Vol. 42, No. 3, pp 322-327 , 2014
Indian Journal of Soil Conservation
Online URL:http://indianjournals.com/ijor.aspx?target=ijor:ijsc&type=home

How much is a watershed worth? An assessment

Biswajit Mondal[1] and S.K. Nalatwadmath[2]

[1]Central Rice Research Institute, Cuttack-753006, Odisha; [2]Central Soil and Water Conservation Research and Training Institute, Research Centre, Bellary-583104, Karnataka.
[1]E-mail: bisumondal@rediffmail.com

ARTICLE INFO

Article history :
Received : March, 2013
Revised : April, 2014
Accepted : August, 2014

Key words :
Direct benefit,
Employment,
Indirect benefit,
Watershed

ABSTRACT

India accords high priority to watershed programmes as a strategy for integrated rural development in drought-prone areas. Watershed development programmes are public funded and thus, valuation of different kinds of indirect benefits to the individual/society in addition to the direct visible benefits are important to support public policies on watershed programmes. The present study attempted to assess various kinds of indirect benefits associated with a watershed project along with visible direct benefits in terms of incremental returns from agriculture. The results showed that due to shift in cropping pattern and enhancement of productivity levels, net returns from agriculture and horticulture increased by around ₹7.43 lakh yr^{-1}. Whereas, values of various recurring indirect benefits were estimated at ₹ 9.80 lakh yr^{-1} and single period benefits due to employment creation and changes in asset value was ₹ 30.01 lakh, which demonstrated that indirect benefits out of natural resource conservation activities are much higher than the direct benefits from the watershed.

1. INTRODUCTION

The recent spurt in watershed development programmes (WDPs) is a policy response to the increasing environmental crisis and non-sustainability of agriculture especially in the future growth regions largely consisting of rainfed areas. The WDPs have traversed through a long way from the scattered measures for soil and water conservation, undertaken mainly as relief works on *ad-hoc* basis, to its present status of a well-conceived integrated approach for enhancing productivity and livelihood security. India has invested significantly on watershed based development strategy especially in rainfed regions. A total of 56.54 m ha of land has been treated (upto March, 2007) through different schemes with an investment of ₹19,471 crore (Sharda *et al*., 2008).

Most watershed projects are being implemented with the twin objectives of natural resource conservation and enhancing livelihoods of rural poor through enhancement of production levels (Sharma and Scott, 2005) along with rehabilitation of degraded lands and restoration/ development of green cover/biomass in the watersheds. Various evaluation studies carried out at different watersheds located in different agro-climatic conditions showed that WDPs have been the key technological interventions to increase agricultural productivity and income as well as for conservation of natural resources (Deshpande and Narayanmoorthy, 1999; Reddy, 2000; Shah, 2001; Kerr *et al.*, 2002 and Mondal, 2011). An overwhelming majority of the studies have endorsed the programme in terms of costs and benefits and few of them also highlighted the less quantifiable ecological benefits (Chopra *et al*., 1990; Deshpande and Reddy, 1991 and Singh, 1994). These studies not only vindicated the economic viability of the programme but also underlined the fact that it is the only alternative to the development of rainfed agriculture in India. Chopra and Kadekodi (1993) proved that WDPs score over other initiatives like Integrated Rural Development Programme (IRDP), Jawahar Rojgar Yojana (JRY), National Rural Employment Programme (NREP) in terms of employment generation and natural capital regeneration in moderately degraded regions. While direct economic benefits of WDPs are measured in money value, many of the indirect benefits are still remained un-accounted by the researchers. Hence, the present study aimed to assess various indirect benefits associated with watershed development programmes along with the direct benefits of productivity enhancement in agriculture.

2. MATERIALS AND METHODS

Study Domain and Data

A watershed (Joladarasi) located in Bellary, which is one of the major drought-prone district of Northern Karnataka was selected purposively for the study. Among the different districts of northern dry zone, Bellary has lower rainfall average varying from 500 to 620 mm. Yield of crops in general in this region are low and is attributed to low rainfall with its ill distribution, lack of adoption of conservation measures and cultivation of traditional cultivars with lower application of nutrients (Patil *et al*., 2012). The situation offered a better opportunity to develop the region through watershed programmes for conservation of natural resources, improving productivity and enhancing livelihoods in the region. The watershed was developed as an Operational Research Project (ORP) by the Central Soil and Water Conservation Research and Training Institute, Research Centre, Bellary during 1983-84 to 1987-88. The watershed with a total area of 569.5 ha was treated with different soil and water conservation measures (Table 1) based on the needs and priorities of the area and technical feasibility.

Data on various bio-physical characteristics of the watershed as well as input-output time series data on farming activities collected by the Research Centre for the period of 1983-84 to 1994-95 were used in this study.

Analytical Tools

There are a large numbers of theoretical techniques that have been used in earlier studies (Chopra and Kadekodi, 1997; Constanza *et al*., 1997 and Verma, 2000) which are applied to estimate the benefits of conservation at macro level and their application at micro scale is albeit limited.

Table: 1
Watershed-based interventions undertaken in Joladarasi watershed

Sl. No.	Name of interventions	Unit	Quantity
1.	Bunding	ha	500
2.	Stone checks	Number	270
3.	Diversion drain	Meter	1500
4.	Land smoothening	ha	250
5.	Graded border strips	ha	1
6.	Construction of farm ponds	Number	13
7.	Planting on graded *bunds*	No. of plants	40,000
8.	Avenue plantation	ha	1.8
9.	Plantation in non-arable land	ha	10
10.	Barbed wire fencing	Meter	1425

Moreover, due to overlapping of various values, it becomes sometimes difficult to demarcate one from another at micro-scale. However, following mix of tools and techniques have been used to assess various direct as well as indirect benefits of conservation activities undertaken in Joladarasi watershed.

Direct Benefits

Changes in land use, cropped area and cropping intensity and productivity of crops over pre-project period were adopted from Nalatwadmath *et al*. (1997) and ORP reports. Productivity levels of each crop under different land usages were then converted into sorghum grain equivalent (SGE) for easy comparison over pre-project period. Net returns from crop cultivation were estimated by considering the input-output price prevailed during the year 2007-08.

Indirect Benefits

Time saved due to fuel-fodder availability - Benefits of additional fodder and fuel wood production

Additional fodder and fuel wood available from agricultural field and *civil soyam* land which used to be collected earlier from forest area were estimated and number of trips required to collect these much quantity of fodder from forest were calculated assuming an average head-load of 0.4 q ha^{-1}. Based on the farmer's responses, average time requirement for a single visit was considered as one hour and number of man days thus saved from visiting the forest to collect fodder and fuel wood were calculated and valued @ ₹ 25 $manday^{-1}$ (prevailing wage rate was ₹ 50 $manday^{-1}$, which was further reduced to 50% due to less employment opportunities).

Improved wellbeing - Benefits from enhanced employment

Additional regular employment for cropping during post-project period over pre-project situation was estimated and valued at prevailing wage rate (@ ₹ 50 $manday^{-1}$). Temporary employment created for different components of the programme *viz.,* soil and water conservation works, plantation activities, *etc.* were also estimated and valued at prevailing wage rate.

Improved status - Incremental rental value of land

Imputed land rent for additional rainfed (@ ₹ 2500 ha^{-1}) and irrigated (@ ₹ 5000 ha^{-1}) area were estimated.

Value of asset developed

One of the indirect benefits of watershed development programme captured through increased land value which was based on farmer's (from control areas) responses on the question as to how much they would pay if they want to buy the land within watershed area and vice-versa. Difference in value of other farm assets including livestock were

estimated based on actual possession and weighed by the land area. These were estimated over outside the watershed instead of pre-project situation to reduce the price effects and effect of other kind of programmes/schemes.

Improved soil status - Benefits from livestock rearing

Additional manures available from dung/droppings of livestock during pre and post-project situation were estimated on fresh weight basis (ICAR, 1997) and valued.

Benefits due to reduction in out-migration

Potential workforce which may out-migrate during the lean season were calculated by subtracting the number of persons who migrate each year and persons (belonging to large and medium category family) who do not migrate from the total workforce. Out-migration checked was calculated by taking the difference of potential out-migration between two periods. Considering the average expenditure of ₹1000 month^{-1} for five months (December to April) which otherwise could have been saved (wage rate in farming activities and off-farm works (un-skilled) in towns are similar in this region) the total saving due to out-migration check were estimated.

Benefits due to reduction in tank siltation

Total soil conserved due to reduction in soil loss from agricultural field (treated area which forms catchment of ponds located at the watershed) during pre- and post-project period were estimated.

3. RESULTS AND DISCUSSION

Estimation of Direct Benefits of the Watershed Progarmme

Due to imposition of different soil and water conservation treatments there has been a phenomenal change in land use, cropping pattern, production, etc. The area under permanent fallow decreased from 35.13 to 3.27 ha which led to an increase in cultivated area by about 5% (Table 2). The rainfed area was 507.65 ha before project implementation; with imposition of watershed treatment it increased to 534.59 ha. The irrigated area also observed to be increased by about 233% due to creation of additional water resources potential through farm pond and augmentation of ground water recharge. During implementation of the programme 10 ha of wasteland was also brought under plantation.

During pre-project period, cereals dominated the rainfed cropping pattern with coverage of nearly 54% of gross cropped area. During post-project period, the area under cereals reduced both in absolute and relative terms occupying only 32% of gross cropped area. This increased area was put under pulses and oilseeds. For better utilization

Table: 2
Changes in land use, cropping pattern and cropping intensity

Particulars	Pre-project (1982-83)	Post-project (1994-95)
Cultivated land (rainfed) (ha)	507.65	534.59
Fallow land (ha)	35.13	3.27
Irrigated land (ha)	2.12	7.06
Non-arable land (ha)	25.10	25.10
Area under different crops (ha)		
Cereals	277.24 (54.39)	173.38 (31.98)
Pulses	-	35.04 (6.46)
Oilseeds	230.53 (45.22)	326.49 (60.22)
Vegetables	0.40 (0.08)	1.66 (0.31)
Other crops	1.60 (0.31)	5.60 (1.03)
Gross cropped area (ha)	509.77 (100)	542.17 (100)
Cropping intensity (%)	93.55	99.50

Figures in parentheses indicate per cent of gross cropped area

of black soils, which are usually left fallow during the *kharif* season, a new system of double cropping with sunflower in early *kharif* followed by bengalgram in *rabi* had been introduced. This enabled optimum utilization of residual moisture, which resulted in increased cropping intensity from 94% (pre-project) to 100% during post project years.

Table 3 presents the changes in crop productivity in terms of sorghum grain equivalent (SGE) during post-project period. The results indicated that the average productivity of the watershed increased by 676 kg ha^{-1} over pre-project period. By considering the input-output prices prevailed during 2007-08, net return from crop enterprises in whole watershed were calculated as ₹ 7.29 lakh during pre-project period and ₹ 14.33 lakh during post-project period, *i.e.* an increase of 97% was observed.

Ber (*Zizyphus mauritiana* var. Gola) was introduced in 0.8 ha area as an alternate land use and it was observed that average fruit yield of 6063 kg ha^{-1} and net return of ₹ 0.39 lakh ha^{-1} realized year^{-1} (Nalatwadmath *et al*., 1997).

Estimation of Indirect Benefits of the Watershed Programme

Benefits accrued due to additional fodder and fuel wood production

Due to shift in cropping pattern and increase in productivity, additional quantity of fodder (hay/straw/by-products of jowar, bajra, groundnut, *etc.)* to the extent of 4485 q yr^{-1} was produced from agricultural and *civil soyam* land. This saved time in collecting the fodder from forest land. Monetary value of time saved worked out to be ₹ 0.35 lakh. Similarly, 1194 q yr^{-1} additional fuel material (by-

Table: 3
Enhancement of productivity and net returns from major crops

Particulars	Pre-project	Post project	Additional	Percent increase
Productivity (SGE in kg ha^{-1})	694	1370	676	97.41
Net returns (₹ in lakh)	7.29	14.33	7.04	96.57

products of redgram, sunflower, *etc.* and twigs/branches from *bund* plantation) produced from agricultural and *civil soyam* land was available resulting in time saving worth ₹ 0.09 lakh yr^{-1}.

Increased employment opportunities at the watershed

Soil conservation works in arable and non-arable land as a part of watershed development programme were executed by manual labour. A total of 37701 mandays' employment worth ₹ 18.85 lakhs under different soil conservation works and 7502 mandays of employment worth ₹ 3.75 lakhs under plantation activities were generated during the implementation period.

Further, introduction of watershed technologies increased the cropping intensity, production levels and shift in the farming activities, which in turn increased the labour absorption per ha of cultivated area from 37 to 54 mandays yr^{-1}, *i.e.* an increase of 45% over pre-project period (Mishra and Mondal, 2008). Additional 17 mandays ha^{-1} amounting to 9217 mandays for the whole watershed was generated whose worth was nearly ₹ 4.61 lakh at the prevailing wage rate every year.

Incremental rental value of land

About 5.74 ha area came under irrigation owing to increased availability of water from farm ponds constructed and augmentation of groundwater recharge. An additional 26.66 ha area, which remained fallow during pre-project period, was also brought under cultivation through soil and water conservation works. Imputed land rent for both the category of land were calculated which was equal to ₹ 0.96 lakh yr^{-1} (Table 4).

Table: 4
Imputed rent (₹ in lakh) for additional cultivated land

Particulars	Pre-project	Post-project	Additional	Imputed land rent
Rainfed land	507.65	534.31	26.66	0.67
Irrigated land	2.12	7.86	5.74	0.29
Total				0.96

Value of asset developed

One of the indirect benefit of watershed development programme was captured through increased land value and it was observed that the value of per ha rainfed land was higher by ₹ 1125 inside watershed over outside watershed area (Table 5). This difference might be due to increase in availability of more *in-situ* moisture and increased soil fertility due to *bunding* and other conservation measures. Rates of irrigated land were at par in both the areas, hence, not considered in the calculation.

Shifting in cropping pattern, irrigation status and production level also led to higher possession of farm assets holding (tools, implements, machinery, irrigation and transport equipments, *etc.*) worth ₹ 1.44 lakh (Table 5) which can also be attributed as the effect of watershed development programme. Additional value of livestock to the extent of ₹ 0.96 lakh over outside watershed was taken as a proxy for the improved status of livestock due to increased fodder availability and biomass development due to watershed progarmme.

Benefits from livestock enterprises

Livestock makes an important contribution to the survival of economically weaker sections especially in ecologically fragile areas of semi-arid watersheds (India Task Force, 1987); small ruminants in particular play an important role in ensuring rural livelihoods against drought related shocks (Pasha, 2000). Even if the importance of small ruminants to safeguard against drought is ignored, the value of manure available from dung/droppings is not in-significant. Results in this study indicated that there was no increase in total livestock population, but there was a change in composition. An additional 37.60 t yr^{-1} dung from

Table: 5
Difference in asset value in watershed and outside watershed area

Assets	Value ha^{-1} cultivated area (₹)			Value for whole watershed (₹ in lakh)
	Watershed (32)	Outside watershed (30)	Difference	
Land value	50990	49865	1125	6.01
Value of farm assets	1719	1453	266	1.44
Value of livestock	1508	1331	177	0.96
			Total	8.41

Table: 6
Changes in livestock composition and additional manures generated

Animal Species	Dung/droppings produced (kg animal^{-1} day^{-1})	Animal number		Total quantity of dung/droppings produced (t yr^{-1})	
		Pre-project	Post-project	Pre-project	Post-project
Cow	12	82	79	359.16	346.02
Buffalo	20	85	89	620.50	649.70
Bullock	15	168	153	919.80	837.68
Calves/young stocks	5	110	153	200.75	279.23
Sheep/goat	3	13	36	14.24	39.42
Poultry	0.25	21	77	1.92	7.03

cattle/buffalo as well as sheep/goat and 5.11 t yr^{-1} droppings from poultry was produced which was worth ₹ 0.24 lakh (Table 6).

Benefits due to reduction in out-migration

As mentioned in the earlier sections, additional on-site and on-farm employment opportunities was generated due to WDP, which might reduce the out-migration of local population in search of employment who in turn were employed locally. Considering similar wages for rural and urban works (Singh, 2012) an amount of ₹ 2.95 lakh yr^{-1} was saved by not migrating to cities (Table 7).

Table: 7
Benefits of out-migration reduction due to watershed development programme

Particulars	Pre-project	Post-project
Total workforce	447	611
Number of persons migrates each year (seasonal migration)	45	31
Persons from large and medium category family who do not migrate	192	311
Potential workforce which may out-migrate	210	269
Out-migration checked (number of migrants)		59
Average expenditure during the period of migration (₹)		5000
Money saved due to migration check (₹ in lakh)		2.95

Benefits due to reduction in tank siltation

Expenditure saved due to reduction in de-siltation requirements assuming ₹ 50 t^{-1} (prevailing market rate) was estimated and the value was observed to be ₹ 0.60 lakh yr^{-1} (Table 8).

Total benefits generated at Joladarasi watershed

In this study, direct visible benefits of watershed development programme at Joladarasi in terms of incremental net returns were estimated at ₹ 7.04 lakh yr^{-1} from crop production and ₹ 0.39 lakh yr^{-1} from horticulture. Whereas, total indirect benefit was calculated as ₹ 9.80 lakh yr^{-1} and one time increase in asset value and value of temporary employment generation was ₹ 31.01 lakh (Table 9).

Table: 8
Savings due to reduction in siltation of ponds/Tanks

Particulars	Value
Reduction in soil loss from treated area (t ha^{-1} year^{-1})	9.50
Total soil conserved which failed to reach pond (t year^{-1})	1207
Savings due to reduction in de-siltation requirements (₹ in lakh)	0.60

Table: 9
Total values of direct and indirect/intangible benefits from the study watershed

Benefit attributes	Value
Direct benefits (₹ in lakh yr^{-1})	
Incremental net returns from agriculture	7.04
Net returns from horticulture	0.39
Total	7.43
Indirect benfits	
Recurring benefits (₹ in lakh yr^{-1})	
Benefits of additional fodder produced	0.35
Benefits of enhanced fuel wood availability	0.09
Value of additional regular employment	4.61
Enhanced land rent	0.96
Benefits of livestock rearing	0.24
Benefits due to lowering out migration	2.95
Benefits due to reduction in siltation	0.60
Total	9.80
Single period benefits (₹ in lakh)	
Value of assets developed	8.41
Value of casual employment during project implementation	22.60
Total	31.01

4. CONCLUSIONS

The results in this study copiously indicate that only a few of the several indirect benefits of WDP estimated which

amount to ₹ 9.80 lakh yr^{-1} and 31.01 lakh at a time. This was much higher than the main visible impact of the programme in terms of incremental net returns of ₹ 7.43 lakh from crop production and horticulture. In a study Nalatwadmath *et al*. (1997) estimated pay-back period (PBP) of the total expenditure made (₹ 7.17 lakh) for the same watershed as 3 years. They also calculated benefit-cost ratio (BCR) using incremental benefits flow considering 15 years project life as 1.45 at 15% discount rate. If indirect benefits flow included in the analysis, the BCR would be 5.28, nonetheless project's benefit never diminishes over time periods. This fact is endorsed to the overall development of watershed through soil conservation, water resources development, plantation, etc. which in turn improved bio-physical and socio-economic attributes of the watersheds including productivity enhancements and ecological benefits. Until the indirect benefits are acknowledged and estimated for decision-making about conservation activities, they will implicitly be assigned a value of zero in cost-benefit analyses, and policy choices will be biased against conservation. Thus, valuation of different kinds of indirect and even intangible benefits to the individual and society is important to support public policies and expenditure on watershed programmes. The information generated through *ex-post* and even *ex-ante* impact evaluation will justify the higher budgetary allocation in WDP considering the significance of land-agriculture-forest-horticulture-livestock linkages for production of various visible and invisible benefits for the people residing in and outside the watershed.

ACKNOWLEDGEMENTS

Authors wish to acknowledge the guidance rendered by Dr. B.L. Dhyani for estimation of different indirect benefits and support of Mr. K. Channabasappa for making available the requisite data from ORP reports. The authors also express their thanks to the anonymous referee as well as Dr. V.C. Pande for useful suggestions and critical comments on earlier drafts of this paper.

REFERENCES

Chopra, K., Kadekodi, G.K. and Murthy, M.N. 1990. *Participatory development, people and common property resources,* Sage Publication, New Delhi, India.

Chopra, K. and Kadekodi, K.G. 1993. Watershed development: A contrast with NREP/JRY. *Econ. Pol. Weekly*, 28(26): A-61.

Chopra, K. and Kadekodi, G.K. 1997. Natural resources accounting in the Yamuna basin: Accounting for forest resources. Ministry of Environment and Forests, India.

Constanza, R., d'Arge, R., deGroot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutoon, P. and van den Belt, M. 1997. The value of the world's ecosystem services and natural capital. *Nature,* 387: 253-260.

Deshpande, R.S. and Narayanamoorthy, A. 1999. An appraisal of watershed development programme across regions. *Artha Vij.,* 41(4): 348-351.

Deshpande, R.S. and Reddy, V.R. 1991. *Watershed development approach in fragile resource regions: An analytical study of Maharashtra.* Mimeograph Series No. 33, Gokhale Institute of Politics and Economics, Pune.

ICAR, 1997. *Handbook of Agriculture*. Indian Council of Agricultural Research, New Delhi.

India Task Force, 1987. Report of the Task Force to evaluate impact of sheep and goat rearing in ecologically fragile zone. Department of Agriculture & Co-operation, Ministry of Agriculture, New Delhi.

Kerr, J., Pangare, G. and Pangare, V.L. 2002. *Watershed development projects in India: An evaluation.* Research Report 127, International Food Policy Research Institute, Washington D.C, USA.

Mishra, P.K. and Mondal, B. 2008. *Employment generation in watershed development programme- A micro analysis.* In: *Advances in Soil and Water Conservation in Indian Perspective*, Soil Conservation Society of India and IGKV, Raipur (C.G.) (India). pp. 256-263.

Mondal, B. 2011. Assessing the impact of watershed development programmes in Bundelkhand region of Madhya Pradesh: An institutional perspective. Ph.D Thesis, Indian Agricultural Research Institute, New Delhi.

Nalatwadmath, S.K., Rao, M.S.R. and Padmaiah, M. 1997. Joladarasi model watershed development programme in Bellary district of Karnataka: A diagnostic evaluation. *J. Rural Dev.,* 16(2): 313-328.

Pasha, S.M. 2000. *Economic and ecological dimensions of livestock economy.* Commonwealth Publishers, New Delhi.

Patil, S.L., Mondal, B. and Channa Basappa, K. 2012. Evaluation of watershed development projects under different institutional mechanisms in Bellary district of northern Karnataka, India. *Ind. J. Soil Cons.,* 40(2): 173-178.

Reddy, V.R. 2000. Sustainable watershed management - institutional approach. *Econ. Pol. Weekly,* 35(38): 3435-3444.

Shah, A. 2001. *Who benefits from participatory watershed development? lessons from Gujarat, India.* IIED Gatekeeper Series No. 97, International Institute for Environment and Development, London.

Sharda, V.N., Juyal, G.P. and Naik, B.S. 2008. Watershed development in India - status and perspective. Central Soil and Water Conservation Research and Training Institute, Dehradun.

Sharma, B.R. and Scott, C.A. 2005. Watershed management challenges: Introduction and overview. In: *Watershed Management Challenges: Improving Productivity, Resources and Livelihoods*. Eds: B.R. Sharma, J.S. Samra, C.A. Scott and S.P. Wani, International Water Management Institute (IWMI) and International Crop Research Institute for Semi-arid Tropics (ICRISAT), Malhotra Publishing House, New Delhi. pp. 245-257.

Singh, J. 2012. *Trade-off of workers between MGNREGS and manufacturing.* Office of the Economic Advisor, Department of Industrial Policy and Promotion, Ministry of Commerce & Industry, Udyog Bhawan, New Delhi.

Singh, D.V. 1994. *Report on concurrent evaluation study of integrated watershed development (Hills) project: Markanda watershed, Himachal Pradesh,* Agro Economic Research Centre, Simla.

Verma, M. 2000. *Economic valuation of forests of Himachal Pradesh*. Indian Institute of Forest Management, Bhopal.