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The Value of Scotland's Water Resources

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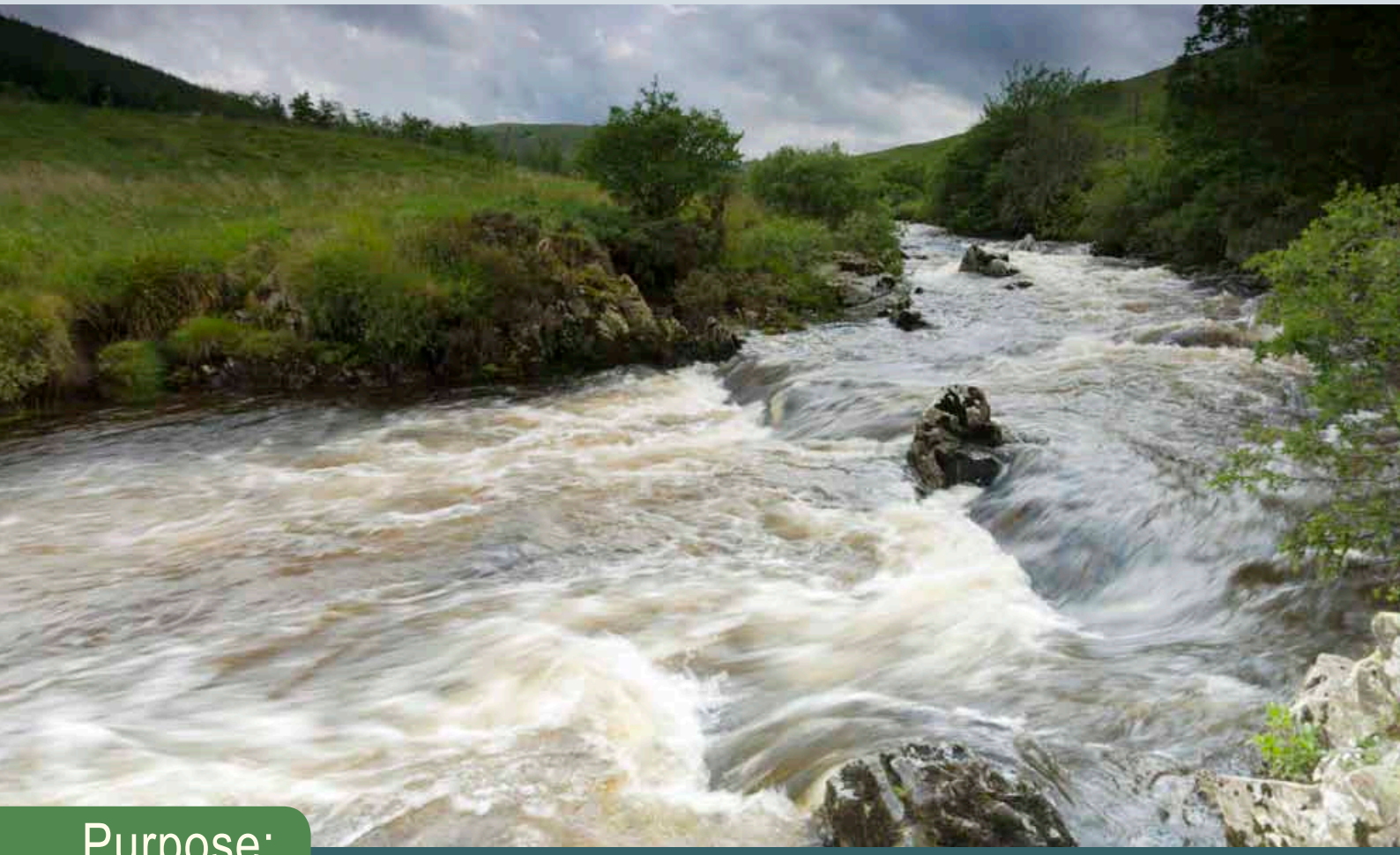


Purpose:

The Scottish Government announced in December 2010 its intention to develop Scotland as a Hydro Nation. This is a 'nation that manages its water environment to the best advantage employing its knowledge and expertise at home and internationally'. As part of this the Water Resources (Scotland) Bill, section 1 (as amended at stage 2), places a duty on Scottish Ministers to:

(a) take such reasonable steps as they consider appropriate for the purpose of ensuring the development of the value of Scotland's water resources,

(b) do so in ways designed to contribute to the sustainable use of the resources.

This note seeks to summarise current academic thinking and evidence on the value of water resources. It considers the Scottish context and examines how the value of water resources might be developed.

Executive Summary

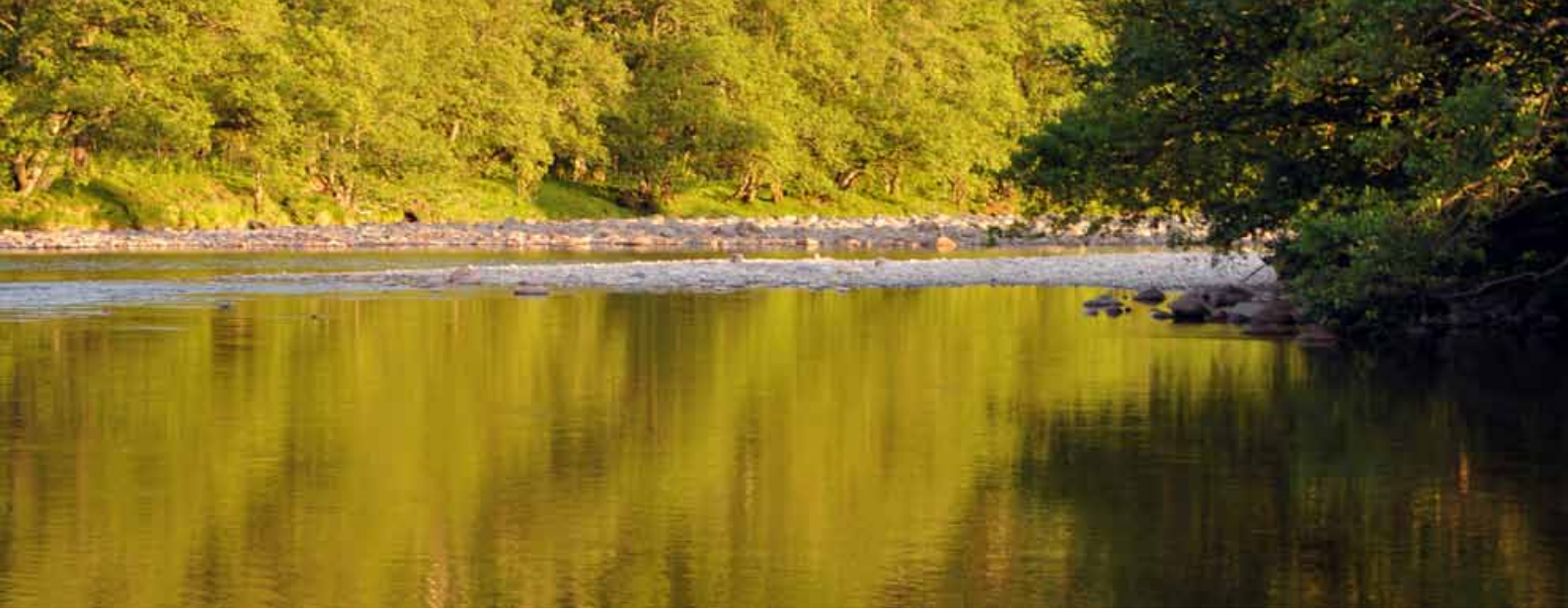
Freshwaters provide society with goods and services that are very important to human well-being. The value of water resources is to be interpreted as the benefits of all ecosystem services that freshwaters provide, including provisioning services (such as clean water and energy), regulating services (such as water purification, flood mitigation and climate regulation) and cultural services (such as recreation, symbolic and religious values).

Understanding and estimating the value of the range of services that freshwaters provide to humans is important to inform decisions about the use and conservation of water resources in a way that maximizes the benefits to society.

Methods to estimate the value of water resources in monetary terms exist. These include methods to estimate the market value of water ecosystem services, as well as non-market values. Monetary estimations allow comparing the benefits with the costs of the measures needed to preserve and enhance natural resources. However, monetary estimations are also criticised because of their reduced view of the notion of value. Non-monetary methods and alternative decision frameworks are also available.

To fully realize the value of Scotland's water resources it is possible to establish mechanisms to promote the sustained provision and enhancement of water ecosystem services in an economically efficient manner, such as Payment for Ecosystem Services.

This note summarises current academic thinking and evidence on the value of water resources to support the development and implementation of the Water Resources (Scotland) Bill and examines how the value of water resources might be developed in Scotland.



What is the *value* of water?

Freshwaters provide society with goods that are very important to human well-being, such as clean water, food and energy. Also, freshwaters provide other services that are less tangible but equally important to humans. For example, they enable recreation and cultural inspiration for people. Moreover, the hydrological cycle contributes to flood protection, climate change mitigation and supports wildlife. All these benefits that freshwaters provide to humans are the so-called 'water ecosystem services'.

Ecosystem services are the benefits that people obtain from nature. For example, clean water supply, flood protection, food production, recreation and cultural inspiration for people.

The notion of value in the Water Resources (Scotland) Bill is to be interpreted as the value of all ecosystem services that freshwaters provide; including provisioning, regulating and cultural services (*see Box 1 for examples*).

Services freshwaters provide to society

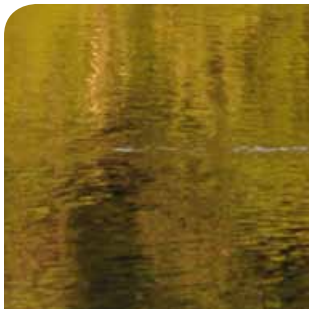
1

Provisioning Services *are the products obtained from ecosystems. For example: drinking water, commercial fishing, water for irrigation to produce food, whisky, hydropower, etc.*

Regulating Services *are the benefits related to the role that freshwaters have in nature. For example: climate regulation, flood regulation, water purification, supporting wildlife, etc.*

Cultural Services *are non-material benefits that people obtain from ecosystems. For example: recreation, aesthetic values, symbolic and religious values.*

The way nature works and delivers it services is complex, and often implies trade-offs. This means that not all services can always be realised at the same time. For example, exploiting the potential of water to produce energy, could potentially negatively affect the fish population and the associated recreational and commercial benefits.



The notion of ecosystem services, including provisioning, regulating and cultural is preferred to that of economic, environmental and social benefits, because the latter might suggest that only the 'economic' component has an economic value. Social and environmental elements are often forgotten, or given less priority, as they are difficult to quantify. The value of ecosystem services relates to all provisioning, regulating and cultural benefits that people obtain from freshwaters.

Why is it important to understand and sustain the value of water?

Changes in the condition of freshwaters can lead to significant changes in how ecosystems function. This in turn affects the provision of water ecosystem services, and the associated benefits. For example, wild salmon and other native species important to Scottish economy and culture are dependent on high quality of water. If water quality decreases, the benefits associated with these species may decline.

Water ecosystem services are threatened globally by climate change, drainage, burning, water extraction, pollution, over-harvesting, invasion by exotic species, land conversion for agriculture and intensification of agricultural production. There has been a considerable change in Scotland's ecosystems and the service they provide over the past years. The delivery of some services has increased considerably, such as the provision of food and energy. However, other ecosystem services have been negatively impacted.

Understanding the value that society holds for water ecosystem services is necessary to make efficient decisions about their use and conservation. **Only when decisions accurately reflect the value of all water ecosystem services, the people of Scotland can be benefited more widely.** *Box 2 illustrates this in the context of the European Water Framework Directive*.

There is longstanding scientific evidence that maintaining and improving the condition of freshwaters provides benefits to society.

The delivery of provisioning services has increased considerably in Scotland. However, most of the habitats and 'natural' ecosystems have declined in area and condition in the last 70 years. (UK National Ecosystem Assessment, page 957)

The role of the value of water in the Water Framework Directive

2

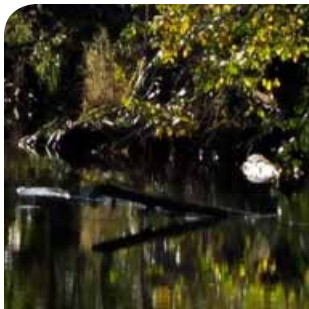
In the early 2000s, The Water Framework Directive (WFD) entered into force in Europe and it was translated into Scotland's legislation in the Water Environment and Water Services (Scotland) Act 2003. The WFD aims at preventing deterioration of water resources, improving the state of freshwaters and promoting the sustainable use of water.

The WFD establishes that nations can postpone or derogate reaching water quality targets if meeting them has "disproportionately high costs". This means that action should only be taken if benefits prove to be higher than the costs, so a social optimum is reached. To calculate this, a Cost-Benefit Analysis (CBA) is required where the costs of the measures to improve water quality are compared to the benefits associated with improved water quality.

Traditionally in water management, CBA has focused only on market benefits, such as food or energy production. However, in this way important benefits associated with improving water quality might be ignored. For example, increased water quality has positive effects on human health and availability of drinking water for which there is not a real market. Moreover, increased water quality contributes to healthy habitats and enhanced biodiversity, valued by society for their scenic beauty and recreational potential, as well as other cultural services.

A CBA which does not consider these "less tangible" services can result in an underestimation of benefits and may bring about a decision of not undertaking action due to disproportionality of costs. This could lead to a sub-optimal decision for society.

It must be noted, however, that a purely monetary assessment of costs and benefits (even if a wide range of intangible benefits are included) might not provide all the information needed for making an appropriate policy decision. Attention must also be given to equity and distribution of costs and benefits, this is: who has to pay for the costs and who enjoys the benefits.



How to measure the value of water resources? *Evidence from Scotland*

The predominant paradigm used to interpret and measure the value of ecosystem services is that of Neoclassical economics, which associates well-being with human welfare measured in monetary terms. Under this theoretical framework, the value of water is measured through individuals' 'willingness to pay' to maintain or increase the services it provides. For example, the value of freshwaters as a provider of fish for human consumption is measured through people's willingness to pay for salmon in the market. The social value would then be the addition of the individual welfare across the whole population.

Monetary valuation does not mean putting a 'price' on water, but using monetary units as a metric to measure the welfare or benefits associated with natural resources. The advantage of measuring the value in monetary units is that it allows comparing the benefits associated with water ecosystem services with costs of ensuring their provisioning *(see Box 2 on the Water Framework Directive for an illustration)*.

Some ecosystem services provided by water can be valued easily since they are traded in markets. For example, the monetary value of Scottish salmon is its commercial price, that is, the price that people are willing to pay for it in the food market. The social value is that of salmon's market contribution to Scotland's GDP. Other examples of ecosystem services which value can be easily assessed in monetary terms include, for example, whisky and hydropower (*see Box 3*).

Under the Neoclassical economics paradigm, the value of water is the utility (satisfaction) obtained by the public from the services it provides, measured in monetary units. The social welfare is the sum of individual welfare.

Value of water for hydropower production in Scotland

3

Background	This study places a monetary value on hydroelectric use of water in Scotland. The study also compares this value with alternative uses of water.
Valuation method	A form of the **replacement cost method** is applied. In this case, this consists of comparing the generation costs between hydropower and the costs of the next reasonable alternative generating energy. The difference in costs can be considered a lower bound of the social value of water for hydropower.
Main results	Authors calculate a range of values of water to hydroelectric generation across Scotland ranging from £9,9m (2.5p/kWh) when compared with coal fired plant with no CO_2 charges, to £165.56m (7.2p/kWh) when compared with offshore wind with standby. The alternative that is generally best suited to performing hydro's role of meeting peak load demands at short notice, is likely to be combined cycle gas turbines, against which the water value of hydropower is £13.2m (2.5p/kWh). This shows that there is a social value of water for hydropower generation. However, hydroelectric production (which consumes a great volume of water) also produces significant opportunity costs (foregone benefits) in comparison to other alternative uses of water, such as potato irrigation and aquaculture.
Full reference	*MacLeod, M. et al. (2005). Counting the cost of water use in hydroelectric generation in Scotland. Energy Policy, 34: 2048-2059.*

Some ecosystem services provided by water can be valued easily since they are traded in markets. For example, the monetary value of water for its use in producing whisky or hydropower.

It is also possible to know the economic impact that the value of some water ecosystem services have in the wider economy and in employment. *For example, Box 4 explains the contribution of freshwater angling to Scotland's economy*.

Value of freshwater angling and its impact to Scotland's economy

4

Purpose of the study	To estimate the contribution of freshwater angling to Scotland's economy.
Valuation method	In this study a **survey** of anglers was carried out to find out angling **expenditures** in Scotland as an indicator of the value of freshwater angling. This information was then used to see the impact on the rest of the economy using the input-output method. Input-output models are constructed from observed economic data for a specific country or region. It is based on the idea that input from one industry may affect the output of another, hence describes interdependencies between the flows of products from one industry to another.
Main results	It is estimated that anglers spend a total of £113m on angling in Scoltand (65% of which is salmon and sea trout). If salmon angling ceased, for example, in the Highlands region, the regional Gross Added Value will be reduced in £12.5m and employment by 781 full time equivalent jobs.
Full reference	*Radford et al. (2004). The Economic Impact of Game and Coarse Angling in Scotland. Scottish Executive. Edinburgh.*

However, there are other ecosystems services that are less tangible and are not traded (or not directly traded) in markets. It is more difficult to understand the value of these services. This is the case for measuring the value, for example, of flood risk mitigation. There is not a specific market in which 'flood prevention' is directly traded, but there are ways in which we can know what is the monetary value of preventing flooding, looking for instance at the costs of property damage *(as the study presented in Box 5)*.

Value of preventing flood risk in Scotland 5

Background	This study provides an assessment of current and future economic impacts of inland flooding on residential and commercial properties in Scotland, in line with expected climate change events. This can be used as an indication of what is the value of mitigating flood risk damages.
Valuation method	**Avoided cost method** can be used to estimate a lower limit to the value of mitigating flood risk (in terms of avoided costs to property damage). The current average annual property damage posed by inland flood risk was calculated in this study by using a sample of 26,000 properties within seven catchments (Findhorn, Don, Clyde, Nith, Carron, Almond and Deveron).
Main results	The assessment of current average annual property damage of the 26,000 houses in the study area is between £1.8- £2.4 million.
Full reference	*Werritty, A., Black, A., Duck, R., Finlinson, B., Thurston, N. and Shackley, S. (2002). Climate Change: Flooding Occurrences Review. Scottish Executive Central Research Unit. http://www.scotland.gov.uk/Resource/Doc/156664/0042098.pdf (accessed 24 January, 2013)*

For ecosystem services that are not directly traded in markets, the monetary value can be calculated looking at related markets such as the property market or at travel costs.

In other cases, the recreational value of water does not necessarily have a market either. For example, contrary to angling for which people are willing to pay a fishing fee, hill walking is 'free of charge' in Scotland. However, there are also ways of measuring how much the people are willing to pay for hill walking, using the costs they incur in travelling, parking, etc. This can serve as an indicator of the monetary value of water resources associated with recreational activities. *See example in Box 6*.

Value of hillwalking: a case study for the Queen Elizabeth Forest Park

6

Background	The Queen Elisabeth Forest Park, is situated 30 miles away from Glasgow. It covers 17,000 hectares and extends from Loch Lomond in the West to the Trossach hills in the East. It is set in spectacular mountain, woodland and freshwater scenery. Back in the 90s, the number of visitors to the Park was estimated at 145,000 per year. This study attempts to value the recreational benefits of this park.
Valuation method	The **travel cost method** is based on inferring the value that people place on a non-marketed good by observing their behaviour in other associated markets. Specifically, willingness to pay for hill walking in the Park is assimilated to the travelling and other visit-related costs (such as parking).
Main results	Authors estimate a value of £1.70 per trip or £160,744 per annum for the total amount of visitors. (These are monetary figures of 1989).
Full reference	*Hanley, N. (1989). Valuing rural recreation benefits: an empirical comparison of two approaches. Journal of Agricultural Economics, 40(3): 361-374.*

There are other services for which it is even more difficult to estimate a monetary value. These services are difficult to value because they have no associated market values such as the costs of property loss or travel costs which can be used to provide an estimation of the social value of water, as in examples provided before. Moreover, people may value a natural resource even though they do not use it. For example, people value the Scottish lochs not necessarily because they use them for recreation purposes, but just because of their symbolic and natural heritage value. The environmental

Measuring the value of water in monetary units allows comparing the benefits of water ecosystem services with costs of ensuring their provision.

economics discipline has developed methods to estimate these so-called 'non-use values'. These methods consist in asking people for their 'willingness to pay' for services provided by freshwaters in a survey *(as explained in Box 7)*.

Value of recreational and non-use of the water environment: case of Scottish lochs

7

Background	This study assesses in monetary terms the value that the Scottish society holds for an improved quality of Scottish Lochs. This value is associated with the possibility of undertaking recreational activities (such as rowing or wind-surfing) as well as the **'non-use' values** associated with reduced pollution of waters and in creased diversity and range of plants, insects, fish, birds and other animals.
Valuation method	**Stated preferences techniques** are used to value goods and services that are not traded in the market. It is based on asking in a survey to a representative sample of the population if they would be willing to pay for an improvement in the water quality and how much.
Main results	The study finds a mean value of £1,500 per hectare of loch improved to the good ecological status. Reaching the good ecological status in 72% of Scottish lochs surface area produces a benefit of £5.7m per year.
Full reference	*Glenk, K. et al. (2011). Public preferences for water quality improvements: implications for the implementation of the EC Water Framework Directive in Scotland. Water Policy, 13(5): 645-662.*

All these examples show how there are ways of estimating the monetary value of a wide range of water ecosystem services, including less tangible ones and 'non-use' values. Using the monetary metric is the predominant way to value water resources, but some criticise this approach, arguing that:

- The reality of human wellbeing is more complex than just monetary elements
- Monetary valuation risks reducing nature to a tradable commodity, which may be considered morally wrong
- Some values are simply not possible to monetise *(Box 8 shows an anecdote from the United States)*.

Monetary valuation is based on a restricted understanding of well-being, measurable in monetary units. There are other theoretical frameworks that try to quantitatively or qualitative analyze non-monetary values.

"God lives in the Water" 8

"Years ago, some time in the mid-1980s, I was testifying in a civil case that Indian tribes in the Pacific Northwest in the USA brought against the operators of several dams on the Columbia River, to fish for salmon out of season for religious purposes. My institution had been hired to put an economic value on salmon as part of an economic analysis of the benefits and costs of limiting this practice. We looked at all the relevant existing work, hired some good recreation demand economists in the region, and came up with a range of values that we believed would pass a 'reasonableness' test. During the trial, one of the witness for the Tribes, and old withered face but amazingly majestic Tribal chief, stoop up in the box, shaking with age, reached his arms up to the heavens and uttered this words: "God lives in these Waters". The lawyer for the Tribes argued that the benefit-cost analysis was irrelevant to the case because spiritual values could not be quantified in dollars and cents. The Indian Tribes won the case!"

(From memory: Dr. John M. Callaway, Sr. Economist at the UNEP Risoe Center In Roskilde, Denmark).

Alternative (non-monetary) frameworks that try to quantitatively or qualitatively analyse the value of natural resources exist. These include questionnaires aimed at eliciting statistically significant information on public attitudes and behaviour in relation to water resources. In-depth interviews and deliberative participatory methods, such as focus groups, citizen juries and consensus conferences, also allow qualitatively gathered information of people's understanding of the value of water. Methods which try to relate the value of natural resources to length and quality of life, also exist. *See Box 9 for an example of the application of one of these methods*.

Value of the Ettrick Valley Floodplain restoration project 9

Background	The managers of the The Upper Ettrick habitat restoration Project included a citizens jury to understand the opinions and priorities of the community so as to incorporate them into project planning.
Valuation method	A **citizens' jury** consists of a small group of people, selected to represent the general public rather than any particular interest-group or sector, which meets to deliberate upon a policy question. Witnesses provide evidence to the jury who come to a decision through discussion on a given topic.
Main results	The jury identified several positive benefits of the project including; getting back to nature, community involvement, flood control, preservation of indigenous life forms and education.
Full reference	*Kenyon, W., Nevin, C. (1999). 'Contingent Valuation and Citizens' Juries. Complement or Conflict'. New Opportunities for Forest-Related Rural Development. IUFRO Symposium Group 6.11.02, Aberdeen, August 1*999.

How might the value of Scotland's water resources be developed?

All ecosystems services provided by freshwaters need to be acknowledged, including goods such as drinking water, food, whisky and energy; and also environmental benefits such as climate regulation, flood mitigation and habitats for wildlife; and social and cultural services, such as recreation, scenic beauty and spiritual inspiration. Evidence shows that all of these benefits are important to humans and have a value to society.

Trade-offs and the complexity of the water ecosystem services need to be considered so that promoting the value of one water service can lead to the decline of another service. For example, the generation of hydropower can have negative effects for wild salmon. Understanding and comparing the full benefits of both options is necessary to maximize the benefits for society.

Monetary values can be used to inform decision making based on Cost-Benefit Analysis and can be added to GDP accounts, but other non-monetary decision support frameworks and measures of social prosperity based on broader understanding of human wellbeing also exist *(see Box 10)*.

When making decisions about sustainable economic growth that involve water resources all ecosystems services need to be accounted for. This may involve estimating monetary values of water resources or using alternative (non-monetary) approaches.

Other decision support frameworks and Measures of Prosperity

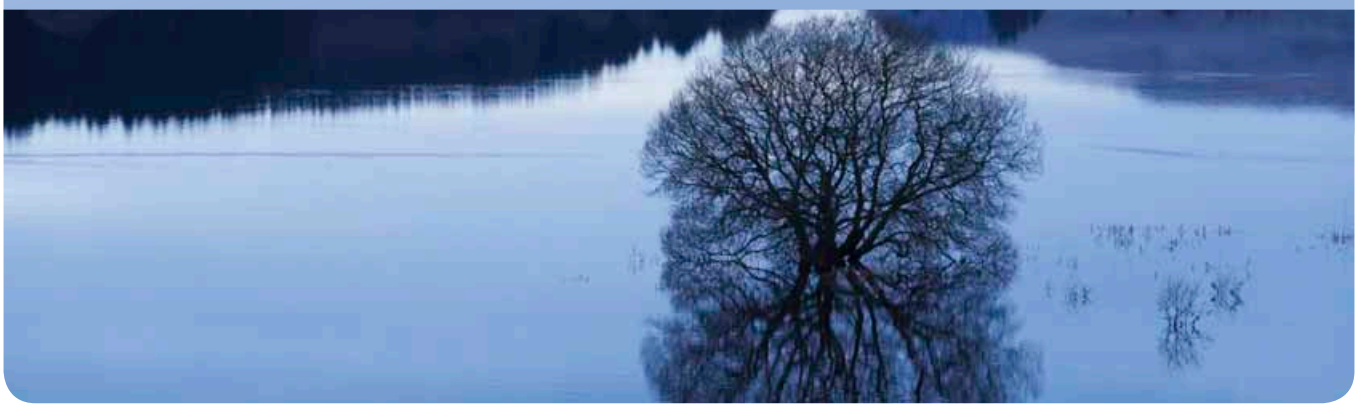
10

Decision support frameworks

Cost-effectiveness analysis	A framework used to compare the costs and outcomes (effect) of alternative course of action. It differs from CBA in that it does not measure the effects in monetary benefits, but for example, in reduced concentration of pollutants. The intention is to compare the outcomes of different actions with their costs in order to identify which gives the greatest result per unit cost.
Multi-criteria analysis	A tool used to rank different options interms of their weighted performance against a variety of criteria. MCA aims to account for all dimensions of effects of different options (various environmental, social and economic impacts) but measures these in different units (in contrast to the monetisation approach of CBA).
Life cycle analysis	An analytical tool used to quantify the environmental impacts of a product or service throughout its lifetime.

Measures of Prosperity

Human Development Index (HDI)	Includes the averaged sum of three separate components: per capita GNP adjusted for purchasing power parity; average life expectancy at birth; and an educational index.
Index of Sustainable Economic Welfare (ISEW)	It provides an alternative measure of economic welfare which is responsive to changes in environmental and social contributions or detractions from welfare, such as unpaid household labour, national resource depletion and urbanisation.
Green National Product and Genuine Savings (GNNP)	It focuses on the value of goods and services produced within a period, and though it does include investment, it does not take into account depreciation or depletion of human, social or natural capital. Net National Production results from subtracting an estimate for depreciation of manmade capital from GNP. GNNP is a modification which attempts to include depreciation in both manmade and these other forms of capital.
UK Sustainable Development Indicators	Include 68 indicators seen to be indicative of progress towards sustainable development, relating to diverse aspects, such as greenhouse gas emissions, biodiversity, crime, employment, poverty, health, etc.



It is possible to establish mechanisms to promote the sustained provision and enhancement of water ecosystem services in an economically efficient manner. Among such mechanisms are Payments for Ecosystem Services (PES). PES initiatives aim to reach mutually beneficial agreements between downstream users of water and upstream land managers in the catchment, in which these get rewarded for changing practice that can ensure or enhance the delivery of benefits.

There is an opportunity for Scottish Waters, but also for private business and industry to participate in initiatives to promote the value of water resources. This is already happening in some cases in Scotland, such as the Scottish Water Sustainable Land Management Incentive Scheme in the Ugie Catchment (see *Box 11*).

There is an opportunity to develop mechanisms to promote the sustained provision of water ecosystem services, such as PES.

Scottish Water Sustainable Land Management Incentive Scheme in the Ugie Catchment

11

The Scottish Water Sustainable Land Management Incentive Scheme makes payments to land owners and farmers for carrying out actions on their land which reduce the volume of diffuse pollution reaching water. Some of the measures that can be funded include: whole farm diffuse pollution management advice and technical support, installation of a biobed, stock fencing and livestock watering and naturalisation of body morphology. The main benefit from the scheme relates to clean and safe drinking water.

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