EXPERT SCOPING WORKSHOP ON

QUANTIFYING THE BENEFITS OF TRANSBOUNDARY WATER COOPERATION

6-7 June 2013

Amsterdam, the Netherlands

Background Document[1]

1. Introduction

The importance of water as a source of life and the problems of its increasing scarcity and deteriorating quality, often turn water into a source of rivalries and conflicts. This is especially true in the context of transboundary water resources where the governance of those water resources involves two or more countries with different needs and priorities under different social, economic, political, and legal systems. On the other hand, the problems of transboundary water management also provide opportunities to cooperate and expand the possibilities for economic growth, improved welfare, and regional security.

To some extent, transboundary water can be seen as a global commons, characterised by non-excludability and rivalry in using the resources that results in reciprocal externalities. The governance of the resources requires some kind of collective framework to regulate users' rights and duties. Institutional failures of this collective framework to establish property rights and ensure compliance leads to over-exploitation of the resources, in terms of quantity and quality (Grafton et al. 2004). Nevertheless water can also be a private good when there are clear property rights assigning the rights and responsibilities in managing and using water resources.

[1] This background document has been developed by Phillia Restiani from the Stockholm International Water Institute (SIWI).

The lack of cooperation in transboundary water management threatens the environmental conditions of the transboundary water resources with its ramifications on the economy and well-being of the countries as well as regional security of the neighbouring region. The importance of building cooperation in transboundary basins is also underlined by the fact that international river and lake basins constitute almost half of the world's continental land area (United Nations 1978) and at least 60 percent in Africa, Asia, and South America (Barrett 1994).

Recognising the need for cooperation to address complex water management issues and to ensure reasonable and equitable use of transboundary waters, the United Nations Economic Commissions for Europe (UNECE) pioneered the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention)[2] in 1992 for its member countries. The UNECE Water Convention intends to strengthen national and international measures for the protection and ecologically sound management of transboundary surface water and groundwater. The Water Convention recognizes that water is a cornerstone of societies and promotes a holistic approach to cooperation, looking at environmental, social and economic implications of water use.

An amendment to the Water Convention was adopted in 2003 to allow accession by all United Nation Member States. As the amendment entered into force on 6 February 2013, the Water Convention became a global legal framework for transboundary water cooperation. In this light, non-ECE countries will be able to join the Convention.

Considerable progress in cooperation on managing transboundary water has been made in the last decades, particularly in the pan-European region. However, transboundary water cooperation still often focuses on a narrow vision of water management, and there is scope for further cooperation around transboundary water. Indeed, the extent to which countries are willing to engage into cooperation is the consequence of the perceptions by each country on the potential benefits of cooperation. This requires the identification and quantification of the full breadth of cooperation benefits and an understanding of the contexts surrounding the potential cooperation. As a result, there is a growing demand by countries for quantitative information on the benefits of different activities in the area of transboundary water cooperation.

The UNECE acknowledges countries' demand for that quantitative information; hence the Parties to the Water Convention have included in their 2013-2015 work programme an area on "Quantifying the Benefits of Transboundary Cooperation". This work area aims to develop a methodological guidance note on how to identify and quantify the benefits of transboundary cooperation. It is expected that this activity will drive the reflection on the opportunities for further broadening cooperation, preventing conflicts and promoting sustainability and peace through water cooperation.

Building on existing studies in this field as well as on the direct experience of the Parties to the Convention and other stakeholders, the work under the Convention will:

1) Develop an approach for identifying and quantifying the benefits of cooperation (through the Expert Scoping Workshop to be organized in June 2013)
2) Gather and share practical experiences in identifying and quantifying benefits (through a dedicated workshop to be organized in May 2014)

[2] http://www.unece.org/env/water/text/text.html

3) Produce a *Guidance Note* on identifying and quantifying the benefits of cooperation (to be completed by September 2015, for approval by the next Meeting of the Parties of the Water Convention).

The Expert Scoping Workshop is the first activity under the work area on benefits. The aim of the Expert Scoping Workshop is to initiate a discussion on the approaches and methods of quantifying the economic, social, environmental and political benefits of cooperation.

The specific objectives of the Expert Scoping Workshop are to:

a) Elaborate particular needs and challenges of policy makers with regard to the value of the benefits.
b) Develop a definition of cooperation in the context of transboundary water management, as the starting point to identify the benefits of transboundary water cooperation.
c) Identify a typology of benefits.
d) Discuss existing approaches and methods for the quantification of the typology of benefits identified.
e) Discuss key elements and characteristics of the methodological *Guidance Note* to be most useful to the Parties to the Convention and other actors as a tool to promote further transboundary water cooperation.

This background document provides a brief overview of existing literature pertaining to the quantification of the benefits of transboundary water cooperation. Some key issues surrounding the topic are presented, upon which further discussion can take place during the workshop. This paper is organized as follows. The next section clarifies the context of transboundary water cooperation, how it can be perceived as a driver for conflict or cooperation, the definition and the challenges of building or maintaining cooperation, and the principle of benefit sharing. Section Three provides an overview of existing analytical frameworks for identifying and quantifying benefits. The discussion covers some useful concepts for valuing the benefits, various valuation methods, and existing framework for benefit typology. Section Four presents a suggested alternative for identifying and quantifying benefits as well some illustrative examples on current studies to quantify cooperation benefits. The last section discusses how quantitative information on cooperation benefits can be used to facilitate and strengthen cooperative actions in transboundary water management.

2. The Contexts of Transboundary Water Cooperation

2.1. Transboundary Water as a Driver for Conflict or Cooperation

As the physical boundaries of surface water and groundwater traverse across administrative or political boundaries, riparian countries share a complex network of environmental, economic, social, political, and security interdependencies. Transboundary externalities that inevitably arise from the use of the transboundary waters often produce conflicts. These conflicts can occur between existing users, between existing and new (planned) uses, over future uses, and as a result of emergency situations (Vinogradov, Wouters, and Jones 2006). Nevertheless, these conflicts can also prompt opportunities for cooperation (Dinar 2008) and the drivers of conflicts can also become the drivers for cooperation. This leads to two different prognoses of the outcome of transboundary water issues: the “water wars” (Gleick 1993; Myers 1993; Homer-Dixon 1994; Cooley 1984; Starr 1991) and water as a catalyst for cooperation (Wolf 1998; Deudney 1991; Dokken 1997).

Water scarcity is one of the most common drivers for transboundary water cooperation. Competing use of limited water resources to meet various domestic, industrial and agricultural and environmental purposes gives rise to water scarcity. Falkenmark (1986) maintains the minimum requirement of 1000 m^3 of water per capita for an adequate quality of life in a moderately developed country. When water availability decreases below the minimum requirement, water scarcity grows and increases the risk of conflict. Water scarcity also brings about environmental scarcity as diminishing water quantity compromises ecosystem's capacities in dissolving pollutants and delivering its environmental services.

Efforts to address water and environmental scarcity in order to meet a specific need for water may lead countries to seek cooperative ways for their mutual benefits. In essence, those drivers for water cooperation illustrate the mechanisms that underpin countries' hydrological interdependence: (a) competition for a finite supply of water; (b) impacts on water quality; (c) timing of water flows (UNDP 2006); and (d) impacts from deteriorating watershed.

Numerous instances have shown that cooperation is indeed possible. The Global Water Partnership has compiled a selection of fifteen case studies highlighting various drivers for cooperation that go beyond merely water scarcity, such as: disaster risk reduction in terms of flash flood management in Central and Eastern Europe; degrading water quality and threatened biodiversity in the Drin River Basin in the Mediterranean (Macedonia, Greece, Kosovo and Montenegro); and the need to increase the resilience to climate change in Africa through Water, Climate and Development Programme (WACDEP).[3]

UNESCO International Hydrological Programme (UNESCO-IHP) undertakes a programme "From Potential Conflict to Cooperation Potential" (PCCP)[4] that aims to foster cooperation between nations by supporting and maintaining peace-building processes. The project focuses on the development of tools for the anticipation, prevention and mitigation of water conflicts. Through research and capacity building activities, the programme brings players engaged in transboundary water management together and helps increase the opportunities for cooperation and development. Using legal framework, PCCP cycle identifies four interconnected and reiterative phases (Vinogradov, Wouters, and Jones 2006):

(a) Phase I: the use of legal context (the rules of international law that apply to the conflict and its resolution);
(b) Phase II: using legal means and mechanism to transform conflict into agreement
(c) Phase III: creating new agreement
(d) Phase IV: implementation of the agreement and dealing with changing circumstances and potential new conflicts.

Despite the complexity of the problems, records show that water disputes can be handled diplomatically. The last 50 years have seen only 37 acute disputes involving violence, compared to 150 treaties that have been signed. Nations value these agreements because they make international relations over water more stable and predictable. There is a consensus among experts that

[3] Global Water Partnership (2013) http://www.gwp.org/Global/Events/Water%20Cooperation%202013/Water%20Cooperation%20booklet_FINAL.pdf

[4] http://www.unesco.org/new/en/natural-sciences/environment/water/ihp/ihp-programmes/pccp/

international watercourse agreements need to be more concrete, setting out measures to enforce treaties made and incorporating detailed conflict resolution mechanisms in case disputes erupt. Better cooperation also entails identifying clear yet flexible water allocations and water quality standards, taking into account hydrological events, changing basin dynamics and societal values.

2.2. Defining Transboundary Water Cooperation

Cooperation can generally be defined as a process through which human beings and groups may move up from one level of social development to the next, richer and more stimulating, one (Bogardus 1964). Dinar (2004a) points out some important principles of cooperation: 1) the democracy principle of managing the cooperation, (2) the voluntary principle of joining and leaving the cooperation arrangements, (3 the autonomy principle of self-sustainability, (4) the equity principle of participating and sharing the benefits, and (5) the universality principle of having a set of goals that attract all participants.

In the context of transboundary water, cooperation can be defined in several perspectives since there has no agreed definition of transboundary water cooperation. Dinar (2004a) points out three possible stages of cooperation: regional conflict, negotiation, cooperation. The extent of cooperation varies from full-scale conflict, partial cooperation to full-scale cooperation. Cooperation normally takes the form of a treaty that must bind the signing parties according to the terms stated in that treaty. The formation of a treaty is often motivated by existing conflicts over use that prompts the pursuit for higher economic efficiency of water use or more equitable allocation of the shared water resources. Nevertheless, those motives are not sufficient condition for treaty formation. From the economic perspective, cooperative arrangements between countries should be both individually and collectively rational (Barrett 1999).

According to Wolf, Yoffe, and Giordano (2003) and Yoffe et al. (2004), there is a wider spectrum of conflict/cooperation as determined by a number of indicators of Basins at Risk (BAR) that link relevant biophysical, socioeconomic, and geopolitical data in a global Geographic Information System (GIS) to water specific events. The spectrum is called Water Event Intensity Scale (WEIS) and has a scale of -7 (conflict) to 7 (cooperation) . This approach found that the likelihood and intensity of dispute arises as the rate of change within a basin exceeds the institutional capacity to absorb that change. With institutional capacity as the main driver for cooperation, the relationship of riparians can take place in two forms:

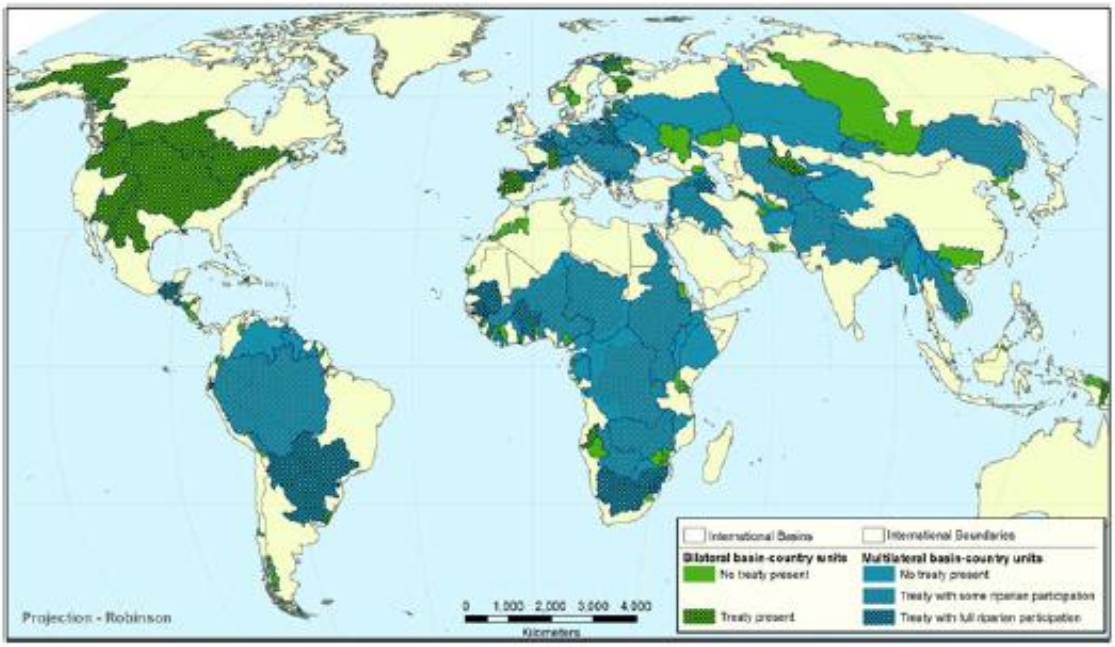
a) Internationalised basins, in which the management institution was developed under a single jurisdiction.
b) Unilateral development in the absence of a treaty or commission.

From a resource control perspective, the riparians can engage themselves in three kinds of situations: (a) shared control; (b) consolidated control; and (c) contested control (Zeitoun and Warner 2006). Zeitoun and Mirumachi (2008) argue that the term “transboundary water interaction” is a better term to reflect the relationship of riparians, rather than merely cooperation and conflict. This argument is grounded on two key perspectives: (i) both conflict and cooperation can co-exist, and more understanding can be gained through the perspective of interaction; and (ii) transboundary water interaction is a political process that is subject to the whims of power. They argue that cooperation has many faces and the existence of a treaty does not necessarily reflect the quality of cooperation. Transboundary Water Interaction Nexus (TWINS) was employed to characterise riparian

interaction, by combining the intensity of conflict and the quality of cooperation. Human Development Report 2006 (UNDP 2006) underscores the range of cooperation that stretches from coordination (such as sharing information) to collaboration (developing adaptable national development plans) to joint action (including joint ownership of infrastructure assets). This report defines transboundary water cooperation as the exchange of baskets of benefits that add to the aggregate welfare of both riparian countries.

2.3. Challenges to Cooperation

The most recent data from the Transboundary Freshwater Dispute Database (TFDD) at the Oregon State shows that there have been 688 agreements signed between 1820 and 2007, out of which 250 independent treaties have been ratified in 113 basins. These treaties nominally govern almost 70% of the world's transboundary basin area. In terms of the content, treaties have also shifted its focus from regulation and development of water resources to the management of resources and institutional setting of the management. In terms of cooperation issues, the environment has become the most important issue in the text, although hydropower, water allocation and irrigation still receive high importance. The issue coverage also becomes more comprehensive and complex, rather than merely strict allocation rules (Giordano et al. 2013).



Source: Giordano et al. (2013)

Figure 1. Treaty Coverage and Riparian Participation at the Basin-Country Level for Bilateral Basins (shades of green) and multilateral basins (shades of blue).

Despite the encouraging status of transboundary water cooperation as reflected in treaties, it does not alleviate the 'wicked' character of transboundary water management require the reconciliation of human values and difficult trade-offs (Mee and Adeel 2012). Building cooperation is mostly a challenging, dynamic, and continuous process. Cooperative management of transboundary waters or treaty formation entails various hydrophysical, environmental, economic, social and political aspects. Cooperation among riparian countries become difficult to realize when those various factors are

deeply interlinked, especially when sovereignty, territorial integrity, and security are at stake (Espey and Towfique 2004). The level of difficulty also increases with the number of countries engaged in the cooperative management.

A number of studies have assessed the factors that influence the success of treaty formation across transboundary river basins. By looking at various indicators of resource constraints, geographic configuration, politics, sociocultural, and economy, the results of some study argue that: (i) river configuration affects asymmetric distribution of power and the likelihood of bilateral treaty formation; (ii) certain similarities in sociocultural factors (such as religion or 'western civilization') significantly encourage cooperation; and (iii) economic differences also influence cooperation (Dinar 2008; Espey and Towfique 2004; Song and Whittington 2004).

UN-Water[5] also highlighted a number of issues that place more pressure on building cooperation. Equitable sharing of water resources is becoming an increasingly complex issue in recent years due to population growth, development pressures, and changing needs and values. The unequal distribution of water is heightened by political changes, resource mismanagement, and climatic anomalies. Inadequate legislative and institutional frameworks coupled with the rising financial burden of aging infrastructures add to this stress. These factors can trigger upheavals as well as demographic and developmental transformations, all of which, in turn, contribute to significant socio-economic differentiations. Growing competition between different sectors and groups has placed increasing strain on the quality and quantity of freshwater supplies. Competition for water also manifests in the demands for different uses – urban versus rural, quantity versus quality, present use versus future demand, and sanitation versus other social priorities. Competition among uses and users has increased in almost all countries, as have the links connecting them, calling for more effective negotiation and allocation mechanisms

Dinar (2004a) argue that there are several reasons that attribute to unsuccessful cooperation: (1) technical complexity of the cooperative project; (2) ill-defined rights and responsibilities of each riparian; (3) the existence of differing goals that cannot be represented by a simple balance of costs and gains to the concerned; and (4) the existence of wider considerations among the and other stakeholders. As an example, Waterbury (2002) points out a number of factors that may make cooperation more difficult in the Nile Basin: (i) high rainfall variability over time and across states in the basin; (ii) economic growth in several basin states has been low or negative; (iii) high population growth rates, and (iv) growing water-related needs in all basin states necessitate immediate action rather than long-term vision.

Self-enforceability of a treaty is a key determinant for cooperation sustainability (Barrett 1994). However, the enforceability of treaties depends on the economic and political powers of the countries involved and the unequal distribution of benefits from implementing the treaties will also affect the enforceability of those treaties. Free-rider deterrence is crucial to ensure this enforceability. Side-payments strategy, e.g. from downstream country to upstream country, can be used to address power asymmetry (Barrett 1999). Other factors that determine the sustainability of cooperative solutions are monitoring, distribution, and information (Morrow 1994). These factors also influence one another. A distributional problem relates to different preferences that countries have over the cooperative arrangement. An information problem occurs when countries are

[5] http://www.un.org/waterforlifedecade/water_cooperation_2013/water_cooperation_challenges.shtml

uncertain of the value of the different cooperative arrangements, and may benefit by sharing knowledge. Monitoring and enforcing cooperative agreement may be expensive and difficult as it requires complicated information. Thus, the distribution of relevant information among the countries is one of the key factors in the effective implementation of a cooperative agreement. On this ground, the information on the benefits of cooperation undoubtedly influences country's decision in the process of building cooperative management.

2.4. Benefit Sharing

The discussion on cooperative management of international shared water has recently shifted its focus from sharing water quantity (allocation) to "benefit sharing" (Sadoff, Whittington, and Grey 2002; Dombrowsky 2009). This concept maintains that the focus on sharing the benefits from water rather than the quantity of water will shift the zero-sum game of water sharing to a positive-sum game of benefit sharing (Biswas 1999; Sadoff and Grey 2002).

With this perspective, riparian countries should focus first on optimizing the generation of basin-wide benefits. Accordingly, the use of water provides the basis for identifying mutually beneficial cooperative action. Perceived fairness by each country in the cooperative basin management plan that maximizes overall benefits is highly essential to motivating and sustaining cooperation (UN-Water 2008).

Equitable benefit sharing implies some form of redistribution of costs and benefits from water uses across national boundaries. There is no international consensus on the criteria for equitable allocation but the general principle of "reasonable and equitable" can be referred from the 1966 Helsinki Rules on the uses of the Waters of International Rivers, the 1992 UNECE Water Convention, the 1995 SADC Shared Watercourse Systems Protocol, and the 1997 United Nations Convention on the Law of Non-navigable Uses of International Watercourses.

Klaphake (2005) in Dombrowsky (2010a) identifies two mechanisms to address unequal distribution of benefits and costs: (i) side payments, and (ii) issue linkages. The form of compensation will be highly situation specific. The hydrology of the river may limit the scope of compensation (Sadoff, Whittington, and Grey 2002). Issue linkage can be understood as side-payments in kind (Dombrowsky 2010a).

3. Existing Framework for the Identification and Quantification of Benefits

As unilateral management of international shared waters impose externalities, Coase (1960) maintains that rectifying the problem requires identification of those external impacts and a negotiation process of the parties to internalise those impacts. Valuation of those impacts is a necessary exercise for that purpose.

In the context of transboundary water cooperation, country will rationally engage in transboundary cooperation if there are benefits they can obtain from the cooperation compared to the case of no cooperation. The value of these benefits can be derived through an identification of the specific benefits of that cooperation and the economic valuation of those benefits. The valuation

methodology is rather similar although not limited to the economic valuation of environmental goods and services. In this section, some useful concepts in economic valuation will be introduced, followed by a discussion on the typology of benefits of transboundary water cooperation.

Valuation methods are not the only tools that economics offer for analysing approaches to transboundary water cooperation. Numerous optimisation models for regional planning, inter-and intra-generational allocation, and market approaches; game theory and econometrics, also provide insight on the matter (Dinar 2004a, 2004b). The quantification of cooperation benefits often use optimisation models that provide more flexibility in modelling the interactions among various components of water uses and users. Nevertheless, most of these analytical tools also require some information on the values pertaining to each option or payoff obtained by each actor. Therefore, this section focuses on the valuation of benefits.

3.1. Some Useful Concepts for the Economic Valuation of Benefits

In conducting valuation, it is important to first understand the difference between "value" and "price". Price of water as reflected in household water bills, for example, is much lower than the true value of water for household purposes. Price is merely a portion of the underlying value of water that is transpired in the market (Bateman 2009). Price should be determined from the interaction between supply and demand. Nevertheless, in the absence of property rights or in the presence of market failure, the price of water, as mostly the case, do not reflect the supply and demand. Likewise, the costs of negative externalities that arise from water use, i.e. degrading water quality and deteriorating watersheds, are not taken into account in the price of economic activities that cause those externalities.

The estimation of value is conducted against a change in the provision of the good and services under consideration, pertaining to a particular scenario or management option or action. Thus, the derived value is the value of an additional unit of provision or the marginal value. Therefore, the measurement of this marginal value entails a specification on the current baseline. The concept of marginal value can be applied both in estimating the marginal benefits of production for consumers and the marginal costs of production paid by suppliers of the goods and services of interest.

Environmental economists use the concept of Total Economic Value (TEV) to calculate the wide range of goods and services provided by environmental resources (Pearce and Turner 1990). TEV consists of the value individual derives from using the environmental resources or "use values", and the value that individuals obtain even when they are not using the resources or "non-use values".

Use values can be categorised into direct-use values, indirect-use values, and option values. Direct-use value is derived from the direct use of the environment now and in the future. Indirect-use value can be illustrated by the values that arise from ecosystem services, such as recycling of organic materials, watershed protection, and water filtering. Option values are those values that people place on environmental resources to have the option of using the goods and services in the future. Direct-use values can be non-consumptive in nature if the resources are not actually used up (consumed) in the process of experiencing it. For example, the scenic or recreational values of lakes. Non-consumptive use values are also called passive use values.

Economic valuation also has its limits (Bateman 2009). First, it is an anthropocentric concept in which the values are related to human preferences. Thus, it does not measure the intrinsic value of the resources for themselves. Second, valuation does not claim to assess the total value of certain goods and services, particularly those of non-market life-support services provided by the environment, even though it attempts to assess various values that individuals derives from enjoying a full range of goods and services. In the context of transboundary waters, these individual users might represent an individual, a group of individuals, and a country using water for a specific purpose in a specific location for a specific time (Sadoff, Whittington, and Grey 2002).

3.2. Valuation Methods

As prices do not necessarily represent the benefits accrued from water use, measuring the value of water often necessitates the use of non-market valuation techniques to derive individual's willingness to pay (WTP). Both revealed preference methods and stated preference method can be used for this purpose. The aggregation of individual WTPs allows us to construct the demand for the assessed goods and services. Young (2005) and Birol, Koundouri, and Kountouris (2010) provide good summary of various water valuation methods, their characteristics, and which TEV component that they measure.

The revealed preference methods (RPMs), or indirect valuation methods, makes use of related or surrogate markets in which the environmental good is implicitly traded in the markets. These methods are appropriate for valuing water resources that are marketed indirectly and thus only their use values can be estimated. Examples of RPMs are Hedonic Pricing Method (HPM), Travel Cost Method (TCM), and a number of cost-based methods, e.g. replacement cost method, aversive expenditure method, production function approach, net factor income, cost-of-illness method, and market prices (Birol, Koundouri, and Kountouris 2010).

The stated preference methods (SPMs), or direct valuation methods, have been developed to value directly those environmental resources that are not traded in any markets, including surrogate markets. This includes contingent valuation methods and choice experiment methods.

Figure 2 lists various economic valuation methods for each component of TEV; while Figure 3 explains the advantages and disadvantages of each valuation method.

TEV component	Economic valuation methods [a]
Direct use values	
Irrigation for agriculture	PF, NFI, RC, MP
Domestic and industrial water supply	PF, NFI, RC, MP
Energy resources (hydro-electric, fuelwood, peat)	MP
Transport and navigation	MP
Recreation/amenity	HP, TC, CVM, CEM
Wildlife harvesting	MP
Indirect use values	
Nutrient retention	RC, COI
Pollution abatement	RC, COI
Flood control and protection	RC, MP
Storm protection	RC, PF
External eco-system support	RC, PF
Micro-climatic stabilisation	PF
Reduced global warming	RC
Shoreline stabilisation	RC
Soil erosion control	PF, RC
Option values	
Potential future uses of direct and indirect uses	CVM, CEM
Future value of information of biodiversity	CVM, CEM
Non-use values	
Biodiversity	CVM, CEM
Cultural heritage	CVM, CEM
Bequest, existence and altruistic values	CVM, CEM

Source: Birol, Koundouri, and Kountouris (2010).

Acronyms refer to production function (PF), net factor income (NFI), replacement cost (RC), market prices (MP), cost-of-illness (COI), travel cost method (TCM), hedonic pricing method (HPM), contingent valuation method (CVM), and choice experiment method (CEM).

Figure 2 Appropriate Economic Valuation Methods for Each Component of TEV

Method	Advantages	Disadvantages
Hedonic pricing method (HPM)	Based on observable and readily available data from actual behaviour and choices.	Difficulty in detecting small effects of environmental quality factors on property prices. Connection between implicit prices and value measures is technically complex and sometimes empirically unobtainable. Ex post valuation. (i.e. conducted after the change in environmental quality or quantity has occurred). Does not measure non-use values.
Travel cost method (TCM)	Based on observable data from actual behaviour and choices. Relatively inexpensive.	Need for easily observable behaviour. Limited to in situ resource use situations including travel. Limited to assessment of the current situation. Possible sample selection problems. Ex post valuation. Does not measure non-use values.
Replacement cost method	Based on observable data from actual behaviour and choices. Relatively inexpensive. Provides a lower bound WTP if certain assumptions are met.	Need for easily observable behaviour on averting behaviours or expenditures. Estimates do not capture full losses from environmental degradation. Several key assumptions must be met to obtain reliable estimates. Limited to assessment of current situation. Ex post valuation. Does not measure non-use values.
Production function method	Based on observable data from firms using water as an input. Firmly grounded in microeconomic theory. Relatively inexpensive.	Understates WTP. Ex post valuation. Does not measure non-use values. Omits the disutility associated with illness.
Cost-of-illness method	Relatively inexpensive.	Understates WTP because it overlooks averting costs. Limited to assessment of the current situation. Ex post valuation.
Market prices	Based on observable data from actual choices in markets or other negotiated exchanges.	Does not provide total values (including non-use values). Limited to assessment of current situation. Potential for market distortions to bias values.
Contingent valuation method (CVM)	It can be used to measure the value of anything without need for observable behaviour (data). It can measure non-use values. Technique is not generally difficult to understand. Enables ex ante and ex post valuation.	Subject to various biases (e.g., interviewing bias, starting point bias, non-response bias, strategic bias, yea-saying bias, insensitivity to scope or embedding bias, payment vehicle bias, information bias, hypothetical bias). Expensive due to the need for thorough survey development and pre-testing. Controversial for non-use value applications.
Choice experiment method (CEM)	It can be used to measure the value of any environmental resource without need for observable behaviour (data), as well as the values of their multiple attributes. It can measure non-use values. Eliminates several biases of CVM. Enables ex ante and ex post valuation.	Technique can be difficult to understand. Expensive due to the need for thorough survey development and pre-testing. Controversial for non-use value applications.

Source: Birol, Koundouri, and Kountouris (2010).

Figure3 the advantages and disadvantages of each valuation method

3.3. Existing Analytical Framework for Identifying and Quantifying the Typology of Benefits

The development of benefit sharing concept requires further specificity, which include the identification of specific benefits pertaining to cooperative action and the quantification of those benefits in economic value as well as water quantity (Phillips et al. 2006). Developing a typology of potential benefits will be an important step of implementing the benefit sharing concept. Despite the existence of a large number of literatures discussing a wide range of benefits of cooperation in transboundary waters, very few systematically review the typology of those benefits.

Phillips et al. (2006) propose the use of Inter-SEDE model, in which international financing and three main drivers or opportunities for cooperative – security, economic development, and environment – provide the basis to assess the flows of benefits. This analytical framework employs quantitative and qualitative indices as a method for benefit quantification. Three river basins are evaluated in the study: the Jordan River, the Keera River, and the Mekong River. Nevertheless, the economic value of the benefits cannot be obtained through this framework.

Another framework for categorising cooperation benefits is recommended by Sadoff and Grey (2002). They identify four types of benefits as presented in the table below and look at how one benefit type might interact with the others. Sadoff and Grey (2005) illustrates how different types of cooperation can evolve along different type of benefit and possible modalities of benefit sharing.

Table 1. Types of Benefits on International Rivers

Benefit Type	The Challenge	The Opportunities
Type 1: increasing benefits *to the river*	Degraded water quality, watersheds, wetlands, and biodiversity	Improved water quality, river flow characteristics, soil conservation, biodiversity and overall sustainability
Type 2: increasing benefits *from the river*	Increasing demand for water, suboptimal water resources management and development	Improved water resource management for hydropower and agricultural production, flood drought management, navigation, environmental conservation, water quality and recreation
Type 3: reduced costs *because of the river*	Tense regional relations and political economy impacts	Policy shift to cooperation and development away from dispute/conflict, improved food and energy security, reduced risk of dispute/conflict and reduced military expenditure
Type 4: increasing benefits *beyond the river*	Regional fragmentation	Integration of regional infrastructure, markets and trade

Source: Sadoff and Grey (2002)

An alternative framework of categorising the benefits of transboundary cooperation is by looking at the conceptual framework for valuing water as: (i) a producers' good; and (ii) an environmental public good (Young 2005). In the first category, the benefits will be related to consumptive water use for all main sector users: agriculture, energy, industry, and households. The second category of benefits is related to both use and non-use values of water for outdoor recreation, aesthetic enjoyment, water quality improvement, disaster risk reduction, and other environmental benefits.

4. Alternative Framework for Quantifying the Benefits of Transboundary Water Cooperation

4.1. An Alternative Framework for Benefit Quantification

Departing from the existing alternative frameworks of benefit typology and the related economic valuation methods, an alternative typology of benefits, as the basis of quantifying the benefits of transboundary cooperation, is formulated as follows:

1) Type 1: the benefits from improved water availability (quantity)

   These benefits arise from how cooperation can address water scarcity issue and result in improved security for production processes in the economy by all main economic sectors, e.g. agriculture, energy, industry, and municipal (commerce and water supply and sanitation). In relation to TEV, this benefit type mostly relates to consumptive direct use values. These benefits can take the form of supply augmentation or demand management. This the benefits can broadly apply to improved water management that results in improved water availability.

   It should be underlined that water availability (quantity) in water bodies also affects water quality and thus the benefits quantification might be closely interlinked. Nevertheless, this benefit type is focused on the change in water quantity from cooperative action.

   Most of the studies that quantify the benefits of transboundary cooperation largely fall into this category as the focus of existing studies are largely on improving the efficiency and equity of water allocation. Another advantage in quantifying these benefits is the availability of market price data of various commodities or goods that relate to various water uses in this category, which allow for the use of more choices of valuation techniques and relatively lower study costs.

2) Type 2: the benefits from improved water quality

   This benefit type comprises of all use values pertaining to improved water quality, such as improved quality for outdoor recreation (e.g. swimming, boating, lake and river fishing), reduced or avoided treatment costs of water for further use (e.g. for hydropower, drinking water), avoided sedimentation costs, and avoided health risks from polluted water. Although not specifically linked to the benefits of transboundary water cooperation, Keeler et al. (2012) provides a good review on the linkage between pollutants, changes in water quality, changes in ecosystem goods and services, and finally changes in the value of those goods and services pertaining to water quality.

3) Type 3: the benefits from watershed or the quality of water ecosystem

   These benefits are similar to Type 1 benefits in Sadoff and Grey (2002) framework and related to indirect use values of water as public environmental good, option values, and non-use values. This Type 3 benefit includes improved biodiversity, improved flood control, improved storm protection, avoided or reduced costs of desertification, improved ground water recharge, and reduced costs of salinization. As an analogy, the valuation of environmental services from wetland ecosystem provides an illustration of these benefits (Brouwer et al. 2003; Brander, Florax, and Vermaat 2006; Acharya 2000).

4) Type 4: the benefits from improved regional security and integration

   This benefit type is similar to Type 3 and Type 4 of Sadoff and Grey (2002) and it is associated with secondary benefits, which arise as the repercussions of the primary benefits (Type 1 to Type 3) . In essence, these secondary benefits relate to how avoided or reduced costs of conflicts might have its multiplier effects on improved trade relations and regional integration. In extreme cases, these secondary benefits can include avoided costs of human migration due to conflicts over resource scarcity. This is also the type of benefits that is seriously lacking in terms of valuation study.

4.2. Examples of Studies on Benefits Quantification

This section provides a brief illustration on examples of studies that quantify the benefits of improved management of transboundary water. It is important to note that there exist a large number of studies that quantify various components of benefits arising from improved management of a river basin. Nevertheless, the quantification of these benefits in the context of transboundary water is less common, and it is even harder to find studies that specifically quantify the benefits of transboundary cooperation. Some studies are conducted within the context of transboundary water but to the perspective of a single country.

Some models have a holistic or integrated nature that allows them to quantify more than one type of benefits in one model. This approach is also preferred because it allows direct modelling of inter-linkages among various users, uses and values in a transboundary system. Many optimization models possess this holistic approach, such as hydroeconomic modeling, integrated assessment models, and regional planning models. For example, in deriving more efficient and equitable water allocation, a model can take into account the benefit of improved watershed quality by imposing a water quota for environmental flow, rather than directly valuing the economic value of the benefits of higher environmental flow.

Table 2 lists a number of examples of existing studies that directly or indirectly quantify the benefits of transboundary cooperation. Even though the list is far from complete, it shows that existing studies have assessed all different types of benefits and nearly all quantify the benefits of improved water availability. The studies are also conducted in only a small number of transboundary water, while the rest of the transboundary systems remain largely unexplored.

Table 2. Examples of Studies on Quantifying the Benefits of Transboundary Water Cooperation

Study	Transboundary Water	Study focus	Benefit Type	Model and methods
McKinney et al. (1999), Cai, McKinney, and Lasdon (2002)	Syr Darya Basin	A long-term, stable, and flexible water supply to meet agriculture, municipal and industrial water demands	Type 1, Type 2, Type 3	Long term hydroeconomic modeling with quantified sustainability criteria
Ringler and Ximing (2006)	Mekong River Basin	Trade-offs between in-stream and off-stream water uses; hydropower, irrigation trade, fisheries, wetland water values	Type 1, Type 2, Type 3	Hydroeconomic model, fish production function, wetland valuation
Ward and Booker (2003)	Upper Rio Grande Basin	The benefits of in stream flow protection for endangered species	Type 1, Type 3	Hydroeconomic model, contingent valuation methods
Ward and Pulido-Velázquez (2008)	Rio Grande Basin	Identify hydrologic and economic impacts of alternative water pricing programs that comply with environmental regulations for protecting water quality	Type 1, Type 2	Hydroeconomic model for Water pricing policy design, implementation, and evaluation
Jeuland (2010)	Blue Nile Basin	Hydropower development in Ethiopia Blue Nile	Type 1	Integrated water resources planning with Monte Carlo simulation
Nigatu and Dinar (2011)	Nile River Basin	Improved social welfare from agriculture and hydropower use and reduced resource degradation	Type 1, Type 3	Hydroeconomic model, with and without trade scenarios, evaluation of GCM
Kucukmehmetoglu and Guldmann (2010)	Euphrates-Tigris River Basin	Water allocation across countries for agriculture, municipal, hydropower and conveyance loss	Type 1	Linear programming
Tilmant, Lettany, and Kelman (2007)	Euphrates-Tigris River Basin	Trade-off between agriculture and hydropower use	Type 1	Comparing static to dynamic allocation
Fisher et al. (2005)	Israel, Jordan, Palestine	Cooperation among parties	Type 1, Type 4	Gains from water trade, shadow pricing
Dombrowsky et al. (2010)	Kidron/Wadi Nar	Wastewater management in arid transboundary case	Type 2, Type 3	Contingent valuation method, replacement costs,multicriteria decision analysis
Cai, Ringler, and You (2008)	Maipo River Basin	Water conservation through substitution between water and other agricultural inputs	Type 1	Hydroeconomic model, crop production function
Tilmant and Kinzelbach (2011)	Zambezi River Basin	Calculate the cost of non-cooperation in the case of water scarcity for hydropower and agriculture use	Type 1	Hydroeconomic modeling

5. From Benefit Quantification to Cooperative Actions

The quantitative extent and the value of benefits will reveal the gains of cooperation or the costs of non-cooperation in transboundary water management to each country. This information will be the basis for implementing benefit sharing. As country understands the positive value of cooperation, this value will stimulate further water cooperation. With this information, negotiation on compensation for more equal redistribution of benefits and costs can be started. Payments for benefits can be made implicitly through purchase agreements, as flexible tools for benefits sharing (Sadoff, Whittington, and Grey 2002).

Measures to quantify benefits of cooperation themselves can also encourage collaborative actions in terms of information sharing since quantitative information required to estimate the value of cooperation benefits. If there are parties who are advantaged by the lack of perfect information, there should be incentives design to encourage the sharing of information.

The quantification of benefits also requires further thought on the direction of externalities. Dombrowsky (2010b) identifies four typologies of unidirectional externality in transboundary water management. The direction and magnitude of externalities indicate to what extent disputed property rights might be a problem and what kind of incentive mechanism is needed to correct the problem.

It should be noted, however, that the benefits and costs of cooperation are not the only factors that affect country's decision to engage in process toward cooperative management of the shared water resources. The perceived political risk or opportunities also influence a country to enter the process of cooperation. The World Bank has produced a study that looks at this political dimension of cooperation (Subramanian, Brown, and Wolf 2012). These risks are related to: (i) capacity and knowledge; (ii) accountability and voice; (iii) sovereignty and autonomy; (iv) equity and access; and last (v) stability and support. Although these risks are less studied, its influence in decision making also requires the consideration of these factors. To the extent possible, these risks need also to be quantified or incorporated in the decision support model that reflects how a country decide to enter cooperation process.

The institutional design of transboundary water governance will shed light on how different institutional arrangement might affect payoff structure and the choice of cooperative or non-cooperative strategy by each country involved (Wu and Whittington 2006).

Cooperation can also be initiated partially and gradually enhanced over time (Gilman, Pochat, and Dinar 2008). Some studies calculate the benefits of such institutional setting such as (Fernandez 2002). Information exchange for instance, has shown to be particularly beneficial to environmental interests (Giuliani and Castelletti 2013).

Various issues above look at the conditions under which country will cooperate and the required incentive mechanism to encourage cooperation. Together with the information on quantitative benefits of transboundary cooperation, all these are necessary analytical tools that will facilitate countries to move from conflict to cooperation.

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