WATER MANAGEMENT IN DEVELOPING COUNTRY: A CASE STUDY OF A WATERSHED DEVELOPMENT PROGRAM IN THE STATE OF BIHAR, INDIA

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Abstract

It has for long been assumed that low-income communities do not know their infrastructure needs, so that decisions have been made by authorities without obtaining information and understanding of household and agricultural water demand. This top-down approach has been the reason for the failure of many water management initiatives, particularly in areas of erosion and reduced soil fertility. Watershed management plays a crucial role in sustainable development along the dry northern fringe of the Indian Peninsula. Two such watershed schemes of Banka District in the state of Bihar, India – Baratanr and Heth Chanan watersheds, both located in the Chandan drainage basin – have been studied to assess the impact on the environment and society, The methodology involved field study, obtaining data on various physical and social parameters, inputs from maps and GPS data, GIS mapping and final analysis. It is found that there are increases in surface water availability, ground water level and soil moisture. Rapid soil erosion due to deforestation is controlled both by treatment and by reforestation procedures. Immediate impact is felt in agriculture productivity, with an increase of irrigated land and single cropping gradually giving way to multiple cropping patterns. The case studies show the importance of participatory approach in effective watershed management. Notable also is the innovation in standard procedures of watershed management that is based upon traditional knowledge and existing resources. Ultimately the sustainability of these projects is gradually paving the way for socio-economic development and gender equity of the otherwise deprived zone.

Keywords

Water Management, Watershed, Soil Erosion, Sustainability.

1. Introduction

It has for long been assumed that low-income communities do not know their infrastructure needs, so that decisions have been made by authorities without obtaining information and understanding of household and agricultural water demand. This top-down approach has been the reason for the failure of many water management initiatives, particularly in areas of erosion and reduced soil fertility because the lack of trust and cooperation from the villagers, often reinforced by the lack of commitment of NGOs and government organizations involved. The project is described in its design, its inner cohesion and its implementation and its style of communication with the villagers as well as the participation of the villagers in the project implementation.

The case study shows the importance of a participatory approach in effective watershed management in two areas of the Chandan river basin, in Banka District in Bihar, India – *Heth Chanan* and *Baratanr* Watersheds. Notable also is the innovation in standard procedures of watershed management that is based upon traditional knowledge and existing resources. Ultimately the sustainability of these projects is gradually paving the way for socio-economic development and gender equity of the otherwise deprived zone. Watershed management plays a crucial role in sustainable development along the dry northern fringe of the Indian Peninsula.

2 .The study areas

Banka is one of the thirty-eight districts of Bihar in India, and occupies an area of 3018 km The district, part of Bhagalpur Division, has a population of 1,608,773 (as of 2001) and has been ranked 3rd. least developed district in India after Kalahandi and Raygadha(Orissa). The average population density is 533 persons /km^2 . The literacy rate is only 43.40%.

The district has two geomorphic divisions- alluvial plains in the north, and hills and pediments in the south. The terrain of the study areas (Heth Chanan and Baratanr water sheds) is a Pre Cambrian rocky area, having fissured formations of granite, gneiss, amphibiolite, quartzite and mica-schists. Four geomorphological surfaces were noted in the study areas, namely:

1. The recent floodplain of the Chandan, having yellow-brown compact clay.
2. The flat alluvial surface overlying the recent floodplain, having water bodies in patches, and having brownish, silt- clay soils.

3. The older alluvial upland having deeply oxidized red clay with ferruginous concretions.
4. The rocky pediplain surfaces developed on the granite gneisses.

Both Heth Chanan and Baratanr lie in the southern zone and is drained by the Chandan river. The ridge line of Heth Chanan and Baratanr Watersheds coincides with the Siljori village road. The drainage line of Heth Chanan meets the Chhatimi Jore-Chandan river , while that of Baratanr meets with the Siljori Jore- Chandan river, the Chandan ultimately confluencing with the Ganga river in the north.

The soil is largely coarse grained, ferruginous, acidic, low in nitrogen and rich in potash (CGWB, 2007). Since groundwater in the Pre Cambrian formations are primarily controlled by zones of structural weaknesses, ground water in the two water shed areas occur in unconfined conditions, and contribute about 5 % to irrigation. The average rainfall being just over 1100 mm. per annum with a summer monsoon concentration therefore has tremendous potential of being trapped for agricultural and other uses. There is ample rainfall in this area, but because of the slope of the land the rainfall is not retained. Due to the differences in elevation the rainwater flows down gully formations. As a result this is a drought prone area.

2.1 Organizational context

National Bank for Agriculture and Development (NABARD):

NABARD is an apex institution handling matters concerning policy, planning and operations in the field of credit for agriculture and for other economic and developmental activities in rural areas. Essentially, it is a refinancing agency for financial institutions offering production credit and investment credit for promoting agriculture and developmental activities in rural areas. (www.nabard.org).

Indian Rural Association (IRA):

A non governmental organization (NGO), IRA is a Voluntary consortium of grass root groups to initiate, support & strengthen the community groups in their efforts to solve the macro & micro level problems through community evolvement, community intended & community propelled actions. IRA was established in March 1995 by a group of Social Scientists, Engineers & Social Workers to understand & support the development dynamics of the rural areas. IRA was selected by NABARD to enhance the status of the rural poor by focusing on rain-fed agriculture through skill building among the rural communities, and through development of self help groups (SHG) for employment generation.

This NGO has ten employees in the study areas: the work involves drainage line development, i.e. where to locate the bands and check dams, development of degraded land by means of reforestation, livelihood development, demonstration and training programs for farmers, area development and women's development. There are two supervisors, one for the technical aspects and one for the social aspects.

3.0 Methodology

The two watershed schemes of Banka District – Baratanr and Heth Chanan watersheds, both located in the Chandan drainage basin – have been studied to assess the impact of watershed management on the environment and society, The methodology involved field study, obtaining data on various physical and social parameters, inputs from maps and GPS data, GIS mapping and final analysis. Interviews were conducted with NABARD official, IRA representatives, and local people to obtain feedback about the development strategies branching out from effective watershed management schemes.

4.0 Scientific and technical aspects

Preliminary studies revealed that there was a lack of any previous soil and water conservation work to prevent gully erosion and enhance agricultural productivity. The study of topographical maps aided in deciding that contour bunding, water harvesting structures and afforestation would be the primary corrective measures for the soil conservation. Since soils of arable land range from sandy loam to silty clay, there was also the need for different soil and water conservation methods supporting the nature of land use. Hence, area treatment was done in the following phases:

- A total of 42291 cu. m.of Field Bunding in Heth Chanan and 37455 cu.m in Baratanr with a cross section of 0.60 sq. m. for checking soil erosion and loss of fertile top soil; grass seeding (Stylo Grass) on bunds to strengthen and stabilize the slopes. This drought –resistant grass is also used as fodder.

- Water Absorption Trenches/Cattle Protection Trenches with a cross section of 1 sq. m. both for checking soil erosion and preventing grazing of horticulture and plantation fields;

- Continuous Contour trenches of 800 m. per hectare in Heth Chanan, and 600 m. per hectare in Baratanr
- Stone outlet to allow escape of excess surface flow;
- Earthen Gully Plugs to reduce velocity of runoff, increase percolation within the gully, and facilitate recharge of wells on the downstream side. Prevention of breaching of this embankment by Rough Stone Pitching.
- Earthen and Concrete Check dams.
- Reforestation through mango plantations and Acacia trees

Figure 1: Land Treatment in Baratanr Watershed

Figure 2: Farm Bunding 47.30 ha. in Baratanr

In the field farm bunding is applied to retain the water. Other parts of the fields are planted with trees, teak, mango trees, Acacia trees which retain water. A cascade of check dams has been built to retain the water and prevent its rushing down. From each check dam there is an outlet lowering the water to flow to a somewhat lower area, where it is stopped by the next check dam, which also has an outlet to the next one. This system covers a height difference of 30 m in total and this system ends up in providing rice fields, freshwater. Barren wasteland is by these interventions turned into fruitful agricultural land increasing their by the agriculture area and food production. In addition erosion is controlled.

Actually the combination of farm bunding and water ponds represents old traditional technology which has been relinquished after the introduction of the tube wells, producing bacteria free water. The paradox is that these tube wells nowadays cause unexpected problems themselves, problems like arsenic, fluoride and nitrate contamination of drinking water and low levels of groundwater if the water is also used for irrigation (Ghosh, et al.).Use of check dams and scientific design of the watershed scheme form the modern inputs. Sophisticated engineering calculations and traditional technologies merge into this system of water retention and management. Increase in soil moisture is calculated on the basis of the difference between ground water before and after the intervention. For the last two years, due to deficient monsoon rains the entire region has been declared as a drought prone area. However, Heth Chanan and Baratanr watershed management schemes have permitted adequate water to the villages located within their ambit. Check dams and bunding have guaranteed that the wells and tanks are fully functional. Percolating water from these structures has raised the groundwater level and also the soil moisture.

5.0 Social aspects

In rural India, the main obstacle to development strategies is lack of inter-sectoral coordination and absence of public participation. The existence of most of the area's population below poverty level further retarded their receptiveness to such innovative programs It took IRA two years to gain the trust of the village communities in Heth Chanan and Baratanr. Initially, the workers started to live with the villagers, shared their food and drinks .On such occasions the problems and priorities of the villagers would be discussed freely. Not many farmers joined them, but those who did, were helped forward by building the first check dams and bandings in the area to contain the water. The success of such initiative spurred the others to join hands with IRA. With time, the confidence of the villagers was won over by the IRA, and they went to each Tola and formed a Tola committee. Each household is represented in such a Tola committee. All these Tola committees were represented in the Village Watershed Community. The disadvantages of the existing situation were discussed and villagers were motivated to understand that without their participation and without their input development would not be possible. Watershed Committees were formed for each village and publicity about the watershed program was initiated through group meetings, village awareness camps and voluntary labour schemes (Shramdaan). Village representatives, with adequate women members, were taken to nearby functional watershed schemes under the guidance of NABARD officials and IRA members. Such exposure visits increased the awareness and benefits of this development initiative. IRA then distributed the plan of action for the villages to analyze and judge. On a small scale they started activities. The demands and preferences of the Tola members were also taken into account. Some Tola's had the problem of fallow land, others had problems of their lands being affected by the construction of bunds. They sat together to discuss the problems to find solutions. In this way priorities were established and procedures adjusted if it was technically viable. IRA workers generally works for five years on one program and then they hand it over to the community and repeat the procedure further downstream till the entire river basin is covered.

This was followed by the Capacity Building Phase in which community mobilization and people's participation was ensured. Watershed committees held regular meetings not only to discuss and decide upon future course of action, but also to arrange for regular visits by government officials and for interactions with other development agencies. The outcome of this integration was an increased agricultural productivity through increase in cropping intensity and expansion of arable land due to greater water availability. This has permitted villagers to diversify to other employment generating activities with the help of loans and subsidies from government banks. Presently, there are nine Self Help Groups in Heth Chanan and seven in Baratanr, comprising mainly of women population, which even promotes inter-lending among villagers.

5.1 Employment generation for marginal and landless farmers

The social part primarily targets at the development of the marginal and landless farmers. 1272 are landless on a total population of 3000 in both the watershed areas. Another category of people are farmers who have insufficient land for their families. Previously, these persons migrated in search of employment after harvesting period. With the implementation of the watershed scheme, agricultural extensions now permits double and triple cropping within the plots, thereby guaranteeing longer employment durations to such under privileged farmers. Although, the different watershed structures are owned by the landlords, their construction and maintenance allow further employment opportunities to the landless persons. This has fulfilled one of the objectives of the social part of the program, which is to prevent this necessity of out-migration.

5.2 Production of Vermicompost

In order to obtain their objectives the NGO, IRA, started mixing with the community. In assessing their opportunities they discovered that farmers had a lot of cattle, the cow dung of which could be used for vermicomposting, a process in which cow dung and other biological waste is put together, fermented and dried. It is utilized as organic fertilizer in agriculture. The NGO has arranged for opportunities to market this compost. This provides the individual farmers with new opportunities of income generation. Other NGOs working in the neighboring areas also buy this cheap organic fertilizer thereby creating a new sustainable market for this indigenous product.

Figure 3: Vermicomposting Unit, Heth Chanan

5.3 Weaving industry and the solar lamp project

In rural societies of Bihar, there are certain population groups who refrain from employment, either because of caste rankings, ego problems or because they are women who do not venture out of their homes. For such potential workforce, IRA workers in collaboration with public sector banks, arranged for loans for installation of hand looms inside the houses. These have particularly enabled the women to produce textiles that are now being marketed in village fairs and weekly markets. Alternate arrangements are made for other women to work on looms installed elsewhere in the village, so as to increase their income generation capacities. The handloom cottage industry therefore permits the women to work within the safe confines of their homes, and at the same time meet their family obligations. Each loom can yield up to seven meters of cloth within one and a half days. The production costs of 1 m cloth is 29 rupees for fiber, 25 rupees labor costs, 10 rupees supervisor costs and rent. Interactions with the Cottage Industry of the Government of India to further the marketing strategy of the cloths produced are under way, with proper branding of the textiles produced thus. Alongside, women also produce agro products like “Poppadums” (Wafers), and incense sticks.

Figure 4: Pit Loom in Siljori Village under Women's Development Program Unit, Heth Chanan

The problem of lack of electricity in these remote villages have been sought to be remediated by the introduction of solar lamps. Apart from providing cheap energy to the village, these lamps allow women to work on the power looms in the evening. The solar system and the powering station as a whole are very simple in setup and operation. If the lamp is charged for 12 hours it can be used for one whole day. The price of those lamps is Rs. 3600. The householder is granted a subsidy of Rs. 360 by NABARD and a loan (micro credit) of Rs. 3000 from other financial institutions. The lamps are produced by a company in Delhi and have a simple and efficient design. The photo voltaic cells' charging center is community-based and maintained by village women. A single battery charge costs Rs. 2. The recharging station can handle 33 lamps at a time and the financial records are carefully maintained. The collection of money creates income for the women supervising the charging station and creates additional investment opportunities.

Figure 5: Solar Energy Panels in Siljori Village

Figure 6: Community -based Photovoltaic cell Charging Unit

Initially a problem arose when some persons postponed their charging rhythm by one or more days in order to spare money. This posed a serious challenge to the sustainable functioning of the Charging Center. Thereupon, IRA workers explained that if the women postponed their sleeping hours by 2 hours in the evening, they would have two extra hours for producing 2 meters of extra cloth. This would end in producing more income and the expenditure incurred in charging the solar cells, i.e. with an investment of only Rs.2 each person would gain Rs. 50 per day. Additionally, the children would get two hours of extra study time by the solar lamp. This motivation has led to full participation among the women members in availing the battery charging facility in 86 villages of the two watersheds.

Employment generation among women in the field of cottage industry and of solar lamp maintenance and charging units were initially met with stiff resistance from the male members of the community. However, once the prospect of enhanced family income was made clear, women were allowed to venture out of their traditional roles of housewives.

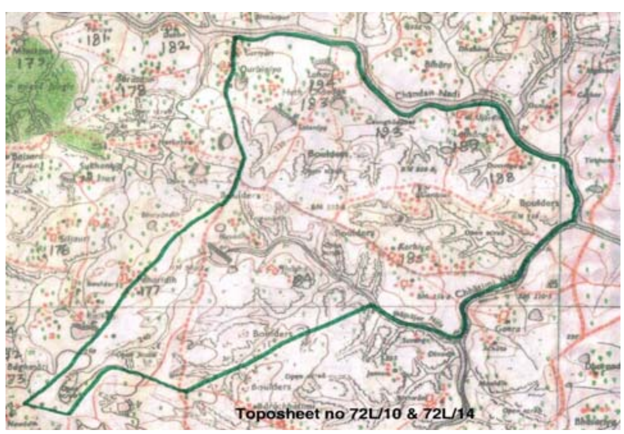

Figure 7: Topo Sheet of Heth Chanan Watershed

Table 1: Heth Chanan Watershed

Name of the Watershed	Heth Chanan Watershed
Village Covered	Heth Chanan, Jhajha, Korhia, Domohan, Gokula, Dumaria, Lathane, Ghonghdabar, Lohari, Siljori (P) & Pahridih (P)
Panchayat Covered	Koria & Siljori
Block	Chanan
District	Banka
Latitude	24’ 35” to 24’ 40” N
Longitude	86’ 40” to 86’ 45” E
Major Drainage system of which Watershed is a part	Chanan River
Length	5000 mt.
Breadth	3000 mt.
Identification code of the Watershed	Heth Chanan Watershed
Highest Elevation in the Watershed	250 mt.
Lowest Elevation in the Watershed	220 mt.
Height difference	30 mt.

Table 2: Details of Heth Chanan Watershed Area

S.No	Description	Area (Ha.)
A	PUBLIC LAND	
1	Government Forest	306.54
2	Revenue Land	4.48
3	Panchayat Land	3.14
4	Gothan (Land occupied by household)	6.13
5	Submergence area due to tank / Pond	0.00
	Sub – Total (A)	320.29
B	PRIVATE LAND	
1	Seasonally irrigated	22.42
2	Perennially irrigated	17.19
3	Rainfed	535.92
4	Fallow (Culturable Waste)	340.60
5	Unculturable Waste	203.40
6	Area not available for treatment	3.68
	Sub – Total (B)	1018.64
	Total (A+B)	1338.93
	Treatable Area	1019.44
1	Average Annual Rainfall of the area	1259.37

Figure 8: Topo Sheet of Baratanr Watershed

Table 3: Baratanr Watershed

Name of the Watershed	Baratanr Watershed
Village Covered	Siljori (P), Pahridih, Baratanr, Manikpur, Parsia(P),Dubba (P), Kasoi (P), Baghamarim (P), Biahi (P), Heth Chanan(P), & Jhajha (P)
Panchayat Covered	Gouripur & Siljori
Block	Chanan
District	Banka
Latitude	24’ 35” to 24’ 40” N
Longitude	86’ 40” to 86’ 45” E
Major Drainage system of which Watershed is a part	Chanan River
Length	6600 mt.
Breadth	3330 mt.
Identification code of the Watershed	Baratanr Watershed
Highest Elevation in the Watershed	250 mt.
Lowest Elevation in the Watershed	220 mt.
Height difference	30 mt.

Table 4: Details of Baratanr Watershed Area

S.No	Description	Area (Ha.)
A	PUBLIC LAND	
1	Government Forest	155.07
2	Revenue Land	3.23
3	Panchayat Land	4.32
4	Gothan (Land occupied by household)	2.55
5	Submergence area due to tank / Pond	6.94
	Sub – Total (A)	172.11
B	PRIVATE LAND	
1	Seasonally irrigated	19.50
2	Perennially irrigated	13.15
3	Rainfed	559.78
4	Fallow (Culturable Waste)	277.14
5	Unculturable Waste	118.78
6	Area not available for treatment	0.00
	Sub – Total (B)	988.35
	Total (A+B)	1160.46
	Treatable Area	988.35
1	Average Annual Rainfall of the area	1259.37

6.0 Conclusion

This Watershed Development program initiated by IRA under the aegis of NABARD and other public sector banks, and implemented and developed by the village community exemplifies the success of the “Bottom-up” development strategy that is generally ignored by the stakeholders of water quality and quantity issues. Heth Chanan and Baratanr watershed schemes comprise of a series of networked water management, economic and social projects against the backdrop of a hostile terrain and an impoverished rural community. With inter-sectoral and public-private participation linkages, the projects have successfully integrated traditional knowledge with modern scientific and technical concepts to obtain a holistic, sustainable development strategy.

The sustainable impacts of Heth Chanan and Baratanr Watershed Programs may therefore be summarized as hereunder:-

- Prevention of water erosion.
- Conservation of rainwater under natural conditions.
- Increase in Soil Moisture content.
- Conversion of single cropped land to multi cropping system.
- Crop diversification.
- Change in cropping patterns- more intense cultivation of rice, millet, corn and sugarcane.
- Reduction in speed of surface runoff, soil erosion, siltation in low lying & increase in ground and surface water level s as a direct impact of area treatment .
- Increase of irrigated area by over 50% due to development of existing Water Harvesting Structures and drainage line treatment.
- Agricultural diversity and surplus leading to diverse economic activities, with a greater role for women entrepreneurs in textile looms and other cottage industries.
- Gender emancipation
- Sustainable use of Solar powered energy in all sectors- agriculture cottage industry, school education.
- Check on out -migration by 85%.
- Total community participation ranging from agricultural activities to marketing the cottage industry products and linking the marketing strategy with the state and national organizations.

7.0 References

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