IMPACT ASSESSMENT OF IRRIGATION DEVELOPMENT IN VEDGANGA BASIN—A GEOINFORMATIC APPROACH

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ABSTRACT:

Irrigation development has been conceived as one of the important rural development programme in India where the rainfed agriculture is characterised by low productivity, degraded natural resources and widespread poverty. Recognising the importance of irrigation development for their perceived ability to promote agriculture and rural development, both Central and State Governments make huge investments in irrigation development. As million of rupees are invested, it is essential that the programmes have positive impact. It is in this context the Impact Assessment of irrigation development and management assumes importance. In this paper an attempt has been made to assess the impact of medium and minor irrigation project of watershed development in Vedganga basin. This study is based on scientific parameter; NDVI and land use/land cover change detections etc. A scientific methodology is developed to monitor assess and evaluate the irrigation development programme. The analysis reveals that even though, the large amount has been invested the impact is not satisfactory.

1. INTRODUCTION

Irrigation development has been conceived as one of the important rural development programme in India where the rainfed agriculture is characterised by low productivity, degraded natural resources and widespread poverty. Recognising the importance of irrigation development for their perceived ability to promote agriculture and rural development, both Central and State Governments make huge investments for it. As million of rupees are invested, it is essential that the programme have positive impacts. It is in this context the Impact assessment of irrigation development and management assumes importance. Integrated impact assessment has been a growing area of study and practice. Impact assessment is the process of identifying the future consequences of a current or proposed action. It is used to ensure that projects, programmes and policies are economically viable, socially equitable and environmentally sustainable. As the irrigation development approach is an integrated one with the involvement and efforts of various departments and considerable budget, there is a need for a suitable indicator to assess the progress of implementation. As the huge amount has been invested through irrigation project, it is necessary to holistically assess and evaluate the long-term effects and the impact of the activities through reliable methods. Conventional ground based sampling has proved costly and time consuming. The repetitive coverage of the satellite provides us an excellent opportunity to monitor the land resources and evaluate the land cover changes through a comparison of images acquired for the same area at different times. Changes like increased area under cultivation, conversion of annual cropland to horticulture, change in surface 'water bodies, afforestation, soil reclamation, etc., could be monitored through satellite remote sensing. Comparison of two times classified outputs and Normalized Difference Vegetation Index (NDVI) images using change detection software was performed to study the land cover and vegetation vigour transformation (Singh, 1989; Fung, 1990). Over the years, it's utility to detect and determine the extent and nature of changes over a period of time has been successfully demonstrated. It is in this context of reducing the cost and time that we address the use of satellite remote sensing as a powerful tool for monitoring and evaluation with the following objectives.

1. Assessment of the past irrigation projects implemented in the watersheds under study area.

2. Evaluation of the impact of these irrigation projects on land use/ land cover, biomass and irrigation pattern.

2. MATERIALS

2.1 Study Area

The region selected for the present study is Vedganga basin of Kolhapur district (Figure 1.)This basin drains entire part of Bhudargad, southern part of Kagal and western part of Ajara tahsil of Kolhapur district. It is located between 16° 3' to 16°30' North latitudes and 73°48' to 74°18' East longitudes occupying an area of 995.16 sq km. The region has diversified physiography, whose western border is demarcated by Western ghats.

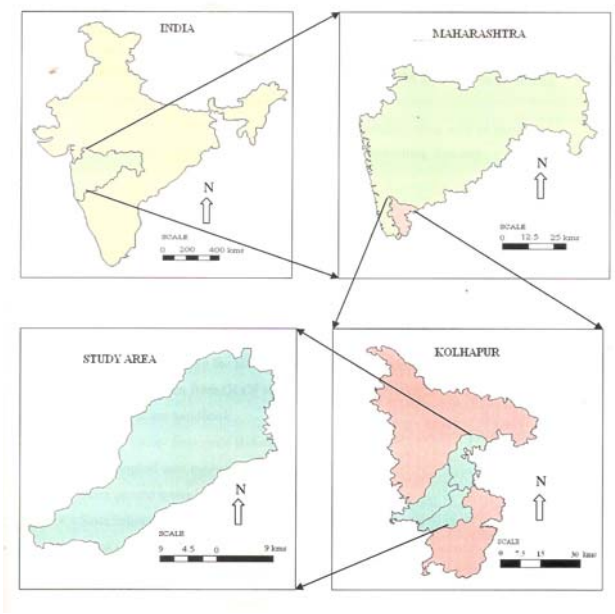

Figure 1. Location Map of Study Region

The soil vary from laterite patches in the west to deep medium black alluvial of the river tracts in the central part and poor grey soil in the east. The monsoon climate dominates the region.

2.2 Role of Remote Sensing and GIS in Impact Assessment

It is very much important that the means of assessment should be very much specific and unbiased. For that sake the recent techniques like remote sensing and GIS have been employed here for evaluation of past irrigation project implemented during 1996-2008 in Vedganga watershed, The study was carried out by using IRS 1C, LISS III data of February 25, 1996 (pre-treatment) and IRS P6, LISS III data of February 14, 2008 (post-treatment) covering the watershed to assess the changes in land use / land cover that have changed over a period of 12 years (1996-2008). The images were classified into different land use/land cover categories using supervised classification by maximum likelihood algorithm. They were also classified into different biomass levels using Normalized Difference Vegetation Index (NDVI) approach. The classified data was transferred to a GIS platform (ERDAS), and change detection was done using logical selection.

2.3 Past Irrigation Projects

During the period of analysis two medium, five minor projects and thirty K.T. wears (Kolhapur type) have been completed (Table 1)The main objective of all these projects was to enhance lift irrigation facilities for 15872 hectors of land for agriculture development. The total cost incurred, which comes around 225.27 Crores.

Name	Year of Comple-tion	Cost (In Crores)	Target Area(In Hectors)
Patgav	2007	81.46	8100
Chikotra	2005	113.76	5630
Hanbarwadi	1998	3.73	367
Megholi	2008	8.48	510
Faye	2007	6.61	700
Kondoshi	2008	8.23	400
Nishnap	2008	3.00	165
Total:		225.27	15872

Table 1. Medium and Minor Irrigation Projects (1996 to 2008) Source: Irrigation Department, Kolhapur, Maharashtra

3. RESULTS AND DISCUSSION

3.1 Impact on Land use /Land Cover Change (LULCC)

This is a general term for the human modification of Earth's terrestrial surface. Though humans have been modifying land to obtain food and other essentials for thousands of years, current rates, extents and intensities of LULCC are far greater than ever in history. Monitoring and mediating the negative consequences of LULCC while sustaining the production of essential resources has therefore become a major priority of researchers and policymakers around the world. According to supervised classified images (figure 2 and 3), seven classes were identified and the changes in land use /land cover is included in Table 2.

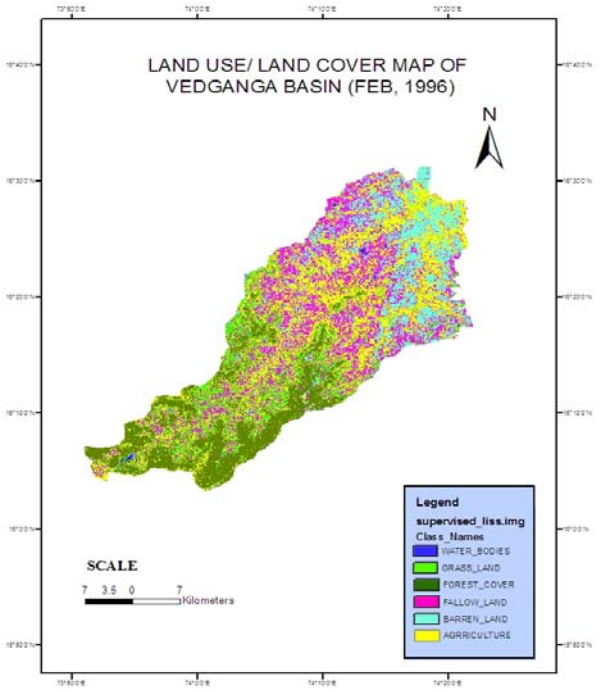

Figure 2. Supervised Classified Image IRS 1C (Pre-Treatment)

In Vedganga basin, out of the total geographical area about 45.13% was under cultivation (Net sown area and fallow land) which has increased up to 57.6% in 2008. This is due to the fact that parts of wastelands land were brought into cultivation**.** The area under fallow land has been decreased by 9.32 percent. This decrease is basically confined away from the river basin, which may be attributed to the better utilization of ground waters resource. The lower reaches of Vedganga basin is having high proportion of agricultural land and low proportion of fallow land and the vise versa situation can be observed in the upper reaches of south western high altitude areas of the basin**.** The south western part of the region which is dominated by western ghat is having dense forest and grassland. The area under forest and grassland has decreased substantially (12.88 per cent) especially in western and southwestern hilly tracks of the basin. Forest and grassland cover plays a very vital role in land and water conservation**.** The region has noted decrease by 5.1 per cent in forest cover during 1996 to 2008. This shows that the natural resources of this basin are not sustainably managed as the actual dense forest which is remaining is about 12.7 percent only. The barren land share is about 19.2 per cent**.** The percent of barren land has not shown any substantial change (decrease of 0.92 percent). Relatively high proportion of this category is confined to degraded hilly and plateau areas of Budargadh tahsil and lower reaches of Chikotra basin of Kagal tahsil**.** The proportion of waterbody, which includes dam, tank and rivers accounts for 0.9 percent. This has shown 0.33 percent increase which is good sign of improved water harvesting facilities. During the period of investigation, the Vedganga basin has observed a substantial LULCC.

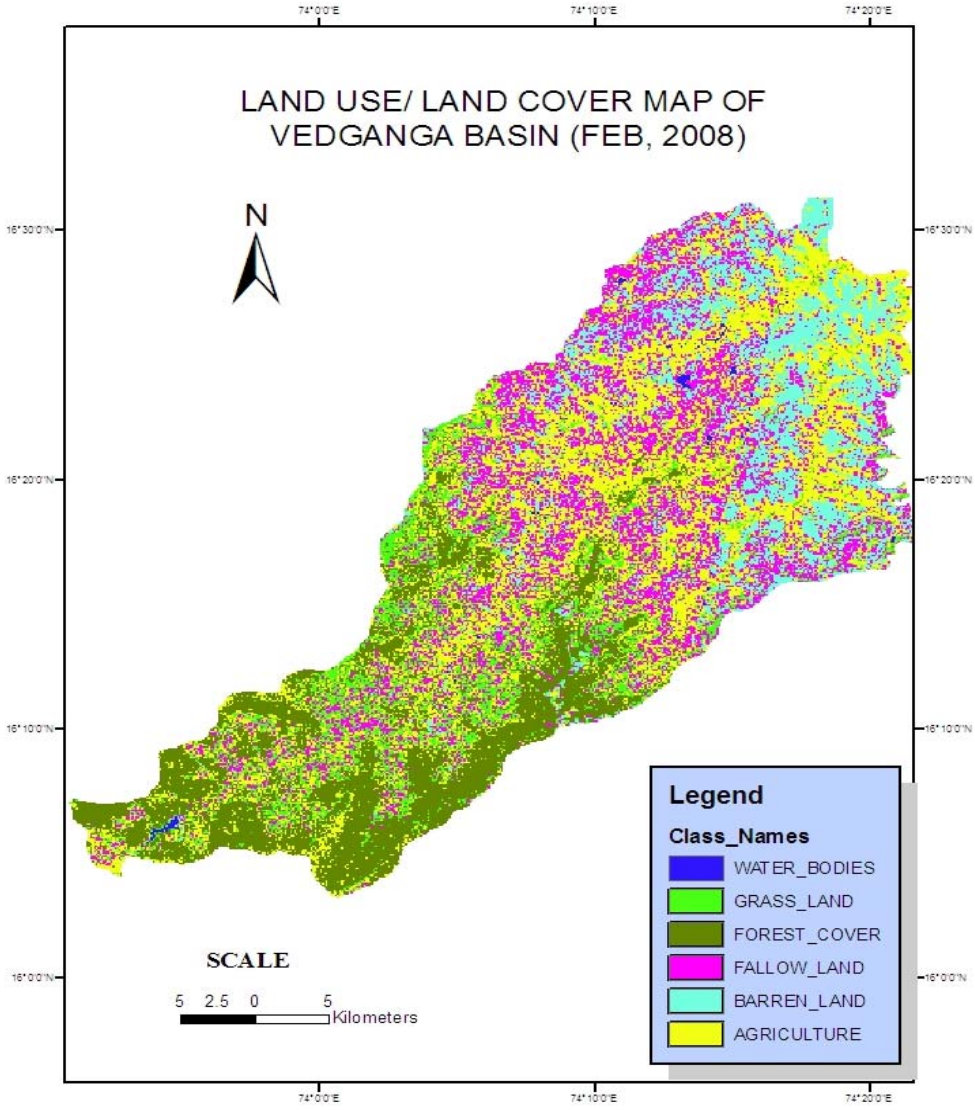

Figure 3. Supervised Classified Image of IRS P6 (Post-Treatment)

Class Name	Year 1996		Year 2008		Change	
	Area (Ha) (%)		Area (Ha) (%)		Area (Ha) (%)	
Grass land	15847.3	16.38	8346.13	8.6	7501.17	- 7.78
Fallow land	18291.3	18.92	9250.153	9.6	9041.147	- 9.32
Barren land	19455.4	20.12	18599.52	19.2	855.88	- 0.92
Forest	17208.1	17.8	12315.1	12.7	4893	- 5.1
Water bodies	547.702	0.57	854.1	0.9	306.398	0.33
Agriculture	25346.3	26.21	47331.1	48	21984.8	21.79
Total	96696.10	100	96696.10	100		

Table 2**:** Land use/ Land cover Change (1996-2008)

3.2 Impact on Biomass

The collection of accurate, timely information of vegetation is always important (Groten, 1993).The collection of such information is expensive, time consuming and often impossible (Eastman and Fulk, 1993). An alternative is the measurement of vegetative amount and condition based on an analysis of remote sensing spectral measurement. The Normalised Difference Vegetation Index (NDVI) gives a measure of the vegetative cover on the land surface over wide areas. Here, by applying this technique in conjunction with change detection analysis the impact of past irrigation programs on biomass has been assessed.

3.2.1 NDVI Formula: NDVI = (NIR - VIS)/ (NIR + VIS) (1)

Where NIR=Near Infrared VIS= Visible Red

3.2.2 NDVI Index and Change Detection Analysis: The NDVI index for Vedganga basin has been calculated for two consecutive images (IRS 1C LISS III and IRS P6 LISS III) for the same season. The NDVI values of IRS 1C LISS III (Pre treatment) and IRS P6 LISS III (post-treatment) image ranges between -1 to 0.76 and -0.30 to 0.57 respectively. A higher value shows the high vegetation areas like forest, which is basically confined to hilly areas of Bhudargadh and Kagal tahsil. The western, south western parts of Bhudargadh and western part of Kagal tahsil is having thick forest. The cultivated fields also show quite high NDVI values as compared to fallow lands, which are basically confined along the Vedganga river. Water bodies are having negative index which is observed at dam and tank site. The status and impact of various watershed projects in the form NDVI is indicated in Figures 4.

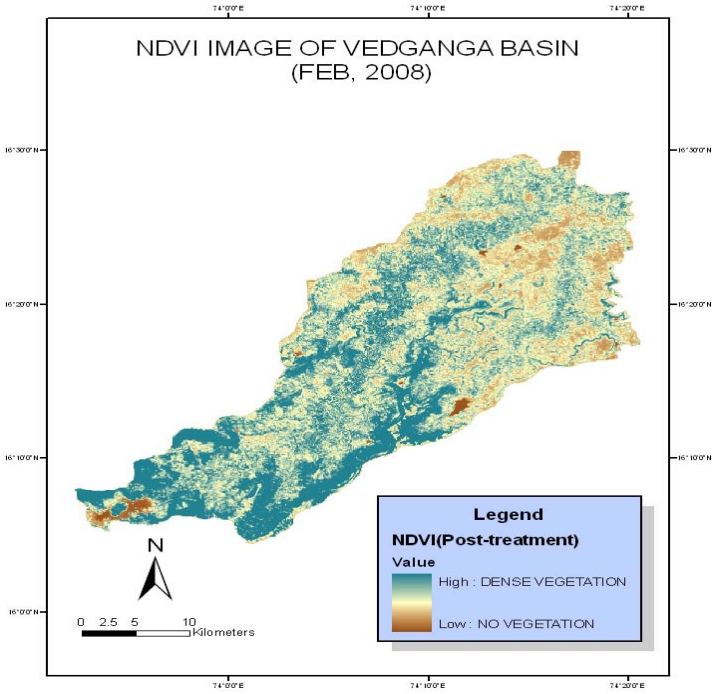

Figure 4. NDVI Index of Vedganga Basin (Post- treatment)

The accurate detection and efficient analysis of changes between time series images are very complicated processes for users rapidly to move from massive image to meaningful information to decision making, including accurate processing of temporal images, synoptic and compared views at varied spatial and temporal scales, and searching changes at large coverage (Singh A., 1989). Change detection was performed by using ERDAS 9.3 for both period satellite data. Negative impact is clearly observed as the dense forest has suffered degradation. That is the result of increased human intervention through agriculture and other activities. The

lower reaches of Vedganga basin is having high proportion of agricultural land which shows positive NDVI values. To some extent, the facility of irrigation along the river basin has been improved as a result the area under cultivation along the river basin has increased. The lower value shows non vegetation areas like barren land, fallow land, water, settlement etc. At few places, the negative index values have disappeared for the category waste/degraded land for the year 2008. It is observed through Change detection analysis in Figure 5. But still the impact is not satisfactory enough.

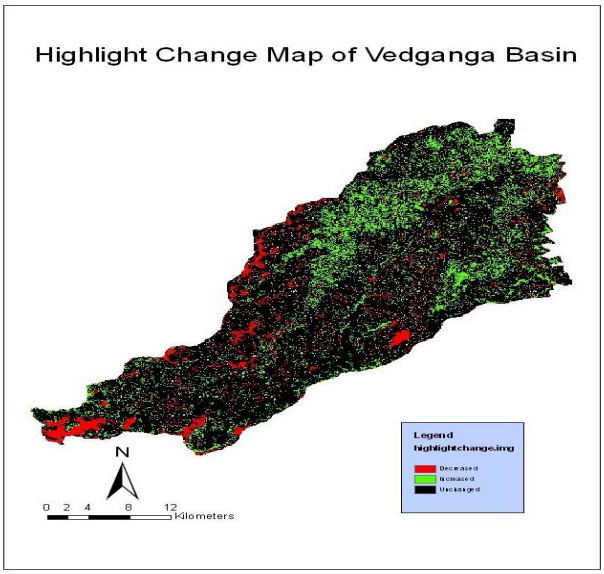

Figure 5. Highlight Change Map of Vedganga Basin

3.3 Impact on Irrigation Pattern

Here, an attempt has been made to examine the changes in the net irrigated area (NIA) under different sources of irrigation. This is the way to assess the effectiveness of irrigation as huge amount has been invested through various irrigation projects.

The particulars of source of irrigation, net cultivated and NIA has been given in Table 3. The NIA in 1995 was 7.61 percent, which has increased up to 15.43 percent in 2008. Under the period of investigation it has shown an increase of only 7.82 percent. In the study region, lift and well are the popular sources of irrigation, which together accounts for 89 percent. The data reveals that both in the pre and post treatment periods, lift irrigation forms an important source of irrigation in the study region. In fact the proportion of NIA under lift irrigation has decreased from 72.83 percent in 1995 to 62.75 percent in 2008 but the total area irrigated by lift irrigation has been increased by 2310 hectors. As regards well irrigation has also increased by 3.14 percent over the same period (from 24 % to 27.14 %) and NIA also increased by 1296 hectors. The Share of canal and tank irrigation is negligible as it accounts for less than 7 percent in 2008. Here the study reveals that the impact has not been up to the desired level like other large-scale watershed development project of India (GOI 2002). As the main objective was to bring 15872 hectors of command area under irrigation but the analysis reveals that only 4316 hectors of land has been brought under irrigation. This is not a positive sign of Irrigation development.

Source of Irrigation	Year 1995		Year 2008		Change	
	Area (Ha) (%)		Area (Ha) (%)		Area (Ha) (%)	
Canal	-	-	306	3.70	+ 306	+ 3.70
Tank	125	3.16	529	6.39	+ 404	+ 3.23
Wells	949	24	2245	27.14	+ 1296	+ 3.14
Lift	2879	72.83	5189	62.75	+ 2310	- 10.08
Net Irrigated Area	3953	9.31	8269	14.11	+ 4316	+ 4.8
Net Cultivated Area	42458	43.90	58567	60.56	+ 16109	+ 16.66

Table 3: Change in Irrigation Pattern

Source: Yearly Irrigation Report of 1995 and 2008, Irrigation Department, Kolhapur, Maharashtra.

CONCLUSION

The satellite images of study region acquired during pre and post treatment periods have offered a rich source of information about changes in land use /land cover and NDVI index in the watershed over a period of 12 years to assess the impact of past irrigation development. It is noted from the above analysis that the investment is highest in lift irrigation but the returns are not satisfactory enough. The impact of irrigation development program depends on effectiveness of the technology in the background of needs, priorities, cultural practices, and community participation. The impact also depends on the political will of the government, acceptability of the people and coordination between officials and public. The results indicated that the area under agriculture away from the river basin has increased substantially as a result of improved well irrigation facility. The Irrigation projects implemented during the period of analysis were not found financially viable.

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