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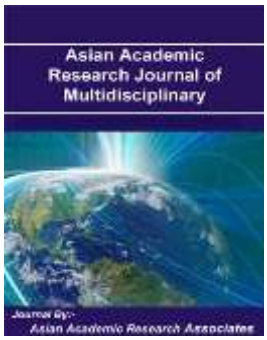

IMPACTS OF SUJALA ON LAND USE /LAND COVER TRANSFORMATION AND SOCIO-ECONOMIC CHANGES IN JONNIKERI WATERSHED

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ABSTRACT

Sujala is a Watershed Development Project designed by the Government of Karnataka and implemented by the Watershed Development Department of Government of Karnataka with tripartite cost-sharing arrangements. The World Bank through International Development Association provided major portion of plan outlay as a loan to Government of India and in turn loan to Government of Karnataka. This study is to analyse the Sujala impacts of these developmental efforts on social, economic, Institutional and environmental parameters after the intervention. Having invested considerable budget, manpower and efforts, the land use /land cover transformation and socio-economic changes of the rural livelihoods needs to be understood and lessons to be drawn. It is in this context, the evaluation of Jonnikeri Nala watershed lying in Aurad taluk, Bidar district was undertaken by Antrix Corporation, Indian Space Research Organisation (ISRO), at the instance of Watershed Development Department, Govt. of Karnataka. Ground data collection through field visit and remote sensing technique is used for this monitoring. Secondary data also collected from rural office and NGO OUTREACH. Remote sensing method is use to understand land use/ land cover change studies and in order to assess the biomass qualitatively, NDVI has been computed using the infrared and red bands of the satellite data.

Introduction:

Integrated Watershed development has become the flagship program for land management in the country for holistic and sustainable development of rainfed areas and to alleviate poverty. A watershed is a geo-hydrological unit that drains to a common outlet, which makes an ideal planning unit for development. Watershed development essentially relates to development of land and water resources through a set of biophysical, technological and social interventions. An Integrated Watershed Management approaches is being adopted in order to conserve rain water, minimize land degradation, arrest soil erosion, improve ground water recharge, increase crop intensity and productivity, meet the demands of fuel wood and fodder and improve the socio-economic conditions of the people.

Sujala is a Watershed Development Project designed by the Government of Karnataka and implemented by the Watershed Development Department of Government of Karnataka with tripartite cost-sharing arrangements. The World Bank through International Development Association provided major portion of plan outlay as a loan to Government of India and in turn loan to Government of Karnataka.

Participatory watershed developments programs are being recognized as the ideal approach for integrated natural resource management in rain fed areas and improve the rural livelihoods. An integrated approach to natural resource management at the watershed level would ideally address the complex system dynamics in watersheds, and achieve environmental benefits where ever it is feasible. National Bank for Agriculture and Rural Development (NABARD) has been actively promoting the watershed development through involvement of village level Institutions and NGO's. Watershed Development Fund has been created for such activity by NABARD and Government of India, with a broad objective of unification of multiplicity of watershed development programs into a single national initiative.

Karnataka is predominantly agriculture based State having more than 70% of its population depending on agriculture and allied activities. Karnataka has two thirds of the geographical area under arid to semi-arid conditions. The State ranks second next to Rajasthan in terms of drought prone with an annual normal rainfall of 750 mm. The, Rain fed agriculture in Karnataka is characterized by low productivity, degraded natural resources and widespread poverty. Most of the people living in arid to semi-arid zones of Karnataka depend on dry land agriculture for their livelihoods. The dry land farming in Karnataka is riddled not only by natural/physical constraints like unfavourable soil, moisture and climatic conditions, but also by the socio-economic conditions of the farmers such as poverty, fragmented land holdings, urbanization etc. Realizing the importance of watershed approach for rainfed farming, Govt. of Karnataka has been implementing watershed development programmes under various schemes with different approaches and technology inputs, cost and subsidies, and Institutional arrangements. NABARD also has promoted watershed development in different districts of Karnataka state with support from watershed development fund from 2002 onwards.

It is always pertinent to analyse the impacts of these developmental efforts on social, economic, Institutional and environmental parameters after the intervention. Having invested considerable budget, manpower and efforts, the land use /land cover transformation and socio-economic changes of the rural livelihoods needs to be understood and lessons to be drawn. It is in this context, the evaluation of Jonnikeri Nala watershed lying in Aurad taluk,

Bidar district was undertaken by Antrix Corporation, Indian Space Research Organisation (ISRO), at the instance of Watershed Development Department, Govt. of Karnataka. The evaluation involved systematic study of all activities implemented and their resultant implications in the watershed area and on the community. Attempts were also made to identify deficiencies if any and to adopt corrective measures in the future course of projects.

Methodology:

The major methodology of the present study is to study and analyse various activities/ interventions carried out in the watershed under the project. Assess and document the visible impacts of the project on the socioeconomic conditions and natural resources. Analysis of biophysical changes like land use / land cover transformation is also important part of this project. Other side impact analysis on social aspects like capacity building, Income generating activities and sustainability aspects. With these methods in mind, Antrix Corporation, ISRO carried out the evaluation in 2011 by visiting the watershed, interacting with the stakeholders, referring the documents / registers and also analysing the satellite images of pre and post treatment period.

Study Area:

Jonnikkeri Nala Watershed Development Project was implemented from January 7, 2002 to April 30, 2009. Jonnikkeri Nala Watershed lies in Aurad Taluk of Bidar District, Karnataka. It is located between 18°10’ and 18° 22’ North Latitudes and 77° 25’ and 77° 30’ East Longitudes falling in the Survey of India topo sheet number 56/F/9. The watershed has geographical area of 800 Hectares, of which 792.8 ha has been treated. There are 247 families covering 4 villages viz., Jonnikeri, Santhpur, Eklara and Kollur.

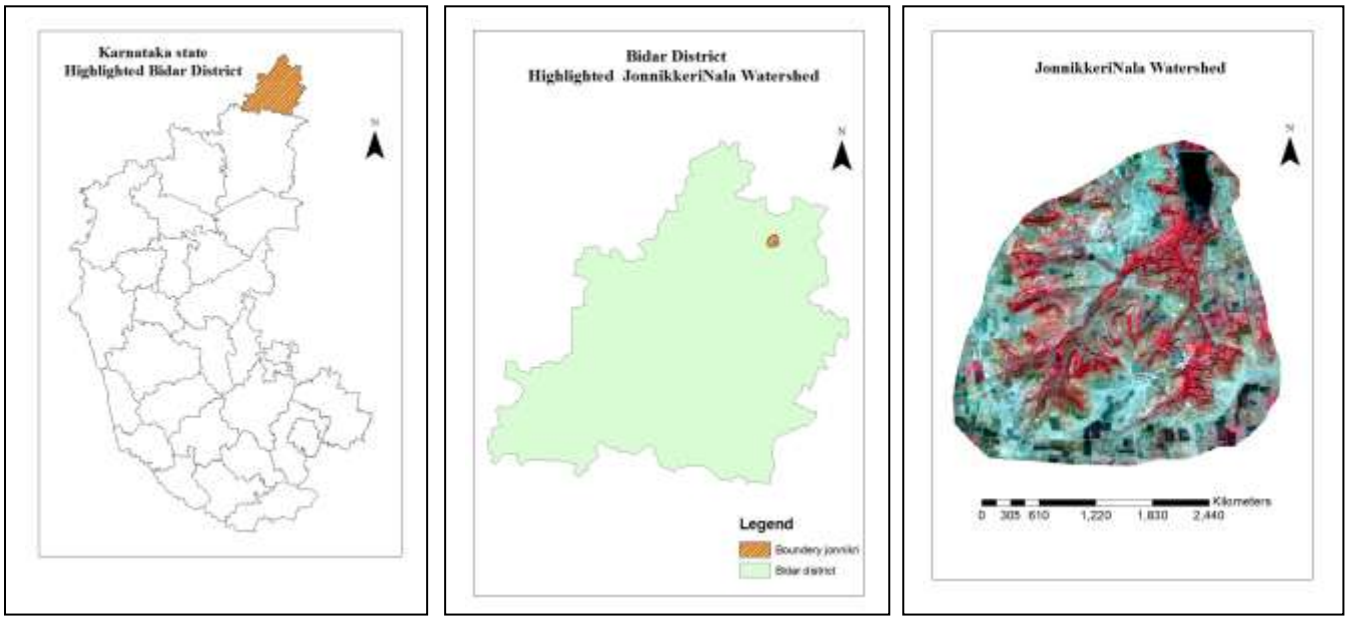


Figure1: Location Map of Jonnikeri Nala Watershed Aurad Taluk, Bidar District

Impact evaluation – data collection & analysis

A combination of satellite remote sensing images and ground based data collection with feedback / observations from stake holders were adopted. A questioner schedule covering all identified indicators to reflect the impact of watershed development was administered for collecting the information. Household level information and feedback was collected by visiting the beneficiaries of the villages of Jonnikkeri Nala Watershed through field visit and surveys. Transect walk was carried out to selected locations to have a first-hand information on various interventions implemented, quality of implementation and its impact, biomass improvement etc. Secondary data was collected from the office of NGO (OUTREACH BIDAR), SHGs and VWC with respect to activities carried out.

Sampling frame: Initially to get an overall status about the project implementation, a list of caste wise actual benefited households was prepared, covering all villages under the project area. This served as a 'Sampling Frame'. This frame provided the total number of families benefited under the project. This information was collected using a simple format as a preliminary exercise. The information served as a starting point for the sampling. Based on this sampling frame, it was decided to sample (overall) 15 percent of the beneficiaries by considering their caste or community. So, 40 households were considered for sampling in this study.

Data Analysis: All the 40 (sampled) households were interviewed using a structured questionnaire. Aspects regarding watershed implementation in Jonnikkeri Nala Watershed like membership status, their participation in capacity building, project planning, implementation, operation and maintenance, impacts etc., were recorded. The household level data was analysed and consolidated at the village level and then generalized to watershed level. For the field survey of natural resources, Global positioning System (GPS) and satellite images were used to ground truth the various land based activities such as soil and moisture conservation structures, horticulture plantations, forestry plantations, crop related, demonstration plots, etc. In general the overall land use / land cover pattern was observed to relate it to satellite images for further analysis. Satellite images of pre and post treatment periods were analysed to spatially map and determine the extent different land use / land cover categories and also generate vegetation index images to study the changes / improvement in biomass.

RESULTS & DISCUSSION:

Surface & Ground Water: The structures constructed/developed under soil and water conservation sector has been assessed from both private and common lands. The feedback revealed that there is an improvement in the water availability at the end of the project (EOP) as compared to the baseline situation. Due to effective soil and water conservation activities like boulder bund, diversion channel, waste weir, water harvesting trench, farm ponds, earthen bund were constructed with peoples' participation in the project area had an impact on the ground water level and yield to a greater extent. In the watershed area, there were 5 open wells. Out of which water levels of two wells were found to be 4.48 meter bgl in December 2005 and now the average is 1.12 meters in December 2009. The other 2 wells were not used.

Earlier rain water used flow to nala immediately and low lying lands ware used to flood and resulting in crop losses. Now due to treatments immediate flow of rain water during the rainy

season reduced and it is seen subsurface flow and raise in water in open well in upper reaches also. These facts indicate the impact of effective implementation of S&WC interventions in these areas.

Agriculture Production: The agriculture productions of major crop in the water shed area were found to be improved after implementation of this project. After interventions, the agricultural land area has increased which help to improve the agricultural production as well as income level of the farmer in this watershed. Below the table shows the change of area, grain yield and income level which show the difference between base line status to End of program (EOP). There has been considerable improvement in the yield of agricultural crops. The Soybean crop has shown maximum increase in area as well as production, whereas the red gram has shown considerable increase in the yield. The following table provides the details of the three important crops.

Table 1: Showing the statistic of base line period and end of project period different crops status

SL	Crop	Period	Area(ha)	Grain Yield(MT/ha)	Income	Overall
1.	Red gram	Base Line	280	3.0	4950	1930.50
		EOP	335	6 -7	17000	6002.37
		Change (%)	19.64	40.00	243.43	140.79
2.	Jowar	Base Line	295	4	3400	1429.53
		EOP	388	6	3800	1762.67
		Change (%)	31.53	15.00	11.76	
3.	Soybean	Base Line	15	10	8000	2691.67
		EOP	85	17	19000	6635.33
		Change (%)	1800	700	137.50	1915.83

(Data collect through field observation)

Comparison of pre and post project information with respect to agriculture indicates the following. The fallow land area is reduced in watershed due to reclamation. At the beginning it was 90 ha, now it has reduced to 48ha. Net sown crop area is increased from 682.80ha to 742ha. Major crops in the beginning were red gram, jowar, green gram, sun flower and avare, now green gram crop reduced which is replaced by soya bean. In case of red gram the area of cultivation increased by 55 ha and. the production increases from 3 quintal per ha to 6-7 quintal per ha. Overall net income increases from 4950 per ha to 15100 per ha. Which is mainly due to increase in grain cost (Rs 3200 per quintal this year) and increase in yield. The area of jowar cultivation is increased by 60 ha and also marginal increase in the production from 4 quintal per ha to 6 quintal per ha. Overall net income increases from 3400 per ha to 3800 per ha which is mainly due to increase in grain cost (Rs 3200 per quintal this year) and increases in yield. Some new crops like maize, soya bean, sun flower and avare are cultivated in the water shed which are not cultivated earlier. Cultivation of fodder for animals increased with varieties like CO1, stylo Hameta and maize are cultivated.

Afforestation and Horticulture: Out of 40 sampled households, 23 have taken horticulture activity. Major species opted are mango with varieties like dashahari, mallika, keshar, benishan and neelam. After the plants were distributed to beneficiaries, NGO had monitored all the activities such as basin preparation, mulching, planting, staking, fencing and watering or provision of critical irrigation, which was carried out by the respective beneficiary.

Livestock: Livestock's activity was an integral part of project. The impact was found after implementation of project in livestock population. The milk yield and number of livestock both have increased. The milk production has increased substantially.

Table 2: Showing the statistic of base line period and end of project period livestock population

Livestock population	Pre Development			Post development		
	Population	Milk yield	Net income	Population	Milk yield	Net income
C.B Cow	5	3600	28000	20	15000	150000
Buffalo	350	82000	4,92,000	485	232800	2328000
Goat	0	0	0	150	0	270000
Sheep	500	0	0	650	0	975000
Local Cow	310	23250	162750	408	367200	367200
Others	398	0	0	442	0	0

(Data collect through field observation)

Cross breed cows increased in number from 5 to 20 and milk production in the area is increased. Daily 355 liters milk produced and marketed. KMF installed bulk cooler in the area. A private dairy run by men group successfully. Goat population is increase considerable from (500 to 650) because of employment opportunities through watershed works to labours. Further continuous training and financial support under live hood to landless labours and women also help to purchases goats.

Fodder Availability: In order to strengthen the trench-cum-bunds under soil and water conservation activities, grass seeds and other plants were dibbled. The farmers have provided the grass seeds. Due to this fodder availability has been increased in the watershed area. Fuel and fodder status and its utilities are given in Table 3.

Table 3: Showing the statistic of base line period and end of project period fodder availability

	Pre development	Post development	%
Total Fodder requirements	3190	4065	27.42
Total fodder availability	2791	4412	58.07

(Data collect through field observation)

Fodder gap in the pre development was 399 tonnes per year. The fodder requirements were met as envisaged and there was surplus fodder of 347 tonnes per year. This is mainly due to cultivation of maize crop and improved fodder varieties and other crops.

Household Income: Annual household income has been enhanced by the activities taken up under NABARD-WDF Scheme. The improvements in agriculture productivity, enhanced agriculture labour man days, additional horticulture income, livestock improvements, etc has proven positive impacts on income level. Pre development activities were confined to only labour work whereas presently diverse activities like rearing of livestock, petty business, tailoring and season wise fruit business.

Migration: 78 persons from 46 families used to migrate for 6 to 8 months before the project in search of employment and livelihood. After the project implementation, migration has considerably reduced to 34 persons from 24 families and the period has reduced to 4 months.

Land use / land cover Classification*:*

A combination of unsupervised and supervised classification techniques was adopted using Maximum likelihood algorithm criteria in order to classify different land use / land cover categories. The major classes delineated are Water body, Dry land crop, Harvested crop, Irrigated crop/plantation, Current fallow and wasteland under arable lands. Classification was done on the satellite data of pre-treatment period (2005) and post treatment period (2010) separately and the statistics derived with respect to spatial extent were compared. The land use / land cover categories statistics during the Pre and post treatment periods are given in table 4.

Table 4: Spatial Extent of land use/ Cover categories

SL No	Land Use/ Land cover	Before Treatment	After Treatment	Change (ha)	Change %(with in category)	Change %(overall watershed)
1.	Water body	20	21	+01	+5	+ 0.12
2.	Dry land crop	291	274	-17	-5.8	- 2.1
3.	Harvested crop	96	121	+25	+ 26	+3.15
4.	Irrigated crop/plantation	118	167	+49	+41.5	+6.16
5.	Current fallow	141	123	-18	- 12.7	- 2.36
6.	Wasteland/ Fallow	129	89	-40	-68.9	- 5.0
	Total	**759**	759			

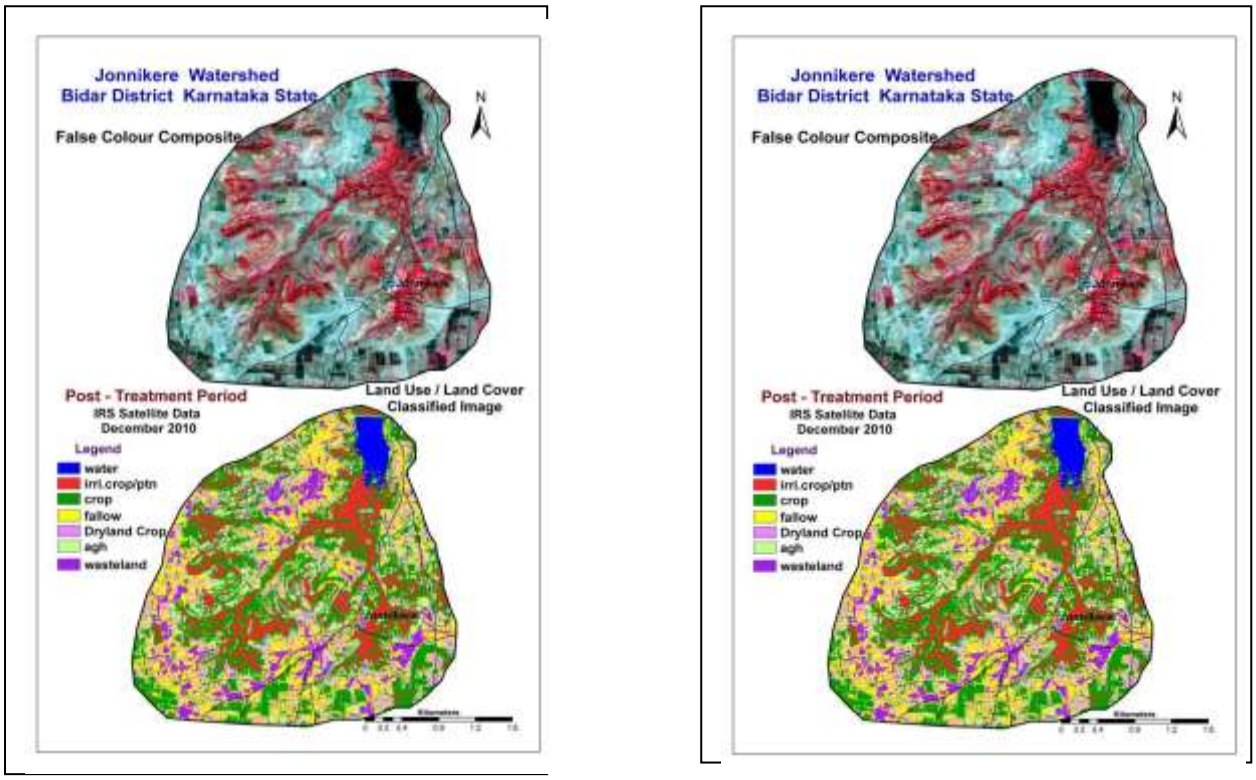


Figure 2: LU/LC map of Jonnikeri Nala Watershed Aurad Taluk, Bidar District before treatment and after treatment

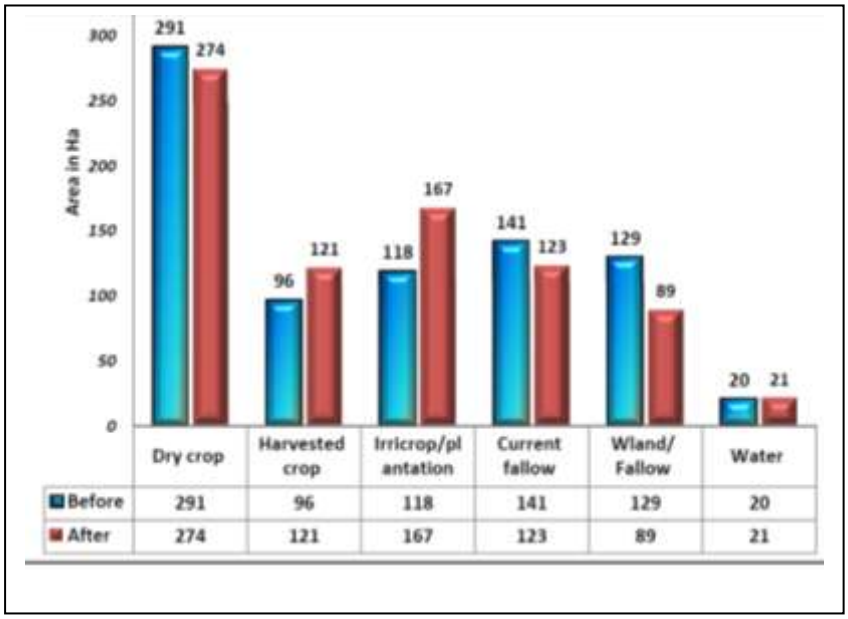


Figure 3: Spatial Extent of land use/ Cover categories

Comparative analysis of the pre and post treatment spatial statistics of land use / land cover indicates that about 5.8 % (with in category) and 2.1 %(overall watershed) of the area under dry land crop has been decreased in post project period. Whereas 26 %(with in category) and 3.15 %(overall watershed) area under harvested crop,is noticed. About 41.5 %(with in category) and 6.16%(overall watershed)area has been brought under Irrigated crop/plantation. About 68.9%(with in category) and 5% (overall watershed) area under wastelands have been reclaimed for cultivation. About 12.7 %(with in category) and 2.36 %(overall watershed) of lands which were fallow have been brought under cultivation. The spatial distribution of different land use / land cover categories and satellite images of pre and post treatment periods are given in the figures 2 &3.

The spectral response of green and healthy vegetation is characterized by a strong absorption in the red region together with a high reflection in the near Infrared (IR) region of the electromagnetic spectrum. The NDVI is highly correlated with vegetation parameters such as green leaf biomass, leaf area and is an indicator of photosynthetic activity and hence is of considerable value for vegetation discrimination and seasonal monitoring. NDVI has been used to describe vegetation discrimination and seasonal monitoring. Water, snow and clouds have negative values because they reflect more red than IR radiation. Rocks and bare soils have NDVI values around 0 since they have similar reflectance in both the bands and represent areas without any vegetation cover. Only green vegetation has positive NDVI values and high values being associated with higher densities / vigour of any given healthy phytomass. In the present study, in order to assess the biomass qualitatively, NDVI has been computed using the infrared and red bands of the satellite data as NDVI = **(IR –R) / (IR+R).** This rationing helps in removing temporally or spatially varying gain and bias factors, suppressing radiance variations arising from topographic slope and aspect and enhances radiance differences between soils and vegetation. The vegetation index in the image has been depicted as nil, low, medium and high categories.

Table 5: Spatial Extent of Vegetation index classes

SL No	Analysis	Before Treatment	After Treatment	Change(ha)	Change % Individual Class	Change% Over watershed
1.	Nil	181	162	-19	-10.5	-2.3
2.	Low	268	261	-7	-2.6	-0.9
3.	Medium	242	256	+14	+5.8	+1.8
4.	High	104	116	+12	+11.5	+1.5
	Total	795	795			

The above table indicates that there is reduction in the Nil and low categories of biomass and slight increase in the category of medium and high categories. The increase is due to biomass build up due to horticulture/ forestry activities.

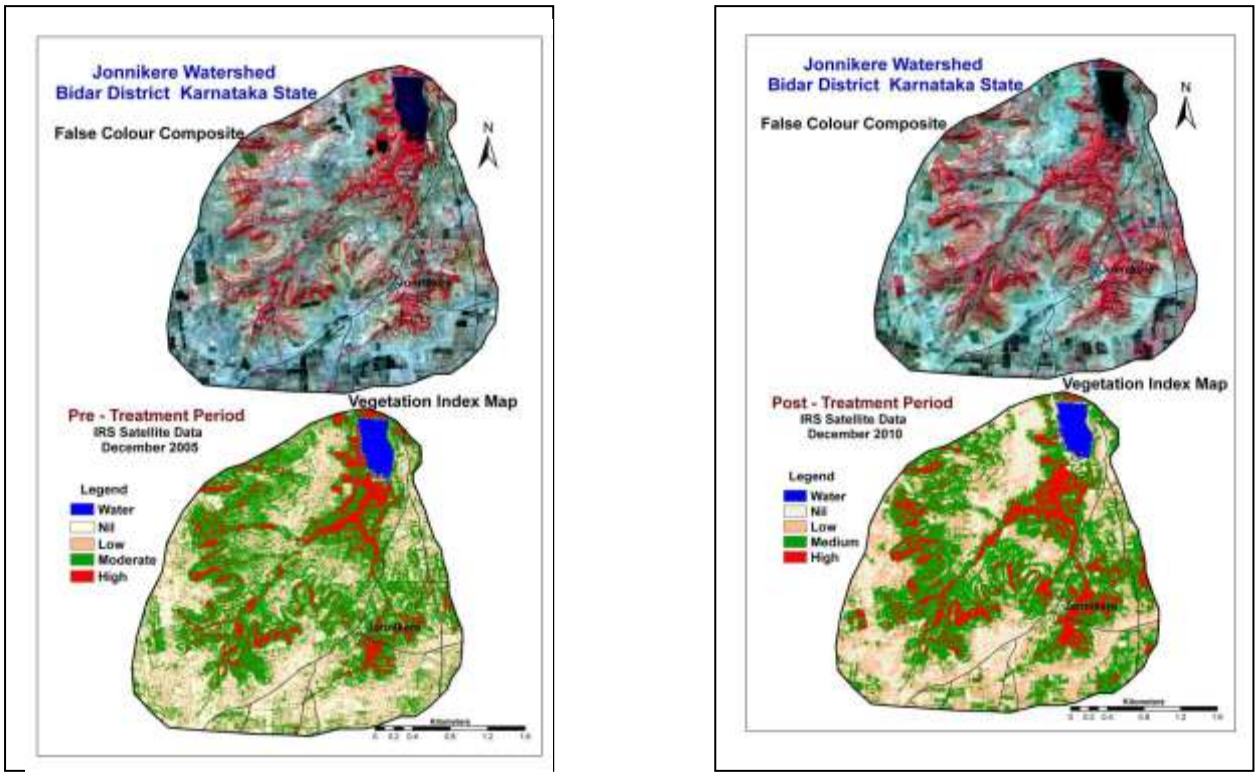
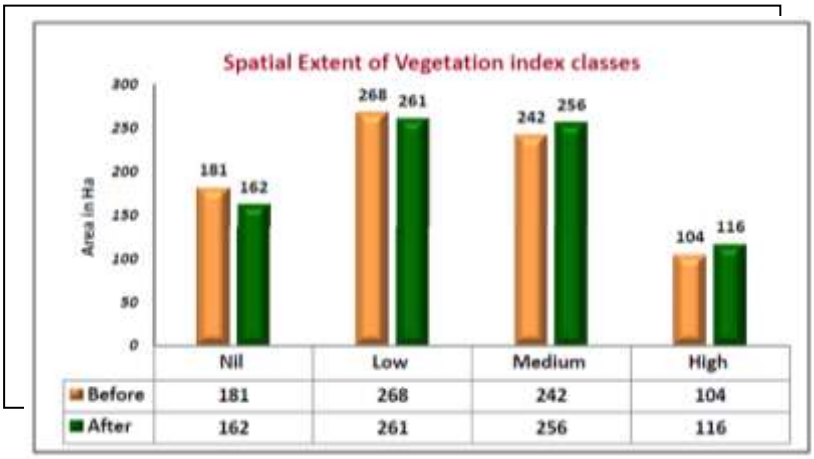


Figure 4: NDVI map of Jonnikeri Nala Watershed Aurad Taluk, Bidar District before treatment and after treatment



The interpretation indicates that, there is an increase in NDVI values for post project scenario. About 11.5 %(Individual Class) and 1.5 %(overall watershed) has shown increased NDVI in high biomass category compared to baseline. About 5.8% (Individual Class) and 1.8 %(overall watersheds) land has shown increased NDVI in medium biomass categories compared to baseline. The reduction of NDVI values in the nil and low categories was found to be about 10.5% and 2.6 % (Individual Class) and 2.3% and 0.9% (overall watershed) land respectively, is observed indicating transformation with biomass. It implies that there is an increase in vegetation densities with biomass in post project scenario compared to base line period. The increase is not that significant since most of the interventions were on the soil and moisture conservation when compared to forestry and horticulture sectors. The spatial distribution of different biomass categories and satellite images of pre and post treatment periods are given in the figures.

CONCLUSION

About 800 ha of Jonnikeri watershed area encompassing four villages has been treated under two phases viz., CBP and FIP phases by investing a total amount of Rs. 41.78 Lakhs from Jan 2002 to April 2009. At the overall level both technical as well as procedural specifications have been followed. It was also noted that not only NGO staff, but also community at large is quite well aware of these guidelines and specifications.

Fourteen Self Help Groups (SHGs) and a Village Watershed Committee (VWC) were formed successfully. The NGO – OUTREACH, Bidar, did the social engineering and facilitated the execution of work. Relatively good involvement of SHGs and VWC in the implementation of project was observed. In the land treatment, more emphasis has been given to soil and moisture conservation measures indicating sectoral approach rather than integrated approach. Household income enhancement has been recorded due to the outputs from the agriculture sector, IGA and employment opportunities. Animal husbandry has been successful in terms of increase in the number of livestock, reduced mortality and increase in the milk yield due to animal health camps and surplus fodder availability.

Effective soil and moisture conservation measures like Trench cum bunding, waste weirs, farm ponds, boulder bunds, gully plugs, etc have not only reduced the soil erosion and runoff, but improved the in situ soil moisture, ground water level and perenniality of water flow in nalas. Due to the improvement in the retention of soil moisture, cropping pattern has been changed and farmers have undertaken crops like soyabean, sunflower and Maize. Net sown cropped area has also increased while reducing the extent of fallow and wastelands. Horticulture / forestry activities are found to be limited. EDP trainings have been innovative in providing capacity in the field of food processing, computers and tailoring/embroidery.

The salient transformations observed in the watershed like Overall improvement in the agriculture sector with respect to yield, cropping Pattern and cropping intensity, Increase in the Net sown area, Reduction in the spatial extent of fallow / wastelands, Employment opportunities generated during the project period, Overall increase in the household income, Limited extent of land cover transformation & biomass increase, Gained knowledge on usage of agriculture waste, organic farming, improved package of practices, INM/IPM etc, Usage of chemical fertilizers has decreased, Livestock improvement with increase in milk yield, Surplus fodder availability in the watershed, Migration reduced, SHG's undertaking IGA- cattle and sheep rearing , tailoring/embroidery, Maintenance fund and social fencing adopted for sustainability.

The biophysical and social interventions have brought in positive changes in the watershed. Its impacts are seen on the ground as well as livelihoods. Horticulture and forestry sector interventions also should have got more emphasis to improve the overall biomass and reduce soil erosion/runoff. Considering the overall performance, the evaluation rating of Jonnikeri watershed falls into **"Moderate**" category.

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