



Business guide to water valuation

An introduction to concepts and techniques

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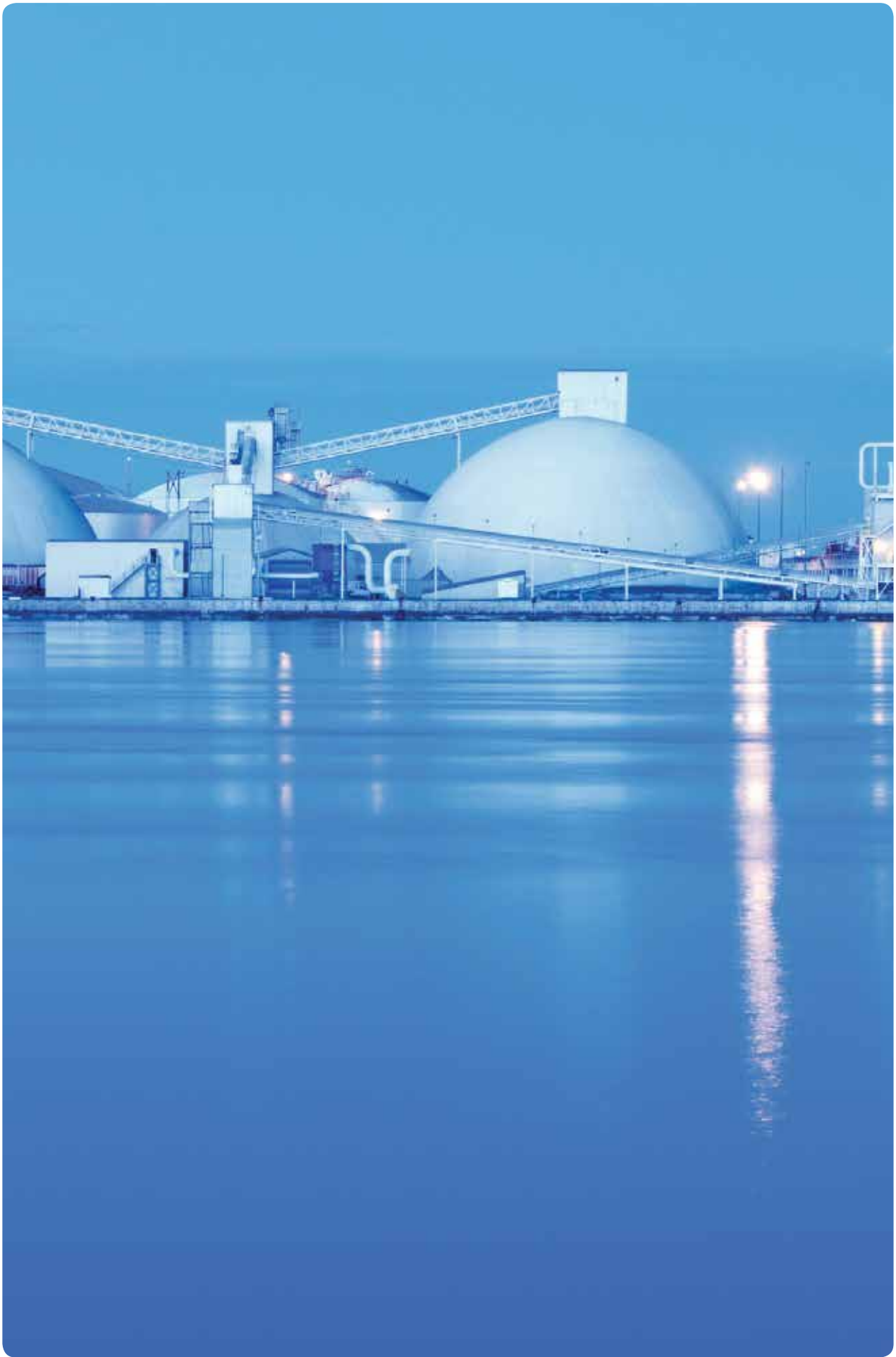
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Foreword

How much is water worth to your business?

You may know your company's annual water bill, but the real value of water is much more complex. "Value" is often used interchangeably with "cost", but the true importance or usefulness of water stretches beyond the expense line, incorporating social and environmental as well as economic factors. I suspect that few of us are really able to answer my question.

However, as business leaders, we are going to need to. There is a global recognition that water is rarely valued or priced appropriately and as water demand continues to stretch and stress water supply, businesses will increasingly need to look at the real value of water to their business. Valuing precious natural resources such as water better, is also the only way we will ever see a world in 2050 where 9 billion people live well, within the limits of the planet. This is not about turning business into an arm of the UN—there are real-world implications for our businesses, from looming regulatory, operational or reputational risks, to unseen costs and hidden opportunities for growth.

This Guide explains the main concepts and techniques associated with water valuation, drawing from the progressive efforts of companies that have already started valuing water. It is illustrated by 25 case studies of business-related applications and will help managers commission, manage and review water valuation studies, as well as make the best use of the findings.

A best-practice approach to water valuation allows you to compare trade-offs between water uses and impacts and to determine the benefits and costs to stakeholders. The bottom line is that the costs will get bigger the longer we wait. Businesses need to start tackling the issue of accounting for the real value of the water they are using—and do it now, before it is too late.



Peter Bakker
President, WBCSD



Executive summary

This *Business Guide to Water Valuation* provides business-specific guidance on the main concepts and techniques associated with water valuation. The intention is to arm business managers with the knowledge and critical eye needed to work with valuation specialists. This will help managers commission, manage and review water valuation studies, as well as make the best use of the findings.

The Guide will also serve a wider audience interested in water valuation, including policy-makers and valuation experts, in order to facilitate consistency in use of approaches and terminology for future water valuation studies.

The Guide draws upon 25 business-related valuation cases from 10 different sectors that illustrate how water valuation can be used to reach different goals (see the map in figure 4 on page 11), and that help explain the concepts and techniques.

It builds on the WBCSD's *Water Valuation: Building the business case* publication, which sets out the international trend towards valuing water and the business case for water valuation. The business case arises from investigating water issues with a value-based lens. Key business case arguments include enhancing decision-making, maintaining and enhancing revenues, reducing costs, managing risks and enhancing reputation.

The Guide also complements the WBCSD's *Guide to Corporate Ecosystem Valuation* (Guide to CEV), which provides a generic approach for businesses to incorporate the value of ecosystem services and environmental externalities within their decision-making. It does this by providing water-specific recommendations, advice and examples for each stage of a CEV.

What is water valuation?

In the strictest sense, water valuation is about assessing the worth of water to different stakeholders under a set of specific circumstances. However, in this Guide, water valuation is used loosely to mean “water-related valuation.” This includes determining values, prices and/or costs associated with six categories of water-related values and impacts. These comprise the three main types of water value (i.e., off-stream, in-stream and groundwater values), the hydrological service values provided by non-water habitats, non-water impacts associated with water use, and impacts from extreme water-related events.



Valuation concepts

Value essentially means “*the importance, worth or usefulness of something*” (source: [OxfordDictionaries.com](https://www.oxforddictionaries.com/)).

Water values may be environmental, social or economic in nature. “Value” is often expressed in terms of how much an individual is willing to pay for something (i.e., given an economic value in monetary terms). However, while money is generally seen as the best universal measure of value, it is not always possible or desirable to express all values in monetary terms.

Instead, valuation should always start with qualitative valuation. This may be purely descriptive, or it can use a scale of value such as high, medium and low. The next level is quantitative valuation, which is based on quantifying physical units or indicators associated with the values. The final level is monetary valuation, where actual money values are determined.

Water valuation studies may be very broad, covering anywhere from one to six categories of water-related value. The coverage depends on the objective and context of the assessment, and can include:

- **Off-stream values:** The benefits gained from use of water abstracted or diverted from a surface- or groundwater source, and from harvested rainwater and seawater;
- **In-stream values:** The benefits generated from water that remains within a waterbody;
- **Groundwater values:** The benefits provided as a result of water collecting and flowing underground;
- **Hydrological services:** The benefits provided by the hydrological functions of habitats that influence water quantity and quality;

- **Non-water impacts:** Non-water environmental, social or economic impacts related to water delivery and use; and

- **Extreme water-related events:** Events that can cause significant impact and loss of value, typically related to either droughts or floods.

When investigating water values, it is important to recognize the difference between value and price. Price relates to an amount of money actually paid for something, typically in some form of market. Water can have a high value but a low or zero price, as it can be withdrawn for free or is supplied at a subsidized price. The price of water indicates its financial or market value, but rarely reflects the full cost of supplying it or the full amount people would be willing to pay for it.

Two other closely interrelated concepts are also worthy of note. “Ecosystem services” is a concept that helps identify the full range of benefits humans gain from the environment – including those from water. “Total economic value” (TEV) is an older concept that provides a useful framework that categorizes environmental benefits into different types of value, each with a related set of potentially appropriate valuation techniques.

Business applications

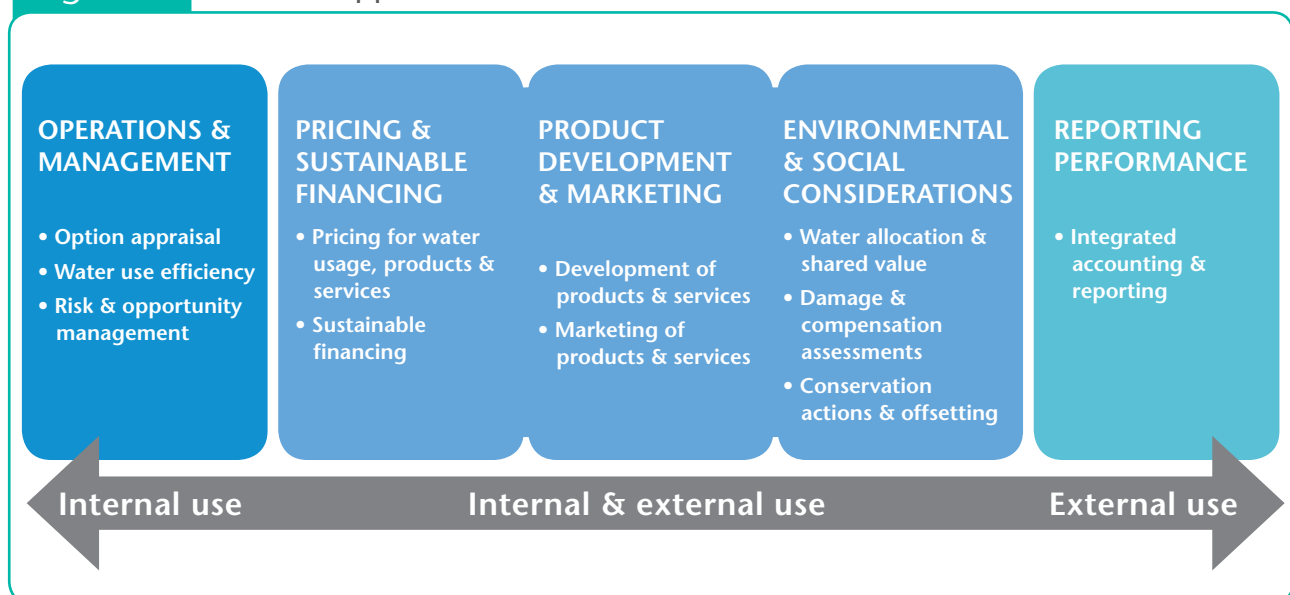
Water valuation is increasingly used to support many different business decision-making contexts (see table 1 on page 12 summarizing the 25 case studies). As water demand continues to outstrip supply, costs to business of using water will escalate and debates over stakeholder needs for water will intensify, threatening supplies.

Water valuation can be applied at any level, whether at a company, project, product or action level. At the heart of these applications lies the ability to compare trade-offs between different water uses and impacts, and to

gain insight as to which stakeholders benefit or lose out, and to what extent. In many cases companies are able to quantify and demonstrate the water-related benefits derived from their actions.

Based on a review of 25 business examples, the Guide identifies five main categories of business application for water valuation: operations and management; pricing and sustainable financing; product development and marketing; environmental and social considerations; and reporting performance.

Figure 1 Business applications for water valuation



Valuation techniques

Over the past few decades, many valuation techniques have evolved that can be used to determine water-related values. While there is increasing attention on monetary valuation, qualitative and quantitative valuations are important too, and may be all that is required to inform a decision (see Figure 2).

Qualitative valuation simply involves describing values and can include an assessment of relative value (e.g., high, medium and low value). Qualitative valuation may involve undertaking interviews or focus groups, or applying professional judgment. It is usually considered an essential step in performing monetary valuation to focus efforts on the most relevant impacts.

Quantitative valuation involves using some form of metric or unit to quantify values. Techniques include, for example, using indicators and multi-criteria analysis. Quantitative valuation is commonly used to support qualitative and monetary valuations.

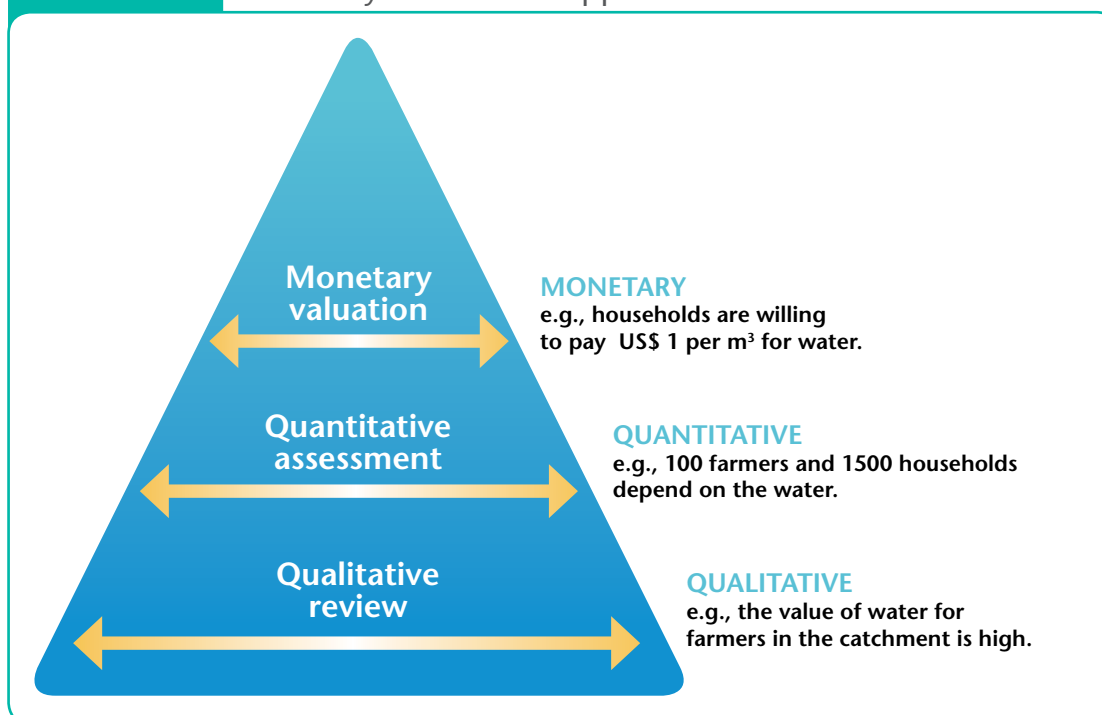
Monetary valuation involves putting a monetary figure on values. Many techniques are available to help do this, and they can be classified within the following categories:

- i) **Revealed preference** approaches, which estimate values based on observing behavior related to market goods and services;
- ii) **Cost-based** approaches that draw upon costs to infer value;
- iii) **Stated preference** approaches, which use questionnaires to elicit human preferences; and
- iv) **Value transfers**, whereby values determined in previous primary valuation studies are used to estimate values elsewhere in a similar context.

Selecting the right technique(s) to use can be a challenge. In addition to describing each technique, the Guide provides advice on which technique is best used for what purpose, and highlights the pros and cons of each.

Figure 2

Hierarchy of valuation approaches



Undertaking water valuation

The process for undertaking business water valuation should be the same as undertaking a corporate ecosystem valuation (CEV). But first, to decide if water valuation is worthwhile, two questions need to be answered: What is the issue at stake? And how is the issue best addressed? If the outcome suggests that valuation should be undertaken, it is recommended that the five stages of the WBCSD's *Guide to Corporate Ecosystem Valuation* be followed and that suitable experts be involved.

The five CEV stages are:

- I. **Scoping:** As for any valuation, it is important to ensure that the scope of the water valuation is carefully established.
- II. **Planning:** Ensuring access to a suitably qualified environmental economist is essential. Involving other experts such as hydrologists and ecologists is also likely to be necessary, depending on the context.
- III. **Valuation:** There are nine steps that should generally apply to all water valuations:
 1. Define the business aspect (i.e., what is to be valued)
 2. Establish the environmental baseline
 3. & 4. Determine physico-chemical and environmental changes
 5. Identify and assess the relative significance of ecosystem services affected and other impacts
 6. Monetize selected changes to ecosystem services and other environmental externalities
 7. Identify internal and external benefits and costs to the company
 8. Compare benefits and/or costs
 9. Apply sensitivity analysis.

IV. **Application:** Once a valuation has been undertaken, there are many potential uses of the information gleaned. Valuation should not just be an academic exercise.

V. **Embedding:** This stage involves adopting water valuation, if proven to be useful, within company processes and procedures.

The appropriate scope may need to be much broader than dealing with just water, and is likely to require consideration of the whole water catchment. The business-as-usual scenario will require careful thought about how water availability, quality and flooding issues may change throughout the year, as well as over time. Other key considerations may include establishing potential cause-effect relationships between business activities and water quantity and/or quality; identifying and dealing with relevant water-related trade-offs; and factoring in potential changes in market prices and payments for ecosystem services.



Resources and next steps

The WBCSD website (at www.wbcd.org/work-program/sector-projects/water.aspx) provides additional resources and materials on corporate water management, water tools for business, and business water valuation case studies. Many other guidance documents and databases exist that can also inform water valuation, a selection of which are identified at the end of this Guide and on the website.

Over the coming years, considerable changes will manifest themselves in relation to how businesses manage their water impacts and dependencies. Key issues will, for example, relate to water pricing, water availability, extreme climatic events, government policies and regulations, new economic instruments (e.g., payments for ecosystem services and offsetting) and calls for more natural capital valuation and integrated accounting and reporting.

Companies are encouraged to explore potential implications and management strategies for their business going forward. As part of this, companies should consider what water management approaches are available and how water valuation may help them. Key first steps are to identify an appropriate study, develop a business case, and involve a suitable team of experts. Finally, it is important to note that water valuation is relevant to most businesses and may only require a fairly simple approach.



1

Introduction to the Guide

What is water valuation?

There is growing recognition of both global disparity in water supply and demand and the fact that water is rarely valued or priced appropriately in decision-making. Consequently, considerable attention is now being focused on the need for better integration of water valuation in water catchment planning and business decision-making. But what does water valuation actually mean?

Water valuation simply means assessing the worth of water to different stakeholders.

Water-related valuation means assessing the worth of all benefits and costs associated with water.

In this Guide, the term “water valuation” is used to encompass all aspects of “water-related valuation”.

For the purposes of the Guide, a technical definition of what is covered by water valuation is **assessing values (as well as prices and costs), whether qualitatively, quantitatively or monetarily, associated with: water use; changes in the quantity and/or quality of water in situ; hydrological services; non-water impacts, and extreme water-related events.**

In the strictest sense, water valuation is about assessing the worth of water, whether in the form of off-stream, in-stream or groundwater values, to different stakeholders under a set of specific circumstances. However, in this Guide, water valuation is used loosely to mean water-related valuation. This includes determining values, prices and/or costs associated with:

- i) The three main types of water value (i.e., off-stream, in-stream and groundwater values);
- ii) Hydrological services of non-water habitats (such as the water filtration function of forests);
- iii) Non-water impacts associated with water use (for example, the societal cost of greenhouse gas [GHG] emissions from energy used to obtain water);
- iv) Extreme water-related events (such as droughts and floods, whether avoiding such events or being impacted by them).

By including all these potential elements, water valuation is an excellent approach to compare trade-offs between competing uses of water, and to assess the value to business and society from using and managing water.

Water valuation should consider all forms of value, including economic, social and environmental values. As explained later, this Guide predominantly focuses on using a welfare economics-based approach to valuation that attempts to do this by drawing upon the concepts of ecosystem services and total economic value. However, the Guide also advocates for the recognition of and accounting for wider environmental, social and economic values outside of this conceptual framework.



Key water statistics

- Global water demand may be 40% greater than the currently available water supplies by 2030 (2030 Water Resources Group, 2009).
- Water demand is predicted to increase by 55% worldwide between 2000 and 2050, with some industries increasing much more, such as manufacturing by 400% and electricity production by 140% (Organisation for Economic Co-operation and Development, 2012)
- In developing countries, more than 80% of untreated sewage is discharged into waterbodies (United Nations, 2011).
- Industry discharges or disposes of 300 to 400 million metric tons of waste into waterbodies each year (United Nations, 2011).
- At least 1.8 billion people use unsafe drinking water and 2.5 billion lack access to adequate sanitation (Onda et al., 2012).



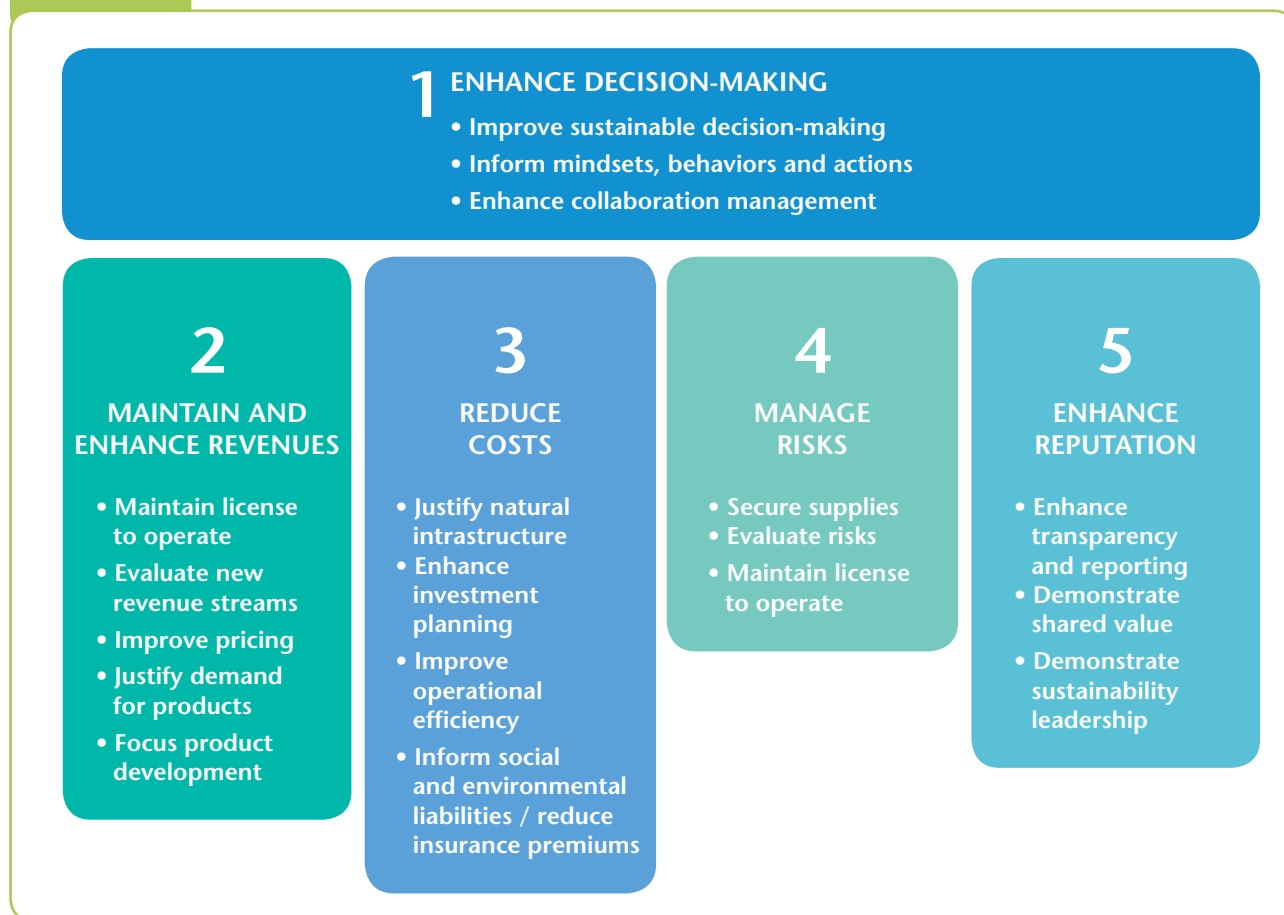
Why should businesses undertake water valuation?

Two sets of drivers are pushing and pulling businesses towards undertaking water valuation. On the one hand is the underlying global and regulatory trend towards natural capital and water valuation and improved water pricing, while on the other is the evolving business case and potential benefits to be gained. Both drivers are investigated in the WBCSD's publication *Water Valuation: Building the business case* (The Business Case Document, WBCSD 2012a).

The main business benefits are summarized in figure 3, and include enhancing decision-making, maintaining and enhancing revenues, reducing costs, managing risks and enhancing reputation. As explained in the Business Case Document and the accompanying *Water Valuation: Business case study summaries* (WBCSD 2012b), most business applications have multiple benefits. In addition, the benefits are often interconnected (e.g., reducing risks also reduces costs).

As explained and demonstrated in section 3 and in the Business Case Document, there are many different business applications for water valuation. One of its key advantages over other water management tools is the use of a value-based lens that can compare trade-offs between different water uses and impacts. This provides insight as to which stakeholders benefit or lose out, and to what extent, from a company's actions. In addition, businesses are able to quantify and demonstrate water-related benefits accruing to various stakeholders from their own actions.

Figure 3 The business case for valuing water



About the Guide

The objective of the Guide is to help businesses undertake water valuation. The Guide explains the main concepts and techniques associated with water valuation by drawing upon 25 business-related applications. These business examples are summarized in figure 4 and in table 1, with further details available on the [WBCSD website](#). The Guide also complements the methodological framework presented in the WBCSD's *Guide to Corporate Ecosystem Valuation* (Guide to CEV, WBCSD 2011a). The Guide to CEV provides a generic approach for businesses to incorporate the value of ecosystem services and environmental externalities within their decision-making, while this *Business Guide to Water Valuation* provides additional guidance from a water perspective.

This Guide contains the following sections:

2. **Valuation concepts** – the main concepts associated with water valuation.
3. **Business applications** – the four main areas of decision-making where businesses can apply water valuation.
4. **Valuation techniques** – the main valuation techniques and associated analytical approaches that can be used to aid decision-making.
5. **Undertaking water valuation** – the main stages and steps for conducting water valuation, providing water-specific guidance.
6. **Resources and next steps** – other key water valuation resources and emerging water issues of relevance to water valuation.

Who is the Guide for?

The primary audience of this Guide is business managers. The intention is to arm them with the knowledge and critical eye needed to work with valuation specialists, whether internal, external or both. This should help managers commission, manage and review water valuation studies, as well as make best use of the findings.

The Guide will also serve a wider audience interested in water valuation, including valuation experts, policy-makers and researchers. As such, it aims ideally to facilitate consistency in use of approaches and terminology for future water valuation studies.

Figure 4 Map showing case studies used in the Guide



Table 1

Case studies used in Guide

Company	Company aspect	Summary	Water element valued
Anglo American	Mining operation	Water price, costs, revenues, internal and external risk are key parameters included in a sustainability valuation approach (SVA®) that explores the potential value at stake related to key project decisions and options, thereby assisting in the decision-making process.	Off-stream: Industry use Extreme water-related events: Droughts
Antofagasta	Copper mines and creation of a wetland reserve	Water-related values are included within an Environmental Risk Opportunity and Valuation Assessment (EROVA) tool being developed to help ensure operations create net environmental value.	Off-stream: Fresh & seawater for consumption and operations In-stream: Biodiversity conservation Hydrological services: Flow control
Cook Composites & Polymers	Construction of a wetland at a facility	Water valuation was an integral element of a valuation study used to justify the viability of installing a natural wetland system instead of renovating a man-made storm-water control system.	Off-stream: Water saved Hydrological services: Flood control and water quality regulation Non-water impacts: Energy savings
The Dow Chemical Company	Chemical plant	As one of three key ecosystem services, the study is exploring the costs and benefits associated with alternative options to enhance freshwater availability in the catchment to help secure supplies at a plant.	Various off-stream and in-stream
EDF	Water use in a catchment	Water valuation was used to optimize water allocation in a water catchment, balancing agriculture, energy, drinking water, recreation and biodiversity needs.	Off-stream: Agricultural use, drinking water In-stream: Recreation and energy
EDP – Energias de Portugal	Hydropower reservoir facility	Water-related values were part of an overall assessment of values generated and lost as a result of having a reservoir in a natural park.	Off-stream: Domestic & agricultural use In-stream: Recreational fishing
Hitachi	Desalination water supply & wastewater treatment plants	Water-related valuation formed part of a wider valuation of environmental impacts associated with installing a new treatment plant to evaluate overall net societal impacts.	Off-stream: Domestic use Non-water impacts: Carbon/ greenhouse gases (GHGs)
Hitachi	Geographic information system (GIS)-based technology product	This study valued various parameters, including water and water pollution, that could be better managed through use of the GIS-based GeoMations precision agriculture tool.	Off-stream: Agricultural use In-stream: Water pollution
Holcim/Aggregates Industries UK	Quarry rehabilitation	A valuation study was used to inform options for a quarry rehabilitation plan involving the creation of a wetland and lake.	In-stream: Recreational and biodiversity value Hydrological services: Flood control
Kraft Foods /Tsb Sugar	Sugar plantation management	Water-related values were some of many environmental impacts and dependencies investigated as part of the development of a tool to assess the risks and opportunities of a supplier farm.	Off-stream: Agricultural use In-stream: Recreation Hydrological services: Flood control Extreme water-related events: Floods & droughts
Lafarge	Quarry rehabilitation	A valuation study was used to enhance land-management planning for a quarry reclamation scheme.	In-stream: Recreational Hydrological services: Erosion control and water purification
Maryland State Water Quality Advisory Committee	River clean-up	Economic valuation and economic impact assessment approaches were used to quantify the benefits and justify continued cleanup of a river affected by acid rock drainage.	In-stream: Recreational, boating & angling
Minera Escondida Limitada	Copper mine operations	The study explored the cost-effectiveness of alternative options to reduce the consumption of high-quality water at a mine in the Atacama Desert.	Off-stream: Industry use
Mondi	Water use and management in a catchment	The cost of water for different user groups (urban/ industrial, forestry and agriculture sectors) was investigated using a GIS-based approach to inform better water resource use.	Off-stream: Domestic, industry forestry and agricultural use

Company	Company aspect	Summary	Water element valued
PUMA	Global supply chain	Water was one of a number of parameters valued in the first-ever environmental profit & loss account (E P&L) to measure and monetize externalities associated with PUMA's operations and supply chain.	Off-stream: Manufacturing and agricultural use In-stream: Freshwater replenishment & ecosystem maintenance
Rio Tinto Iron Ore	Iron ore mine dewatering options	The study assessed the costs and benefits associated with dewatering in mining to select optimal surplus water management options and ensure working towards achieving a net positive biodiversity impact.	Off-stream: Biodiversity conservation and agricultural use
Rio Tinto	Mine-related forestry biodiversity landscape management	Valuation was used to explore the nature, extent and distribution of costs and benefits associated with potential biodiversity offsets to gain a license to operate and inform potential offset market opportunities.	Hydrological services: Erosion control and water purification
South Australia Water Corporation	Water management in a catchment	This study used valuation to evaluate and justify implementation of catchment management actions (e.g., sediment ponds and improved drainage) rather than install new water treatment plants.	Off-stream: Agricultural use Hydrological services: Erosion control and water purification
Veolia – Berlin	Land and water management involving biofuels	Valuation was used to determine the best financial and societal option for land and water use involving biofuel production for a company landholding, and to explore opportunities for payments for ecosystem services.	Off-stream: Agricultural & biofuel use plus on-land biodiversity and recreation values Non-water impacts: Carbon
Veolia – CCED	Sanitation system	The study identified and valued the additional societal benefits gained by installing a new sanitation system that enhances coastal water quality, enables wastewater reuse and provides flood control from buffer ponds.	Off-stream: Agricultural use In-stream: Recreation/tourism Hydrological services: Flood control
Veolia - Crépieux-Charmy	Water supply catchment area	Valuation was undertaken to assess the benefits (including water purification and biodiversity conservation) provided by a large catchment area used to supply Lyon with water.	In-stream: Biodiversity conservation Hydrological services: Water purification Non-water impacts: Carbon
Xylem	Improvements to national water supply management	The company commissioned a willingness-to-pay survey to investigate how much more households and businesses are willing to pay to guarantee a more reliable supply of water.	Off-stream: Domestic and business use
Yarra Valley Water	Water supply	The study estimated the values of water abstracted and distributed to water users, plus the value of water resources and associated ecosystem services, in the Yarra Valley.	Off-stream: Domestic and industry use In-stream: Recreation/angling Groundwater Hydrological services: Water purification, habitat maintenance, and waste assimilation
Yarra Valley Water and Melbourne Water	Water management system for new development	Quantitative valuation using multi-criteria analysis helped inform the selection of a preferred water management system for a new development.	In-stream: Water quality Groundwater Off-stream: Drinking water Non-water impacts: GHG emissions
Yorkshire Water	Water and wastewater services	A stated preference survey assessed domestic and business customer willingness to pay for various levels of water and wastewater service.	Off-stream: Drinking water In-stream: Bathing Extreme water-related events: Droughts & floods

Note: Additional details can be found in [Water Valuation: Business case study summaries](#) (WBCSD 2012b) and on the [WBCSD website](#).

2

Valuation concepts

This section explains some of the key concepts relating to water valuation. It builds on the Business Case Document and draws upon the 25 business valuation examples.

Water valuation and values

Water valuation means assessing the value (or worth) of water to different stakeholders. The values of water may be associated with off-stream use of water, water that is maintained in-stream, or groundwater. In this Guide **water valuation** actually means **water-related valuation** (see water-related values section below).

Water values may be environmental, social or economic in nature. Many such values can be measured in terms of how much an individual is willing to pay for something (i.e., given an economic value in monetary terms). However, while money is generally seen as the best universal measure of value, it is not always possible or desirable to express all values in monetary terms.

Given the difficulties inherent in a monetary valuation of the environment (see the [Business Case Document](#)), a hierarchy of valuation approaches has been developed (see figure 2). Valuation should always start with **qualitative valuation**. This may be purely descriptive or can use a scale of value such as high, medium and low. Qualitative valuation allows all aspects of value to potentially be identified, and may be the only level of valuation required to inform a decision.

The next level is **quantitative valuation**, which is based on quantifying physical units or indicators associated with the values. For example, this could include cubic meters of water consumed, or additional tons of output (e.g., wheat or manufacturing products) resulting from increased water use. Determining physical quantities is often a critical step in supporting qualitative and monetary valuation. Ideally, quantitative valuation should

Value: The importance, worth or usefulness of something source: [OxfordDictionaries.com](https://www.oxforddictionaries.com/)).

The value of water is based on the many different forms of benefit it provides to people. In simple terms, when values are generated, they can be considered as benefits, and when values are destroyed or lost, they can be considered as costs. Costs saved are also benefits, or values gained.

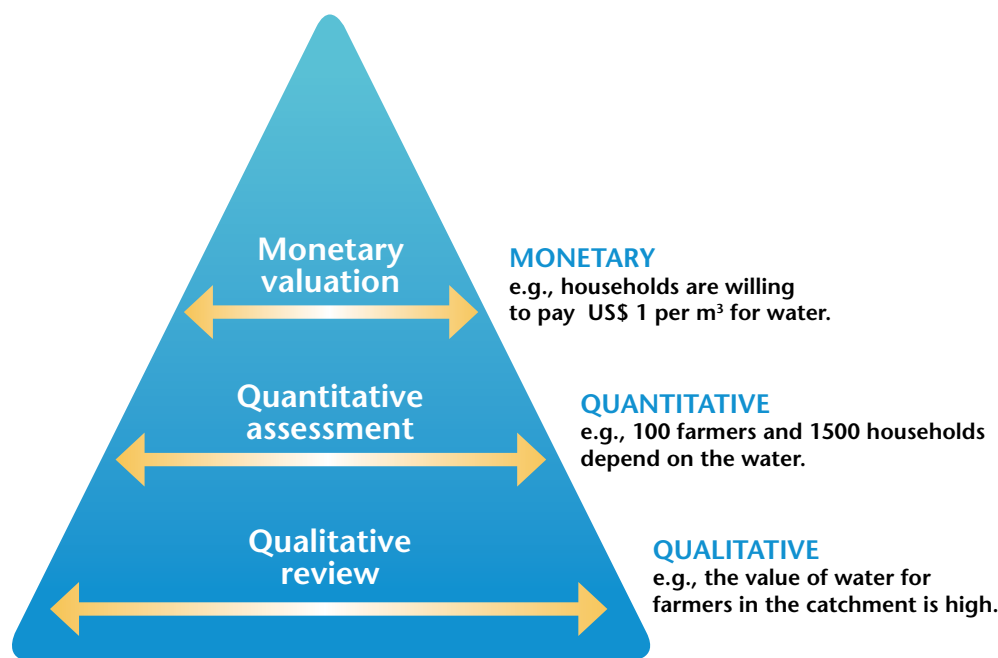
include indicators that inform something's actual "value," such as number of people or yield affected, rather than simply the volume of water consumed.

The final level is **monetary valuation**, where actual money values are determined. For example, the value of each cubic meter of water in a particular catchment may be estimated to be worth US\$5 to a particular industry.

As explained in *The Economics of Ecosystems and Biodiversity* (TEEB 2010a) there are multiple theories of value. These include the human preference-based approaches of welfare economics and political science, as well as biophysical approaches that include resilience theory and industrial ecology/thermodynamics. This Guide focuses on welfare economics as this approach has perhaps the greatest international traction with policy-makers and businesses.



Figure 2 Hierarchy of valuation approaches



Antofagasta is developing a framework based tool (EROVA) to evaluate qualitative, quantitative and monetary values for all potential environmental impacts associated with its projects and operations. It evaluates water itself, as well as several hydrological services. The qualitative assessment initially determines the relative positive and negative values generated based on five levels of value. This is converted to a 25-point score used in a quantitative valuation aggregating all affected parameters. Then, if desired, monetary valuation is conducted based on value transfers and, in some cases, primary valuation data. Additional quantitative data is used to support the qualitative and monetary valuation.

Welfare economics and sustainability values

Welfare economics involves evaluating human well-being based on the behavior and utility of individual households and firms in order to assist decision-making, to optimize the allocation of limited resources. Utility is typically measured in terms of an individual's willingness to pay, which can be used in benefit cost analyses (BCA) to inform the optimum allocation of resources, such as water, among competing stakeholder uses.

The concept of "total economic value" (TEV) was introduced to provide a more comprehensive framework within welfare economics that allows monetary value estimates to be incorporated for non-marketed environmental and social values, to complement market-based economic values.

Table 2

Examples of economic welfare values and other sustainability related values

Dimension of sustainability	Examples of welfare economics values (i.e., contributing to TEV)	Examples of other sustainability values (not additive to TEV)
Economic	<ul style="list-style-type: none"> • Market values for food, timber, properties, energy and industrial goods produced (reflected in business profits) • Tourism values • Carbon market prices • Flood protection of assets 	<ul style="list-style-type: none"> • Some contributions to GDP • Expenditure in local economies • Contribution to national and local taxes • Number of small businesses
Environmental	<ul style="list-style-type: none"> • Conservation/biodiversity value (non-use values) • Carbon sequestration 	<ul style="list-style-type: none"> • Ecological values, such as preserving species and evolutionary potential • Intrinsic value of organisms
Social	<ul style="list-style-type: none"> • Flood protection of houses • Recreation • Wild food gathering • Aesthetic values • Impact on health 	<ul style="list-style-type: none"> • Jobs • Household incomes • Good social relations • Gender and age equality • Freedom of choice and action • Spiritual values

Using the TEV approach, monetary values can be estimated for human-related environmental and social benefits that are additive. In effect, this converts environmental and social values into economic (i.e., societal or public) values to enable a total or net human welfare value to be derived through the use of BCA. However, it can be argued that other types of sustainability-related values exist beyond those values that can be monetized and included within TEV. Table 2 provides examples of welfare economics values and other sustainability values categorized under environmental, economic and social headings. The sustainability values include some values beyond human valuation (e.g., intrinsic value), some that are challenging to put monetary values on (e.g., spiritual values) and some that represent an alternative means of measuring welfare values (e.g., jobs and expenditures).

These other sustainability-related values are not theoretically additive to welfare values within a BCA, but instead either represent different ways of accounting for the same welfare benefits or provide different perspectives of value. Although the main focus of this Guide is on welfare economic values, the other forms of value are recognized as being important and are also addressed to an extent. For example, see section 4 on economic and socio-economic impacts.

Water-related valuation and values

As explained previously, water-related valuation refers to determining values, prices and/or costs associated with any one of six categories of water-related values. The categories include: off-stream, in-stream and groundwater values; hydrological services of non-water habitats; non-water impacts associated with water use; and extreme water-related events. Impacts should be considered from the perspectives of both a change in quantity and quality. These six types of water-related values are defined and explained below, with examples illustrated in figure 6.



As will become evident later in the Guide, water valuation studies may be very broad, covering anywhere from one to six categories of water-related value. The coverage depends on the objective and context of the assessment. Although most water-related values are additive, as is highlighted later, important trade-offs can occur. For example, abstracting water for off-stream use may reduce remaining in-stream values. Also, the value generated by producing desalinated water is partly offset by the societal cost of extensive greenhouse gas (GHG) emissions incurred in the process.

Off-stream values: These are benefits gained from use of water abstracted or diverted from a surface- or groundwater source, and from harvested rainwater and seawater (desalinated or not). Sometimes referred to as **consumptive use values**, they include industrial, agricultural, municipal and domestic water use. Such values may accrue to one stakeholder at the expense of others and often result in reduced in-stream values. As discussed later, the value should take into account any costs of using the water – for example, reduced in-stream values and other non-water

costs. If water is abstracted for use (e.g., industrial cooling or cleaning) and is returned to the same waterbody, loss of in-stream values may be negligible. However, the costs of any impacts resulting from related contamination should be accounted for (e.g., reduced in-stream and off-stream values further down the watercourse).

In-stream values: These are the benefits generated from water that remains within a waterbody (e.g., lake, river, canal, wetland, etc.). Sometimes referred to as **non-consumptive uses**, they include recreation, fishing, navigation and biodiversity conservation values, as well as hydrological services. It is important to recognize the upstream-downstream connectivity between waterbodies, and hence the longitudinal nature of many in-stream values. For example, this relates to hydrological services (e.g., upstream wetlands providing water flows downstream) and fish requiring habitat connectivity. It is thus worth noting the importance of maintaining environmental flows within rivers to retain biodiversity and associated values onsite and downstream. Many in-stream values can be simultaneously derived

Figure 6 Illustration of water-related values covered in Guide



by different stakeholders. The different types of benefit can be valued and summed to give a total value arising from a waterbody. Key issues to be aware of include the reduction of in-stream values arising from off-stream uses, and reduction in in-stream values as a result of reduced water quality (e.g., from discharges and/or reduced flows).

Groundwater values: These are the benefits provided as a result of water collecting and flowing underground. In addition to the obvious off-stream values generated when groundwater is abstracted, groundwater values include: water storage; water flow regulation; water filtration; prevention of land subsidence; mitigation of saltwater intrusion; and contribution to river flows downstream.

Hydrological services: These are the benefits provided by the hydrological functions of habitats that influence water quantity and quality. All waterbodies provide these values, but so too do many non-aquatic habitats. For example, forests and grasslands can help reduce surface water run-off, ensuring that more water flows through the underlying soil. This can help reduce flooding, prolong the availability of water downstream, reduce sedimentation, and cleanse water by filtering it and assimilating wastes such as excess nutrients and pollutants. Businesses may cause water-related impacts by degrading or enhancing non-aquatic habitats in a watershed, or they may be affected by the actions of others on non-waterbodies.

Non-water impacts: These are non-water environmental, social or economic impacts (either positive or negative) related to water delivery and use. The most common ones encountered are non-water environmental costs. When undertaking water valuation, non-water impacts should be accounted for, such as the societal cost of greenhouse gas emissions and air emissions from the energy used to pump and/or desalinate water. They also include positive impacts, such as carbon sequestration benefits arising from planting trees as part of mitigation.

Extreme water-related events: These are extreme weather events typically related to either a lack of water (drought), or an excess (flood), that can cause significant impacts and loss of values. Excessive off-stream use of water can exacerbate the impact of droughts by reducing the availability of surface water. Habitat degradation and land conversion for development can reduce the flood attenuation role of non-waterbody habitats, thereby making floods worse. It is, however, important to note that the natural periodic flooding of floodplains provides vital benefits to many stakeholders, for example the renourishing of adjacent agricultural land.





EDP conducted valuation to investigate the financial and societal values provided as a result of locating their hydropower reservoir facility in a 7,200-hectare watershed in Portugal. The valuation included two **off-stream values** — the value of water supply for human consumption and for agricultural irrigation. It also included two **in-stream values** — recreational fishing and power generation from the dam.

Yarra Valley Water calculated the total economic value of water to Melbourne to help it select the best community outcome when assessing alternative water supply options. It found that the largest single contribution to determining the value of water was groundwater. In an average year this was AUD 4.85/m³ (US\$4.66/m³) out of a total indirect use value of AUD 5.85/m³. The valuation was based on a literature review and used a value function based on the relationship between water value and scarcity. The groundwater value was predominantly due to groundwater recharge and freshwater replenishment values, while the other indirect use value was for waste assimilation and habitat maintenance.

Rio Tinto piloted the valuation of the **hydrological services** of forest ecosystems at a site in Madagascar by looking at reduced soil erosion and the value of resulting benefits to agriculture, as well as at the provision of clean drinking water to urban areas sourcing water from the watershed.

Kraft is developing a biodiversity and ecosystem services tool that determines the level of risk and costs to potential food commodity suppliers resulting from such issues as potential **extreme water-related events** (i.e., drought and flood events).

For its **Maldives valuation**, **Hitachi** determined the value of **off-stream benefits** of water for domestic and business use, together with various **non-water environmental impacts** associated with a new desalination and power plant. The latter included the cost of greenhouse gas (GHG) emissions and other air emissions (NO_x, SO_x and particulate matter) associated with the construction and operation of the plant, and from potential pipeline damages to coral reefs.

Businesses will no doubt increasingly be interested in the financial costs they potentially face as a consequence of extreme water-related events. Associated business impacts are likely to be exacerbated by climate change, and assessing the full implications for businesses is challenging due to the complex nature of supply chains, which are often first to suffer. Weather events in the United States dominated global insurance losses in 2012, the third most costly year on record, at US\$77 billion, according to a 2013 news release by Swiss Re.

The relationship between values, benefits, costs and prices

In simple terms, when something gives rise to a value, it can be considered a benefit, whereas when something results in the loss of value, it can be considered a cost. In welfare economics, the costs and benefits of a project are compared using a BCA to determine an overall net change in value from a societal perspective. The values represent what the costs and benefits are worth in aggregate to different individuals.

The term “price” has an entirely different meaning. This relates to an amount of money actually paid for something, typically in some form of market. For example, in some places, water can have a high value (it is much sought after) but a very low or zero price, as it can be withdrawn for free or is supplied at a subsidized price. The price of water indicates its financial or market value, but rarely reflects the full cost of supplying it or the full amount people would be willing to pay for it. Thus the price does not necessarily reflect its actual value.

The discrepancies between water value and price are considered by many to be an underlying driver of global water problems. Consequently, considerable efforts are being made by organizations such as the Organisation for Economic Co-operation and Development (OECD) to encourage countries and water companies to improve water-pricing policies to either move towards full cost pricing or sustainable cost recovery (OECD, 2009).

Value: The importance, worth or usefulness of something. See discussion at the start of section 2.

Benefit: Something that promotes or enhances human well-being. It is effectively synonymous with value, in that if a project or product creates value, it is producing a benefit. Water provides a range of environmental, social and economic benefits (or values) to different stakeholders in many different ways. A gain in value is considered to be a benefit, as is a reduction in cost.

Cost: The value that must be given up to acquire, obtain or achieve something (definition from WebFinance, Inc.'s BusinessDictionary.com). The cost of water should include the financial costs of providing the water (e.g., abstraction, treatment and delivery) as well as any societal costs incurred from using it (i.e., loss of value from damaging the environment and from forfeiting other potential uses of the water). A loss of value is considered to be a cost.

Price: The amount of money expected, required or given in payment for something (definition from OxfordDictionaries.com). Water usage has a price (i.e., a market price to purchase tap or bottled water), but the price paid rarely reflects the actual value that individuals or businesses hold for it, and the price rarely includes the full cost of supply (i.e., what is given up to obtain it).

Full cost pricing: In relation to charging for water usage (and recovering costs for water services), this means **setting a price that reflects both the financial costs and societal costs of obtaining water, including resource and environmental costs** (based on the European Union Water Framework Directive [EU, 2000]).

Sustainable cost-recovery: The setting of a mix of tariffs, taxes and transfers to facilitate long-term investment planning that ensures affordability to all categories of users and financial sustainability to service providers (based on Organisation for Economic Co-operation and Development, 2009).

The concept of full cost pricing is based on the increasingly advocated principles of “user pays” and “polluter pays.” This means setting a price for off-stream water use that considers the full economic costs of using water. As shown in figure 7, the full economic cost of water includes not only the financial costs incurred in obtaining the water, but also other societal costs (i.e., loss of values) associated with using the water.

Financial costs should include whole life costs of the project (e.g., capital, operation, maintenance and decommissioning costs), as well as other administrative costs (such as billing customers and dealing with regulatory requests). Societal costs include various environmental costs (water-related and non-water-related impacts), as well as resource (opportunity) costs from not being able to use the water for other purposes.

Note that figure 7 primarily relates to water quantity rather than water quality. Impacts on water quality should also include an assessment of implications to all components of societal and financial costs. In addition, it is important to recognize that business activities that improve water availability and/or quality potentially generate an equivalent set of societal and financial benefits.

When considering the full value of off-stream water use, the financial and societal costs associated with using that water to determine a net value should be deducted in theory. It is important that the trade-offs between gains in off-stream values and losses of in-stream values be recognized and accounted for, as they can often be significant. Evaluating trade-offs between the use of water for one activity over another is an important potential application of water valuation.

However, evaluating trade-offs is not always straightforward in a large and complex watershed. Depending on the volume abstracted, there may be no associated foregone opportunity costs or noticeable impact to stream values. Or it may be that the marginal impact of one company's actions is negligible, while the overall cumulative impact is considerable. In such cases, the overall impact can be apportioned between those causing the impacts. The same principle applies to apportioning the costs of waterbodies polluted by a mix of sources.

Note that companies may also be interested in assessing the cost to the business of running out of water, or of being impacted by poor water quality. In such cases, the cost is equivalent to the loss of value from reduced output, increased production costs or even from shutting down operations.

Figure 7 The full economic costs associated with off-stream consumptive water use

Full economic costs	Societal costs (externalities)	Environmental costs	Non-water-related impacts (e.g., GHGs)
		Resource costs	Water-related impacts (e.g., loss of in-stream values)
			Foregone opportunity costs (e.g., other abstraction values lost)
	Financial costs (including any internalized environmental or resource costs)		Administration
			Operation & maintenance
			Capital

Mondi undertook a valuation that identified the cost of water to different stakeholder groups in a catchment in South Africa. The cost was simply a financial cost to the stakeholder based on the price paid for it in the market (i.e., its market price). The study revealed that forestry plantations paid 26 million Rand at 0.38 Rand/m³, farmers paid 41 million Rand at 0.70 Rand/m³, and industry paid 69 million Rand at 0.81 Rand/m³.

PUMA constructed the first-ever environmental profit and loss account (E P&L) that details the environmental impact for key areas, including the use of water in producing sport-lifestyle products, along its entire value chain. PUMA estimated the value of water in each watershed based on the loss in value (i.e., cost incurred) to stakeholders, such as from freshwater replenishment and ecosystem maintenance. The average value of this loss came to around € 0.80/m³ water, which was included in the E P&L as the societal cost for each cubic meter of water consumed in the supply chain (PUMA, et al., 2011). This cost is effectively a shadow price for water in the E P&L, which alerts PUMA to the potential significance of societal losses for which they currently do not pay.



Economic, financial, societal and other values

Technically speaking, economic values can comprise both financial and societal values. However, the word “economic” is often used interchangeably with “financial.”

Financial values are also referred to as private values. These are typically based on actual financial transactions, and are values that may affect the bottom line of a company's accounts either positively or negatively.

Societal values, also referred to as public values, are typically not accounted for by an organization, yet these values may affect them. They are hence also known as externalities or third party impacts. Many environmental and social values are societal values as they are often not traded in a market and therefore have no market price.

Economic value: These are “values measured at their ‘real’ cost or benefit to the economy, usually omitting transfer payments and valuing all items at their opportunity cost to society” (Source: Emerton and Bos, 2004). A simpler definition is “the amount (of money or goods or services) that is considered to be a fair equivalent for something else” (source: [dictionary.reference.com](#)). Economic value can also refer to financial and/or societal values.

Financial value: The importance, worth or usefulness of something to an organization or individual measured in terms of market prices.

Societal value: The importance, worth or usefulness of something accruing to organizations, individuals and society that does not have a market price.

Externality: A consequence of an action that affects someone other than the agent undertaking that action and for which the agent is neither compensated nor penalized through the markets. Externalities can be positive or negative (source: MA, 2005).

Veolia conducted a valuation in Germany that evaluated alternative water and land management options relating to biofuels on one of their landholdings. As part of the study, they performed a financial analysis that assessed the overall net financial returns to the company from the options, and a separate financial analysis to determine the potential financial profitability of each biofuel option. In addition, they undertook an economic analysis that included the financial values together with various societal values arising from the options. The societal values included changes in aesthetic/non-use values resulting from biodiversity and landscape impacts affected by water availability. They also included societal costs from GHGs emitted as a result of pumping water (i.e., non-water impacts).

Rio Tinto Iron Ore is currently trying to integrate the societal value of changes to ecosystems as a result of dewatering in mining in Western Australia. Rather than continue business as usual and look only at financial values based on real costs incurred and income, valuation of water-induced ecosystem changes is being used to calculate the full economic costs and benefits of a range of different water use options. This will allow the company to take the external costs and benefits of its operations into account when identifying optimal water management options.



Economic and socio-economic impacts

In addition to economic values, businesses, governments and other stakeholders may also be interested in economic and socio-economic impacts that result from projects and activities. “Economic impacts” focus on impacts to local and regional economics, as measured through such indicators as number of jobs, average and total incomes, revenues and taxes generated, as well as total expenditure. Caution is needed, because economic impacts are just a different way of expressing the benefits that give rise to economic values, so they cannot be added together.

“Socio-economic impact” is a broader term that encompasses economic values and economic impacts, as well as other socio-economic indicators and data relating to different stakeholder groups. Regional governments and some stakeholder groups often may prefer to know the economic and socio-economic impacts of projects rather than economic values. Such impacts are often included in environmental impact assessments.

Economic impacts: A macroeconomic effect on commerce, employment or incomes produced by a decision, event or policy (source: WebFinance, Inc.’s Businessdictionary.com). It usually focuses on impacts to a regional economy, in particular those to gross domestic product, expenditures, incomes, jobs and taxes.

Socio-economic impacts: The impacts a development has on community social and economic well-being. This includes changes in community demographics, housing, employment and income, market effects, public services, and aesthetic qualities of the community (source: Edwards, 2000).

The **Maryland State Water Quality Advisory Committee** study ascertained the economic impact benefits from maintaining the Potomac river as a clean river by preventing acid mine drainage from polluting the North Branch of the river. The resultant in-stream benefits include anglers and boaters spending US\$2.1 million per year in two local counties, with additional knock-on expenditures of US\$0.89 million. This was estimated to support 40 full-time equivalent jobs and generate US\$266,000 per year in state and local taxes.



Ecosystem services

Ecosystem services are the benefits that society gains from the environment. They represent the flow of benefits over time accruing from the stock of **natural capital**, which includes habitats and species. As habitats, waterbodies generate many ecosystem services, and water itself is also labeled an ecosystem service. Furthermore, as all life on Earth requires water, all biodiversity-related ecosystem services ultimately depend on water.

Identifying relevant ecosystems services is often an important step in undertaking water valuation. This is especially the case as using an ecosystem services review (ESR) approach is usually the first form of analysis companies take in relation to evaluating ecosystem services. The ESR is a five-step methodology for companies to identify and manage ecosystem service impacts, dependencies, risks and opportunities (see WRI, 2012). Table 3 shows how the main ecosystem service categories typically relate to water-related values.

Figure 8 shows the main water-related ecosystem services under four categories.

Provisioning services are the products provided by ecosystems, which includes off-stream use of freshwater for domestic, municipal, agricultural and business purposes. These uses can, in turn, give rise to considerable value through, for example, irrigating crops; use within commercial products; and use in industrial processes. Water is also used to produce energy, both off-stream as part of the energy-making process or as cooling water, and in-stream for hydropower. Other water-related products include food (e.g., fish), fiber (e.g., reeds) and potential pharmaceutical products.

Regulating services are the benefits obtained from the regulation of ecosystem processes. Where associated with water, they are known as **hydrological services**. They may be provided by waterbodies and non-waterbody habitats. For example, wetlands, forests and grasslands can act as sponges and filters, slowing the flow of water within a catchment. As a result, they can reduce flooding, erosion and sedimentation, and improve water quality and long-term flows in downstream waterbodies.



Waterbodies and water itself can give rise to important **cultural services** (defined as the non-material benefits people obtain from ecosystems). This includes recreational benefits such as angling, canoeing, boating and bank-side walking, as well as enhancing nearby property values, providing a means of transport for goods and people, plus educational and research opportunities. Other cultural services include more esoteric benefits such as aesthetic, spiritual and inspirational values. In addition, by maintaining biodiversity, waterbodies can give rise to conservation benefits such as support of iconic (e.g., salmon) and rare species.

for life more often found away from the site (e.g., on land or downstream). They are important benefits for waterbodies, but care is needed to avoid double-counting them.

A final additional category often mentioned is **supporting services**. These are underlying natural processes, such as photosynthesis and nutrient recycling, that support and underpin all the above services. They are usually accounted for by addressing the categories above, hence their omission from table 3.

Habitat support services are the benefits habitats provide by supporting species elsewhere (see TEEB, 2010a), which are commonly generated by waterbodies. For example, waterbodies often act as breeding grounds, nursery and foraging areas, biological corridors, drinking pools and genetic pools that act as temporary support

Table 3 Relationship between water-related values and ecosystem services

	Provisioning services	Regulating services	Cultural services	Habitat support services
Off-stream values	●	○	○	○
In-stream values	●	●	●	●
Groundwater values	●	●	●	○
Hydrological services	○	●	○	○
Non-water impacts	○	○	○	○
Extreme water-related events	○	●	○	○

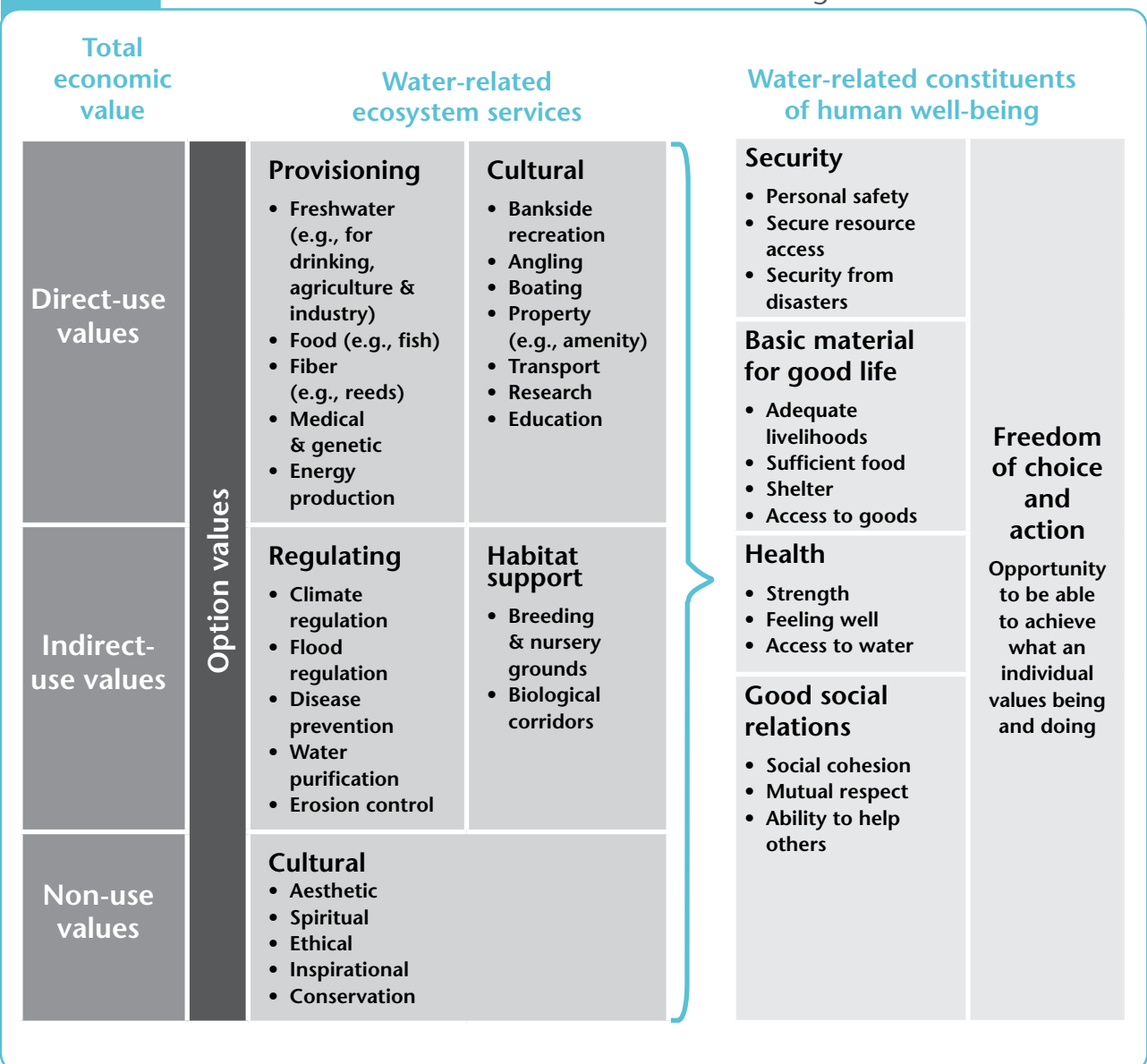
● = strong direct link ○ = weaker indirect link

Total economic value and ecosystem services

Total economic value (TEV) is a framework that covers the full range of economic values arising from the natural environment. The TEV concept has been around much longer than that of ecosystem services, and the two concepts are closely related. TEV was developed to categorize and inform the aggregation of all associated market and non-market economic values. The environmental valuation techniques detailed in section 5 have evolved to address the different components of TEV.

Each ecosystem service gives rise to human welfare values in the form of one of four TEV components. These components are direct use, indirect use, option and non-use values. Water-related ecosystem services are mapped across the four TEV components as shown in figure 8. As explained later, these benefits (or values) give rise to different forms of human well-being.

Figure 8 Water-related ecosystem services and links with total economic value and well-being



Direct-use values: This relates to human values arising from the direct use of water and waterbodies. Such values include all provisioning services (by definition) and those cultural services involving direct use of water or waterbodies, including recreation.

Indirect-use values: This relates to human values gained indirectly as a result of ecological functions that maintain and protect natural and human systems through services such as waste assimilation and flood control (i.e., regulating or hydrological services) and the support of species by habitats – for example, through nurseries and biological corridors (i.e., habitat support services).

Option values: This is the human value (or premium) placed on maintaining waterbody habitats, species and genetic resources for future possible use. This value potentially applies to all ecosystem service categories.

Non-use values: This is a non-material value humans can derive from maintaining waterbodies and water, regardless of any current or future use, for spiritual, aesthetic and conservation reasons (i.e., cultural services). Motives include individuals gaining value just from knowing that things exist (existence value), from knowing others will benefit (altruistic value), and from knowing future generations will benefit (bequest value).

However, it is important to recognize that, in addition to the above TEV components, there will always be an element of additional intrinsic value associated with water and waterbodies. This value is non-anthropocentric and relates to the fact that habitats, species and indeed water have a value in their own right, irrespective of humans (i.e., it is subtly different from existence value, which is anthropocentric).

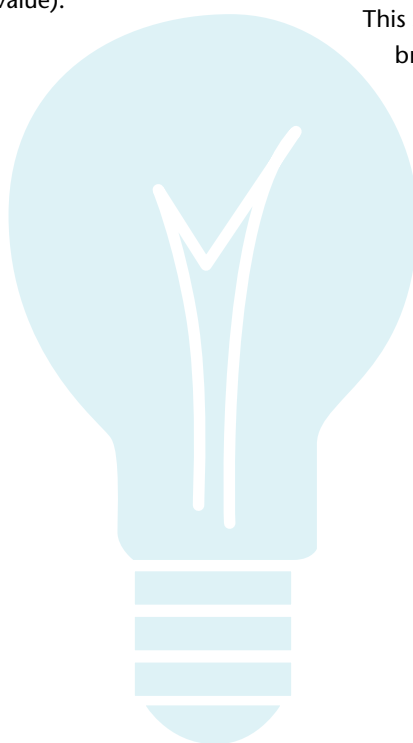
Rio Tinto piloted the valuation of ecosystem service benefits and costs associated with forest management protection in the Fort Dauphin region, which is currently being deforested at a rate of 1-2% per year. The company identified a range of ecosystem service impacts and applied appropriate valuation techniques based on the TEV category they relate to. For example, this included provisioning services, such as non-timber forest products (i.e., direct use values); hydrological regulating services, such as erosion control and water filtration (i.e., indirect use values); and biodiversity-related cultural services, such as wildlife habitat/conservation benefits (i.e., non-use values).



Human well-being

The 2005 Millennium Ecosystem Assessment report proposed that ecosystem services give rise to five constituents of human well-being. These are set out in figure 8, along with those subcomponents of relevance to water and waterbodies. It is important to note that by focusing only on the economic welfare components of TEV, not all elements of human well-being associated with ecosystem services are necessarily covered.

This supports the case for consideration of broader social and ecological aspects when valuing water.

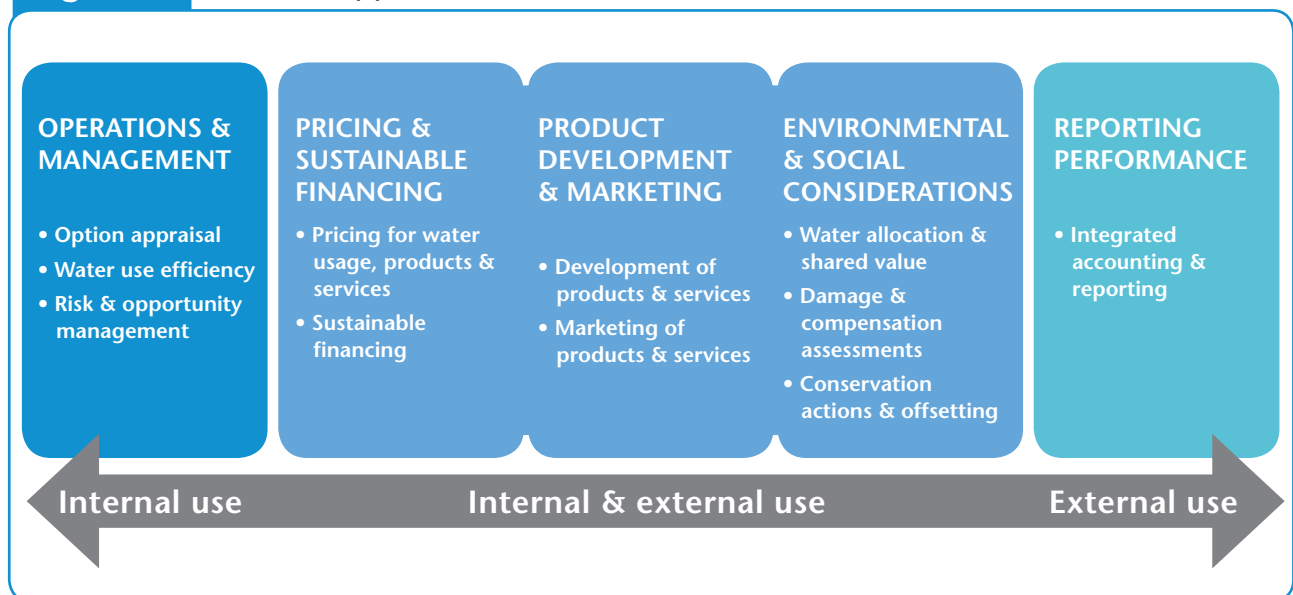


3

Business Applications

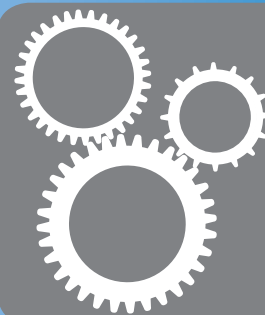
Water valuation is increasingly used in many different business decision-making contexts. It can be applied at any level: company, project, product or action, as well as at different scales and degrees of detail. This section builds on an initial list of business applications for water valuation set out in the Business Case Document, and is informed by a review of 25 actual business case studies. Figure 9 highlights five main categories of application, with examples for each. Over time, other potential applications are bound to arise as well.

Figure 9 Business applications for water valuation



Manager tips: Business applications

- If unsure how best to apply water valuation to your business, talk to an experienced practitioner for advice. There are numerous potential applications of water valuation to consider.



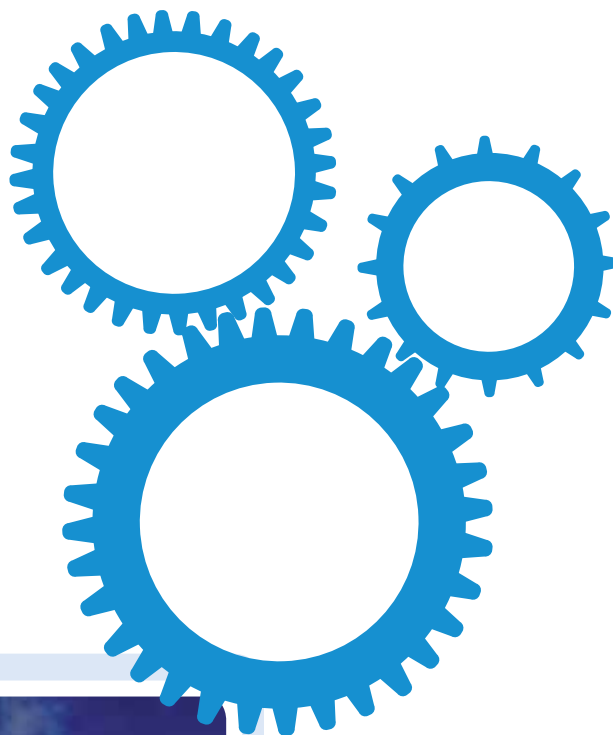
Operations and management

Perhaps the most common business application of water valuation is to improve company operations and management, including option and investment appraisals, water-use efficiency, and informing/managing risks and opportunities. These applications are typically for internal company use, although the results can be of use in external stakeholder dialogues.

Option (investment) appraisal: Valuing water and water-related ecosystem services and impacts can help businesses evaluate the trade-offs between uses and impacts. These evaluations can then be used to inform the selection of preferred options and optimum levels of investment. This includes evaluation of man-made or natural infrastructure (such as managed wetlands); products and services; and processes or actions, such as mitigation measures.

Water-use efficiency: Valuation can be used to value the benefits associated with more efficient water use, thereby helping to justify reduced water consumption or impacts on water quality. This may relate to new technologies, water recycling or wastewater treatment options, etc.

Risk & opportunity management: Valuation can be used to identify and prioritize business risks and opportunities associated with ecosystem service dependencies and impacts. While a qualitative assessment (such as by doing an ecosystem services review) has proved to be useful in identifying risks and opportunities, incorporating an additional value-based perspective can bring a further level of information. This may be achieved by determining potential relative values or monetary values associated with those risks and opportunities.



Business examples – Operations and management

Hitachi undertook water valuation to inform an investment relating to a desalination, wastewater treatment and gas-fired power plant in the Maldives. The evaluation determined that the projects were viable from both a financial and economic perspective. The results were useful to demonstrate the nature and extent of overall benefits (i.e., increased water supply and reduced GHG, air emissions and noise) compared to the financial and environmental (e.g., coral damage) costs.

The Dow Chemical Company applied water valuation to evaluate alternative water management options in the Brazos river basin for their operation in Freeport, Texas, where increased water shortages are predicted. The company investigated five options, including implementing water efficiency programs and replacing invasive plants that consume large amounts of water, in comparison to expanding their existing reservoir system. The analysis estimated water supply savings, the value of public/ societal benefits generated, and scheme costs.

South Australia Water demonstrated using valuation that it is more cost-effective to invest in catchment management actions, such as creating sediment ponds and wetlands, rather than to invest in a new water treatment plant.

Minera Escondida used a financial cost approach to identify the most cost-effective projects to invest in to reduce consumption of high-quality water at a Chilean mine.

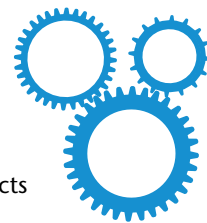
Yorkshire Water conducted a questionnaire study to elicit household and business customer willingness to pay for sixteen competing service areas, such as security of water supply, river water quality, bathing water quality, etc. This helped prioritize and inform the most appropriate level of investment for each customer service area.

Rio Tinto Iron Ore is using valuation of the ecosystem impacts of a range of potential water use options to inform management of dewatering flows in Western Australia. The aim is to estimate the full costs and benefits associated with the ecosystem impacts of each water management option in order to allocate the water in a manner that minimizes negative welfare impacts. The need to minimize

discharge to the environment has encouraged the company to invest in hay production on pastoral stations surrounding the mine to allow the relatively beneficial use of surplus water through irrigated fodder production.

Kraft Foods is developing an ecosystem services risk and opportunity valuation tool to apply to its food commodity supply chain. The additional valuation component, in particular the monetary aspect, helps provide a further level of information to evaluate and manage potential supplier risks and opportunities linked to ecosystems.





Pricing and sustainable financing

Water valuation can help inform the preferred pricing of products and services, as well as potential sustainable financing options. These applications tend to be of use both internally and externally.

Pricing of water usage, products and services: Valuation can assist with developing an appropriate pricing policy for water usage and other water services. This can help ascertain an appropriate price for the supply of drinking or industrial water, and how that price may differ depending on the quality and level of supply. Water valuation will also be able to inform the pricing of products that entail significant water consumption, whether by adding in the full cost for the water used, or through surveys that elicit how much individuals are actually willing to pay for water or for differing levels of water service.

Sustainable financing options: Water-related valuation can help in determining suitable pricing policies to ensure long-term finances are in place, as well as the setting up of payments for ecosystem services initiatives.

In the **Yorkshire Water valuation**, results from the willingness-to-pay questionnaire were used to help inform discussions with the United Kingdom government regulator Ofwat regarding customer water bills (i.e., water prices) for different levels of water supply service.

Veolia assessed the willingness to pay of visitors and the general public to contribute towards more environmentally desirable water and land-use options at a site in Germany. While not suitable for the site surveyed, the concept of site visitors potentially contributing financially towards environmental enhancements at Veolia-owned sites was certainly proved.

Development and marketing of products and services

Water valuation can help inform the development of products and services and improve the way they are marketed and to whom. Again, these applications tend to be used for both internal and external purposes.

Development of products and services:

Valuation can be a powerful contributor to the formulation and development of products and services. In particular, it can highlight the scope and extent of improvements to functionality and thereby enhance customer benefits. It can also help demonstrate the values associated with reduced water and wastes in the production, use and disposal of products.

Marketing of products and services: Valuation can also play a key role in helping to promote and market water-related products and services. This can be achieved by better understanding the nature and extent of different benefits, and how this varies across market segments and stakeholder groups. Such information and evidence can be used to educate potential consumers and to better target marketing and sales campaigns.

Hitachi applied environmental valuation to investigate which environmental parameters their GeoMation Farm technology product should focus on for their United States and French markets. It also helped determine the potential level of financial and societal monetary benefits obtainable from the application of GeoMation to typical farms in those countries. The outcomes are being used to inform further product development and marketing strategies in these target countries.

Over the past two years, **Xylem** has conducted national surveys to demonstrate that households and businesses in the United States want greater investment in water-related infrastructure (which Xylem supplies). They determined that households alone are willing to pay more than US\$6.4 billion a year to ensure improved water supplies.

PUMA extended its E P&L approach to the product level in 2012 to monetize and measure environmental externalities across the entire supply chain, including water consumption associated with four initial products (shoes and T-shirts) to compare the environmental impacts of more sustainable and conventional products throughout the production and consumer life phases. The Product E P&L results reveal that a pair of their InCycle biodegradable shoes has environmental externality costs of only € 2.95 compared to environmental costs of € 4.29 for a pair of their conventional suede shoes.

Social and environmental considerations

Water valuation has been used for decades to help quantify and value environmental and social impacts for public sector projects. The private sector is now beginning to appreciate the role water valuation can play in determining the preferred allocation of water, determining appropriate levels of compensation and assessing the value of conservation actions and offsets. These applications also have both internal and external uses.

Water allocation and shared value: Water valuation can be used to inform a variety of decisions relating to the balance of water use by stakeholders and associated societal values. Monetary valuation is ideal for the exploration and quantification of different competing stakeholder uses and values for water in a catchment (i.e., analyzing trade-offs). On the one hand, it can help determine a theoretical optimum allocation of water among stakeholder groups to maximize overall economic values, and on the other it can determine the extent to which different stakeholder values are impacted by company actions. It can thus help inform river basin management planning, as well as assessments of net positive impact and creating shared value (i.e., generating net benefits to stakeholders and the company).

Damage and compensation assessments: Valuation can help inform a suitable and fair price (or action) to compensate stakeholders affected by loss of water volume and quality as a result of company impacts. A number of situations exist where companies have faced, or are facing, significant water-related compensation claims where valuation could help arrive at appropriate levels of payment, not least by evaluating all potential sources of abstraction and contamination. Valuation can also help in setting environmental insurance premiums, which are increasingly required within Europe.

Conservation actions and offsetting: Valuation of water and associated ecosystem services can help assess benefits from conservation actions – for example, those related to biodiversity offsetting. Valuation can also be a powerful means of evaluating the optimum level of mitigation and offsetting, and potentially determining the value of any additional credits that may ensue.

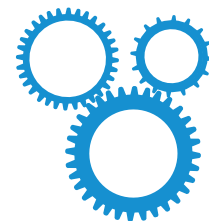
Mondi undertook water valuation to investigate the extent to which different stakeholders use and pay for water in a watershed catchment in South Africa. They used the results to inform not only the management of their water-dependent forest-related operations, but also catchment management planning in the area, the intention of which was to balance water use among all stakeholder groups to enhance overall societal benefits.

In their German biofuel land and water management valuation, **Veolia** used the results to help select the best option from both a financial and societal perspective. In this way they could maximize their financial returns and the societal benefits accruing to affected stakeholders.

Antofagasta is developing a risk, opportunity and valuation tool to evaluate and achieve their sustainability goal of “creating environmental value” at each of their mining operations. Water use and impacts on hydrological services are just a few of the many environmental parameters being accounted for and assessed in terms of impacts on different stakeholders.

EDF conducted an economic valuation study to optimize water use in a river valley in France, thereby enhancing overall societal benefits as well as improving their financial returns. Alternative water uses include drinking water, agriculture, recreation, hydroelectric power generation and maintaining an environmental flow. Monetary values were considered for different water uses throughout the year, which demonstrated benefits from restricting agricultural water abstraction at certain times, and maintaining reservoir water levels in July and August for recreation and tourism. To match this commitment, EDF put a water management plan in place. The analysis also informs appropriate levels of compensation to affected farmers.

In **Rio Tinto's** Madagascan study, valuation was used to explore the potential value of investments that could be made in mining-related conservation actions through biodiversity offsets. As part of an assessment of economic costs and benefits arising from a potential forest protection scheme, values were estimated for two key forest hydrological services: reduced soil erosion and water filtration. In addition to other ecosystem values (carbon sequestration and biodiversity), values were calculated for water flow regulation and sedimentation control benefits resulting from forest protection. A per hectare value for ecosystems was calculated to inform the theoretical development of an approximate per hectare floor price for possible future biodiversity banking schemes.



Reporting performance

Finally, water valuation will increasingly be used to inform external stakeholders about the sustainability and management of a company through integrated accounting and reporting.

Integrated accounting and integrated reporting:

Water-related valuation can help enhance the level and usefulness of information provided externally within company accounts and reports. Putting monetary values on externalities such as GHG and air emissions, and water consumption can help shareholders understand how sustainable a company is and the extent of possible future liabilities. In addition, it can highlight the extent to which a company is providing positive impacts through, for example, pollution prevention, pollution removal activities and habitat enhancements. As the concepts of integrated reporting and accounting and demonstrating net positive impacts take off, the number of companies including valuation of water (and other environmental and social parameters) within their accounts and company reports should escalate significantly.

PUMA's environmental profit and loss account (E P&L) complements the company's annual financial report. The E P&L includes the estimated societal costs of various environmental impacts, including water use, for their whole supply chain. PUMA's parent company, Kering, adopted the E P&L as a best practices tool and is implementing the approach across their Luxury and Sport & Lifestyle brands to construct a group E P&L for publication in 2016 (PUMA 2012). Such a step demonstrates strong leadership in sustainability, and will undoubtedly be replicated by many other companies.



4

Valuation techniques

How exactly does one go about putting an actual value on the many different benefits associated with water? This section explains some of the main valuation techniques, with the intention of helping business managers understand which techniques are appropriate and when, as well as identifying key issues to be aware of.

Overview of techniques

Over the past few decades, many valuation techniques have evolved that can be used to determine water-related values. The majority of available academic research, business applications and guidance tend to focus on monetary valuation techniques. However, qualitative and quantitative valuation techniques are important too, especially given the limitations of monetary valuation. In addition, qualitative valuation is usually considered an essential step when undertaking monetary valuation, to help focus efforts on the most relevant impacts to monetize. Quantitative valuation is commonly used to support relative qualitative valuation and monetary valuation.

To illustrate the different approaches, table 4 provides example categories and techniques for qualitative, quantitative and monetary valuation. These are described in more detail later in this section. Before that, the next subsection gives an indication of which techniques are most relevant for which ecosystem service.

Which technique should be used?

So which techniques should be used for which value? Table 5 provides a rough indication as to how each

ecosystem service can be valued. The first point to note is that qualitative and quantitative valuation techniques can generally be used to value all water-related ecosystem services. For monetary valuation, the selection of technique depends on the ecosystem service (see table 5 and discussion below), as well as the resources and time available, and accuracy required (see pros and cons of techniques in table 6). In certain situations it may be best to avoid monetary valuation, for example when significant spiritual values are potentially impacted.

In monetary terms, the value of something, such as off-stream water use, is simply how much somebody is willing to pay for it (or receive compensation for it). For off-stream domestic or personal consumption, the ideal approach to monetary valuation is to use carefully designed, stated preference willingness-to-pay surveys to elicit how much individuals are willing to pay for water. In theory, the initial amount that humans require simply to survive (i.e., for drinking, cooking and washing) is likely to have a very high value. Beyond this, the value is a function of how much additional enjoyment (utility) humans get from using water for a range of purposes – cooking, washing themselves, cleaning things, watering their gardens, etc.

Manager tips: Valuation techniques

- If you want different stakeholder values assessed, such as agricultural and recreational use, the outcome will be more reliable and credible if the stakeholders are involved in the valuation process.
- It is common for businesses to initially explore the situation independently, before involving third parties in valuation studies.

Table 4 Overview of valuation techniques

Nature of valuation	Category	Example technique	Description of technique
Qualitative valuation	Surveys	Semi-structured interviews	One-to-one surveys with open-ended questions to explore ideas and values
	Deliberative approaches	Focus groups/ in-depth discussions	Open group discussions that can involve debate and learning
	Relative valuation (expert judgment)	Evaluation of high/ medium/low values	Determines relative value of benefits (and/or costs) in terms of being high, medium or low, using available data and expert judgment
Quantitative valuation	Surveys	Structured questionnaires	One-to-one surveys employing a consistent set of questions allowing quantitative analysis
	Indicators	Indicators of ecosystem services	Uses a range of quantified information, such as yield of produce per hectare and visitor numbers
		Quality-adjusted life years (QALYs)	Quantifies impact on human health in a single metric based on length and quality of individual lives
	Analytical approaches	Multi-criteria analysis	Selects a range of parameters and rates and ranks their value through scoring and weighting, using workshops and professional judgment
Monetary valuation	Revealed preference approaches	Market prices	Uses actual market prices to indicate value
		Change in production	Relates change in ecosystem service (e.g., water quantity) to change in marketed output
		Travel cost method	Uses information on time and cost incurred visiting a site for recreation to elicit a value
		Hedonic pricing	Identifies difference in market price that can be attributed to ecosystem qualities
	Cost-based approaches	Replacement costs	Uses cost of replacing an ecosystem service with artificial infrastructure to equate service value
		Damage costs avoided	Based on damage costs incurred to property, infrastructure and production when protective hydrological services are lost
	Stated preference approaches (questionnaires)	Contingent valuation	Questionnaire that elicits an individual's willingness to pay to maintain or create environmental assets
		Choice experiments	Questionnaire that elicits willingness to pay values for specific environmental attributes based on choice of costed options
	Value (benefits) transfer		Infers value at one site based on detailed valuations conducted at a similar site elsewhere

Table 5 Valuation techniques for different water-related ecosystem services

Type of value	Category of service	Ecosystem service	Qualitative	Quantitative	Monetary							
					Revealed preference				Cost-based		Stated preference	Value transfer
					Market prices	Change in production	Hedonic pricing	Travel cost	Replacement cost	Damage costs avoided		
Off-stream	Provisioning	*Water for domestic use	√	√	√						√	√
		*Water for agriculture	√	√	√	√					√	√
		*Water for industry	√	√	√	√					√	√
		*Water for power	√	√	√	√			√		√	√
In-stream	Provisioning	Food and fish	√	√	√	√					√	√
		Water for power	√	√	√	√			√		√	√
		Genetic/ pharmaceutical	√	√		√					√	√
		Property enhanced	√	√			√				√	√
	Regulating	*Water storage	√	√		√			√			√
		*Water purification	√	√		√			√			√
		*Flood control	√	√		√			√	√		√
		Recreation	√	√				√			√	√
	Cultural	Angling	√	√	√	√		√			√	√
		Transport	√	√	√	√					√	√
		*Biodiversity/non-use	√	√							√	√

*Ecosystem service relevant to groundwater

Notes: Water for power can be both an off-stream and in-stream value.

Hydrological services are the same as the regulating services: water purification and flood control.

Non-water impacts can be valued using several of the valuation techniques.

Extreme water events can be valued using several of the techniques, apart from hedonic pricing and the travel cost method.

For **off-stream agriculture and industry use**, the value of water is based on how much it is worth to the organization (i.e., what it is willing to pay for it). This is correlated with how much additional revenue water helps generate or the cost it saves. The best approach for valuation is either change in productivity (which can determine changes in the value of outputs such as yields and revenues, based on the volume of water used) or

stated preference surveys. Sometimes the market price for off-stream water can be used, but it is important to recognize that the price may be heavily subsidized and rarely reflects its full value to society.

For **in-stream provisioning services**, change in productivity is usually the best technique to use, as is use of market prices where they exist. For **in-stream**



regulating services (and terrestrial hydrological services), change in productivity, replacement costs, and damage costs avoided are all potentially suitable. For property values, hedonic pricing is suitable.

For **in-stream cultural services**, angling and commercial transport can be valued to an extent using change in productivity and market prices. Recreation and angling can be valued using the travel cost method. However, all forms of cultural service are perhaps best valued using stated preference techniques. Indeed, the only way to value biodiversity conservation/non-use value is through stated preference techniques, although actual contributions to related charities can also inform such values.

Value transfer and stated preference approaches can be used to place monetary values on **all water-related ecosystem services**. On the one hand, value transfers provide ballpark estimates that are cheap to undertake, on the other, stated preference questionnaire surveys yield more accurate values, but are more expensive. As more stated preference study results become available, and experience in value transfer evolves, the value transfer approach is becoming increasingly popular.

Qualitative valuation

Qualitative valuation requires the identification of relevant values (benefits and/or costs), and undertaking some form of evaluation, ranging from simple description of importance to assessment of relative value. Approaches for gathering information and views for qualitative valuation include literature reviews, open-ended semi-structured surveys, focus groups and expert judgment. Relative valuation assessment involves some form of scoring (i.e., rating) of values relative to each other for a particular context. This may be in terms of low, medium or high value, or using a 5- or 10-point scale, indicating whether they are positive or negative values where appropriate.

Manager tips: Qualitative valuation

- Adopt a consistent approach with clear definitions for different levels of value, where possible.
- Support the qualitative valuations with quantitative information, where practicable.
- Where possible, use an environmental economist for relative valuation. Ideally, involve other relevant experts as well – in particular ecologists, but potentially, hydrologists, air quality experts, sociologists, etc.
- Involve wider stakeholders in the valuation process to review the outputs adds to their robustness and credibility.

Key steps for a relative valuation

1. Identify the full range of potentially relevant impacts in terms of changes in value (both positive and negative) resulting from what you are assessing.
2. Agree on the scale of values to use for the different impacts (e.g., high, medium or low value – or a score of 0-5, for example).
3. Assign a relative value for each impact (change in value) using a consistent approach, drawing upon relevant information to hand. This may be based on professional judgment, stakeholder interviews, stakeholder workshops and/or a review of available information (including quantitative information).
4. Ideally involve some form of consensus (e.g., between technical staff, experts, stakeholders and academics) to add credibility and robustness.



As part of an overall monetary valuation process in the Maldives study, **Hitachi** initially undertook a relative qualitative valuation of different impacts associated with several alternative scenarios. The analysis is shown in the table below. The scenarios included the existing baseline (i.e., a snapshot of values for the current situation), business as usual (i.e., the implications of continuing to use the existing power, water supply and wastewater scheme) and two new water-supply (desalination plant) scenarios. The last two included a new gas-fired power supply, with one scenario also involving the installation of a new wastewater plant. For the qualitative valuation, a scale of 0-3 was used, indicating low, medium and high values (positive and negative). The valuation assessment was undertaken by an environmental economist with extensive environmental impact assessment experience, and was reviewed by internal team members.

Ecosystem/ externality		Ecosystem services/environmental externality		Relative value of ecosystem /externality associated with that scenario					
				Existing baseline	Business as usual	New water supply & power		New water, power & wastewater plant	
					Water supply, waste & power	Construction	Operation	Construction	Operation
Ecosystem	Land available	PS	Other land uses	++	++	+	+	+	+
	Beach/ foreshore	CS	Recreation	++	+	+	++	+	++
	Coral reefs	PS/RS/CS	Recreation/coast protection/ fisheries/non-use	++	+	+	++	+	++
	Seabed	RS	Supports fisheries	+	-	-	+	-	+
	Sea/fisheries	PS	Fish	+	-	-	0	-	++
	Freshwater	PS	Water – drinking use	++	-	-	+++	-	+++
	Groundwater	PS/RS/CS	Source of freshwater	+	-	0	-	-	++
Externality	Air emissions	OEE	NOx, SOx, CO, PM, HC	---	---	-	-	-	-
	GHG		CO ₂ , GHG	---	---	-	--	-	--
	Noise		Noise	---	---	-	-	-	-
	Visual		Visual	-	-	-	-	-	-
	Road disruption		Traffic, noise	0	0	-	0	--	0
	Fuel storage		Risk of explosion	--	--	0	--	0	--

Key: Green shade = positive impact (i.e., benefit); Red shade = negative impact (i.e., cost)

+ = minor, ++ = moderate, +++ = major positive event

- = minor, -- = moderate, --- = major negative event

0 = no/negligible impact

PS = provisioning service; RS = regulating service; CS = cultural service; OEE = other environmental externality



Quantitative valuation

Numerous forms of quantitative assessment exist, some of which can be linked to water-related valuation. In particular, it can inform and support relative qualitative valuations and monetary valuations. Approaches to quantitative valuation range from using structured surveys to using various forms of indicators and metrics (e.g., use of quality-adjusted life years [QALYs] for health impacts), to more complex analytical techniques such as multi-criteria analysis (MCA). The latter is frequently used in water resource management studies to compare alternative management options.

MCA involves the identification and assessment of a broad range of parameters typically covering environmental, social and economic (including financial cost) issues for a range of alternative project options. The parameters are first scored (rated) based on the extent of impact (e.g., on a scale of 10 or 100), and then weighted based on their relative importance within that context. By calculating a weighted average, the options can be given an overall score and ranking to help select the preferred one.

Key steps for a multi-criteria analysis

1. Establish the decision context, in terms of aims, decision-makers and other key players.
2. Identify the options.
3. Identify the objectives and a set of criteria (parameters) that best reflect the values associated with the consequences of each option.
4. Describe and score the expected performance of each option against the criteria.
5. Assign weights for each of the criteria to reflect their relative importance to the decision.
6. Combine the weights and scores for each option to derive an overall value.
7. Conduct a sensitivity analysis of the results to changes in scores or weights.

Manager tips: Quantitative valuation

- Ensure a comprehensive but mutually exclusive set of criteria are included.
- Involve a broad range of stakeholders to agree upon the scores and weights applied.

Yarra Valley Water and Melbourne Water

undertook a multi-criteria analysis to inform the selection of a preferred water management system for a new housing and commercial development. Through consultation with key industry stakeholders and academic experts, they identified 12 sub-measures (parameters) with scores ranging from 0 to 100, depending on the level of standard met by each. The measures included potable water, pollutant discharges, GHG emissions, storm water run-off and groundwater, which were weighted for importance based on stakeholder agreement. A community value ratio was then determined for each option, representing the degree of community benefit (i.e., total weighted score) divided by financial cost. The preferred option was an integrated water management approach involving wastewater recycling and large retention areas catching storm water run-off. Proposed follow-up work includes assessing the willingness of stakeholders to pay for the additional costs associated with the environmental benefits gained.

Monetary valuation

Monetary valuation of environmental impacts has evolved significantly over the past few decades, with many techniques now available. The main categories are:

- i) **Revealed preference** approaches that estimate values based on observing behavior related to market goods and services;
- ii) **Cost-based** approaches that draw upon costs to infer value;
- iii) **Stated preference** approaches, which use questionnaires to elicit human preferences; and
- iv) **Value transfers**, whereby values determined in previous primary valuation studies are used to estimate values in a similar context.

The range of techniques available can be bewildering, but it is important to select the correct technique. Undertaking two or more techniques to value the same impact can be worthwhile and will add to the confidence of the outcome.

Fortunately, with the advent of value transfers, undertaking monetary valuations need not be time consuming or costly. Indeed, it may simply involve setting up a simple spreadsheet and inserting some ballpark estimated values. However, great care is clearly needed to apply and rely on such an approach. The degree of accuracy required for the decision is critical to which technique is selected.

A) Revealed preference approaches

1) Market price based

Where market prices are available for water-related ecosystem services, the price can be used as a proxy for value. However, there is often no market for water, and hence no universal market price. Where water markets do exist, water prices are often set politically, and are lower than their actual value. This may be because water is subsidized or is simply not charged at its full value. The same applies to other water-related services. For example, anglers may pay a permit fee to fish in a waterbody, but that price may be much lower than the angler would be willing to pay.

Various market price or market cost based approaches can be used. A few examples include:

Residual value: The average value of water in its final use can be determined by calculating the total market value (net of input costs) of agricultural or industry use, and dividing that by the volume of water required in the production process.

Derived demand function: The total value of water to a household or business is determined based on an inverse demand function, which relies on the statistical regression analysis of observed water volumes purchased at different prices. It requires good data from metered water use, which is not often available.

Opportunity costs: A value foregone as a result of implementing an action (i.e., the cost of the opportunity lost) is used as proxy value. For example, the value of creating a wetland on agricultural land can be considered to be at least the value of agricultural production foregone (net of subsidies).

Mitigation costs/avertive behavior: The price paid to mitigate environmental impacts provides a minimum proxy value for those impacts. For example, the cost of providing water filtration may be used as a proxy for the value of water pollution damages.

Cost of illness: The cost of pollution can be inferred based on the cost of illness that results when people become ill as a result of that pollution. Costs include medical expenditures and losses due to reduced labor.

(See Worley Parsons Canada Ltd and Eftec [2010], and United Nations Statistics Division [2007] for further details.)

If a business is more interested in the financial implications associated with water, whether for revenue generation or cost control purposes, then market prices for water-related impacts may be the key focus.

When the likelihood of an outcome is uncertain, such as the business risk from a flood or drought, the expected value approach can be used. Here, a range of probabilities for different outcomes is multiplied by the estimated potential value expected for each probability, from which a single weighted average expected value is derived.

Key steps

1. Identify the most appropriate market price based approach to use based on the nature of the problem and availability of data.
2. Collate relevant data and costs associated with the impact.
3. Make appropriate adjustments, as required, to derive a proxy value (e.g., net out subsidy costs). Also, make any suitable adjustments for the country or context if relying on data from other contexts.
4. Aggregate the value (e.g., across the population affected).



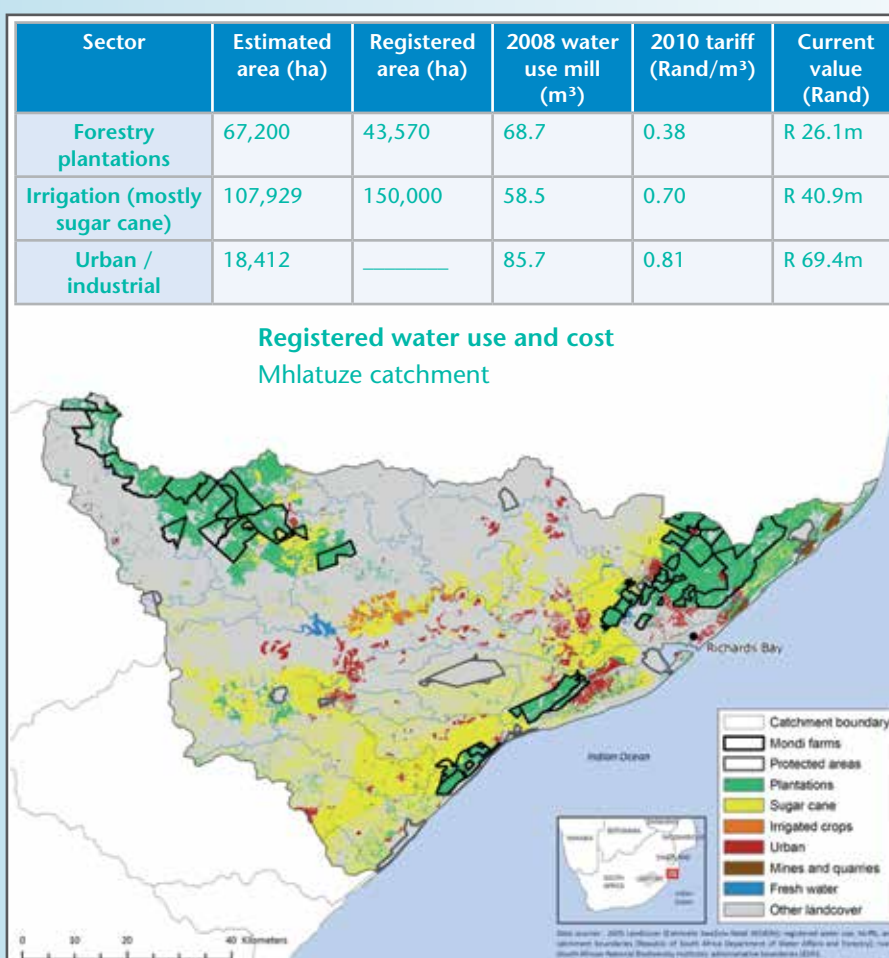
Manager tips: Market price based valuation

- When market prices for water or ecosystem services are used, they rarely reflect their full value to users and are thus typically an underestimate.

Yarra Valley Water used a demand function approach to estimate the value of water to households in the Melbourne region. They found that the predicted willingness to pay of households (AUD 1.89/m³) was virtually identical to the tariff prices set for domestic use (AUD 1.90/m³).

EDP used market price calculations to determine the value of water for hydroelectric power generation and for human consumption. In both cases, market prices per unit (€/MWh/year and €/m³ of water, respectively) were multiplied by the number of units per year. Operational costs incurred in generating these benefits were subtracted to obtain net values.

Mondi used actual market prices (tariffs) that different stakeholder user groups pay for off-stream water consumption in a catchment in South Africa. As shown below, a geographic information system (GIS)-based map was used to help illustrate outputs. Mondi determined that the financial cost to forestry plantation water users is Rand 0.38/m³ x 68.7 million m³/year = Rand 26.1 million/year.



2) Change in productivity

The change in productivity approach (also referred to as the production function approach or effect on productivity) relates changes in the output of a marketed good or service to a measurable change in ecosystem service inputs. For example, estimations can be made of the reduction in agricultural or business output resulting from a reduced volume or quality of off-stream water. The cause-effect relationship can be technically difficult to determine, and complex formulae and calculations can be required to determine the results with accuracy.

Key steps

1. Identify the relevant ecosystem service to be valued, either a provisioning or regulating service, where a well-established link between the quantity and/or quality of output and water provision exists.
2. Identify the production process for which the ecosystem service is an input (e.g., crop yields or mining output).
3. Estimate the production function. Collect data on the quantity and unit cost of production inputs and outputs or refer to similar previous assessments, and use similar assumptions and adjust as necessary for differences in context.
4. Create before and after scenarios. Measure or estimate current conditions and model or estimate future conditions.
5. Estimate net revenues *before* the change in ecosystem input.
6. Estimate net revenues *after* the change in ecosystem input.
7. Calculate the change in net revenues.

Manager tips: Change in productivity

- It may be important to identify those changes in quantity or quality large enough to result in price changes, as opposed to those changes absorbed by the market.
- Rules of thumb from similar studies or expert opinion can be applied to estimate the change in outputs (e.g., assume an increase in crop output of 10% when more water is provided).

Yarra Water Valley used a change in productivity approach to estimate the value of water to five business sectors in the Melbourne region. They based the calculations on data from a Chinese study, adjusted for Australia, which investigated the variation in production to different industries caused by a change in units of water used. The results suggested that for 1,000 m³, the paper sector valued water at AUD 0.16/m³, the food sector at AUD 0.49/m³, the pharmaceutical sector at 0.62/m³, construction at AUD 1.47/m³ and the automobile sector at AUD 5.11/m³. The analysis estimated a weighted average willingness to pay of AUD 1.25/m³ compared to an actual industrial water price of 1.91/m³.

In **Veolia's** German water and land management valuation study, change in productivity was used to assess the value of agricultural fodder and energy crop outputs under four different scenarios of differing crops and levels of irrigation. This involved estimating potential revenues based on crop market prices, crop yield per hectare and hectares of each crop farmed. The crop yield was assumed to decrease by 25% to 33% with less water, depending on the crop type.

To estimate the hydrological service values associated with forested watersheds, the **Rio Tinto Madagascar study** reviewed research analyzing the relationship between deforestation, increased erosion, reduced soil fertility and increased sedimentation in rice fields in Madagascar. For the benefit transfer exercise, an estimate was based on a change in productivity approach: the doubling of the rate of deforestation was expected to reduce rice yields by 8% due to the siltation of rice paddy fields. This loss in production was valued at US\$ 40 per hectare.

3) Travel cost method

The travel cost method (TCM) can be used to determine water-related recreational values, such as boating, angling and general visitor use of waterbodies. It is based on the rationale that recreational values for a site are linked to the frequency of individuals visiting and the time and expenses incurred in undertaking those visits. A questionnaire needs to be suitably designed and implemented to capture such visitor information, enabling individual and total recreational values to be inferred from a demand curve (i.e., frequency of visits related to costs of visiting). Either an individual or zonal TCM can be conducted. The former is more common and is explained here. Various issues such as general accessibility to site and potential for joint visits to nearby attractions should be considered before deciding on the suitability of this approach.

Key steps

1. Design suitable questionnaire (data to be collected includes place of residence, demographics, attitudinal information, purpose, frequency, length and costs of visit to site).
2. Administer questionnaire to site visitors (ensuring adequate sample size and representative mix of visitors).
3. Analyze data and determine a demand function (using econometric techniques to determine demand relationship based on relevant factors, such as frequency of visits and costs to get to the site, etc.).
4. Estimate average recreation value (based on integrating the area under the demand curve to estimate an average value of enjoyment per individual).
5. Determine total annual recreational value by multiplying the average individual value by the number of annual visitors.

Manager tips: Travel cost method



- Think carefully before commissioning this type of study. Although based on people's actions, many reasons exist as to why people travel to and visit different sites. The frequency of visits, time and expenditure incurred do not always reflect people's value for a site.
- Travel cost surveys can be combined with stated preference surveys. Comparing two sets of valuations can test and enhance the reliability of the results.
- Crude approximations can be applied, for example multiplying visitor costs (e.g., travel costs and time) by the number of visitors (see EDP example below).

As part of their reservoir valuation, **EDP** undertook an approximate form of the travel cost method to estimate the annual value of recreational fishing in the reservoir. To do this, they accounted for the annual number of anglers using the reservoir, the price of fishing licenses and anglers' average travelling costs. The estimates were based on the official records of licenses issued and on data available from the literature.

A **non-business example** of a more sophisticated travel cost study is one undertaken to assess the recreational value of Keenjhar lake in Pakistan (Delhavi and Adil, 2011). Using a single-site truncated count data travel cost model, they estimated an average value of US\$116 per visit for an average of 1,000 daily visits, giving a total annual value of US\$42 million. This was based on eliciting information on travel times and expenses incurred by 741 respondents, the vast majority of whom were day trippers.



4) Hedonic pricing

Hedonic pricing is useful for valuing water-related attributes that affect the price of marketed commodities. For example, changes in the value of properties near waterbodies can be attributed to changes in water quality and water levels. Statistical analysis is used to disentangle the value of a marketed commodity based on a set of characteristics that influence its price. Those characteristics, or attributes, may include factors such as the number of bedrooms, garden size, distance from the river and river water quality.

Key steps

1. Collate data (e.g., dataset of property prices and/or primary surveys, including those on environmental characteristics that are the focus of the valuation).
2. Undertake regression analysis of property prices against explanatory variables (including environmental good).
3. Derive an overall implicit price function.
4. Estimate a demand curve for the characteristic of interest.
5. Estimate the change in total value due to a change in environmental good (through integrating the demand curve).

In a **non-business example** outlined in *Lakeshore property values and water quality: evidence from property sales in the Mississippi Headwaters region*, Krysel et al. (2003) undertook a hedonic pricing study to explore the relationship between water clarity and lakeshore house prices for various lakes in Minnesota. Based on some 1,200 house sales and water-quality data over a six-year period, they developed a hedonic equation. This determined that a 1-meter increase in water visibility (with a base of 3-4 meters of visibility) could increase property prices by between US\$1 and US\$424 per foot of frontage depending on the lake, resulting in a total increased value of US\$30,000 to US\$93 million per lake. The reduction in property price estimated for each meter decrease in visibility was greater.

A simple **theoretical business example** is as follows. Company A installed a new treatment plant to improve the quality of wastewater discharged from its manufacturing plant into a river. It was estimated that improved river water quality would add an additional 5% to the property values for the 200 houses, worth on average US\$500,000, located within 100 meters of the river. The societal value gained is $200 \times 5\% \times \text{US\$500,000} = \text{US\$5 million}$.

Manager tips: Hedonic pricing

- This approach can be data- and time-intensive to conduct properly. However, crude approximations may suffice (see tip below and example).
- A more simplistic approach is to ask local property agents to provide approximations as to percentage premiums for different environmental attributes.



B) Cost-based approaches

1) Replacement cost approach

The replacement cost technique can be used to value hydrological services that may be impacted, and/or to justify investment in use of green infrastructure. In the first case, the value of a habitat that provides hydrological services (such as water purification and flood control functions) can be assumed to be equivalent to the cost of replacing those functions in the event of habitat loss with artificial infrastructure that provides the same level of service. In the second case, the approach can be used to evaluate whether it is more cost-effective to invest in creating or managing natural green infrastructure, such as wetlands and forests, to provide water filtration and flood control services, compared to costly investments in man-made infrastructure, such as water treatment plants and concrete flood defenses, to provide equivalent services.

These types of assessment should factor in the long-term maintenance and operation costs of artificial infrastructures and the loss (or gain) of other ecosystem service values provided by the natural habitat in question.

Key steps

1. Identify the primary ecosystem service to be valued.
2. Assess the scale and extent of use of the ecosystem service.
3. Determine the nature of man-made goods, services or infrastructure needed to replace the ecosystem service at the current scale of use.
4. Estimate the cost of the artificial replacement (include capital, maintenance and decommissioning costs).
5. Identify and account for other ecosystem services affected.

Manager tips: Replacement cost approach

- It is important that replacement cost values consider the wider bundle of services provided by an ecosystem (for example, wetland habitats provide many other provisioning, regulating and cultural ecosystem services in addition to the hydrological functions being replaced).
- The quality or level of replacement service should reflect that which is provided by the ecosystem service. So if a wetland only provides a partial water filtration function, its value is not the equivalent of a high-specification filter plant, but of one that filters water to the same level of service as the wetland.
- The least cost man-made solution should be used as the value.
- Ensure that adequate maintenance costs are included for a long enough period of time in the proposed artificial solution.

Cook Composites and Polymers used the replacement cost approach to demonstrate that it would be cheaper to construct a wetland than to replace a man-made storm water control system at a manufacturing facility in Houston. The wetland would enhance flood control and water purification, as well as generate various other biodiversity-related benefits. They estimated that over a 20-year period, constructing the wetland would cost US\$980,000 compared to a cost of US\$1.2 million (assuming a 5% discount rate) for the construction and operation of the man-made system.

2) Damage costs avoided

The “damage costs avoided” approach can be used to value hydrological services and extreme water-related event impacts, based on estimating predicted values of damages in situations with and without the regulating service or water impact in question. The difference in damage values equates to the value of service provided.

The approach can be complex if reasonably accurate values are required. For example, determining flood-related values involves calculating and comparing annual average damages based on damages associated with different flood return periods (e.g., 1-in-2-year, 1-in-50 year, and 1-in-100-year events). The necessary data may not be available or may be difficult to model.

Considerable work has been done on this around the world, particularly in relation to evaluating the cost of flood damages. For example, in the U.S., the Department of Agriculture has a suite of flood-damage assessment tools, while in the U.K., the Department of Environment, Food and Agriculture has developed a set of flood-damage evaluation manuals with, for example, standardized residential property damage values available based on property type and different flood heights. Insurance companies are also beginning to investigate the damage costs associated with flood and drought events, and are linking this back to ecosystem services and climate change impacts.

Key steps

1. Identify the ecosystem service (usually a regulatory service) to be valued.
2. Estimate the likely cost of damages in a situation without the ecosystem service provided (or without the project impact on the ecosystem service). The expected value approach is often used to do this, which is a function of the probability and value of possible outcomes multiplied together.
3. Estimate the likely cost with ecosystem service provided (or with the project impact on the ecosystem service), again potentially using the expected value approach.
4. Determine the difference in value between the “with” and “without” scenarios.

Manager tips: Damage costs avoided

- The damage cost avoided approach typically only provides a lower value estimate of the regulating services.
- If using a value transfer approach as in the Lafarge example below, make sure that any ensuing value is appropriate given the context.

In relation to the reclamation of a quarry in Michigan, U.S., [Lafarge](#) assessed the value of various ecosystem services associated with alternative land management options. The aim was to help inform the selection of the preferred option. Two hydrological services, the sediment and nutrient control functions provided by vegetation, were valued using a damage costs avoided approach. In both cases, the InVEST tool was used to determine the amount of sediment and nutrients retained by different vegetation cover slowing the flow of water. This enabled estimates to be made of potential future costs avoided (e.g., from reduced dredging and water treatment).

As part of their Communauté de Communes de l'Estuaire de la Dives (CCED) study, [Veolia](#) undertook a partial damage costs avoided approach to value the benefits from reduced flooding as a result of installing buffer ponds as part of a new wastewater collection network. The buffer ponds were designed to help reduce flood damages for floods with up to a 1-in-10-year return period. Unfortunately, Veolia could only use data for floods with a 1-in-3-year return period, so their valuation of this benefit (calculated to be 1.7% of total benefits) is a low estimate.

C) Stated preference approaches

Stated preference approaches involve surveys to ask a representative sample of a specific population what their preferences are. They are commonly used to ascertain the willingness to pay (WTP) of consumers and businesses for water consumption.

There are two main types of stated preference surveys. [Contingent valuation](#) (CV) surveys typically involve asking consumers to directly state their WTP for something (often alternative options that provide



different levels of non-marketed benefit, such as water).

Choice experiment (CE) (or choice modeling) surveys ask respondents to choose a preferred option from a set of alternatives, as described by a set of 5 or 6 different attributes (parameters), one of which is a price they would have to pay. Through econometric modeling, it is possible to elicit the monetary values of different levels of each attribute (e.g., each percentage improvement in river water quality is worth US\$0.30 per household).

The key advantage of these approaches is their flexibility in valuing any specific environmental, social or economic asset or impact. Indeed, they are the only primary valuation method capable of determining non-use values. In addition, they allow for potentially rigorous primary data collection and valuation addressing a particular issue in a specific location.

Disadvantages include the fact that undertaking comprehensive and robust stated preference surveys can be time consuming and expensive. Furthermore, unless conducted carefully to overcome various potential biases, they can result in poor or meaningless results. For example, respondents may state a strategically high or low willingness to pay, or they may be unfamiliar with what they are being asked to value, potentially resulting in low estimates of value. It is important to recognize that results are based on what respondents claim rather than being observed by behavior.

However, experience in undertaking stated preference surveys is growing rapidly, enhancing reliability and reducing costs. For example, reasonably accurate results can be gained from using carefully designed smaller scale (quasi) contingent valuation studies with smaller sample sizes. Also, the use of Internet-based delivery is becoming increasingly accepted, further lowering implementation costs.

Key steps for a CE or CV

1. Conduct initial research to explore the scope of what is to be valued.
2. Choose a survey method (e.g., face-to-face, mail or telephone) and valuation technique (CV or CE).
3. Choose a target population to sample (i.e., all people who may be affected by the impact, for example people visiting a site, or total households in a catchment or country) and sampling strategy (e.g., random and/or stratified).

4. Decide on questionnaire design and what form of elicitation format (e.g., open-ended WTP, payment ladder) and payment vehicle (e.g., water bills, tax, donation, car park charges, etc.) to use.
5. Test the questionnaire using focus groups, especially if the topic is new, and run pilot tests to check the wording and understanding of the questionnaire.
6. Conduct the main survey using a large enough sample.
7. Conduct econometric analysis, including work to identify outliers (e.g., extreme high bids) and protest bids (e.g., unwillingness to accept the scenarios presented).
8. Test validity and reliability.
9. Aggregate and report.

Manager tips: Stated preference approaches

- Ensure the survey sample used is representative of the target population.
- Make sure the selected sample size is appropriate and fully justified. It is recommended that around 250 questionnaires be completed (assuming a target population of up to 1 million people and a 95% confidence interval). However, sample sizes of around 100 could still yield useful results, given appropriate caveats.
- Make sure that adequate efforts are made to overcome the majority of biases associated with the approach, such as hypothetical, information, strategic, starting point and payment vehicle bias.
- Check that the assumptions used are conservative and clearly set out.
- Make sure an experienced person is used to design and analyze the stated preference survey. Although they appear simple, questionnaires can yield meaningless results if not well designed. Poor analysis and incorrectly dealing with biased responses can also lead to results of limited use.
- Encourage use of simple but effective visual information to help explain what is being valued.
- Check that the payment scenarios are realistic and politically acceptable.

Xylem undertook a CV of the general public in the United States in both 2010 and 2012 to create a Value of Water Index for the country. In addition to asking about people's use of and concerns over water use and management, respondents were also asked how much extra in water bills they would pay to improve the water supply through infrastructure upgrades. Conducted by telephone, the first survey interviewed 1,000 adults across the country, while the second did the same plus a further 250 in New York. In 2010, the average household was willing to pay US\$6.20 more per month, while in 2012 it was US\$7.70 more per month (based on over 60% being willing to pay more). Xylem determined that, when extrapolated by the population, this would generate US\$6.4 billion in additional funds for the U.S. government to invest in water infrastructure.

Rio Tinto Iron Ore is conducting a choice experiment to estimate the value of changes to ecosystems linked to managing dewatering in iron ore mining. The environmental changes (or attributes) valued include rehabilitated rangeland, impacts on ancient woodlands, impacts on water supply to waterholes with important cultural values to indigenous peoples, increased jobs created for indigenous and other peoples and additional town water supply provided by re-injected aquifers. The survey instrument was developed by experts and tested on focus groups across Australia (Sydney, Adelaide and Perth). The survey will be delivered digitally via the Internet, ensuring a minimum of 800 responses received from across Australia.

Veolia undertook a CV to estimate visitor and general public values arising from different water and land management options at one of their landholdings in Germany. It was a small-scale (quasi) CV in that only 124 visitors and 83 members of the general public were interviewed, and no initial focus group sessions were held. Outputs from the survey included statistics on which options were preferred, with a majority preferring the "two different energy crop" scenario to the alternatives of "one energy crop" or "no further irrigation". Stated willingness to pay values of visitors for the two energy crops were between € 1.9 - € 7.8 per person per year. The average general public non-use values were € 0.6 for East Berliners and € 3.80 for West Berliners per adult per year. These values were then multiplied by total visitor numbers and adult population numbers in Berlin to give total values. The images were used in the survey, together with other images and descriptions to inform respondents as to how the different scenarios might look.



No irrigation



Energy crop

D) Value (benefit) transfer

Value (or benefit) transfer has evolved as an alternative low-cost approach to monetary valuation. It involves transferring value estimates from existing economic valuation studies (the study site) to the site in question (policy site), making adjustments where appropriate to allow for key differences in the context (e.g., the level of change, the importance of the water-related services affected, socio-economic factors of the population affected).

Given its low cost to undertake, it is an attractive approach to valuation. However, it has its limitations, and is only appropriate for high-level valuations. Often there are insufficient similar primary valuation studies to draw upon. It is also easy to apply inappropriately, which can give valuation a bad name, so at least some expert input is advisable.

Key steps for value transfer

1. Identify the change in ecosystem service to be valued at the policy site.
2. Determine the affected population at the policy site.
3. Conduct a literature review to identify relevant primary studies (i.e., study sites).
4. Assess the relevance and quality of the study site values for transfer.
5. Select and summarize the data available from the study site(s).
6. Transfer the value estimate from study site(s) to the policy site, making appropriate adjustments as necessary.
7. Calculate total net present value benefits or costs.
8. Assess uncertainty and acceptability of transfer errors.

Comparison of techniques with pros and cons

The selection of valuation techniques should take into account a number of key factors, including the type of ecosystem service of interest, whether a monetary value is needed, the degree of accuracy required, the availability of relevant data and existing similar values to transfer, and the time and budget available to spend. Table 6 summarizes some of these features and identifies a few pros and cons associated with each of the techniques explained above.

Manager tips: Value (benefit) transfer



- If general public non-use values are to be determined, employ appropriate justification for the correct population used when calculating average non-use WTP values (e.g., a watershed or county/state population). Bear in mind that non-use values typically reduce with distance from the site (known as distance decay).
- Ensure it is clear what the WTP value units are, and that they are correctly aggregated over populations and time (e.g., are they based on per adult or per household, and as one-off or annual values).
- Ensure that potential substitution effects are considered in the questionnaire design (i.e., whether other similar ecosystems provide a similar service nearby). For example, if your site is protecting a lake when there are numerous others nearby, the value is likely to be less than if it is the only lake.

Holcim's valuation study used value transfers to value two in-stream water benefits linked to a quarry rehabilitation option. This included valuing biodiversity conservation non-use benefits from the creation of a wetland habitat. A study site transfer value of £53/household per year for 5 years was selected based on a previous stated preference WTP survey for the creation of a similar habitat in a nearby county whose population had similar socio-economic characteristics. This value was applied to the policy site population, which was deemed conservatively to be that of the City of Ripon (6,747 households). The study also estimated the recreational value of a boating lake created in a deep part of the quarry. A transfer value of £4.93/resident per year was selected from a previous UK boating valuation study. Total boating benefits were then estimated based on an assumed 1,000 boaters per year with a 10% increase per year for first 10 years and 5% thereafter.

Table 6 Comparison of valuation techniques

	Technique	Data required	Time (duration)	Budget (US\$)	Skills required	Advantages	Disadvantages
Qualitative valuation	Semi-structured interviews	Stakeholder information to inform sampling frame	Weeks - months	Medium (US\$ 1,000s – 10,000s)	Questionnaire design, interviewing	+ Open ended so can capture broad information.	- Does not allow much quantification.
	Focus groups/ in-depth discussions	Stakeholder information to inform sampling frame	Weeks - months	Medium (US\$ 1,000s – 10,000s)	Questionnaire design, interviewing	+ Open ended so can capture broad information.	- Does not allow much quantification. - Requires careful selection of individuals/groups to be successful. - Difficult to obtain representative sample of attendees.
	Evaluation of high/ medium/ low values	Information on all parameters to be evaluated	Days - weeks	Low (US\$ 100s – 1,000s)	Environmental economics	+ Can be very broad and include any parameters desired.	- Can be somewhat subjective.
Quantitative Valuation	Structured questionnaires	Stakeholder information to inform sampling frame	Weeks - months	Medium (US\$ 1,000s – 10,000s)	Questionnaire design, interviewing	+ Enables greater level of quantification.	- Allows less opportunity to capture broader information.
	Indicators of ecosystem services	Information on all parameters to be evaluated – ideally quantified information	Weeks	Medium (US\$ 1,000s – 10,000s)	Analytical	+ Can be very broad and include any parameters desired.	- May not capture all the relevant values.
	Multi-criteria analysis	Information on all parameters to be evaluated – ideally quantified information	Weeks - months	Medium (US\$ 1,000s – 10,000s)	Analytical	+ Can be very broad and include any parameters desired. + Can be kept simple.	- Can become overly complicated.
Monetary valuation	Market prices	<ul style="list-style-type: none"> • Market price of ecosystem goods or services • Costs involved to process and bring the product to market (e.g., crops) • Data on water use versus price of water 	Days - weeks	Low (US\$ 100s – 1,000s)	Basic – or econometrician	<ul style="list-style-type: none"> + A readily transparent and defensible method since based on market data. + It can reflect an individual's willingness to pay (WTP). 	- Only applicable where a market exists for the ecosystem service and data is readily available.
	Change in productivity	<ul style="list-style-type: none"> • Data on changes in output of a product • Data on cause and effect relationship (e.g., loss of crops due to reduced water) 	Days - weeks	Low (US\$ 100s – 1,000s)	Basic (potentially agricultural expert and/ or process engineer)	+ If data is available, it is a relatively straightforward technique to apply.	<ul style="list-style-type: none"> - Necessary to recognize and understand the relationship between the ecosystem service and output of product. - Can be difficult to obtain data on both change in the ecosystem service and change in productivity.
	Travel costs	<ul style="list-style-type: none"> • Amount of time and money people spend visiting a site for recreation or leisure purposes • Motivations for travel 	Weeks – months	High (US\$ 10,000s)	Questionnaire design, interviewing and econometric analysis	<ul style="list-style-type: none"> + Based on actual behavior (what people do) rather than a hypothetically stated WTP. + The results are relatively easy to interpret and explain. 	<ul style="list-style-type: none"> - Approach is limited to direct use recreational benefits. - Difficulties in apportioning costs when trips are to multiple places or are for more than one purpose. - Considering travel costs alone ignores the opportunity cost of time while travelling.



Monetary valuation	Technique	Data required	Time (duration)	Budget (US\$)	Skills required	Advantages	Disadvantages
	Hedonic pricing	Data relating to differences in property prices that can be ascribed to the different ecosystem qualities (e.g., number of bedrooms, quality of river, and distance from river)	Days - months	Medium (US\$ 1,000s – 10,000s)	Econometric	+ Readily transparent and defensible method, because based on market data and WTP. + Property markets are generally very responsive so are good indicators of values.	- Approach is largely limited to benefits related to property. - The property market is affected by a number of factors in addition to environmental attributes, so these need to be identified and discounted (e.g., number of bedrooms)
	Replacement costs	The cost (market price) of replacing an ecosystem good or service with a man-made equivalent (e.g., replacing flow regulation of habitat with flood defense scheme)	Days – weeks	Low (US\$ 100s – 1,000s)	Basic	+ Provides surrogate measures of value for regulatory services (which are difficult to value by other means). + A readily transparent and defensible method when based on market data.	- Can overestimate values. - Does not consider social preferences for services or behavior in the absence of the services. - The replacement service probably only represents a proportion of the full range of services provided by the natural resource.
	Damage costs avoided	<ul style="list-style-type: none"> • Data on costs incurred to property, infrastructure or production as a result of loss of ecosystem services • Damages under different scenarios, including with and without regulatory service 	Weeks	Low (US\$ 100s – 1,000s)	Engineering and bio-physical processes	+ Provides surrogate measures of value for regulatory services that are difficult to value by other means (e.g., storm, flood and erosion control).	- The approach is largely limited to services related to properties, assets and economic activities. - Can overestimate values.
	Contingent valuation (CV)	<ul style="list-style-type: none"> • Stated value that people place on an ecosystem good or service (e.g., water quality, wildlife in a river); demographic and biographical information on survey respondents • Obtained through survey questionnaires 	Weeks – months	High (US\$ 10,000s)	Questionnaire design, interviewing and econometric analysis	+ Captures both use and non-use values. + Extremely flexible - it can be used to estimate the economic value of virtually anything. + Gives a much more accurate outcome than benefit transfers.	- The results are hypothetical in nature and subject to numerous different biases from respondents: - e.g., respondents may express a positive WTP to promote a warm glow effect, overestimating value; - e.g., if the cost is perceived as a tax, respondents may express a negative WTP, underestimating value. - It is resource intensive.
	Choice experiments (CE)	<ul style="list-style-type: none"> • As for CV above, although CE contrasts several different scenarios • An appropriate set of levels are required for the different parameters (e.g., poor, medium, good and excellent river water quality) 	Weeks – months	High (US\$ 10,000s)	Questionnaire design, interviewing and econometric analysis	+ Captures both use and non-use values. + Provides theoretically more accurate values for marginal changes (e.g., values per % increase in coral cover). + Gives a much more accurate outcome than benefit transfers.	- The results are subject to bias from respondents and are hypothetical in nature. - It is resource intensive. - It can be mentally challenging for respondents to truly weigh up the alternative choices given to them in the time available.
	Value transfer	<ul style="list-style-type: none"> • Valuations from similar studies elsewhere • Data on key variables from different studies (e.g. GDP per person) 	Days - weeks	Low (US\$ 100s – 1,000s)	Basic or econometric analysis if using bid functions	+ Low cost and rapid method for estimating recreational and non-use values.	- The results can be questionable unless carefully applied. - Existing valuation studies may be more robust and numerous for some services than for others.

Incorporating values into different types of analysis

Businesses can incorporate water-related values into various types of analysis, the more common of which are briefly described below. Table 7 reveals how the valuation techniques and types of analysis are relevant to the various water valuation applications.

- **Discounted cash flow (DCF)** is used to determine the value of an asset, activity or company based on the sum of future cash flows discounted to present day values, typically using the weighted average cost of capital. A DCF is purely based on financial market prices.
- **Benefit cost analysis (BCA)** is used to assess the economic and/or financial viability of a project or measure. It involves identifying and valuing all associated costs and benefits in monetary terms, and converting them to present-day values using a carefully selected discount rate. A BCA purely based on financial prices is similar or equivalent to a DCF.
- **Cost-effectiveness analysis (CEA)** is used to identify the most financially cost-effective means of achieving a pre-determined objective, which can be expressed in specific, non-monetary terms (e.g., cubic meter, habitat units, etc.). An example of this approach is marginal abatement cost curves (MACC), where alternative actions are ranked in order of their cost-effectiveness and presented graphically.
- **Distributional analysis (DA)** involves determining the distribution of costs and benefits of a project/measure among the stakeholders concerned. It can thus identify which stakeholders gain and which lose out, and by how much. Distributional effects can be used to inform BCAs, sustainable financing opportunities, liability claims, and claims over creating shared value and net positive impacts.
- **Risk & opportunity analyses (ROA)** identify potential material risks and opportunities associated with company operations. They typically involve evaluating probabilities of occurrence and the magnitude of potential outcomes, often in financial terms.
- **Economic and/or socio-economic impact analyses (ESI)** focus on regional economic impacts that projects may bring to the economy, such as increased gross domestic product (GDP), jobs, incomes, expenditure, tax, as well as broader socio-economic impacts, such as demographic, education, health, community and crime impacts.
- **Environmental impact assessments (EIA)** of major projects usually already include a section on socio-economic impacts. It is possible that in the coming years economic valuation will also be included in EIAs, for example, to inform the nature and extent of 'necessary' mitigation measures and impact offsets.



In their German valuation study, **Veolia** used a **financial BCA** to reveal that only the single energy crop scenario was financially viable, with a benefit-cost ratio (BCR) of 1.03. It also applied an **economic BCA** that included societal impacts as well. This demonstrated that the “two energy crop” scenario was most favorable from a societal perspective, with a BCR of 17.4.

Minera Escondida applied a **CEA** using a **MACC** approach to find the most cost-effective actions to reduce high-quality water consumption at their copper mine in the Atacama desert in Chile. This was achieved based on calculating the present value of financial costs and savings (i.e., net present values) of different actions compared to volumes of water that each action saved. In this way a dollar value per cubic meter of water saved was determined.

In their forest valuation study, **Rio Tinto** undertook a **distributional analysis** to ascertain to what extent different stakeholder groups would be affected. The study highlighted that the majority of benefits accrue to the global population through carbon sequestration and biodiversity-conservation non-use values, while many of the costs associated with reduced agriculture and collection of non-timber forest products affect local people. The valuation results could thus help inform the need for compensatory measures and minimum levels.

Kraft's tool is being developed to **identify and value** ecosystem-related commodity supply chain risks and opportunities **qualitatively**, with an option to value potential risks and opportunities monetarily.



Anglo American has developed a sustainability valuation approach that estimates the **value at stake** associated with key project decisions. This approach includes the consideration of nine sustainability value drivers, of which water is one. The approach is being extended to other areas of the business, including procurement.

Antofagasta's project and site evaluation framework tool is being designed to assess environmental risks and opportunities, undertake **BCA (qualitatively, quantitatively and monetarily)**, and evaluate the extent to which multiple stakeholders may be affected, using **distributional analysis**.

The **Maryland State Water Quality Advisory Committee** study on cleaning up acid rock drainage mining pollution on the Potomac River included an **economic impact assessment** as well as **economic valuation**. The economic impact assessment ascertained that anglers and boaters spend US\$2.1 million per year in two local counties, with knock on expenditures of US\$0.9 million resulting in around 40 full-time equivalent jobs and US\$266,000 in state and local taxes.



Table 7

Relevance of valuation techniques and analysis to water valuation applications

Application	Role valuation can play	Most relevant valuation techniques	Most relevant forms of analysis
Option (investment) appraisal	Identifies optimum financial and/or economic option	All, SP	BCA, DA, ESI, EIA
Water use efficiency	Identifies most cost-effective solution and can determine associated societal benefits	CB, CiP	CEA, BCA
Risk & opportunity management	Helps quantify potential risks and opportunities in monetary terms	All, CB	ROA, BCA, CEA
Pricing for water usage, water services and products	Can inform how much users may be willing to pay, what the full costs are, and the full extent of benefits	All, CiP	BCA, DA
Sustainable financing	Can inform which stakeholders are willing to contribute or pay how much	All, SP	BCA, DA
Development and marketing of products and services	Can inform what functionality would deliver greatest benefits and can help identify and quantify associated stakeholder values	All, SP	BCA, DA
Water allocation, shared value & net impact	Informs optimum allocation of water among stakeholders, and the extent of stakeholder losses or gains	All, SP	BCA, ESI
Damage and compensation assessments	Can inform which stakeholders should be compensated and by how much	All, SP	BCA, DA, ESI
Conservation actions and offsetting	Can inform the nature and level of conservation/offsetting required and the extent to which additional benefits are generated	All, SP	BCA, DA, ESI
Integrated accounting and reporting	Can provide range of information on values (including monetization) for the integration of environmental and social impacts within accounts and reports	VT	—

Valuation techniques:

All = All techniques potentially applicable

CB = Cost based

CiP = Change in productivity

SP = Stated preference

VT = Value transfer

Types of analysis:

BCA = Benefit cost analysis

CEA = Cost-effectiveness analysis

DA = Distributional analysis

ROA = Risk and opportunity analysis

ESI = Economic & socio-economic impact

EIA = Environmental & social impact assessment



Tools to assist with valuation

A number of tools are being developed to assist with qualitative, quantitative and monetary valuations. This includes the development of open-access, off-the-shelf valuation tools as well as many proprietary tools. The WBCSD *Eco4Biz* publication (WBCSD, 2013a) provides an overview of many biodiversity and ecosystem service tools that are currently publically available to aid business decision-making. Several of these can help perform qualitative, quantitative and monetary valuation with respect to water.

However, it is important to stress that the use of such tools is not essential for businesses to conduct water-related valuations. Basic recommendations are simply that water valuations follow the [Guide to CEV](#) methodology and use a simple spreadsheet to ascertain the nature and extent of values identified. Companies are also increasingly developing their own bespoke tools designed to focus on the specific parameters and applications most relevant to their interests.

Various non-valuation related tools can also be used to inform water-related valuations, including:

- The *Corporate Ecosystem Services Review* (ESR) to identify relevant water-related impacts and dependencies;
- Geographic information systems (GIS) to map and quantify areas of different habitat and waterbodies affected;
- Life cycle assessments (LCA) to quantify units of resources used and emissions and discharges released; and
- Water-related tools to inform issues, risks and opportunities to be addressed, and provide relevant water-related information (e.g., [Global Water Tool](#) [WBCSD, 2011b], [Local Water Tool](#) [GEMI 2012]).

Lafarge used InVEST to undertake the sediment and nutrient control valuation elements of their study. However, the tool significantly overestimated sediment costs compared to actual costs incurred to meet strict government sediment control standards. This highlights that considerable care is required in using and interpreting the potential relevance of off-the-shelf tool results.

Kraft and **Antofagasta** are developing Excel spreadsheet-based tools, with the assistance of consultants, which focus on company-specific issues and parameters.

Maryland State Water Quality Advisory Committee used IMPLAN to generate the knock-on expenditure, jobs and tax results for their economic impact assessment of remediating acid rock drainage on the Potomac River in the United States.

Hitachi, in their Maldives study, used LCA tools to generate quantitative data for a selection of non-water impact parameters, such as carbon, GHGs, NOx, SOx and volatile organic compounds.



5

Undertaking water valuation

The process for undertaking business water-related valuation should be no different from that of undertaking a corporate ecosystem valuation (CEV). First, two fundamental questions need to be answered: What is the issue at stake? And how is the issue best assessed? If the outcome suggests valuation should be undertaken, it is recommended that the five stages of the WBCSD's *Guide to Corporate Ecosystem Valuation* be followed, and that suitable experts be involved. Advice on undertaking those stages and engaging such experts is provided here with particular reference to water.

More information on the Guide to CEV can be found on the WBCSD website at: www.wbcd.org/web/cev.htm

What is the issue at stake?

The first question is to determine the overall issue that needs to be addressed. It may be a purely water-focused issue or a much broader one requiring a wider ecosystem, environmental or sustainability perspective. It may be a project or product issue or a company-wide issue. It may be related to identifying and managing potential company risks or opportunities, or both.

As environmental, social and economic sustainability issues grow in importance globally, businesses will increasingly be faced with more, and broader, issues than previously encountered. A good place to start is either to follow the five stages of corporate water management, as set out in the WBCSD's *Water for Business* (WBCSD, 2012c) publication (see figure 10), or consider the four key categories of business water management in the *Ceres Aqua Gauge* (Ceres, 2012).

How is the issue best assessed?

Having identified the issue, there may be alternative means of addressing it without the need for valuation. *Water for Business* provides a summary of water tools available to help businesses evaluate different issues linked to each stage of corporate water management. Water-related valuation is not necessarily required, but it does provide an additional powerful lens through which to consider water issues. Figure 10 shows where the different example applications of water valuation (see section 3) best fit into corporate water management. It is important to remember that many of the applications allow positive company impacts on water-related values to be accounted for.

To ascertain whether water-related valuation may improve business decision-making, it is recommended that the screening questions from the Guide to CEV be answered (see adapted version in figure 11).





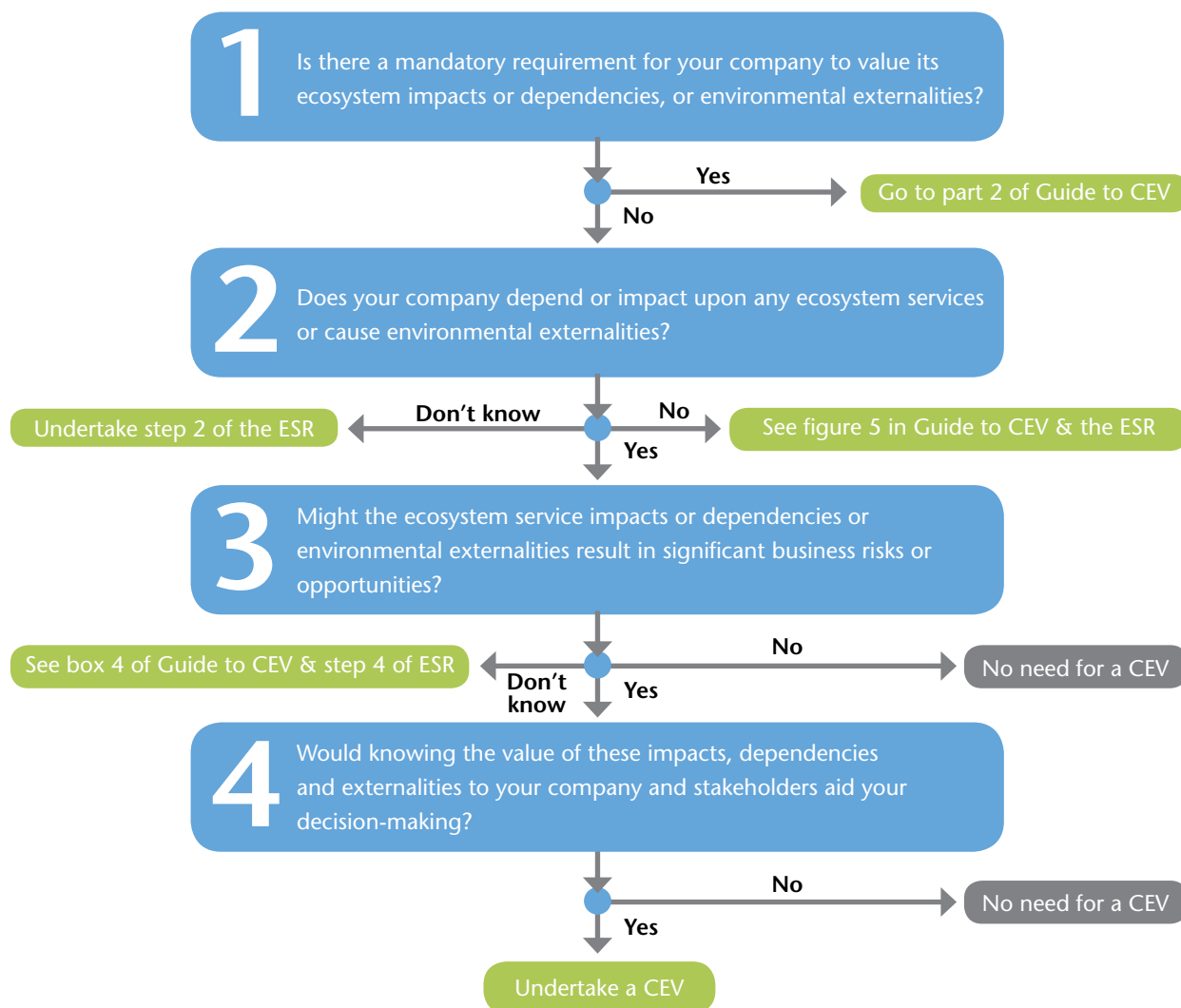
Figure 10 Linking water valuation applications to corporate water management



Adapted from Water for Business (WBCSD 2012c).

Note: The bullets in steps 2 to 5 indicate where water valuation applications fit best.

Figure 11 Guide to CEV screening questions



Source: WBCSD, *Guide to Corporate Ecosystem Valuation*

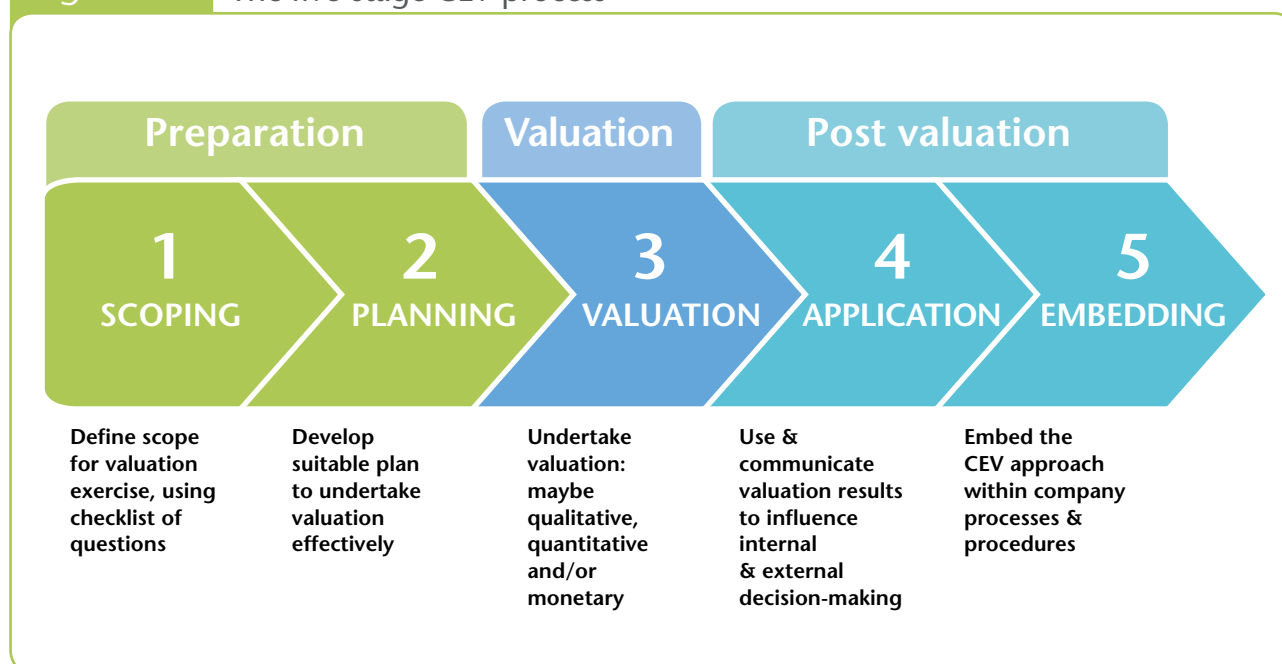
Follow the five CEV stages

Having decided to undertake water valuation, it is advisable to follow the five CEV stages. As shown in figure 12, these stages start with scoping what is to be valued, and progress through to embedding valuation approaches within company processes. In the following sections, specific water-related guidance is provided that complements the CEV's five stages and nine valuation steps.

Stage 1 – Scoping

As for any valuation, it is essential to ensure that the water-related valuation is carefully scoped. Whether the focus is purely on water or wider environmental or sustainability issues, there are many different applications, approaches and scales of assessment that can be pursued. The ten scoping questions in the Guide to CEV should be carefully considered, although most of the key issues are covered in the Manager tips box.

Figure 12 The five-stage CEV process



Manager tips: Stage 1 – Scoping

- Don't necessarily just focus the valuation on water. Consider evaluating broader ecosystem services as well as wider environmental or sustainability parameters to factor in trade-offs and improve overall sustainability decision-making.
- Try to identify several different business case arguments relevant to your water valuation to strengthen your case for action.
- Geographical and temporal boundaries are especially important for water. Whole river catchments should ideally be considered as the correct spatial scale to use (see *Sharing Water: Engaging Business* WBCSD, 2013b). These may have cross-border implications for other countries downstream or upstream. It is important to consider continuity and connectivity between waterbodies, other habitats and local communities dependent or impacting upon them. It should also be recognized that water has a source and a sink.
- A medium time horizon such as 25 years should be considered. Too short a timeframe may not adequately account for changing supply and demand issues, while too far into the future becomes too uncertain.
- Refer to any relevant water standards that should be adhered to, such as the ISO 14046 Water Footprint Requirements and Guidelines.
- Make use of the many potential sources of information available, such as the WBCSD Global Water Tool, UN Food and Agriculture Organization (FAO) and World Resources Institute (WRI).
- Where appropriate, link the analysis to Water Disclosure Project data.
- Consider the use of supporting tools, such as LCAs that include water components, and GIS, which can help identify and quantify associated waterbodies.

Stage 2 – Planning

Careful planning of valuation studies is essential. Ensuring access to a suitably qualified environmental economist and hydrologist as part of the study may be necessary, depending on the context.

Manager tips: Stage 2 – Planning

- Ensure the right skills can be made available within the team – especially an environmental economist, hydrologist and ecologist, depending on the issues and level of detail and accuracy required.
- If the valuation is to be undertaken at a high level – for example, qualitative or ballpark monetary values – then adequately experienced environmental economist skills may suffice.
- Seasonality issues should be anticipated and planned for if undertaking site visits and collecting baseline data. For example, water flows, vegetation, wildlife and visitor numbers and type may vary considerably depending on the time of year.

Stage 3 – Valuation

There are nine valuation steps outlined in the Guide to CEV that should generally apply to all water-related valuations. Each step is addressed in the Manager tips box. In addition, two key challenges in relation to water valuation are worth noting. One is determining what impacts (positive and negative) should be accounted for, and the other is accounting for any significant cause-effect linkages between changes in habitat cover, water quantity and quality and associated values.

Stage 4 – Application

It is crucial to recognize that once a valuation has been undertaken, there are many potential uses of the information gleaned. Valuation should not just be an academic exercise. It is worth exploring a wide range of possible internal and external applications of the results to inform and enhance decision-making. As shown previously in figure 10, most applications have both internal and external uses, although ultimately, all applications can be used both internally and externally. Whether a company is a water user or water provider, all applications are potentially relevant.

The language used in disseminating the different results must be carefully tailored to the target audience. For example, a brief to the CEO needs to be concise and relate to business case arguments, while for the operations team it may be more technical. However, it must be made relevant to the business in all cases. Communicating with external stakeholders, governments, regulators and technical stakeholder groups will require a reasonable level of detail, while local stakeholder groups and communities will need a simpler and briefer summary.



Manager tips: Stage 3 – Valuation

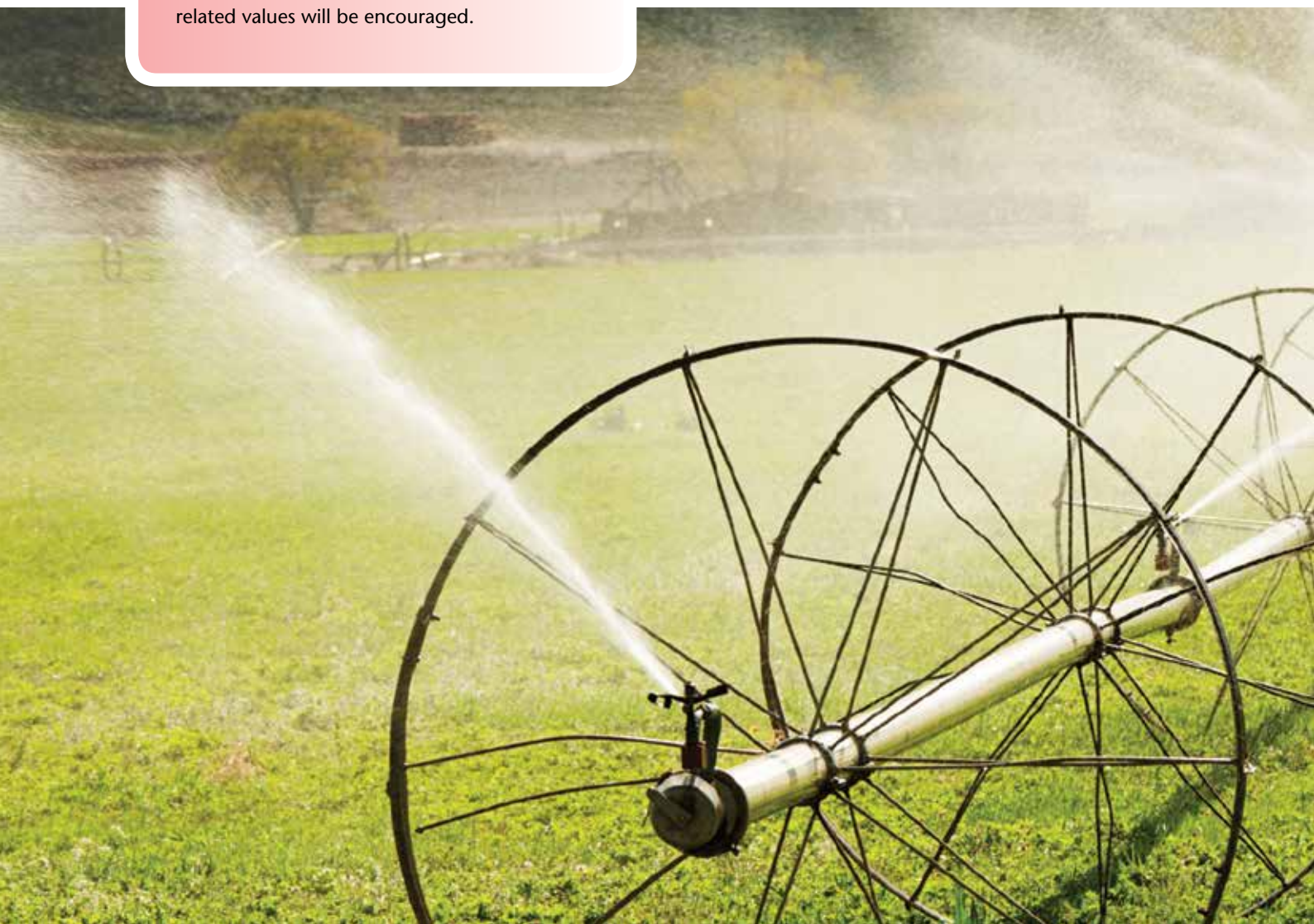
Valuation step		Manager tips
1	Define the business aspect (i.e., what is to be valued)	<ul style="list-style-type: none"> • Carefully consider what business aspect is to be valued, as well as what alternative options should be evaluated. Try not to make the assessment too narrow or too broad. • Think about whether construction, operation and decommissioning phases should be included, and whether non-water impacts associated with these should be factored in too.
2	Establish the environmental baseline	<ul style="list-style-type: none"> • It will be important to understand how water availability may change under the business as usual (BAU) scenario, for example through changes in supply and demand and potential climate change impacts. • Where appropriate, it may be necessary to take into account how waterbodies may change in terms of flow levels and water quality, based on macro-economic changes in the catchment area. • It can be important to identify any known or proposed land-use or urban planning constraints or projects, such as those that may affect water availability or flooding. • An understanding of periodic changes in water flows and levels is important. Peak and low flow states compared to average flows can have very important impacts on business use, as well as being very important from an ecological perspective.
3 and 4	Determine physico-chemical and environmental changes	<ul style="list-style-type: none"> • Determining the cause-effect relationships between business activities, water levels, water quality and values (e.g., off-stream and in-stream) is likely to be a critical part of the assessment. • Understanding changes to, and the associated implications of, hydrological services may also be important. • It is important to remember that ecosystem services are often mutually interdependent, especially in spatial and temporal contexts. The ability of a wetland to provide fish is related to water regime maintenance and retained habitat connectivity. • The use of life cycle assessments (LCA) may help account for various water- and non-water-related impacts, such as GHGs and air emissions associated with energy use.
5	Identify and assess relative significance of ecosystem services affected and other impacts	<ul style="list-style-type: none"> • It is important that the full range of potential environmental, social and economic impacts be considered here. • In particular, this should include all impacts to off-stream and in-stream values, hydrological services, other non-water impacts (e.g., GHG emissions) and water-related extreme weather event impacts.
6	Monetize selected changes to ecosystem services and other environmental externalities	<ul style="list-style-type: none"> • If undertaking monetary valuation, monetize the more important and readily monetized values, such as off-stream abstraction use values and recreation impacts associated with changes to surface waterbodies. • Spiritual and some other cultural water values may best be left to qualitative assessment. • Care is needed to avoid double counting values, for example if several valuation techniques are used to value impacts. This is best achieved through the advice of a valuation expert. • Consider how best to deal with non-use values associated with maintaining good water levels and water quality in waterbodies. These are controversial values that can be substantial.
7	Identify internal and external benefits and costs to the company	<ul style="list-style-type: none"> • Consider the possibility that water may be charged for in the future, if not already charged for now, and the potential for further water price increases. • Consider potential payments for ecosystem services in the future, either as a potential charge or revenue stream to the business.
8	Compare benefits and/or costs	<ul style="list-style-type: none"> • Ensure the full set of appropriate potentially significant costs and benefits is somehow accounted for, subject to the purpose of the analysis and the outcome of step 5. • Find a way of showing any key non-monetary values (i.e., qualitatively or quantitatively) alongside those that are monetized.
9	Apply sensitivity analysis	<ul style="list-style-type: none"> • Consider testing a change in price of water, and in electricity price if pumping or desalination is relevant. • If relevant, test to see what the implications may be for increased droughts and floods over the analysis time horizon.

Manager tips: Stage 4 – Application

- There are many global drivers encouraging and facilitating the adoption of environmental valuation by the public and private sectors. It will become increasingly important for businesses to understand how valuations work, and how the results may be used.
- Global policies are changing rapidly in relation to payment for ecosystem services (PES) and biodiversity and ecosystem service offsetting schemes. This will lead to additional risks and opportunities that valuation may help evaluate.
- Company reporting requirements are moving towards more integrated reporting. This may entail looking more closely at natural, social and manufactured capital impacts and dependencies with a link to water, in particular in relation to water supply, access and treatment.
- A number of companies recognized as leaders in sustainability issues are exploring the use of valuing externalities, including water, in their annual accounts (e.g., PUMA and their EP&L). It could become the norm in the future.
- As the Water Disclosure Project evolves, it is possible that a move towards recognizing water-related values will be encouraged.

The results of the ecosystem valuation exercise at **Rio Tinto Iron Ore** will feed into a full cost-benefit analysis of the extension of iron ore mine operations above the water table to below the water table. The aim is to use the case study in Western Australia to develop guidelines for managing the water and ecosystem impacts associated with dewatering. It is hoped that information gathered on the relative costs and benefits of potential mitigation actions and water disposal options will inform decision-making in order to promote sustainable management of water resources, as well as careful management of ecosystem impacts in order to reduce any adverse effects on the well-being of all relevant stakeholders.

Hitachi used the results of their GeoMation valuation to further refine and develop the GIS-based precision agriculture decision-support tool and to inform their marketing strategy for the product. This involved focusing development of the tool on those environmental values (which included water availability and quality) with the greatest potential materiality to the end users. In addition, they are using the values calculated to inform the business case arguments to promote the product.



Stage 5 – Embedding

There is little doubt that water valuation will receive far greater global interest in the coming years from a political and societal perspective, with a growing need for businesses to understand and report on water-related values and externalities. Development of water valuation-related processes and systems are likely to be required within companies in order to mainstream water valuation.

Manager tips: Stage 5 – Embedding

- If it is not already doing so, encourage your company to participate in the annual CDP Water Disclosure Project, and then try building links between the disclosure results and water valuation issues.
- Experiment with adding a water valuation element to other existing water management tools your company may be using.
- Work together with other environmental and sustainability staff within your company to explore and develop a case for valuing water along with other environmental, social and economic and sustainability parameters.
- It is likely that under the forthcoming International Integrated Reporting Council (IIRC) Integrated Reporting Framework, company impacts and dependencies on water and hydrological services will ideally need to be evaluated in relation to natural, social and manufactured capital, if considered potentially material.

Since undertaking their land and water management CEV in 2011, **Veolia** has initiated the following actions to help embed CEV within the company:

- Communicating the approach and its capacity to help make better-informed decisions;
- Developing expertise in water-related ecosystem services valuation, and undertaking further CEVs;
- Concentrating efforts at operations with the biggest potential values, and convincing such sites to value the ecosystem services they interact with;
- Considering new payment mechanisms to capture (part of) these values, and build an ecologically enhanced business model;
- Sharing the results with public authorities and governments to ensure the emergence of facilitating policy frameworks.

Rio Tinto Iron Ore intend to standardize the process of identifying, measuring and monetizing ecosystem impacts in order to develop decision support tools for operations faced with decisions about extending mines to below water table.

Having undertaken several CEV studies, **Hitachi** feels that simplification and customization are needed to embed all or part of the CEV process in their environmental management system. To help embed the approach, Hitachi also considers it important to raise awareness internally about the links between ecosystems and business, and plans to do this using the WBCSD Business Ecosystems Training material (WBCSD, 2013b).



What skills are needed at each stage?

There is no getting away from the fact that water valuation needs input from an experienced environmental economist and potentially a sociologist. The extent to which these and other skill sets are needed depends on the complexity of the valuation to be undertaken and the degree of reliability one wants in the outputs. Managers are advised to consider table 8 below and look at page 31 of the Guide to CEV to see what other people should be involved at each stage. Depending on the issues encountered, other specialist expertise that may be required includes: inter alia, hydrology, ecology, ecotoxicology, GIS, remote sensing, landscape, air quality and noise.

Who can assist in undertaking valuations?

If the right skills are not found in-house, various sources of expertise are available to help. The key is to find the right individual or mix of skills required. A good starting point is to involve an experienced environmental economist or water resource economist, which may be all that is required. Or, he or she may act as a useful sounding board to identify other expertise needed, such as a hydrologist, ecologist, agronomist and/or sociologist.

The following types of organizations and individuals can all potentially provide environmental economics, water economics and/or other related expertise.

- Universities
- Specialist non-governmental organizations
- Consultancy firms
- Independent consultants and experts.

Table 8 Manager and environmental economist knowledge and skills needed

Stage	Manager	Environmental economist
1) Scoping	Knowledge and ability to bring together the right mix of people to scope what is required	Knowledge and experience to advise on key ecosystem services and externalities to investigate, and suitable valuation approaches and tools, if any, to use
2) Planning	Ability to ensure that whoever is planning the methodology, budget, etc., has an appropriate level of experience to be doing it	Ability to propose a suitable methodology and help estimate the time and budget required
3) Valuation	Reasonable understanding of the different valuation techniques and analytical approaches available, and their pros and cons	Solid experience to undertake a valuation; if full rigorous stated preference surveys are to be undertaken, then additional econometric skills are likely to be required
4) Application	Communication skills to apply and leverage the results both internally and with stakeholders	Comprehensive knowledge and experience to advise on how best to interpret and use the results
5) Embedding	A vision to promote and the ability to influence and motivate others within the company	Knowledge and experience to help guide the company to adopt and integrate a suitable approach





6 Resources and next steps

The [WBCSD website](#) provides additional resources and materials on corporate water management, water tools for business and business water valuation case studies. Many other guidance documents and databases exist that may also be used to inform water valuation, a selection of which are listed below.

Useful references on water valuation

Emerton and Bos (2004). *Value: Counting ecosystems as water infrastructure*. IUCN Report. Water and Nature Initiative.
Turner et al (2004). *Economic valuation of water resources in agriculture*. Report to FAO.
Worley Parsons Canada Ltd and Eftec (2010). *Water Valuation Guidance Document*. Report to Canadian Council of Ministers of the Environment.

Useful references on valuation

Fish et al (2011). *Participatory and deliberative techniques to embed an ecosystem services approach into decision-making: an introductory guide*. Defra Project Code NR0124.
Department for Communities and Local Government (2009). *Multi-criteria analysis: a manual*. January 2009: London.
TEEB (2010a). *The economics of ecosystems and biodiversity: Ecological and Economic Foundations*. Edited by Pushpam Kumar, Earthscan, London and Washington.
WBCSD (2011a). *The Guide to Corporate Ecosystem Valuation. A framework for improving corporate decision-making*. World Business Council for Sustainable Development (WBCSD).

Useful databases on water

FAO Aquastat database: www.fao.org/nr/water/aquastat/data/query/index.html
UN Global Environmental Monitoring System (UNGEMS): www.gemstat.org
European Environment Agency publication on water databases: www.eea.europa.eu/publications/92-9167-051-0
US Environmental Protection Agency databases: www.epa.gov/waters/data/index.html
World Health Organization referenced databases: www.who.int/water_sanitation_health/database/en/

The coming years will bring considerable changes in how businesses manage their water impacts and dependencies. The following trends indicate that businesses need to monitor the situation and adapt to dynamic and turbulent times ahead:

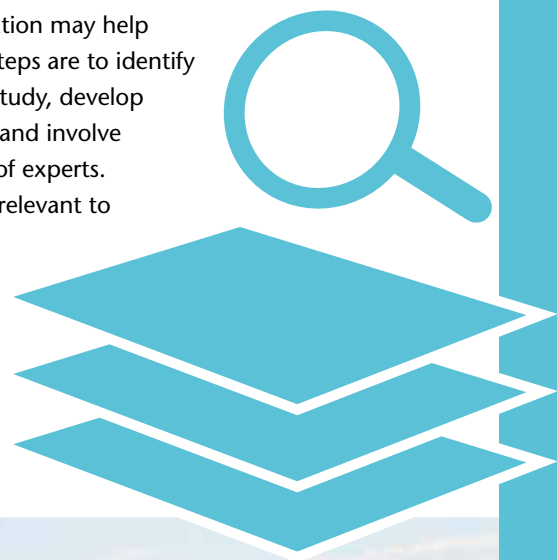
- Increased water pricing
- Reduced availability of water
- More extreme water-related events
- Increasingly stringent and innovative government policies and regulations
- More payments for environmental service schemes (e.g., water catchment payments)
- Widespread use of biodiversity and ecosystem services offsetting
- Growing business water risks and opportunities
- Standardized water accounting methodologies
- Greater efforts to put monetary values on water, and
- New approaches to integrated accounting and reporting, taking into account natural capital.



In line with the above, various international initiatives are underway exploring how best to value and account for natural capital, including water. Among them are the TEEB for Business Coalition, the Natural Capital Declaration, the B Team and the World Bank Wealth Accounting and Valuation of Ecosystem Services (WAVES). However, it may be a few years before any standardized approaches and values are agreed upon.

Companies are encouraged to explore potential implications and management strategies for their business going forward. As part of this, companies should consider what water management approaches are available and

how water valuation may help them. Key first steps are to identify an appropriate study, develop a business case, and involve a suitable team of experts. Remember, it is relevant to most businesses and may only require a simple spreadsheet-based approach.



Key definitions

Benefit cost analysis: A technique designed to determine the feasibility of a project or plan by quantifying and comparing its costs and benefits (adapted from MA 2005).

Contaminant: A contaminant is any physical, chemical, biological or radiologic substance or matter that has an adverse effect on air, water, land/soil or biota. The term is frequently used synonymously with pollutant (OECD 2007).

Cost: The amount or value of that which must be given up to acquire, obtain or achieve something (source: WebFinance, Inc.'s BusinessDictionary.com).

Corporate ecosystem valuation (CEV): A process to make better-informed business decisions by explicitly valuing both ecosystem degradation and the benefits provided by ecosystem services (WBCSD 2011a).

Cultural ecosystem services: The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including knowledge systems, social relations and aesthetic values (MA 2005).

Economic value: Values measured at their "real" cost or benefit to the economy, usually omitting transfer payments and valuing all items at their opportunity cost to society (Emerton & Bos 2004). The term economic value is also sometimes loosely used to encompass both financial (private) values and societal values.

Economic welfare analysis: Benefit cost analysis of the allocation of resources, economic activity, and distribution of the resulting output on a society's welfare (WebFinance, Inc.'s BusinessDictionary.com).

Ecosystem services: The benefits that people gain from the environment. These include provisioning, regulating, cultural and supporting services (MA 2005).

Environmental costs: The costs (or value) of damage imposed on the environment and ecosystems that affects human well-being (synonymous to societal and externality cost). In the context of water valuation, environmental costs may be water-related (e.g., related to water pollution) or non-water-related (e.g., the societal cost of greenhouse gas emissions).

Environmental externalities: Environmental externalities include externalities to ecosystems and ecosystem services, but they also include impacts upon people, buildings and infrastructure and other economic activities (e.g., from air emissions) (WBCSD 2011a).

Externality: A consequence of an action that affects someone other than the agent undertaking that action and for which the agent is neither compensated nor penalized through the markets. Externalities can be positive or negative (MA 2005).

Extreme water-related events: These are extreme events typically related to either a lack of or excess of water (e.g., floods and droughts), often causing significant impacts and loss of values.

Financial value: The importance, worth or usefulness of something that is measured in terms of market prices; sometimes referred to as private values.

Financial cost: The total amount of money (i.e., price) paid by an entity to acquire something. For water services this includes the costs of providing and administering these services (e.g., operation, maintenance and capital costs) (Wateco 2003); also referred to as private costs.

Full cost pricing: In relation to charging for water usage (and recovering costs for water services), this means setting a price that reflects both the financial costs and societal costs of obtaining it, the latter including resource and environmental costs (based on the EU Water Framework Directive [EU 2012; OJEC 2000]).

Groundwater values: The benefits provided as a result of water collecting or flowing underground.

Habitat services: The importance of ecosystems to provide living space for resident and migratory species (thus maintaining the gene pool and nursery service) (TEEB 2010a).

Hydrological services: The benefits provided by hydrological functions of non-waterbody habitats that influence water quantity and quality elsewhere.

In-stream values: The benefits gained from water use that occurs within a stream channel and impounded waters (i.e., values of in-situ water within surface waterbodies) (based on the USGS National Water-Use Information Program).

Intrinsic value: The value of someone or something in and for itself, irrespective of its utility for someone else (MA 2005).

Natural capital: An economic metaphor for the limited stocks of physical and biological resources found on Earth (MA 2005).

Net present value: The difference between the present value of the future cash flows from an investment and the amount of investment (source: WebFinance Inc.'s Businessdictionary.com).

Non-use value: The value individuals derive from knowing that environmental features are maintained (e.g., pristine habitats and iconic species) even though they do not directly or indirectly use them (WBCSD 2011a).

Non-water impacts: These are non-water environmental, social or economic impacts (positive or negative) related to water delivery and use. Also sometimes referred to as non-water environmental costs.

Off-stream values: The benefits gained from water use that depends on the diversion or withdrawal (abstraction) of water from a surface- or groundwater source and conveyed to the place of use (based on the USGS National Water-Use Information Program).



Payment for ecosystem services: A voluntary transaction whereby a well-defined ecosystem services (ES) is bought by a minimum of one ES buyer from a minimum of one ES provider if and only if the ES provider continually secures the ES provision (i.e., with an element of conditionality) (based on Wunder, 2005).

Present values: A future amount of money that has been discounted to reflect its current value, as if it existed today.

Price: The amount of money expected, required or given in payment for something (source: OxfordDictionaries.com).

Provisioning services: The products obtained from ecosystems, including for example, genetic resources, food and fiber, and fresh water (MA 2005).

Regulating services: These are the benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water and some human diseases (MA 2005).

Resource cost: The cost of foregone opportunities that other users suffer due to the depletion of the resource beyond its natural rate of recharge or recovery (e.g., linked to the over-abstraction of groundwater) (Wateco 2003).

Shadow price: Prices used in economic analysis, when market price is felt to be a poor estimate of real economic value (Emerton & Bos 2004).

Shared value: For the purpose of this document, this is defined as a company generating net societal value to stakeholders in addition to generating financial value for the company and their shareholders.

Societal costs: The cost to society of an activity, which comprises resource (opportunity) costs and environmental damages.

Societal value: The importance, worth or usefulness of something accruing to individuals and society that does not have a market price. Impacts to societal values are typically referred to as externalities.

Socio-economic impact analysis: Analysis that evaluates the impacts development has on community social and economic well-being using both quantitative and qualitative measures, covering aspects such as changes in community demographics, housing, employment and income, market effects, public services and aesthetic qualities of the community, etc. (Edwards 2000).

Subsidy: Current unrequited payments that governments make to enterprises or individuals on the basis of the levels of their production activities or the quantities or values of the goods or services that they produce, sell, consume or import (based on OECD 2007). For an updated discussion on definitions of subsidies see *Overview of key methods used to identify and quantify environmentally-harmful subsidies with a focus on the energy sector: draft report* (OECD 2012).

Supporting services: Ecosystem services that are necessary for the maintenance of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation, and retention, nutrient cycling, water cycling and provisioning of habitat (MA 2005).

Sustainable cost recovery: The setting of a mix of tariffs, taxes and transfers to facilitate long-term investment planning that ensures affordability to all categories of users and financial sustainability to service providers (based on OECD 2009).

Tariff: A water tariff is the price or charge paid for by consumers for water services and management (based on Winpenny 2013).

Tax: A compulsory contribution to state revenue, levied by the government on workers' income and business profits, or added to the cost of some goods, services and transactions (source: OxfordDictionaries.com).

Transfer: A transaction in which one institutional unit provides a good, service or asset to another unit without receiving from the latter any good, service or asset in return as counterpart (OECD 2007).

Valuation: An estimation of the worth of something, often in monetary terms (based on OxfordDictionaries.com).

Value: The importance, worth, or usefulness of something (based on OxfordDictionaries.com).

Value (or benefit) transfer approach:

An economic valuation approach in which estimates obtained by whatever method in one context are used to estimate values in a different context (MA 2005).

Water pricing: Determining an appropriate amount of money to charge for the use of water.

Water-related valuation: The assessment of values (and/or prices and costs), whether qualitatively, quantitatively or monetarily associated with changes in quantity and/or quality of water and related ecosystem services.

Water services: All services that provide, for households, public institutions or any economic activity, (a) abstraction, impoundment, storage, treatment and distribution of surface water or groundwater, and/or (b) wastewater collection and treatment facilities that subsequently discharge into surface water (EU 2000).

Water usage: For the purposes of this document, water usage refers to water that has been abstracted from surface or groundwater for use by, for example, agriculture, industry, energy production and households (i.e., water usage gives rise to off-stream values).

Acronyms

AUD	Australian dollar
BCA	benefit cost analysis
BCR	benefit cost ratio
CB	cost based
CCED	Communauté de Communes de l'Estuaire de la Dives
CE	choice experiment
CEA	cost-effectiveness analysis
CEV	corporate ecosystem valuation
CiP	change in productivity
CV	contingent valuation
DA	distributional analysis
DCF	discounted cash flow
EIA	environmental impact assessment
EP&L	environmental profit and loss account
ES	ecosystem services
ESI	economic & socio-economic impact
ESR	Ecosystem Services Review
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
GEMI	Global Environmental Management Initiative
GHG	greenhouse gas
GIS	geographic information system
IIRC	International Integrated Reporting Council
IUCN	International Union for Conservation of Nature
LCA	life cycle assessment
MACC	marginal abatement cost curve
MCA	multi-criteria analysis
NPV	net present value
OECD	Organisation for Economic Co-operation and Development
PES	payment for ecosystem service
PV	present value
QALY	quality adjusted life year
ROA	risk and opportunity analysis
SP	stated preference
TCM	travel cost method
TEEB	The Economics of Ecosystems and Biodiversity
TEV	total economic value
UN	United Nations
US	United States
VT	value transfer
WTP	willingness to pay
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

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