International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 7.328
Peer Reviewed Bi-Monthly
Vol. 11 No. 5 May-June 2024

An Economic analysis of ecological repercussion and usegubility impact of irrigation system in satara district of Maharashtra

Dr. Nilima Rajaram Mirajkar
Head of Economics Department, MTES,Doshi Vakil Arts College and G.C.U.B. Science and Commerce College Goregaon, Raigad
Corresponding Author: Dr. Nilima Rajaram Mirajkar
DOI- 10.5281/zenodo.12705085

Abstract:

Researchers have undertaken a comprehensive examination of the Koyana Dam, focusing on both its environmental and economic impacts. The primary objective of this study is to discern the positive and negative consequences of the dam on the environment and economy. The researchers aim to elucidate the beneficial effects, such as the reduction in flood intensity and frequency, improved agriculture productivity, enhanced soil fertility, mitigation of waterlogging, and a decrease in water-borne diseases and reduced soil nutritional value.

In terms of economic impact, the study concentrates on improvements in agricultural productivity, the subsequent increase in farm income, and the overall rise in agriculture production. Data for this research has been gathered through both primary and secondary sources. The primary data was acquired through survey methods, while secondary data, essential for the study, was sourced from books, journals, periodicals, and reports from governmental and other relevant agencies.

The study employs an analytical and descriptive approach, revealing that the Koyana Dam is poised to play a pivotal role in fostering economic upliftment and development within the society. The findings underscore the significance of the dam in contributing positively to both the environmental and economic dimensions of the region.

Keywords: Dam, Water, Environmental impact, Flood, Agriculture.

Introduction:

Water is an indispensable element for the survival of all forms of life on Earth. In the realm of agriculture, two crucial inputs are water and land. The contemporary society faces a substantial demand for water, with this demand escalating at a rate of approximately 100 million people annually, mirroring the global population growth. Throughout history, dams and reservoirs have been strategically erected worldwide to mitigate floods, supply drinking and residential water, generate energy, and facilitate irrigation.

In response to this escalating demand, numerous projects have been initiated to construct dams. These structures, by regulating water delivery at specified intervals and managing stream regimes, have played a pivotal role in the evolution of civilizations. The distribution of dams across countries and regions, as illustrated in a diagram based on a World Commission database from the year 2000, reveals China as the leader in dam construction, followed by other parts of Asia, North and Central America, and the United States.

Dams emerge as essential components for the developmental progress of any country globally. As defined by the International Commission on Large Dams (ICOLD), a dam is characterized by a maximum height of 15 meters or more from the lowest foundation to the crest, with a capacity to impound more than 3 million cubic meters of water when the height falls within the range of 5 to 15 meters.

Statement of the Research Problem:

Dams exert a range of environmental effects, encompassing both positive and negative aspects, beyond their roles in stream regime regulation, flood prevention, water supply for residential and irrigation purposes, and energy generation. The ecological consequences of a dam remain consistent regardless of its location. These effects span both short-term and long-term durations, influencing the immediate vicinity as well as the broader regions served by the dam. Examples of dam-related environmental impacts encompass social and antisocial consequences, as well as both beneficial and detrimental outcomes..

Objectives of the Study:

The Main Objective of the study is to study the ecological and economic repercussions of the Koyana Dam.Specific objectives are as follows

1. To assess the environmental impact of Koyana dam.
2. To study the economic impact of Koyana dam.

Research Methodology:

The current research employs an analytical and quantitative approach. To gather comprehensive data, the study utilizes a combination of essential methods. Primary data is acquired through a survey

methodology, while secondary data, crucial for the study, is sourced from diverse outlets such as books, journals, government websites, periodicals, and reports.

Methods of Data Collection:

The present study is based on primary as well as secondary data as given below.

Primary Data:

The primary data have been collected from, a structured questionnaire was administered to 200 respondents from the dam's catchment area. This sample size of 200 respondents was determined through purposive sampling, ensuring a targeted and relevant participant group for the study. Primary data is gathered through the implementation of a well-structured questionnaire and through methods such as interviews, group discussions, and observations. This multifaceted approach ensures a comprehensive and robust data foundation for the research in the field of environmental economics The ongoing research initiative falls within the realm of environmental economics, necessitating the collection of

Secondary Data:

The secondary data has been collected through the study area profiles, information is extracted from publications and official records of Maharashtra's Public Works Department, Irrigation Department, Forest Department, and Agricultural Department, specifically pertaining to dams.The various books, research articles, published and unpublished M. Phil. dissertations and Ph. D. theses, minor and major project reports, etc. are also considered

Sample Design:

The sample selection process involves the utilization of a non-random sampling approach, specifically employing the purposive sampling method. The selection is focused on the Pune region, with a deliberate choice of a single dam due to its significant rainfall and well-irrigated area. The chosen large-sized dam for this study is the Koyana Dam located in the Pune Region.

Analysis of the Data:

The primary data have been analyzed through descriptive and inferential statistical tools and techniques. In descriptive statistics percentages and frequency are used and software's like MS-Word, MS-Excel, and SPSS have been used for data processing and tabulation .

Significance of the Study:

The significance of the present research study is as follows:

1. The current research study aids in the comprehension of the notion of dam environmental consequences.
2. The study is helpful in formulating environmental policy especially relating to the large sized dams.
3. The study can play an important role in providing the knowledge and creating awareness among the people and society about the adverse environment impacts of the large sized dams.

Scope of the Study:

The scope of the present study is classified into the following four elements.

Topical scope:

The topical scope of the present study is to explore ecological and economic repercussions of the Koyana Dam. Hence it is entitled An analysis of the ecological and economic repercussions of the Koyana Dam..

Geographical scope:

The geographical scope of the present research study is the satara district which covers all 11 talukas.

Analytical scope:

The analytical scope consists of ecological and economic repercussions of the Koyana Dam. For analysis of data, the researcher has used different dimensions such as ecological and economic repercussions of dam. The researcher has used MS-Excel, MS-Word, and SPSS. Percentage is used for analysis of data.

Periodical scope:

The ecological and economic repercussions of the Koyana Dam in the satara district has been studied from 2001-02-to 2018-19.

Limitations of the Research Study:

The limitations of the present research study are as follows:

1) Present research is related to only the environmental impact of Koyana dam,
2) Present research focused on socio-economic impact of Koyana dam.
3) Researcher is not covered all dimensions of dams.
4) The conclusion of this research may not be applicable to other.

Koyana Dam:

The Koyna Dam stands as the largest dam in the state of Maharashtra, situated on the Koyna River near Koyananager in the Patan taluka of Satara district. Primarily designed for hydroelectric power generation and irrigation purposes, the Koyna Dam holds the distinction of producing the highest amount of hydropower in both the Maharashtra state and India. Given its pivotal role in power generation, the Koyna Dam is often referred to as the lifeline of Maharashtra.

Irrigation Area of Koyana Dam:

Due to the Koyana Dam, irrigation facilities have been made available to 11 talukas in Satara district. Following table no.01 shows the taluka wise irrigation area in hectares.

Table No.01
Taluka wise Irrigation Area of the Koyana Dam (2001-02 to 2018-19) (Area in Hectors)

Sr. No	Taluka	Total Area Under Irrigation		Growth Area Under Irrigation
		2001-02	2018-19	
1.	Mahabaleshwar	3303	5055	1752
2.	Wai	1689	3495	1806
3.	Khandala	19875	25641	5766
4.	Phaltan	54027	65982	11955
5.	Man	20402	24692	4290
6.	Khatav	21020	27631	6611
7.	Koregaon	18011	24596	6585
8.	Satara	24900	32652	7752
9.	Jawali	9509	14562	5053
10.	Patan	12715	15800	3085
11.	Karad	15493	22651	7158
	Total	**200944**	**262757**	**61813**

(Source: Govt. of Maharashtra, Irrigation Status Report 2018-19)

Attributed to the Koyana Dam, the overall irrigated area in 2001-02 stood at 200,944 hectares, as illustrated in the aforementioned table. Phaltan taluka led with the maximum irrigated area of 54,027 hectares, followed by Satara taluka with 24,900 hectares, Khatav taluka with 21,020 hectares, Man taluka with 20,402 hectares, and Khandala taluka with 19,875 hectares. Fast forward to 2018-19, and the irrigated area expanded significantly to a total of 262,757 hectares. Phaltan taluka maintained its lead with the largest irrigation area, encompassing 65,982 hectares. The Koyana Dam continued to play a pivotal role in irrigating areas, with Satara covering 32,652 hectares, Khatav with 27,631 hectares, Khandala with 25,641 hectares, Man with 24,692 hectares, and Karad with 22,651 hectares.

The Positive Environmental Impacts of the Koyana Dam:

Table No. 02
Reduced Flood Intensity and Frequency

Sr. No.	Impact Scale	Frequency	Percent
1	Negligible Insignificant	24	12
2	Low Significant	48	24
3	Enough Significant	68	34
4	Significant	60	30
	Total	**100**	**100**

(Source: Field Survey)

As per the data presented in Table No. 2, 34% of the overall respondents express the belief that the construction of dams has led to a noteworthy reduction in the intensity and frequency of floods. A significant 30% of respondents attribute the dams' role in diminishing the intensity and frequency of floods to the substantial accumulation of rainwater in the dammed areas. The significance of dams in decreasing the intensity and frequency of floods receives a low rating from 24% of the respondents, while only 12% consider this issue as negligible.

Improved Agriculture Productivity:

Table No.03
Improved Agriculture Productivity

Sr. No.	Impact Scale	Frequency	Percent
1	Low Significant	38	19
2	Enough Significant	96	48
3	Significant	66	33
	Total	**200**	**100**

(Source: Field Survey)

As indicated in Table No. 3, 48% of the surveyed participants hold the belief that the productivity of lands irrigated by dams has witnessed a significant increase. Additionally, 33% of respondents attribute the notable enhancement in the productivity of irrigated lands to the dams' ability to provide timely and ample irrigation, thereby fostering higher agricultural output.

Conversely, only 19% of respondents consider this matter as relatively insignificant.

The progress in irrigation infrastructure within the Satara district has led to a comprehensive boost in crop production. Various crops, including sugarcane, groundnuts, sunflower, vegetables, and other cash crops, have experienced a substantial rise in production.

Improved Soil Fertility:

Table No. 04
Improved Soil Fertility

Sr. No	Impact Scale	Frequency	Percent
1	Low Significant	35	17.5
2	Enough Significant	96	48
3	Significant	69	34.5
	Total	**200**	**100**

(Source: Field Survey)

According to the information presented in the table above, 48% of the total respondents affirm that water sourced from dams has played a significant role in enhancing soil fertility. An additional 34.5% of participants attribute a notable improvement in soil fertility to the water supplied by dams. The consistent provision of water for agriculture throughout the year allows for crop rotation, leading to an enhancement in soil fertility, as acknowledged by 34.5% of respondents. In contrast, 17.5% of participants consider this matter to be of minor importance.

Negative Environmental Impact of Large Sized Dams:

Water Logging Area:

Water logging and salinity represent interconnected global environmental challenges that require attention from every country. This issue is particularly pronounced in developed nations, where an annual addition of 2 to 3 million hectares of fertile land to the agricultural areas affected by water logging occurs worldwide. In India alone, approximately 10 million hectares of cultivated land are impacted by water logging.

Table No.05
Water Logging Area

Sr. No.	Impact Scale	Frequency	Percent
1	Rarely	38	38
2	Very Rarely	105	52.5
3	Never	57	28.5
	Total	**200**	**100**

(Source: Field Survey)

As depicted in Table No. 5, 52.5% of the overall respondents indicate that they very rarely encounter water logging issues in the dam's area. Another 38% of participants state that they are rarely aware of water logging problems. In contrast, 28.5% of respondents assert that they have never experienced water logging problems in the vicinity of the dam.

Water-borne Diseases:

As per a report from the World Health Organization (WHO), over two billion individuals reside in regions where they face the risk of contracting malaria. The annual incidence of clinical malaria is estimated to exceed 300 million cases, leading to more than one million fatalities each year attributed to malaria-related causes.

Table No.06
Water-borne Diseases

Sr. No.	Impact Scale	Frequency	Percent
1	Frequently	11	5.5
2	Rarely	29	14.5
3	Very Rarely	121	60.5
4	Never	39	19.5
	Total	**200**	**100**

(Source: Field Survey)

Based on the provided statistics, 60.5% of the overall respondents mentioned that diseases like malaria and jaundice, caused by water from dams or rivers, are encountered very rarely by their family members. Only 19.5% of those surveyed have never experienced such illnesses. A minimal 14.5% of respondents reported occasional instances of this disease. Furthermore, a mere 5.5% of participants noted frequent exposure to such illnesses.

Reduced Soil Nutritional Value:

Table No.07
Reduced Soil Nutritional Value

Sr. No.	Impact Scale	Frequency	Percent
1	Rarely	32	16
2	Very Rarely	127	63.5
3	Never	41	20.5
	Total	**200**	**100**

(Source: Field Survey)

As indicated in Table No. 07, 63.5% of the total respondents express the belief that the nutritional value of the soil has rarely decreased since the construction of dams. For 20.5% of respondents, the nutritional value of the soil has never decreased since the dams were built. Additionally, 16% of respondents assert that the nutritional value of the soil has only rarely decreased after the dams were established

Economic Impacts:

A) Positive Economic Impacts of Koyana Dam:
Table No.08
Positive Economic Impacts on Agriculture Sector

Sr. No.	Statement	Strongly Agree	Agree	Agree to some extent	Disagree	Strongly Disagree
1	Improving Agricultural Productivity	17 (8.5)	132 (66)	51 (25.5)	0	0
2	Increase in Agriculture Production	80 (40)	98 (49)	22 (11)	0	0
3	Positive Change in the Cropping Pattern	79 (39.5)	93 (46.5)	28 (14)	0	0
4	Increase in Farm Income	88 (44)	94 (47)	18 (9)	0	0
5	Increase Net Sown Area	61 (30.5)	109 (54.5)	30 (15)	0	0
6	Increase Gross and Net Irrigated Area	51 (25.5)	99 (49.5)	26 (13)	24 (12)	0
7	Utilize Uncultivated Land	106 (53)	74 (37)	20 (10)	0	0
8	Developed Agro-based Industries	56 (28)	127 (63.5)	17 (8.5)	0	0
9	Farm Mechanization	117 (58.5)	70 (35)	13 (6.5)	0	0
10	Increase Agriculture Employment Rate	68 (40.5)	109 (52.6)	23 (6.9)	0	0
11	Improve Livelihood Sources	75 (37.5)	95 (47.5)	30 (15)	0	0
12	Asset and Capital Formation	58 (29)	111 (55.5)	31 (15.5)	0	0
13	Increase Food grains Production	121 (60.5)	71 (35.5)	9 (4.5)	0	0

(Source: Field Survey)

According to Table No. 08, a significant 66% of the total respondents affirm that improved irrigation facilities have led to an increase in agricultural productivity. A noteworthy 8.5% of those polled wholeheartedly agree with this statement, while 25.5% agree to some extent. The availability of perennial water for farming is acknowledged by respondents as a factor allowing for the cultivation of various crops throughout the year, thus boosting farm productivity.

Furthermore, 49% of the total respondents support the statement that agricultural production has increased due to access to dam water, with a substantial 40% strongly endorsing this view. To some extent, 11% of respondents agree with this statement.

Regarding the improvement in cropping patterns, 46.5% of the total respondents agree that it has occurred since the construction of dams. This statement is strongly supported by 39.5% of respondents, who suggest that the year-round

availability of dam water has influenced farmers to shift from traditional crops to cash crops. To some extent, 14% of respondents agree with this statement.

The notion that the availability of water from dams has increased farm income finds agreement from 47% of the total respondents, with 44% expressing complete agreement and 9% agreeing to some extent.

Concerning the expansion of the net sowing area due to dam irrigation facilities, 54.5% of the total respondents support this statement, with 30.5% strongly endorsing it and 15% agreeing to some extent. However, 12% of those polled disagree with this assertion.

The statement that dams enable the use of uncultivated land is strongly agreed upon by 53% of respondents, with 37% supporting this view to some extent. To some extent, 10% of respondents agree with this statement.

In terms of the development of agro-based industries due to increased irrigation accessibility, 63.5% of the total respondents agree, while 28% strongly support this statement. To some extent, 8.5% of respondents agree with this view.

Respondents suggest that increased water availability boosts agricultural production, supplying raw materials to industries and resulting in the expansion of agro-based industries.

Regarding farm mechanization after accessing water from dams, 35% of the total respondents support this statement, while 58.5% strongly endorse the view. To some extent, 6.5% of respondents agree with this statement.

In terms of increased agricultural employment due to dams, 52.6% of the total respondents agree, with 40.5% strongly supporting this statement. To some extent, 6.9% of respondents agree.

The statement that livelihood sources improve after the dams is supported by 47.5% of respondents, with 37.5% strongly endorsing this view. To some extent, 15% of respondents agree.

Due to dams, 55.5% of respondents agree that asset and capital formation have occurred in the agriculture sector. This statement is strongly supported by 29% of respondents, while 15.5% agree to some extent.

The assertion that the production of food grains increased after the dams is strongly agreed upon by 60.5% of the total respondents, with 35.5% supporting this statement. To some extent, 4.5% of respondents agree

The Total Agriculture Land:

Table No- 09
Total Agriculture Land Before and After the Dams (Acre)

Sr. No.	Total Agriculture Land	Before Dams	Percent	After Dams	Percent
1	Upto 1	40	20	45	22.5
2	1 to 2.5	72	36	83	41.5
3	2.5 to 5	36	18	30	15
4	5 to 7.5	32	16	28	14
5	Above 7.5	20	10	14	7
	Total	**200**	**100.0**	**200**	**100.0**

(Source: Field Work)

The data presented in the above table reveals that, among the total respondents, 13 individuals possessed total agricultural land up to 1 acre before the dams. Post-dams, the number of landholders with total agriculture land up to 1 acre increased to 45, constituting 22.5% of the total.

Prior to the dams, there were 72 landholders (36%) with agricultural land ranging from 1 to 2.5 acres, and after the dams, this figure rose to 83 (41.5%).

For those holding total agricultural land in the range of 2.5 to 5 acres, the count was 36 (18%) before the dams, decreasing to 30 (15%) after the dams.

Similarly, before the dams, 32 landholders (16%) possessed total agricultural land between 5 and 7.5 acres, and this number decreased to 28 (14%) after the dams.

The proportion of agricultural landowners with more than 7.5 acres was 20 (10%) before the dams, and after the dams, it increased to 14 (7%).

The Negative Economic Impact of the Koyana Dam:

a. Negative Economic Impacts on the Agriculture Sector:

Table No. 10

Negative Economic Impacts on the Agriculture Sector

Sr. No.	Statement	Strongly Agree (5)	Agree (4)	Agree to some extent (3)	Disagree (2)	Strongly Disagree (1)
1	Decrease Agricultural Productivity	0	0	19 (9.5)	156 (78)	25 (12.5)
2	Reduced Agriculture Production	0	0	20 (10)	131 (65.5)	49 (24.5)
3	Increase Infertile Lands	0	0	38 (19)	127 (63.5)	35 (17.5)
4	Reduced Farm Income	0	0	12 (6)	156 (78)	32 (16)
5	Increase Fallow Lands	0	13 (6.5)	28 (14)	86 (43)	73 (36.5)
6	Increase Saline Lands	0	0	73 (36.5)	91 (45.5)	36 (18)
7	Polluted Farm Water	0	9 (4.5)	98 (49)	64 (32)	29 (14.5)

(Source: Field Work)

Referring to Table No. 10, a significant 78% of the total respondents express disagreement with the statement suggesting that agricultural productivity has decreased due to excessive water use. To some extent, 9.5% of respondents agree with this statement, while 12.5% strongly disagree.

Concerning the assertion that agriculture production has declined due to excessive dam water use, 65.5% of the total respondents disagree with this statement. To some extent, 10% of respondents agree, and 24.5% strongly disagree.

For the statement claiming that infertile land has increased due to excessive water use, 63% of the total respondents express disagreement. To some extent, 19% of respondents agree, while 16% strongly disagree.

Regarding the notion that farm income has decreased due to lower productivity, 78% of the total respondents disagree. To some extent, 6% of respondents agree.

About the claim that the amount of fallow land has increased, 43% of respondents disagree, while 36.5% strongly disagree. In contrast, 14% of respondents agree, and 6.5% support this statement.

In terms of the statement suggesting that saline land has increased due to excessive dam water use, 45.5% of the total respondents disagree, and 18% strongly disagree. On the other hand, 36.5% of those polled agree to the same degree.

For the statement asserting that polluted farm water is directly mixed into river water or water channels, 49% of respondents agree to some extent. This statement is disputed by 32% of respondents, while 14.5% strongly oppose it. Additionally, 4.5% of respondents support this statement.

The Total Infertile Land:

Table No.11

Total Infertile Land Before and After the Dams (Acre)

Sr. No.	Total Infertile Land	Before Dams	Percent	After Dams	Percent
1	Upto 1	69	36.6	91	50.0
2	1 to 2	43	18.3	40	29.2
3	2 to 4	41	19.7	38	16.7
4	Above 4	47	25.4	31	4.2
	Total	**200**	**100.0**	**200**	**100.0**

(Source: Field Work)

Referring to the data in the above table, before the dams, 69 respondents (36.6%) had total infertile land up to 1 acre, which decreased to 91 after the dams, constituting 50.0%. In the category of 1 to 2 acres of total infertile land, 43.3% of respondents had this condition before the dams, and after the dams, this figure slightly decreased to 40.2%.

For total infertile land in the range of 2 to 4 acres, there were 41 respondents (19.7%) before the dams, and after the dams, this number reduced to 38 respondents, accounting for 16.7%. Furthermore, in the category of more than 4 acres of total infertile land, 47% of respondents had this condition before the dams, and after the dams, this percentage decreased to 31%.

The lands that had been fallow for years due to a lack of water before the dams had become infertile. However, with the increased availability of water following the construction of dams, these lands were brought under large-scale cultivation, resulting in a reduction in the amount of infertile land.

Conclusion:

Upon scrutinizing the environmental impact of large dams in Maharashtra, two distinct aspects come to light: positive and negative consequences. On the positive side, the Koyana dam yields benefits such as flood control, land improvement, positive shifts in crop structure, enhancement of surface water resources, groundwater recharge, reduction of water pollution, creation of wildlife habitats, biodiversity preservation, fostering an aquatic environment, and the generation of open spaces.

Conversely, negative environmental impacts of the Koyana dam encompass the formation of waterlogging areas, water pollution, waterborne diseases, effects on the aquatic environment, emissions of toxic gases, unpredictable floods, loss of wildlife habitats, depletion of soil nutrients, soil erosion, landslides, and deforestation in the dam's vicinity.

Beyond the environmental ramifications, the economic consequences of the Koyana dam are also noteworthy, encompassing both positive and negative aspects. Positive economic outcomes include increased agricultural production, favorable shifts in cropping patterns, augmented agricultural income, expanded irrigation areas, the growth of agro-based industries, agriculture mechanization, heightened employment, wealth and capital creation, and increased food production. This economic progress extends to agriculture, industrialization, and services. On the flip side, negative economic effects entail reduced agricultural production, expansion of infertile land, the creation of fallow lands, and an increase in saline soils.

The social impacts of dams encapsulate both positive and negative facets. Positive social impacts involve the establishment of livelihood opportunities, the growth of the tourism sector, infrastructure development, the provision of clean and sustainable water, and a decline in waterborne diseases. Conversely, negative social consequences encompass the destruction of historical and religious sites, deterioration of social harmony, inequality in water distribution, and the emergence of social and political disputes.

Suggestions:

The effective management of water discharge from the dam is crucial for flood prevention. Careful planning by the dam management board can significantly reduce the risk of flooding, ensuring that the released water is properly managed. This proactive approach helps prevent negative impacts on the environment, society, and the economy. Swift repairs to dam leaks are essential to maintaining the integrity of the structure. Timely repairs not only prevent further damage but also contribute to the preservation of wetlands in the dam area.

In areas undergoing rehabilitation, the government should prioritize the development of robust and sufficient infrastructure, addressing the current deficiencies. Compensation for farmers who have lost their lands should involve the provision of suitable and productive alternatives. Furthermore, the government should ensure the provision of sturdy and well-maintained housing for families affected by the dam, fostering a supportive and secure environment for these communities.

Refarances:

1. Wajid, Usman and Khan (2013), 'Socio-Economic Impact of Small Dams on Local Vicinity'. A case study of Aza Khel Dam Peshawar. Global Journal of Management and Business Research Economics and Commerce, Vol. XIII, Issue-V, Version-I, Government of Maharashtra, Irrigation Status Report 2001-02, Dept. of Irrigation, Mumbai, p. 14.
2. Government of Maharashtra, Official Report of Irrigation Department of Kolhapur 2018-19, pp. 1-5.
3. Government of Maharashtra, Irrigation Status Report 2019-20, Dept. of Irrigation, Mumbai, pp.15-20.
4. Baijal P. and Singh P. K. (2000) Large Dams: Can We Do Without Them? Economic and Political Weekly, May 6, 2000, pp.1659-1665.
5. Khagram Sanjeev (2014) Dams and Development Connell University Press, Ithaca and London, p.16.
6. Tilt Bryan (2015) Dams and Development in China, Columbia University Press, New York, pp.31-33.
7. Butlin, Jhon A. (1981) The Economics of Environmental and Natural Resource Policy; Westview Press, Boulder, Colorado, pp.45-48.
8. https://www.indiawaterportal.com
9. https://www.outlookindia.com
10. https://www.drishtilas.com