarle beach is *naturally* highly attractive and the nature base tourism place. *Therefore, this* beach has high coastal tourism potential and scenic beauty.

5. Conclusion:

The ARC GIS 9.3, Global Mapper (2013), OS AHP free software and Microsoft excel (2007) based evaluation technique, i.e., AHP, analysis, is most applicable *to identifying* tourism potential and its scenic beauty in the study area. The study was conducted using 10 major criteria related to the physical parameter, i.e., beach morphology (BM), landscape features (LF), beach sand colour (BSC), beach sunrise and sunset view (BSV), and beach water clarity (BWC) size of the area (SA), coastal slope (%) (CS), adjacent land uses (ALU), Seas, Lakes, Streams (SLS), Integrity (I) are observed to identified tourism potential. The PVI index shows that *the tourism potential* with attractive natural scenic beauty in this study area. *Some* criteria show the environment assessment potential value is low. Therefore, development of road and railway network is helpful for improvements in the activities. The local people can participation in the tourism activities but they are facing the problems like steep slope, small size settlements, language barrier, transport facilities, etc. Therefore, tourism awareness in local people and development of infrastructural facilities will be helpful for development of tourism activities in the seacoast area with natural beauty, environmental suitability and natural resources.

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Abbreviations: AHP: Analytical Hierarchy Process; SOI: Survey of India.

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Research Approaches in Social Sciences

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Abstract-

According to Encyclopedias of Social Science, Research is defined as " the manipulation of things, concepts or idea or symbols for the purpose of generalization to extend, correct or verify knowledge whether that knowledge aids in the construction of a theory or in practice of an art". Research in social science is carried in a two way namely theoretical and applied. Theoretical research provides the improvement knowledge of social problems, and to make planning to solve same for betterment of the society. Applied research explain cause and effect relationship in scientific way to improve the human life. Research in social sciences has different types of approaches. They are depends on research objectives and methodology used as well as researchers attributes. Social science research is useful to solve the problems of the society and took progression, change and welfare. Social research gives an idea of insight problems and foresight of the solutions. In this paper an attempt has been taken to analyze different approaches used in social sciences.

Keywords – manipulation, theoretical, applied, betterment, approach.

Introduction

Research approaches are techniques that investigator follows when conducting study. They are vary according to nature of topic and choice of researcher. In Social science research is always trying to solve the problems happening in the society. Research in Social Sciences depends on space, time, region, climate and attitude of the people etc. natural and man-made elements. Surrounding condition creates many problems to resolve those researchers using many methods and approaches in social sciences. Social science researchers used basic strategic methods to challenge existing problems with the help of prior reality. In social science researchers are used mainly three types of approaches qualitative, quantitative and mixed (Kankam,2019). With the help of qualitative approaches researchers observe, describe, explain, ideas or views about research its depends on theory but, in quantitative approaches researchers used quantified data, data analysis, scientific methods, correlate fact and theory etc. to obtain more realistic accuracy.This paper examines approaches used in social sciences on the basis of research attributes. Today social science research can be pure or applied that helps to analyze existing varied social issues with the help of modern techniques and methods to be used. (Lagad S. J.,2020).Issues in social sciences studied with the help of observation and techniques used(Salunke V.S.et.al. 2019).Generally selection of approaches is depends on nature of research.

Objectives

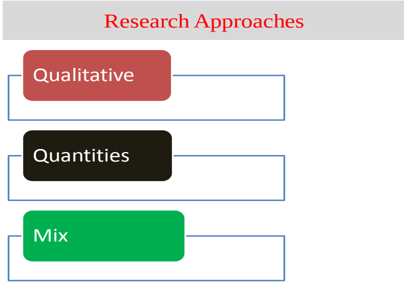
1. To examine concept of social science research approaches.
2. To understand approaches used as per nature of study.

Methodology

The study is entirely based on secondary data collected through published and unpublished publications, thesis and e-sources.

Discussion and Result

Recently various approaches of research are increases to develop quality of the innovation and ideas.



Qualitative Approaches-

In qualitative research mostly researcher are used in general methods for the study. They are

1. **Descriptive approach –**
   This approach focusing to describe the object. In this approach critical analysis can't did by investigator. Mostly in literature this type of approach is used.
2. **Observation Approach-**
   To analyze objectives with the help of observation and visibility. Mostly in social sciences used this type approach.
3. **Field, Survey and Interview Approaches-**
   To obseva grount reality, collection of data, measurement, sample collection of the object etc. this type of research did by researcher. Such a type of approach used in scientific analysis.

Quantitative Approaches

Systematic analysis of the issues or problems data collection, analysis, mathematical and stastical techniques, equation etc. are used for research to finding different pattern causal relationship and perditions.. It is one of the scientific research approach..

1. **Survey Research-**
   It is the basic tool for quantitative outcome of research and studies. Survey method are used for ask questions to respondent while using online survey and poll, thrugh e-resources etc.
2. **Co -relational research-**
   It is comparison between two different entities is invariable. This research conducted for establishment a relationship between different parameters and how they affect each other.

Deductive Approach

With the help of hypothesis and assumption, theory researcher used various laboratory methods and steps to verify objectives.

Inductive Approach

In this approach hypothesis are developed and analysis, examination, evaluation did by specific methods.

Conclusion-

Social science research is an important to decrease intensity and solve problems which are increases rapidly day by today. To increase quality of research various traditional and modern approaches are used by researcher. This paper is useful to researchers to improve knowledge and adopt different approaches in their research to generate good outcome in the field of social research. Social science research plays vital role for researchers in order to proffer solutions on social issues based on globally accepted scientific processes.

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पश्चिम विदर्भाच्या विकासामध्ये जलसिंचनाची भूमिका (एक भौगोलिक विश्लेषण)

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सारांश-

शेतीचे शाश्वत स्वरूपाचे उत्पादन आणि उत्पादनातील वाढ हि नैसर्गिक घटका बरोबरच मानवी प्रयत्नावरही अवलंबून असते जलसिंचन खते,सुधारित बी-बियाणे, जंतू व किटकनाशके इत्यादीच्या साठ्याने शेतीची उत्पादन क्षमता काही पटीने वाढविण्यासाठी मदत होते. जलसिंचन हा प्राचीन काळापासून शेतीचे उत्पादन वाढविण्यासाठी वापरला जाणारा प्रकार आहे. महाराष्ट्रातील पावसाचे स्वरूप लहरी स्वरूपाचे आहे. पावसाच्या विचलिततेचा परिणाम शेती उत्पादनावर होत असतो. काही ठिकाणी शुष्क तर काही ठिकाणी ४० दिवस पावसाचे आहे. याचा परिणाम शेतीच्या उत्पन्नावर निश्चित होत असल्यामुळे जलसिंचन आवश्यक आहे. शेतीचे जास्तीत जास्त उत्पादन घेण्याकरिता जलसिंचन गरजेचे आहे. प्रस्तुत अभ्यासाद्वारे पश्चिम विदर्भाच्या विकासामध्ये जलसिंचनाची भूमिका काय आहे. ते अभ्यासले आहे. सन २००७-०८ मध्ये २.३८ लाख हेक्टर क्षेत्र सिंचनाखाली होते त्या मध्ये वाढ होऊन सन २०१७-१८ मध्ये २.७० लाख हेक्टर झाले. हा वापर किंवा वाढ कमी असून टे वाढविणे गरजेचे आहे. ज्यामुळे पश्चिम विदर्भातील जिल्ह्यांचा सर्वांगीण विकास घडून येईल.

विजंसज्ञा – शाश्वत. विचलता, बी-बियाणे, शुष्क.

प्रस्तावना –

पावसाच्या पाण्या व्यतीरिक्त पिकांना दिलेल्या पूरक पाण्याला जलसिंचन असे म्हणतात. भारतातील ४५० जिल्ह्यांपैकी बागायत क्षेत्र असलेल्या ४४ जिल्ह्यामधून देशाच्या अन्नधान्य उत्पादनापैकी ५० टक्के उत्पादन होते. या ४४ जिल्ह्यांपैकी जास्त जलसिंचन क्षेत्र असणाऱ्या १४ जिल्ह्यात देशाच्या २५ टक्के अन्नधान्याचे उत्पादन मिळते. यावरून शेतीसाठी जलसिंचनाचे महत्व लक्षात येते. पृथ्वीचा ७१ टक्के भाग पाण्याने व्यापलेला आहे. जागतिक पाण्याच्या वितरणाच्या बाबतीत भारताचा जगात ब्राझील, रशिया, चिन, कॅनडा नंतर पाचवा क्रमांक लागतो. परंतु जलसिंचना खालील क्षेत्राच्या बाबतीत भारताचा जगात प्रथम क्रमांक लागतो. भारतात सरासरी ११९ सेमी पाऊस पडतो. भारतात एकूण ४०० दशलक्ष हेक्टर पाणी मिळते. यापैकी ११५ दशलक्ष हेक्टर मी पाण्याची वाफ होते. पृष्ठभागावरून वाहणाचा पाण्यापैकी १५ दशलक्ष हेक्टर मी पाणी धरणात अथवा तळयात साठविले जाते. महाराष्ट्रामध्ये एकूण ६ प्रशासकीय विभाग आहे. ज्यामध्ये अमरावती व नागपूर विभाग विदर्भामध्ये येतो तर पश्चिम विदर्भामध्ये अमरावती प्रशासकीय विभागाचा समावेश होत असून यामध्ये अमरावती, अकोला, वाशीम, बुलढाणा व यवतमाळ या पाच जिल्ह्याचा समावेश होतो. पश्चिम विदर्भामध्ये जलसिंचन विविध साधनाद्वारे केले जाते. ज्यामध्ये विहिरी, तलाव धरणे इत्यादी घटकाचा समावेश होतो, परंतु या घटकाचे वितरण सारखे झालेले नाही त्यामुळे त्याचा प्रत्यक्ष परिणाम शेतीच्या उत्पादनावर दिसून येते.

अभ्यास पद्धती –

संशोधन कार्य द्वितीयक सामुग्रीवर आधारित आहे. या शोध कार्याकरिता, संशोधन पत्रिका, पुस्तके, विविध समाचार पत्र, इंटरनेट, सामाजिक आर्थिक समालोचन व शासनाचे पत्रक या आधारे तयार केलेला आहे.

अभ्यासाचा उद्देश –

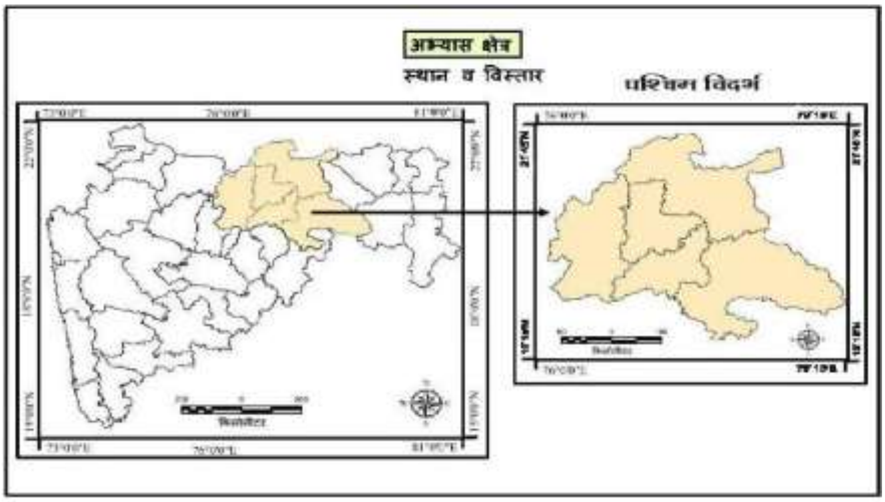
१. पश्चिम विदर्भातील जलसिंचन क्षमतेचा अभ्यास करणे व निष्कर्ष काढणे.
२. जिल्हास्तरीय शासनाच्या विविध प्रकल्पामध्ये होणार्या बदलाचे अध्ययन करणे.

अभ्यासाचे क्षेत्र –

महाराष्ट्र राज्याच्या पूर्वेस असलेल्या विदर्भ या प्रांतामध्ये पश्चिम विदर्भाचा समावेश होतो. पश्चिम विदर्भात अमरावती, अकोला, वाशीम, यवतमाळ व बुलढाणा या जिल्ह्याचा समावेश होत असून हा अमरावती प्रशासकीय विभागाचा भाग आहे. पश्चिम विदर्भाचा अक्षांशीय विस्तार १९° १५' ते २१° ४५' उत्तर अक्षांश ७६° ०' ते ७९° १५'

पूर्व रेखांश एकूण क्षेत्रफळ ४५३८४ चौ.की.मी. असून २०११ च्या जनगणनेनुसार लोकसंख्या १,१२,५८११७ आहे. या क्षेत्राची एकूण जलसिंचन असता २०१७-१८ नुसार ५०३६.३५ हेक्टर आहे.

(स्थान व विस्तार नकाशा) नकाशा क्र. १.१



पश्चिम विदर्भ-

जिल्हानिहाय निर्मित सिंचन क्षमता व बदल सारणी क्र.१.१

अ.क्र.	जिल्हा	निर्मित सिंचन क्षमता (हेक्टर मध्ये ०००)		वाढ / घट
		२००७-०८	२०१७-१८	
१	बुलढाणा	८९.९४	१०३.८९	१.५५%
२	अकोला	५६.८३	५८.१२	०.२२%
३	वाशीम	४४.४१	६१.६६	०.२४%
४	अमरावती	१०७.६२	११४.३६	०.६२%
५	यवतमाळ	१६०.१८	१८२.४८	१.३३%
एकूण महाराष्ट्र		४६४०.२१	५०३६.६५	०.८५%

(स्त्रोत : सामाजिक आर्थिक समालोचन महाराष्ट्र २००७-०८, २०१७-१८)

सारणी क्रमांक १.१ मध्ये पश्चिम विदर्भातील जिल्हा निहाय निर्मित सिंचन क्षमता दाखविलेली आहे. सन २००७-०८ मध्ये निर्मित सिंचन क्षमता यवतमाळ व अमरावती जिल्ह्यामध्ये सर्वात जास्त अनुक्रमे १६०.१८ हेक्टर व १०७.६२ हेक्टर होती तर कमी सिंचन क्षमता अकोला व वाशीम जिल्ह्यामध्ये अनुक्रमे ५६.८३ व ४४.४१ हेक्टर होती. २०१७-१८ चा अभ्यास करता असे दिसून येते की, सर्वात जास्त सिंचन क्षमता यवतमाळ व अमरावती या जिल्ह्यामध्ये तर सर्वात कमी सिंचन क्षमता अकोला व वाशीम जिल्ह्यामध्ये दिसून येते. सन २००७-०८ व २०१७-१८ या दहा वर्षाच्या कालावधीमध्ये नवीन स्त्रोत निर्माण करून जलसिंचन क्षमता वाढविण्याचा प्रयत्न करण्यात आला या १० वर्षामध्ये सर्वाधिक वाढ १.५५ टक्के बुलढाणा या जिल्ह्याची दिसून आली. तर सर्वात कमी वाढ अकोला ०.२२ टक्के वाढ झालेली दिसून आली. म्हणून महाराष्ट्राचा विचार करता या काळात जलसिंचन क्षमता वाढविण्याचे प्रयत्न ०.८५ टक्के झाले.

पश्चिम विदर्भ – जिल्हानिहाय प्रत्यक्ष सिंचित क्षेत्र व बदल (२००७-०८ ते २०१७-१८ हेक्टर मध्ये)

सारणी क्र.१.२

अ.क्र.	जिल्हा	प्रत्यक्ष सिंचन क्षेत्र		वाढ / घट टक्केवारी
		२००७-०८	२०१७-१८	
१	बुलढाणा	२३.९१	५३.९४	१२.५६
२	अकोला	१०.१४	२३.९३	१३.५९
३	वाशीम	५.१७	२०.४९	२९.६३
४	अमरावती	२३.८	१०१.९१	३२.८१
५	यवतमाळ	२९.९	४९.९४	६.७०
एकूण महाराष्ट्र		२७३२.१४	३९५०.०७	४.४५

(स्त्रोत – सामाजिक आर्थिक समालोचन महाराष्ट्र)

सारणी क्र. १.२ च्या आकडेवारी नुसार २००७-०८ या वर्षात प्रत्यक्ष सिंचीत क्षेत्र सर्वाधिक प्रमाणात यवतमाळ जिल्ह्यामध्ये २९*.९ हेक्टर होते तर सर्वात कमी प्रमाणात वाशीम जिल्ह्यामध्ये ५.१७ हेक्टर होते. २०१७-१८ या वर्षात सर्वाधिक जल सिंचीत क्षेत्र अमरावती जिल्ह्यामध्ये १०१.९१ हेक्टर असून सर्वात कमी प्रमाण यवतमाळ जिल्ह्यामध्ये ४९.९४ हेक्टर होते. सन २००७-०८ ते २०१७-१८ या दहा वर्षाचा विचार करता काही जिल्ह्यामध्ये मोठ्या प्रमाणात वाढ झालेली दिसून आली. प्रामुख्याने अमरावती व वाशीम जीळयास्त दशवर्षात जलसिंचन क्षेत्रात वाढ झाली ती अनुक्रमे ३२.८१ टक्के व २९.६३ टक्के इतकी होती तर सर्वात कमी क्षेत्र वाढले ते यवतमाळ जिल्ह्यामध्ये ६.७० टक्के झाले होते. महाराष्ट्र राज्यामध्ये २००७-०८ ते २०१७ १८ या दशवर्षाच्या कालावधी मध्ये प्रत्यक्ष जलसिंचन वाढीचे प्रमाण ४.४५ टक्के इतके आहे.

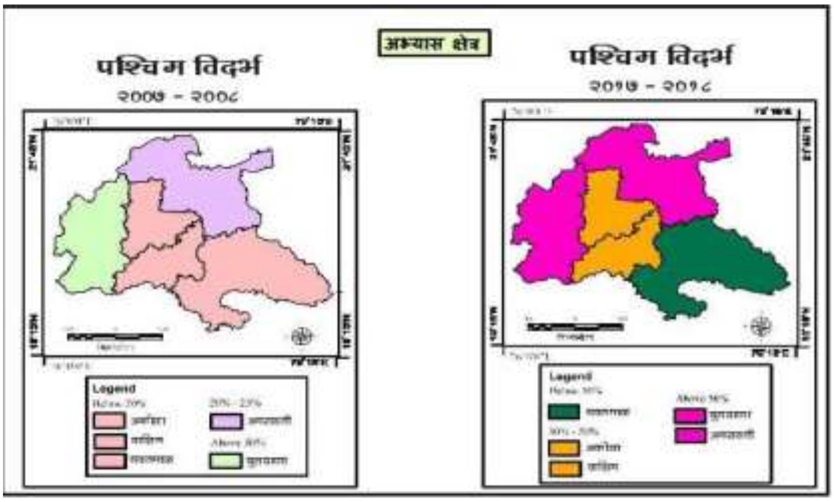
पश्चिम विदर्भ-

सिंचीत क्षेत्राची नीमित सिंचन क्षमतेची टक्केवारी (२००७-०८ ते २०१७-१८)

सारणी क्र.१.२

अ.क्र.	जिल्हा	सिंचित क्षेत्राची निर्मीत सिंचन क्षमतेची टक्केवारी	
		२००७-०८	२०१७-१८
१	बुलढाणा	२६.५८	५१.९३
२	अकोला	१७.८४	४१.१७
३	वाशीम	११.६४	३३.२३
४	अमरावती	२२.११	८९.१२
५	यवतमाळ	१८.६७	२७.३७
६	एकूण महाराष्ट्र	५८.८८	७८.४३

नकाशा क्र.१.२



सारणी क्र.१.३ मध्ये विदर्भातील जिल्हा निहाय सिंचित क्षेत्राची निर्मीती सिंचीन क्षमतेची असलेली टक्केवारी दाखवलेली आहे. तर नकाशा क्र. १.२ मध्ये २००७-०८ व २०१७-१८ मधील वितरण स्पष्ट करण्यात आलेली आहे. वरील अभ्यासानुसार असे दिसून येते कि महाराष्ट्र राज्याचा विचार करता २००७-०८ मध्ये टक्केवारी ५८.८८ टक्के होती तर २०१७-१८ मध्ये टक्केवारी ७८.४३ टक्के होती. पश्चिम विदर्भामध्ये सिंचीत क्षेत्राची टक्केवारी सर्वाधिक बुलढाणा जिल्हात २६.५८ टक्के होती तर कमी टक्केवारी वाशीम जिल्ह्याची ११.६४ टक्के होती तसेच २०१७-१८ या वर्षाचा विचार करता सर्वाधिक टक्केवारी अमरावती जिल्ह्याची ८९.१२ टक्के तर कमी टक्केवारी यवतमाळ जिल्ह्याची २७.३७ टक्के एवडी होती. सर्व घटकाचा अभ्यास करता एकूण महाराष्ट्राच्या सरासरीच्या तुलनेने वरील टक्केवारी खूपच कमी आहे. त्यामध्ये २०१७-१८ मधील अमरावती जिल्हा हा अपवाद दिसून येतो.

वरील अभ्यासावरून जलसिंचनाच्या बाबतीत आजही पश्चिम विदर्भ मागासलेला असून मोठ्या प्रमाणात जलसिंचन क्षेत्र वाढवून जलसिंचन क्षमता वाढविणे गरजेचे आहे. जिल्हानिहाय विचार करता आजही अमरावती जिल्हा वगळता इतर जिल्ह्याशी स्थिती समाधानकारक नसल्यामुळे जलसिंचन अभाव. या ठिकाणी शेतकरी वंचित राहिल्यामुळे

दुष्काळ, नापिकी यामुळे या विभागातील शेतकरी आत्महत्या सारखे परिणाम दिसून येतात. त्यामुळे जलसिंचन क्षमता असलेले प्रकल्प लवकर पूर्ण करून जलसिंचन क्षेत्र वाढविल्यास शेतीमधील उत्पादन होवून पश्चिम विदर्भ सुद्धा इतर क्षेत्राच्या तुलनेने विकसित होईल.

निष्कर्ष –

पश्चिम विदर्भातील अमरावती जिल्हा वगळता इतर जिल्ह्यामध्ये जलसिंचन क्षेत्राचे प्रमाण कमी दिसून येते ते राज्याच्या सरासरी पेक्षा खूपच कमी आहे. त्यामध्ये वाढ करणे गरजेचे आहे.

उपाययोजना –

१. शासनाचे प्रकल्प पूर्ण करून त्यांना शेती खाली आणणे गरजेचे आहे.
२. राज्याच्या सरासरीपेक्षा जलसिंचन क्षेत्र कमी असून ते वाढविण्याकरिता उपाययोजना करणे आवश्यक आहे.
३. इतर जलसिंचनाचे स्त्रोत निर्माण करून पश्चिम विदर्भातील जलसिंचन क्षेत्र वाढविणे आवश्यक आहे.
४. लोकांमध्ये जनजागृती करून पावसाचे पाणी भूगर्भात मुराविण्यासाठी जनजागृती करणे आहे.
५. शेत तळे तयार करण्याकरिता शेतकऱ्यांना प्रोत्साहित करणे.

संदर्भसूची –

१. लोकसंख्या भूगोल – डॉ. विठ्ठल घारपुरे
२. कृषी भूगोल – डॉ. सुरेश फुके
३. प्रादेशिक नियोजन – प्रा. दास
४. सामाजिक व आर्थिक समालोचन – महाराष्ट्र राज्य

प्रा. डॉ. अतुल अ. काळबांडे

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महाराष्ट्र राज्यातील चिखलदरा तालुक्यातील माती व वनांचे संवर्धन

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सारांश:
महाराष्ट्रातील अमरावती जिल्हयातील चिखलदरा तालुक्यातसुध्दा जंगलतोड, अतिचराई,भटकी शेती व शेतीची अनियोजीत पध्दतीमुळे मोठया प्रमाणात जमीनीची धूप होत आहे चिखलदऱ्यामधील मातीचा PH थोडासा आम्लीय ते किंचीत अल्कधर्मी असून PH मूल्य ५.७४ ते ८.५७ पर्यंत आहे. याचाच अर्थ मेळघाट प्रदेशातील उच्च स्थानावर अतिवृष्टीमुळे खनिज विरघळते त्यामुळेच PH मूल्य जास्त दिसून आले आहे म्हणून शेती पध्दतीमध्ये सपाटीकरण करुन जमीनीची मशागत करणे आवश्यक आहे तसेच माती धरुन ठेवणाऱ्या पिकांची लागवड करुन शेतीमध्ये हरभरा, ज्वारी, बाजरी, कडधान्य व चारा घेतल्यास मृदा संवर्धनास पोषक पर्यावरण निर्मीती होते. चिखलदरा तालुक्यातील वनांचा होणारा ऱ्हास व वनाला लागणाऱ्या आगीवर नियंत्रण आणण्याकरीता वनसंवर्धनाची आवश्यकता आहे. त्याकरीता वन लागवड कार्यरत ठेवणे अत्यावश्यक आहे. जनावरांच्या मुक्त चराईकरीता वेगळया ठिकाणी जनावरांना जागा उपलबध करुन देण्यात यावी. पाणलोट विकास कार्यक्रमांतर्गत सपाटीकरण, बांधबंदीस्ती, कंटूर बांडीग, बंधाऱ्याच्या पायथ्याशी झाडोंरा गवत वाढवून मृदा व वनसंवर्धनाचे कार्य पूर्ण करायला पाहिजे. तसेच संर्वधन करताना चिखलदरा पर्यटन स्थळाचा विकासही करण्याकरीता शासनाने विशेष लक्ष दिले पाहिजे जसे स्काय वॉक कृत्रिम पुल बांधण्यात येत आहे. त्यामुळे अनेक आंतरराष्ट्रीय पर्यटक सुध्दा याठिकाणी भविष्यात भेटी देऊ शकेल तसेच येथील पर्यटन केंद्राला चालना मिळू शकल्यामुळे लोकांना मोठया प्रमाणात रोजगार प्राप्त होईल व पुढे या पर्यटन केंद्राला 'अ' दर्जा प्राप्त होऊ शकेल.

बीज संज्ञा: अल्कधर्मी, स्काय वॉक, सेंद्रीय पोषक स्त्रोत, पॉईंट, डिस्पोझल

प्रस्तावना: मानवाने आपले जीवन सुखी करण्यासाठी नैसर्गिक साधनसंपदेचा शोध घेऊन त्याचा उपयोग केला ही साधनसंपदा मर्यादीत असल्याने तिचा वापर काळजीपूर्वक केला पाहिजे. काही नैसर्गिक साधन संपदांचा क्षय होऊ लागला आहे. नैसर्गिक साधनसंपदेचा मानवी संस्कृतीवर प्रभाव पडत असतो. आज जागतिक स्तरावर प्रदुषणाची समस्या निर्माण झाली आहे. पर्यावरणाचे संतुलन बिघडले आहे त्याचे मूळ कारण नैसर्गिक साधनसंपदेचा वापर करुन त्याची वाढ व विकास होणे गरजेचे झाले आहे. त्यासाठी साधनसंपदेचे नियोजन व त्यांचे तंत्रज्ञानाच्या साहाय्याने व्यवस्थापन करणे आवश्यक आहे. मानवी संस्कृतीच्या भरघाव वाटचालीत साधनसंपदांचे महत्त्व अजोड आहे. साधनसंपदांचा अनिर्बंध वापर झाल्यामुळे मानवाला पर्यावरणात्मक समस्यांना सामोरे जाण्यास नैसर्गिक संपदाचे जास्तीत जास्त जतन कसे करता येईल याविषयी विविध स्तरांवर तज्ञांची धडपड सुरु झाली आहे. निसर्गातील घटकांचा पारस्पारिक समतोल हा देखील साधनसंपत्तीच्या नैसर्गिक अस्तित्वावर बराचसा अवलंबून आहे. मानवाची वाढती संख्या तंत्रज्ञान प्रगती साधनसंपत्तीच्या मूळ अस्तित्वाला भेदून जात आहे म्हणून जमीन, पाणी, वनस्पती व प्राणी या प्रमुख संपदाचे रक्षण व सर्वंधन करणे अति महत्वाचे आहे तसेच येणाऱ्या पिढयांच्या दृष्टीने मानवाचे आद्य कर्तव्य ठरते. म्हणून याकरीता महाराष्ट् राज्यातील अमरावती जिल्हयातील चिखलदरा तालुक्यातील माती व वनांचे संवर्धन हा विषय संशोधन लेखाकरीता निवडला आहे.

संवर्धनाचा अर्थ साधनसंपत्तीच्या वापरावर पूर्ण नियंत्रण असा अभिप्रेत नाही. संपदा संवर्धन

म्हणजे एखाद्या संपदेचा उचित व काळजीपूर्वक वापर करुन त्या संपदेचा अनावश्यक विनाश टाळणे होय. तसेच संपदा जास्तीत जास्त प्रकारे पूर्नउपयोगात कशा आणता येतील यासंबंधी कृतीशील प्रयत्न करणे म्हणजे जंगलतोड केली तर त्याचप्रमाणात वृक्षलागवड देखील केली पाहिजे म्हणजेच वनसंवर्धन घडून येईल. भूतलावर मानवासहित सर्व सजीवांच्या दृष्टीने नैसर्गिक वनस्पती हा प्राण आहे. स्थान, हवामान, भूरचना, गुणधर्म व मृदा या भौगोलिक घटकांचा प्रत्यक्ष व सामुदायिक परिणाम नैसर्गिक वनस्पतीच्या एकूण स्वरुपावर होतो. पृथ्वीवर विविध प्रकारच्या नैसर्गिक वनस्पती आढळतात. याच उंच वाढणारे वृक्ष, मध्यम उंचीचे झाडे, लहान—मोठी झुडूपे, गवत वेली व बांबु यांचा समावेश होतो. भूसंपदा मानवाच्या दृष्टीने अत्यंत महत्त्वाची संपत्ती आहे. मानवाचे व्यवसाय वस्त्या वाहतूक यांसाठी भूमिसंपदा मुलभूत माध्यम म्हणून वापरल्या भूमिसंपदेत मृदा किंवा जमीन मानवाला शेतीव्यवसायासाठी आवश्यक ठरते. विदारण क्रियेने भूपृष्ठावरील खडकांपासून वेगळा झालेला कणयुक्त भाग म्हणजे मृदा होय. गेली हजारो वर्षे मानव मृदेचा शेतीसाठी वापर करीत आहे. तथापि मृदेच्या संवर्धनाबाबत पुरेसे लक्ष न दिल्यामुळे मृदेचा अतिवापर केल्यामुळे जमीनीची झीज आहे आहे यालाच मृदेचे धुप होणे असे म्हणतात.

वसुंधरेवर राहणाऱ्या सर्व जिव प्राण्यांचे जीवन मृदा व वनांवर निर्भय आहे या दृष्टीने मृदा व वन हे मानवी प्राण्यांकरीता व अन्य प्राण्यांकीरता एक अत्यंत महत्त्वाची संपत्ती आहे. मानवाचे कृषी कार्य, वस्त्या, वाहतूक याकरीता मानव मृदेचा वापर करतो त्याचप्रमाणे घर बांधणी, विविध लाकडी वस्तू, औषधी इंघन, फळे, फुले व जनावंराचा चारा इ. कामाकरीता वृक्षाचा वापर केल्या जातो. मानवाच्या आऱ्हासी वृत्तीमुळे वृक्षांचे प्रमाण कमीतकमी होत आहे. यामुळे संपूर्ण जीवसृष्टी धोक्यात येत आहे. वृक्षाचे प्रमाण कमी झाल्यामुळे जागतिक तापमानात वाढ होत आहे आणि त्यामुळे विविध नैसर्गिक संकटे निर्माण होत आहे. म्हणूनच जंगल बचाव असे न म्हणता प्रत्येकाने वृक्षाचे संवर्धन केले तर येणाऱ्या संकटांना सामोरे जाता येईल यामुळे वृक्ष संवर्धन करणे हे अत्यंत महत्त्वाची बाब आहे.

गेल्या हजारो वर्षापासून मानव आपल्या उदरनिर्वाहाचे साधन म्हणून मृदेचा शेतीकरीता वापर करीत आहे. दरवर्षी होणाऱ्या शेतीवापरामुळे शेतीमध्ये कृत्रिम रासायानिक फवारणी, रासायनिक खते व पाण्याचा मोठया प्रमाणात वापरामुळे जमीनीची सुपिकता कमी होत असल्यामुळे उत्पादनावर परिणाम होत आहे. म्हणूनच आज मृदा संवर्धनाची आवश्यकता आहे. संपूर्ण पृथ्वीवर ज्याप्रमाणे वृक्ष व मृदेचा दुरुपयोग सुरु आहे त्याचप्रमाणे प्रत्येक राखीव व संरक्षित जंगलांमध्ये वृक्षतोड, जंगलांना लाणाऱ्या आगी याकडेही लक्ष देणे आवश्यक आहे. म्हणूनच भविष्याचा विचार करुन येणाऱ्या संकटाला तोंड देण्याकरीता मृदा व वनसंवर्धन करणे ही एक काळाची गरज बनली आहे.

अभ्यासाची उद्दिष्टे : १) चिखलदरा उंच पठारावर वसलेले असल्यामुळे उतारानुरुप मृदेची धूप अधिक प्रमाणात होत आहे त्याकरीता उपाययोजनेचा अभ्यास करणे. २) चिखलदरा मधील मौल्यवान वृक्षांची होत चाललेली कमी संख्या यांचे अध्ययन करणे ३) स्थानिक लोकांचे शेती पध्दती बदलाची माहिती घेणे ४) वृक्ष व मृदेच्या संवर्धनाकरीता उपाययोजना करणे. ५) चिखलदऱ्यामधील होणाऱ्या स्काय वॉक मुळे निर्माण होणारी परिस्थितीचा अभ्यास करणे

अभ्यासाची पध्दती:

सदर संशोधन लेखात प्राथमिक स्त्रोतांचा वापर करण्यात आला. प्रत्यक्ष निरीक्षणाव्दारे संकलन केलेली माहिती, दुय्यम स्वरुपाची आकडेवारी, शासकीय कार्यालयातून घेतेलेल्या माहितीच्या आधारे अध्ययन केले आहे.

अभ्याासक्षेत्र: चिखलदरा हे थंड हवेचे ठिकाण असून समुद्र सपाटीपासून १,११८ मी. उंचीवर असून गाविलगड या पर्वतावर वसले असून पठाराची रुंदी १३२ कि.मी. तर लांबी १३४ कि.मी. आहे. हे ठिकाण महाराष्ट्राच्या उत्तरेस तर अमरावती जिल्हयाच्या वायव्य भागात असून सातपुडा पर्वतरांगाच्या शिखरावर वसलेले आहे. चिखलदरा

अक्षवृत्तीय तवस्तार २१° २३" उत्तर ते २१°१९" उत्तर असून ७७° १८" पूर्व ते ७७°१९" पूर्व आहे. चिखलदरा मधील कमाल तापमान १०३° फॅ. इतके असून सरासरी वार्षिक पर्जन्य १५४ से.मी. पडतो.

विषय विवेचन: साधनसंपत्तीचे संवर्धन म्हणजे पर्यावरणात उपलब्ध असणाऱ्या संपदेला वाया जाण्यापासून नियंत्रित करणे किंवा वाचवणे होय. गेली हजारो वर्ष मानव मृदेचा शेतीसाठी वापर करीत आहे. मृदेचा अतिवापर केल्यामुळे जमिनीची झीज होत आहे. तसेच भूपृष्ठाचा उतार, हवामान, भौगोलिक कारणे, जंगलतोड, अतिचराई, भटकी शेती व शेतीची अनियोजीत पध्दती अशा अनेक कारणांमुळे जमीनीची झीज घडून येते. चिखलदरा तालुक्यातसुध्दा जंगलतोड, अतिचराई,भटकी शेती व शेतीची अनियोजीत पध्दतीमुळे मोठया प्रमाणात जमीनीची धूप होत आहे त्याकरीताच मृदा संवर्धन करणे आवश्यक आहे. त्याचप्रमाणे जंगलतोडीमुळे व जंगलाच्या आगीमुळे वनांचा मोठया प्रमाणात ऱ्हास होत आहे त्यामुळे वनांचे संवर्धन करणेही तेवढेच महत्वाचे आहे. चिखलदरा मध्ये असणाऱ्या अनेक औषधीयुक्त वनस्पती, फळे, कंदमुळे, मध, लाख, मोह, डिंक, फुले, पाने, कात व खोड अशा वनसंकलनाचे काम चालते. काही जंगलक्षेत्रात अनुकुल उतारावर स्थलांतरीत शेती केली जाते. गवताळ वनस्पतीच्या प्रदेशात पशुपालन व्यवसायामुळे वनस्पतीचा ऱ्हास होत आहे. काही भागात मोठया प्रमाणात वनकटाई झाल्यामुळे वनसंपदेचे प्रमाण कमी होत आहे. लाकुडकटाई व लागणाऱ्या आगीमुळे वनांचे प्रमाण आज कमी होत आहे. चिखलदरा तालुक्यामध्ये २००१ च्या जणगणनेनुसार ग्रामीण भाग २५०८ चौ.कि.मी. क्षेत्रफळ असून एकूण लोकसंख्या ९०,८५० एवढी आहे तर नागरी भाग ४ चौ.कि.मी. क्षेत्रफळाचा असून एकूण लोकसंख्या ४,७११ एवढी आहे. २०११ च्या जणगणनेनुसार वाढत्या लोकसंख्येमुळे होणाऱ्या जंगलव्याप्त क्षेत्राचा ऱ्हास जास्त प्रमाणात होत आहे.

२०१५ ते २०१७ या कालावधीत चिखलदरा तालुक्यातील काही आदिवासी भागात मातीचे सर्वेक्षण करण्यात आले त्यामध्ये मातीची सुपिकता व सध्याच्या जमीन वापराचा अभ्यास करण्यात आला असता असे लक्षात येते की, मानक विश्लेषण पध्दतीचा वापर करुन पी.एच., विद्युत वाहकता, सेंद्रीय कार्बन, उपलब्ध नायट्रोजन, फास्फरस, पोटॅशियम आणि उपलब्ध सुक्ष्म पोषक घटक (Zn, Mn, Fe, Cu) याचे विश्लेषण करण्यात आले. चिखलदरा मातीचा PH थोडासा आम्लीय ते किंचीत अल्कधर्मी असून PH मूल्य ५.७४ ते ८.५७ पर्यंत होती याचाच अर्थ मेळघाट प्रदेशातील उच्च स्थानावर अतिवृष्टीमुळे खनिज विरघळते त्यामुळेच PH मूल्य जास्त दिसून आले आहे तर सेंद्रीय कार्बन कमी ते मध्यम होते, पौष्टीकतेच्या दृष्टीने जास्त पावसाच्या प्रदेशातील मातीमध्ये उपलब्ध N व P प्रमाण कमी तर K चे प्रमाण मध्यम होते. उपलब्ध सुक्ष्म पोषक घटक मध्यम ते जास्त आहेत. त्यामुळे उपलब्ध जमीनीच्या उत्पादनातील अडथळे ओळखून जमीनीच्या क्षमतेनुसार योग्य जमीनीचा वापर करणे आवश्यक आहे.

सध्याच्या तपासणीवरुन असा निष्कर्ष काढता येते की, बेसॉल्टवर विकसीत झालेला डोंगराळ प्रदेश असल्याने, जमीनीचा उतार जास्त असल्याने मातीची खोली उथळ ते मध्यम सें.मी. पर्यंत भिन्न होती. जास्त पावसाच्या प्रदेशात मातीत N प्रमाण कमी तर K चे प्रमाण मध्यम होते. तर उपलबध सुक्ष्म पोषक घटक मध्यम ते जास्त आहेत. Zn, Mn, Fe, Cu या घटकाचा वापर, वाढीव सेंद्रीय पोषक स्त्रोत, शाश्वत जमीन वापर, पीक पध्दती, व योग्य अशा अनेक पध्दतीचा अवलंब करुन जमिनीची सुपीकता वाढवण्यासाठी योग्य व्यवस्थापन पध्दतीची गरज आहे.

जंगले व वनस्पती: चिखलदरा तालुक्यामधील नैसर्गिक वनस्पतीवर भूगर्भीय, प्राकृतिक व हवामान इ. घटकांचा परिणाम झालेला दिसून येतो. विशेषत: या संदर्भात हवामान वव मातीचा संबंध वनस्पतीच्या वाढीसी असल्याने या घटकांचा परिणाम मोठया प्रमाणात झालेला दिसून येते. जंगल ही नैसर्गिक संसाधन असून पर्यावरण परिसंस्था संतुलन

ठेवण्याच्या दृष्टीने महत्त्वाचे आहे. त्याचप्रमाण या तालुक्यातील वास्तव्य करणाऱ्या लोकांना रोजगाराच्या दृष्टीने लाभदायक ठरतात. औषधी, गुरांचा चारा, वस्ती व निवारा इत्यादीच्या दृष्टीने जंगले महत्त्वपूर्ण ठरतात. जंगलाचे प्रमाण पर्वतीय प्रदेशात जास्त असून ज्या भागात जास्त पाऊस पडतो तेथे वनस्पतीची वाढ चांगल्या प्रकारे आढळून येते. या प्रदेशात वनस्पतीच्या ३९८ जाती दिसून येतो परंतु या सर्व जातीतील काही वृक्ष आणि वनस्पती दुर्मिळ व विरळ होत आहे. या जंगलामध्ये साग, बांबु, धावडा, साल, तेंदू तसेच ऐन कडरम, मोह व बिहाडा इ. जातीचे वृक्ष आढळतात. उन्हाळयात शुष्कपर्णी पानझडीच्या वृक्षामध्ये अमलवास, टेटू, कुंभ, जलकुंभी, पळस यासारखी वनस्पती फुलू लागतात.

मृदा:

संपूर्ण प्राकृतिक संसाधनात मृदा एक महत्वपूर्ण आधारभूत संसाधन आहे. मृदेमधून वनस्पतीला अन्न मिळते. लहान रोपटयांपासून मोठया वनस्पतीपर्यंत सर्व मृदेतून जन्माला येतात व त्या वनस्पतीवरच संपूर्ण मूलभूत गरजा अन्न, वस्त्र, निवारा, आर्थिक क्रिया, कृषी उत्पादन, पशुपालन, वनउद्योग मृदेवरच आधारित आहे. शेती विकासात व पीक उत्पादनात मातीची भूमिका महत्वाची असते. मृदेची खोली, पोत आणि रंग यानुसार अमरावती मधील मृदा संवर्धन खात्याच्या निरीक्षणानुसार चिखलदरा तालुक्यात तीन प्रकारची माती आढळते.

१. डोंगर माथ्यावरील भरड व खरड मृदा: ही डोंगर भागात राहून मातीत हयुमसचे प्रमाण अतिशय कमी असून अविकसीत आहे. चिखलदऱ्याचे तुटक पठारी भागात प्रामुख्याने हलकी व खडकाळ जमीन आढळते. यामध्ये हलक्या प्रतीचे खरीप पिके घेतली जातात.

२. मध्यम व काळसर भूरकट मृदा: ही मृदा पर्वतीय प्रदेशातून वाहत आलेल्या काळया मातीचे थर विस्तारलेले दिसतात. या प्रकारची मृदा डोंगराच्या उतारावर आढळते.

३. सखोल व सूपिक मृदा: नदीचे खणन व संचयनामुळे विकसीत झालेली गाळाची मृदा सूपीक असते तसेच या मृदेत सेंद्रीय पदार्थाचे प्रमाण जास्त असते. या मृदेत ज्वारी, तूर, कुटकी, भात, सोयाबीन, कापूस, गहू, हरभरा, सूर्यफुल, भाजीपाला व संत्रा हे पिके घेतल्या जातात.

चिखलदऱ्यामधील होणाऱ्या स्काय वॉक पुलामुळे निर्माण होणारी परिस्थिती: चिखलदरा हे थंड हवेचे ठिकाण असून अमरावती जिल्हयातील एक पर्यटन स्थळ आहे. या पर्यटन स्थळाला चांगला दर्जा मिळावा म्हणून याठिकाणी पर्यटकांला आकर्षित करण्याकरीता महाराष्ट्र शासनाने चिखलदरामधील हरीकेन पॉईंट ते गोराघाट पॉईंट दरम्यान स्काय वॉक पुल बांधण्यात येत आहे. जवळजवळ चिखलदरामधील ०.९२८६ हेक्टर क्षेत्रापैकी ०.८१२६ हेक्टर क्षेत्र वापरण्यात येत आहे. स्काय वॉक पुल पुर्ण झाल्यानंतर निर्माण होणारी परिस्थिती खालीलप्रमाणे सांगता येईल १) पुलावरुन जातांना कोणत्याही पर्यटकाने प्लॉस्टीक, डिस्पोझल व इतर खाण्याच्या वस्तु सोबत नेऊ नये याची दक्षता घ्यावी लागेल किंवा अशा भागात कचरा फेकु देऊ नये, फेकल्यास कठोर कारवाई करावी. २) पुलावर माकडे चढल्यास मानव व प्राणी संघर्ष घडून येऊ शकते. अशाठिकाणी मोठया प्रमाणात माकड प्रजाती वाढल्यामुळे पर्यटकांला त्रास होऊ शकते. ३) कचरा व प्लास्टिक फेकल्यामुळे पुलाखालील क्षेत्रामध्ये असणाऱ्या जैविक विविधतेचा ऱ्हास होऊ शकते. ४) उन्हाळयात जंगलाला आगी लागू नये म्हणून पर्यटकांनी ज्वलनशील सिगारेटचे तुकडे व आगपेटी कोठेही स्काय वॉक पुलावरुन फेकु नये. ५) ज्या कंपनीला स्कॉय वॉक पुलाचा ठेका दिला जाईल त्या कंपनीने अतिशय कठोर नियम लावायला पाहिजे त्यामुळे पुढील निर्माण होणारी परिस्थितीला आळा बसु शकेल. भविष्यात असे अनेक प्रकल्प या पर्यटन स्थळाला मिळाले तर या पर्यटन स्थळाचा विकास होऊन येथिल आदिवासी जमातीला रोजगार मिळेल म्हणजेच येथील साधनसंपत्तीचा ऱ्हास न करता मोठया प्रमाणात पर्यटनाला चालना मिळू शकते.

वन संवर्धनाचे उपाय: चिखलदरा तालुक्यामध्ये वनांचे संरक्षणासाठी तसेच संतुलनासाठी पूर्वापार वैदिक

काळापासून एकूण भूभागापैकी ३३ टक्के भाग हा वनासाठी राखीव असून या भागापैकी ४ टक्के भूभाग हा कायमस्वरुपी मानवी हस्तक्षेपापासून दूर राहावा म्हणून राष्ट्रीय उद्याने व अभयारण्ये स्थापन करण्यात आलीत. वनांचा होणारा ऱ्हास व वनाला लागणाऱ्या आगीवर नियंत्रण आणण्याकरीता वनसंवर्धनाची आवश्यकता आहे. त्याकरीता खालील उपाय करता येईल मानव स्वहिताकरीता, शेतीकरीता, फर्निचरकरीता मोठया प्रमाणात वृक्षतोड करतात ती कमी करुन वनलागवड कार्यरत ठेवणे अत्यावश्यक आहे. जनावरांच्या मुक्त चराईकरीता वेगळया ठिकाणी जनावरांना जागा उपलबध करुन दयावी. पाणलोट विकास कार्यक्रमांतर्गत सपाटीकरण, बांधबंदीस्ती, कंटूर बांडीग, बंधाऱ्याच्या पायथ्याशी झाडोंरा गवत वाढवून मृदा व वनसंवर्धनाचे कार्य पूर्ण करणे. उन्हाळयात जास्तीत जास्त जंगलाला लागणाऱ्या आगीमध्ये मानवी हस्तक्षेप आढळून येतो त्याकरीता जंगलामध्ये फिरतांना सिगारेट, आगपेटी व इतर ज्वलनशील पदार्थाची बंदी करावी. तसेच जंगलाला लागणाऱ्या आगीवर नियंत्रण करण्याकरीता प्रत्येक चिखलदरा पॉईटवर योग्य यंत्रणा बसविणे आवश्यक आहे.

मृदा संवर्धनाचे उपाय: वाढीव सेंद्रीय पोषक स्त्रोत, शाश्वत जमीन वापर, पीक पध्दती, व योग्य अशा अनेक पध्दतीचा अवलंब करुन जमिनीची सुपीकता वाढवण्यासाठी योग्य व्यवस्थापन पध्दतीची गरज आहे. म्हणून शेती पध्दतीमध्ये सपाटीकरण करुन जमीनीची मशागत करणे आवश्यक आहे तसेच माती धरुन ठेवणाऱ्या पिकांची लागवड करुन शेतीमध्ये हरभरा, ज्वारी, बाजरी, कडधान्य व चारा घेतल्यास मृदा संवर्धनास पोषक पर्यावरण निर्मीती होते. येथील आदिवासी जमातीने नुकतेच शेती पध्दतीमध्ये बदल करुन मोठया प्रमाणात आपल्या शेतीमध्ये स्ट्रॉबेरीचे पिके घेतल्या जात आहे त्यामुळे येथील शेतकऱ्याची परिस्थिती सुधारत आहे.

एकदंरीत संपूर्ण संशोधनाअंती असे स्पष्ट होते की महाराष्ट्रातील अमरावती जिल्हयातील चिखलदरा तालुक्यामध्ये चिखलदरा हे पर्यटन ठिकाण उंच पठारी भागावर असल्यामुळे पर्वतीय भागाची झीज होत आहे त्यामुळे मृदेचा ऱ्हास होत आहे तसेच रस्त्यांकरीता मोठमोठी झाडे कापल्या जात असल्यामुळे वृक्षाचाही ऱ्हास होत आहे. प्रत्येक पर्यटकांनी येथील प्रत्येक पॉईंट पाहत असतांना व सौदर्यांचा आस्वाद घेत असतांना प्लास्टीकच्या वस्तु, डिस्पोजल वस्तु व इतर खाण्याच्या वस्तु इतरत्र न फेकता ठराविक डस्टबीन मध्ये टाकल्यास येथील सौदर्य जसेच्या तसे राहू शकेल. म्हणूनच भविष्यात पर्यटकांचा ओढा वाढून चिखलदरा हे ‘अ’ दर्जाचे पर्यटन स्थळ बनू शकण्यास कोणी रोखू शकणार नाही.

निष्कर्ष:

१. भूपृष्ठरचना उंच सखल पठारी डोंगरी व उतार तीव्र असल्या कारणाने मृदेची धूप अधिक प्रमाणात घडून येते.

२. स्थानिक लोकांचा प्रमुख व्यवसाय फळे, फुले, शिकार, लाकूडकटाई इ. असल्यामुळे स्थानिक लोकांना उद्योगधंदयाच्या अभाव दिसून येतो.

३. शेतीची पारंपारीक पध्दती व दैववादी प्रवृत्ती आढळून येते.

४. शेतीत तंत्रज्ञानाचा अभाव असल्यामुळे जुन्या पध्दतीने शेती केल्या जाते त्यामुळे शेतीचे उत्पादन कमी होत आहे म्हणून येथील शेतकऱ्यांना शेती तंत्रज्ञानाबद्दल माहिती पुरविणे.

५. मौल्यवान वृक्षांची इंधन (जळाऊ) वापराकरीता अत्याधिक वापर होत आहे. त्याचा वापर कमी करणे आवश्यक आहे.

६. मृदा नापिक असल्यामुळे पिकांचे उत्पन्न कमी होत आहे त्यामुळे मृदेची सुपिकता वाढविण्याकरीता प्रयत्न करणे.

७. मुलभूत सुविधेचा अभाव असल्यामुळे येथील वनांत राहणाऱ्या जमातीचा विकास होत नाही त्याकरीता येथील जमातीकडे लक्ष देणे आवश्यक आहे.

८. चिखलदऱ्यामध्ये होणाऱ्या जंगलाचा नाश कमी करण्याकरीता तेथील जंगलात राहणाऱ्या जमातीने वनांचे संवर्धन करायला पाहिजे.

९. मृदा संवर्धनाकरीता सपाटीकरण, बांधबंदीस्ती, राबवावेत.
कंठूरबांडीग हे राष्ट्रीय कार्यक्रम म्हणुन नेहमी

संदर्भसूची: १)

प्रमिलाकुमार व श्रीकमल शर्मा : कृषी भूगोल

२) श्री. खतीफ : भारतीय कृषीच्या समस्या

३) टी. के. श्रीवास्तव : भूगोल कि सांख्यिकीय विधियॅा

४) Pramila Kumar : Agriculture Geography

५) आर्थिक व सामाजिक समालोचन: अमरावती (१९९१,२००१)

६) District census handbook :

डॉ. विजय के. टोम्पे डॉ. सचिन एन. भोंबे

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जळगाव जिल्ह्यातील अनुसूचित जमातीच्या लोकसंख्येचे वितरण व लोकसंख्या वाढीच्या दराचे भौगोलिक अध्ययन

नरेंद्र अशोक पाटील[1] डॉ. प्रवीण विलासराव ठाकरे[2]
[1](संशोधन विद्यार्थी, भूगोल) डॉ. बाबासाहेब आंबेडकर मराठवाडा विद्यापीठ, औरंगाबाद
[2] (संशोधन मार्गदर्शक) सहाय्यक प्राध्यापक, भूगोल विभाग राजर्षी शाहू कला, वाणिज्य व विज्ञान महाविद्यालय, पाथरी
तालुका – फुलंब्री, जिल्हा- औरंगाबाद डॉ. बाबासाहेब आंबेडकर मराठवाडा विद्यापीठ, औरंगाबाद
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सारांश

आदिवासी लोकसंख्येस अनुसूचित जमातीची लोकसंख्या म्हटले जाते. अनुसूचित जमातीच्या लोकसंख्येचे स्वतःचे वेगळे अस्तित्व आणि विशिष्ट संस्कृती आहे.सामुहिक जीवन जगण्याची पद्धती, एकत्रित निर्णय, आवश्यक तेवढेच पिक घेणे, वनांचे रक्षण करणे अशा विविध चांगल्या पद्धती या जमातीच्या लोकसंख्येकडून शिकण्यासारख्या आहेत.

भारतातील अनुसूचित जमातीच्या लोकसंख्येचे प्रमाण २०११ च्या जनगणनेनुसार १६.६% आहे तर महाराष्ट्र राज्यातील हे प्रमाण १०.१०% आहे. प्रस्तुत संशोधन निबंधात जळगाव जिल्ह्यातील अनुसूचित जमातीच्या लोकसंख्येचे तालुकानिहाय वितरण आणि लोकसंख्या वाढीच्या दराचे अध्ययन करण्यात आलेले आहे.

बिजसज्ञा अनुसूचित जमाती, लोकसंख्या, वितरण, वाढ

प्रस्तावना

जळगाव जिल्ह्यामध्ये २०११ च्या जनगणनेनुसार सुमारे १०% लोकसंख्या ही अनुसूचित जमातीची आहे. या जिल्ह्यात भिल्ल, भिल गारीसा, कोळी धोर, डोंगर कोळी, पारधी, अशा विविध जमाती वसलेल्या आहेत. तर तालुकानिहाय त्यांच्या वितरणात तफावत आहे. प्रस्तुत संशोधनामध्ये यवतमाळ जिल्ह्यातील अनुसूचित जमातीच्या लोकसंख्येचे २००१ आणि २०११ या जणगणनेतील लोकसंख्येचे तालुकानिहाय वितरण आणि २००१ ते २०११ याकाळातील वाढीचा न्द्र याचे विवेचन करण्यात आलेले आहे.

उद्दिष्ट्ये

प्रस्तुत अभ्यासाचे मुख्य उद्दिष्ट्ये पुढीलप्रमाणे आहेत,

१) जळगाव जिल्हातील अनुसूचित जमातीच्या लोकसंख्येचे वितरण तालुकानिहाय अभ्यासणे.

२) जळगाव जिल्हातील अनुसूचित जमातीच्या लोकसंख्येतील वाढीच्या दराचे तालुकानिहाय तुलनात्मक अध्ययन करणे.

अभ्यास क्षेत्र

जळगाव जिल्हा हा महाराष्ट्र राज्यात उत्तरेकडे स्थित असून हा जिल्हा नाशिक प्रशासकीय विभागामध्ये येतो. या जिल्ह्याचा अक्षवृत्तीय विस्तार २०° १३' ०९" उत्तर ते २१° २१' ४०" उत्तर अक्षवृत्त असून रेखावृत्तीय विस्तार हा ७४° ४६' ५३" पूर्व ते ७६° २३' ०९" पूर्व रेखांश आहे. जळगाव जिल्ह्यात एकूण १५ तालुके असून या जिल्ह्याचे एकूण भौगोलिक क्षेत्रफळ ११७६५ चौ.किमी. आहे. वर्ष २०११ च्या जनगणनेनुसार जिल्ह्याची एकूण लोकसंख्या ही ४२२९९१७ असून त्यापिकी २१९७३६५ पुरुर्ष तर २०३२५५२ स्त्री लोकसंख्या आहे. जिल्ह्याच्या उत्तरेकडे मध्य प्रदेश राज्याची सीमा आहे, तर पूर्वेकडे बुलढाणा जिल्हा, दक्षिणेकडे औरंगाबाद व जालना जिल्हा, नैऋत्येकडे नाशिक जिल्हा आणि पश्चिमेकडे धुळे जिल्हा आहे.

माहिती स्त्रोत व अभ्यास पद्धती

प्रस्तुत संशोधन हे दिव्तीयक स्त्रोताद्वारे प्राप्त माहितीच्या आधारावर पूर्ण केलेले आहे. अनुसूचित जमातीच्या लोकसंख्येची आकडेवारी ही जळगाव जिल्हा जनगणना अहवाल २००१ आणि २०११ यातुन संकलित केलेली आहे. लोकसंख्या वाढीचा दर काढण्यासाठी पुढील सूत्राचा उपयोग केलेला आहे.

$$\text{लोकसंख्या वाढीचा दर} = \frac{P1 - P0}{P0} \; X\,100$$

P1 – चालू जणगणनेतील लोकसंख्या

P0 – मागील जणगणनेतील लोकसंख्या

संकलित केलेली आणि सूत्राच्या सहाय्याने प्राप्त झालेल्या माहितीचे सारणी मध्ये मांडणी करण्यातल आलेली आहे. तसेच अनुसूचित जमातीच्या लोकसंख्येचे वितरण नकाशामध्ये दर्शविले असून लोकसंख्या वाढीचा दर हा आलेखाच्या सहाय्याने दर्शविण्यात आलेला आहे.

जळगाव जिल्ह्यातील अनुसूचित जमातीची लोकसंख्येचे वितरण – २००१

सारणी क्रमांक १ मध्ये जळगाव जिल्ह्यातील अनुसूचित जमातीच्या लोकसंख्येचे तालुकानिहाय वितरण आणि एकूण लोकसंख्येशी असलेले प्रमाण दर्शविलेले आहे.

सारणी क्रमांक १

जळगाव जिल्हा – अनुसूचित जमातीच्या लोकसंख्येचे वितरण – २००१

तालुके	एकूण अनुसूचित जमातीची लोकसंख्या	एकूण लोकसंख्येशी प्रमाण %	पुरुष %	स्त्रिया %
चोपडा	69893	25.71	51.37	48.63
येवल	51059	20.54	51.33	48.67
रावेर	44704	15.67	51.25	48.75
मुक्ताईनगर	20186	14.65	51.68	48.32
बोदवड	4519	5.71	52.14	47.86
भुसावळ	16035	4.93	51.55	48.45
जळगाव	50304	9.08	51.85	48.15
एरंडोल	17314	11.69	50.55	49.45
धारगाव	23130	14.40	51.71	48.29
अमळनेर	30715	11.70	51.32	48.68
पारोळा	18133	10.67	50.37	49.63
भडगाव	14906	10.48	51.09	48.91
चाळीसगाव	29274	8.20	51.87	48.13
पाचोरा	18442	7.32	51.30	48.70
जामनेर	27337	9.47	51.17	48.83
एकूण	**435951**	**11.84**	**51.39**	**48.61**

स्त्रोत – जनगणना अहवाल, जळगाव जिल्हा – २००१

वर्ष २००१ च्या जनगणनेनुसार जळगाव जिल्ह्यातील एकूण अनुसूचित जमातीची लोकसंख्या ही ४३५९५१ असून एकूण लोकसंख्येच्या तुलनेत त्याचे प्रमाण ११.८४% असलेले आढळते. जिल्ह्यात या लोकसंख्येचे सर्वाधिक वितरण हे चोपडा, येवल आणि जळगाव तालुक्यात आढळते,या तालुक्यात ५० हजारापेक्षा अधिक अनुसूचित जमातीची लोकसंख्या वसलेली आढळते. चोपडा आणि येवल तालुक्यात एकूण लोकसंख्येच्या तुलनेत हे प्रमाण २०% अधिक असून इतर तालुक्यात हे प्रमाण २०% पेक्षा कमी आहे. बोदवड तालुक्यात या जमातीच्या लोकसंख्येचे वितरण सर्वात कमी असून एकूण लोकसंख्येशी हे प्रमाण केवळ ५.७१% असलेले आढळते.चाळीसगाव, पाचोरा, जामनेर, जळगाव, भुसावळ आणि बोदवड या तौक्यात हे प्रमाण १०% पेक्षा कमी आहे.अनुसूचित जमातीतील पुरुष लोकसंख्येचे प्रमाण हे ५१.३९% तर स्त्रियांचे प्रमाण हे ४८.६१% आढळते. स्त्री व पुरुष प्रमाण हे सर्वच तालुक्यात जवळपास सारखे असल्याचे दिसून येते. बोदवड तालुक्यात पुरुष प्रमाण हे ५२.१४% सर्वात अधीक तर पारोळा तालुक्यात हे प्रमाण सर्वात कमी ५०.३७% असल्याचे आढळते. तसेच स्त्रियांचे प्रमाण पारोळा तालुक्यात सर्वात अधिक ४९.६३% तर बोदवड मध्ये सर्वात कमी ४७.८६% असलेले आढळते. इतर तालुक्यात पुरुष प्रमाण ५१ ते ५२ % आणि स्त्रियांचे प्रमाण ४८ ते ४९%% दरम्यान आहे.

जळगाव जिल्ह्यातील अनुसूचित जमातीची लोकसंख्येचे वितरण – २०११

सारणी क्रमांक २ मध्ये जिल्ह्यातील अनुसुस्चीत जमातीच्या लोकसंख्येचे वितरण, एकूण लोकसंख्येशी प्रमाण आणि स्त्री व पुरुष प्रमाण २०११ च्या जनगणनेनुसार दर्शविलेले आहे.

जिल्ह्यात २०११ च्या तुलनेत अनुसूचित जमातीची लोकसंख्या आणि एकूण लोकसंख्येशी त्याचे प्रमाण वाढलेले आहे. वर्ष २०११ मध्ये अनुसूचित जमातीची एकूण लोकसंख्या ही ६०४३६७ एवढी असून एकूण लोकसंख्येशी त्याचे प्रमाण १४.२९% आहे. याकाळात देखील या जमातीच्या लोकसंख्येचे सर्वाधिक वितरण हे चोपडा, येवल आणि जळगाव तालुक्यात आढळते. येवल मध्ये ९० हजारापेक्षा अधिक अनुसूचित जमातीची लोकसंख्या असून जळगाव आणि येवल तालुक्यात ६० ते ७० हजार दरम्यान आहे. चोपडा तालुक्यात या जमातीच्या लोकसंख्येचे एकूण लोक्संख्येसोबत प्रमाण ३०.८६% तर येवल तालुक्यात हे प्रमाण २५.०७% आहे.जळगाव तालुक्यात या जमातीच्या लोकसंख्येचे वितरण अधिक असले तरी एकूण लोकसंख्येशी हे प्रमाण केवळ १०.०७% आहे. जळगाव तालुक्यातील अनुसूचित जमातीची लोकसंख्या ही प्रामुख्याने शहरी भागात वसलेली आहे.

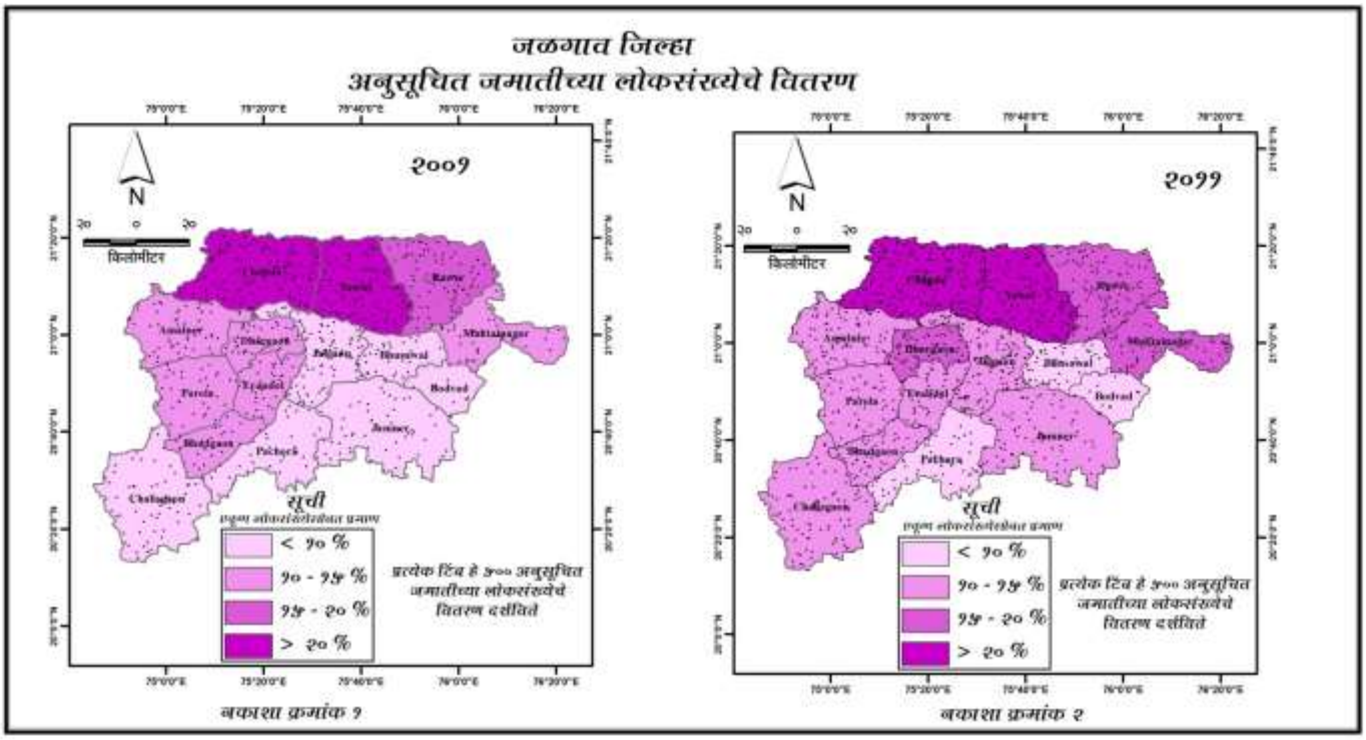
सारणी क्रमांक २

जळगाव जिल्हा – अनुसूचित जमातीच्या लोकसंख्येचे वितरण – २०११

तालुके	एकूण अनुसूचित जमातीची लोकसंख्या	एकूण लोकसंख्येशी प्रमाण %	पुरुष %	स्त्रिया %
चोपडा	96521	30.86	51.76	48.24
येवल	68248	25.07	50.76	49.24
रावेर	53512	17.15	50.95	49.05
मुक्ताईनगर	28849	17.65	51.70	48.30
बोदवड	6647	7.24	52.66	47.34
भुसावळ	23100	6.43	50.89	49.11
जळगाव	68075	10.07	51.59	48.41
एरंडोल	24604	14.78	50.97	49.03
धारगाव	29524	17.02	51.79	48.21
अमळनेर	41883	14.55	51.59	48.41
पारोळा	27119	13.78	51.03	48.97
भडगाव	22712	13.94	51.25	48.75
चाळीसगाव	45800	11.04	51.06	48.94
पाचोरा	28754	9.93	51.36	48.64
जामनेर	39019	11.15	51.07	48.93
एकूण	**604367**	**14.29**	**51.32**	**48.68**

स्त्रोत – जनगणना अहवाल, जळगाव जिल्हा – २०११

भुसावळ तालुक्यात याकाळात या लोकसंख्येचे एकूण लोकसंख्येशी हे प्रमाण सर्वात कमी ६.४३% तर भडगाव तालुक्यात या लोकसंख्येचे सर्वात कमी वितरण आहे. बोदवड, भुसावळ आणि पाचोरा या तालुक्यात हे प्रमाण १०% पेक्षा कमी आहे. अनुसूचित जमातीच्या लोकसंख्येतील पुरुष प्रमाण याकाळात ५१.३२% तर स्त्रियांचे प्रमाण ४८.६८% आहे. स्त्रियांचे प्रमाण २००१ च्या तुलनेत थोडे वाढलेले आढळते.येवल, रावेर, भुसावळ आणि एरंडोल तालुक्यात पुरुष प्रमाण ५० ते ५१ % आणि स्त्रियांचे प्रमाण ४९ ते ५०% दरम्यान आहे. तर इतर तालुक्यात पुरुष प्रमाण ५१ ते ५२% आणि स्त्री प्रमाण ४८ ते ४९% दरम्यान आहे.



नकाशा क्रमांक १ नकाशा क्रमांक २

जळगाव जिल्ह्यातील अनुसूचित जमातीच्या लोकसंख्येचा वाढीचा दर (२००१ ते २०११)

सारणी क्रमांक ३ मध्ये जिल्ह्यातील अनुसूचित जमातीच्या लोकसंख्येचा एकूण आणि स्त्री-पुरुष लोकसंख्या वाढीचा दर तालुकानिहाय दर्शविलेला आहे.जळगाव जिल्ह्यात २००१ ते २०११ यादरम्यान सर्वच तालुक्यात अनुसूचित जमातीची लोकसंख्या वाढलेली असल्याने लोकसंख्या वाढीचा दर सर्वच तालुक्यात धनात्मक आहे. संपूर्ण जिल्ह्यात याकाळात ३८.६३% दराने ह्या जमातीची लोकसंख्या वाढलेली आहे. तर पुरुष लोकसंख्येच्या तुलनेत स्त्री लोकसंख्या वाढीचा दर थोडा अधिक आहे. पुरुष लोकसंख्या वाढीचा दर ३८.४५% तर स्त्रियांचा दर ३८.८२% आहे.तालुकानिहाय लोकसंख्या वाढीच्या दरात तफावत आढळते. चाळीसगाव (५६.४५%), पाचोरा (५५.९२%) आणि भडगाव (५२.३७%) या तालुक्यात जरी ह्या जमातीची लोकसंख्या कमी असली तरी वाढीचा दर मात्र सर्वाधिक आहे. २००१ ते २०११ यादरम्यान ५०% पेक्षा अधिक लोकसंख्या वाढीचा दर दिसून येतो. रावेर तालुक्यात (१९.७०%) सर्वात कमी वाढीचा दर असल्याचे आढळते. इतर तालुक्यात हा दर २० ते ५०% दरम्यान आहे.

सारणी क्रमांक ३

जळगाव जिल्हा - अनुसूचित जमातीच्या लोकसंख्येचा वाढीचा दर (२००१ ते २०११)

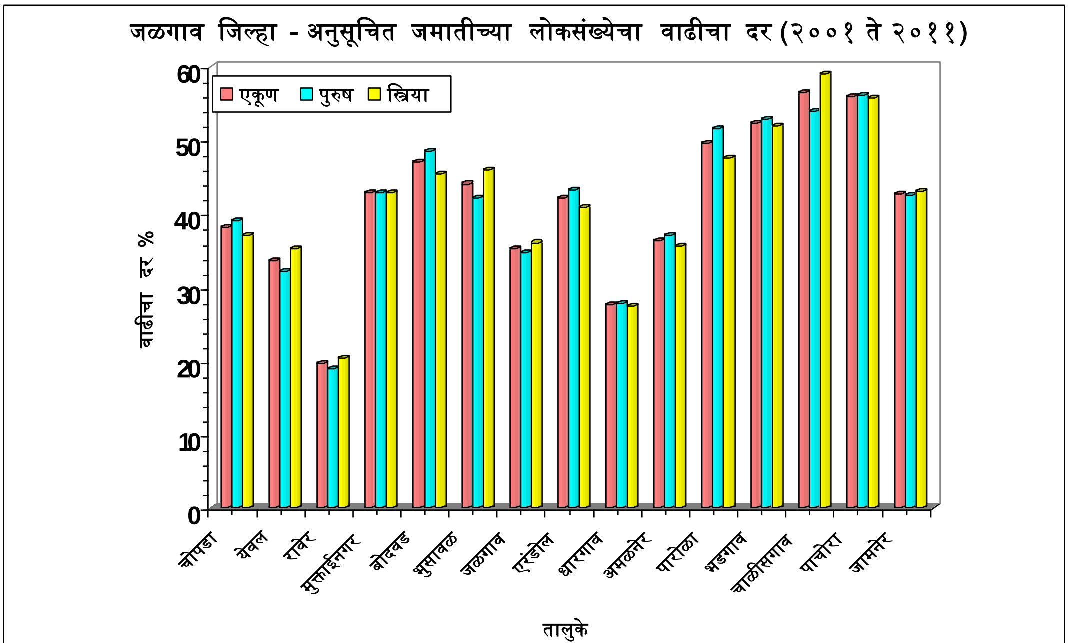
तालुके	एकूण %	पुरुष %	स्त्रिया %
चोपडा	38.10	39.13	37.00
येवल	33.66	32.19	35.22
रावेर	19.70	19.00	20.44
मुक्ताईनगर	42.92	42.96	42.86
बोदवड	47.09	48.56	45.49
भुसावळ	44.06	42.22	46.02
जळगाव	35.33	34.64	36.07
एरंडोल	42.10	43.29	40.89
धारगाव	27.64	27.85	27.42
अमळनेर	36.36	37.08	35.60
पारोळा	49.56	51.52	47.57

भडगाव	52.37	52.84	51.88
चाळीसगाव	56.45	54.00	59.09
पाचोरा	55.92	56.12	55.70
जामनेर	42.73	42.45	43.03
एकूण	**38.63**	**38.45**	**38.82**

स्त्रोत – संशोधक

पाचोरा (५६.१२%), चाळीसगाव (५४%), भडगाव (५२.८४%) आणि पारोळा (५१.५२%) या तालुक्यात पुरुष लोकसंख्या वाढीचा दर ५०% पेक्षा अधिक असून धारगाव (२७.८५%) तालुक्यात हा दर ३०% पेक्षा कमी आहे. इतर तालुक्यात हा दर ३० ते ५० % च्या दरम्यान असलेला आढळतो.

अनुसूचित जमातीच्या लोकसंख्येतील स्त्री लोकसंख्या वाढीचा सर्वाधिक दर हा चाळीसगाव (५९.०९%), पाचोरा (५५.७०%) आणि भडगाव (५१.८८%) असून हा दर ५०% पेक्षा अधिक आहे. तर रावेर मध्ये (२०.४४%) सर्वात कमी आहे. इतर तालुक्यात हा दर २५ ते ५०% दरम्यान असलेला आढळतो.



आलेख क्रमांक १

निष्कर्ष व उपाययोजना

जळगाव जिल्ह्यात अनुसूचित जमातीची लोकसंख्या सर्वच तालुक्यात वसलेली असून त्याच्या वितरणात मात्र तफावत आहे. तसेच २००१ ते २०११ याकाळात सर्वच तालुक्यात ही लोकसंख्या वाढलेली असली तरी वाढीच्या दरात तफावत आहे. अनुसूचित जमातीच्या लोकसंख्येतील स्त्री लोकसंख्येचे प्रमाण कमी असले तरी २००१ ते २०११ याकाळात लोकसंख्या वाढीचा दर पुरुषांच्या तुलनेत स्त्रियांचा दर ०.३८% ने अधिक आहे. येअव्ल, रावेर, भुसावळ, चाळीसगाव आणि जामनेर याच तालुक्यात स्त्री लोकसंख्या वाढीचा दर हा पुरुषांच्या तुलनेत थोडा कमी असून इतर तालुक्यात अधिक आहे.

चोपडा तालुक्यात नैसर्गिक वनस्पतींचे आच्छादन अधिक असल्याने या तालुक्यात अनुसूचित जमातीचे वितरण सर्वाधिक आढळते. तर जळगाव तालुक्यात शहरी भागात ही लोकसंख्या अधिक आढळते. भडगाव, चाळीसगाव या तालुक्यात ही लोकसंख्या प्रामुख्याने ग्रामीण भागात नैसर्गिक वनस्पती क्षेत्र अधिक असलेल्या प्रदेशात वाढलेली आहे. अनुसूचित जमातीची लोकसंख्या ही बहुतांश वेळेस कामासाठी भटकंती करत असते आणि त्यामुळेच याच्या वितरणात २००१ मध्ये आणि २०११ मध्ये थोडीफार तफावत आढळते. ग्रामीण भागात शेतीचा विकास केल्यास तसेच रोजगारांची उपलब्धता केल्यास या जमातीचे स्थलांतर कमी होईल. तसेच या जमातीतील प्रगत लोकसंख्येने पुढाकार घेतल्यास या जमातीचा विकास लवकर होईल.

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पर्यावरण संतुलनात वन्यजीवांचे योगदान – एक भौगोलिक अध्ययन

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DOI- 10.5281/zenodo.7547142

प्रस्तावना :-

विसाव्या शतकातील बेसुमार वाढत जाणाऱ्या लोकसंख्येचा वन्यजीवांच्या अस्तित्वावर मोठ्या प्रमाणात परिणाम झाला आहे. मानवाची वाढत जाणारी लालसा ही वन्यजीवांची संख्या घटण्याचे प्रमुख कारण आहे. वन्यजीवांच्या झालेल्या बेसुमार, प्राण्यांवर बंदी असताना सुद्धा मोठ्या प्रमाणात सस्तन प्राण्यांची होत असलेली हत्या किंवा त्यातून मिळणाऱ्या वस्तूला जागतिक बाजारपेठेत किंमत त्यामुळे निसर्गाचा समतोल मोठ्या प्रमाणात वाढत चालला. आपल्या पर्यावरणात अनेक अन्नसाखळ्या आहेत. पर्यावरणातील या साखळयांमुळे सजीव सृष्टीतील प्रत्येक सजीवाला अन्न मिळते आणि तो आपला जीवनकाळ पूर्ण करतो. जर अन्नसाखळी मधील एक दुवा नष्ट झाला तर संपूर्ण पर्यावरण समतोल बिघडून जाते. वन्यजीवांना असलेले धोके तसेच त्या धोक्यात असलेल्या वन्यजीवांच्या प्रजातींचे संरक्षण करण्यासाठी करण्यात येणाऱ्या उपायोजना ह्या अत्यंत महत्त्वाच्या असून त्याकडे या संशोधनातून मी लक्ष वेधू इच्छितो. गेल्या अनेक वर्षात मानव हा वन्यजीवांच्या बरोबरीने या भूतलावावर गुण्यागोविंदाने राहत आहे. परंतु काही दशकांची स्थिती पाहिली तर या दशकांमध्ये मानवाने वन्यजीवांच्या बेसुमार हत्या केल्या आहेत. वाढत्या शहरीकरणात व औद्योगीकरणात वन्यजीवांच्या राहण्याच्या जागा उद्ध्वस्त करण्यात आल्या वाढत्या प्रदूषणामुळे सुद्धा वन्यजीवांच्या प्रजोत्पादन क्रियेवर प्रतिकूल परिस्थिती निर्माण झाली आहे. आज वन्यजीवन हे पर्यावरणात टिकून राहणे अत्यंत अवघड झाले आहे. त्यामुळेच अनेक प्राण्यांच्या जाती या नष्ट होण्याच्या मार्गावर आहेत. अनेक प्राणी जंगलातून शहरी भागाकडे किंवा रस्त्यांवर स्वतःच्या संरक्षणासाठी किंवा उदरनिर्वाहासाठी जंगल सोडून शहरी भागात येताना दिसतात. खऱ्या अर्थाने घनदाट जंगल म्हणजे त्यांचे निवारा होईल परंतु जंगलातच त्यांच्या गरजा पूर्ण होत नाहीत मानवाच्या हस्तक्षेपामुळे आज वनाचा ऱ्हास झालेला आहे. परिणामतः वन्य जीव धोक्यात आले आहे. जर वन्यजीवांची ही पातळी अशीच कमी होत राहिली तर त्याचे गंभीर परिणाम मानवाला भोगावे लागू शकतात, यासाठीच वन्यजीवांचे संवर्धन व संरक्षण ही काळाची गरज आहे.

अभ्यासाचे क्षेत्र :-

भारतामधील सर्वत्र प्रस्थापित झालेल्या विविध अरण्ये किंवा तत्सम वन्यजीव संघटनातील येणाऱ्या घटकांचा विविध पशुपक्षांचा, वन्यजीवांचा व प्राण्यांचा अभ्यास जाणून घेण्यासाठी माझे अभ्यासाचे क्षेत्र हे संपूर्ण भारत असून त्या क्षेत्रात येणाऱ्या उत्तर भारत, मध्यप्रदेश, छत्तीसगड, महाराष्ट्र तसेच विविध राज्यातील विविध प्रांतातील भौगोलिक परिस्थितीनुसार निर्माण झालेल्या परिस्थितीचा अभ्यास करून भारतातील वन्यजीवपरिक्षेत्राविषयी जाणून घेण्याचा प्रयत्न करत आहे, प्रस्तुत संशोधन लेखात करत आहे.

अभ्यासाची उद्दिष्टे :-

प्रस्तुत संशोधन लेखामध्ये खालील उद्दिष्ट्ये घेण्यात आलेली आहे.

१) वन्यजीव प्रांतातील परिस्थितीचा तसेच पशु पक्षांच्या जाती प्रजातींचा अभ्यास करणे.

२) लुप्त होत चाललेल्या विविध पशु पक्षांच्या व वन्यजीवांच्या प्राण्यांच्या माहितीच्या आधारे त्या त्या परिक्षेत्रातील व त्या राज्यातील विविध परिस्थितीचा आणि प्राण्यांचा अभ्यास करणे.

३) विविध परिक्षेत्रात निर्माण झालेल्या प्रदूषण युक्त परिस्थितीचा अभ्यास करून वन्यजीवांमध्ये निर्माण झालेल्या बिकट परिस्थितीचा अभ्यास करणे.

४) भारतातील वन्यजीवपरिक्षेत्र कायद्याचा व त्या कायद्याच्या अनुषंगाने नवनिर्मित करण्यात येत असलेल्या विविध योजना प्रकल्प आणि पद्धतींचा अभ्यास करणे.

५) पशुपक्ष्यांच्या प्रजातींमध्ये स्थलांतर आणि कालांतर यातून निर्माण झालेले बदल.

संशोधन पद्धती :-

प्रस्तुत संशोधन लेखात प्रामुख्याने आवश्यक असलेल्या प्राथमिक माहितीचा तसेच दुय्यम स्वरूपात गोळया करण्यात आलेल्या विविध माहितीचा आधार घेऊन इंटरनेट तसेच विविध पुस्तके आणि वृत्तपत्र कात्रणातून प्राप्त झालेल्या माहितीचा आधार घेत या संशोधन कार्याला योग्य दिशा देण्याचा माझा मानस आहे. त्याचप्रमाणे मेळघाट परिक्षेत्र व पूर्व मेळघाट कार्यालयात उपलब्ध झालेल्या व नवीन प्रकाशित झालेल्या माहिती व शोध निर्मितीच्या आधारावर आवश्यक ती माहिती गोळा करून त्या पद्धतीने संशोधनाला योग्य दिशा देण्याचा प्रयत्न केलेला आहे.

विषय विवेचन:-

पर्यावरणाचा समतोल राखण्यासाठी महत्वाचा घटक असणारे पक्षी व प्राणी जगविण्याची जबाबदारी महत्वाची आहे. आज माणूसच वनसृष्टी नष्ट करण्याचे काम करीत असल्यामुळे पर्यावरणाचे संतुलन बिघडत चालले आहे. पर्यावरण व्यवस्थापन ही मानव आणि निसर्ग यांच्यात समन्वय साधणारी प्रक्रिया आहे. त्याद्वारे पर्यावरणाचे संतुलन बिघडू न देता व प्रदूषणविरहित पर्यावरण राखून मानवाचे हित साधण्याचा प्रयत्न केला जातो. पर्यावरणाच्या आपत्तीवर नियंत्रण ठेवण्याची प्रक्रिया ही पर्यावरण व्यवस्थापनाचे एक अंग असून यात नियोजन, विश्लेषण व मूल्यांकन यांच्या आधारे संसाधनांचा विचारपूर्वक उपयोग करण्याचे तंत्र वापरले जाते. पर्यावरणाच्या अवनतीमुळे सर्व सजीवांच्या अस्तित्वाला धोका निर्माण झाला आहे. त्यामुळे पर्यावरणतज्ज्ञ, अभ्यासक, शासक, प्रशासक, सामाजिक तसेच राजकीय कार्यकर्ते या समस्यांवर विचारविनिमय करीत आहेत. त्यातूनच पर्यावरण व्यवस्थापन ही संकल्पना पुढे आली आहे. पर्यावरण व्यवस्थापन ही विकास व नियोजनाच्या संदर्भातील संकल्पना आहे. यात समाजाचा सर्वांगीण विकास करणे तसेच नैसर्गिक संसाधनांचा समतोल वापर करून सामाजिक व आर्थिक विषमता दूर करणे, ही उद्दिष्टे अभिप्रेत आहेत. त्याचबरोबर मानवाच्या अविचारी कृतींवर नियंत्रण, नैसर्गिक संसाधनांचे संरक्षण व पर्यावरणीय समस्यांच्या निवारणासाठी निर्धारित केलेली तत्त्वे यांचा पर्यावरण व्यवस्थापनात समावेश होतो. मानवाच्या सामाजिक व आर्थिक विकासाबरोबर पर्यावरणाची गुणवत्ता राखण्याचा प्रयत्न यातून केला जातो.

वाढत्या औद्योगीकरणामुळे किंवा नागरी वस्तीमुळे सस्तन प्राणी किंवा पक्षी यांची संख्या कमी होत आहे काही जीवांच्या तर प्रजातीच नष्ट झालेल्या किंवा लुप्त होत चाललेल्या आहे. पर्यावरणावर मोठ्या प्रमाणात होत असलेली शिकार तसेच विविध वृक्षांची तोड, जमीन अधिग्रहण किंवा वृक्ष लागवडीचा होत असलेला अभाव या सर्वांमुळे पर्यावरणाचे शोषण होत असल्याचे लक्षात येत आहे. एखाद्या ठिकाणी सुरुवातीपासूनच काही प्रजाती आणल्याने त्या ठिकाणी असणाऱ्या मूळ जनावरांच्या प्रजातींना धोका निर्माण झालेला आहे. अनेकदा नवीन प्रजातींमुळे त्या भागातील स्थानिक प्रजातींचा नामशेष होण्याच्या मार्गावर आहे.

जंगलात वाघ असणे हे समृध्द जंगलाचे प्रतिक आहे. जंगलात असलेल्या अन्नसाखळीमधील वाघ हा मुख्यघटक आहे. तसेच वाघामुळे जंगलात असलेल्या वनस्पतींचे आणि इतर तृणभक्षी प्राण्यांमध्ये समतोल राखला जातो. त्यामुळे वाघ हा पर्यावरणातील असमतोल राखण्यासाठी जैविक साखळीतील महत्वाचा घटक आहे. वाघांची संख्या ज्या जंगलात जास्त असते ते जंगल किंवा तेथील भाग हा सर्व दृष्टीने परिपूर्ण असल्याचे मानले जाते. जंगल उत्कृष्ट असेल तर मानवी जीवन सुसह्य होण्यास कारणीभूत ठरते. वनसंपदेमुळे सर्व प्राणीमात्रांसाठी आवश्यक असलेला ऑक्सिजन, मुबलक पाणी, आणि जमिनीची धूप थांबण्यासही मदत होते. पर्यायाने जंगलांसाठी सर्व वन्यजीव वाचविणे हे आपले प्रथम कर्तव्य आहे. त्यात वाघ हा या जैविक साखळीतील महत्वाचा घटक आहे. व्याघ्र प्रकल्पासाठी घोषीत केलेले क्षेत्र हे निमसदाहरित जंगल असून ते दुर्गम व अति उतार असलेले, डोंगराळ तसेच घनदाट असल्याने या भागात गवे, सांबर, रानडुक्कर, लंगूर यांचा वावर जास्त प्रमाणात आहे. तथापि, त्यांची संख्या ही इतर अभयारण्य किंवा इतर व्याघ्र प्रकल्पांच्या तुलनेत कमी असल्याने त्यांच्या संख्येत वाढ होण्याच्या दृष्टीने वनविभागामार्फ़त प्रयत्न केले जाणार आहेत. यामुळे त्या भागातील वाघांचे अस्तित्व कायम टिकविण्यासाठी मदत

होणार आहे. व्याघ्र प्रकल्पाच्या माध्यमातून वाघांसाठी पोषक वातावरण तयार करुन, त्यांचे प्रजनन वाढवून त्यांच्या संख्येत वाढ करणे हा प्रमुख उद्देश असणार आहे. व्याघ्र प्रकल्पात मानववस्ती नसलेल्या व मानवी वर्दळ नसलेल्या जंगल भागांचा विकास कोर क्षेत्र म्हणून केला जाणार आहे. त्या सभोवताली असलेल्या क्षेत्राला बफर म्हणून निश्चित केले जाणार आहे. जेणेकरुन तेथे राहणाऱ्या लोकांना त्यांच्या गरजा भागविण्यासाठी कोर क्षेत्रावर अवलंबून न राहता, त्यांना त्यांच्या गरजा त्यांच्या गावातच भागविणे शक्य होणार आहे. व्याघ्र प्रकल्पाच्या माध्यमातून वाघांचे संनियंत्रण करणे, त्यांच्या संख्येत वाढ होण्यासाठी त्यांच्या अधिवासामध्ये सुधारणा करणे महत्त्वाचे आहे.

पर्यावरणामध्ये होत असलेले प्रदूषण किंवा जलप्रवाहात होत असलेली प्रदूषित पाण्याची वाढ ज्यामुळे जलसृष्टीला धोका निर्माण झाला आहे समुद्रामध्ये सोडल्या जाणारी कारखान्याचे प्रदूषित पाणी त्यामुळे जलप्रदूषणातून अनेक जलचर प्राण्यांची प्रजाती लुप्त होत चाललेली आहे प्लास्टिकच्या कचऱ्यामुळे सुद्धा वन्यजीवांचे जीवन धोक्यात आलेले आहे सतत वाढत असलेल्या प्रदूषणामुळे पर्यावरणाचा समतोल पूर्णतः बिघडलेला असून विविध प्रकारच्या प्रदूषणामुळे मग वायू प्रदूषण जलप्रदूषण भूमी प्रदूषण या सर्व कारणांमुळे विविध पक्षी प्राणी मासे कीटक किंवा एकमेकांवर निर्भर असलेले भक्षक हे सर्व नष्ट होत चालले आहे. हवामानात होणारा बदल किंवा मोठ्या प्रमाणात कारखान्यातून वाढत असलेल्या प्रदूषणाच्या पातळीमुळे पर्यावरणातील पक्षांच्या प्रजाती सुद्धा नष्ट होत चाललेले आहे. वन्य जीवन ची संवर्धन ही आज काळाची गरज असून त्या अनुषंगाने वनविभाग आता दरवर्षी वन महोत्सव अंतर्गत विविध प्राण्यांचे संवर्धन तसेच वनस्पतीचे व वृक्षांची लागवड करून वृक्ष संगोपन करण्याचे प्रयत्न करीत आहे. नुकतेच काही दिवसांपूर्वी भारताचे पंतप्रधान नरेंद्र मोदी यांनी आपल्या भारतामध्ये लुप्त होऊन गेलेला चिता हा प्राणी पुन्हा या भारतात आणून त्याचे संगोपन त्याचे संवर्धन करण्याचा मानस केला आहे वन्यजीवांचे व त्यांच्या मूळ अधिवासात असलेल्या विविध प्राण्यांचे संगोपन आणि संवर्धन करण्याचा मानस आज वनविभाग पूर्णपणे करीत आहे यामध्ये विविध राष्ट्रीय उद्याने व वन्यजीव अभयारण्य उभारण्यात आलेली असून उत्तरांचल येथे असणारे जीम कॉर्बेट व्याघ्र प्रकल्प, मध्यप्रदेशातील बांधवगड राष्ट्रीय उद्यान, गुजरात मधील गीर राष्ट्रीय उद्यान, राजस्थान मधील रणथंबोर राष्ट्रीय उद्यान इत्यादी अभयारण्ये आज प्रेक्षणीय स्थळ तसेच संगोपन केंद्र म्हणून उपलब्ध आहे.

भारताच्या स्वातंत्र्यानंतर राष्ट्रीय उत्पन्नात शेतीचा वाटा ४८% इतका होता सध्या तो २२% ते २४% वर येऊन पोहोचला आहे. संगणकाच्या नवनवीन तंत्रज्ञानाच्या काळात शेतकरी आत्महत्या का करतो यावर चिंतन करण्याची वेळ आलेली आहे. आजच्या परिस्थितीत ज्या पद्धतीने शेतकऱ्यांची आत्महत्या होत आहे त्याचप्रमाणे वन्य जीवांचे सुद्धा संगोपन त्या त्या परिक्षेत्रात अत्यंत कठीण होत असल्याचे लक्षात येत आहे आणि हाच एक चिंतनाचा विषय आहे.

व्याघ्र प्रकल्पात आढळणारी नैसर्गिक वनस्पती, तलाव, विविध प्रकारची रंगीबेरंगी पक्षी हे पर्यटकांना आकर्षित करतात. हे पर्यटन केंद्र विकसित होण्यासाठीच्या तरतुदी व तेथील नैसर्गिक संपत्तीच्या संवर्धनासाठी काय करता येईल, याबाबतचा आढावा शोधनिबंधात घेण्यात आला आहे. शोधनिबंधासाठी मिळवलेली माहिती ही प्राथमिक व द्वितीय स्वरूपाची असली तरी सद्यस्थितीच्या अवलोकनासाठी प्रत्यक्ष संदर्भग्रंथ, प्रसिद्ध व अप्रसिद्ध लेख तसेच प्रत्यक्ष निरीक्षणाद्वारे माहिती संकलित केलेली आहे.

निष्कर्ष :-

मानवी मनात निर्माण झालेल्या लोभापायी तसेच सृष्टीमध्ये सातत्याने निर्माण झालेले प्रदूषण किंवा निर्मित कृत्रिम व्यवस्थापन यामुळे वन्यजीवांची ऱ्हास ही वाढली आहे त्यामुळे वन्यजीवांना धोका निर्माण होऊ नये किंवा त्यांची संगोपन संवर्धन करण्यात अडथळा निर्माण होणे या अनुषंगाने पर्यावरण संवर्धन व संगोपन हे अत्यंत महत्त्वाची व काळाची गरज आहे. वन्यजीवांच्या संवर्धनासाठी करण्यात येणारे उपाय, त्यातील कायदे व त्यातील योजना यांचा अभ्यास प्रत्येक व्यक्ती आणि समाजासाठी आवश्यक असून त्या अनुषंगाने शाळा, महाविद्यालय शासकीय विभाग व निमशासकीय विभाग तसेच सेवाभावी संस्था यामधून वन्यजीव संगोपन संवर्धन करणे गरजेचे आहे. त्यासाठी या सर्व संस्थांनी पुढे येऊन वन्यजीवांचे संवर्धन करता येईल त्यासाठी उपाय योजना किंवा त्याचे फायदे याविषयी विविध माहिती प्रकल्प सातत्याने समाजापुढे प्रत्येक व्यक्ती पुढे आणणे आवश्यक आहे. आपल्या आधुनिक जीवन

पद्धतीमुळे पर्यावरण, वन्यजीव आणि पृथ्वीचा समतोल बिघडू नये याची काळजी आपण प्रत्येकाने घेणे आवश्यक आहे. सध्या एका जागतिक महामारीशी आपण लढत असताना पर्यावरण आणि वसुंधरेच्या संवर्धनासाठी वैश्विक प्रयत्नांचे महत्त्व प्रकर्षाने अधोरेखित होत आहे. वसुंधरेच्या रक्षणासाठी डोळस विचार आणि कृती अपेक्षित आहे. जागतिक वसुंधरा दिनानिमित्ताने सर्वांनी सजग दृष्टिकोन ठेवून पर्यावरणाचा समतोल राखण्याचा व वसुंधरेच्या रक्षणाचा संकल्प करुया.

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मभूप संशोधन पत्रिका

खंड २१, पृष्ठ क्रमांक २५

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भारतातील जैवविविधता आणि त्यांच्या संवर्धनामध्ये मानवाची भूमिका

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प्रस्तावनाः-

जैवविविधता हे एक निसर्गिक संसाधन मानले जाते. निसर्गाने मानवाल विविध देणग्यापैकी ही एक देणगी असुन मानवी जिवन सुखकार करण्यासाठी महत्वाचा घटक आहे. परंतु सध्याच्या काळात जैवविविधतेचा प्रश्न गंभीर बनलेला आहे.वाढती लोकसंख्या नैसर्गिक साधन संपततीचा अमर्याद वापर वृक्षतोड, भुमिच्या वापरात होत जाणारे बदल यामुळे संजीवाच्या अनेक प्रजाती नष्ट झाल्या आहे व ब-याच नष्ट होण्याच्या मार्गावर आहे. उष्ण तापमान पट्टयातील वंनामध्ये पृथ्वीवरील सजिवांच्या ५०% जास्त प्रजाती आढळतात. परंतु मानवाच्या हस्तक्षेपामुळे अनेक प्रजातींचे अस्तीत्व धोक्यात आले आहे. मानवाच्या हस्तक्षेपामुळे सजीवांच्या प्रजाती नष्ट होण्याचा दर नैसर्गिकरित्या नष्ट होणा-यांच्या दराचा सुमारे १००० पट्टी जास्त आहे. असे शास्त्रज्ञ म्हणतात. हा संहार केवळ उष्ण पट्यातील वंनामध्ये चालु आहे. म्हणुन पट्यातील वनांचे संरक्षण करणे गरजेचे मानले जाते.

जैवविविधता टिकविण्यासाठी गरज आहे. जंगल सर्वधनाची जंगल हे वन्य जिवनाचे व जिवाणुंची वस्तीस्थाने म्हणुन वन्य जिवनाच्या रक्षणासाठी वनांचे रक्षण करणे आवश्यक आहे.पर्यावरणाचासमतोल राखण्यासाठी वन व वन्य जिवन वाढविणे जैवविविधतेची जपणुककरणे तसेच तिचे सर्वधन करणे ही काळाचीगरज आहे. जैवविविधतेचा पर्यावरणाचा आत्मा असुन वन वा वन्य जिवन एकाचा नान्याच्या दोन बाजु आहे. त्यामुळेच समतोलीत पर्याकरणासाठी जैवविविधतेचे संरक्षण करणे आवश्यक आहे. वनस्पती प्राणी व जीव-जिवाणुच्या विविधजाती व प्रजातींच्या पुढील पिढ्यांनसाठी संवर्धन आणि सौरक्षण काळाची गरज व मानवाची अनुषंगिक जबाबदारी आहे. अन्यथा धोक्याचा लाल दिवा लुकलुकायला लागला आहे.गरज आहे ती मानवाने सावधहोऊन सावरण्याची अन्यथा निसर्ग क्षमा करणे अशक्य आहे.

उद्दिष्टे :-

(१) निसर्गाचा समतोल राखणे.
(२) वन व वन्य जीवांची निसर्गाशी नाते जोडणे.
(३)वनस्पती व प्राण्यांच्या दुर्मिळ प्रजातींचे विनाशापासून संरक्षण करणे.
(४) जंगलांचा विनाश थांबविणे.
(५) जंगली वनस्पती व प्राण्यांच्या अनुवंशीय जनुकांची जोपासना करणे.

संशोधन पध्दतीः-

प्रस्तुत शोध निबंधाचा अभ्यास करण्यासाठी दुय्यम स्त्रोतांचा आधार घेण्यात आला आहे. सदर लेखाकरीता स्पष्टीकरण पध्दतीचा वापर करण्यात आला आहे. याचबरोबर सारणी पध्दतीचा वापर करून सविस्तर स्पष्टीकरण करण्यात आले आहे. याशिवाय प्राथमिक स्वरुपाची माहिती ही दैनिक वृत्तपत्रे, मासिके, पर्यावरणविषयक अहवाल संशोधन परिष इंटरनेटच्या वेगवेगळया साईटचा वापर करून मिळवलेली आहे.

स्पष्टीकरणः-

प्रस्तुत शोध निबंधाचे स्पष्टीकरण सविस्तरपणे खालील प्रमाणे दिलेले आहे.

जैवविविधतेच्या व्याख्याः-

जैवविविधता ही निसर्गाने मानवाला दिलेली देणगी असुन मानवाच्या अस्तित्वासाठी आणि प्रगतीसाठी आवश्यक आहे. मानवाच्या सभोवताली विविध प्रकारच्या वनस्पती प्राणी सुक्ष्म जिव यांचा समावेश आहे. या सजीवांच्या आकार प्रकार संरचना यामध्ये भिन्नता दिसुन येते. तरीदेखील एका विशिष्ट वातारणात विविध प्रकारच्या आणि वेगवेगळया संख्येचे सजीव दिसुन येतात. संजीवांच्या या एकत्रित अदिवासास जैवविविधता असे म्हटले जाते. 'रिओडी जानेरो' या ब्रिटिशमधील राजधानीमध्ये इ.स. १९९२ मध्ये वसुंधरा शिखर परिषद संपन्न झाली. त्यावेळ पासुन जैवविवधिता हा शब्द प्रचलित झाला. जैवविविधतेच्या व्याख्या अनेक शास्त्रज्ञाने केलेल्या आहेत. त्यामधील पुढील व्याख्या महत्वाच्या मानल्या जातात.

१) वॉल्टर डी. रोसेन यांच्या मते, "एकाच परिसंस्थेत किंवा परिसंस्थेशी संबंधीत क्रियांमध्ये भिन्न

जातीच्या भिन्न संख्येच्या संजिवाचे एकत्रीकरण म्हणजे जैवविविधता होय. ''

२) ''एखाद्या विशिष्ट परिस्थितीमध्ये वाढणा-या विविध वनस्पती प्राणी व जिवाणु यांच्या जाती म्हणजे जैवविविधता होय.''

जैवविविधतेच्या संवर्धनाची गरज :-

भारतातील विविध जैविक घटकांचे संरक्षण करण्याची गरज निर्माण झाली आहे. शासनाच्या पातळीवर त्यासाठी अनेक उपाययोजना राबविल्या जात आहेत. पर्यावरण वन्य जीवप्रेमी, खाजगी संस्था इत्यादींच्या माध्यमातून सुद्धा याबाबतीत प्रत्यक्ष कार्य केले जात आहे. वन्य प्राणी व वनस्पतींच्या संवर्धनाबाबतीत काम करण्यासाठी भारत सरकारने पर्यावरण मंत्रालयाची स्थापना केली. इ.स. १९८८ पासून नवीन जंगल धोरण तयार करण्यात आले. २ एप्रिल १९९२ पासून प्राणी, पशुपक्षी यांच्या व्यापारावर बंदी घालण्यात आली असून त्यांची आता निर्यात करता येणार नाही. आज जगाला वन संवर्धनाची गरज निर्माण झाली आहे. त्यामुळे वन्य जीव प्रजातींचे संरक्षण होणार असून पुढील पाच फायदे होणार आहेत.

(१) निसर्गाचा समतोल राखणे
(२) जनुक बैंक
(३) आर्थिक मूल्य
(४) शिक्षण
(५) मनोरंजन

भारतातील जैवविविधता संपन्न ठिकाणे :-

"ज्या क्षेत्रात विपुल प्रमाणात वनस्पती, प्राणी आणि सूक्ष्म जीव आणि त्यांच्या प्रजाती आढळतात अशा क्षेत्रास जैवविविधतेसाठी अनुकूल किंवा सर्वाधिक जैवविविधतेचे क्षेत्र असे म्हणतात. संपूर्ण जगभरात एकूण २५ संपन्न जैवविविधता प्रदेश (Hot Spots) आहेत. भारतातही काही ठिकाणी असे हॉट स्पॉटस् (अनुकूल क्षेत्रे) आढळतात. उष्ण कटिबंधातील विषुववृत्तीय प्रदेशातील सदाहरित जंगलात जैवविविधता कमालीची असते. तेथील मुसळधार पाऊस व घनदाट जंगले यामुळे तेथे जमिनीवर पडणारा पाचोळा लवकर कुजतो. त्यावर कीटक, कवके मोठ्या प्रमाणावर वाढतात. इतर वनस्पतींचीही वाढ होते. भारतात सर्वसाधारणपणे अंदमान, निकोबार, लक्षद्वीप आणि केरळातील जंगले हॉट स्पॉटस् समजली जातात. कारण येथे अनेक प्राणी आणि वनस्पती एकत्र राहतात. दुर्मिळ झाडे वगैरेंच्या अनेक प्रजाती वाढत राहतात. जेवढ्या जास्त प्रजाती एकत्र येतील तेवढे हॉट स्पॉटचे पर्यावरणातील महत्त्व वाढत असते."

भारतातील जैवविविधता संपन्न विभाग :-

भारतामध्ये जैवविविधता संपन्न ठिकाणांच्या दृष्टिकोनातून पुढील तीन विभाग महत्त्वाचे आहेत-

(१) **ईशान्य भारतः-** ईशान्य राज्यात भारतातील ६३% सस्तन प्राणी व १,५०० स्थानिक वनस्पतींच्या प्रजाती आढळतात.

(२) **पश्चिम घाटः-** पश्चिम घाटामध्ये सरपटणाऱ्या प्राण्यांच्या प्रजातींचे प्रमाण जास्त आहे तसेच १,५०० वनस्पतींच्या प्रजाती येथे आढळतात.

(३) अंदमान आणि निकोबार बेटेः- अंदमान व निकोबार बेटामध्ये सुमारे २,२०० फूल वनस्पतींच्या जाती व १२० नेचे वनस्पतींच्या जाती आढळतात.

जैवविविधतेवरील संकटांची कारणेः-

प्रस्तुत शोध निबंधामध्ये जैवविविधतेच्या संकटाची कारणे पुढीलप्रमाणे आहे.

१) पृथवीवरील जैविवविधतेच्या –हासाचे प्रमुख कारण म्हणजे मागील काही वर्षात त्यांच्या अधिवाचा मानवाकडुन केला गेलेला विनाश आहे.

२) जगामध्ये वन्य प्राण्यांचे बेकायदा शिकार मोठ्या प्रमाणात केली जात आहे. त्यामुळे वन्य प्राणी नामशेष होण्याच्या मार्गावर आहे.

३) मानवाने इंधन, चारा, इमारती, लाकुड यासाठी जंगलाची कटाई केली. त्यामुळे वनात राहणा-या प्राण्यांची घरे नष्ट झाली.

४) जगातील वाढती लोकसंख्यमुळे मानवाला निवारासाठी घरे कमी पडू लागली. म्हणुन त्याने जंगलाचा नाश केला. परिणामी वन्य जिवांचे अस्तित्व धोक्यात आले.

५) उद्योगधंद्यासाठी मानवाने मोठ्या प्रमाणात वृक्षतोड केली.

६) अनेक नद्यांवर धरणे बांधल्यामुळे नद्यांचा प्रवाह खंडीत झाला. या खंडीत प्रवाहाचे वाळवंट झाले. त्यामुळे जलचरांचा नाश झाला.

७) मानवाने मोठया प्रमाणात लोह, तांबे, कोळसा, पेट्रोलियम पदार्थ यासाठी अनेक खाणी खोदल्या त्यामुळे सुध्दा ब-याशा प्राण्यांचे अस्तितव धोक्यात आले.

भारतातील वनस्पती व प्राण्यांच्या संकटग्रस्त प्रजातीः-

भारतामध्ये हवामान आणि प्राकृतिक रचनेतील विविधतेमुळे जवळपास ८१,००० जीवजंतूंच्या आणि ४५,००० वनस्पतींच्या प्रजाती आढळून येतात. १,५०० प्रजाती अत्यंत संकटग्रस्त अवस्थेत आहेत. भारताचे क्षेत्रफळ जगातील क्षेत्रफळाच्या २.४% इतके आहे. येथे जगातील एकूण जीवजंतूंच्या ६५% जीवजंतू निवास करतात. जागतिक वन क्षेत्रफळापैकी भारतात फक्त २% वन क्षेत्र आहे. भारतात जागतिक पशूंपैकी १८% पशू, ६०% वाघ, ७०% आशियन हत्ती व इतकेच भारतीय गेंडे आढळून येतात. भारतात माशांच्या (मासे) २,५४६ प्रजाती, १,२२८ पक्ष्यांच्या,

४,००० कीटकांच्या, ४२८ सरपटणाऱ्या जीवांच्या, ३७२ सस्तन प्राण्यांच्या, २०४ उभयचर प्राण्यांच्या प्रजाती आढळून येतात. यापैकी सस्तन प्राण्यांच्या ८३, पक्ष्यांच्या ११३, सरपटणाऱ्या जीवांच्या २१, उभयचर प्राण्यांच्या ३ प्रजाती व अनेक कीटकांच्या प्रजाती लुप्त झाल्यासारख्या आहेत. तक्ता क्र. ६.१ मध्ये भारतातील नष्ट होत चाललेल्या जीवजंतूंची संख्या दर्शविली आहे.

सारणी क्र. १
भारतातील नष्ट होत चालेल्या जीवजंतूची संख्या (२०१४)

अ.क्र.	प्रजाती	नष्ट झालेल्या प्रजाती	नष्ट होण्याचा धोका असलेल्या प्रजाती
१	वनस्पती	३८७	१९,०८१
२	मासे	२६	३४५
३	उभयचर	४	५३
४	सरपटनारे	२४	१७६
५	पाठीचा कणा नसलेले जीव	१०१	१,३५९
६	पक्षी	१३६	१,०३८
७	सस्तन	८५	५१०
	एकूण	**७६३**	**२२,५६२**

अशाप्रकारे भारतात वनस्पती, प्राणी, पशु-पक्षी यांच्या अनेक जाती व प्रजाती होत्या. पण मानवाने स्वतःच्या स्वार्थासाठी या सर्व सजीवांचे अस्तित्व धोक्यात आणले आहे. सजीवांच्या बऱ्याच जाती-प्रजाती नष्ट होण्याच्या मार्गावर आहेत. काही नष्टसुद्धा झाल्या आहेत.

निष्कर्षः-

१) जैवविविधतेचे संवर्धनासाठी कडक कायदे करणे व त्या कायद्याची पारदर्शकपणे अंबलबजावणी करणे गरजेचे आहे.

२) जैविक उत्पादने आणि प्रक्रिया यांच्या मूल्यवर्धनासाठी जैवतंत्रज्ञान वापरले पाहिजे.

३) स्थानिक लोकांनी वनस्पती आणि प्राणी या विषयीच्या ज्ञानाचा समृध्द साठा ठेवला पाहीजे.

४) जैवविविधता संवर्धनामध्ये जनसहभाग सक्रीय असणे गरजेचे आहे.

५) वन्यजिवांच्या शिकारीवर बंदी आणने.

६) राष्ट्रीय उद्याने आणि उभयारण्यांची स्थापना करणे.

संदर्भग्रंथ सुचीः-

१) डॉ. विठ्ठल घारपुरे (२०१४) 'पर्यावरणशास्त्र', पिंपळापुरे अॅण्ड कं. पब्लिशर्स, नागपुर.

२) ए. बी. सवदी, पी.एस. कोळेकर (२०१३) 'पर्यावरणशास्त्र', निराली प्रकाशन, शिवाजी नगर, पुणे.

३) डॉ. अरुण कुंभारे (२००४): 'पर्यावरण जागृती, पायल पब्लीकेशन, पुणे.

४) डॉ. प्र. द. राऊत (२००९) पर्यावरण अभ्यास', शिवाजी विद्यापीठ, कोल्हापूर

५) डॉ. प्रकाश सावंत (२०१०): पर्यावरण व प्रदूषण, सरस्वती बुक कंपनी, पुणे-२

६) डॉ. वसुधा पुरोहित (२०१२): 'पर्यावरणाचे अर्थशास्त्र विद्या बुक्स पब्लिशर्स. औरंगपुरा, औरंगाबाद

७) खतीब के. ए. (१९९७): 'मानवी भूगोल', मेहता पब्लिशिंग हाऊस, पुणे

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महाराष्ट्रातील वाढत्या लोकसंख्येवर दुग्ध व्यवसाय संशोधन व विकास संस्थांची भूमिका.

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प्रस्तावना :

प्राचीन काळापासून भारत या देशात पशुपालनाचा व्यवसाय करण्यात येतो. भारत पारंपारिक पशुपालनात जगात अग्रेसर आहे भारताने जगातील अनेक देशांना जातिवंत पशुधन पुरवठा करून विकासात मदत केली आहे. गाय व म्हशींच्या संख्येच्या बाबतीत भारताचा पहिला क्रमांक लागतो. महाराष्ट्रात शेती क्षेत्राला महत्त्व असल्याने पशुपालन व्यवसायालाही महत्त्व प्राप्त झालेले आहे. त्यामुळे दुग्ध व्यवसाय हा कृषी अर्थव्यवस्थेच्या विकासात महत्त्वाची भूमिका बजावतात दुग्ध व्यवसाय हा शेतीपूरक व्यवसायाबरोबरच कुटुंबाला पूरक उत्पन्न मिळवून देण्याबरोबरच ग्रामीण भागात रोजगार निर्मिती द्वारे विशेषतः भूमिहीन मंजूर लहान व सीमांकित शेतकरी तसेच महिलांना सहाय्यभूत ठरतात राज्यातील सुमारे 51.6% लोक ग्रामीण भागात राहत असून त्यापैकी 52 टक्के लोक शेतीवर उपजीविका करतात परंतु शेतीत अधिक लोकांना रोजगार देण्याची क्षमता नसल्याने शेतीला पूरक व्यवसाय म्हणून पशुपालन व्यवसायाला महत्त्व प्राप्त होत आहे. पशुधनाच्या घनतेत महाराष्ट्र प्रथम क्रमांकावर आहे कारण महाराष्ट्राची पशुघनता 223 जनावर इतकी आहे. तर भारताची पशुघनता 166 जनावरे आहे सण १९९७ च्या पशुगणनेनुसार महाराष्ट्रात पशुधन सुमारे 3.96 कोटी होते ते सन 2019 च्या पशुगणनेनुसार 53 कोटी झाले.

उद्दिष्टे:

1. महाराष्ट्रातील दुग्ध व्यवसायात संशोधन व विकास सेवा पुरविणाऱ्या संस्थांचा आढावा घेणे.
2. महाराष्ट्रातील दुग्ध व्यवसायाच्या विकासात संस्थांचे योगदान तपासणे.
3. दुग्ध व्यवसायाच्या विकासापुढील आव्हानांचा अभ्यास करणे.
4. दूध उत्पादन क्षेत्रात शाश्वत वाढ व विकास करणे.

तथ्य संकलन:

प्रस्तुत संशोधनाचे अध्ययन करण्यासाठी प्राथमिक व द्वितीय माहितीचा आधार घेतला आहे.

1. प्राथमिक माहिती =प्राथमिक माहितीही दुग्ध संकलन केंद्र तेथील अधिकारी पदाधिकारी सभासद आणि दुग्ध उत्पादक यांच्या प्रत्यक्ष भेटी घेऊन त्यांची मुलाखत घेण्यात आली.
2. दुय्यम माहिती = द्वितीय माहिती ही प्रकाशित व अ प्रकाशित पुस्तके वार्षिक अहवाल जनगणना अहवाल समिती अहवाल वर्तमानपत्रे, नियतकालिके, जर्नल्स, संदर्भ ग्रंथ व संकेतस्थळांचा उपयोग करून माहिती संकलित करण्यात आलेली आहे.

महाराष्ट्रातील दुग्ध व्यवसाय :

भारत हा कृषिप्रधान देश असल्यामुळे प्राचीन काळापासून दुग्ध व्यवसाय हा देशात आणि राज्यात सुरू आहे परंतु पूर्वी हा व्यवसाय कौटुंबिक पातळीवर करण्यात येत असे त्याला व्यवसायाचे स्वरूप नव्हती मात्र महाराष्ट्र राज्याने दुग्ध व्यवसायात मोठी झेप घेतली आहे राज्यात दुग्ध व्यवसाय दुग्ध उत्पादनात प्रथम क्रमांक उत्तर प्रदेश या राज्याचा आहे तर महाराष्ट्राचा कुल पशुधनात क्रमांक सहावा आहे . दुसऱ्या महायुद्धाच्या काळामध्ये अन्नटंचाईमुळे गर्भवती स्त्रिया व लहान मुल यांचे कुपोषण टाळण्याच्या दृष्टीने मुंबई महानगरपालिकेने दूध वाटप योजना सुरू केली .स्वातंत्र्यपूर्व कालखंडात लष्करांच्या दुधाची गरज भागवण्यासाठी ब्रिटिशांनी मिलिटरी डेअरी फार्म स्थापन केले होते मुंबई शहरातील गोठ्यांचे पुनर्वसन शास्त्रीयरीत्या करणे तसेच शहरातील लोकांना स्वच्छ दूध मिळण्याच्या उद्देशाने आरे दूध वसाहतीची स्थापना 1947 ला करण्यात आली . शहरातील नागरिकांना निर्जतूक दूध मिळण्याच्या उद्देशाने 1952

साली आशियातील पहिली दुग्ध शाळा स्थापन करण्यात आली महाराष्ट्राच्या ग्रामीण भागात दुधाचे उत्पादन वाढविणे ग्रामीण भागातील छोट्या शेतकऱ्यांना किफायत शीर जोडधंदा उपलब्ध करून देणे खेड्यातील भूमिहीन शेतमजूर आणि अल्प उत्पन्न गटातील बेरोजगार यांना रोजगारांची संधी उपलब्ध करून देणे आणि असे करीत असतानाच शहरी भागातील ग्राहकांना चांगल्या प्रतीचे दूध वाजवी भावाने उपलब्ध करून देणे अशी सुस्पष्ट उद्दिष्टे नजरेसमोर ठेवून महाराष्ट्र शासनाने 1958 साली स्वतंत्र अशा दुग्ध व्यवसाय विकास विभागाची स्थापना केली.

मोठ्या शहरातील ग्राहकांना उपलब्ध करून देण्याची क्रिया सुखर व्हावी यासाठी राज्यात विविध ठिकाणी 38 शासकीय दूध शाळा व ८१ दूध शीतकरण केंद्र स्थापन करण्यात आली दुधाच्या उत्पादनात होणारे चढ-उतार लक्षात घेऊन दुधाची भुकटी तयार करण्याचे चार कारखाने शासकीय क्षेत्रात आणि सात कारखाने सहकारी क्षेत्रात तर वीस खाजगी क्षेत्रात कार्यरत असून या सर्व कारखान्यांची मिळून दूध भुकटी तयार करण्याची एकूण प्रतिनि क्षमता 623 मॅट्रिक टन इतकी आहे या सर्व उपाययोजनांमुळे महाराष्ट्रातील समस्त दूध उत्पादकांना खात्रीची बाजारपेठ उपलब्ध झाली आहे

दूध व्यवसायातील संशोधन व विकास संस्था:

स्वातंत्र्यपूर्वक कालखंडात 1862 साली पुणे येथे पहिली पशुवैद्यकीय गोशाळा उघडण्यात आली 868 साली जनावरांच्या आजारावर वैद्यकीय उपचार सजीवविण्यासाठी भारतीय पशुधन प्ले कमिशनची स्थापना करण्यात आली या कमिशनच्या सूचनेवरून लाहोर येथे पहिली पशुवैद्यकीय महाविद्यालय उघडण्यात आली 1889 साली इम्पिरियल बॅक्टेरिया लॉजिकल लॅब्रोटरी उघडण्यात आली.

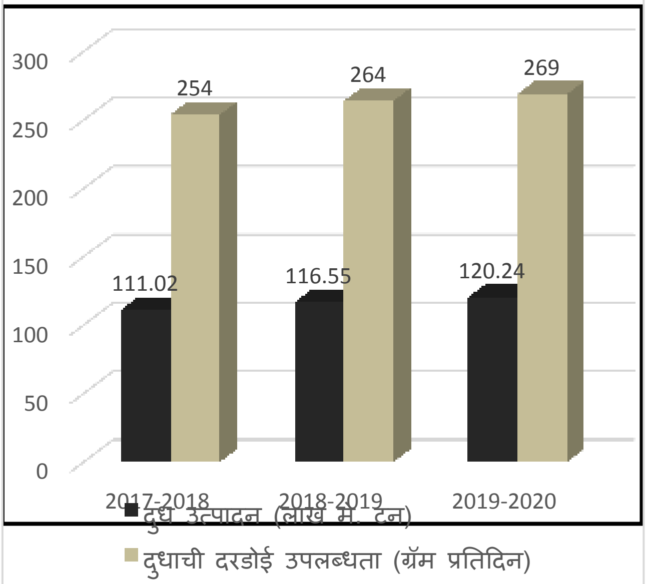
1919 साली भारतात प्रथमच पशुगणना करण्यात आली. मिस्टर विल्यम स्मिथ या इम्पेरियल डेअरी तज्ञांच्या शिफारशीवरून शास्त्र पद्धतीने पशुसंखर पशुखाद्य व पशुपालनाच्या व्यवसाय व्यवस्थापनाकडे विशेष लक्ष देण्यात सुरुवात झाली. १९२३ साली बंगलोर येथे इम्पिरियल इन्स्टिट्यूट ऑफ ऍनिमल हेब्रेटी अंड डायरिंग या संस्थेची स्थापना करण्यात आली . 1941 साली या संस्थेचे इम्प्रियल डेरी इन्स्टिट्यूट असे नामांतर करण्यात आले 1955 साली पुन्हा नॅशनल डेअरी रिसर्च इन्स्टिट्यूट असे या संस्थेचे नाव बदलण्यात आली 1939 साली भारतात प्रथमच कृत्रिम रेतन कार्यक्रमास प्रारंभ करण्यात आला 1960 - 62 च्या दरम्यान मिरज कोल्हापूर, धुळे, अहमदनगर, नागपूर, औरंगाबाद इत्यादी शहरांमध्ये शासकीय दूध योजना सुरू झाल्या. त्यापूर्वी मुंबई शहरासाठी 1951 सालापासून आरे येथे दूध वसाहतींची स्थापना आणि दररोज अडीच लाख लिटर दुधावर प्रक्रिया करण्याची क्षमता असलेल्या अरे दूध डेरी ची सुरुवात झालेली होती त्यानंतर दहा वर्षांनी म्हणजेच 1961 साली युनिसेफच्या सहकार्याने वरळी दुग्ध शाळेचा प्रकल्प आकारास आला. शहरी भागातील दुधाची वाढती मागणी पूर्ण करायची असेल तर महाराष्ट्राच्या ग्रामीण भागात दुधाचे उत्पादन वाढविणे गरजेचे आहे.महाराष्ट्र राज्यात सहकारी दूध महासंघाची महानंद दुग्ध शाळा तसेच कोल्हापूर जिल्हा सहकारी दुग्धोत्पादन संघ, कोल्हापूर जवळील वारणा सहकारी दूध उत्पादन संघ, अकलूजचा शिवामृत सहकारी दूध उत्पादन संघ अशा अनेक सहकारी संस्था ही आता दूध प्रक्रिया शहरी भागात दुवा टप दुग्ध शाळा उभारणी तसेच दुग्धजन्य पदार्थांची निर्मिती आणि विक्री अशा विविध क्षेत्रात उतरलेल्या आहेत.

महाराष्ट्रातील दूध उत्पादन व दरडोई दूध उपलब्धता

वर्ष	दुध उत्पादन (लाख मे. टन)	दुधाची दरडोई उपलब्धता (ग्रॅम प्रतिदिन)
2017-2018	111.02	254
2018-2019	116.55	264
2019-2020	120.24	269

(स्रोत = बेसिक ऍनिमल हस्बटरी स्टॅटिस्टिक 2020, पशुसंवर्धन व दुग्धविकास विभाग केंद्र शासन.)

आलेख



वरील तक्त्यावरून असे लक्षात येते की 2017 -18 मध्ये राज्यात दूध उत्पादन हे 111.02 लाख मॅट्रिक टन तर दुधाची दरडोई उपलब्धता 254 ग्रॅम प्रतिदिन मध्ये आहे तर 2019 -20 दूध उत्पादन हे 120.24 तर दुधाची दरडोई उपलब्धता ही 269 एवढी आहे यावरून आपल्याला असे समजते की महाराष्ट्रातील दूध उत्पादन व दूध दरडोई उपलब्धता ही 2017- 18 मध्ये कमी तर 2019 - 20 मध्ये सतत वाढ होत आहे असे आढळून येते.

दूध व्यवसाय संशोधन व विकास संस्था पुढील आव्हाने:

2011 च्या जनगणनेनुसार महाराष्ट्राची लोकसंख्या 11.2 कोटी आहे हे प्रमाण देशाच्या लोकसंख्येच्या 9.4% इतकी आहे. या लोकसंख्येला 2030 पर्यंत 129 लाख मॅट्रिक टन दूध उत्पादनाची गरज भासणार आहे 2019 -20 साली120.24 लाख मॅट्रिक टन दूध उत्पादन उपलब्धता आहे उपलब्ध पशुधनाच्या आधारे ही गरज भागविणे अवघड आहे राष्ट्रीय दूध व्यवसाय योजनेत सुचविल्याप्रमाणे दुधाची आणि आरोग्य घटक भेसळ टाळण्यासाठी जैवतंत्रज्ञानाच्या सहाय्याने पशु सुधार प्रकल्प राबवावी लागणार आहेत संशोधन संस्थांना जागतिक स्तरावर सिद्ध झालेल्या तंत्रज्ञानाचा आधार घेऊन दूध उत्पादन खर्च कमी करण्यासाठी निकराचे प्रयत्न करावे लागणार आहे पशु, पशु आरोग्य, खनिज मिश्रणे, पशुखाद्य, पशुविज्ञान, लसीकरण, चारा ,यांत्रिक साधनांचा वापर ,शास्त्रीय गोठा, तज्ञांची मार्गदर्शन हे सर्व प्रकल्प एकात्मिक दूध व्यवसाय विकास योजनेअंतर्गत शेतकऱ्यांपर्यंत पोहोचवावे लागणार आहेत दूध उत्पादनातून भरपूर फायदा प्राप्त होऊ शकेल इतपत किमती दूध उत्पादकांना मिळणे आवश्यक आहे. या दृष्टीने संशोधक व विकास संस्थांना प्रयत्न करावे लागणार आहेत.

समस्या:

1. दूध व्यवसाय हा शेतीपूरक जोड व्यवसाय म्हणून केला जातो.

2. महाराष्ट्रात दूध उत्पादन वाढीचा वेग मंद स्वरूपाचा आहे.

3. विविध प्रकारच्या शासकीय योजना आहेत त्या शेतकऱ्यांपर्यंत जलद गतीने पोहोचविल्या जात नाही.

4. दूध व्यवसायाचे शिक्षण, प्रशिक्षण देण्याची सुविधा कमी आहे.

उपयोजना:

1. दुग्ध व्यवसायात अत्याधुनिक उत्पादन तंत्राचा अवलंब करावा.

2. दूध व्यवसाय उत्पादकांना दूध व्यवसायाचे शिक्षण, प्रशिक्षण देण्यात यावे.

3. पशुवैद्यकीय सेवा, अल्प व्याजदराने जनावरे खरेदीसाठी कर्ज पुरवठा करावा.

4. अधिक दूध निर्मितीसाठी प्रोत्साहन द्यावे.

5. शासनाने भांडवल पुरवठा करून डेअरी प्लांट सुरू करावे.

6. शिक्षण संशोधन आणि विकास या तीन सुत्री योजनेचा अवलंब करावा.

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