# Land Capability Classification in Hiranyakeshi Basin of Maharashtra (India): A Geoinformatics Approach

**Sachin S. Panhalkar, Sagar P. Mali, C.T. Pawar**

***Abstract*— Land, water and soil are precious natural resources whose proper use affects the life supporting systems, Sustainable Development cannot be successful without proper conservation of natural resources. However, management of land resources is inevitable for both continued agricultural productivity and protection of the environment. Land capability classification is the basis of proper watershed management. Land should be used as per its capability and treated as per its need to avoid land degradation. The main objective of the present study is to identify the land capability classification of the Hiranyakeshi basin of Maharashtra state by using Geoinformatic techniques. For the present study, USDA (1973) classification based on parameters like soil depth, soil texture, slope, erosion, land use /land cover have been considered to define land capability classes. CartoDEM data of 30 m resolution is used to derive slope map of the basin with the help of ArcGIS software. IRS P6 LISSIII image (2007) has been used to classify land use/land cover map with supervised techniques. Union Overlay method is applied to preserve the geometry and attribute information of all the input parameters. In SQL environment, queries have been generated to identify individual land capability classes. The analysis reveals that Class I, II, III, IV, VI and VII are identified. About 18% geographical area belongs to Class-II and 37% to class IV. However, it is observed that present land use land cover is not as per the capability of the land. Hense, the land use pattern need to be modified according to identified land capability classes to conserve the land resources of Hiranyakeshi basin.**

***Index Terms*-- Land Capability, Geoinformatic, Land degradation, Land resource conservation.**

## I. INTRODUCTION

The sustainable development of a region needs not only protection and reclamation of natural resources particularly soil and land but also requires a scientific basis to maintain harmony with environment. These resources should be managed in a sustainable manner so that the changes proposed to meet the needs of development are brought out without diminishing the potential for their future use (Kanwar, 1994). It has been essential in a country like India where majority of the population depends on agriculture and about 60 percent of total arable land (142 million ha) in the country is rain-fed. A large portion of the rain-fed areas (65% of arable land) in India is characterized by low productivity, high risk and uncertainty, low level of technological change and vulnerability to degradation of natural resources (Joshi, et al, 2004). Over the years, the sustainable use of land and water has received wider attention among policy makers, administrators, scientists and researchers.

Land capability is the basis of watershed management programmes. The basic principle of soil and water conservation is to use the land and according to its capability and treat the land according to its needs. Therefore the knowledge of land capability classification is a prerequisite and important for planning, implementation and execution of soil and water conservation programmes (Tideman, 2000). Land is the most valuable natural resource, which needs to be harnessed according to its potential. Due to over exploitation and mismanagement of natural resources coupled with socio-economic factors, the problem of land degradation is on the rise. Land resource is one of the limited resources. The use of land is not only determined by the user but also by the land capability. The land capability is governed by the different land attributes such as the types of soil, its depth and texture, underlying geology, topography, hydrology, etc. (Panhalkar,2011). Land capability units are grouping of one or more individual soil mapping units having similar potential and continuing limitations and hazards. Land under same capability units produce similar kinds (and quantities) of cultivated crops/pastures/plants, with similar management practices require similar conservation measure under the same kind and condition of vegetative cover and have comparable potential of productivity (Rajora, 1998).

United State Department of Agriculture (USDA, 1973) guidelines have been applied to determine land capability. Eight classes of land designated with Roman number I to VIII. First four classes are suitable for agriculture and necessity of soil conservation measures and management practices have been used in the class I to IV. Class V to VIII, are not suitable for agriculture, but can be used for pasture, range, woodland, grazing and wildlife purposes. The criteria for placing a given area in a particular class involves the landscape location, slope of the field, depth, texture and land use /land cover (Tideman, 2000). Thus, the capability units are groupings of soils that have common responses to pasture and crop plants under similar systems of farming. Ekanayake, G. et al, (2003) have also made an attempt to identify land suitability by applying GIS technique for forest.

**Manuscript received May 31, 2014.**

**Sachin S. Panhalkar,** Department of Geography, Shivaji University, Kolhapur, MS, INDIA

**Sagar P. Mali,** Department of Geography, Shivaji University, Kolhapur, MS, INDIA

**C.T. Pawar,** Department of Geography, Shivaji University, Kolhapur, MS, INDIA

## II. OBJECTIVES OF THE STUDY

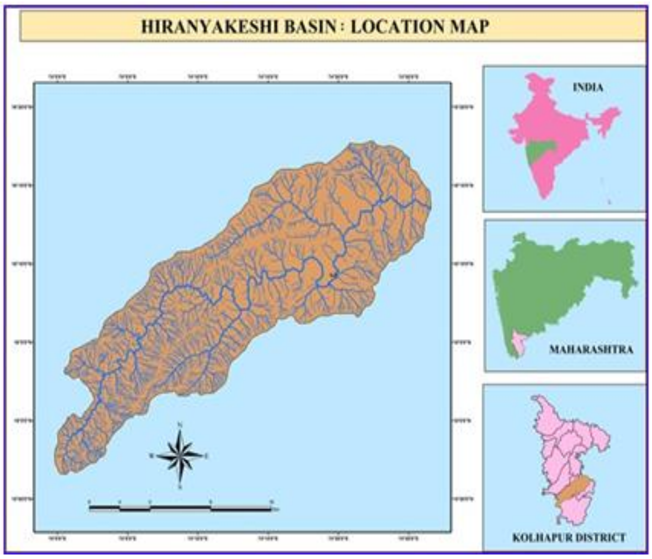


**Fig: 1. Location Map**

Objective of present research work to identify the land capability classes of the Hiranyakeshi Basin

## III. STUDY AREA

The region selected for present study is Hiranyakeshi basin of south Maharashtra which comprises an area of 722 $km^2$ and lies between 16° 00' N to 16° '18 N latitude and 74° 00' E to 74° 30' E longitude in Ajra and Gadhinglaj tahsils of Kolhapur district and some part of Savantwadi tahasil of Sindhudurg District of southern Maharashtra. Minimum and maximum elevation of the area is 619 meter and 960 meter respectively. Sahyadri ranges lies in the west part of basin and slope of region is decreasing from west to east. Hiranyakeshi river flows from south west to north east direction and meets Ghataprabha river in Karnataka before it meets to Krishna. Rainfall is not evenly distributed in the basin and it decreases from west to east from more than 3000mm/years to less than 1000mm/year respectively.

## IV. DATA AND METHODOLOGY

Secondary data from various sources has been collected for land capability classification. Satellite image of IRS P-6 LISS-III sensor of year 2007 and CartoDEM image has been colleted from Bhuvan website of govt. of India. Soil depth and texture map have been colleted from the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Nagpur. Table: 2.1 chart shows detail about data and its sources.

**Table: 1 Data and sources**

| Sr. No | Data | Source |
|---|---|---|
| 1 | LISS-III Image (Dec 2007) | Bhuvan website: |
| 2 | Carto-DEM image | |
| 3 | Soil Depth Map | NBSS & LUP, Nagpur |
| 4 | Soil Texture Map | |

Parameters for land capability classification viz. land use / land cover, soil depth, soil texture and slope have been used to identify land capability classes and sub-classes. Land use / land cover classes were derived from IRS-P6 LISS-III satellite image (Fig:2) of 23.5 m. spatial resolution of year 2007 by applying Superwise classification method in ERDAS 9.1 software (Fig:5). Slope map obtained from CartoDEM satellite image of 30m. spatial resolutions (Fig:3). Soil depth and soil texture (Fig:4) maps are obtained from National Bureau and Soil Survey and Land Use Planning (NBSS&LUP,2005), Nagpur. All these thematic maps have been victorized in ArcGIS 9.3 software. Union overlay operation is being carried out as per USDA classification (1973). GPS techniques are applied to collect the class wise locational data for field checking and validation of results. Following Fig: 6 exhibits the research methodology adopted for present research work.

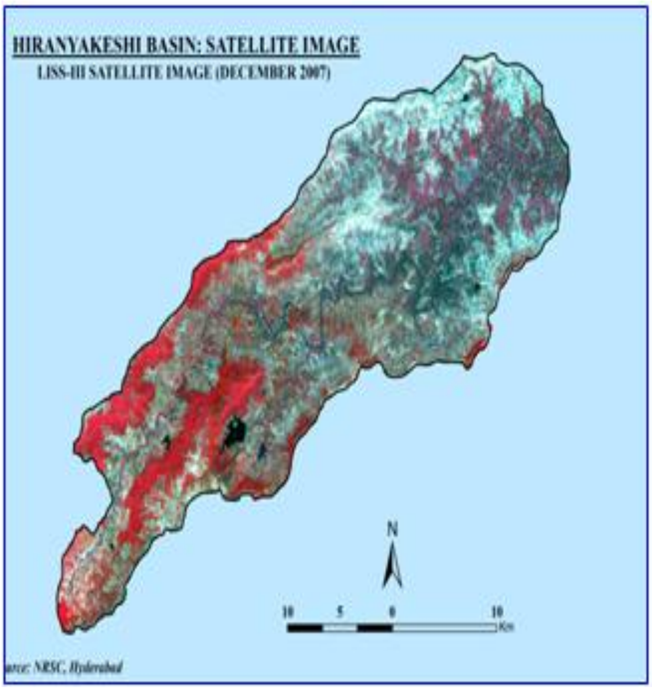


**Fig: 2. IRS-P6 LISS-III Satellite image**

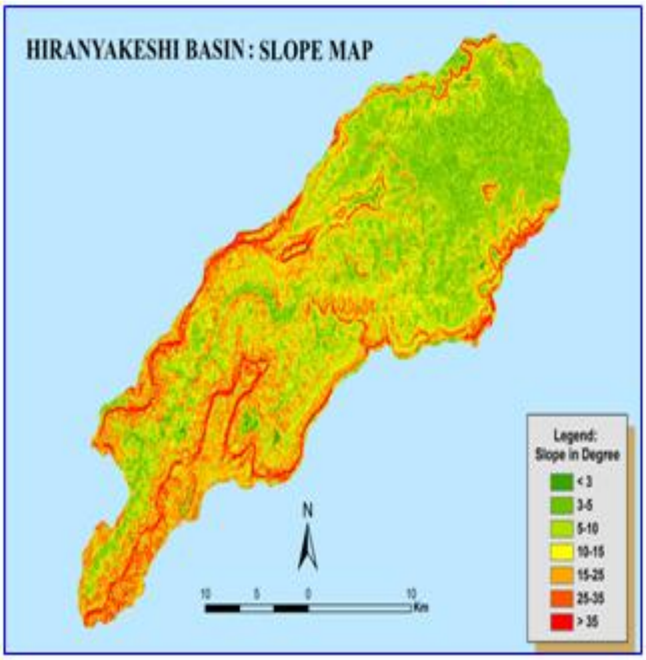


**Fig: 3. Slope Map**

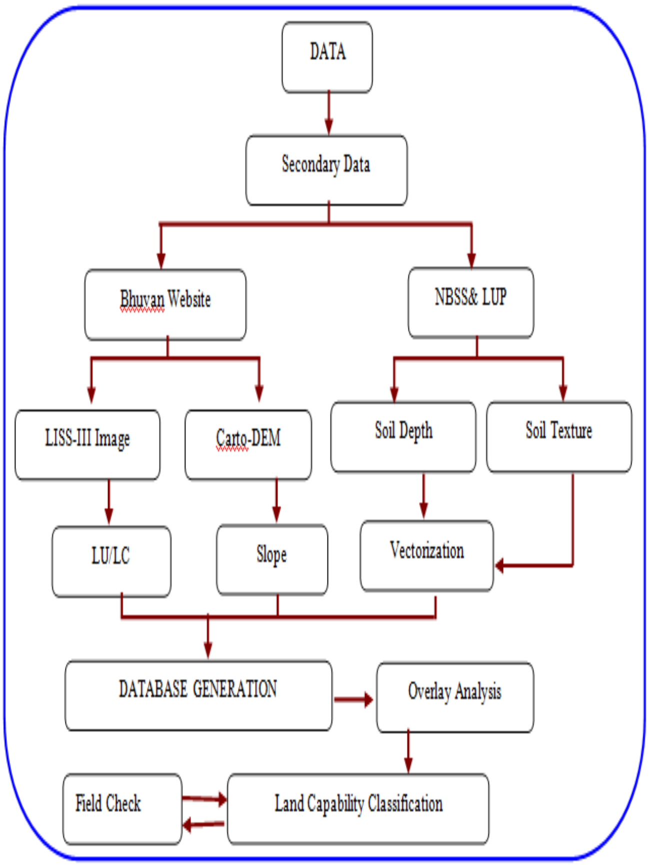


Fig: 6. Research Methodology chart

## V. RESULT AND DISCUSSION

The land capability class is the broadest grouping of the land capability classification and gives an indication of the general degree of limitation to use and the versatility of the land. "Land capability" classifications provide a ranking of the capacity of each part of a land resource to sustain broad land use classes (Rosser, et al., 1974). Six main LCC classes have been identified by considering the above mentioned parameters. Those are I, II, III, IV, VI and VII (Fig:7).

**Land Capability Classes:**

**a) Class I:**

This class is very limited as the major part of the basin belongs to hilly area. Class I has been observed in the lower reaches of Hiranyakeshi river in Ajra and Gadhinglaj tehsil. This class has occupied only 0.6% of the study area.

**b) Class II:**

The analysis reveals that class II has been observed along the Hiranyakeshi river. This class covers 133 sq. km area (18.53 %) which is dominated by gentle slope. This class is identified as most suitable for agricultural crop production. Soils in this class require careful soil management, including conservation practices, to prevent deterioration or to improve air and water relations when the soils are cultivated. The soils can be used for cultivating crops. The soils in this class provide the farm operator less latitude in the choice of either crops or management practices than soils in class I. The limitations are few and the practices are easy to apply for this class.

**Table 2: Areal Extent of Land Capability Classes**

| Sr. No. | LCC Class | Area in sq. km | Area (In per cent) |
|---|---|---|---|
| 1 | Class-I | 4.5 | 0.60 |
| 2 | Class-II | 133 | 18.53 |
| 3 | Class-III | 162 | 22.52 |
| 4 | Class-IV | 271 | 37.55 |
| 5 | Class-VI | 126.5 | 17.50 |
| 6 | Class-VII | 24 | 3.30 |
| **Total** | | **722** | **100** |

***Source: Based on overlay analysis.***

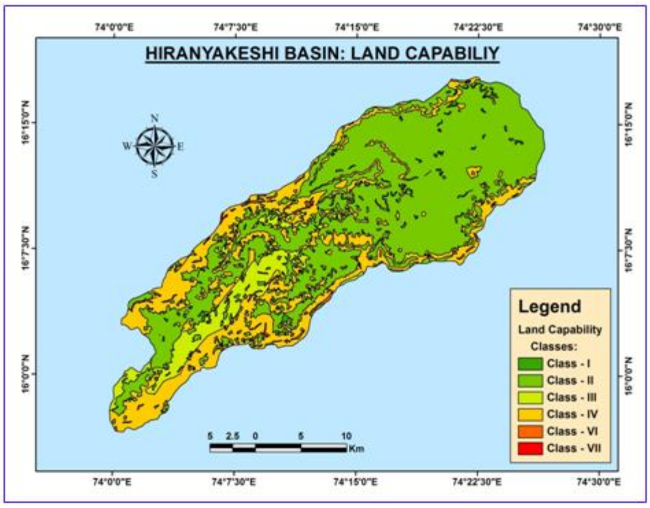


**Fig: 7. Land Capability Classes in Hiranyakeshi Basin.**

**c) Class III:**

This class is extended between class II and IV. Its spatial extent is much more in lower reaches of Hiranyakeshi basin as compare to upper reaches. The total area covered by this class is about 162 sq. km (22%). Soils in class III have more restrictions than those in class II and when used for cultivated crops. The conservation practices are usually more difficult to apply and to maintain. Limitations of soils in class III restrict the amount of clean cultivation; timing of planting, tillage, choice of crops and harvesting.

**d) Class IV:**

This is a most dominant class with respect to areal extent in the study region, which accounts for 271 sq. km area (37.55 %). The restrictions in use for soils in class IV are greater than those of class III and the choice of plants is more limited. When these soils are cultivated, more careful management is required and conservation practices are more difficult to apply and maintain. Soils in class IV can be used for crops, pasture and woodland. Soils in class IV are well suited to only two or three of the common crops or the harvest produced may be low in relation to inputs over a long period of time. Many sloping soils in class IV are suited to occasional but not regular cultivation.

**e) Class VI:**

This class ranks second in the study region as it covers area of about 17.50% of the region. The analysis reveals that in upper reaches of Hiranyakeshi river towards south western side this class mainly dominates. Physical conditions of soils placed in class VI are such that it is practical to apply only for range or pasture improvements, if needed, such as seeding, liming, fertilizing, and water control with contour furrows, drainage ditches, diversions or water spreaders.

**f) Class VII:**

This class has occupied very small area i.e. only 3.30 percent of the study area. It is having severe limitation for agriculture practices, as the slope is very steep and soil depth is also shallow. This class should not be considered for agriculture uses.

**Table3: Land Use Appropriates to different Land classes.**

| CLASS | CROPPING SUITABILITY | PASTORAL SUITABILITY | LANDUSE OPTIONS |
|---|---|---|---|
| 1 | High | High | Many |
| 2 | | | |
| 3 | Medium | | |
| 4 | Low | | |
| 5 | Unsuitable | Medium | Limited |
| 6 | | Low | |
| 7 | | Unsuitable | Extremely Limited |

**Source: After NWASCO, New Zealand, 1979.**

## VI. CONCLUSION

The methodology adopted has permitted to identify land capability classes for decision-making process. The analysis reveals that dominantly Class II, III, IV and VI are present in the study region. Out of that Class II which is much suitable for agriculture accounts for 18.53% area. Class IV is a dominating class as far as the areal extent is concerned comprising 37.55 % area. Classes IV and VI are most susceptible to land degradation; Hence, it is recommended that integrated watershed development need be planned by considering land capability classification of Hiranyakeshi basin.

## ACKNOWLEDGEMENT

The present research paper is an outcome of the U.G.C. Major Research Project entitled "Watershed Development and Management in Hiranyakeshi Basin (Maharashtra): A Geoinformatic Approach". The Research team is very thankful to the U.G.C. authorities for generous funds approved for the said project. We are also thankful to Department of Geography, Shivaji University, Kolhapur for providing GIS Lab facilities for research work.

## REFERENCES

[1] Ekanayake, G.K. & Dayawansa, N.D.K., (2003) "Land Suitability Identification for a Production Forest through GIS Technique" http://www.gisdevelopment.net/application/environment/overview/mi03148.html
[2] Joshi, P.K., Pangare, V., Shiferaw, B., Wani, S.P., Bouma,J., and Scott, C., (2004) "Watershed Development in India: Synthesis of past experiences and needs for future research", Indian Journal of Agriculture Economics, Vol.59(3), pp. 303-320
[3] Kanwar, J.S., (1994) "In Management of Land and water resources for land and water for sustainable agriculture and environment. Diamond jubilee symp. Indian Soc. Soil Science, New Delhi, pp. 1-10.
[4] National Bureau of Soil Survey and Land Use Planning (2005) Soil Resource Mapping Project, National Bureau of Soil Survey and Land Use Planning (NBSS&LUP and DOS), Nagpur.
[5] National Water and Soil Conservation Organization (1979) Our Land Resources, Wellington, New Zealand.
[6] Panhalkar S.S., (2011) "Land Capability Classification For Integrated Watershed Development by Applying Remote Sensing and GIS techniques", ARPN Journal of Agriculture and Biological Science, Vol. 6(4), pp. 46-55.
[7] Rajora, R., 1998. Integrated Watershed Management, Rawat Publications, New Delhi and Jaipur.
[8] Rosser, J., Swartz, G. L., Dawson, N.M., and H. S. Briggs, (1974) "A Land Capability Classification for Agricultural Purposes", Div. Land Utilization. Tech. Rep.14.
[9] Tideman, E.M., (2000) Watershed Management – Guidelines for Indian Conditions, Omega Scientific Publishers, New Delhi.
[10] United States Department of Agriculture, (1973) Soil Conservation Service, Land Capability Classification, Agriculture Handbook No. 210

**Dr. Sachin S. Panhalkar**
**Designation:** Associate Professor
Department of Geography, Shivaji University, Kolhapur
**Subject Specialization:** Watershed Management, GIS, GPS and Remote Sensing Technology

**Mr. Sagar P. Mali,**
**Designation:** Research Student, Department of Geography, Shivaji University, Kolhapur
**Subject Specialization:** Watershed Management, Geoinformatics, Urban Utilities and Planning.

**Prof. C.T.Pawar** Former Professor and Head, Principle Investigator, UGC Major Research Project, Department of Geography, Shivaji University, Kolhapur
**Subject Specialization:** Watershed Management, Resource Management, Agriculture Geography, Physical Geography.