AIJR Preprints
Section: Working Paper
Article Id: 250, Version: 1, 2020
URL: https://preprints.aijr.org/index.php/ap/preprint/view/250
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NOT PEER-REVIEWED

Version 1: Received: 13 October 2020 / Approved: 15 October 2020 / Online: 15 October 2020

Economic Valuation of Small Scale Water Management Intervention in Barind Area, Bangladesh

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ABSTRACT

An Integrated Water Resources Management (IWRM) project is being implemented by DASCOH in the north-western part called Barind tract in Bangladesh. The primary goal of the project is to help local government institutions to contribute to the increasing availability of water for disadvantaged people in the Barind area through sustainable, effective, and inclusive management and usage of water resources. This study is designed under the scope of this project and cross-checks the achieved objectives in terms of how much benefit the project drips down to the targeted population. For all of the interventions implemented by the project, health and household labor cost reduction is found to be very significant. However, some interventions have a skewed impact on some particular parameters while others have a partial impact.

Keywords: Economic Valuation, Cost Benefit Analysis, Water Management

1 Introduction

1.1 Background

Bangladesh is well on its way to fulfill its ambitions to become a high middle-income country. The economic growth rates and poverty reduction have been achieved in spite of extreme challenges ranging from volatile political ambience to climate change, the most important being pressure on land use, climatic impacts, environmental protection, governance, globalization and macro-economic development. The country is mostly alluvial flood plain which makes it favorable to agricultural operations but vulnerable to flooding. Located in the world's largest delta, Bangladesh is dominated by its huge water resource system, yet in the many parts of the country, the adequacy of drinking water in terms of both quantity and quality is undermined due to inequity in distribution, unbalanced water allocation, contamination and at the point of consumption. Water crises are often crises of governance. To address interrelated issues of securing access to sustainable sources of safe water, it is imperative to have improved modes of water governance that support the implementation of IWRM.

With support from the Swiss Agency for Development and Cooperation (SDC), the Swiss Red Cross (SRC) is implementing IWRM project for the Barind Tract area in Bangladesh in collaboration with the DASCOH Foundation, a Non-Governmental Organization (NGO). The primary goal of the project is to help local

How to Cite:

Md. Suman Miah and Israt Zahan, "Economic Valuation of Small Scale Water Management Intervention in Barind Area, Bangladesh". *AIJR Preprints*, 250, Version 1, 2020.

government institutions to contribute to the increasing availability of water for disadvantaged people in the Barind area through sustainable, effective, and inclusive management and usage of water resources. The current study is conducted under the scope of this project and cross-checks the achieved objectives in terms of how much benefit it drips down to the targeted population.

1.2 Purpose

The study is designed to evaluate the impact of various schemes implemented by the above mentioned IWRM project. Barind IWRM project is developed to pilot and test rules and bye-laws under Bangladesh Water Act 2013 which, in addition, further pilots water development and management schemes ranging from drinking water supply and irrigation water management to groundwater recharge focusing 4R principle (water reuse, reduce, recycle and restore.) The primary target group of the IWRM project is the people affected by water scarcity and a lack of reliable access to water resources. From an estimated population of over 1.58 million in the project areas, approximately 40% are poor. Through the implementation of the schemes, the project will reach approximately 250'000 direct beneficiaries, of which 70% are expected to be disadvantaged. The remaining 750'000 people will indirectly benefit from these interventions. Approximately about 50% of those who will benefit would be women. Having this prognosis, in theory, the study examines the implemented schemes in terms of economic impact, converted the value of the impact into monetary form to exhibit the actual benefit reached to the targeted community/population. [1]

1.3 Economic Valuation: Conceptualization

Primarily economic valuation means assigning a monetary value to environmental factors (such as the quality of air and water and damage caused by pollution) that are normally not taken into account in the financial valuation. However, this confines the broader spectrum of the application of economic valuation limiting it into environmental pollution only. Economic valuation provides a means for measuring and comparing the various benefits of any human intervention or natural system. As defined by the World Health Organization (WHO) that it can enumerate the potential costs and value of the anticipated benefits of a proposed program, policy, or regulatory initiative, and reflect trade-offs inherent in alternatives. In that perspective, economic valuation can be defined as the monitory value of possible impact from a certain intervention that it might bring to its beneficiaries encompassing the positive and negative externalities. For an instance, a certain intervention, here let's say a pond re-excavation, might have an impact on groundwater recharge, year-round water availability for the beneficiary's domestic use, return from aquaculture, tree plantation, etc. and on the other hand, there are investment cost and Operation and Maintenance (O&M) cost. Now the return and the inputs, when evaluated into the monetary aspect, are compared to check the cost-benefit ratio which furthers exhibit the schemes' economic viability. [2]

The concept of total economic value (TEV) provides a framework to comprehensively evaluate natural and environmental resources, and there is an increasing consensus that it is the most appropriate one to use. To conduct a complete economic valuation exercise, it is necessary to distinguish between *use values* and *non-use values*. They later refer to those current or future (potential) values associated with a resource/intervention that relies merely on its continued existence, unrelated to use, for instance, groundwater recharge from a pond. Typically, use values involve some human 'interaction' with the resource/intervention whereas non-use values do not. This distinction is sometimes difficult to detect. For example, when a check dam is constructed, the retained water is used for irrigation in the first hand, for the fisheries and the nearby households (HHs) use the water for domestic purpose, all of which has use value in terms of water quantity. On the other hand, it also contributes to the groundwater system in the long run, the wetland based eco-system and vegetation, bringing the non-use value. Now if we see critically, the use-value of retained water has some more impact on livelihood improvement like impact on health, savings on HH labor cost, etc. which are difficult to quantify. These values are dynamic and in many instances, they are 'intrinsic' value which is a form of non-use value. Assumptions and estimations are required to quantify them.

1.4 Risks and Uncertainty

As stated earlier, there is an array of factors in terms of social and environmental aspect which are to be considered during economic valuation. These factors are either implicitly linked to the implemented intervention or explicitly impacting the beneficiaries. Both social and environmental externalities are dynamic by nature as they keep changing according to geographical and social perspective. [3, 4]

The project area encompasses 6 Upazilas in 2 districts of Barind. This comprises *high* and *low* Barind exhibiting the geographical variations. Besides, socio-economic characteristics are also diverse. About 4.9% of the total population is an ethnic minority who has limited access to water resources as the project baseline study reveals. Now, when valuating individual intervention, many of the possible impacts like benefits from the interventions if further developments are realized are assumed. For example, a newly re-excavated pond is not currently having any fish cultivation or tree plantation by the bank of it. The study assumes these activities for the future and accounts for the benefit based on the estimated value-added cost of similar kinds nearby and potential benefits. Negative environmental externalities (like pollution or impact on groundwater declination due to drinking water supply interventions etc.) are excluded during the calculation.

2 Methodology

2.1 Valuation Technique

The study applies the Cost-Benefit Analysis (CBA) technique, an imperial method applied by economists worldwide to test the economic viability of an existing or proposed activity. The basic concept of this method is that it takes into account not only the possible benefits for society and nature but also the costs that accrue due to the implementation of the intervention. In the current context, cost-benefit analysis involves subtracting the monetary cost of a given intervention from the monetary value of all the benefits generated by the same development to obtain a net benefit or cost streams for the intervention. However, all values are calculated based on the present market price. In the IWRM context, it is not only essential to compare the benefits of alternative investments but also important to ask, which investment is generating the highest "value for money" and hence this valuation technique is adopted.

The valuation has been done in four stages: defining intervention, identifying the possible impacts, valuing the impact, applying the Net Present Value test.

2.1.1 Defining the Intervention

In this stage, the interventions are identified according to their category, location, and some direct beneficiaries. The critical is here to define the service area and the number of beneficiaries. The beneficiary number is directly linked to the associated impacts and their valuation. For the simplification of the calculation, only direct beneficiaries are taken into consideration.

2.1.2 Identifying the Possible Impacts

The next step involves identifying the possible impacts accruing from different interventions. There are interventions like drinking water supply, irrigation improvement, groundwater recharge, and rainwater harvesting. All these have different impacts and sometimes they don't have any direct impact on the beneficiaries. On the other hand, the impact of groundwater recharge and rainwater harvesting intervention can only be capsulated in the long run. The implemented interventions, therefore, were critically observed individually to identify the possible impacts on their beneficiaries. For an instance, a drinking water supply intervention has installed a submersible pump. Now this stage would involve listing all resources used, i.e., labor costs, material cost, operation, and maintenance cost and benefits from the implementation of it i.e., the cost of HH labor saved which was required to collect water from distant, the cost of health saved due to safe drinking water supply. Again, for a pond re-excavation scheme, the benefits would be the cost of water saved for different HH purpose which was based on GW earlier, the cost of HH labor saved, the cost of aquaculture output from the pond, the cost of irrigation output, the cost of GW recharged water, etc. Each intervention was surveyed separately and the possible costs and benefits were identified.

2.1.3 Valuing the Impact

The valuation process involves assigning monetary value against each impact identified in the above stage. The valuation has been done based on the unit price of goods and services. For example, the cost of water saved is calculated based on the unit price of water supplied by Barind Multipurpose Development Authority (BMDA). On the contrary, the cost of HH labor saved is calculated based on the average daily wage rated for the area where the intervention is located, thus the calculated HH labor cost varies as the area of intervention changes. Again, for the calculation of aquatic or agricultural output, the cost has been calculated based on the current market price of the goods per unit. Below are the equations that are used to calculate the input and output cost: [5, 6, 7]

$$\text{Investment Cost (IC)} = \frac{\text{CpC}}{5} + OMC + VAC$$

Where,

CpC = Capital Cost required to install the facility

OMC = Operation and Maintenance Cost per year

VAC = Total cost of fish cultivation/ tree plantation (Fingerling/fish feed/fertilizer/seeds etc)

CpC has been divided by 5 assuming the facility will last for 5 years.

$$\text{Return on Investment (ROI)} = \text{CWat} + HHLC + HC + AO + TPO + FCO$$

Where,

CWat = Cost of water (saved)

HHLC = HH Labor cost (saved)

HC = Health cost (saved)

AO = Agricultural output

TPO = Tree Plantation Output

FCO = Fish Cultivation Output

Further to calculate the each of the return on investment parameter, the below equations were used:

$$a)\ CWat = [\{(Number\ of\ Population * LPCD * 365 * Unit\ price\ of\ water) + (number\ of\ cattles * average\ water\ intake\ per\ cattle\ per\ day * 365 * Unit\ price\ of\ water) + Area\ of\ recharge\ surface\ in\ sq.m * 0.96)\} * 5\%\ error]$$

$$b)\ HHLC\ (save) = [Number\ of\ person * Time\ spent\ for\ water\ collection\ per\ day\ per\ person * average\ hourly\ wage\ per\ person * 365 * 5\%\ error]$$

$$c)\ HC\ (saved) = [Number\ of\ person * average\ health\ cost\ per\ person\ per\ month * 12 * 5\%\ error]$$

$$d)\ AO = [Amount\ of\ crop\ produced\ in\ last\ season\ in\ ton * unit\ price\ of\ crop * 0.20 * 5\%\ error]$$

$$e)\ TPO = [Amount\ of\ fruit\ or\ vegetable\ produced\ in\ kg * Unit\ price\ of\ fruit * 5\%\ error]$$

$$f)\ FCO = [Amount\ of\ fish\ \ produced\ in\ kg * unit\ price\ of\ fish\ per\ kg * 5\%\ error]$$

After expressing all the relevant costs and benefits in monetary terms, then they were converted into present value (*PV*) terms because of the time value of money or time preference aspect. The present value of a cost or benefit (*X*) received in time *t* is calculated as follows:

$$PV(Xt) = Xt\ [(1+i)^t]$$

All IC and ROI were converted into PV to make them uniform to compare at a later phase. To elaborate, the value of each impact was calculated over five years. For example, if the output of the first year is 100 BDT, the value of 100 in the next years may become 90 due to the devaluation of money. Therefore, this time effect has been taken into account by discounting all costs and benefit flows by using a discount rate *(i)* which is assumed for now to be 5% (Bangladesh Central Bank discount rate).

2.1.4 Applying the NPV Test

The main purpose of cost-benefit analysis is to help select interventions that are efficient in terms of their use of resources. To do so the discounted losses (investment cost) is to be compared with the discounted gains (return on investment). Net Present Value (NPV) was calculated summing up to prevent the value of IC and ROI. Mathematically-

$$NPV = (\sum ROI_t\ (1+i)^{-t} - \sum IC_t\ (1+i)^{-t}) / \sum IC_t\ (1+i)^{-t})$$

The summation runs from t =0 (the first year of the project) to t =5 (the last year of the intervention. The criterion for intervention acceptance is; accept if and only if NPV>0. Given two project with positive NPV, the one with a higher NPV should be selected. Furthermore, the cost and benefit ratio was calculated to examine the performance of the interventions.

2.2 Data Collection

A structured questionnaire was used for data collection and the survey was conducted for each intervention separately. After developing the first set of questionnaires, a field-tested was carried out, and later required adjustment was made based on the verification. Below are the parameters which were collected through the questionnaire survey:

a) Number of beneficiaries
b) Number of cattle
c) The capital cost required to implement the intervention
d) Amount of water supplied per HH
e) Amount of water supplied to the irrigated land
f) Type of crops cultivated
g) Amount of production per crop
h) Unit price of crop according to type
i) Unit price of HH water
j) Unit price of irrigation water
k) Type of Maintenance cost per year
l) Electricity cost per intervention if any
m) Recurrent cost per intervention if any
n) HH average health cost per month
o) Daily average wage rate
p) Cost of production (fish cultivation)
q) Cost of production (tree plantation)
r) Cost of production (agricultural crop)
s) Amount of fish produced
t) Amount of fruit/vegetable grown
u) Amount of crop produced
v) Area of irrigated land
w) Area of rainwater collection in sq. meter
x) Average rainfall of the year
y) Area of total recharge area in sq. meter

2.3 Data Limitations

The collected information is dynamic. The responses are based on the assumption and sometimes they are being predicted. For instance, a certain impact may not be realized at the survey period but assumed to be in place as the beneficiaries have planned to do it. A pond that is re-excavated is now ready for fish cultivation and the beneficiaries have planned to do it in the coming monsoon. The assumptions on the impact calculation have considered this. It calculates the possible outcomes from the fish cultivation and so on. On the other hand, the cost assumption from health cost saving is largely based on the response from the beneficiaries and there was little to no chance to verify the answers. There is no standard health cost benchmark for the study area with which the collected data can be compared and verified. Furthermore, the HH labor cost also follows the same. These datasets could not be verified with any reference dataset. However, to minimize the uncertainty 5% error adjustment was done in calculating the benefits. [6]

3 Results and Discussion

By the end of 2018, a total of 73 water interventions have been implemented in the study area reaching out to approximately 47000 direct beneficiaries of whom 21% are an ethnic minority. A total of 18 million BDT is spent over a year (January 2018 to December 2018) to implement these interventions. The analysis shows that the pipeline water supply has the highest coverage in terms of the number of beneficiaries having lower investment share. On the other hand, pond re-excavation has comparatively lower coverage while its share in total investment is the highest. Figure 1 shows the percent of beneficiaries and share of total investment according to the type of intervention being implemented in the study area. However, it is not conclusive that a certain intervention is efficient just because of its reaching out to the capacity of beneficiary coverage; it gives an overall indication though. Depending on the applicability and diversity of the intervention, the efficiency is to be measured. The implementation of the schemes must reflect the community demand. For example, in a distant village, where the inhabitants are suffering from an extreme shortfall of water, a re-excavated pond will have a significant bearing on their livelihood. The number of beneficiaries in that village, which is geographically isolated, can be very limited but the implementation of the scheme reflects the need and demand of the society.

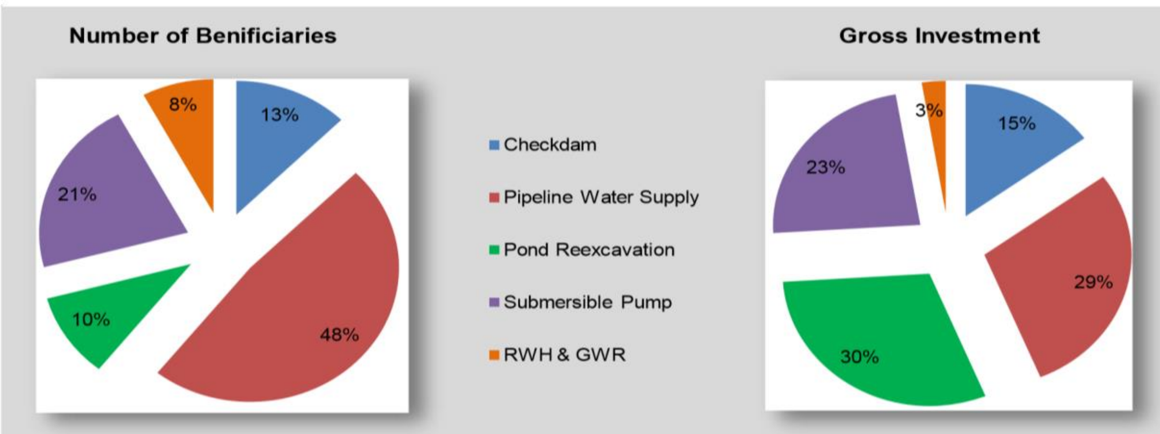

Figure 1: Percentage of beneficiaries and share of total investment according to the type of intervention

The project established Water Resources Management Committee (WRMC) in each village which has developed a community development plan based on their demand and supply. The project is supporting the LGIs to materialize these plans enhancing the community's negotiation capacity and social empowerment. A larger community in the study area (approximately 4.7%) belongs to an ethnic minority who are socially isolated and disadvantaged having '*limited' to 'no accesses* to the water resources. In many instances, they need to travel more than 4 KM on foot to collect their daily HH water. IWMR project in Barind predominantly focuses this stratum to mainstreaming them by providing basic access facilities to water resources. The project commits to reaching its benefit to approximately 250,000 beneficiaries by the end of 2020 of which 70% are expected to be disadvantaged populations. Therefore, implantation of the intervention should coin with the proximity of the ethnic minority as well as the maximum number of beneficiaries. The selection of the intervention may play a vital role, i.e., identifying the type of intervention that has a larger command area, have long terms impact on water sustainability as well as the capacity to solve the water crisis on an immediate basis. From this perspective, low-cost rainwater harvesting for HH use as well as groundwater recharge can be effective as evident from figure 1. This intervention has multiple effects, like in one way, part of the collected water can be used for daily HH purposes, and on the other hand, the rest of the water can go straight to the aquifer recharging it for long terms sustainability. The impedance to this intervention is that it is fully dependent on the rainy season. However, a way out could be like establishing submersible pumps along with the rainwater injection into the aquifer so that the amount of water withdrawn from the submersible pumps for drinking water supply can be subtracted by the Rain Water Harvesting (RWH). Alternatively creating *artificial shallow aquifer* can also be a short to medium-term solution covering a larger population.

3.1 Economic Value of Impacts

Economic valuation of the impacts shows that from the implemented 73 interventions, beneficiaries have received or will receive health benefit, HH daily labor reduction, increased output from agriculture, tree plantation, and fish cultivation which is equivalent to approximately 21 million BDT per year against the total investment of 18 million gross. From the statistics, it seems to be financially profitable at the first look. However, a closer look into the figure 2 reveals that instead of harmonization, many of the interventions have skewed impact on the community.

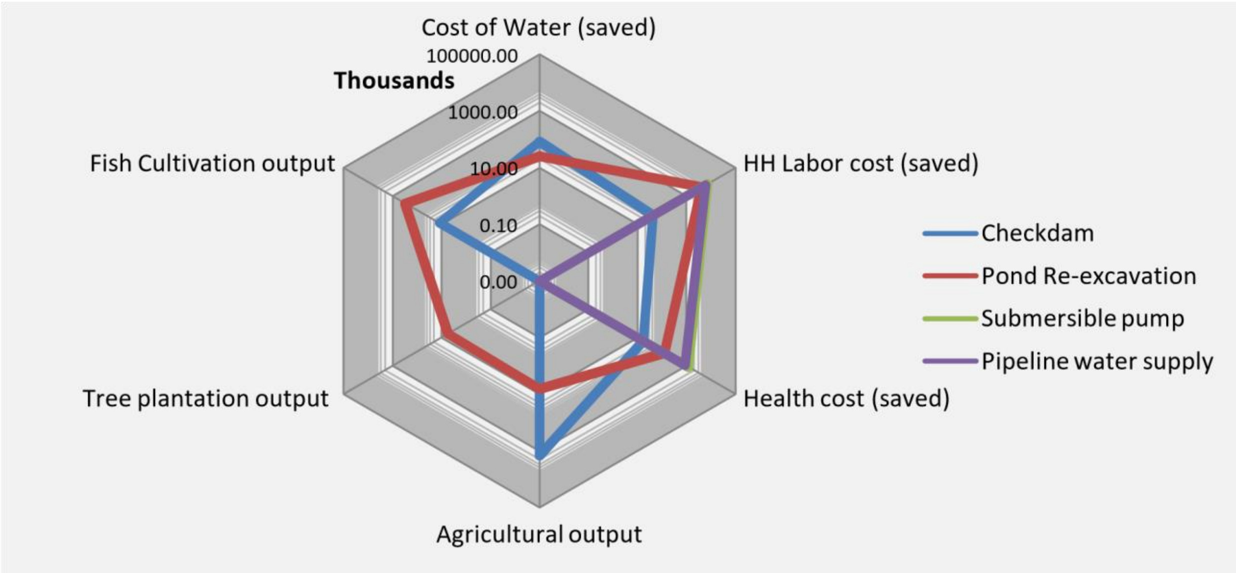

Figure 2: Economic value of the impacts

For instance, all of the interventions have a significant health impact, while submersible pump and pipeline water supply are not having an impact from the cost of water saved which is obvious as both of the interventions are withdrawing water from the aquifer. The impact would be more visible if these interventions would adopt surface water treatment and supply the treated water for domestic purposes. On the other hand, check dams are incurring no impact on output from tree plantation and lesser impact on the output from fisheries than that of ponds which, in a practical sense, should be bigger due to its larger coverage area and natural fishing advantage. A major reason behind this might be due to the absence of an appropriate operation and maintenance system for large intervention like cross dams. A pond is located within the community and its O&M involves primarily the direct beneficiaries. This, compared to the cross dams, is less complicated, as cross dams have multiple uses encompassing a vast command area with larger capacity for irrigation water supply promoting surface water use, retaining rainwater, promoting groundwater recharge, and increased fish cultivation. On the contrary, a pond having the same dimensions but limited magnitude, its simplicity in O&M makes it more popular and effective. Therefore, as a prime trust of IWRM, a well-defined and effective O&M can potentially scale up the benefits from cross dams eventually and harmonization in impacts will be visible as in the case of a pond.

For the submersible pumps and pipeline water supply intervention, the impact on reducing HH labor cost is much higher. As mentioned earlier, the realization of access to water at the doorstep for many areas has significantly reduced the daily labor time, especially for the women which have also contributed to their health. This residual time is spent either on income-generating activity or as leisure time.

3.2 NPV Test

As discussed earlier, the NPV test reflects which intervention is efficient in terms of resource utilization. The analysis was done considering 5 years as project duration period and summed up all monetary values of impact during this 5 year time. Each financially converted impact was further equalized into the present market value.

The investment capital (IC) also followed the same procedure to be uniform. Results show that all interventions have positive NPV (NPV>0), which implies the fact that all of them are financially beneficial (figure 3).

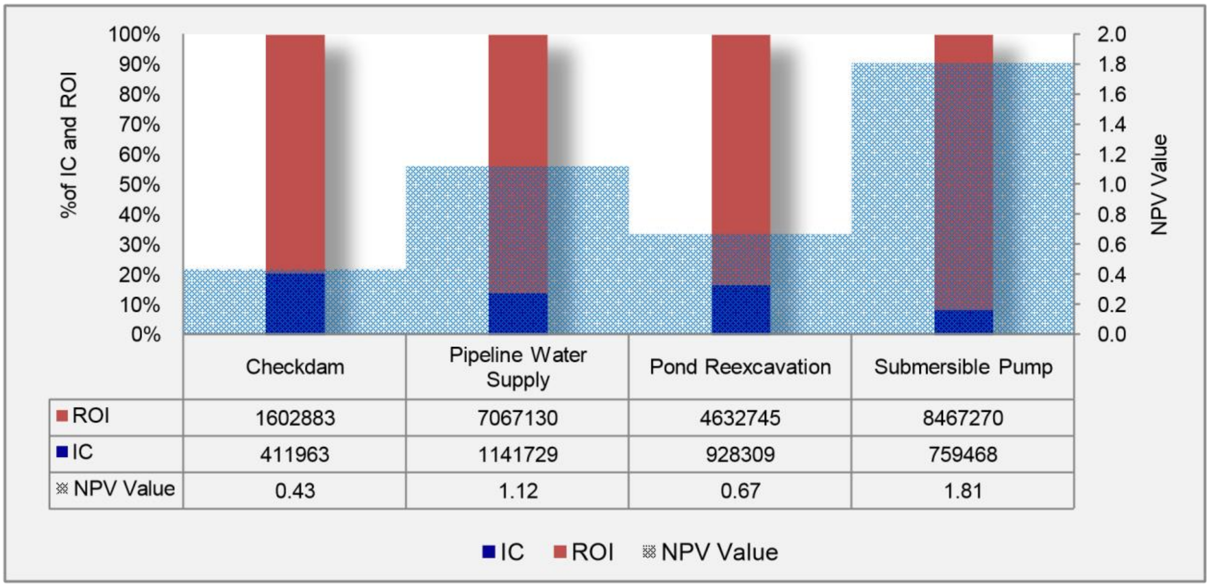

Figure 3: NPV, IC, and ROI comparison

However, there remain a few questions which seek the answer:

I. Even though the ROI is four times higher than the IC for Check Dams, why does the NPV is the lowest?

II. Does the NPV value indicate that the project should install more Submersible Pumps in the study area?

III. Why NPV is different for Pipeline water supply (PWS) and submersible pump (SP) when both use the same technology but PWS provides more service coverage than SP? IV. Does the NPV is proportional to the IC and ROI in the study area?

Check dams, as stated earlier, serve multiple purposes promoting 4R principles of IWRM. The project has constructed check dams but lacked appropriately introducing 4R unless surface water-based irrigation water supplies supplementary to GW irrigation. The best of it is yet to come. The field observation reveals that an appropriate operation and management system for check dams is completely absent which means the following aspect is to be addressed.

a) Who owns the water that reserved in the canals,

b) how this water will be used,

c) what will be the water tariff against what service (irrigation, HH, etc),

d) How the maintenance will be done (repairmen if required)

e) How the water will be supplied

f) What are the measures to be taken to add more value into the check dams (can be fish cultivation, tree plantation along the bank, etc)

g) How the benefit will be distributed among the beneficiaries etc.

The submersible pumps are installed to respond to drinking water shortage in the areas where crisis prevails to its highest and the access to drinking water resources is absent. However, it is a direct extraction of GW and a service providing intervention. Though safe drinking water supply is the highest priority and basic human right, in an area with higher aquifer vulnerability, spontaneous installment of submersible pumps can be a threat in long run. The groundwater drawdown trend in the study area shows that over the last 20 years it has declined for more than 10 meters (0.5 meters/year). This is quite alarming because the depth of the aquifer is heterogeneous and the thickness is also very low. Having this vulnerability, the sustainability of the submersible pumps and the potential risk of drying up of aquifer at the depth where these pumps are installed are is to be carefully reviewed. Furthermore, along with installing the pumps both for irrigation and drinking water, each facility should have a groundwater recharge point simultaneously to make sure that the withdrawal water is replenished by the rainwater injection. This will have additional cost implications and associated NPV will go down from the current rate. Due to the current service providing the nature of this intervention the NPV is much higher.

On the other hand, analysis reveals that the pipeline water supply intervention has a lower NPV than submersible pumps even though they are having the technology in use when PWS, besides, is reaching water at the doorstep of the HHS. The potential reason behind this is the additional cost required to install the pipeline from the water tank to the water collection point. This added cost has an impact on the NPV, however yet this can be minimized by enhancing the operational capacity and enlarging the service coverage. An appropriate business model can be developed pilot basis like below:

> The services from the PWS scheme will be charged. All beneficiaries must pay for the water and the collected amount will be deposited in a bank account. WRMC on behalf of the beneficiaries will operate the intervention. The committee in charge of the O&M, in discussion with the stakeholder, will establish an appropriate tariff for all beneficiaries. After at least 1 year, the installed facility will be extended to the nearby villages and water supply service will be provided to those villages revisiting previously establish tariff rates. It may increase or decrease depending on the need and coverage, however, eventually the rate should go down based on the scale of economies. The collected tariff will help to raise funds for operation and maintenance as required. At the later phase, few groundwater recharge points will be installed around the pumps promoting GW recharge and stabilizing the GW drawdown.

This brings again the necessity of an effective and active O&M system. Unlike cross dams, in the case of submersible pumps and PWS, such committees exist and are functioning, for an instance, in Jamtara village of Pakri Union. Nevertheless, the necessity of training for these committees is there to enhance their capacity.

4 Conclusion

This study aimed to examine the efficiency of the intervention valuating the impacts on monetary terms. The potential benefits of any activity or development, in general, are reached to the stakeholder both in-kind and cash. When development goals are meant for the betterment of the community, some negative externalities always accompany them, in another word they are the cost of development. In the social and environmental perspective, these externalities are too dynamic to explore, yet have much significance on economic valuation. A critically conducted economic valuation of all possible impacts can give direction on what is required to be improved, which is more logical to adopt and to improve our understanding of how the natural environment benefits us. However, economic value evidence is only one input to decision making. All other scientific, social, environmental, ethical, and legal factors must also be considered as with any other type of evidence, better information about economic values does not necessarily result in better decisions.

The current study, in this direction, has some of the findings that capture facts related to the impact of different interventions. The impacts are found to be unevenly reached. Some interventions have a skewed impact on some particular parameters while others have a partial impact. A potential reason behind that is the absence of an appropriate operation and management system. Due to this, the maximum use of benefit from the intervention is yet to receive by the beneficiaries. This is particularly true for larger interventions like a cross dam. The extended coverage and capacity of such interventions are to be understood properly. WRMCs, as a nucleus of IWRM in Barind, is established in each village with a vision that they will work closely with the local water resource development and coordinate with LGIs. This is one major area where these WRMCs can play a vital role to ensure the maximum benefit reaching the stakeholder minimizing the negative externalities.

For all of the interventions, the health and HH labor cost reduction is found to be very significant. This puts the evidence on the necessity of these interventions to be implemented and as required replicated. On an average, each HH in the intervention area spends approximately 3-4 hours every day to collect their daily HH water where WHO defines the collection time of more than 30 minutes as '*No* Access' [8]. The spent time for water collection not only consumed their daily working hour but also limited their working efficiency having severe health impact. In many areas, due to drinking water unavailability, the ethnic villagers needed to pay a higher price to collect water from the nearby non-ethnic villages. Sometimes access was denied straightway on religious ground. Humiliation was part of their daily life. On the other hand, lack of drinking water provoked diseases, especially to the children. The implemented drinking water intervention, both submersible pumps, and pipeline water supply bring significant change in the livelihood of these beneficiaries ranging from health improvement to social empowerment. With little improvement in O&M and the introducing GW recharge system, this intervention can be replicated at the places where severe drinking water crisis prevails.

5 Declarations

5.1 Acknowledgements

We thank IWRM team and field staff for supporting the data collection. We also acknowledge Jahangir Alam Khan, Project Coordinator, IWRM Project and Akramul Haque, Chief Executive Officer, DASCOH for their cordial support.

5.2 Funding source

This study was done under the IWRM project activities. The project was financially supported by Swiss Agency for Development and Cooperation SDC.

5.3 Competing Interests

The authors declared that there is no conflict of interest in publishing this study report.

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