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Analysis and Evaluation of Impact on Watershed by using Different Indices

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Abstract

Analysis of Data for Evaluation of Impact on Watershed is carried out on Indla- Ghatkheda Village. These watersheds are in satpuda region, Amravati, Maharashtra, India. The Data required to calculate the indices are collecting from PhD holder Dr. Sanju S. Vinchurkar thesis from this data we can calculate the indices. From study of Indices, we can conclude that. The drainage area of Indla-Ghatkheda watersheds, are 933 and 539 ha. The Land Leveling Index in Indla-Ghatkheda watersheds attains maximum value of 1.0. The Critical Area Index reported is 0.85. The reported value of Irritability index is 1.39. Poverty Index before the implementation of project was 30 which decrease to 16 after completion of project. It is a very good impact of project on the level of poverty The Regular Employment Generation Index of Indla-Ghatkheda village found to be 255.31 after completion of watershed project. The Human Development Index Reported for the Indla-Ghatkheda watershed is found to be 1.03; the runoff conservation index for indla village is 47%. And the total runoff conservation index for ghatkheda village is 17%. The assessment of soil erosion has been carried out in Indla-Ghatkheda and Masod watersheds. Out of total area 7.3 sq km. area has soil loss range is less than 0.20tons/ha/year categorized as very low erosion area. 6.4sq.km. area has soil loss range between 0.21 to 0.45 tons/ha/year. 3.1 Sq.km area has soil loss range between 0.46 to 0.84 tons/ha/year. It is observed that, approximately 1 Sq.km area have soil loss range between 1 ton to 4.56 tons per ha/per year the induced watershed eco index found to be 0.192%. The

Carrying Capacity Index reported for the Indla-Ghatkheda and Masod watershed is 1.33. These are all the ranges we can observed while calculating the Indices.

Keywords: *Land Leveling Index, Poverty Index, Runoff Conservation Index, Water Conservation Index.*

INTRODUCTION

Watershed development is the most important program for rural development especially for the rain fed area region. It enhances the groundwater table and soil moisture is retained for longer period resulting in healthy growth of vegetation.

The aim of this study was sustainable development in the Indla- Ghatkheda watershed area through soil and water conservation activities. Sustainable development defined as development that meets the need of the present without compromising the ability of future generation to meet their own needs.

Watershed is geographical unit draining at a common point by a system of streams, is called watershed. (S.S. Vinchurkar 2012) For study of indices, we collecting the raw data for calculating index the data collected from Phd student Dr. Sanju S. Vinchurkar. Thesis he is working on topic of (Evaluation of impact on watershed using socio-economic, sustainability and management techniques).

RESEARCH METHODOLOGY

The watershed cluster was selected from Amravati district such as Indla-Ghatkheda watershed in Amravati taluka. The term watershed cluster was used in the study, which can be described as "an area comprised of two or more micro watersheds at a single place adjacent to each other having different drainage channels". These watershed clusters were selected purposively because Government of Maharashtra Launched watershed development programme under Vidarbha pan lot vikas Mission 2005-2015 in India Indla-Ghatkheda watershed at Amravati district of Vidarbha region of Maharashtra.

The study was taken with the main objective to find out the evaluation of impact on watershed using different indices in Indla-Ghatkheda watershed in Vidarbha region of Maharashtra. The respondents were selected from the

beneficiary farmers of watershed clusters with the help of stratified proportionate random sampling plan. Frothy respondent farmers selected from Indla-Ghatkheda watershed cluster.

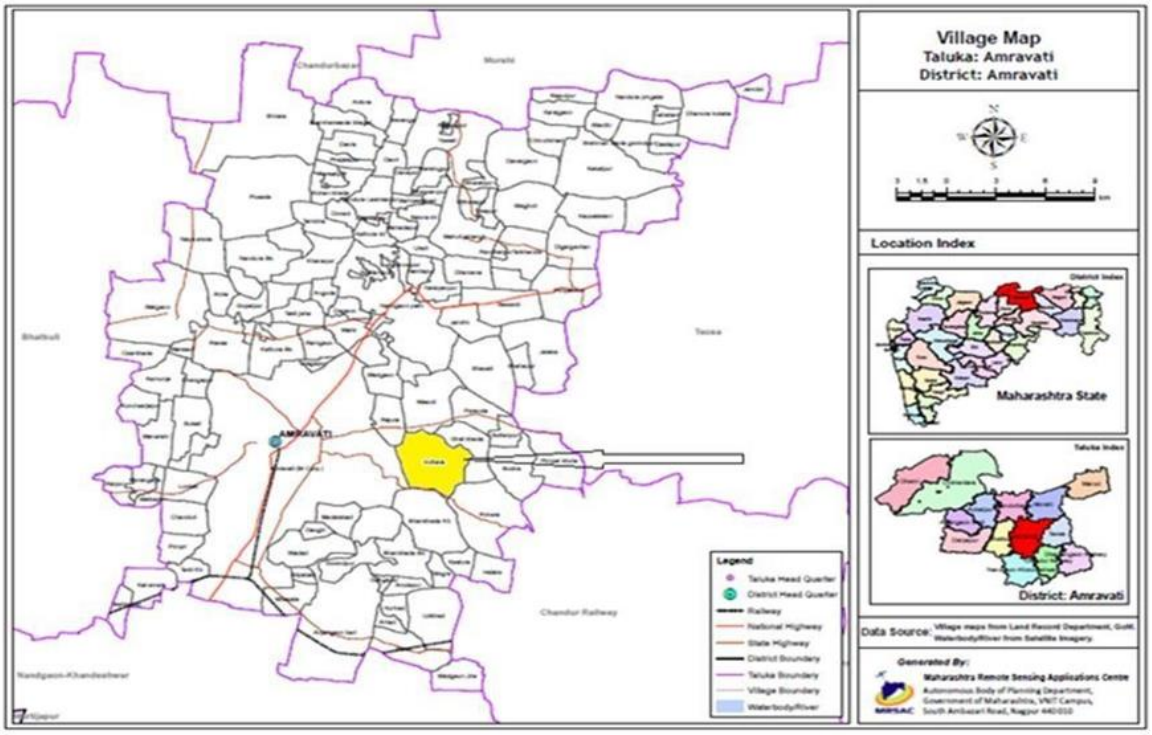

Fig. 1: Location Map of Indla-Ghatkheda Watershed

Following indicators are used for the evaluation of impact on Indla-Ghatkheda watershed:

Management indicator

It includes Land Levelling Index, CriticalArea Index and Irrigability Index.

- Land levelling index (LLI)

$$\text{Land Levelling Index (LLI)} = \frac{\text{Recommended slope (\%)}}{\text{Existing or treated slope (\%)}}$$

- Critical area index

$$\text{Critical Area Index (CAI)} = \frac{\text{Benefitted critical area from structures}}{\text{Total Critical Area}}$$

- Irritability Index

$$\text{Irritability Index (II)} = \frac{\text{Additional gross irrigated area}}{\text{Net incremental irrigated area}}$$

Socio-economic indicator

Following socio-economic indicators have been selected to analyze the impact of watershed projects.

- Poverty Index (PI)

$$\text{Poverty Index} = \frac{\text{Number of BPL Families}}{\text{Total number of families}} \times 100$$

Regular employment generation (REG) index Regular Employment Generation

Index calculated with the help of following formula.

$$\text{Regular Employment Generation Index (REGI)} = \frac{\sum EiXAi\ (After\ the\ project)}{\sum E_j x A_j\ (\text{Before the project})}$$

Where,

Ei= The number of man-days utilized per hectare in the ith enterprise (crop, horticulture, agro-forestry, forces try, live stock, fishery etc.) in a year after the project

Ai = Area in hectares utilized in the ith esieereine (crop, horticulture, agro-forestry,livestock, fishery etc.) in a year after the project,

Ej = the number of man days utilized per hectare in the jth enterprise (crop, horticulture, agro- forestry, forestry, livestock, fishery etc.) in a year before the project,

Aj= Area in hectares utilized in the t enterprise (crop, horticulture, agro-forestry, forestry, livestock, fishery etc.) in a year before the project, and

k,n = Number of enterprises before and after the project, respectively.

Human Development Index

Human Development Index was calculated by using following formula.

$$\text{Height for Age Coefficient (HAC)} = \frac{\sum_{j=1}^{k} \sum_{i=1}^{n} Observed\ hij}{\sum_{j=1}^{k} fj\ X\ Recommended\ hj}$$

Where,

h = Height of a child in cm, i= ith Observation

j= jth class and

fj= number of observations (frequency) in jthclass.

Sustainability indicator

Following sustainability indicators have been calculated by using their respective formula

$$\text{Runoff conservation Index (RCI)} = \frac{\text{Runoff water conserved in the watershed after the project}}{\text{Runoff water estimated before the project}} \times 100$$

Soil erosion risk index

Assessment of Soil Erosion was obtained from the RUSLE model using Remote Sensing and GIS, annual soil erosion rate is presented in Table No. 6.6

Induced watershed eco index

$$\text{Induced watershed eco index (EWEI)} = \frac{\text{Additional area vegetated during the project}}{\text{Total area of the watershed}}$$

- Carrying Capacity Index (CCI)

$$\text{Carrying Capacity Index (CCI)} = \frac{\text{Quantity of fodder available}}{\text{(No. Of standard livestock units) x (Standard requirement of green fodder per livestock unit)}}$$

- Participatory watershed development index (PPI)

$$\text{PPI} = \frac{\text{Mean Participation score}}{\text{Maximum participation score}} \times 100$$

$$\text{Where, } P = \frac{\sum_{i=1}^{N} p_i}{N}$$

Where, N= Total number of respondents

$$P_i = \sum_{i=1}^{k} (PPi + PIi + PMi)$$

where,

PPi = Total scores obtained by a respondent due to participation in programmed planning;

PIi = Total scores obtained by a respondent due to participation in programmed implementation;

PMi = Total scores obtained by a respondent due to participation in programmed maintenance;

K = Total number of statements on which responses of the respondents were recorded;

Pi = Total participation scores obtained by individual respondent in planning, implementation and maintenance.

RESULTS AND DISCUSSION

Management Indicator

Following indicators have been selected to analyze the impact of watershed projects.

Land Levelling Index (LLI) –

Land Levelling Index (LLI), which is the ratio of recommended land slope to the existing land slope, can be utilized in the pre-project (PrP) and post-project (PoP) scenarios to quantify the extent of land improvement. The implementing agency has given preference to drainage line treatment.

In both Indla-Ghatkheda and Masod villages the graded bunding is the only activity reported for converting the slope. Approximately 35 ha of land has been covered under the Vidarbha Panlot Vikas Mission (VPVM). The recommended slope is 5% and treated slope is 5%. Where, existing slope refers to the individual land slope before the inception of the project and treated slope isthe moderated slope resulting from land levelling activities. Higher value of LLI isa measure of better moderation in land slope. LLI can attain a maximum value of 1.0, which refers to a perfectly levelledfield.

Table 1: Land Levelling Index

Name of Village	Watershed (ha)	Slope (RS)	Treated Slope	Levelling Index
Indla- Ghatkhed	1462	5%	5%	1.0

Critical Area Index (CAI) –

Critical Area Index (CAI), which is theratio of the critical area benefited due to treatment with conservation structures and the total critical area that needs to be treated. The critical area index is reported for the watershed is 0.85, which nearly equal to ideal value 1. It means critical area benefited due to the watershed treatment is maximum indicating increase in biomass production. See table 2

Table 2: Critical Area Index

Name of village	Total area Of watershed	Benefited Critical Area (ha)	Total Critical Area	Critical Area index
Indla-Ghatkhed	1462	104	121	0.85

Irrigability Index –

Watershed has immense importance in irrigation development. The objectives of watershed activities are to improve upon the ground water conditions. The village Indla has irrigated area 59 ha under Rabbi crop and 17 ha under horticulture presently. The Ghatkheda village has only 9 ha of total cultivated area (5%) presently. (Reference- Jalyukta Shivar Report, 2018, Govt. of Maharashtra) In the pre conditions of watershed project, See Table 3

Table 3: Irritability Index

Name ofVillage	Total Areaof Watershed (ha)	Additional Gross Area(ha)	Net Incremental Irrigated Area(ha)	Irritability Index
Indla-Ghatkhed	1462	85(24ha in precondition)	61	1.39

The index can attain any value more than 0, and a higher value will indicate successful utilization of harvested water inthe watershed management project. The reported value for irrigability index is 1.39, which proves that, irrigation status of village is good and improving.

SOCIO-ECONOMIC INDICATOR

Following socio-economic indicators have been selected to analyze the impact of watershed projects.

Poverty Index

In Indla-Ghatkheda watershed total population is 1595 as per the 2011 census. The total population composed the 500 families. In pre-condition of watershed project total families below poverty line (BPL) families are 75 out of 250 families, hence the poverty line ratio is 30%.

Before project out of total 250 families, 75 (30%) families are below poverty line (BPL) and 175(70%) families are above poverty line (APL). The table shows that poverty index is 30%.

But after the project 210 i.e., 84% families found above poverty line and remaining only 40 (16%)families below poverty line with poverty index of 16%. From the above findings it is quite clear that there is decrease in BPL families in the study region. Hence it is inferred that because of watershed development program me there is improvement in the socio-economic status of the Indla-Ghatkheda village peoples.

Table 4: Socio-economic status of Indla-Ghatkheda village before and after the project

Sr. No.	Item	Before Project			After Project		
		No.	Total	Poverty Index (PI)	No.	Total	Poverty Index (PI)
1.	Total Population	1595			1595		
2.	APL Families	175	250		210	250	
3.	BPL Families	75		30	40		16
4.	SC Families	09	250		09	250	
5.	OBC & Open Families	241			241		

Table 5: Regular Employment Generation Index

Sr. No.	Name of Enterprise	Before Project		After Project		REG (Index)
		No. of Days Utilized per ha in a Year	Area (ha)	No. of Days Utilized per ha in a Year	Area (ha)	
1.	Crop	70	81	136	92	255.31
2.	Horticulture	7	10	15	10	
3.	Agro Forestry	8	9	12	9.46	
4.	Forestry	9	10	12	11	
5.	Livestock*	53	42	97	73	
6.	Fishery	0	9.54	6	9.54	

(Note – *Total livestock in the study villages is 800 (Ref- Jalyukta Shivar Assessment Report, 2017), Live stock data is collected from Veterinary Department, Indla and Ghatkheda).

Regular employment generation (REG) index In the drought region of the country, distress migration is very common social anxiety. Migration is associated with non-availability of regular employment in local habitat. Unskilled Labors is usually affected with distress migration.

Regular employment generation ratio of Indla-Ghatkheda and Masod village has been calculated with interacting with agriculture laborers associated with agriculture and allied activities.

The analysis is given in Table mentioned above. The data for pre and post project conditions is analyzed. The change in ground water levels shifted the cropping pattern with introduction of some new crops. In pre conditions of the projects, farmers and labors remain engaged for 70 days, whereas in post condition of watershed development it is almost doubled i.e., for 136 days as the area under crop is increased from 81 ha to 92 ha. As far as Horticulture concern in study villages no significant change has been observed.

The labor transactions have been doubled in horticulture crop. Some of farmers preferred for agro-forestry practices, which also shows increased involvement of labors in post conditions of projects. Livestock is one of important parameter in successful watershed. The area under fodder cover has been 42 to 73 ha, which has increased the involvement of labors.

Fishery is one of newly introduced income generation activity. In the stored water some of fish hunting families are sustaining their livelihood.

Human development index

Human Development Index (HDI) is one of best indicator to assess the overall development of village dwellers. The data on the various aspects of height, weight etc. has been collected with structured interview schedules. The primary data collected from inhabitants, whereas the secondary data have been collected from Anganwadis (Pre -Primary schools).

The human development index (HDI)reported for the Indla-Ghatkheda and Masod watershed is 0.99. HDI is nearly equal to 1. It means human development index increased due to watershed management project.

Sustainability Indicator

Following sustainability indicators have been selected to analyze the impact of watershed projects.

Runoff conservation index

It is an important indicator to define as to how much runoff has been conserved within the watershed for bio-mass production and/or groundwater recharge after adopting need-based watershed interventions.

The runoff conservation index has been calculated for Indla and Ghatkheda village separately. The village Indla has 935 TCM of runoff available as per the stranger's chart. The total runoff conserved is 426 TCM. The run off conservation index for Indla village is 46%. It revealed that, still village have wide scope to implement the watershed activities. The village Ghatkheda have runoff as per stranger table is 511.44. Total arrested runoff with existing work is 89 TCM. Total runoff conservation index for Ghatkheda village is 17%. It revealed that, village Ghatkheda have wide scope to implement the watershed activities than Indla village.

Runoff conservation index of Indla and Ghatkheda village can be improved by implementing water conservation measures such as farm bunding, water conservation trenches, drainage line treatment etc. Soil erosion assessment of Indla- Ghatkheda watershed was done and results presented in Table 6 Out of total area 7.3 Sq. Km area have soil loss range is less than 0.20 tons per ha/ per year categorized as very low erosion area. 6.4 Sq. Km area have soil loss range between 0.21 and 0.45 tons per ha/per year. 3.1

Sq.km area have soil loss range between 0.46 and 0.84 tons per ha/per year.

Approximately 1 Sq. Km area have soil loss range between 1 ton and 4.56 tons per ha/per year. The details are given in Table 6.

Induced Watershed eco index

Induced Watershed Eco Index is calculated for Indla-Ghatkheda and Masod village. In watershed PTP/06/05/03, 02, 06 these villages comprise the 1462 ha of the watershed.

Soil erosion risk index

Table 6: Induced watershed Eco Index of Indla-Ghatkheda-Masod villages

Sr. No.	Season	Land use	Indla, Ghatkheda and Masod Area (ha)		
			Before Project	After Project	Increase in Area (ha)
1	Kharif	Cultivated land under crop	249	462	213
		Barren land	121	17	104
2	Rabbi	Cultivated land under crop	13	68	55
		Barren land	121	17	104
3	Summer	Cultivated land under crop	7	21	14
		Barren land	121	17	104
Total Cultivated land under crop					**282**
Total Watershed Area = 1462 ha					
Induced watershed Eco Index = 0.192					

Table 7: Soil erosion assessment of Indla-Ghatkheda watershed

Watershed	Soil loss area (sq.Km)	Soil loss Rate (tons/ha/yr)	Soil erosion intensity
PTG/06/05/03	7.3	<0.20	Very low erosion
PTP/06/5/02	6.4	0.21-0.45	Low erosion
PTP06/5/06	3.1	0.46-0.84	Low to moderate
	0.6	0.84-1.38	Moderate to high
	0.2	1.39-2.14	High to very high
	0.1	2.15-4.56	Very high
Total	17.8		

The study area is very nearer to Amravati city and therefore people from the city came to this area and constructed concrete houses on the cultivated area. But the area under cultivation increased up to 19.2% which indicates that additional 19.2% area rehabilitee through green vegetation.

Carrying capacity index

"It is capacity of nature in which maximum number of individuals that can be supported by resources of nature at subsistence level." The earth's ecosystem having finite capacity. Today the capacity of earth's ecosystem is strongly affected by growing population. The carrying capacity index reported for the Indla-Ghatkheda and masod watershed is 0.989 This village is surrounded with 998 area of forest land, which provides the good potential for generating of fodder to entire livestock.

Table 8: Carrying Capacity Index

Sr. No.	Particulars	No. of Animals	Fodder required	Total fodder	fodder	Carrying
1.	Cow	357	15	5355	5300	0.989
2.	Buffalo	790	15	11850	11720	

CONCLUSION

Based on the observations, survey and various indicators following conclusions appears to be justified.

Management Indicators:

1. The Land Levelling Index in Indla-Ghatkheda watershed attains maximum value of 1.0, which refers to perfectly levelled field.

2. The Critical Area Index reported in Indla-Ghatkheda watershed is 0.85, which nearly equal to ideal value 1. It means critical area benefited due to the water shed treatment is maximum indicating that biomass production is increased.

3. The reported value of Irritability Indexes 1.39, which proved that irrigation status of village is good and improving.

Socio-economic Indicators:

1. In the Indla-Ghatkheda watershed, the Poverty Index before the implementation of project was 30 which decrease to 16 after the completion of project. It is a very good impact of project on the level of poverty.

2. The Regular Employment Generation Index of Indla-Ghatkheda village found to be 255.31 after completion of watershed project. It means employment is increased after the

completion of watershed project. Economic development of the area is constantly in progress, there is considerable increase in biomass due to in situ moisture conservation after completion of project. Which resulted in increase in animal population and milk production. Hence huge population of the area is engaged in dairy & related business by taking advantage of nearby Amravati Municipal Corporation area. Therefore, the index is more than expectation. The Human Development Index reported for the Indla-Ghatkheda watershed is found to be 0.99, which is nearly 1. It means human development increased due to watershed management project. It may be due to the economical development area; children get sufficient nutritional food. The area has fairly good dairy development hence the villagers as well as the children able to consume dairy products. The 'Mid-Day Meal' in Anganwadi and schools also supported the nutrition of children. Therefore, the overall health of the children is improved which resulted in increase in human development index.

Sustainability Indicators

1. The runoff conservation index has been calculated for Indla and Ghatkheda village separately. The village Indla has 935 TCM of runoff available as per the stranger's chart. The total runoff conserved is 426 TCM. The runoff conservation index for Indla village is 46%. It revealed that, still village have wide scope to implement the watershed activities. village Ghatkheda have runoff as per stranger table is 511.44. Total arrested runoff with existing work is 89 TCM. Total runoff conservation index for Ghatkheda village is 17%. It revealed that Ghatkheda village has wide scope to implement the water shed activity rather than Indla.

2. The assessment of soil erosion has been carried out in Indla–Ghatkheda and Masod watersheds. Out of total area 7.3 Sq. Km. area have soil loss range is less than 0.20 tons/ha/year categorized as very low erosion area. 6.4 Sq. Km. area have soil loss range between 0.21 to 0.45 tons/ha/year. 3.1 Sq. Km area have soil loss range is between 0.46 and 0.84 tons/ha/year. It is observed that, approximately 1 Sq. Km area have soil loss range is

between 1 ton and 4.56 tons per ha/per year.

3. Induced Watershed Eco Index is calculated for Indla, Ghatkheda and Masod village. The induced watershed eco index found to be 0.192 which shows that additional 19.2% area was rehabilitee through green vegetation.

4. The Carrying Capacity Index reported for the Indla-Ghatkheda and Masod watershed is 0.989. This village is surrounded with 998 area of forest land, which provides the good potential for generating of fodder to entire livestock. It was also observed that the farmers in Indla-Ghatkheda watershed have participated moderately in the watershed development program planning and implementation stages, whereas, high level of participation was exhibited by farmers in maintenance stage of watershed development program me.

Therefore, it could be concluded that the stakeholder farmers of Vidarbha region participates more by contributing labor in maintenance of soil and water conservation structure simplemented in their fields through government sponsored watershed development programmes to enhance their sustainable agricultural production due to more availability of irrigation water.

All the indices except soil loss and induced watershed eco index were found satisfactory. Hence following recommendation were suggested for these two indices, Untreated area should be identified and appropriate treatment should be implemented to reduce soil loss.

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