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Water Resources Planning Organization

Inception Report

Study on Developing Operational Shadow Prices for Water to Support Informed Policy and Investment Decision Making Processes

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Abbreviations

BADC	Bangladesh Agricultural Development Corporation
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BDP	Bangladesh Delta plan
BMDA	Barind Multi-purpose Development Authority
BPDB	Bangladesh Power Development Board
BWDB	Bangladesh Water Development Board
CMI	Census of Manufacturing Industries
CV	Contingent Valuation
DPP	Development Project Proforma /Proposal
ECA	Environmental Conservation Act
LGED	Local Government Engineering Department
IFPRI	International Food Policy Research Institute
MoEF	Ministry of Environment and Forest
NWP	National Water Policy
NEP	National Environmental Policy
NWMP	National Water Management Plan
SDG	Sustainable Development Goals
TCM	Travel Cost Method
TEV	Total economic value
WARPO	Water Resources Planning Organization
WTA	Willingness to accept
WTP	Willingness to pay

1. Introduction

1.1 Background

Water is one of the most used (and abused) natural resource on earth. While nearly three-fourths of the earth is covered with water in the oceans, fresh water which is necessary for use by humans for sustaining life and for various economic and sociocultural practices, is just about 2% of the total available water and of that 2%, only a little is available in liquid form as rainfall, in wet bodies and rivers, and water underground. This very small volume is distributed unevenly over space and time (between and within years) making it a scarce resource in most places and situations. It is therefore imperative that this scarce resource be allocated among its different uses and groups of users in an equitable and also efficient way. This aspect of allocation of water is stated explicitly in SDG 6 on water and its sub-goals.

One major principle for such efficient and equitable allocation is to do so based on how human society value such a resource in alternative uses. Valuing water is thus a prerequisite for efficient and equitable distribution of water among its different uses and groups of users. Bangladesh apparently has a lot of water because of generally high rainfall (though distributed unevenly over space and time). Yet, it already does suffer from scarcity of water the intensity of which varies from place to place. Much of it used for agriculture and in most cases quite inefficiently leading to major wastage. Certain industries are major users of water for either industrial processes or cooling purposes. Many do depend on own arrangements for sourcing water mainly from underground reservoirs, a common property resource and thus suffer from the oft-repeated problem of "tragedy of the commons" (Hardin and Garrett, 1968 and Frischmann, Marciano, and Ramello, 2019). On the other hand, there is at best limited information on the quantum and sources of such uses. Lastly, water is used for drinking and other residential purposes, which must be supplied as a matter of basic human right. Agricultural water demand was estimated to be 33km3/year and the corresponding figures for domestic and industry were 2.7 km3 and 2.9 km3 in 2011 (Rahman 2016).

Efficient allocation of resources is indicated by the absence of both overuse and misuse and for this, we need to know the price of such a resource. Since water is not priced through the market and is accessible for use by various users free either of charge or at a minimum nominal price (like water supplies in cities), it is likely that the resource is over-exploited and so may be on the verge of depletion. As such, there is a need to understand the value of water in its different uses.

Value of water serves two purposes. First, this may be used as a guide towards pricing of water for different purposes, which may take value as a major element (but not necessarily the only one) for making such decisions. Second, the value may be used to estimate a set of shadow prices for water in its different types of use. Previously, water was never used as an input, which has to be costed for estimating net social benefits in public sector investment decision-making. An estimated set of shadow prices for water will thus help in allocating public sector resources for investments in areas or projects where social benefit net of social costs of all inputs including natural resources such as water may be used for prioritisation. If and when such shadow prices are estimated these may be used for operational purposes of revised guidelines for DPPs. Future public investment projects can thus directly benefit from such estimates.

Given the importance of valuing water in Bangladesh, Water Resources Planning Organization (WARPO) has assigned the task of developing operational shadow price of water to support investment and policy decision-making processes to Centre for Environmental and Geographic Information services (CEGIS). The present assignment covers four sectors, Agriculture, Domestic, Industry, and Ecosystem services considering several hotspots such as Coastal Zone, Barind and Drought Prone Areas, Haor and Flash Flood Areas, Chattogram Hill Tracts, River Systems and Estuaries and Urban Areas etc that are identified by Bangladesh Delta Plan 2100.

1.2 Objective

The main objective of this study is to develop a set of shadow price of water (an intrinsic value of water) for agriculture, industry, municipal and eco system services so that it can contribute at policy level and investment decisions in the public and private sector. Note that when water is used as priced resource, one will also need a set of conversion factors for translating these administered or market prices into shadow prices for use in investment decision analysis.

For private sector investment decision-making and operation, the shadow prices will provide guideline for pricing water for such purposes, again noting that actual prices may reflect not simply value of water but also other socio-economic factors. Similar considerations shall apply for other non-public uses of water and environmental safeguards and considerations. In effect, all these will improve allocation of water resources and support to attain sustainable development goals.

1.3 Rationale of the project

Water remains an indispensable natural resource and is used in diversified ways including for sustaining life of all forms including humans. There are strong demands for water by all competitive sectors. There, however, is no proper guiding principle for allocating water for diverse purposes of life sustenance, economic production and for socio-cultural as well as ecosystem services vital for keeping natural ecological balance. It is happening because valuing water is not well recognized or practised in Bangladesh. In fact valuing water is not clearly mentioned in existing polices/acts or legislations.

The Bangladesh Water Act 2013 identifies the significance for managing all forms of water resources in the context of natural flow of surface water and recharge of groundwater. The Act provides the legal framework for development, management, extraction, distribution, usage, protection, and conservation of water resources. However, the Act falls short of consideration of the idea of evaluating the value of water considering all costs due to and benefits provided by water. The estimation of value of water and the shadow prices and consequently conversion factors for market prices of water, where they exist, thus presents a transformative opportunity to convert risk to resilience, poverty to well-being, and degrading ecosystems to sustainable ones (Bellagio, 2017).

For Bangladesh, it is of particular importance as it is a densely populated active delta, with multiple and increasing competing water demands, diminishing groundwater aquifers, increasingly polluted surface and groundwater bodies, with high vulnerability to climate change. In line with Sustainable Development Goal 6: ‘Ensure availability and sustainable management of water and sanitation for all’, in Bangladesh there is an imperative need for valuing water to ensure equitable access to safe and affordable drinking water, increase water-use efficiency in economic uses and protect and restore water-related ecosystems essential for continued existence and proper functioning of other human systems.

1.4 Scope of Work

The present study has three major parts, namely:

In Part 1, the study will develop a set of shadow prices for water across its various uses in different sectors of Bangladesh along with conversion factors wherever so necessary and refine them as part of case studies (action research). These values can be operationalized as guidelines in investment and policy decisions by the public and private sectors, as well as by civil society. The shadow prices for water will be developed through a multi stakeholder process to ensure their acceptance by stakeholders. How far harmonisation may be practical will also be investigated and where so, these will be harmonised.

In Part 2, an attempt will be made to mainstream shadow prices of water in policy and decision-making processes. Capacity development and training will be provided to selected public sector officials to operationalize shadow prices within the DPP process.

In Part 3, scopes and options for making shadow prices operational for private sector decision-making processes will be identified. Demonstration case studies with selected private sector companies can guide as lighthouse examples on how to operationalize shadow prices for water for private (business) sector investment decision. Capacity development and training will be provided to the private sector and civil society organisations as appropriate to ensure the integration of the shadow price of water in their decision-making.

1.5 Outputs and deliverables

Under this project, the expected outputs are shown in Table 1.1 and the deliverable within the project period are shown in Table 1.2.

Table 1.1: The expected outputs of the project

SL	Expected set of outputs
1	Best practice methodologies and past and ongoing initiatives on valuing water/usages of shadow price for water as basis for investment and policy decisions around the world
A-2	Best practices on using value of water for investment decision making
A-3	Framework for valuing water/developing shadow for water for Bangladesh
A-4	Four (4) case studies (action research) to test and refine the valuing water framework for Public sector
A-5	Three (3) case studies on shadow price for water in private sector decision making
A-6	One harmonized set of values for water
A-7	Designed incentive structure for companies to engage in sustainable water resources management
A-8	Process of streamlining valuing water into public investment decision making
A-9	Capacity building/training program (Material and Manual)
A-10	Program on awareness raising campaign on the value of water

Table 1.2: The expected outputs of the project

Deliverables		Contents
*1.	Inception report	▪ Background including the overview and lessons learnt of best practices & methodologies used to value water in Bangladesh and abroad ▪ Approach and methodology ▪ Work plan and deliverables ▪ Outline of suggested 7 demonstration case studies
*2.	Interim Report	▪ Mid-term progress of the study ▪ Framework for valuing water ▪ Outcomes of demonstration case studies
*3.	Shadow prices on water	▪ Set of shadow prices for water in tabular format ▪ Data related to shadow prices in digital form ▪ Underlying models/ calculations and assumptions
*4.	Draft updated version of DPP documents	▪ Standard DPP Format and Manual incorporating shadow price of water for Planning Commission
*5.	Action Plan for Capacity Development	▪ Materials for Capacity Development ▪ Overview of target audience and timeline of concrete capacity building sessions
*6.	Action Plan for Awareness Raising	▪ Actions and activities related to awareness raising Modalities and targeted audience for awareness campaign including strategy
*7.	Draft Final Report	▪ Background, methodology, ▪ Shadow prices framework, data used, ▪ Assumptions, capacity building and awareness raising ▪ Case studies output ▪ Study outputs
★8.	Final Report	▪ Comprise with all the information including methodology, outputs and final outcomes

1.6 Structure of the Report

The inception report consists of four chapters:

First chapter is named as ‘Introduction’, which described the background of the project, objectives, scope of works.

Second chapter is ‘Literature review and Policy Analysis’ which includes two sections; one is review of different documents on concept, methods and best practices of shadow price and the second section described the relevant policies, plan.

Third chapter is ‘Approach and Methodology’ which gives a clear understanding on how to develop shadow price/valuing water for four sectors agriculture, municipal, industry and ecosystem services.

The last chapter is ‘work plan and deliverables’ which describes the work plan to develop shadow price within time period including all the deliverables, field visits, consultation, workshop etc.

2. Literature Review and Policy Analysis

Finding the economic value of water, when it is not properly priced through the market, requires considerable understanding of its productivity in different uses. It has not be done in Bangladesh and thus it requires extensive literature review including reviews of different policies/ legislations of Bangladesh to identify, the real reasons behind protecting water resources in Bangladesh (implicitly or explicitly). This will help to develop methods for finding the shadow price of water in different uses. In addition to this, it is also important to review the best practices in the world for valuing water. This will be a guide to assess and select the best method for valuing water in Bangladesh context considering particularly deficiencies in data availability. Following sections describes various concepts in valuing water, methods of analysis to find the value (of water), and some best practices, polices/legislation related to efficient utilization of water.

2.1 Review of literature

This section discusses the concepts of valuing water and is followed by the methods used to find values in different sectors of the economy such as agriculture, groundwater, ecosystem services etc. Both national and international best practices on valuing water is also reviewed within it.

2.1.1 Concept of valuing water

Water is used for many purposes and some of them are complementary while others are competing. In general, water resources have many uses and the ecosystem assessment literature has categorised them into four distinct types of use: a) provisioning use of water – where water is used directly or indirectly for production of various goods and services for us; b) regulatory use of water – where water is used to regulate various ecological functions like precipitation, drought, flooding, etc.; c) cultural use of water – where the ecosystems surrounding waterbodies or water sources contribute towards developing non-consumptive use of water like tourism services, cultural heritages, etc.; and d) supporting use of water to continue life over time for both human and plants and animals. These different usages are not necessarily mutually exclusive and so it is hard to find values of water across individual uses.

Private sector tends to use the language of finance, while governments often employ concepts from economics using a range of environmental, rights-based, or social-goods for valuing water. Morgan and Orr (2015) emphasized that all of the stakeholders should have a legitimate claim on water and its use, and so a corporate perspective must both understand and negotiate these different ways of valuing water as a scarce resource. There are others who define value of water differently like Rogers, Bhatia and Huber (1997) considered the value of water to be divided into economic value (i.e Value of water in industrial and agricultural use) and intrinsic value (i.e pure existence value). Whereas, Turner and Postle (1994) consider the economic value of water resources and aquatic ecosystems in terms of four separate components (abstraction of water, fisheries, recreation and biodiversity). De Groot (1992) categorizes the components of ecosystem value according to the impact on welfare, using a broad definition that encompasses environmental, physical and mental health, employment and social contacts as well as material prosperity.

2.1.2 Estimation of valuing water

For estimation purposes, the total economic value (TEV) of water comprises of both direct, indirect use and also future use of water (Figures 2.1) which also shows common methods of estimation on which more will be said later) ;

- Direct use values of water arise out of direct use of water such as water for drinking and irrigation purposes, industrial uses, etc.
- Indirect use values of water are associated with services provided by water resources such as for navigation, fisheries, recreation, drainage, recharge of the aquifers, etc.
- Non use values of water are the values of water due to its services like protection of our aquatic biodiversity, conserving human life by protecting species of animals and plants, etc.

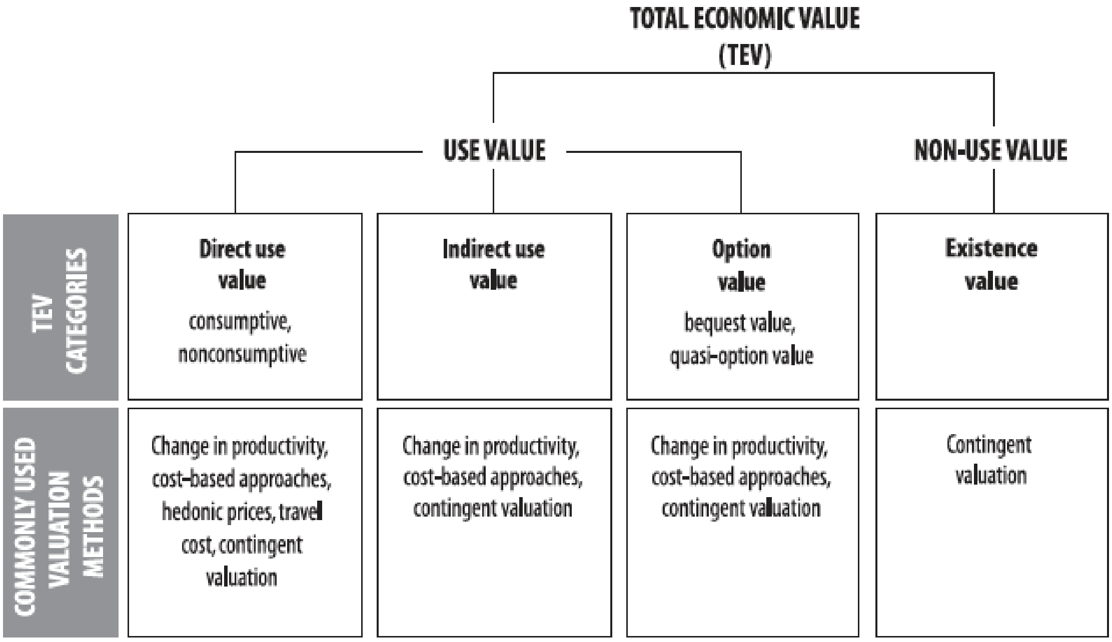

Figure 2.1: Components of the total economic value of water resources

Understanding values from each of these uses help policy makers to design an efficient trade-off between these usages. The Turkish government (Croitoru et al., 2016) has considered a set of policy issues related to water resource management (WRM), including estimating the economic value of water and used a similar framework of valuation that consists of estimating direct use values, Indirect use values and non-use values of water. Ultimately, they estimated Total Economic Value (TEV) for their case and used them to develop an efficient water use mechanism.

Another study in China (Liu et al., 2014) calculated shadow price of water resources by using the extended input-output table on water conservancy for nine major river basins. They also used two nonlinear models to calculate industrial water and productive water for 2020 and 2030. In addition, there several studies which estimated values of water across different river basins in order to promote efficient use of water in China (Du, Fan, & Tang, 2016; Duan, Liu, Ren, & Peng, 2016; Feng, Yan, & Yan, 2014).

2.1.3 Concept and methods of valuing water from the position paper on valuing water of Bangladesh

The position paper gives a clear exposition of valuing water and different approached to be used for valuing water. The authors mentioned that valuing water provides a basis of all costs and benefits derived from the use of water in all spheres of life including social, economic and environmental dimension. It also concluded that disregarding these costs and benefits in policy and investment decisions might lead to misallocation of resources (Gulland, Hone, Pohlner 2018). Therefore, there is a need for valuing water across various uses in Bangladesh so that Bangladesh can ensure efficient use of our scarce water resources.

The paper summarized different approaches used to value water resources. Each of the approach comprises of different methods.

a) Revealed preference approaches include those methods, which are based on people's revealed behavior in the market where water is used directly or indirectly. The market itself may be a direct market like drinking water market or irrigation water market or it may be a surrogate market where a different product or service market can be used to trace the value of water using market data. These are described below.

Market price method

Data on the water price and water use are used to estimate value of water. The market is determined by relative demand and supply of a good or service. In this case, it reflects the true scarcity value of water (if the market is competitive) and its marginal value (IUCN, 2004)

Production function/residual value method

Water is used for many production process, such as for agricultural or textile industry as basic input. Thus by assessing the impact on production by changing either the quantity or the quality of water on the production process, the value of water can be established. This is possible even in absence of market prices for water.

Surrogate market price method (hedonic pricing)

The absence or presence, or the quality or quantity of water, can influence the price for other goods or services. Thus, the value of water is sometimes indirectly in people's expenditure.

b) 'Cost-Based Approaches' infer the value of water incurred Some popular methods under this approach are-

Replacement cost method

The value of water can sometimes be estimated with reference to avoided costs or the cost of replacing a water-related service. The cost of the replacement can be taken as an estimate for the value of water.

Mitigative or advertise expenditure

If the loss of water service, or a decline in its quality or quantity, has negative effects, the cost of required mitigation or aversion measures can be used to estimate the value of this water service.

Damage cost avoided

In cases where water ecosystems protect economically valuable assets, the damage cost resulting without this ecosystem can be used as an estimate for the value of this water service.

c) Stated Preferences Approaches where value of water is derived using a hypothetical market along with a real response from various stakeholder. The method, when used effectively, may be used to track value of a resource (like water) which has significant non-use values. Some popular methods under this approach are-

Contingent Valuation Method (CVM)

The value of water can be estimated based on the response of users to hypothetical scenarios, which seek to stimulate their willingness to pay (WTP) willingness to accept (WTA) for specific water services.

Conjoint analysis

Almost similar to CV. Respondents are asked to either rank them or choose between them, rather than stating their WTP or WTA.

Choice experiments

Similar to CV, the value of water can be estimated based on responses of users to choose between alternative attributes of a resource (here water) under different scenarios, such as policies. For example, people will be asked whether they want low quality of high quantity of water of vice versa (Gulland, Hone, Pohlner 2018).

2.1.4 Methods used for valuing water for different uses

Since 1960s economists have developed a variety of techniques for assessing the value of nonmarket goods and services which are not priced and/or traded in markets. Some of the earliest attempts to value a non-marketed natural resources involved estimating the value of water for use in agriculture in the United States. These early approaches did not use consumers preferences but used profit maximizing models of farm management to value water. Models used linear and non-linear programming approaches and the water constraints to find the shadow price of water. Specifically, economists had to infer value by examining changes in returns to the farm associated with changes in the amount of water applied. In this way, they could estimate the value of both surface and ground water. (National Research Council. 1997). In the following sections explains some common practices of valuing water in agriculture sector, ground water, ecosystem services are discussed (so far have been reviewed).

2.1.5 Valuation of water in agriculture sector

There are several methods that can be used to value water used in agriculture. Of them the most direct method is to value productivity of water using the production function approach. Alternatively, using duality theorem it is also possible to use the cost function or the profit function to find value of water used in agriculture.

Production function method

This involves assuming a production function where water is an input in the production process. Theoretical details of the economic principles based on which such pricing, and hence, the demand and supply curves for water can be derived, have been provided by Tsur et al. (2004: 64-85). A simplified version of the production function approach known as fixed proportions, or residual known as fixed proportions method. The net profit for each hectare of agricultural land is calculated, excluding water costs. The net profit is estimated to reflect the value of water.

The key economic equation is: $\pi = \sum NiXi$

where π is total net benefit excluding water costs, Ni is the net benefit per hectare excluding water costs for land use I and Xi is the area of land use i. In this case, the land use refers to a possible production system which can be comprised of a number crop rotations.

The net profit per hectare excluding water costs can be disaggregated into

$$Ni = Ri - Mi - Li - Ki - Di$$

Where Ri is the benefit of output per hectare for land use i. Mi; is the materials and equipment cost per hectare for land use I, Li is the labor cost per hectare for land use i. Ki is the capital cost per hectare for land use I,and Di is the land cost per hectare for land use i. All relevant benefits and costs should be included. If relevant costs are excluded, the value of' water will be overstated (Young 2005)

Gibbons (1986) compiled several studies done in the US on marginal value of water using crop water production function approach. The value of water for different agricultural products ranged from USD 0.01 to 0.57 per m3 in a couple of states in 1980 USD. All estimates regardless of methods to derive them depend on assumptions about the technology or efficiency of the irrigation system. Production functions assume specific field application efficiency. Irrigation water values increase with a rise in crop price and an improvement in irrigation efficiency.

2.1.6 Valuing water for groundwater in Australia

Groundwater valuation is an instrument for efficiently allocating groundwater resources over time, which supports sustainable groundwater management. According to National Centre for Groundwater Research and Training in Australia, the valuation methodology for groundwater can be both ‘revealed’ preference and ‘stated’ preference techniques. The most commonly used are the deprival value, residual value, market prices and proxy market prices. Other methods such as hedonic pricing, benefit transfer and replacement cost or avoidance have not been found in published groundwater case studies, however are still used in the consideration of groundwater value. However, the most appropriate valuation methodology will vary, depending on the circumstances, data availability and what value (extractive, non-extractive and option value) is being assessed (Deloitte Access Economics ,2013).

Deprival value method

The deprival value represents the cost users would incur to replace groundwater with the next least costly alternative source. This methodology is based on the assumption that if groundwater users were deprived of groundwater, they would be willing to pay up to the value of the next best alternative water source, less groundwater’s associated ongoing costs

(Marsden Jacob Associates, 2012). In Australia, valuing ground water Shepparton Irrigation Region is located in the Murray Darling Basin, this method has been used for dairy, horticulture and cropping activities

Residual value method

The residual value represents the value of the product that is generated from the use of groundwater. It is calculated by determining the profit (revenue less costs incurred) associated with using groundwater to produce the given product (RM Consulting Group,2008). This methodology is generally assumed to be appropriate when it is not possible or prohibitively costly to replace groundwater with an alternative source. For example, Assessment of economic value of GW for consumptive purposes in Victoria this method has been applied. Residual value method applied to irrigated agriculture (subtracting all costs associated with GW from revenue generated) (Deloitte Access Economics, 2013).

Market price method

The market price is revealed by the prices paid for groundwater entitlements and allocations in water markets throughout Australia. In some cases where groundwater is used in an area where surface water trading occurs, the price paid for surface water is used as a proxy for groundwater value (Deloitte Access Economics, 2013).

Proxy market price method

The proxy market price is revealed not through the market price paid for the resource itself, but through other costs to access (or protect) the resource. Examples might include the costs that groundwater users are willing to incur to access groundwater resources, such as drilling, pumps, pipes and storage or, alternatively, the scale of past investments that have been made to protect the resource (Deloitte Access Economics, 2013).

Productivity method

This is the marginal value-add made possible by groundwater use in industries that utilize groundwater as an input to production. In efficient markets this should, in theory, reveal the same value as the market price method (Deloitte Access Economics, 2013).

Benefit transfer

The benefit transfer method is where revealed preferences transfer from one area to another area (adjusted for other variables as needed) (Deloitte Access Economics, 2013).

Hedonic pricing

Hedonic pricing reflects the contribution of groundwater rights to higher land values, in situations where groundwater access entitlements have not been unbundled from land. This requires that groundwater availability be isolated as the sole source of difference in property prices which, in reality, is not always a practical approach (Deloitte Access Economics ,2013).

Replacement or damage cost avoidance

This is the cost that is avoided through groundwater availability eliminating the need to develop an alternative, more expensive source of water, or through avoiding the need to undertake environmental remediation or protection (Deloitte Access Economics, 2013).

Option values

Another important value of groundwater relates to the option to use it in the future, or its 'insurance' value, which can underpin investment decisions in agriculture and mining and provides value even when the groundwater is not used (Deloitte Access Economics, 2013).

2.1.7 Methods for valuing water for ecosystem services

The ecosystem provides various kinds ecosystem services. Not all such services are unidirectional in the sense that rise in one type of ecosystem service may lower another kind of such services. Value of ecosystem services is the relative contribution of ecosystem to the goal of supporting sustainable human well-being. Any decision, which may lead to such trade off, implies valuation ((Ghosh and Bandyopadhyay 2009). Note also that one of the major service of water is to provide services, which maintain ecological balance of the natural system. There may be all kinds of such ecological balance, which include water needed in water and heat balance, biological balance, water-sediment balance, water-salt balance. In the narrow sense, eco-environmental water refers to the water resources quantity needed to maintain these balances as well as prevent degradation of the ecological environment. While ecological water is a part of water resources, which is necessary to maintain the integrity of the ecosystem, it is also a part of water consumption (Grizzetti et al 2015). Based on these considerations, some of the methods used for valuing ecosystem services of water are shown in Table 2.1.

Table 2.1: Some notable studies on the valuation of ecosystem services of water

Author	Methodology Classification	Summary
Kaplowitz (2000)	Contingent valuation methods	Empirical test of the use of focus groups versus individual interviews to identify and value ecosystem goods. Examine hypothesis that focus groups and individual interviews, all else being equal, "reveal similar sets of information about a shared mangrove ecosystem"
Kerr (2002)	Informal personal interview	Looks at watershed development projects initiated in India under various types of organizations and qualitatively analyzes the impact of those projects on the poorest sector of society. Women and the poorest in the villages were hurt the most, where public lands are closed to use for revegetation
Chomitz et al.(1998)	Analysis of financing Environmental services	Details particulars of Costa Rican federal programme for four forest benefits: biodiversity, carbon sequestration, watershed protection, ecotourism, and scenic values.
Kumar et al. (2003)	Production function approaches	Evaluates groundwater recharge through the agricultural production in the floodplains of the Yamuna river in the corridors of Delhi.
Pan et al(2002)	Ecological function analysis and indirect valuation methods	Attempted to estimate the Baoan lake ecosystem services (COfixation, O2

Author	Methodology Classification	Summary
		release, nutrient recycling, water conservancy and water supply and SO2 degradation) and its indirect economic values on the basis of ecological function analysis and economic methods.
Sekar (2003	Contingent valuation methods and hedonic pricing methods	Conducted for Kargambathur village of Vellore district in the state of Tamil Nadu in India to assess the effects of deterioration of the Palar river due to pollution from the leather industry

Source: Ghosh and Bandyopadhyay: 2009

2.1.8 Best practices of valuing water in Bangladesh

In Bangladesh, there are very limited published estimate of value of water. Nasima Chowdhury estimated use value of irrigation water in Bangladesh using the production function approach (Chowdhury, 2010). She found that Bangladeshi farmers are using water inefficiently and on average for a taka of water the productive value in terms of rice is only 0.05 taka whereas for a 1 taka expenditure on fertilizer increase output value by 12.42 taka. The low marginal productivity of water indicates that water is overused in Bangladesh agriculture. However, her study did not have full account for water used in agricultural land because data on volume of water used by area of land was not available.

Mullick, Babel and Perret (2011) made two estimates for Teesta River irrigation for water withdrawn and water applied in the field. The estimates were respectively US cents 2.4 and 6 per cubic metre. Noting now that for Asian countries the lowest value is US cents 4.1, if we average the values this comes to US cents 2.8. Possibly for Bangladesh, tentatively therefore for illustrative purposes we can take a value of US cents 3 or at average exchange rate say Taka 2.4 per cubic metre.

Chakravorty (2003) developed water-pricing mechanism, named a pro-poor framework based on two surface water irrigation projects of BWDB. He used direct methods to derive price of water under alternative pricing principle. Experiences of two Bangladeshi irrigation projects - Meghna Dhanagoda and Pabna were used to compare the practice of recovery of irrigation cost from the farmers, with the derived economic cost of water per m^3. In deriving the cost, only surface water for irrigation was considered, plus the poverty reduction objective, along with society's preference for water use. Partial equilibrium approach had been taken towards pricing of water, because Bangladesh has no well-functioning water market, no efficient water allocation by using multi-period, multi-location systems. The pricing frame was based on two major scenarios: pricing for those who use critical volume of water under a production regime pricing for those who waste water under the same production regime. Three sets of alternative uses were used: (1) Winter Rice (2) Culture Fish and (3) Industry and Domestic. Total tariff and additional tariff are calculated on the basis of volume of water used, relative weights of social preferences for each type of use and net value of outputs and O&M costs per m^3 of water.

Bangladesh Agriculture Development Corporation (BADC) and Barind Multi-purpose Development Authority (BMDA) have also established the pricing mechanism for pre-paid or smart card. BMDA actually introduced the smart cards early on in 2006 and now all the tube wells (nearly 15,000) under BMDA is operated with smart cards generally, but not as found always, owned individually by all farmers for a smart card under BMDA issued to an individual farmer). Individual farmer level ownership allows farmers better control over when and how much to irrigate the field and thus the water abstraction may be even lower than that happens in case of BADC smart cards. This system is a volume-based pricing and has apparently resulted in lowering use of water than previously. Yet, there appears to be various types of social arrangement around the basic volumetric pricing.

Table 2.2: BMDA prices for water

DTWs	LLPs
0.5 to 0.75 cusec - 80 tk/hour 0.76 to 0.99 cusec - 90 tk/hour 1 cusec - 100 tk/hour 2 cusec - 115 tk/hour	Single lifting - 120 tk/hour Double lifting - 150 tk/hour

Converting cusec into cubic metres per hour, for water from a one cusec DTW, BMDA farmers pay somewhat more than BADC farmers paying by volume. However, comparing BWDB tariff, BMDA farmers pay almost 16 times the price paid by BWDB farmers. Apart from these, other attempts made in Bangladesh to value water will be explored to sort out the best practice methodologies in Bangladesh. In both cases, stocktaking of best practice methodologies will be performed based on following two criterion or cases:

- Using the value of water/ shadow price for water as basis for investment and policy decisions including pricing for water by the public sector and private sector (incl. financial institutions);
- Usage of value of water for designing and setting financial and regulatory instruments, such as tariffs, taxes, standards/ benchmarks, polluter pays etc.

Besides, CEGIS made a consultation with Bangladesh Water Development Board (BWDB) about the water ricing of irrigation projects in Bangladesh as exhibited in the pictures below:

Figure 2.1: Consultation with chief water management, BWDB about water pricing of irrigation projects of BWDB

BWDB mentioned that according to Water Policy 1999, and Bangladesh Water Development Board Irrigation Service Charges and Collection Regulations, 2003, The BWDB would collect irrigation water service charge per acre per crop season to recover a part of O&M cost of the irrigation project. BWDB would provide irrigation water through gravity, pump and lift irrigation method. As such, irrigation charge varies in different irrigation projects, for example, it ranges from BDT 100 per acre per season to BDT 650 per season per acre.

2.2 Review of GoB's policy, laws-rules on valuing water of Bangladesh

Increasing urban and irrigation water demand and absence of valuing water price is leading to a major development barrier and environmental problem in Bangladesh specifically in water sector area, impacting on ground water dependent ecosystems and the population who depend on them for their livelihood activities. However, Bangladesh has a well-developed set of environmental Policies, Plans, Acts and Rules that deal with Environmental Resources, Human Resources and Economic Resources. This section provides a brief summary of the content and applicability of the policies, plans, and legislation in valuing water sector.

The Dublin principle implies pricing as one of the mechanisms for economizing use of water, raising its efficiency and productivity. The Rio principle implies human rights to water putting an upper boundary to the use of prices. On the other hand, the UN's Sustainable Development Goal 6 is to ensure affordable access to water and sanitation for all by 2030.

2.2.1 Polices related to water resources development

The Department of Environment, the Ministry of Environment and Forest (MoEF) is the main responsible agency to control and abatement of water pollution in Bangladesh. Broadly, Department of Environment (DoE) is mandated to set and enforce environmental regulations for all forms of pollution and media (air, water and soil). Specifically in relation to water pollution, DoE are responsible for pollution control; setting water quality standards (WQS) for water use and discharge; issuing environmental clearance permits; and declaring and protecting degraded ecosystems.

The Ministry of Water Resources through several of its agencies, particularly the Water Resources Planning Organization (WARPO) and BWDB are responsible for all other forms of water management in Bangladesh. The BWDB is principally responsible for implementation, operation and maintenance of water related projects, whilst WARPO is mandated to provide advice on policy, planning and regulation of water resources. The policies and laws through which the BWDB, WARPO and DoE operate include the National Water Policy; the National Environment Policy and Rules; and the Environmental Conservation Act. There are more than 200 laws aimed at addressing environmental issues in the country (*Final Research Report Section 2, Alexandra Clemett*).

In 1999 the National Water Policy (NWP) was drawn up with the goal improved water resources management and protection of the environment. Every public agency, every community, village and each individual has an important role to play in ensuring that the water and associated natural resources of Bangladesh are used judiciously so that the future generations can be assured of at least the same. One of the major objective of NWP is "*Accelerate the development of sustainable public and private water delivery systems with appropriate legal and financial measures and incentives, including delineation of water rights and water pricing*"

Water sources like **ground water and surface water**, are precious assets of Bangladesh with unique regional characteristics. Apart from their economic importance, they have great economic and environmental value. These ground and surface water account for a large share of the rural and urban potable water, natural capture fisheries, surface water irrigation, and provide a habitat for a wide variety of aquatic vegetation and birds.

The water bodies usually connect to some adjoining river through khals. In the past, water bodies have been drained through engineering interventions and turned into cropland for immediate gains. The adverse effects of such interventions have been deleterious to the environment. They have destroyed the fish and aquatic vegetables that thrive in these wetlands and are important in the diet of the rural poor. They have also blocked the flow of wastes, discharged from the flood plains and domestic sources, which naturally move out of the water bodies (wetland) through the khals into the river's drainage system.

The Government believes that in order to assist the natural processes of groundwater recharge, maintenance of aquatic life and ecological balance, disposal of wastes through the dynamic river system, and for turning the huge water bodies into recreational areas, their planned development is essential. It is, therefore, the policy of the Government that: Natural water bodies such as beels, haors, and baors will be preserved for maintaining the ground water recharge and aquatic environment and facilitating drainage.

In 2018 the National Environmental Policy (NEP) was drawn up with the aim of providing environmental protection, pollution control, and protection of biodiversity and sustainable management of the environment considering sixteen (16) objectives. The relevant objective of the Policy, which are pertinent for this study, are: i) maintaining the ecological balance and overall development through protection and Improvement of the environment; ii) ensure public private partnership for development of environment out of 16 objectives.

The ***National Agricultural Policy 2018*** was enacted for the overall development of Bangladesh agriculture and farmers focusing on different development strategies, especially the Sustainable Development Goals. At the end of 2018, the government has adopted the New Agriculture Policy (NAP) by revising the NAP of 2013. As mentioned in the document, the main goal of the new policy is attaining safe, profitable and sustainable food and nutrition security. The objectives and strategies are set in this policy considering different problematic and convenient scenarios of Bangladesh. The policy has mentioned several directives which is relevant to agriculture development are given below: i) Advanced agro-technologies should be introduced to tackle adverse climate condition like flooding, drought, storm, salinity, erosion, disease, insect onslaught etc; Different varieties of crop should be invented and popularized which are high yielding, tolerant to adversity and suitable for different agricultural climate, spatially for the mountainous, drought-prone, Barind, char area, haor region, water logged and coastal area; iii) Sustainable land-water management and integrated crop management activities should be expanded and encouraged to protect agriculture related biodiversity.

The ***Industrial Policy (2010) of Bangladesh***, announced recently, proposes an integrated strategy of economic growth through rapid industrialization. It envisages an increase in the industry sector’s share in GDP to 40 percent by 2021, with the proportion of the workforce employed in the sector concurrently rising to 25 percent of the country’s total labour force. It has brought some improvements over the immediate past (2005) industrial policy, in particular about the classification of industry and redefinition of industry size in terms of both fixed capital and the employment of labour.

In 2017 the Integrated Minor Irrigation Policy was drawn up with the aim of providing modern and technical irrigation services for reducing the irrigation input cost and increasing the crop production and food security and poverty reduction. The objectives of the policy are ten. The relevant objectives with this study are: i) Public and private cooperative base irrigation system should be promote for increasing the capacity of irrigation facilities; ii) Ensure balanced utilization of ground and surface water;

2.2.2 Relevant plan/ programs on water and infrastructure

National Environment Management Action Plan, 1995 identified the key environmental issues, and the actions required to halt or reduce the rate of environmental degradation, improve the natural and manmade environment, conserve habitats and bio-diversity, promote sustainable development and improve quality indicators of human life. In the "Wetland Issues" section, the NEMAP emphatically pointed out that "the reduction of wetlands is one of the marked features of environment degradation in Bangladesh". Strategies and associated action plan directly or indirectly related to study are as below:

Water sector

- Flood proofing, Flood Protection measures
- Re-designing the projects for creating infrastructure for facilitating fish migration to and from floodplains.
- Research development activities on the fish migration and natural recruitment in the FAP area

Wet land

- Implementation of wetland conservation laws and creation of sanctuaries.
- Bio-diversity conservation
- Development of a comprehensive wetland management policy

The National Water Management Plan (NWMP) was prepared in 2001 and approved in 2004, the first planning document prepared following the principle of IWRM. It was a framework plan consisting of 84 programmes grouped into eight sub-sectoral clusters and spatially distributed across eight planning regions of the country. The strategies and plans for water sectors, which are directly and indirectly related to the study, are as below:

- Integrated development and management of haors and wetland;
- Reduction of encroachment and exploitation of ecologically sensitive haor basin;
- Integrated river management plan covering erosion control, dredging and other elements of river maintenance such as pollution control, abstraction, navigation and environmental needs.

The Bangladesh Climate Change Strategy and Action Plan, 2009 was adopted as a 10-year programme (2009-2018) to build the capacity and resilience of the country to meet the challenges of climate change in different sectors. The BCCSAP established programmes of action on six main pillars for the first five-year period (2009-2013). Programmes relevant to the study under these six pillars are stated below:

- Adaptation in fisheries and livestock systems to ensure local and national food security;
- Livelihood protection in ecologically fragile areas;
- Raising productivity of agricultural land and lowering emissions of methane by efficient use of water;

- Increase water efficiency in built environments with further mention to groundwater lowering in major cities including Sylhet; and

The Haor Master Plan was prepared in 2012, the first planning document prepared for Haor region. It was a framework plan consisting of 17 Development areas. The Plan will be implemented in three phases. The three phases of the Plan are: *Short Term: 1-5 years (from FY 2012-13 to FY 2016-17); Medium Term: 6-10 years (from FY 2017-18 to FY 2021-22) ; and Long Term: 11-20 years (from FY 2022-23 to FY 2031-32)* The major plans for water sectors which are directly related to water resources are as below:

- Pre-Monsoon Flood Protection and Drainage Improvement in Haor Area
- Flood Management of Haor Area
- River Dredging and Development of Settlement
- Development of Early Warning System for Flash Flood prone area in Haor and dissemination to Community Level
- Village Protection against Wave Action of Haor Area

2.2.3 Legal Framework

- **Bangladesh Water Act, 2013** is the latest and most important legal document, which was prepared to make provision of integrated development, management, abstraction, distribution, use, protection and conservation of water resources. In relevant to water resources area, this act specifically stated legal bindings on conservation of water bodies or any other water source and management there for conservation of biodiversity dependent on it, in section 22 (b). Other directives of this act are: i) Delineation of water stress area and preferential use of water from sources for different purposes like for agriculture, fisheries, drinking water, industry etc; ii) Ensuring normal flow in water course prohibiting any kind of diversion through construction of structures without feasibility study; This act also emphasized preparation of National Water Resources Plan which will provide guideline to assess impact of different development on water resources.

Bangladesh Water Rule, 2017 is prepared by WARPO with a view to implement Bangladesh Water Act, 2013. The main purpose of this rule is to ensure the water right of every citizen of Bangladesh. The rule has described the laws regarding the extraction and proper use of surface and ground water.

The Bangladesh water act 2013 identifies the significance for managing all forms of water resources in the context of natural flow of surface water and recharge of groundwater. The rule provides the legal framework for development, management, extraction, distribution, usage, protection, and conservation of water resources. However, the Act falls short in evaluating the value of water considering all costs of and benefits provided by water. The lack of clear directives that will capture proper valuation of the water. This rule has given WARPO the authority to give clearance to any agency or owner for development projects in or near a water body under the condition that it would not cause any adverse impact to it, specifically for: i) flood control and management project; ii) water supply and sanitation project; iii) surface water irrigation project; iii) hydraulic intervention project; iv) water extraction or storage project; v) floodplain development project; vi) Project on surface water use for industry; vi) river training works or river bank protection project; vii) river or canal dredging project; and viii) fishery development project in surface water

Increasing public awareness thus in terms of water consumption and usage is another priority of this rule. Emphasis has been given on delineation of water stress area in a scientific way and considering socio-economic perspective. Participatory approach is given priority in this rule to overcome such water stressed situation.

Underground Water Management Law, 2018 repealed the Ground water management ordinance 1985. It is the main legislative document in Bangladesh relating to conservation of the ground water aquifer and protection of unauthorized installation of shallow tube well and deep tube well for irrigation purpose. The directives under the law are:

- This law is applicable only for those tube wells (shallow and deep) used for irrigation purpose in agriculture field in Bangladesh;
- Installation of tube wells in any agriculture field should be got permission from Upazila Parishad (UP); otherwise, no tube well would be installed in agriculture filed. If any tube well installed in the agriculture field then the user will punished by the UP.
- An Upazila Irrigation Committee should be formed to investigate the feasibility of the tube well. This committee will be responsible to investigate the status of the aquifer of proposed tube well, location of already installed tube well and their distance from proposed tube well, irrigable area of the proposed tube well, and suitable place for tube well installation.

Underground Water Management Rules, 2019, this rules published considering the section 12 under the underground water management law 2018. The directives under the rules are:

- An Upazila Irrigation committee to be formed with Upazila Government officials for an Upazila. The member of the committee to be nine;
- A prescribed filled up form as per Tafshil-2 should be submitted by the user to Upazila Irrigation Committee for getting permission of installation of tube well;
- A fee will be submitted in against of Tube well (shallow and Deep) to the UP as per rules. This voucher should be attached with the filled up form as per Tafshil-2.
- After getting permission from the committee, a license fee in against of the proposed tube well should be submitted to the selected Bank provided by Upazila member-secretary.
- The following criteria should be ensure during installation of tube well;
    - The tube well should be installed in the land which land is suitable for Boro, wheet, maize and vegetables cultivation;
    - Proposed tube well should be installed from 1.5 km distance from the flowing river.
    - The platform height of tube well should be free from flooding;
    - Installation place of tube well should be unique for proper distribution of water.
    - The distance between two tubes well should be 250 meter to 880 meter. This distance should be fix considering the capacity of tube well.

Environmental Conservation Act (ECA), 1995 is currently the main legislative document in Bangladesh relating to conservation of the environment, improvement of environmental standards and control and mitigation of environmental pollution. Some directives of this act which directly or indirectly reflects conservation or management of ecosystem. These directives are: i) Safety measures or remedial measures should be undertaken to prevent portable accident which may cause degradation and pollution of environment; ii) Research and capacity development are emphasized for conservation, improvement and pollution of the environment; iii) Collection and publication of information regarding environmental pollution should be performed; iv)Inter-agency co-ordination should be established; v) Ecologically Critical Area should be declared if any ecosystem is in the state of critical situation and no interventions should be undertaken in this designated area; vi) Industrial development on any kind of environment or ecosystem is matter of approval of authority

Therefore, this act portrays some strict features regarding conservation of environment as well as ecosystem preventing pollution. This act also states to formulate environmental guideline to conserve the environment.

Bangladesh Environmental Conservation Rules (ECR), 1997 promulgated to implement the Environment Conservation Act, 1995 that is particularly relevant for controlling pollution in Environment. This ECR mainly focused on enforcement of laws for clearance of different categories of industry on different location of environment. However, declaration Ecologically Critical Area considering 12 important components of environment is mentioned in this rule, where human habitat, forests, wetland and biodiversity of the relevant area are specifically enunciated to take under consideration.

Seventh Five Year Plan (2016-2020) has been prepared as a continuation of 6th five year plan (2011-2015) and address the development sectors where Bangladesh is still lagging behind. It intends to fulfil the social and economic outcomes that visualized in '**Perspective plan (2010-2021) of Bangladesh'**. The Perspective Plan sets the strategic directions and provides for making the Vision 2021. Vision 2021 reflects the fundamental socio-political philosophy that people are the source of all power and all development is for the well-being of the people. Precisely, the Perspective Plan provides the road map for accelerated growth, eradication of poverty, inequality, and human deprivation. The expectation is that by 2021, the war against poverty will have been won, the country will have crossed the middle income threshold, with the basic needs and rights of the population to be ensured on a sustainable basis without damaging the environment.

In the 7th five year plan, strategies/plans have been developed for in total 14 sectors which have been identified and are used by the implementing ministries of Bangladesh. One of those sectors is water resources sector. Use of Water Resources and Water Economy: Due to climate change and lifting ground water in an unplanned way, a significant portion of the country is not getting irrigation water during dry season. Therefore, a well-planned irrigation management system is essential for gradual increase of cropping intensity as well as yield. The government has laid special emphasis on the increased use of surface water and reduced use of groundwater in irrigation to protect the ecological balance and reduce irrigation expenses. Thus, conjunctive use of surface and groundwater would be stressed. As part of the strategy creation of water reservoir/ rain water harvesting in rain fed/coastal/hilly areas will be encouraged, and small scale water resources systems will be developed (particularly through BADC/LGED/BWDB) along with monitoring the maintenance of the small scale water resources infrastructure at local levels by ensuring community participation and taking care of environmental and social issues.

The **Sustainable Development Goals (SDGs),** also known as the Global Goals, were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. This study attain with Goal 6: Clean Water and Sanitation. Clean, accessible water for all is an essential part of the world we want to live in and there is sufficient fresh water on the planet to achieve this. However, due to bad economics or poor infrastructure, millions of people including children die every year from diseases associated with inadequate water supply, sanitation and hygiene.

Water scarcity, poor water quality and inadequate sanitation negatively affect food security, livelihood choices and educational opportunities for poor families across the world. At the current time, more than 2 billion people are living with the risk of reduced access to freshwater resources and by 2050, at least one in four people is likely to live in a country affected by chronic or recurring shortages of fresh water. Drought in specific afflicts some of the world's poorest countries, worsening hunger and malnutrition. Fortunately, there has been great progress made in the past decade regarding drinking sources and sanitation, whereby over 90% of the world's population now has access to improved sources of drinking water.

To improve sanitation and access to drinking water, there needs to be increased investment in management of freshwater ecosystems and sanitation facilities on a local level in several developing countries

3. Approach and Methodology

Developing shadow prices of water for four sectors is not a straightforward task since these values will obviously be different for different sectors. In addition, a good number of stakeholders and experts will be involved in this project. Therefore, an approach and methodology has been suggested considering the best practices around the world and contextualising them as far as practicable in the Bangladesh perspective.

The entire approach involves both primary and secondary data collection, data analyses and a series of consultation with stakeholder at different levels. The following section will give a detailed description of approach and methodology to be followed for developing shadow price which may be changed/ altered (if required) during actual practice/ application. The figure below illustrates steps that would be followed in conducting the study:

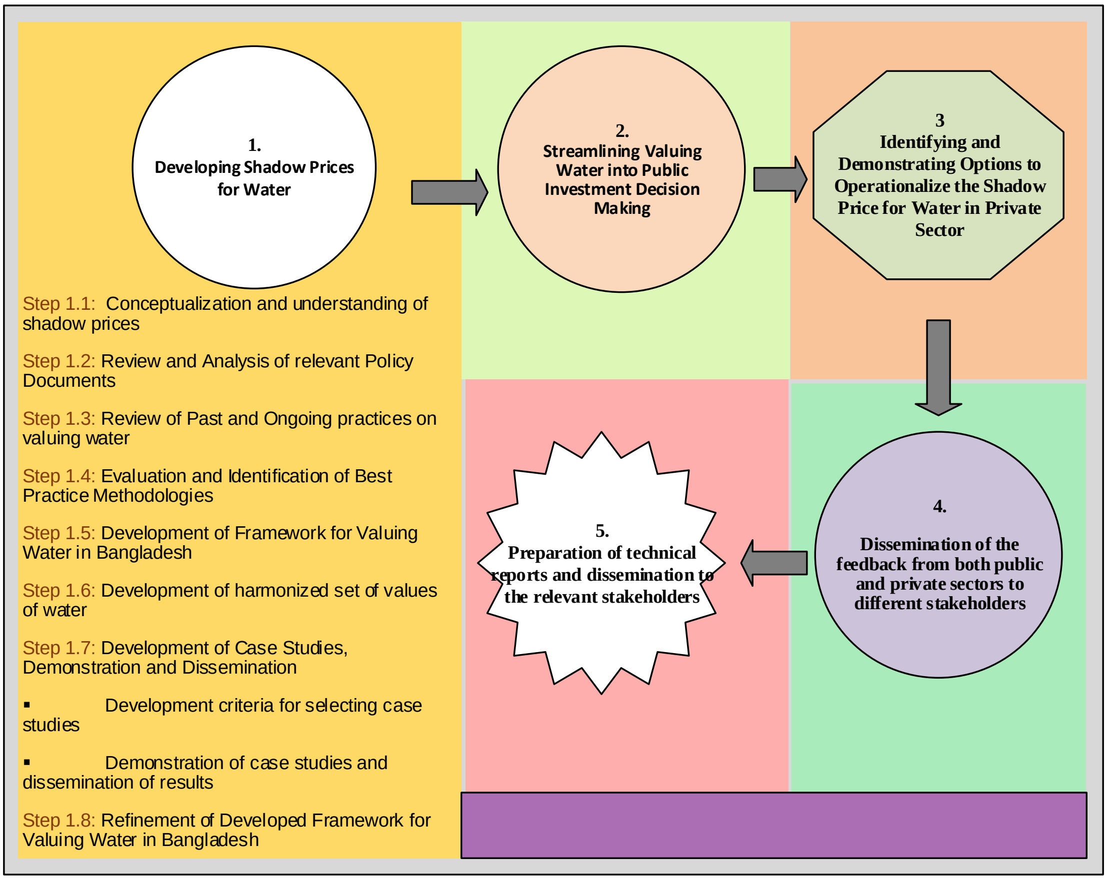

Figure 3.1: Approach and methodology for developing shadow price

3.1 Conceptualization and understanding of shadow prices

The concept of shadow price is nothing new in Bangladesh as this has been a major issue in practice for public sector investment decision-making in all plains of economy. Issues arise when imperfections exist in the market, as the social price or cost (shadow price) of a good or service differs substantially from its market price (Little-Mirlees: 1991) which then necessitates the requirement of concept of shadow pricing to signify the real or "scarcity value" of a resource for a particular society. The most cited example in this case is that of unskilled labour which is generally available in developing countries. Thus it does not have much of a scarcity value bit in the market, they get wages which is much higher than their scarcity value.

Generally natural resources have thus not yet been extensively considered in investment decision-making based on their shadow prices. But we do know that in many cases, resources such as land as well as water is scarce and their social cost should be based on their scarcity value. Currently, therefore the focus is on valuing a natural resource recognizing and considering all costs due to benefits provided by the resource, including their economic, social and ecological dimensions (Bellagio Principles, 2017). It can be a useful tool to determine equitable and incentivized pricing schemes for the resource. Valuing water has been prioritized as global action to achieve sustainable water resources management by the UN (SDGs) and the World Bank High Level Panel for Water.

Understanding the total economic value of water, i.e. the value to the economy, society and environment, can provide a basis to find strategic responses to Bangladesh's various water resource challenges. Present practice facilitates investment decisions based on the Development Project Proforma/ Proposals (DPP), following the guidelines provided by the Planning Commission of the Ministry of Planning of the GoB. Both financial and economic analyses are required to examine the feasibility of a project in the views of the sponsoring agency and holistically for the whole economy respectively. Shadow Price Conversion Factors (SCF) calculated by Planning Commission are used to arrive at economic prices which are expected to reflect true scarcity value of the particular resource or inputs.

The Planning Commission presently use shadow prices and conversion factors for translating market based financial prices to economic (or social prices)in DPPs. However, no such shadow prices or social scarcity value is used in case of natural resources. For that matter, for instance, the cost of water for constructing a building evaluates financial costs in purchasing water from utilities or sourcing from open water bodies or from the underground. This becomes part of total financial cost. However, when estimating the economic cost of the project, no economic price or shadow price is used to estimate the total economic cost of the project and thus, benefits are overestimated and there is a misallocation of resources. The present study which will try to estimate shadow prices of water under different circumstances, sectors and uses using an appropriate valuation method will remedy the situation, leading to lower wastage of water and its misuse and thereby allocate water to the uses best from human welfare point of view.

A question arises here is whether the set of shadow prices so estimated may be harmonised over sectors, uses, region and social groups. Much depends on actual estimates that are obtained. If these are similar which is unlikely, no such harmonisation may be made. However, what the study will try to do is to estimate harmonised shadow prices individually across for each single sector.

3.2 Review and analysis of relevant policy documents

Detailed review and analysis of relevant national and international policy documents will be reviewed and summarized based on their indicative directives on valuing water. Tentative list of policies which will be reviewed are as follows:

- Bangladesh Water Act, 2013
- Bangladesh Water Rule, 2017
- Bangladesh Agriculture Policy, 2018

- Bangladesh Industrial Policy, 2010
- Bangladesh Environment Policy, 1992
- National Water Policy, 1999
- Small Irrigation Policy, 2014
- Integrated Minor Irrigation Policy, 2017
- Underground Water Management Law, 2018
- Haor Master Plan, 2012
- Bangladesh Delta Plan, 2100
- Sustainable Development Goals, 2030
- Dhaka Water Supply Master Plan
- Seventh Five Year Plan

At this inception phase many of them have been reviewed and discussed in Chapter 2, section 2.2

3.3 Past and ongoing practices of valuing water

In parallel, the past and ongoing practices of valuing water in Bangladesh and in other countries will be reviewed. At this inception phase few initiatives are already identified and reviewed such as ongoing initiatives, the documents that have been reviewed so far are position paper on valuing water of Bangladesh, valuing water in agricultural sector in India, valuation of ground water in Australia, water pricing experience and innovations, Methods of Valuation of Water Resources: A Review etc. All these will give an idea about the possible/ applicable methods for valuing water in Bangladesh.

The limitations and success of different methods (Stated Preference, Revealed preference, Cost based etc.) will be reviewed and the common or widely used method for the above stated four sectors will be identified. Precisely, it will help to understand which methods can be useful/ applicable for Bangladesh context. For example, Heineken's brewery in Mexico, an impressive showcase for sustainable and equitable water use, that can be replicated across the industry sector. Another action is the MoU signed by the government of the Netherlands, Nespresso, Nestlé, the Colombian Coffee Growers. All these initiatives should be reviewed to get idea about water valuation and/ or usage practises and to develop similar concepts across the sectors in Bangladesh. In Bangladesh, BMDA has some form of developed mechanism for charging for irrigation water usage via DTWs although it is not used on extensive levels. They have introduced pre-paid card meters for more than 600 DTWs.

3.4 Evaluation and identification of best practice methodologies

After completing all the above steps best practices will be identified considering several criteria:

- Objective of valuing water
- Sector (Agriculture, Municipal, Industry and Ecosystem services) and country-wide national estimate
- Methodology, data used and Data availability in Bangladesh
- Limitation of the methods in Bangladesh context

Based on it, following matrix will be expanded during this study. The matrix will eventually show which method for valuing water is applicable or not applicable for four economic sectors in Bangladesh based on availability of data. It is to be noted here that following matrix is in initial/ conceptualization phase which will be further refined as this study progresses.

Table 3.1: Response matrix for applicability of valuing water method to Bangladesh (demo)

Methodology	Applicability to Bangladesh			
	Industry	Urban	Agriculture	Environment
Revealed Preference Market prices				
Revealed Preference Surrogate Market Price				
Revealed Preference Production function				
Cost-based				
Stated preference				

Color Code (Example): Green-Applicable; Orange-limited applicable; Red-not applicable

3.5 Development of a general framework for valuing water in Bangladesh

Framework development for valuing water is the most important step of this study. The purpose of this framework is to help practitioners, researchers and academicians to value water in Bangladesh. The steps to be followed for developing framework are;

- Setting the principles
- Identification of Issues and Challenges
- Identification of Factors
- Assessment of Data Needs and Availability
- Identification of Proxy Variables and Uncertainty Analysis
- Development of Framework for Valuing Water
  - ✓ Choice of Valuation Tools/methods
  - ✓ Methods/tool to be used for valuing water
  - ✓ Development of Harmonized Set of Values of Water
  - ✓ Data Collection and Consistency Check
  - ✓ Estimation of Shadow Price of Water and Conversion Factors for Market Prices

3.5.1 Setting the principle

Principles will be set considering lesson learned of best practices around the world, assessing coherency among exemplary methodologies, multi-dimensional aspects (i.e. economic, social and environmental), spatial and temporal dimension, source and availability of water, response of supply demand relationship, acceptability of multi-stakeholders etc. Amalgamating this information, tentative principles of valuing water in Bangladesh may include the following, but not limited to:

- Shadow prices need to reflect the full value of water, i.e. consider its economic, social and environmental dimensions;
- Shadow prices need to reflect the complexity inherent to water resources, i.e. be differentiated by region, season, sector and source (as applicable and feasible);
- The shadow prices for water will be derived in a consistent framework across sectors, regions, seasons and sources to allow for comparability;
- Shadow prices for water are derived by different methodologies (depending on data availability);
- Ensure required data sources are available/ could be available in future and are trusted by stakeholders.

3.5.2 Issues and challenges for valuing water

There are many challenges to estimate value of water. Prominent among them is the unavailability of data on actual use of water across different uses in Bangladesh. Understanding the value of water will be useful for planners to plan for investment in protecting water bodies and water resources. For example, in case of depletion of water bodies, values of water provides an estimate of cost of disappearance of water bodies and so it can be used to justify public investment on protecting water bodies (for example). Investment if protecting rivers from pollution often requires huge economic costs (often-private costs for industries) whereas values of water will provide the benefits of such actions and so it can be used to justify interventions to prevent damages in the quality of water.

However, there are many challenges to estimate value of water. Data availability, accuracy and consistency of data, complex and diversified hydrological dynamics, temporal variation of availability of water from sources, understanding of supply-demand relationship, nature and extent of demand, changing technological advancements etc. are considered to be the major challenge. Secondly, time requirement to get the resultant valuation validated from different stakeholders and getting their consent from multiple layers of stakeholders will be time consuming. Therefore, these type of relevant issues and challenges will need to be identified. Thirdly, micro-economic issues like using production function when water is simultaneously used for several purposes like drinking, food, biomass energy, manufacturing, power, recreational services etc., will pose difficulty in segregating their costs and benefits. Data sources which are planned to be used for conducting the study ranges from already published documents of BBS, CMI, IFPRI, BADC, BMDA, BPDB etc. Primary data will also be collected as and when felt necessary. Rapid Appraisal techniques like FGDs and KII will also be conducted to get the necessary data.

As such, general estimates of values of water in major use and non-use situations will help planners to use them for justifying the investment in the cost-benefit or cost-effectiveness framework of project appraisal.

3.5.3 Identification of the value of water across different uses

At this stage, the study proposes to provide estimates of the value of water in four major sectors i.e. 1) Agriculture, 2) Industry, 3) Municipality and 4) Environment and Ecosystem.

The following table shows water use within these sectors and the type of service (using the Taxonomy of MEA – Millennium Ecosystem Assessment of UNEP). The last column mentions the valuation method to be used to estimate the value of water.

Table 3.2: Water use within different sector and their valuation method

Sector	Use of water	Type of service	Valuation Method
Agriculture			
	Irrigation	Provisioning	Production function method
Industry			
	RMG and Textile	Provisioning	Surrogate market approach / Replacement Cost method
	Food and Beverage	Provisioning	Surrogate market approach / Replacement Cost method
	Power	Provisioning	Surrogate market approach / Replacement Cost method
	Construction	Provisioning	Surrogate market approach / Replacement Cost method
Municipalities			
	Drinking water	Provisioning	Surrogate market approach
	Shadow price of water	use value	Input-Output Table & Multiplier Analysis
Environment and Ecosystem			
	Fish sanctuary	Habitat	
	Wetland	Supporting	Contingent Valuation Method
	Transport		
	Shadow price of water	use and non-use values	Economy-ecology model using input-output model

To assess value of water in these sectors, the study team will assess data needs and data availability. Data requirement for estimation of valuation of water will be assessed from stocktaking of best-case methodologies, past and ongoing activities and review of standard approaches in national and international literatures. In addition, data availability status in Bangladesh for identified parameters with corresponding potential sources will be assessed through consultation with client, relevant stakeholders and representative of data generating agencies. Some data may be found in already published government reports or documents, which will also be explored.

3.5.4 Identification of proxy variables and uncertainty analysis

In some cases, data may not be available against required parameters to estimate value of water. Under this situation, proxy variables will be identified through the literature review on best practices, which will be useful to find a substitute value of the parameters. Furthermore, suitable criteria or method for uncertainty analysis will also be outlined to assist the analyses using expert judgment. Risk and uncertainty will be considered through probability distribution by calculation of Expected Return $\sum L_i x P_i$ and Coefficient of variation (Standard Deviation/ Expected Return).

Table 3.3: Probability distribution function for occurrence of normal, extreme wet and extreme dry years (demo)

Samples	Probability (Pi)	Loss and damage Amounts (Li)
1	30%	.2
2	40%	.3
3	20%	.1
4	10%	.05

The above probability function can be used to incorporate uncertainties with regard to any phenomena by multiplying normal, wet, or dry year benefit with above probability distributions.

3.5.5 Development of an operational framework for valuing water

As challenges regarding data availability is predominant in Bangladesh, framework for valuing water will be developed for two cases if required,

a) ***Best case* framework/ methodologies:** The ideal framework regardless of data restrictions, however, considering on-ground realities in Bangladesh.

b) ***Practical* framework/ methodologies:** The framework that can be applied as part of this project subject to data constraints.

The most common available framework in literatures for understanding the wider array of economic values of water is the total economic value (TEV) framework (explained in earlier chapters and also below). As in consumptive use, the TEV framework uses the concepts of willingness to pay and willingness to accept but considers a much wider scope of impacts. This kind of ideal framework or approach will be the starting guiding tool to develop the framework in the context of Bangladesh. However, the finally developed framework will consider the complex hydrological dynamics, temporal dimensions i.e. seasonality issues. In essence, study team will focus on development of a holistic framework for valuing of water in Bangladesh.

The framework will be designed to address the multiple type of benefits and costs associated with water use in development projects. By understanding the costs and benefits of water-use in different projects, decision-makers can make more informed decisions that are both financially, economically, socially and environmentally responsible. The Framework will consist of the following:

- Guidance to identification of benefits and beneficiary
- Guidance to identification of costs and its bearers
- Selection of appropriate tools of valuing water
- Strategy for level of perfection
- Consideration of vulnerability and risks etc.

Identification of types of benefits

The benefits of water-sector projects need to be apportioned under financial and economic, social and environmental titles.

- Economic benefits arise from the direct use of water resources like in crop irrigation.
- Indirect uses of water can be many like use of irrigation water for drinking, cleaning etc. Water related ecosystem services also provide an apparent ‘free service’ that can support other economic activities such as recreation, sport and tourism.
- Social benefits of water are diverse and often hard to measure because many, such as community identity, amenity and equity, are indirect. The provision of clean air and water, and places to walk and exercise provide the basis for improved community health, physical and spiritual. Water bodies can also play a role in connecting, communicating and networking between communities through social activities for entrepreneurship development and growth.
- Direct benefits include existence of flora and fauna, clean water and connectivity promoting species diversity etc. Indirectly, environmental improvements can in turn lead to social and economic activity.

The benefit identification process needs to consider non-use values within economic values in the following manner:

Table 3.4: Different types of uses for calculating TEV

Use-value			Non-Use value		
Direct use	**Indirect use**	**Option use**	**Existence**	**Altruistic**	**Bequest**
Consumptive uses like irrigation, manufacturing, and non-consumptive e.g., recreation)	Ecosystem services, flood control, habitat etc,	Future direct and indirect use value	Knowledge of continued existence of resources	Knowledge of use of resources by current generation	Knowledge of passing on resources to future generation continued existence of resources

In summary, total Economic Value = **Direct Use Value + Indirect Use Value** + **Option Value** + **Non-use Value (Externalities)**

Identification of full cost of water

Full cost of water resources will be calculated by summing financial and economic cost, social and environmental cost in the following manner:

Table 3.5: Full cost of water (example)

Financial and economic cost	Env. cost	Social cost
Direct and Indirect tangible cost like Capital charges, O&M cost, Financial and Economic dis-Externalities	Direct and indirect Environmental dis-externalities	Direct and Indirect Social dis-externalities

Table 3.6: Details of the full cost of water (example)

Financial and Economic charges additionally to include items like:	Environmental charges additionally to include items like:	Social charges additionally to include items like:
Expenses incurred for monitoring and evaluation; Environmental Management Plan implementation expenses Price and Physical Contingencies Pre-project consultancy expenses Sunk cost already incurred	Lowering of groundwater table Pollution of existing water source Water logging Degrading of water quality Climate change adversities Disaster vulnerability	Conflict of stakeholders and its resolution Demise of social Networking, Homogeneity and connectivity. Curtailment of aesthetic beauty Loss of Heritage Demise of social custom

Identification of type of beneficiary

The user of the framework needs to identify type of beneficiaries in the following manner:

The three levels of benefits are:

- **Individual benefits** contribute to personal welfare. These make up the market economy as personal utility (e.g., market price, willingness to pay) and individual wellbeing.
- **Community benefits** contribute to the welfare of the community and are things like networking, common and shared values and goals, and access to cultural and natural heritage for building a homogenous and cohesive society.
- **Institutional benefits** are those that fulfil institutional goals and values. For example allowing use of water-resource for tourism may allow local Union Parishad to earn a levy or licensing fee etc.

Combining type of benefits and beneficiaries

Table 3.7: Combination of benefits by beneficiary

	Individual	Community	Institutional
Financial and Economic	Higher crop benefit, Benefit from property values, Health savings from exercise along water body, reduced climate impact event damages, energy savings	Greater local commerce, attractive to businesses, reduced climate impact event damages	Efficiency, cost-effectiveness, social returns into the economy, avoided costs for changing risks
Social	Personal wellbeing, opportunities to meet friends, opportunities for recreation, places to play	Venues for events, increased social contact in public spaces, knowing one's neighbors, rapid recovery after climate impact events	Community resilience and Community health, strong Neighborhood identity, strong post-climate impact event recovery
Environmental	Enjoyment of flora and fauna, personal environmental values being met	Friends groups and volunteerism, environmental education	Conservation values met, high biodiversity

3.5.6 Choice of valuation tools

Various tools of valuation exist. Some tools may have advantage over others in terms of data availability and its quality, degree of confidence, general acceptance by the researchers etc. Review of literature made in this study has elaborated on the type of analyses involved in the various methods. Description of available major tools of valuing water along with their advantages and disadvantages are provided below.

Table 3.8: Types of valuation tools applicable to the situation

Type of benefits and beneficiary identified	List of costs including who bears them and when	Methods: valuation techniques	Assumptions (method, limitations and caveats)	Steps for reinforcing confidence
All possible impacts whether in economic, social, environmental or scientific fields to be identified.	Economic Environmental and Social	• Full cost of water calculated and divided by water volume • Qualitative assessment of environmental and social impacts	• Correct estimation of volume of water is available • Reliability of cost data	Cross-check with similar other studies within country or abroad.
All possible impacts whether in economic, social, environmental or scientific fields to be identified.		• Net Return to Water by Residual Methods • Qualitative assessment of environmental and social impacts	• No other input is missed • Correct estimation of volume of water is available • Reliability of cost data	Risk/Uncertainty included
All possible impacts whether in economic, social, environmental or scientific fields to be identified.		• Marginal Productivity of water via regression model. - Qualitative assessment of environmental and social impacts	• Multi-co-linearity is eliminated • Correct estimation of volume of water is available • Reliability of cost data	Advanced tools to increase reliability of the estimate.
All possible impacts whether in economic, social, environmental or scientific fields to be identified.		• Cost-Benefit method including willingness to pay for benefit. • -Qualitative assessment of environmental and social impacts.	Reliable data on WTP is available	- More reliability as it considers both benefit and costs in the same tool. - Sensitivity - Analysis (Best/Worst/ Benefit change/Cost change/High) to be done

Type of benefits and beneficiary identified	List of costs including who bears them and when	Methods: valuation techniques	Assumptions (method, limitations and caveats)	Steps for reinforcing confidence
All possible impacts whether in economic, social, environmental or scientific fields to be identified.		• Contingent Valuation Method • Non-market valuation (Willingness to pay, Willingness to accept). • Qualitative assessment of environmental and social impacts	• Reliable data on WTP and WTA is available • Higher precision level in sampling	Proper validation of data
All possible impacts whether in economic, social, environmental or scientific fields to be identified.		• Qualitative assessment / • Description of consequence)	• Effective FGD and Key Informant Interview	Need to be backed by literature review
All possible impacts whether in economic, social, environmental or scientific fields to be identified.		• Travel Cost Method (TCM) value of recreational site estimated. • Qualitative assessment of environmental and social impacts	• Survey on expenditures of time and money to travel to specific site. • Uses real market data	Use stratified sampling to include traveler valuation

3.5.7 Methods/tools to be used for valuing water

Given the general principles above, table 3.9 shows that diverse set of water valuation methods that may have to be used depending on availability of data, existing water use practices, confidence level of the researcher about reliability of data etc. Generally, for quantitative cases, methods like Full Cost, Residual value, Net Return, Cost-Benefit methods will be used while for qualitative cases revealed preference, willingness to pay and other contingent valuation methods will be used. Actual choice of methods will depend on type of data requirement and ease in their collections given the period of the study.

Table 3.9: Methods/tools to be used for valuing water

	Direct USE value: ➢ **Irrigation for agriculture** ➢ **Domestic and** ➢ **Industrial water supply**	**Indirect NON-USE value:** ➢ **Flood Control** ➢ **Storm protection** ➢ **External eco-system**	**Potential future uses**	**Allowing Biodiversity for species diversity**	**Deriving recreational service**
Full cost of water calculated and divided by water volume - Qualitative assessment of environmental and social impacts	√				
Net Return to Water by Residual Methods -Qualitative assessment of environmental and social impacts	√	√	√		
Marginal Productivity of water via regression model. -Qualitative assessment of environmental and social impacts	√				
Cost-Benefit method including willingness to pay for benefit. -Qualitative assessment of environmental and social impacts	√	√			√
Non-market valuation (Willingness to pay,		√	√	√	√

	Direct USE value: ➢ **Irrigation for agriculture** ➢ **Domestic and** ➢ **Industrial water supply**	**Indirect NON-USE value:** ➢ **Flood Control** ➢ **Storm protection** ➢ **External eco-system**	**Potential future uses**	**Allowing Biodiversity for species diversity**	**Deriving recreational service**
Willingness to accept). -Qualitative assessment of environmental and social impacts					
Qualitative assessment / Description of consequence)			√	√	√
Travel Cost Method (TCM) value of recreational site estimated. - Qualitative assessment of environmental and social impacts			√	√	√

3.5.8 Sensitivity analysis and estimation of a harmonized set of values of water

We have already stated the difficulties involved in estimating harmonized shadow prices across sectors. While these will be harmonized as far as practicable within sectors. However, based on assumptions, it may be possible to estimate sets of shadow prices for low, medium and high range. Once this is done, there is likely to be overlaps among these shadow prices across sectors. If so, such overlaps may be used as a principle for harmonization of shadow prices. However, this will be a purely empirical exercise.

Data collection and consistency check

Required data for parameters following developed framework for valuation of water will be collected from relevant sources and consistency will be checked using standard process. If any data are not found, proxy variables will be identified and uncertainty analysis of those proxy variables will also be performed using expert judgment.

Status of collected data, consistency level will be clearly stated in transparent manner before going for detailed estimation of shadow water price of water.

3.5.9 Estimation of shadow price of water and conversion factors for market prices

Shadow prices for water will be estimated covering all above mentioned sectors i.e. Agriculture, Industry, Municipalities and Ecosystems & Environment considering identified issues and challenges, factors, hydrological dynamics and supply-demand relationship for water. Estimation of shadow price will conducted for different temporal dimensions i.e. dry and wet season. Technological advancement will remain constant for the estimation period.

In addition, shadow water price will be estimated for two critical areas and two non-critical areas considering spatial diversity in water scarcity, saline and flood prone areas etc. Lesson learned from these case studies will also be summarized to refine the developed framework.

3.5.10 Dissemination of case study results

In this stage, outcome of case studies with lesson learned will be disseminated among relevant stakeholders to let them know the process of water valuation in Bangladesh and how to apply it in different circumstances. Opinions aired in multi-stakeholder workshops will be considered for refining the framework developed for water valuation. It is planned to hold one small multi-stakeholder workshop (focus group discussion) for each demonstration case study to ensure that diverse opinions are heard and considered, and stakeholders develop ownership.

3.5.11 Refinement of framework for valuing water

The lessons learned from case studies will be utilized for refinement of the framework developed for valuing water. After completion of the initial set shadow prices for water, a national workshop (stakeholder consultation) will take place to allow for comments and verification, and validation of the shadow prices. Relevant stakeholders from agriculture, industry, municipalities and environment sectors, experts in valuing water, Water Working Group of World Bank and other relevant stakeholders will be invited to give their feedback on finalized framework on water pricing. Further, this workshop will function as an initial consultation for the Ministry of Planning on how the shadow price for water and conversion factors shall be included in the DPP Format and DPP Manual.

3.6 Streamlining valuing water into public investment decision making

After finalizing, the shadow prices will be mainstreamed into both public and private investment/ decision making process and policies. A Project Proforma (PP) can take three forms. They are:

- Development Project Proforma /Proposal (DPP) (For Aided Project)
- Development Project Proforma /Proposal (DPP) (For wholly GOB financed project)
- Technical Assistance Project Proforma/Proposal (TPP)

Therefore, the planning commission will be consulted on how to incorporate the Shadow price of water into the DPP format. In fact, as is well known, the Planning Commission will need Conversion factors for converting market prices of water into shadow prices. These processes will incorporate conversion factors to factor in different conditions and context. Based on their opinion the DPP will be updated and a revised DPP format will therefore be drafted and consulted with relevant stakeholders. Once it is finalized thus, the DPP manual will be updated which will attempt to explain, step by step, how to prepare Development Project Proposal based on the revised DPP. For endorsement of the changes to be made in manual by the

Planning Division, a stakeholder consultation will be conducted which will be coordinated by Planning Division and GED with following stakeholders;

- Ministry of Planning including all divisions of the Planning Commission and Planning Division;
- Prime Minister's Office
- Ministry of Water Resources;
- Ministry of Local Government, Rural Development and Cooperatives;
- Ministry of Industries;
- Ministry of Agriculture;
- Ministry of Environment, Forest and Climate Change;
- Ministry of Fishery and Livestock;
- Ministry of Housing and Public Works;
- Ministry of Power, Energy and Mineral Resources;
- Ministry of Textiles and Jute;
- Ministry of Commerce;
- Ministry of Chattogram Hill Tracts Affairs;
- Private sector associations, such as BGMEA;
- National and multi-national private sector companies and
- Civil society

Once the concept containing the conversion factors for valuing water is well understood, the Planning Division and the GED will consider revising DPP Format and updating DPP Manual.

To ensure consideration of the economic analysis, the following assessment formats require an update:

- Ministry Assessment Format (MAF), format outlines the criteria for assessment of new Development Project Proposals (DPPs) submitted to the Sponsoring Ministry/Division for approval of the competent authority. The assessment is to be completed by the Planning Wings in the relevant Ministry/ Division by scrutinizing the submitted DPP and attached documents, as well as conducting hearings with the Agencies/ Departments responsible for formulating the project. This format is a supplementary document to be utilized by the Project Assessment Committee (PAC), formally called the Project Scrutinizing Committee (PSC).
- Sector Appraisal Format (SAF), which is a supplementary document for the Project Evaluation Committee (PEC) and has to be completed by the respective Sector Divisions in the Planning Commission.

3.7 Operationalization of valuation of water for pricing of water in private sector decision making

The estimated value of water and the background framework may also be used to regulate the use of water by the private sector from various sources extraction of resources. For example, private sector may over-use a resource (like water) because it is not priced appropriately. In this situation, an understanding of the value of water and its level will help regulators/ users (like WASA, BWDB, WARPO, rural and urban communities) to argue for introduction of appropriate regulations so that water efficiently used and not misallocated. This is particularly true in case of large beverage companies (like Coca Cola, RFL and others) who are major extractor of ground water. Value of water estimates can be used to regulate their extraction using a pricing mechanism following the value as the guideline.

3.8 Sharing the outputs for feedbacks from relevant stakeholders

At this stage the feedback from both public and private sectors will be disseminated among the stakeholders who are from the very beginning (from inception phase) are involved to make a consistent shadow price for four sectors

3.9 Preparation of technical reports and dissemination to the relevant stakeholders

After preparing technical report, it will be disseminated among the stakeholders from both public, private organizations that are working in sectors; agriculture, domestic, industry and ecosystem services and national and international experts on valuing water.

4. Work Plan-Deliverables and Reporting Schedule

4.1 Introduction

A well thought work plan is necessary to accomplish a project successfully in time with proper quality. For this project, all the steps of works and services have been analyzed and a task list has been prepared accordingly considering the ToR of the study. Expected durations are calculated considering the persons involved, complexity of tasks and period of works and time availability as per duration of the study.

4.2 Work plan and deliverables

The assignments are broadly categorized into three major components. For efficient and timely execution of the study, a detail work plan has been designed and work scheduled has been framed and presented in the following Table 4.1

Table 4.1: Comprehensive plan for execution of the study

Sl	Activity	Oct' 19	Nov,19	Dec'19	Jan'20	Feb'20	Mar'20	Apr'20	May'20	Jun'20
A.	**Inception Stage**									
A1	Literature review									
A2	Develop initial ideas on valuing water framework									
A3	Prepare outline of 7 demonstration case studies									
A4	Preparation of Inception report									
B.	**Case Studies (4 for Public sector and 3 for private sector)**									
	Public Sector									
B1	Field visit for Case study 1									
B2	Field visit for Case study 2									
B3	Field visit for Case study 3									
B4	Field visit for Case study 4									
	Private Sector									
B5	Field visit for Case study 5									
B6	Field visit for Case study 6									
B7	Field visit for Case study 7									
C	**Focus Group Discussions (FGD)**									
C1	FGD for case study 1									
C2	FGD for case study 2									
C3	FGD for case study 3									
C4	FGD for case study 4									
C5	FGD for case study 5									
C6	FGD for case study 6									
C7	FGD for case study 7									

Sl	Activity	Oct' 19	Nov,19	Dec'19	Jan'20	Feb'20	Mar'20	Apr'20	May'20	Jun'20
D	**Interim Stage**									
D1	Final Valuing water framework									
D2	Outcomes of demonstration case studies									
D3	Preparation of Interim report									
D4	Set of shadow prices for water									
D5	Draft updated version of DPP documents									
E.	**Meetings**									
E1	Meeting with Project Steering Committee									
E2	Meeting with Project Implementation Committee									
E3	Meeting with High Level Valuing Water Committee									
E4	Meeting with Technical Valuing Water Committee									
E5	Meeting with Ministry of Planning									
E6	Meeting with PD for dissemination of study progress									
F	**Action plan for training of capacity development (8 nos.)**									
F1	Preparation of materials for capacity development									
F2	Schedule for conduct capacity building sessions									
G	**Workshops**									
G1	Inception workshop									
G2	Final Dissemination Workshop									

4.3 Study team

The name of the study team members have been involved in this study mentioned below.

Sl	Name of Staff
1	M. Asaduzzaman, PhD , Natural Resource Economist (Team Leader)
2	A.K. Enamul Haque, PhD , Water Economist (Deputy Team Leader and Coordinator)
3	Chowdhury Saleh Ahmed, PhD , Econometrician (Focus Natural Resources)
4	Md Motaleb Hossain Sarker , Water Resource Management Expert
5	Apurba Kumar Sarker , Economist Focus (Natural Resources)
6	Nityananda Chakravorty, Regulatory/ Policy Specialist (Focus Water)
7	Dr. G. M. Khurshid Alam, PhD ; Sustainable Business Expert
8	Ahmmed Zulfiqar Rahaman , Data Collector
9	Tanvir Ahmed , Data Collector
10	Nahid Jabeen , Translator (Bengali/ English)

Other members include the following;

- Mr. Kazi Kamrull Hasan, Environmental Specialist (Environment and Water),
- Ms. Sarazina Mumu, Environmentalist.

4.4 Reporting schedule

The following schedules will be followed to submit the study reports under the study:

Deliverables	Oct' 19	Nov,19	Dec'19	Jan'20	Feb'20	Mar'20	Apr'20	May'20	Jun'20
Reports									
Inception report									
Interim report									
Draft Final Report									
Final Report									

References

Duan, Y.Z., Liu, G.J., Ren, C. and Peng, X.B. (2016) Environmental Water Price Based on Water Environment Capacity and Ecological Water Consumption: A Case Study of Hefei. Journal of Geoscience and Environment Protection, 4, 100-109.

<http://dx.doi.org/10.4236/gep.2016.44013>

Frischmann B, Marciano A, Ramello G 2019, Tragedy of the Commons After 50 Years. Journal of Economic Perspectives—Volume 33, Number 4—Fall 2019—Pages 211–228.

Ghosh N and Bandyopadhyay J 2009. Methods of Valuation of Water Resources: A Review, www.sawasjournal.org, Volume 1, Issue 1.

Gibbons, D. (1986), "The Economic Value of Water. Resources for the Future", Washington DC, https://www.scirp.org/(S(czeh2tfqyw2orz553k1w0r45))/reference/ReferencesPapers.aspx?ReferenceID=1580396 , accessed on 27th November, 2019

Global Water partnership (GWP) 2017, High Level Panel On Water (HLPW) Valuing Water Initiative Final Report.

<https://www.gwp.org/contentassets/c9b3aaf1e71044ef857c3c2efc9ff243/hlpw---vwi---final-report_1dec-2017_draft.pdf>

Grizzetti B, Lanzanova D, Liquete C, Reynaud A 2015, Cook-book for water ecosystem service assessment and valuation, JRC science and Policy Report, European Commission.

Gulland J M, Hone S , Pohlner H 2018, Position Paper on valuing water in Bangladesh.

Hardin, Garrett. 1968. "The Tragedy of the Commons." *Science* 162 (3859): 1243–48.

Narayanamoorthy, A. (2011). Development and composition of irrigation in India. Temporal trends and regional patterns. *Irrigation and Drainage, 60,* 431–445.

National Research Council. 1997 *Valuing Ground Water: Economic Concepts and Approaches*. Chapter 4: Economic Valuation of Ground Water. Washington, DC: The National Academies Press. doi: 10.17226/5498.

Pham A 2017, 2030 WRG's work on Water Valuation – the Dhaka Water Conference 2017, viewed on 2 December 2019,

<https://www.2030wrg.org/2030-wrgs-work-on-water-valuation-the-dhaka-water-conference-2017/>

Rahman R 2016, 'Bangladesh National Conservation Strategy' IUCN and Bangladesh Forest Department, viewed on December 2, 2019

<https://bforest.portal.gov.bd/sites/default/files/files/bforest.portal.gov.bd/notices/c3379d22_ee62_4dec_9e29_75171074d885/3.%20Water%20Resources_NCS.pdf>

Tsur, Y.; Roe, T.; Doukkali, R. and Dinar, A. 2004. Pricing irrigation water: Principles and cases from developing countries. Washington: Resources for the Future.

Young, R (2005.). *Determining the Economic Value of Water.* Washington, D.C.: Resources for the Future.