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Water and Benefit Sharing in International River Basins

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Diane Arjoon, Dr. Amaury Tilmant, Dr. Markus Herrmann

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1 Introduction

Natural resources are economically, socially and environmentally important in ensuring healthy living conditions and ecosystems. Our dependance on water to meet our basic needs and to support an ever increasing standard of living, along with the necessity of water to sustain our planet's fragile ecosystems, makes it unique among natural resources. Despite its importance, one third of the world is facing water shortages. It is a general belief that the current and predicted water crisis is due to soaring water demands and a decrease in supply. It is becoming evident, however, that generally poor management of the available resource is the actual problem. It can be argued that, rather than being in the midst of a water availability crisis, we have a water management crisis, and that creative policy reforms will allow us to obtain much more from our current resources (*Zilberman et al.*, 1993). Until recently, the focus in water resource management has been on the allocation of the physical resource itself to competing uses. Increasing pressures such as population and economic growth, increased demand for food and energy, and increased climate variability are leading to a perceived shortage of water to satisfy all uses. Within the boundaries of a nation, the problems of responding to these pressures are large, however, in the case of water resources that are shared between countries (transboundary or international water resources) the problem is enhanced and the solution becomes more complicated due to the added necessity of cooperation between those countries.

There are more than 250 rivers around the world that cross the boundaries of two or more countries. Statistics taken from *Wolf* (2009) show that the basins of these rivers makes up approximately 47% of the earth's land surface, includes 40% of the world's population and contributes almost 60% of freshwater flow. Of the countries involved, 21% of these lie entirely within an international basin and, including these 21%, 33 countries have over 95% of their territories within these basins. Nineteen international river basins are shared by five or more riparian countries (Fig. 1).

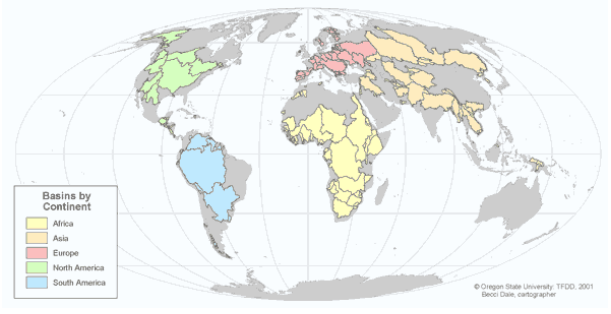

Fig. 1. International river basins

Benefit sharing has recently been suggested and studied as an effective strategy to promote cooperation in the case of transboundary rivers. This strategy requires that the entire river be managed as a unit, regardless of the number of countries that it flows through, and that efficient policy frameworks be developed and accepted by all nations involved.

In the absence of binding mechanisms, the harmonious management and development of international river basins is left to the goodwill of riparian countries. However, in a context of resource scarcity, this goodwill may be buffeted by the fear of entering a zero sum game. To circumvent the problems inherent in this perception, some authors have suggested that the problem of water sharing in international basins be considered in terms of the benefits related to water use, rather than on the allocation of water itself (*Biswas*, 1999; *Sadoff and Grey*, 2002). The idea is to transform a zero-sum game into a positive sum game through the equitable sharing of benefits based on mutual agreements. It is by

developing water resources at the basin scale that synergies can be identified, that negative impacts can be mitigated, and that profits can be maximized. However, at this stage, benefit sharing remains a concept that must be further analyzed, and the conditions and principles of implementation must be determined.

The current report will present a literature review on benefit sharing in transboundary natural resources, with an emphasis on water resources and transboundary rivers. After an overview of the problem, a general discussion on water allocation will be presented, followed by a review of water allocation in transboundary river basins.

2 Overview of the Problem

Water scarcity, in it's simplest form, involves an imbalance between water demand and supply. The use of water has grown at more than twice the rate of the global population over the last century (*FAO*, 2012) and recent issues such as ecosystem degradation are forcing a reevaluation of the way this resource is used. On the supply side, pollution and climate change are two main concerns. The perception that water is becoming scarce as a result of these trends has led many to conclude that a water scarcity crisis is inevitable. "Yet, the more predictable challenges (or potential crisis) can be largely avoided by adjusting the way in which water is managed and governed" (*Moriarty et al.*, 2004). In this section, the main water demand and supply drivers are briefly reviewed, followed by a discussion on water scarcity.

2.1 Water Demand

According to the United Nations, the world population will level off at 9.2 billion people in 2050, with most of this growth being absorbed by less developed regions (*United Nations Department of Economic and Social Affairs*, 2006). This population increase, along with the current trend of increased living standards in developed and developing nations, has resulted in an increase in demand for water in the agricultural, energy, domestic and industrial sectors.

Over the same period, food demand is predicted to increase by 70% (*Bruinsma*, 2009). Current estimates indicate that 80% of the additional food supplies required to feed this future world population will depend on the availability of a reliable water supply for irrigation (*Biswas*, 2007). In the energy sector there is an expected 160% increase in demand over the next three decades (*Steer*, 2010). This, along with increased investment in clean energy, will make hydropower and biofuels increasingly important uses of water. In fact, the increased demand for hydropower and biofuels is already being felt, with Asian developing countries doubling their total hydropower generating capacity between 1990 and 2000 (*Biswas*, 2007) and the United States increasing the production of fuel ethanol from 195 million to 10.75 billion gallons over the last 30 years (*Renewable Fuels Association*, 2010).

A relatively new demand-side driver is the need to maintain the environment that supports human needs by ensuring the benefits of a healthy ecosystem. These benefits, such as nutrient recycling, climate regulation, flood and drought regulation, tourism and recreation, groundwater recharge, water purification and preservation of diversity, are commonly referred to as "ecosystem services". Studies on the value of allocating water to ecosystem services have increased (*Costanza et al.*, 2008; *Worldwatch Institute*, 2007; *World Water Assessment Programme*, 2012) and ecosystem services are estimated to be worth trillions of dollars on an annual basis (*Postel and Carpenter*, 1997).

2.2 Water Supply

As the world demand for freshwater resources continues to grow, the supply of usable water is being affected mainly by climate change and an increase in contamination. Climate change, however, is the only supply-side driver that ultimately determines how much water will actually be available (*World Water Assessment Programme*, 2009).

Managing water is about managing its naturally occurring variability. Climate change threatens to make this variability greater by shifting and intensifying the extremes and by altering the timing, magnitude and duration of precipitation events leading to changes in precipitation patterns, which may result in some regions receiving too little rain and others receiving too much, and making precipitation less dependable and more erratic. The Stockholm Environment Institute estimates that, based on only moderate climate change, the proportion of the world's population living in countries of significant water stress will increase from approximately 34 percent (in 1995) to 63 percent by 2050 (*Simms et al.*, 2004). In Africa's large catchment basins of Niger, Lake Chad and Senegal, the total available water has already decreased by 40-60 percent, and desertification has been aggravated by lower than average annual rainfall, runoff and soil moisture, especially in Northern, Southern and Western Africa (*United Nations*, 1992).

Water contamination affects the proportion of water that is usable. Polluted water that cannot be used for drinking, bathing, industry or agriculture may effectively reduce the amount of water available for use in a given area (*UNEP*, 2010). For example, a 2008 report on the Yellow River argued that severe pollution caused by factory discharges and sewage from fast-expanding cities has made one-third of the river unusable even for agricultural or industrial use (*Branigan*, 2008).

2.3 Water Scarcity

The United Nations defines water scarcity as the point at which the aggregate impact of all users impinges on the sup-

ply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be fully satisfied (*United Nations*, 2007).

Measuring Water Scarcity

The best known and most used indicator of national water scarcity is per capita renewable water, in which various threshold values are used to distinguish between different levels of water stress (*Falkenmark*, 1989). According to this indicator (known as the Falkenmark Indicator), an area experiences water stress when annual water supplies drop below 1700 m^3 per person, water scarcity when annual supplies drop below 1000 m^3 per person and absolute scarcity below 500 m^3.

Using the Falkenmark indicator, there are currently around 700 million people in 43 countries suffering from water scarcity, with sub-saharan Africa having the largest number of water stressed countries of any region. By 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be living under water stress conditions. With the existing climate change scenario, almost half of the world's population will be living in areas of high water stress by 2030, including between 75 million and 250 million people in Africa. Additionally, water scarcity in some arid and semi-arid places will displace between 24 and 700 million people (*United Nations*, 2005). Fig. 2 shows the state of global water scarcity in 2000 and in 2050.

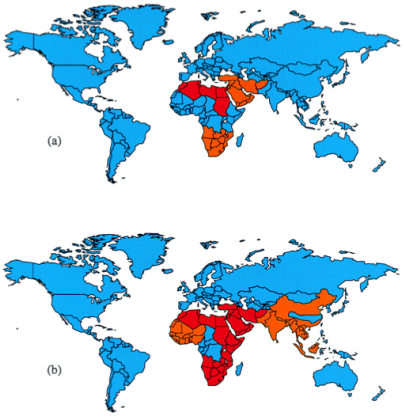

Fig. 2. Global water scarcity (a) now and (b) in 2050. Regions are coded according to their per capita annual renewable freshwater resource. Red-less than 1000 m^3 per person per year, orange-between 1000 and 2000 m^3per person per year and blue-greater than 2000 m^3 per person per year: data from *Fischer and Heilig* (1997), figure from *Wallace* (2000)

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While the Falkenmark indicator measures the physical scarcity of water, water scarcity can also be defined on an economic basis (Fig. 3). Economic water scarcity can occur in regions that have adequate water reserves, but where poor governance and infrastructure prevent it from being fully usable or where inefficient use and mismanagement of water resources leads to waste and contamination. Economic water scarcity can be alleviated through better governance and infrastructure investment, but physical water scarcity is projected to grow steadily as a result of the combined impacts of climate change and population growth.

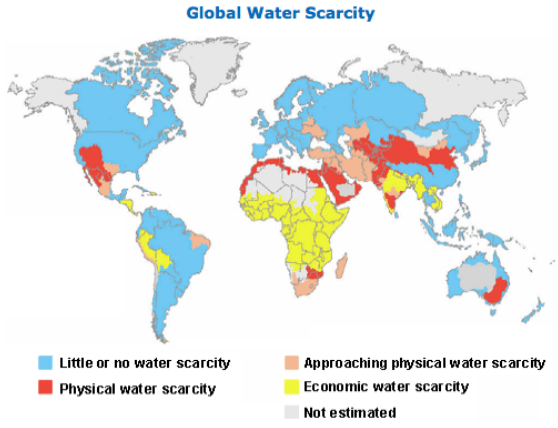

Fig. 3. Global economic and physical water scarcity (source *International Water Management Institute* (2006)).

Causes of Water Scarcity

While it is generally accepted that water scarcity is a result of increased demand and decreased supply, there has been an increased belief that water scarcity has little to do with water availability.

The *United Nations Development Programme* (2006) has written that "the scarcity at the heart of the global water crisis is rooted in power, poverty and inequality, not in physical availability". It goes on to state that "There is more than enough water in the world for domestic purposes, for agriculture and for industry. The problem is that some people, notably the poor, are systematically excluded from access by their poverty, by their limited legal rights or by public policies that limit access to the infrastructures that provide water for life and for livelihoods. In short, scarcity is manufactured through political processes and institutions that disadvantage the poor. When it comes to clean water, the pattern in many countries is that the poor get less, pay more and bear the brunt of the human development costs associated with scarcity."

There is also growing consensus that the water crisis problem is one of poor management. *Cosgrove and Rijsberman* (2000) state that "There is a water crisis today. But the crisis in not about having too little water to satisfy our needs. It is a crisis of managing water so badly that billions of people - and the environment - suffer badly." Natural water scarcity, due to climate and hydrological processes, is aggravated by poor water management which leads to inadequate water al-

location in space and time (*Pereira et al.*, 2009). Water management processes such as uncontrolled demand, inequity in water allocation, inappropriate irrigation practices, land misuse, poor infrastructure and poor management institutions all influence water scarcity. The need for effective water management is essential. *Qaddumi* (2008) insists that the manner in which the challenge of managing water is confronted "will determine future patterns of development, macroeconomic growth potentials, and the extent of poverty burdens."

3 Water Allocation

Water allocation is the central concept in the management of scarce water resources. "A useful working definition would be that water allocation is the combination of actions which enable water users and water uses to take or to receive water for beneficial purposes according to a recognized system of rights and priorities" (*UNESCAP*, 2000). The overall objective of water allocation is to maximize the economic, social and environmental benefits of water to society (*Wang et al.*, 2003). In this section, the benefits of water and their corresponding principles of efficiency, equity and sustainability will be described, followed by a discussion of current water allocation mechanisms.

3.1 Principles of Water Allocation

Efficiency - Water as an Economic Good

The concept of water as an economic good is a view of water allocation from an economic perspective with the outcome being to maximize the economic benefits of water to society. This is a notion that is widely accepted by water resource managers.

According to *Browning and Zupan* (2006), the allocation of an input is economically efficient if it is Pareto optimal. A precondition to the attainment of economic water allocation efficiency is the equimarginal principle (*Juana*, 2008) which states that the marginal benefits of water should be the same for all users or sectors (*Agudelo*, 2001). In this context, economically efficient water allocation results when the benefits from using one additional cubic unit of water in one sector (or for one user) is the same as for all sectors (or users). Once this is achieved, any redistribution of water can make no sector better-off without making another worse-off. The implication of this principle is that "resources should be allocated in such a way that all the users and consumers derive equal value in using additional units of the resource" (*Juana*, 2008). If this were not the case, society would benefit by allocating more water to the sector in which the benefits, or returns, are the highest (*Dinar et al.*, 1997).

A second definition, that is much more widely used in practice, is the Hicks-Kaldor definition of efficiency (*Howe et al.*, 1986). In the Pareto optimality definition nobody is allowed to be made worse off. In the Hicks-Kaldor definition, some may be made worse off, initially, as long as the returns for those who gain outweigh the losses of those who lose (*Schilizzi and Black*, 2007). This definition allows for benefit transfers to be made in such a way that nobody will end up worse off while those who gain will still gain something. This less strict definition of efficiency is usually applied in the practice of policy making.

Equity - Water as a Social Good

Water as a social good deals with the basic human need for this resource. Until recently, the right to water was not explicitly defined as a basic human right. In 2010, the United Nations General Assembly included the right to water and sanitation as a basic human right (*United Nations*, 2010) and access to safe drinking water and basic sanitation was defined as one of the Millennium Goals in 2000. These basic rights cannot be achieved unless access to water of a supporting quantity and quality is secured.

Equity is the principle underlying the social benefit of water. Equity relates to the fairness of water allocation "across different economically diverse groups in the population of a country or water management area" (*Juana*, 2008). Equitable water management, then, requires that all users have equal access to sufficient, affordable and safe water to meet basic needs or to the benefits generated from the use of the resource (*Department of Water Affairs and Forestry*, 1998). In other words, water allocation should be concerned not only with deriving the maximum benefits from the use of the resource, but also with how the process of allocation improves the standard of living of the most vulnerable in the population. In many cases, equity in the access to water is not compatible with the objective of economic efficiency. Meeting social objectives of water allocation may require that governments provide subsidies or free service or differential price structures based on income.

Sustainability - Water as an Environmental Good

The environmental benefits of water include provisioning services (food, fresh water, fuel), regulating services (flood attenuation and disease control), cultural services (spiritual and religious, recreation) and supporting services (soil formation, nutrient cycling) (*Ranganathan et al.*, 2008).

The sustainable use of water resources is becoming an increasingly important aspect in the allocation of water from the perspective of society (*Koundouri*, 2005). Intergenerational equity and the critical nature of ecological services provided by water resources are just two rationales for considering sustainability. Additionally, the in situ value and public good nature of water resources should enter into water allocation decisions and, even though the benefits from the environment cannot always easily be assessed in monetary terms, they should be evaluated in the decision making processes.

3.2 Mechanisms of Water Allocation

Different forms of water allocation schemes exist that attempt to combine the efficient and equitable sharing of water. Many, however, were developed prior to the recognition of the value of environmental flows, therefore, few, if any, schemes exist with explicit requirements to consider sustainability in allocation decisions.

Dinar et al. (1997) discuss four major water allocation mechanisms: marginal cost pricing, public allocation, water markets and user-based allocation mechanisms.

Marginal Cost Pricing

Marginal cost pricing (MCP) is an allocation strategy that equates the marginal value of water to the unit cost of water allocation by targeting a price for water which is equal to the marginal cost of supplying the last unit of that water. This is considered an economically efficient, or socially optimal, allocation by maximizing the total value of production across all affected sectors of the economy (*Dinar et al.*, 1997).

One advantage of MCP is that it is theoretically efficient. "Not only are the marginal costs and benefits equal, but also, at the efficient price, the difference between the total value of water supplied and the total cost is at a maximum (*Dinar et al.*, 1997). As well, MCP avoids the tendency to under-price water, which avoids the overuse of water in times of scarcity because prices would rise to reflect the relative scarcity of the resource.

One of the principle limitations of MCP is the difficulty in defining the marginal cost itself (*Saunders et al.*, 1977), due to difficulties in collecting sufficient information to correctly estimate and, subsequently, monitor benefits and costs. MCP also tends to neglect equity issues. During periods of resource scarcity, lower income groups may be negatively affected if prices increase sufficiently. Practically, MCP is difficult to implement, requiring volumetric monitoring which is costly and difficult of administer. Additionally, the concepts underlying MCP are often poorly understood by policymakers and administrators (*United Nations*, 1980). Finally, the information requirements for an efficient system of administered prices are demanding and much of this information would necessarily be gathered by trial-and-error experimentation (*Phelps and Graubard*, 1978). As a result of numerous disadvantages and difficulties in implementing MCP, few good examples of its application exist.

Public Water Allocation

A public or administrative water allocation strategy is used when the state determines the quantity of water to be reserved for environmental sustainability and other priority uses, while it allocates or distributes the balance of the water among different sectors of the economy, often through water permits that define water use rights (*Wang*, 2005) or through administered water pricing schemes (*Haddad*, 1997). The allocation rules of this mechanism may be based on historical facts (such as prior rights), on equitable shares in available water volumes (such as regulated riparian rights), on individual requirements, or even on political pressure. Three main points support the argument for administrative intervention in the allocation of water resources: it is difficult to treat water in the same way as most market goods, water is widely perceived as a public good, and large-scale water development is too expensive for the private sector (*Dinar et al.*, 1997).

Administrative water allocation often leads to inefficient water use and a failure to create incentives for water conservation and improved use efficiency (*Meinzen-Dick and Mendoza*, 1996). Little flexibility in responding to changes in water demand is also evident (*Dinar et al.*, 1997).

Public water allocation is widely practiced, usually consisting of various pricing schemes, such as flat or fixed rates, that are simple to manage and easy for users to understand.

Water Markets

A market-based allocation of water is referred to as an "exchange of water-use rights" (*Dinar et al.*, 1997). In a pure market-based allocation the demand for, and the supply of, water resources dictates the quantities to be traded as well as the unit price of water in the market and water is reallocated from low to high marginal value uses, making this an efficient allocation mechanism (*Juana*, 2008). Government intervention is sometimes necessary in order to create the necessary conditions for markets to operate. This intervention includes defining the original allocation of water rights, creating the institutional and legal framework for trade, and investing in basic necessary infrastructure to allow water transfers (*Holden and Thobani*, 1995).

Water markets provide several benefits for sellers, buyers and the environment. The seller has the opportunity (under certain conditions) to improve profitability. The buyer benefits from the increasing water availability encouraged by the market. The environment may benefit in two ways in the case of water trade between the agriculture and urban sectors: the water market induces a shift towards improved water management and efficiency in agriculture, which reduces irrigation water related pollution and farmers may afford to internalize externality costs or even pay higher pollution related social costs (*Dinar et al.*, 1997).

There are several unique challenges in the design of a well-functioning water market. These include: measuring water, defining water rights when flows are variable, enforcing withdrawal rules, investing in conveyance systems, sale of water-for-cash by poor farmers, externality and third party effects, and environmental degradation (*Dinar et al.*, 1997). As well, it can be argued that water is public property and markets cannot work for raw water (*Wang*, 2005). In addition, a purely market-based allocation mechanism often prices out of the market the critical and most vulnerable populations who depend on water for basic survival strategies and livelihoods (*Juana*, 2008).

Water markets, although a relatively new concept in some countries, exist in some form in Australia (*Pigram et al.*, 1992), Spain (*Reidinger*, 1994), California (*Howe and Goodman*, 1995), Chile (*Hearne and Easter*, 1995), and India (*Saleth*, 1996). *Dellapenna* (2000) maintains that water markets are rare in reality and there are no true free markets.

User-Based Allocation

User-based water allocation occurs through the collective management of water sources, supplying water for either collective or individual use (*Turner et al.*, 2004). This allocation mechanism is employed in community wells, farmer-managed irrigation systems, and systems managed by water and sanitation associations (*Tang*, 1992; *Pitana*, 1993; *Ostrom et al.*, 1994). Established rights to water use is a requirement for successful allocation. An appropriate institutional framework that has the capacity and strength to determine and regulate use is also necessary (*Turner et al.*, 2004). Many factors affect the viability of organizations for water management but *Coward* (1986) argues that property rights are a critical factor. *Meinzen-Dick and Mendoza* (1996) point out that user groups cannot make decisions regarding water if they have no rights over that water.

Dinar et al. (1997) points to the potential flexibility to adapt water delivery patterns to meet local needs as a major advantage of user-based water allocation. This is due to the fact that those directly involved in the use of the water have more information on local conditions and they do not have to rely on rigid formulations to determine allocation. User organizations are also able to take into account domestic needs such as watering animals and washing clothes, along with agricultural needs. This may result in improvements in output per unit of water, or in equity, or both (*Dinar et al.*, 1997). Additional advantages include administrative feasibility, sustainability and political acceptability.

In order for user-based allocation rules to operate, a very transparent institutional structure, which may not always be available, is required (*Dinar et al.*, 1997). Local user-based institutions may be limited in their effectiveness because all sectors of water use are not represented (for example industrial demand). Therefore, coordination between the various use sectors are required and this could work through federations of user groups.

Examples of user-based allocations can be found in *Coward* (1980) and *Tang* (1992).

4 Transboundary Water Allocation

As indicated in the previous section, allocating water is not a straightforward process. Sharing water in an international context is even more complicated. Whenever a river crosses national boundaries, its use by one country has an effect on other countries sharing the same basin. This fact has lead to lively debates on conflict and cooperation on international rivers with some predicting rising water conflicts and potential wars (*Starr*, 1991; *Gleick*, 1993; *Lowi*, 1993; *Homer-Dixon*, 1994; *Klare*, 2001) while others suggest that water may serve as a catalyst for cooperation (*Wolf*, 1998; *Wolfe and Brooks*, 2003; *Turton*, 2000).

Recent literature has shown that cooperation is more likely to occur than conflict (*Iyob*, 2010; *Wolf*, 2007; *Zeitoun and Mirumachi*, 2008), and most agree that cooperation must happen in order to ensure the equitable sharing of basin waters.

The international community has developed general rules and guidelines with respect to water management in international river basins, however, shared water resources remain without a universal treaty to regulate its use and protection. Specific treaties to delineate water allocation between nations do exist. *Wolf* (1999) has compiled an extensive list of these treaties.

In this section, international water law with respect to water allocation in transboundary situations is highlighted. This is followed by a brief discussion of the need for cooperation in international river basins.

4.1 Principles of International Water Law

Varying theories and principles have emerged in an attempt to define and delineate the rights of riparian states with respect to the use of shared water. These principles are: the Harmon Doctrine (absolute territorial sovereignty), absolute territorial integrity, limited territorial sovereignty/integrity and the community of co-riparian states in the waters of an international river.

Absolute territorial sovereignty

The Harmon Doctrine, or the principle of absolute territorial sovereignty is expressed as "a state is free to dispose, within its territory, of the waters of an international river in any manner it deems fit, without concern for the harm or adverse impact that such use may cause to other riparian states" (*Salman and Salman*, 2007). In other words, this doctrine asserts the rights of upstream nations to use and pollute rivers with no regard for the effect of their actions on downstream nations. For obvious reasons, Harmon's opinion was criticized and discredited.

Absolute territorial integrity

The doctrine of absolute territorial integrity establishes the right of a riparian state to demand the continuation of the natural flow in an international river into its territory from upper riparian(s) and imposes a duty on that state not to restrict the natural flow of water to other lower riparians. This principle limits the use of water by an upstream state to a minimal amount. This is the exact opposite of the principle of absolute territorial sovereignty and is intended to favour downstream riparians. Like the Harmon Doctrine, this principle has been

criticized and is not recognized as part of contemporary international water law.

Limited territorial sovereignty/integrity

The principle of limited territorial sovereignty or limited territorial integrity accepts the principle of riparian rights - that every nation bordering a watercourse has a right to use the water flowing in its territory - but establishes a corresponding duty to ensure that this use does not harm the territory or interests of other riparian nations. This doctrine restricts both of the previous principles and asserts the equality of all riparians in the use of the waters of the international river.

Community of co-riparian states in the waters of an international river

This principle states that "the entire river basin is an economic unit, and the rights over the waters of the entire river are vested in the collective body of the riparian states, or divided among them either by agreement or on the basis of proportionality" (*Salman and Salman*, 2007). This is an extension of the principle of limited territorial sovereignty/integrity, but goes beyond by vesting the rights over the river in a collective body.

This principle did not gain wide acceptance because riparian states believe that it forces them to reach an agreement. This is an ideal principle that "overlooks sovereignty and nationalism, and the competing demands of the different riparians" (*Salman and Salman*, 2007).

The theory of limited territorial sovereignty/integrity is the prevailing theory that has formed the basis of international water rights and obligations (*McCaffrey*, 2001). Working out the details, however, has proven to be a complex and challenging task.

4.2 International Water Law

Codification of the principles of international water law can be credited to the Institute of International Law (IIL), the International Law Association (ILA) and the International Law Commission (ILC).

IIL and ILA

The IIL and the ILA are two scholarly non-governmental organizations that have made major contributions to the law of international watercourses through the adoption of a number of resolutions and rules. It should be noted that these resolutions and rules do not have any formal standing and, as thus, are not legally binding. Table 1 shows an overview of the work of the IIL and the ILA.

It is evident from that the resolutions of the IIL emphasize the obligation not to cause significant harm to other riparian states, while the ILA resolutions are centred around the principle of reasonable and equitable utilization of the shared watercourses.

The UN Convention on Non-navigational Use of International Watercourses

In 1970, the United Nations General Assembly, working with the ILC, passed a resolution to study international watercourses, in an attempt to reconcile conflicting principles and theories regarding the sharing of these waters. In 1997, the UN Convention on the Non-Navigational Uses of International Watercourses was adopted. This Convention emphasizes cooperation and aims to establish the two main principles of the equitable and reasonable utilization of international water and the obligation not to cause significant harm. The Convention, however, does not define one principle as overriding the other, which leaves them open to interpretation. Currently, the Convention has yet to be ratified (with only 16 of the 35 countries having signed) and the "different understandings of the riparian states of the manner in which the Convention has dealt with the issue of the relationship between equitable and reasonable utilization and the obligation not to cause significant harm is no doubt a major reason for this situation" (*Salman and Salman*, 2007). The concepts and principles of international water law remain unsettled (*Caflisch*, 1998), ambiguous (*Wolf*, 1999) and prone to subjective interpretation (*van der Zaag et al.*, 2002), offering little guidance to the problem of allocation of shared water resources (*Gleick*, 1998) resulting in a major global challenge.

4.3 The Need for Cooperation in International River Basins

Attempts to apply international water laws to ensure the efficient allocation of water in transboundary river basins has resulted in a large number of international river agreements. Many of these, however, have been bilateral in structure, even in those basins that include more than 2 riparian countries. For example, the Nile Water Agreement was negotiated only between Egypt and Sudan although there are eleven riparian countries on the Nile. A 1951 agreement on the Mekong River excluded Burma and China and a 1991 agreement on the the management of the Ganges River included India and Nepal, but excluded Bangladesh.

At the core of managing international rivers is the fact that water flows (*Alam et al.*, 2009) and that this water is incorrectly treated as a stock rather than a flow (*Qaddumi*, 2008). The basis of cooperation is the recognition that interdependencies, created by the transient nature of water, exist.

From an economic perspective, transboundary water problems can be thought of as unidirectional externality problems since transboundary river basins, by their very nature, create negative externalities due to the fact that the boundaries of the institutions that have the power to govern the use of water do not coincide with the boundaries of the river basins

Table 1. Overview of international water laws by the IIL and ILA

Organization	Regulation	Year	Comments
IIL	Madrid Declaration	1911	Established absolute prohibition against activities that may result in injury to other riparians. Stood in sharp contrast to the Harmon Doctrine.
	Salzburg Resolution	1961	Emphasized the obligation of the states to not cause harm to other states. Subjected the right of that state to use the waters of the shared river to the right of use by other states. Relaxed the absolute prohibition of the Madrid Declaration.
		1979/1997	Prohibit any acts that may cause pollution to watercourses, or adversely harm other riparians.
ILA	Dubrovnik Statement	1956	Confirmed the sovereign control each state has over the international river within its own boundaries, but required that state to exercise such control with due consideration of its effects on other riparian states.
	New York Resolution	1958	Stated that each co-riparian state is entitled to a reasonable and equitable share in the beneficial uses of the waters of the drainage basin.
	Tokyo Meeting	1964	Focus on principle of equitable utilization of shared waters.
	Helsinki Meeting	1966	Established the principle of equitable utilization of shared waters as the guiding rule for the work of the ILA in the field of international rivers.

themselves (*Howe*, 2003). An externality arises when the production or consumption activities of one riparian have direct effects on the production or consumption of another riparian and implies a Pareto inefficient allocation of the resource (*Dombrowsky*, 2008). The "pervasive unidirectional feature of water use means that resolution of basin conflicts through mutual control of external effects that work reciprocally is generally ruled out" (*Rogers*, 2011). Aside from the water allocation problems that arise from sharing a common resource, there are other problems such as water quality degradation in downstream riparians as an effect of upstream use. Even when the negative effects are due to natural occurrences, they may be mistaken by downstream countries as man-made externalities and lead to further mistrust and tensions among riparians in the basin (*Rogers*, 2011).

The challenge in a transboundary setting is how to internalize the external effects. According to the Coase theorem (*Coase*, 1960), the internalization of external effects and the realization of gains from cooperation are possible through voluntary bilateral negotiations based on side payments if property rights are well defined and transaction costs (including information, bargaining, monitoring and enforcement costs) are negligible (*Dombrowsky*, 2008).

The Coase theorem implies that cooperation is conceivable, in principle, in the case of unidirectional externalities. However, the conditions under which this can happen, according to Coase, do not apply in the context of an international shared resource. First, there exists no external authority to define property rights, to solve problems of information and other transaction costs and to enforce international agreements. As well, the Coase theorem "implies that the institutional prerequisites for cooperation in the management of international waters are already demanding in bilateral negotiations" (*Dombrowsky*, 2008). This leads to the consideration that cooperation is even more complicated and difficult to achieve in the case of multiparty negotiations, as is the case in many transboundary river basins.

The use of benefit sharing has been suggested as a method of fostering cooperation in transboundary waters, in particular (*Sadoff and Grey*, 2002,).

5 Benefit Sharing

5.1 The Concept of Benefit Sharing

The concept of benefit sharing was first formalized in international environmental law and governance in the 1992 Convention on Biological Diversity (CDB). In this document the term "benefit-sharing" was used in relation to plant genetic resources. The aim of the CBD is to conserve and promote sustainability in the use of biodiversity and to ensure that the resulting benefits are shared equitably with the communities from which the plant genetic resources were obtained (*Artuso*, 2002; *Berg*, 2001; *Weijer*, 2000). *Nkhata et al.* (2012) describes the concept as denoting "forms of social accountability and responsibility to direct returns from use of natural resources, be they monetary or non-monetary, back to a range of designated participants within socially designed arrangements". Over time, the concept has been discussed and studied with respect to a number of natural resource domains and applied to many including forestry, wildlife, water management, pharmaceutical, oil and mineral prospecting and human genetic research.

With respect to transboundary water resources, benefit sharing is defined as the development of water uses in their optimal locations, and the distribution of the benefits derived from these uses, rather than the water itself, to users across the basin (*Alam et al.*, 2009). *Hensengerth et al.* (2012) has a more general definition: "benefit-sharing can be seen as the translation into practice of international water law, and specifically the principles of equitable and reasonable utilization, and of the absence of harm, which the international and regional conventions emphasize" while *Sadoff and Grey* (2005) define benefit sharing as "any action designed to change the allocation of costs and benefits associated with cooperation".

One of the main arguments in focusing on the benefits derived from the use of water rather on the allocation of the

water itself is that a zero-sum game of water-sharing can be replaced by a positive sum game of benefit-sharing (*Dombrowsky*, 2010; *Biswas*, 1999). One way that this may occur is through the use of benefit sharing to bypass the issue of water and property rights. If the focus is shifted from the allocation of physical volumes of water to the various values derived from the use of water (including economic, social, political and environmental benefits), then riparians will view the problem as one of positive-sum outcomes associated with optimizing the benefits rather than the zero-sum outcomes associated with the division of water (*Qaddumi*, 2008). *Qaddumi* (2008) also argues that since cooperation in the management of transboundary water resources can be difficult as a result of unclear and contested property rights, benefit sharing may also help to increase cooperation in international river basins. "The prospect of potentially gaining higher benefits by cooperating rather than by maintaining he status quo or by taking unilateral action encourages states to cooperate with each other in their use of shared rivers" (*Hensengerth et al.*, 2012). This argument is supported by *Sadoff and Grey* (2002), *Sadoff and Grey* (2005) and *Phillips et al.* (2006).

The underlying argument for benefit sharing in transboundary basins is that by focusing on the benefits instead of quantities, "difficult negotiations on water allocations may be avoided" (*Dombrowsky*, 2010). *Sadoff and Grey* (2002) argue that by focusing on the benefits derived from the use of water in a river basin, rather than from the physical water itself, the perspective of basin planners may be broadened. They point out that in order to "negotiate the management and development of international shared rivers, riparians can focus their negotiations on the allocation of water rights or on the distribution of benefits derived from the use of water (*Sadoff and Grey*, 2005). This insinuates that the sharing of rights (physical allocation) and the sharing of benefits are understood to be alternative negotiation strategies.

Other authors question the separation between the negotiation of benefits and the negotiation of rights. *Phillips et al.* (2006) argued that the demand for the equitable allocation of water resources, and the approach of sharing benefits, are in fact two sides of the same coin and that an agreement on water allocations (rights) must happen prior to the sharing of benefits. *Daoudy* (2007) states that "optimal water-usage solutions may not be congruent with the principle of equitable utilization". *van der Zaag et al.* (2002) argue that "the rights of the riparian countries sharing a common water resource have to be established before economic or financial transactions concerning water allocation can occur" and *Richards and Singh* (2001) conclude that "valuation of the use of water cannot be analytically separated from the allocation of property rights".

Dombrowsky (2009) takes this debate a step further by pointing out that the sharing of rights and the sharing of benefits can be delinked depending on whether there are negative or positive externalities. In the case of negative unidirectional externality problems, a basic agreement on property rights (the right to abstract or pollute the water for example) is a prerequisite for any benefit-sharing scheme. "Once agreement on property rights has been reached, the parties may start trading these rights and optimising the use of the resource" (*Dombrowsky*, 2010). In the case of positive unidirectional externalities (such as the provision of flood control benefits for the downstream party, by the upstream party, through water retention measures) no property rights to water are involved. The question, rather, is whether the downstream party benefiting from upstream measures has an incentive to contribute toward the provision of the positive externality (*Dombrowsky*, 2010). The benefits gained through cooperation can be realized regardless of the allocation of water rights.

The types of benefits that can be generated and shared are discussed by *Sadoff and Grey* (2002). They have classified the international river according to the type of benefits that can be derived: the ecological river ("benefits accorded *to the river*"), the economic river ("benefits to be reaped *from the river*"), the political river ("costs arising *because of the river*") and the catalytic river ("benefits enabled *beyond the river*"). Details of these classifications are given in Table 2.

Phillips et al. (2006) describes the Inter-SEDE model which builds upon this classification. Economic, environmental or security benefits can be generated and activities in these various spheres may have spill-over effects. They propose to identify security, economic and environment drivers in international river basins and, based on this, to then identify opportunities for development at various scales (household, sub-national, national, regional, global) within each of these spheres.

In a concept paper on benefit sharing and transboundary water management by the Southern African Development Community (*Southern African Development Community*) a benefit-sharing wheel with eight categories of benefits is presented. These categories include economic, environmental, agricultural, social, political, hydrological, physical and commercial (Fig. 4). Benefit Wheels can be used to characterize the countries sharing a watercourse, transboundary basins as a whole, parts of those basins and smaller geographical areas by generating a wheel specific to each situation . This provides a tiered approach to analyzing the utilization of fresh water, and is useful in defining complex relationships (*Southern African Development Community*).

The benefit categories that have been developed by *Sadoff and Grey* (2002), *Phillips et al.* (2006) and *Southern African Development Community* are a starting point for benefit generation. They can also be used to aid in the understanding of the range of sectors that can be included in generating benefits from cooperation and of the possible size of the basket of benefits (*Phillips et al.*, 2006).

While both *Sadoff and Grey* (2002) and *Phillips et al.* (2006) discuss the benefits that can be generated in a trans-

Table 2. Categories of Cooperation and Challenges (as proposed by *Sadoff and Grey* (2002))

Type of Benefit	Challenges	Opportunities
Increasing benefits to the river	Degraded water quality, watersheds, wetlands and biodiversity	Improved water quality, river flow characteristics, soil conservation, biodiversity and overall sustainability
Increasing benefits from the river	Increasing demands for water, sub-optimal water resource management and development	Improved water management for agriculture/hydropower, flood-drought management, navigation, environmental conservation, water quality and recreation
Reducing costs because of the river	Tense regional relations and political economy impacts	Policy shifts from dispute/conflict to cooperation/development; from food/energy self-sufficiency to food/energy security; reduced conflict risk and military expenditure
Increasing benefits beyond the river	Regional fragmentation	Integration of regional infrastructure, markets and trade

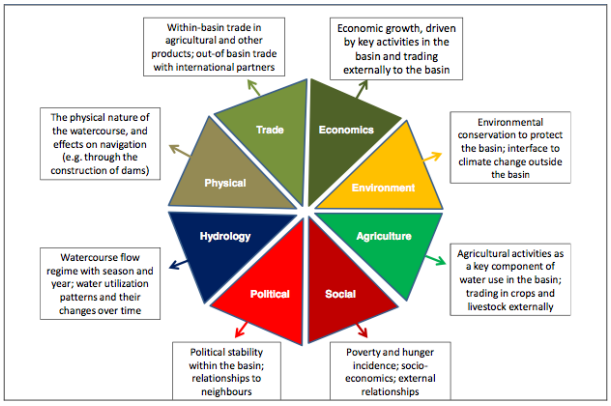

Fig. 4. SADC Benefit Sharing Wheel (source *Southern African Development Community*)

boundary river basin, neither specifically address the question of how these benefits can be shared.

Klaphake and Scheumann (2006) identifie two forms of benefit sharing: compensation (side-payments) and issue-linkages. Descriptions of these mechanisms are shown in Table 3.

The (*World Commission on Dams*, 2000) presents definitions of benefit sharing mechanisms specifically with respect to large dam projects. These benefit sharing mechanisms, however, can be applied to other types of water infrastructure as well. These benefit sharing mechanisms are classified as monetary and non-monetary. Monetary benefit sharing mechanisms involve the sharing of part of the monetary flows generated by the operation of the infrastructure with the affected communities to compensate project-affected populations for lost assets and lost access to resources. Non-monetary benefit sharing schemes reflect the development strategy element of a comprehensive compensation policy aimed at restoring and improving the livelihoods of project-affected populations. Table 4 lists these mechanisms.

In a subsequent paper, *Sadoff and Grey* (2005) suggest alternative mechanisms of benefit sharing, including direct payment for water use (e.g., municipal or irrigation supplies), direct payment for benefits (e.g., fisheries, watershed management) or compensation for costs (e.g., inundated land, pollution), purchase agreements (e.g., power, agriculture products), financing and ownership arrangements (e.g., power infrastructure) and broadened bundle of benefits, including provision of unrelated goods and services and less tangible (e.g. reputation) benefits.

Qaddumi (2008) suggests that focusing on an economic analysis of benefits would be an extremely effective tool for leading riperians toward cooperation because it "yields results that are quantifiable and therefore less subject to contestation than more qualitative analysis", without diminishing the importance of potential benefits from other categories of benefits.

The discussed benefit sharing mechanisms have been adopted in a wide variety of agreements between riparian countries. *Klaphake and Scheumann* (2006) detail 18 different benefit sharing agreements, mostly centred on dam construction designed to generate and use hydropower. The Lesotho Highlands Project on the Senqu/Orange river basin utilizes mechanisms such as direct payments for water, purchase agreements and financing arrangements. The agreement between India and Nepal on the Mahakali River is based on cost sharing and a power purchase arrangement. The India-Bhutan agreement on the Chukha hydropower project includes payments made by India to Bhutan for power exports. Other examples of benefit sharing in international river basins are detailed by *Yu* (2008), *Phillips et al.* (2006), *Hensengerth et al.* (2012) and *Daoudy* (2007).

5.2 Case Studies

The following section details two important benefit sharing agreements: one on the Senegal River and another on the Columbia River.

The Senegal River Basin

The Senegal River rises in Guinea and flows through Mali, Mauritania and Senegal. The most recent agreement between the riparians is the 2002 Senegal Water Charter. This Charter addresses problems arising from the construction of two dams as part of an agreement in 1978 (the Manantali hydroelectric dam in Mali, completed in 1988 and the Diama salt-water intrusion barrier near the mouth of the river, conpleted in 1986). Resulting problems in the downstream portion of the basin include the degradation of ecosystems, the elimina-

Table 3. Forms of Benefit Sharing (as discussed by *Klaphake and Scheumann* (2006))

Benefit Sharing Mechanisms		Typical Applications
Compensation	Monetary	Financial transfers between riperians
		Participation in project costs, infrastructure financing or other measures (eg, reduction of discharges)
		Payments for water usage to existing rights-holders
		Acquisitions of subsidiaries / joint ventures / direct investment
		Price and volume agreements for water and energy
	Non-Monetary	Allocation of water rights
		Agreement on allocation of quantities of energy
Issue Linkages	Within water sector	Realization of tradeoff deals with opposite cost-benefit allocation (e. g. improvement of navigability to sea against reduction of discharges on upper course)
		Concessions on water allocation in other river basins
	Outside of water sector	Trade concessions, transportation agree- ments, immigration issues, border controls, supply agreements (e. g. energy, oil), and the like

Table 4. Mechanisms of Benefit Sharing (as discussed in the *World Commission on Dams* (2000))

Benefit Sharing Classification	Mechanism	Notes
Monetary	Revenue sharing with local or regional authorities	revenue sharing through taxes on revenues or royalty regimes; may be the result of negotiations between local or regional authorities and the promoter or may be defined in the legislation
	Development funds	financed from power sales, water charges etc.; provide seed money for fostering economic development in the project-affected area
	Equity sharing or full ownership	allowing local or regional communities to partly or fully own a dam project; risk sharing as well as profit sharing with affected communities; communities may gain a degree of control over the design and operation of the project
	Taxes paid to regional or local authorities	taxing the infrastructure operators on the projects property value or other basis; State legislation defines the taxes to be paid to the local/ regional authorities, based on a percentage of project sales or net income
	Preferential electricity rates or other water-related fees	a form of revenue sharing; results in less revenue for the dam owner and avoided costs for beneficiaries
Non-monetary	Livelihood restoration and enhancement	securing income through employment in the construction and in the operation of the project; possible employment in the agricultural, fishery or recreational sectors
	Community development	through increasing the access and quality of primary services, such as domestic water supply and electrification, transportation, health and education; facilitate access to markets and common resources (e.g. forests)
	Catchment development	custodianship of catchment resources; opportunities to improve the management and benefit generation of the catchment area, for example through improved irrigation, reforestation etc.

tion of traditional flood-recession agriculture and a variety of public health problems such as malaria, diarrhea and schistosomiasis. As part of the 2002 Charter, the riparians made the decision to alter the flow regime of the river in order to mimic natural, pre-dam conditions by creating artificial floods through releases from the Manantali Dam, at the cost of some hydropower. This cooperative solution was possible due to a clause in the 1979 treaty that gave joint ownership to all riparians of all works constructed on the river. Along with introducing the concepts of sustainability and protection of the environment, the 2002 Charter focuses more heavily on the concepts of equity and cooperation, with Article 4 of the Charter stating that "the guiding principles of any distribution of the River's water will guarantee to the populations of the riparian States, the full pleasure of the resource, with respect to the safety of the people and the works, as well as the basic human right to clean water, in the perspective of sustainable development". The Charter puts the focus onto the people who are affected by large projects on the river and is the the first treaty concerning international water courses that invokes the human right to water.

The Columbia River Basin

The Columbia River between Canada and the United States is governed by the Columbia River Treaty of 1964 and is an example of the equitable sharing of downstream benefits. Provisions of the Treaty required that Canada build 3 storage dams. It was recognized that these projects would increase the useable energy and dependable capacity of power plants downstream in the United States as well as providing irrigation and flood control benefits in the United States, which would not have been possible, at the same cost, without these projects in Canada. In return for building the 3 dams, Canada was entitled to a lump sum payment for irrigation and flood control benefits as well as one half of the additional power generated by power plants in the United States as a result of water storage in Canada. Three basic principles govern the division of power benefits under the Treaty, as well as the responsibility for the costs associated with production of those benefits:

1. The power benefits generated as a result of the cooperative development of Canada and the United States are to be shared on a substantially equal basis, provided that an equal division will result in an advantage to each country as compared with the alternatives available to it;

2. When an equal division of power benefits will not result in an advantage to each country, the countries must then negotiate and agree upon such other division of benefits as will be equitable to both countries and make cooperative development feasible;

3. Each country is to bear all capital and operating costs for facilities it will provide in its own territory to carry out the cooperative development mandated by the Treaty.

These principles allowed each nation to determine the benefits that they believe were attainable through cooperation. A bi-national structure was then developed to provide a mechanism to create the benefits. The principles provided that the benefits would be divided 50/50 and that each party would bear its own costs, but left room for the formula to be adjusted if one of the parties felt that they would receive benefits less than what they could attain by acting unilaterally. The power of the principles lies in the recognition of the benefits of one country and the costs in the other without comparing the two. Rather they permit the development of a framework which facilitates a negotiation process that recognizes the concerns of each country and introduces a formula which enables both countries to benefit from the development (*Sanderson*, 2009).

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