IWRM Action Hub

IWRM TOOL - D1.02

Economic Value of Water

Summary

Economists and analysts use several methods for calculating the value of water for water projects and policies. However, there can be large differences between values when evaluating competing uses for water reallocation purposes. One of the techniques to assign monetary value to water in the absence of prices is shadow pricing. This Tool defines what “real economic value” means, discusses the role shadow pricing plays in the economic valuation, identifies major techniques for economic valuation of water, and discusses practical limitations of using shadow prices in relation to water.

Real Economic Value and Shadow Pricing

Prices are said to be a gross estimation of the value for traded goods and services. The market price doesn’t capture the “real” value of a product or service, however. For example, a kilowatt hour produced through burning coal or by a solar panel may be equivalent in terms of price, though it involves different social and environmental costs and, in that regard, would not hold for equal “values” depending on the way it was produced. Observed prices fail to reflect true economic values, taking into account government regulations that set prices for commodities, as well as taxes, subsidies and trade restrictions that create distortions in the market. In other cases, there may be no market price at all (UNDESA, 2012).

Economists use shadow pricing to assign a monetary value to the non-marketed or “abstract” goods and services, in hopes of better reflecting their total social, economic, and environmental costs and benefits (Tinch et al., 2019). In the absence of water markets or where these markets function poorly shadow pricing is used to estimate the economic value of water (UNDESA, 2012). This is often the case in agriculture where the water charge is below the marginal value product of water and shadow pricing is utilised to conduct different types of analysis (Diao & Roe, 2000; Bierkens et al., 2019). Shadow pricing method should reflect different economic values depending on when, where, and how water occurs (van der Zaag & Savenije, 2006).

Real Economic Valuation for Benefit-Cost Analysis

One of the most widely used economic techniques to evaluate projects or policy choices is Benefit-Cost Analysis (BCA) (Tool D1.01). This approach requires systematic enumeration of all the benefits and all the costs, tangible, or intangible, whether readily quantifiable or difficult to measure, that will accrue to all members of society if a particular project or policy is adopted (Stokey and Zeckhauser, 1978). Shadow prices are used for initiatives where the assignment of a dollar value doesn't reflect the expected benefits associated to delivering a particular good or service. For example, a river bank cleanup programme involves costs that can be easily assigned to a dollar figure, though many of its benefits may not be so straightforwardly quantifiable money wise. In this case, analysts would assign a shadow price to positive externalities such as the improved health of the surrounding ecosystem and the higher wellbeing of local residents (Tools C4). Through shadow pricing, the economic analysis could then internalise the wider social and ecological impacts of the project (i.e. make them economically commensurable) which, in turn, would better inform decision-makers on the true "value" of the cleanup scheme.

When applying the BCA evaluation framework, there are two critical steps that must be undertaken:

1. Determine all impacts of the project or policy, favorable and unfavorable, present, and future.
2. A monetary value should be assigned to these impacts (benefits are favorable impacts; costs are unfavorable impacts).

For example, for a water infrastructure project (a piped water distribution system) or a water reallocation policy (capping groundwater withdraws for agriculture), the evaluator must determine positive and negative externalities to all members of society (and to the environment). Step two in the BCA framework would lead the evaluator to resort to shadow pricing valuation of those benefits and costs that are not already assigned to a monetary value. To bring this to conclusion, BCAs cannot be accurate without shadow pricing, as it would disregard externalities and merely focus on these marketed costs and benefits (ADB, 2017; EC, 2014).

Methods for Calculating the Real Economic Value

A variety of methods can be used to measure the real economic value of water (Möller Gulland et al., 2020; UNESCO, 2021). Most of those methods fall under the umbrella of three different economic valuation approaches, (1) revealed preference; (2) cost-based; and (3) stated preference (Fig. 1).

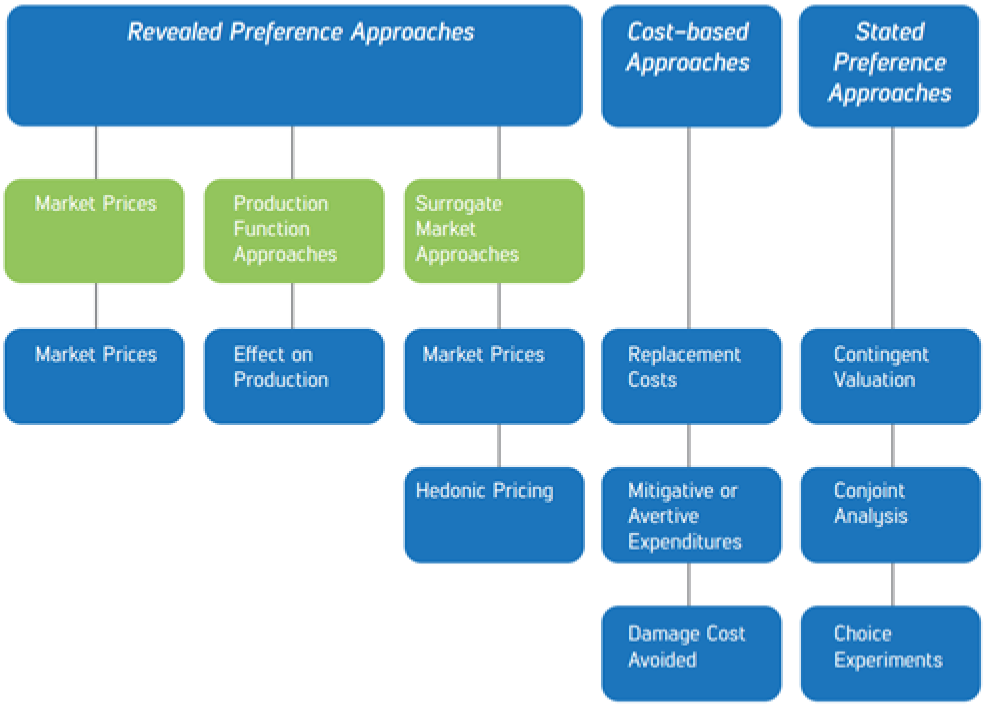

Figure 1. Valuing water approaches and methods. Source: Möller Gulland et al. (2020).

“Revealed Preference Approaches” observe actual peoples’ behaviour in markets where water is relevant. This includes methods such as:

- **Market price method** is based on statistical estimation of the demand curve (for example, for water services) when sufficient variation in water prices is present.
- **Residual value** represents marginal contribution of water to output and is calculated by subtracting the costs of all non-water inputs from the total value of output. The approach is commonly used in agriculture and manufacturing (Berbel et al., 2011; Kiprop et al., 2015). The method is sensitive to variations in the equation though when non-water inputs are underestimated, the price of water goes up.
- **Hedonic valuation** implies that part of a product or service (bundle of characteristics), observations of real transactions of that product or service might serve as a proxy to determine the price people are willing to pay for water, such as agricultural land prices in different locations (Faux & Perry, 1999).

There are also “Cost-Based Approaches” that infer the value of water derived from costs incurred to mitigate damage, replace the service, or avoided costs if the services are well maintained (López-Morales & Mesa-Jurado, 2017):

- **Replacement cost:** uses the cost of replacing an ecosystem or its services as an estimate of the value of the ecosystem or its services. For example, the flood protection services of a wetland (Tool C3.04) might be replaced by a retaining wall.
- **Mitigative expenditures and damage cost avoided:** are also used to estimate the value of water service/ecosystem, for example, when the loss of a wetland upstream reduces the ability of the ecosystem to purify itself, thus, requiring additional costs for purification technologies.

Lastly, there are “Stated Preference Approach” methods which involves questioning stakeholders directly for their preferences when market transactions cannot be used as a basis to estimate the value of water.

- **Contingent valuation:** is a type of willingness to pay method (Hutton, 2001) that allows people to value water services/projects presented to them in a hypothetical market, which is usually done via a survey (Whittington et al., 1990).
- **Conjoint analysis:** determines what combination of a limited number of attributes is most influential on respondent's choice or decision-making (Farber & Griner, 2000).
- **Choice experiments:** ask respondents to rank or choose between alternative proposed scenarios.

There are several other cross-cutting methods which are not necessarily linked to one economic valuation approach in particular (UNESCO, 2021):

- **Mathematical programming models:** are mainly used for water allocation in agriculture and infrastructure development based on maximising the value of output, subject to production inputs given that supply of the resource is limited (Young, 1996). The methods applied include linear programming or simulation to compare marginal values of water, as well as computable general equilibrium model (Liu et al., 2008).
- **Demand functions:** apply econometric analysis to derive value from the household's or firm's demand function based on either actual sales of water (revealed preference) or the use of the willingness to pay method (stated preference). However, imperfect information, in both developed and developing markets, hinders accurate derivation of the demand curve (Lange & Hassan, 2006).
- **Tradeable water rights** can help establish a proxy economic value for water. Water markets are found in Australia, Chile, Iran, South Africa and Spain's Canary Islands, as well as in some of the western states of the United States of America (Tool C4.02). This is still a contentious issue due to the presence of informal water markets in South Asia (Carey & Sunding, 2001), the absence of standardised approaches to valuation (Seidl et al., 2020) and their ambiguous impact on consumers and the environment.
- **Water footprint:** is another method that can be considered by producers and decision-makers to estimate the economic viability of water usage in production, processing and delivering goods and products (Tool C5.03) (Tober, 2021). The indicator reflects freshwater use looking at both direct and indirect consumption and differentiating between blue (surface and groundwater), green (precipitation) and grey (water required to assimilate pollutants) water footprints. Water footprint combines supply chain thinking and water resources thinking, including water productivity and scarcity (Hoekstra, 2017).

Challenges within Economic Valuation of Water

Despite a wide variety of methods available, economic evaluation of water remains a difficult task due to several reasons:

- Calculation of shadow prices for water uses in the absence of real prices demands making assumptions about the behavior of multiple variables (such as population, agriculture or industrial output, demand of water dependent products, local hydrological conditions).
- Data is often not available or is expensive to collect, which is exacerbated by the fact that water values are very site-specific (UNDESA, 2012).
- When evaluating between different water allocation options, economists must monetise the benefits and costs associated to different use which, in reality, often comes down to comparing apples and oranges (UNESCO, 2021).

- There is little standardisation in methods used and assumptions applied (UNDESA, 2012), which leads to the risk of double-counting (UNESCO, 2021).
- Economic methods of valuation become more inappropriate with growing uncertainty, especially noted in trying to evaluate future value of water (Fig. 2).

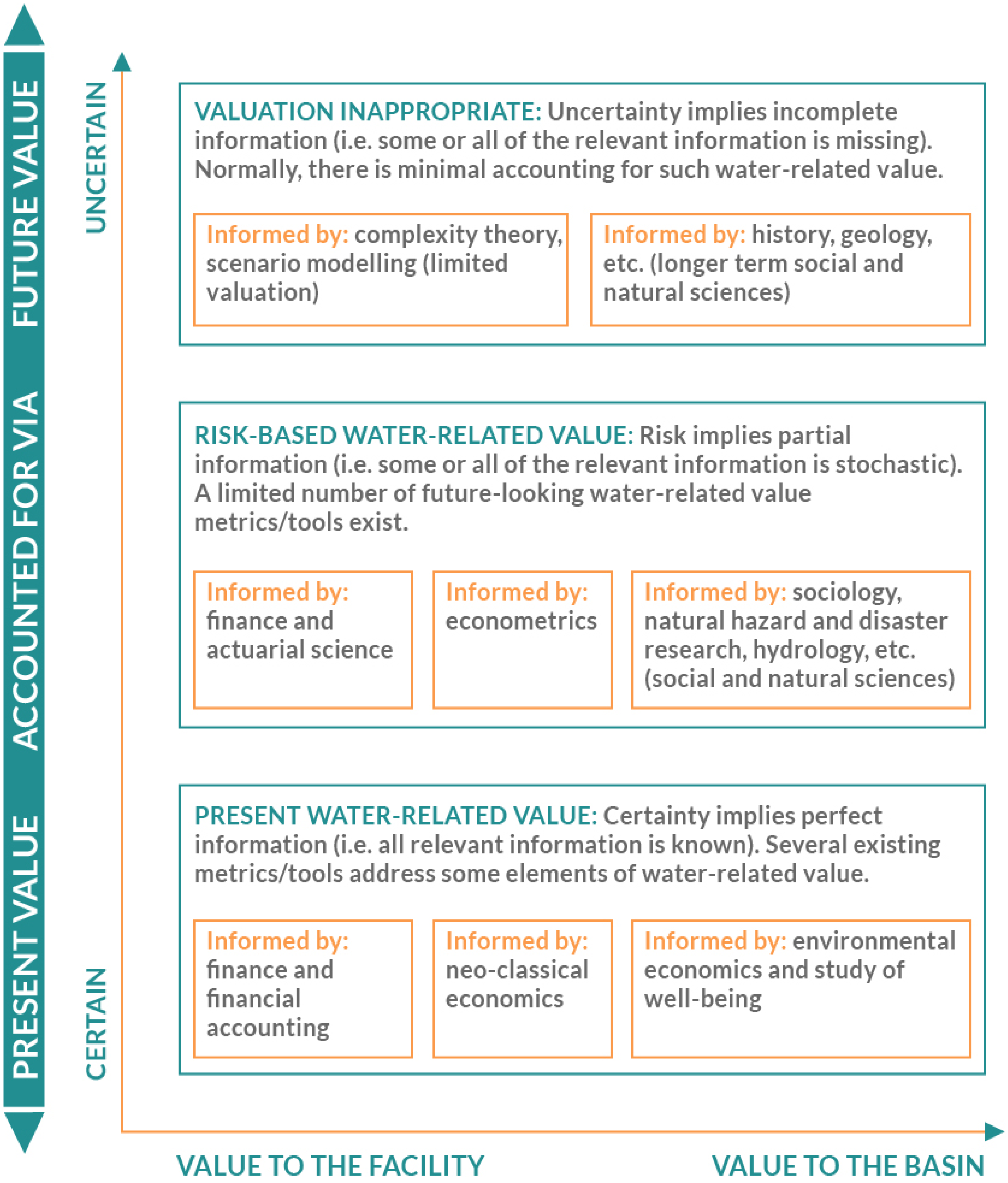

Figure 2. Valuation affected by uncertainty Adapted from UNESCO (2021).

Thematic Tagging
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