Journal of Resources Development and Management
ISSN 2422-8397 An International Peer-reviewed Journal
Vol.8, 2015

Cost Benefit Analysis on Pond Ecosystem Services in Peri -Urban Agriculture

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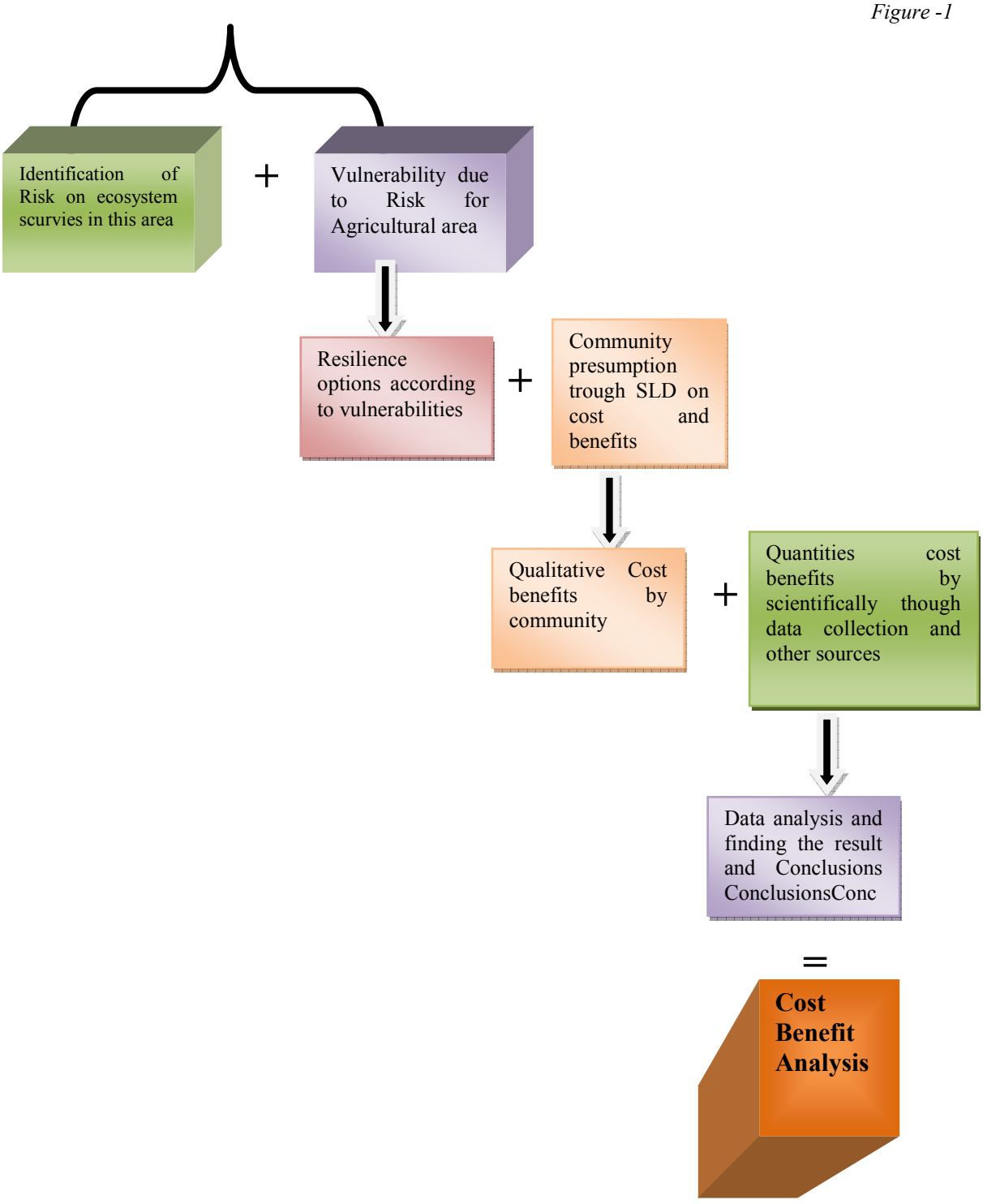
Abstract
The fast pace of urbanization is upsetting the natural ecosystems in peri-urban areas that further impact the livelihood of people and other environmental services. Some of the first casualties of this phenomenon are the common resources like ponds or water-bodies. Water for agriculture, storm-and waste-water regulation, along with protection from natural disasters and soil erosion, are some of the services that affect small and marginal farmers. This research is based upon an actual case study from a village in peri-urban area of Gorakhpur, Uttar Pradesh, where a pond with an area of 0.55 acre was constructed under MNREGA in the year 2004.The paper focuses on the cost benefit analysis of natural and manmade ponds or wetlands located in the peri-urban areas in providing the ecosystem and livelihood services to small and marginal farmers around Gorakhpur city. Community consultations were undertaken in these areas to ascertain the vulnerabilities and resilience options. Based on these community consultations a qualitative benefit-cost ratio was derived which was followed by a more rigorous quantitative CBA using data collected from secondary sources as well as from the community. It was found that the people value the services provided by the ponds to be significant as shown by the highly positive benefit to cost ratio in both qualitative as well as quantitative analyses.
Keywords: Cost Benefit Analysis, Livelihood, Peri-Urban areas, ponds, Qualitative CBA.

Introduction

Gorakhpur is located in the Terai belt of Eastern Uttar Pradesh, India. In terms of population growth, it is at present the second largest city of Eastern Uttar Pradesh. Geographically, the city is situated on the left bank of the river Rohin at the confluence of the rivers Rapti and Rohin.The city's 147 sq.km is divided into 70 administrative wards and 175 villages converge by Gorakhpur development authority (GDA) master plan 2021. For many years farmers and ranchers have been building ponds for livestock water and for irrigation. By 1989 more than 1.10 million ponds had been built in the India, mostly W.B and Orisa,Kerla and Bihar by land users on privately owned land. More will be needed in the future. The Gorakhpur city residential unit have the double in the city during 1981-2001(GDA master plan 2021) and as compared to 103 small and large /lake in the city during 1950s, there are only some 20-25 remaining at present (see map-1).The demand for water has increased tremendously in recent years, and ponds are one of the most reliable and economical sources of water. Ponds are now serving a variety of purposes, including water for livestock and for irrigation, fish production, field and orchard spraying, fire protection, energy conservation, wildlife habitat, recreation, erosion control, and landscape improvement. On this topic research analysis is restricted to some extent where research has on fishery and paddy has been carried out by some universities/organization. In this study we have tried to detailed cost benefits analysis of digging the pond and their facilities in agriculture focusing on community participation and secondary data.

Methodology of Cost Benefits –

Figure -1



On the basis of above methodology a village was selected taking into considerations risk of ecosystem and vulnerability of village with respect to agriculture depicted in Table-1. A community consultation was conducted in village to indentify the resilience options of vulnerability amongst the community *depicted in Table-2*. A share learning dialogue (SLD) was conducted at village level to know the cost and benefits on the resilience options (qualitative) *depicted in Table-3 &* 4. After SLD a scoring process indicting 01(lower) and 10(higher) was conducted with community consultation *depicted in Table-5* as per scouring process then one resilience option was identified amongst 06 resilience options. A quantitative Cost benefits was analyzed using secondary data and information from community and other sources.

Results and Discussion

In this study results and discussion are in two parts one is community participation depicted in(table-1 to table-5) , and another is secondary data collected from various sources. Participatory approach from community is not considered in many study of cost and benefit analysis from various organization/ university. Where as community participatory approach has been considered in this study and reflects a good result.

(Table-1) Risk and Vulnerability in this area

Risk	Vulnerability
Rapid conversation of land use like housing, less open spaces, encroachment of Ecosystem services	Crops damages due to water logging and flood
Water logging /flood	Less option of Irrigation facility
Throughout the garbage and severe from the city to peri-urban villages	Dependency of farmers on single cropping pattern (insecurity of foods, dignity and debt etc.)
	decreasing of livelihood

(Table-2)Resilience Option of vulnerability

Vulnerability	Resilience options
Crops damages due to water logging and flood	• Loft farming/aquaculture • Permanent raise bed • Proper drainage system • Cultivation Resilient verities / crops/techniques
less option ponds and there facility and crops diversity (post flood or rainy seasons)	• Digging the ponds and bund around the farm • Use of surface water • Minimum bore well form the ground water • Conserve the open/agriculture area or do not change the land use plan • And the agriculture sub system like pods, animals, forestry and off farm activities
Dependency of farmers on single cropping pattern (insecurity of foods, dignity and debt etc.)	• Time and space management • And the agriculture sub system like pods, animals, forestry and off farm activities • Proper distribution of common resources within the village
Dwindling of livelihood	• Fishery and duck raring • Aquaculture • Lac of other options of Washer man • Converted of skilled works like labour, shops etc.

(Table-3) Cost analysis on ponds and there facilities

Sln.	Resilience options	Cost		
		Economic	Social	Environmental
1	Digging/ conservation of ponds	Input for aquaculture related activities , Bricks, cement ,sand , plantation and labour, (8)	Land ,labour contribution ,conflict and monitoring (4)	Loss of soil fertility and Methane emission through garbage in ponds (2)
2	Use of surface water/water conservation	Fuel ,labour, pumping set ,irrigation pipe and maintenance (5)	Fare ,conflict, distribution (3)	Less recharge to ground waters(1)
3	bore well form the ground water	Pipe ,labour, engine ,house and irrigation pipe (6)	Fare, time and crop damages loss(4)	ground water table decrease due to more and dry scale (2)
4	Conserve the open/agriculture area or do not change the land use plan	Enforcement cost, penalty and demarking (iron, cement, bricks etc.) (9)	Conflict ,contribution of labour and time (3)	-
5	And the agriculture sub system like ponds, animals, forestry and off farm activities	Ploughing, seeds, fertilizer, irrigation, weeding, labour and breed and plantation (10)	all family is involved(2)	Adverse effect of Chemical fertilizer pesticides and Methane emission(1)
6	Develop bonding around the farm	Labour and equipment(7)	Land ,labour contribution ,conflict(5)	-

(Table-4) Benefit analysis on ponds and there facilities

Sln.	Resilience options	Benefit		
		Economic	Social	Environmental
1	Digging the ponds and conservation	Irrigation, wages, less water logging/ flood ,animal husbandry and profit for livelihoods(fishery, washer man/cultivation of aquaculture(10)	Cultural, drinking and washing the animals, health and contribution /distribution of equal recourses (7)	increasing of ground water table, flow of the oxygen ,improved the soil fertility and promote water cycle(3)
2	Use of surface water/water conservation	Save the fuel, less labour and equipments and other option(duck raring)(3)	Alternative options of irrigation around the farm, collective farming and marketing(4)	Water table increases and buffing capacity of the water logging/flood (2)
3	bore well form the ground water	Timely irrigation facility, yield increases and selection the crops(5)	Less conflict, interested of the farmers for the agriculture activities and social harmony(3)	-
4	Conserve the open/agriculture area or do not change the land use plan	Less damages of the crops due to Water logging /flood ,agricultural activities is continue, (7)	Livelihood of family, ,epidemic/communicable diseases ,social harmony, unity and cultural activities(5)	Increasing of ground water, buffering capacity of the flood/water logging(4)
5	And the agriculture sub system like ponds, animals, forestry and off farm activities	Increase cropping intensity, Increase in overall income, risk minimized ,multiple sources of income (8)	Livelihood and food security ,dignity (5)	Increasing buffering capacity of the flood, biomass ,soil fertility and flow of the oxygen(2)
6	Develop bonding around the farm	Conserve the Moisture , maintain the soil erosions, weed control and less use of fertilizers (7)	Equal nutrition of the soil, check the runoff of rain water(2)	Ground water recharges (1)

(Table-5) Analysis of according to scoring of the costs and benefits

Sl. No.	Resilience Options	Costs			Total	Benefits			Total	Cost benefit ration
		Economic	Social	Environment		Economic	Social	Environment		
1	**Digging the ponds and conservation**	**8**	**4**	**2**	**14**	**10**	**7**	**3**	**20**	**1.4**
2	Use of surface water/water conservation	5	3	1	9	3	4	2	9	1.0
3	bore well form the ground water	6	4	2	12	5	3	-	8	0.7
4	Conserve the open/agricultur e area or do not change the land use plan	9	3	-	12	7	5	4	16	1.3
5	Add the agriculture sub system like ponds, animals, forestry and off farm activities	10	2	1	**13**	8	5	2	**15**	1.2
6	Develop bonding around the farm	7	5	-	**12**	7	2	1	**10**	0.8

All cost and benefits scoring are according to community consultation and then cost benefit ratio has been calculated depicted in (Table-5). From the above table one option is selected taking higher cost benefit ratio into account. The higher C.B ratio is (Digging the pond and conservation) which is out of six resilience options. And developed a theory of change for a quantitative analysis (cost and benefit) depicted in Fig-2. In theory of change tried to find out the eight parameters determining it a base of cost benefit analysis. As per this

analysis an impact is improvement of socioeconomic condition and sustainable management of ecosystem.

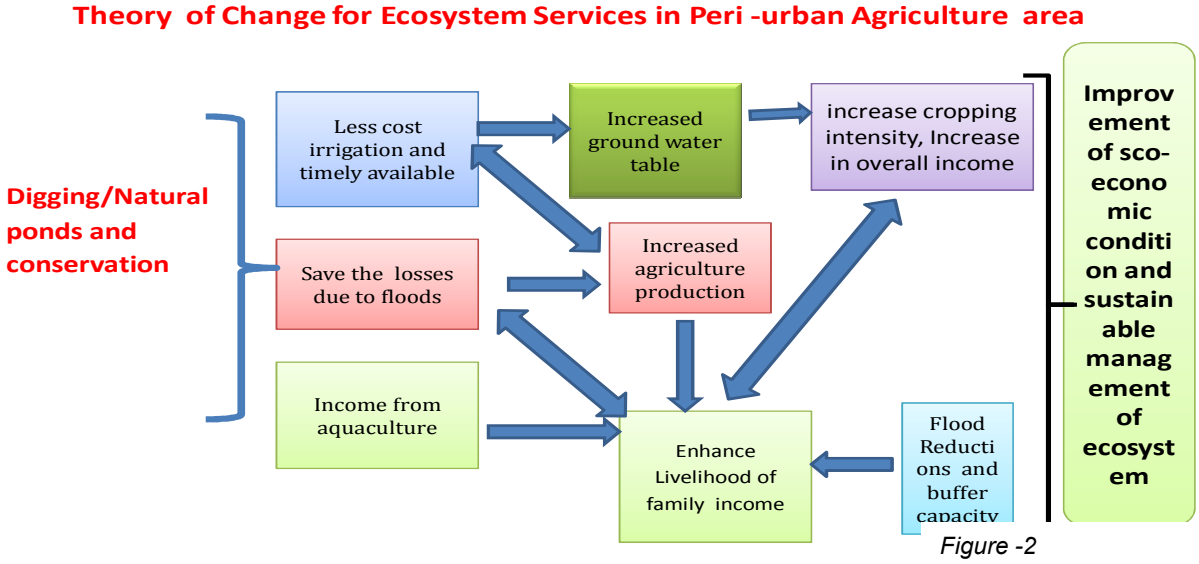


Figure -2

Analysis of Costing a ponds: While costing of a pond it has been focused on three variables like economic, environmental and social, where as social costing is not fairly distributed (All social costs can not be calculated)

Table-6

Resilient Option	**Economic**	**Economic Proxy Variable**	**Environmental**	**Env. Proxy Variable**	**Social**	**Social Proxy Variable**
Digging Ponds For Conservation(76363.60 metre2 and depth 3.63 meter)						
Cost	99000	Bricks	30000	Loss of soil fertility (average production of two crop season wheat and paddy per acre production 15 quintal each crops @1500 Rs. Per quintal	0	Conflict/Fare Distribution
	17500	Cement				
	12800	Sand				
	660	Bund plantation (3 M.)				
	58800	Labour				
	1500	Input for aquaculture related activities				
	3500	Fish (fingerlings)				
Total	**1,93,760**		**30,000**		**0**	

Analysis of Benefits: While analyzing benefits of ponds we have considered three variables like economic, environmental and social. Some Social benefits cannot be measured quantitatively like religious values, cultural activity.

Table-7

Economic Benefit	Economic Proxy Variable	Environmental Benefit	Env.Proxy Variable	Social Benefit	Social Proxy Variable
Digging Ponds For Conservation (76363.60 metre2 and depth 3.63 meter)					
15000	Avoided costs of irrigation(two time irrigation of 5 acre per save the cost Rs. 1500	10000	Increased ground water table flow(bore well is failed or water table blow then new bore well cost is high but ground water is maintain save a 10000	0	Culturally acceptable & drinking and washing the animals, health and contribution /distribution of equal recourses
58800	Increased wages? Whole wages Rs.58800 among the villagers				
22500	Avoided losses due to floods 30% of the crop loss in raniy season e.g. paddy crops total production in 15 quintal per. Total 5 acre covered by pond				
3000	Increased agriculture production				
50000	Income from aquaculture approximate 5 quintal of fish production @10000 per year				
0	Flood Reductions (60 % of rain water for the enhance of buffer)				
1,49,300		**10000**		**0**	

According to theory of change , key role of ecosystem services in the agriculture and other dimensions are depicted in the figure-03

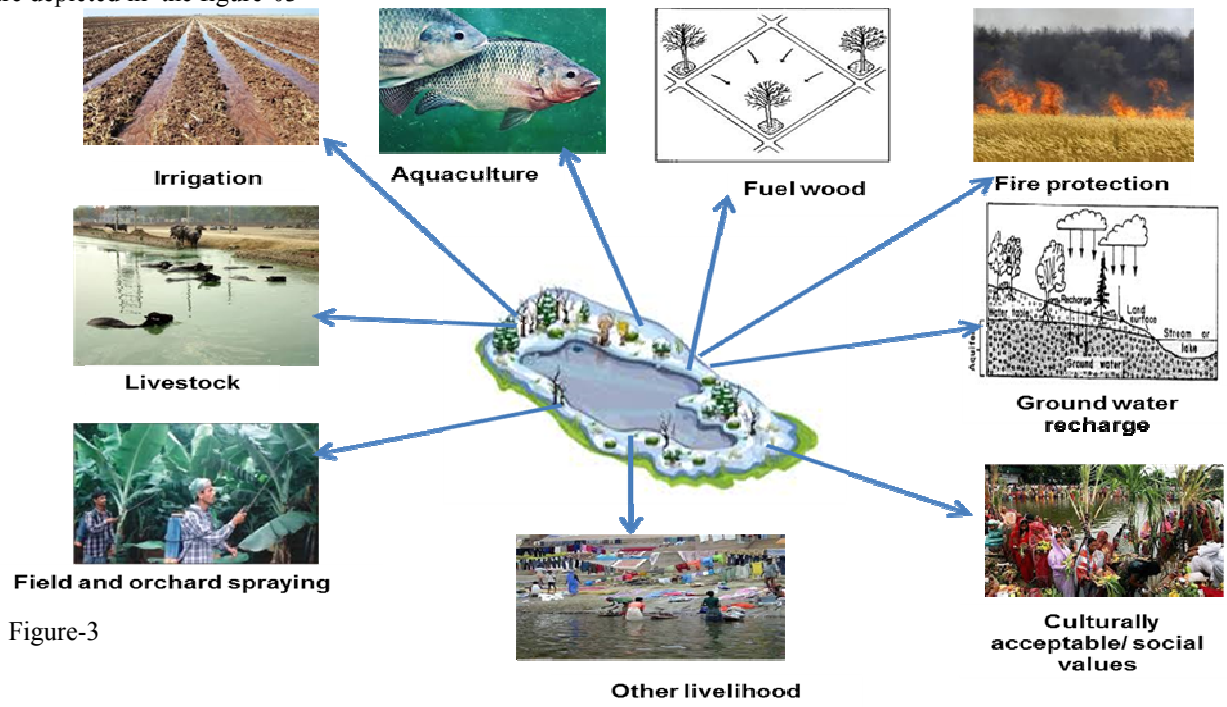


Figure-3

Irrigation-

Farm ponds are now an important source of irrigation water particularly in the peri urban area which does not have the organized irrigation system. Now many farmers in the peri urban areas are irrigating their crops. Water requirements for irrigation are greater than those for any other purpose discussed in this paper. The area irrigated from a farm pond is limited by the amount of water available throughout the growing season. Pond capacity must be adequate to meet crop requirements and to overcome unavoidable water losses. For example, a 3-inch application of water on 1acre requires 81,462 gallons. Consequently, irrigation from farm ponds generally is limited to high-value crops on small acreages, usually less than 5 acres. The irrigated area covered by a pond is five time more than capacity of the pond

The required storage capacity of a pond used for irrigation depends on these interrelated factors: water

requirements of the crops to be irrigated,

Rainfall expected during the growing season, application efficiency of the irrigation method, losses due to evaporation and seepage, and the expected inflow to the pond.

Fish production/ aquaculture-

Many land users are finding that fish production is profitable. A properly built and managed pond can yield from 3 to 4 pounds of fish annually for each acre of water surface. A good fish pond can also provide recreation and can be an added source of income should you wish to open it to people in the community for a fee.

Ponds that have a surface area of a quarter acre to several acres can be managed for good fish production. Ponds of less than 2 acres are popular because they are less difficult to manage than larger ones. A minimum depth of 8 feet over an area of approximately 1,000 square feet is needed for best management.

Field and orchard spraying-

You may wish to provide water for applying pesticides to your field and orchard crops. Generally, the amount of water needed for spraying is small, but it must be available when needed. About l00 gallons per acre for each application is enough for most field crops. Orchards, however, may require 1,000 gallons or more per acre for each spraying.

Provide a means of conveying water from the pond to the spray tank. In an embankment pond, place a pipe through the dam and a flexible hose at the down- stream end to fill the spray tank by gravity. In an excavated pond, a small pump is needed to fill the tank.

Fire protection-

A dependable water supply is needed for fighting fire. The pond is located close to your agriculture farm and house provide a centrifugal pump with a power unit and a agriculture field and hose long enough to reach all sides of all the buildings. Also provide for water for fighting. During the summer harvesting time was maximum possibility of fire in the wheat crops. Such a stream running for 5 hours requires 1/4 acre-foot of water. If you live in an area protected by a rural fire fighting organization, provide enough storage to operate several such streams. One acre-foot of storage is enough for four streams.

Vegetables production-

Vegetables production on the pond bank round the year was an additional innovation over traditional pond management. The production of vegetables generally small farmers do not have access to sufficient vegetables round the year for their nutrition because of resource limitations. In this regard, vegetables production in integrated pond management increased the year round availability of vegetables for family consumption of the respective households. Moreover, cash from selling of additional vegetables contributed to increased total income of the households. However, this approach for vegetables production exhibited a remarkable impact on the resource poor farmers having the similar ponds for income generation and family nutrition.

Recherché ground water table-

Quantification of the rate of natural ground water recharge is a basic pre-requisite for efficient ground water resource management. It is particularly important in regions with large demands for ground water supplies, where such resources are the key to economic development. However, the rate of aquifer recharge is one of the most difficult factors to measure in the evaluation of ground water resources**.** Find hydrologic soil groups in the watershed, as per the following criteria:

Soil Group	Infiltration capacity (cm/hour)
A Sandy soil	7.5 - 11.5
B Sandy lome	4.0 - 7.5
C Clay soil	0.13 - 4.0

Livestock-

An understanding of stock water requirements helps in planning a pond large enough to the needs of the stock using the surrounding grazing area. The average daily consumption of water by different kinds of livestock shown here is a guide for estimating water needs.

Kind of livestock	Gallons per head per day
Beef cattle	12-15
Dairy cows (drinking only)	15
Dairy cows (drinking and bath needs)	35
Sheep	1
Goat	1.5

The amount of water consumed at one pond depends on the average daily consumption per animal, number of livestock served, and period over which they are served.

Analysis of Cost and benefits in long term:

In the last tried to put as a whole analysis of CB in long term (10 years) depicted in table-8 which shows breakeven point of a pond can be reached at 4th year. The table-9 shows that, IRR, NPV and benefit cost ratio. It reflects a positive sign of profits.

Total net present value cost (NPV) and total net present value benefit and net benefit has been reflected in table-10, which is again a positive sign of sustainability of an ecosystem in long terms.

The benefit-cost ratio, reimbursement period, and present value of costs

Table-8

Parameters	Year 0	Year 1	year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
	0	1	2	3	4	5	6	7	8	9	10
Initial investment & Maintenance	223760	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000
Operational costs	0	0	660	0	0	2555	0	0	0	0	2555
TOTAL COSTS	223760	30000	30660	30000	30000	32555	30000	30000	30000	30000	32555
BENEFITS	0	159300	100500	100500	100500	100500	100500	100500	100500	100500	100500
	-223760	129300	69840	70500	70500	67945	70500	70500	70500	70500	67945
Discount Rate	12%	-	-	-	-	-	-	-	-	-	-
Year wise NPVs Costs	223760	26785.71	24441.96	21353.41	19065.54	18472.58	15198.93	13570.48	12116.50	10818.30	10481.84
Year wise NPVs benefits	0	142232.14	80117.98	71533.91	63869.57	57026.40	50916.43	45461.10	40590.26	36241.31	32358.31
Net Benefits (PV Benefits - PV Costs)	-223760.00	115446.43	55676.02	50180.51	44804.02	38553.82	35717.49	31890.62	28473.77	25423.01	21876.47
Break Even point	0	-108313.57	-52637.55	-2457.04	42346.98	80900.80	116618.29	148508.91	176982.68	202405.69	224282.16

Table-9

Net Present Value (NPV)	202405.69
BCR	1.52
IRR(Estimated)	47.00%

Table-10

Total NPVs Costs	385583.42
Total NPVs benefits	587989.10
Net Benefits (PV Benefits - PV Costs)	202405.69

Conclusions

The study concluded that conservation of pond is profitable especially when there is proper management and timely inputs. The study conclusively proves, through both qualitative (participatory) as well as quantitative approaches, that there are significant benefits to the community of conserving natural ecosystems like ponds and water bodies. The research shows that the investments in ponds have a total NPV of Rs. 202405.69 and benefit to cost ratio (BCR) is 1.52 at a social discount rate of 12% while the break even can be achieved in the fourth year itself. Evidence presented through qualitative CBA show that there are many aspects related to opportunity cost, social cost and environmental cost of conservation of a pond that are not measurable in economic terms, but their its benefits are quite important to the community and society as a whole. In the light of high economic, social and environmental benefits, the rational for promoting natural ecosystem based livelihood systems, especially among small and marginal land holding households is highly justified. Based on the findings and conclusions it is recommended that land use should be preserved to sustain livelihoods in peri-urban areas.

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