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Land Capability and Suitability: A Case Study of Mutha Catchment

Dr. Vilas Kamble
Head Department of Geography, Modern College of Arts Science and Commerce Shivajinagar Pune 411005.

Abstract:

Land evaluation is important to estimate its productivity, which further helps for land use planning. This paper evaluates the land capability by adopting USDA classification system. The assessment of land capability involves an evaluation of the degree of limitation, imposed by permanent or semi-permanent attributes of land to one or more land uses.According to this, when entire area has been classified, it is observed that, class I and II are totally absent in the study area, and rest of the classes present i.e., III, IV, V, VI have been described and displayed in tables and elaborated in the following lines.Soil productivity assessment exercised for Temghar lake catchment has produced very good results. Several parameters in each and every factor of Storie Index have been computed in GIS environment which almost covers soil as well as terrain parameters. Entire area divided into more than 7000 grid cells each covering about 77.2 m^2. The spread of the grade 3,4,5 almost comprises 98.50% of the total land surface area. It can be therefore said that, soil productivity in the study area is not at all good, however some of the land facets are amenable and can be regenerated for optimum potential desired land use. Land capability classes, suitability classes almost match with the productivity classes. Soil environment except in pediment and valley floor exhibit severe degradation therefore land capability as well as suitability and productivity of the land is not up to the expectation. It needs to be properly planned to minimize the degradation therefore Integrated land resource management plan is necessary to cope up with this problem.

Keywords: Land evaluation, FAO, Storie Index Method, USDA, Mutha Catchment, GIS, Soil Productivity

Introduction:

The concept of land capability was developed during the 1930s in the USA, but the wide spread adoption of land capability schemes only began after 1960s. The assessment of

land capability involves an evaluation of the degree of limitation, imposed by permanent or semi-permanent attributes of land to one or more land uses.

The land capability classification of Temghar lake catchment has been performed by adopting USDA classification system and the method developed by soil survey department of Maharashtra state. The system of soil survey department more or less is similar to that of USDA system of classification. USDA system is widely used in Indian environment.

The broadest categories of the system could have been worked out for the present study area indicating degree of their limitation on a broadest level. Various soil properties and village level soil survey data from soil survey department has been incorporated in the preparation of land capability map.In the present analysis, topographic aspect (slope rock outcrops), erosional aspect (signs of erosion), hydrological characteristic (soil drainage), physical soil condition (stoniness, depth, texture, soil stoniness, available water capacity, chemical properties of soil (CaCO3, pH and organic carbon and organic matter)etc. have been considered for each of the soil sample location along with soil profile characteristics.

In the present study an attempt has also been made to identify land suitability classes on existing resource conditions. Broad level classification of land suitability is attempted using FAO framework.

Study Area:

The area selected for the present study is a catchment area of Temghar lake catchment from western Maharashtra. The Temghar dam commenced in the year 2000. The dam has been constructed keeping in view the increasing population of Pune city and thus linked to Khadakwasla irrigation project. The main purpose of these minor/medium projects is to supply water for Pune city as well as for irrigation in Haveli, Daund, Indapur, and Baramati tahsils.

The present study has been initiated to assess available natural resources in the lake catchment area itself and to ascertain the potential of it to hold these populations in the same catchment.The dam is located near village Temghar across river Mutha. The study area is a catchment of Temghar dam and located between 18° 47' 00"N to 18° 38' 00" latitude and 73° 27 to 73° 32' 00" Elongitude. The study area is located about 50 Km. to the west of Pune city. It is accessible by road only from Pune via Khadakwasala- Bahuli or via Pirangut - Mutha (S.H-57). The nearest railway station and Airport is at Pune. The Mutha river is a right bank tributary of the Bhima River in main Krishna basin. The Mutha river originates in the main Sahyadri ranges in taluka Mulshi, District Pune and flows through Mulshi and Haveli tahsils before meeting Mula river in Pune. The dam is located at about 13 km. from the origin of the river Mutha. The catchment area is 37.7 km^2. up to dam site including water body and area under water body is 4.99 km^2. The average gradient of the river at the dam wall location is 35 m/km. the average width of the valley is 4km.

The study area is characterized by various slope segments. There is a considerable variation in soil properties. Sandy material is generally confined to higher slopes, whereas agriculture land shows silty, clayey and loamy and loamy sand in abundance.The general color of soil along hill slope area is dark reddish and it is dark brown to yellowish brown in the Mutha valley floor. It seems the soils in the valley floor are rich in the amount of organic matter and humus content. Most of the valley floors are presently submerged. Along most of the hill slopes are barren, devoid of vegetation and thus exhibits very high potential land surfaces for surface runoff and soil loss, therefore top soil layer is very thin and almost lost at same places. Higher hill slopes have thin film of soil and it is also less compact compared to the agricultural soil on the hill slopes wherever forest cover exists, soils are enriched in organic matter, whereas in plain regions, due to the mixing of the soil with the other ingredients such as stones, grass, gravel has resulted in the modification of the soil properties.

Objectives:

1. To study land capability of temghar lake catchment
2. To suggest methods for the land capability.

Data base and Methodology:

The FAO framework: - The framework for land evaluation (FAO 1976 a) is a standard set of principles and concepts on which national or regional land evaluation systems can be constructed. It emphasizes in particular the importance of explicitly stating the intended land use and the level of management envisaged, and that land evaluation may be either on current suitability or, as for irrigation drainage schemes, on potential suitability. It should be emphasized that, the system is only a framework, and for most projects it will need quantifying with detailed specifications as discussed in FAO (1979 a) and Smyth et. al. (1979).

The frameworks structure as shown in table 4.3 is compatible with other systems but allows with great flexibility. There are two orders, termed suitable (S) and not suitable (N), conditionally suitable land (Sc) is a 'phase' of the order suitable, and approximates to classes 4 and 5 of USBR, but its extent must be small with respect to the total study area; Definitions of FAO land classes are given in table 1. The framework employs several terms to define or describe land features in particular 'land quality' and 'land characteristics'.

USDA: Land capability classification performed for the Temghar lake catchment following the USDA method, demonstrated very good results. As mentioned earlier the study area is characterized by hilly terrain with considerable higher slopes, have pronounced effect on the land capability classification of the study area. The village wise information of soil environment of the study area has been obtained from soil survey department and field observations in the study area led to prepare a rating table for the capability classification.

Storie Index Method :

This method of soil rating known as the Storie index is based on the soil characteristics that govern the lands potential utilization and productive capacity. It depends on other physical and economic factors that might determine the desirability of growing certain plants in a given location.

The percentage values are assigned to the characteristics of the soil itself, including the soil profile (Factor A), the texture of the surface soil (Factor B), the slope (Factor C) and the condition of the soil exclusive of profile, surface texture and slope, for example drainage , alkali content, nutrient level, erosion and micro relief (factor X). The most favorable or ideal conditions with respect to each factor are rated at 100%. The percentage values or ratings for the four factors are then multiplied, the result being the Storie index method of rating of soil.

The characteristics of soil profile (factor A) -are essentially the features of the surface layers. Soils that are deep and readily pervious to roots and water are rated at 100%. Profiles with dense clay sub soil are rated lower. Primary or residual soils are rated in accordance with the depth of bedrock.

Next, the soils are rated on the basis of the texture of the surface soils. Medium textured soils such as the loams and silt loams are rated highest.

Rating of the slope of the land is considered as factor C. nearly level or gently sloping land is rated at 100%. As the slope increases, the rating for this factor decreases. As shown in the soil rating chart, single letters are used to indicate simple slopes and double letter to indicate compound slopes. The percent slope expresses the number of feet rise or fall for 100 feet horizontal distance.

Conditions exclusive of profile, soil texture, and slope are considered in factor X on the soil rating chart these conditions consist of drainage, alkali, or salt content, general nutrient level, acidity, erosion and micro relief . if two or more condition exists that are listed under factor X, the rating for each are treated independently, that is, they are multiplied in order to secure the factor X rating.

soil survey: -

In order to infer characteristics of soil with respect to topography a detail soil survey plan has been prepared which involves mainly the soil survey at reconnaissance level. Soil survey thus conducted mainly includes, soil sample collection with soil anger, core tube, and infiltrometer. While collecting soil samples; effective rooting depth of plants has been considered, i.e.upto 25cms.It is also intended to collect the samples to represent almost all slope segments details are given in the preceding lines.

Collection of soil sample & field measurements.

Field components of present study mainly composed of observation based on soil sample collection according to change in the slope along with this field measurement of hydraulic conductivity and infiltration capacity has also been conducted in the field. Around 31soil samples has been collected and 167 field observations has been carried out in the field.

Ground truthing

Remote sensing data mainly used of very high-resolution data of sensor SPOT a true color image. The extension of features mainly vector in nature has been verified in the field through ground check on truthing.

Secondary Data

Secondary data mainly obtained from talathi office at Temhgar, Paud panchayat samitee at Paud, Tahsil office at Paud, forest department government of Maharashtra, soil survey department government of Maharashtra, Maharashtra Engineering Research Institute (MERI) Nasik, Geological survey of India, Pune Irrigation department, Pune, Pune district project affected rehabilitation office, Pune, NGO like Gomukh, Kirloskar consultants, census hand books (Pune districts) 1991, 2001 etc.

Results and Discussion:

Land capability classification performed for the Temghar lake catchment by USDA method:

Class III – Moderate cultivation: - This class measures about 20.13 %(7.59 km ^{2}(75.90 ha.) of the total land surface area and mainly confined to the pediment surfaces with insignificant gullied topography. The extent of this class is noticed to southern part on a wider scale and covers maximum undulating, rolling pediments of Temghar and Vede villages.

In the northern part it is noticeably delineated along pediments and follows the general shape of villages, and some north eastern part of the village Vegre.

Class IV – Limited cultivation: -Almost entire catchment in the back water area of reservoir is demarcated by this class. The area under this class admeasures 62.60% (23.60 km ^{2} or 236.00 ha.) of the total land surface area. Degrees of limitations have been increased in this class. Exclusive part which occupied by these classes are III, V and VI along with water body of four villages i.e. mainly comprising Temghar, Vegre, Vede and Lavarde.

Class V – Intensive grazing: -Followed by the class IV, upper part of the water body mainly marginal portion of the catchment has occupied by this class. The area under this class is 1.33% (0.50 km ^{2} or 50 ha.) of the total land surface area. The extent of this class is noticed to the southern part of village Temghar, southern part of the village Lavarde and western part of the village Vegre.

Class VI – Moderate grazing and forestry: - This class mainly covers the portions of waste lands, forest lands and degraded forests in both sides of Temghar lake catchment confined mainly to plateau summit and fringe areas. The area under this class is about 2.71 %(1.02 km ^{2} or 10ha) of the total land surface area, this class ranks first as far as the extent of the land capability classes is concerned.

Land capability classification performed for Temghar lake catchment indicates that, terrain in the lake catchment is not suitable for intensive farming. Moreover, moderate cultivation can be adopted for only 20% of the total land surface area. Very high percentage accounted for class IV seems to be the potential land surface area for horticulture and is a significant part of land surface area. Area under class III and class IV around 82% of total land surface area is a amenable portion of the terrain for various kind of uses.

Table No. 1: Land suitability classification of Temghar lake catchment by FAO Framework)

Temghar Drainage Basin				
Area under Land Capability classification				
Sr. No.	**Land Capability Classes**	**Area**		
		Km²	**Ha**	**Percentage**
1	Class I	Absent		
2	Class II	Absent		
3	Class III	8.03	803	21.71
4	Class IV	0.32	32	0.87
5	Class V	24.04	2404	65.01
6	Class VI	0.84	84	2.27
Water Body		3.75	375	10.14
Total		**36.98**	**3698**	**100.00**

Land suitability classification promotes more specific about the fitness of the land for a given use, this being implied by the word 'suitability' rather than 'capability'. Thus, for instance, it is possible to map land suitability for specific use of land. The soil survey being at exploratory and reconnaissance level owing to prefeasibility level. Land suitability of the study area has been attempted following FAO framework. (Table no.1)

Table No. 2:Area under Land suitability classes

Temghar Drainage Basin					
Area under Land suitability classes					
Sr. No.	**Suitability class**		**Area**		
			Sq. Km	Ha	Percentage
1	S1	Highly Suitable	Absent		
2	S2	Moderately Suitable	0.18	18	0.49
3	S3	Marginally Suitable	2.53	253	6.84
4	N1	Currently Not Suitable	7.42	742	20.06
5	N2	Permanently Not Suitable	23.1	2310	62.47
6	NR	Not Reliable For Cultivation	3.75	375	10.14
Total			**36.98**	**3698**	**100.00**

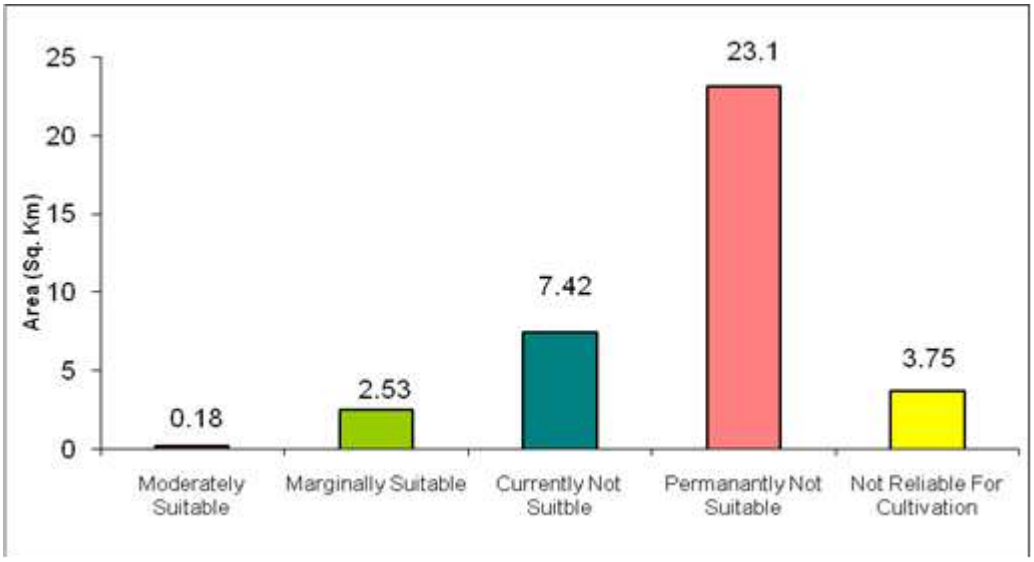

Fig 2: Area under Land suitability

S 1 – Highly suitable: - This class is absent in the Temghar lake catchment.

S 2 – Moderately suitable: - Low lying pediment surfaces and plain surfaces of the study area is a potential zone of moderately suitable land for cash crops as well as food grains, for both Rabbi and Kharif seasons. The area is exclusively suitable for paddy cultivation provided; dependable water supply is made available and even for rain fed conditions also. This category covers about 0.36% (0.95km^2) of the total land surface area.

The recommended potential use of these lands may enrich the socio-economic status of the nearby villages as a whole and villagers in particular. The main villages comprising this area are Lavarde and Vede

S 3 – Marginally suitable: - This category covers the area to about 7.19% (2.71km^2) of the total area and mainly covers the extensive pediments up to the base of plateau fringe surface zone. The relative relief varies between 40 to 60 m with % dissection index which varies vary between to 4 to 8 %. This category may be amenable by erecting anti erosion structures in the area. The potential use of land may be attributed to growing of medicinal plants and horticulture. Horticulture practicing in this part no doubt be initiated by innovative technology of irrigation through sprinkler and drip irrigation. Lift irrigation schemes should be undertaken as there is a plenty of water supply in the form of water body of Temghar reservoir in the area.

Afforestation through horticulture and growing of native species may be certainly helpful in multipurpose conservation of the land resources in the study area. Moreover basin treatment should be given in the form of gully plugging and Gabion structures which will help to enrich the ground water resources in the study area.

N 1 – Currently not suitable: - This category covers about 18.75% (7.07km^2 areas) of the total land surface area and rank second in terms of its extent in area. The plateau fringe

surface area is a characteristic of this category and appeared to be highly dissected with high range of relative relief from 80 m to 120 m. The soils are good enough to support native tree plantations in the area.

Recently the trend of construction of farm houses and an afforestation of the lands by their owners at a elevation has been introduced in the area. This is a welcome trend of land utilization in these remote areas, may provide employment opportunities to the local people as well as restoration of scarce species is possible, however this has led to unpredicted runoff and soil loss in the study area. The bare nature of hill slopes in this area may be covered by introduced plantation with limited inputs. Water supply may be made available and through lift irrigation scheme from Temghar reservoir in the area.

N 2 – Permanently not suitable: - This category has covered about 59.87% (22.57km^2) of the total land surface area and is characterized by summit convex parts of the plateau surfaces with thin soil cover and mainly sandy to sandy clayey soils. The moisture conditions are optimum in the area but provide a good recharge zone to ground water storage. The input cost may be of higher magnitude if the land is utilized for other purposes.

Class 1 / categories	Area in km^2	% Area
S 1	Absent	Absent
S 2	0.86	0.49
S 3	2.53	6.84
N 1	7.42	20.06
N 2	23.01	62.47
Total	**36.98**	**100**

Table no. 3 Land suitability classification of Temghar lake catchment

Land suitability thus provides potentiality of the land resources in the area. This is ascertain through linked potential utilization from N 2 – recharging of ground water – N 2 – check to soil erosion by introduced plantation and based on dependable water supply, S 3 – horticulture and extensive afforestation – S 2 – grazing of cash crops and food grains – S 1 – will certainly achieve the socio-economic upliftment – wildlife conservation – restoration of species through forest conservation and enrichment of socio-economic status of the village poors. This exercise will certainly focus on sustainable development and potential land resource management.

Land Productivity Assessment

Soil grading by Storie Index method

For simplification six soil grades have been set up in by combining soils having ranges in index rating as follows;

Grade1 (excellent): soils that rate between80and100%and which are suitable for a wide range of crops. This grade is absent in the study area.

Grade 2 (good): soils that rate between 60-79% and which are suitable for most crops. Yields are generally good to excellent. This grade is absent in the study area.

Grade 3 (fair): soils that rate between 40-59% and which are generally of fair quality. With less wide range of suitability than grade 1 and 2. Soils in this grade may give good results with certain specialized crops. About 10.48% of Temghar lake catchment fall under this grade i.e. 3.95 km^2

Grade 4 (poor): soils that rate between 20-39% and which have a narrow range in their agricultural possibilities. For example, a few soils in this grade may be good for rice, but not good for many other uses. 63.26% of the study area comes under this grade i.e. 23.85 km^2

Grade 5 (very poor): soils that are rate between 10-19% ate of very limited use except for pasture, because of adverse condition such as shallowness, roughness and alkali content. About 11.72% of Temghar lake catchment fall under this grade i.e., 4.42 km^2

Grade 6 (nonagricultural): soils that rate less than 10 % include. For example, tidelands, river wash, soils of high alkali content and steep broken land.1.30% of Temghar catchment comes under this grade i.e. 0.49 km^2

1.6 Conclusion:

Soil productivity assessment exercised for Temghar lake catchment has produced very good results. Several parameters in each and every factor of Storie Index have been computed in GIS environment which almost covers soil as well as terrain parameters. Entire area divided into more than 7000 grid cells each covering about 77.2 m^2. The output map displayed in fig no and productivity classes displayed in table no

It can be observed from above fig and table that productivity classes of grade 1 and 2 are almost absent in the study area and productivity from fair to non-agricultural land do exist in the study area. Grade 3 and 4 of fair and poor productivity almost comprises 73.74% of the entire catchment area and 84.99% of the total land surface area. Very poor of the grade 5 accounts to 13.51% of the total land surface area. Thus, the spread of the grade 3,4,5 almost comprises 98.50% of the total land surface area. It can be therefore said that, soil productivity in the study area is not at all good, however some of the land facets are amenable and can be regenerated for optimum potential desired land use.

Land capability classes, suitability classes almost match with the productivity classes.

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