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Article

*259 LAWYERS WRITE TREATIES, ENGINEERS BUILD DIKES, GODS OF WEATHER IGNORE BOTH: MAKING TRANSBOUNDARY WATERS AGREEMENTS RELEVANT, FLEXIBLE, AND RESILIENT IN A TIME OF GLOBAL CLIMATE CHANGE

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I. Introduction

This Article identifies and critically reviews the importance of adaptability and flexibility in treaties and institutional arrangements by providing resilience in the face of the anticipated impact of climate change on the good governance of international waters. [FN[FN1]] Building greater ***260** resilience and adaptability into international waters agreements is essential to address the uncertainties in hydrological and ocean processes associated with climate change. [FN[FN2]] There is also growing consensus that conflict over natural resources can be linked to extreme events and climate change, [FN[FN3]] and this is receiving increased attention in foreign policy development. [FN[FN4]] Surface water resources are especially vulnerable to the anticipated consequences of climate change, due to the strong linkage surface water resources have with precipitation and temperature. [FN[FN5]] Other international waters such as international large marine ecosystems and international groundwater resources are also potentially impacted by climate change events. [FN[FN6]] Climate change and adaptation need to be at the forefront of water policy. Technical solutions, such as dams, are important elements in strategies to deal with climate change; however, they have their limitations. [FN[FN7]] At the core of successful adaptation will be institutions that are designed and maintained with the flexibility and capacity to develop and implement innovative and adaptive strategies to mitigate the impacts of climate change.

In this Article, "international waters" are water resources that are shared by two or more sovereign states. They include international freshwater, international groundwater, and international Large Marine ***261** Ecosystems (LMEs). [FN[FN8]] Included in the definition of international waters are "boundary" water resources where the boundary between two or more sovereign states is formed by an international lake or river. The definition further includes "successive" water resources where an international river (or underground aquifer) flows from one sovereign state to another.

International waters are critically important. Nearly half of the world's population is located within one or more

of the over 260 international freshwater drainage basins alone that are shared by two or more sovereign states. [FN[FN9]] Even more striking than the absolute number of international freshwater drainage basins is a breakdown of each sovereign nation's land surface that falls within those drainage basins. [FN[FN10]] There are 145 nations that include territory within international freshwater drainage basins. Of the thirty-three countries that have greater than ninety-five percent of their territory within international freshwater drainage basins, twenty-one lie in their entirety within them. There are nineteen international freshwater drainage basins that are shared by five or more riparian countries. The Danube is by far the most complex, with eighteen nations in its drainage basin. The Congo, Niger, Nile, Rhine, and Zambezi drainage basins are each shared by between nine and eleven countries; the remaining thirteen international freshwater drainage basins each have between five and eight riparian countries. [FN[FN11]]

This Article accepts the proposition that current climate predictions are largely correct and that there will be greater variability in precipitation, with a general trend at higher latitudes and elevations of greater precipitation in the wet season and reduced precipitation in the dry season. [FN[FN12]] This Article argues there is an urgent need to design and ***262** implement institutional arrangements to deal specifically with these challenges. [FN[FN13]] The Article focuses on the structure of arrangements to deal with or accommodate changes associated with climate change.

Over the past century an increasing number of transboundary water agreements have been developed. The majority of these agreements deal largely with infrastructure development and water allocation, either directly through irrigation or indirectly through timing, such as holding water back during the summer to provide power in the winter. [FN[FN14]] Regrettably, few of these agreements establish institutional structures that have the intrinsic capacity to adapt to changes in the hydrologic regime through phenomena such as climate change. [FN[FN15]] Existing institutional arrangements need to be critically reviewed to determine whether they are resilient in the face of extreme climate events or whether they fail to meet the challenge of adaptation. This is of paramount importance in the developing world. However, member countries of the Organization for Economic Co-operation and Development (OECD) [FN[FN16]] are similarly vulnerable to the deleterious consequences and potential impacts of climate change. For example, it is questionable whether many of the existing water compacts covering the southwestern United States would withstand alterations associated with climate change scenarios. [FN[FN17]]

Although the study of resilience and adaptability of international legal arrangements is relatively new, a recent analysis of the Orange-Senqu River Commission indicates it is resilient and adaptive to the challenges of climate change. [FN[FN18]] The authors assessed various agreements ***263** within the basin from 1983 to the creation of the Commission in 2000 in terms of use of allocation strategies, drought response provisions, ability to amend or review the process, revocation clauses, and institutional responsibilities such as data gathering and decisionmaking. [FN[FN19]] They conclude that the existing agreements contain mechanisms to promote adaptability, the most important of which are the institutional structures and mandates of the basin organizations. [FN[FN20]] These allow for flexibility in managing the water resources, including their use of adaptive management.

However, many other international drainage basins currently lack the institutional flexibility and capacity to deal with anticipated changes due to climate change. The Indus River is a prime example of a basin that will be significantly challenged by climate change. The rivers of the Indus basin flow from Tibet into India and then Pakistan through Kashmir. Under the Indus Waters Treaty (IWT), [FN[FN21]] Pakistan has control over the three western

rivers and India has control over the three eastern rivers. [FN[FN22]] The IWT calls for the exchange of hydrographical information and the optimum development of the rivers, and it expresses a future intention to cooperate to the fullest possible extent. [FN[FN23]] However, the reality is that the countries manage "their" rivers as sole sovereigns. [FN[FN24]] ***264** For more than forty-five years this "hands-off" approach avoided open conflict. However, recent Indian plans to develop hydro-power and irrigation projects on "Pakistan's rivers" have raised significant concerns in Pakistan. [FN[FN25]] Dam development in India, often perceived in Islamabad to negatively affect Pakistan, has been increasingly prominent over the past decade. [FN[FN26]] Most recently, India has been seen to be avoiding renewing talks with Pakistan regarding the Wullar Barrage on the Jhelum River, which India initiated in 1985 and stopped two years later over official protests from Pakistan. [FN[FN27]] The arrangement of passive cooperation, or tolerance of each other, as laid out in the IWT, is insufficient to meet the challenges of the future. A significantly more nuanced approach that focuses on the mutual gains that are available to both countries is needed to optimize the Indus's waters in the face of climate change. [FN[FN28]] A more active or mutual cooperation, such as that encountered in the Columbia River, is needed to optimize the waters of the Indus as climate change and increasing demand place pressure on resources. [FN[FN29]]

While the Indus may be an extreme situation, it is by no means an isolated one. The Ganges-Brahmaputra, Han, Incomati, Kunene, Kura-Araks, Lake Chad, La Plata, Lempa, Limpopo, Mekong, Ob (Ertis), Okavango, Orange, Salween, Senegal, Tumen, and Zambezi basins have ***265** all been identified as basins with a significant potential for conflict exacerbated by climate change. [FN[FN30]]

II. The Challenge of Change

Climate change is expected to have a profound and devastating effect on life as we now know it. According to the United Nations Economic Commission for Europe:

> Climate change will result in significant impacts on our water resources and some of the effects are already visible now. Nearly all countries [in Europe] are expected to be negatively affected by impacts ranging from increased frequency and intensity of floods and droughts, worsening water scarcity, intensified erosion and sedimentation, reductions in glaciers and snow cover, sea level rise, and damage to water quality and ecosystems. Moreover, climate change impacts on water resources will have cascading effects on human health and many parts of the economy and society, as various sectors are directly dependent on water. [FN[FN31]]

There is controversy over the causes of climate change. [FN[FN32]] However, there is emerging consensus that climate change is affecting marine currents, hydraulic regimes, and temperatures. [FN[FN33]] Climate models predict different magnitudes of change in different locations. However, climate change models generally envisage extreme variability of weather in the upcoming decades. [FN[FN34]] In terms of terrestrial ecosystems, many arid areas will experience reduced water availability due to increased evaporation and limited dry seasons. [FN[FN35]] Temperate regions will experience reduced summer precipitation and more rains in wet seasons. [FN[FN36]] Of great concern in many parts of the world, particularly Central and South Asia, is the ***266** loss of glaciers and snowfields, which have historically acted as natural reservoirs by releasing water in the dry season. [FN[FN37]]

A review of flows in the Ganges River Basin over the last decade illustrates the potential impact of increased extreme weather and climate conditions. During the monsoon period in 1998, Bangladesh experienced one of the

most devastating floods in history, covering two thirds of the country and severely affecting the rice harvest. [FN[FN38]] In response, the United Nations World Food Programme launched one of the largest food relief operations in its history. [FN[FN39]] Six months later the country was ravaged by the worst drought in half a century, which also impacted food production. [FN[FN40]] In 1996, India and Bangladesh signed an agreement over the operation of the Farakka Barrage to divert water from the Ganges away from Bangladesh to regulate flow into Calcutta. [FN[FN41]] After the extreme flooding in 2006, however, came a drought and Bangladesh accused India of not releasing sufficient water at Farakka. [FN[FN42]] However, a few months later Bangladesh experienced flooding again, as gates of the barrage were torn away by high water. [FN[FN43]] This alternating between severe flooding and drought is hampering development in one of the lowest per-capita-income countries in the world. Climate change predictions for the Ganges basin anticipate slightly increased annual flows, with reduced dry season volumes and greatly increased flooding during the wet season. [FN[FN44]]

Climate change may also strongly influence the distribution and abundance of marine resources and fisheries. [FN[FN45]] More specifically, climate ***267** change is expected to lead to:

1. Yield and species losses in tropical reef fisheries due to habitat loss,

2. Community turnover in temperate fisheries owing to increasing transition from cold-water species to warm-water species, and

3. Increased diversity and yield in Arctic fisheries arising from the arrival of southern species combined with increased primary production resulting from ice-free summer conditions. [FN[FN46]]

Climate changes will undoubtedly alter many of our natural resource systems in ways that we have little experience with to date. “How societies deal with such changes will depend largely on their capacity to adapt--to plan and implement effective responses to change--a process heavily influenced by social, economic, political and cultural conditions.” [FN[FN47]]

Climate change is also accompanied by increased pollution, as well as increased demand for water resources. [FN[FN48]] The convergence of these factors will increasingly challenge conventional approaches to water resource management. [FN[FN49]]

Societies with highly adaptive capacities in institutional, political, and socio-economic terms will be more resilient to future changes. More than a decade of work by Aaron Wolf and his research team at Oregon State University shows that extremes of both cooperation and aggression over water are seen in marginalised climates such as arid and semi-arid regions. [FN[FN50]] This research indicates that neither conflict nor cooperation are conclusively determined by factors like water scarcity or water sharing. They are, however, exacerbated by those factors. [FN[FN51]] Tension is created ***268** when the speed of change exceeds the ability of institutions to mitigate that change. [FN[FN52]] The most common ways that countries alter international drainage basins are through changes in the quantity and quality of water at any given time. Quality is primarily affected by pollution, which can be industrial, as in the case of the Rhine, [FN[FN53]] or agricultural, as in the case of the Rio Grande and Colorado rivers. [FN[FN54]] Altered quantity of flow can also be affected through climate variability, creation of storage facilities,

and large-scale extractions. [FN[FN55]]

Social, political, and economic factors may be more influential in basins than those of climate change. The work of Charles Vörösmarty and others indicates that population growth and increasing individual consumption will have a greater impact on water resource scarcity than that induced by climate change. [FN[FN56]] Moreover, Clionadh Raleigh, in her examination of climate-induced conflict, determined that population growth and density are strongly correlated with increased risks of conflict. [FN[FN57]] In assessing local resource management systems' relationship to conflict, Raleigh concluded that the effects of political and economic factors outweighed environmental effects. [FN[FN58]] Political, social, economic, and environmental interdependencies need to be considered when ***269** assessing something as complex as the nature of conflict. For example, Thomas Homer-Dixon has argued that while not directly responsible for conflict, increasing water scarcity will indirectly enable conflict through secondary political and socio-economic destabilization. [FN[FN59]] Homer-Dixon does not accept the notion that wars would be specifically fought over water, but he believes that conflict would be much more complex where resource scarcity undermines socio-economic stability and political interests and thus leads to increased tension. [FN[FN60]]

Whether it is economic instability created in one state through dam building, or whether it is altered precipitation patterns due to climate change, the effectiveness and flexibility of institutional arrangements to adapt to change will arguably determine whether a basin falls into conflict or rises to cooperation in times of water stress. [FN[FN61]] The Indus River valley is a case of institutional arrangements failing to adapt to change. Instead of increased cooperation in the face of increased demand and altering hydrology, we see increased unilateral action and increased tension as a result. Rather than setting up greater institutional linkage, the Indus Treaty separated management of a number of shared tributaries by allocating three to India and three to Pakistan. [FN[FN62]] This state of hydro-political "tolerance," as opposed to hydro-political cooperation, has persisted since the Indus Treaty was signed in 1960. [FN[FN63]] While the agreement has survived numerous hostilities between the countries, [FN[FN64]] it is becoming increasingly evident that India's development of dams on certain tributaries, which Pakistan claims affects its share of the Indus waters, is increasing hydro-political tensions in the region. [FN[FN65]] The more water India diverts upstream, the less water is available for Pakistan downstream. [FN[FN66]]

***270** In contrast to the Indus, the Danube Basin is a case in which strong institutional development turned a potentially confrontational situation into one of cooperation. The Danube is Europe's second longest river and drains from Germany to the Black Sea. The basin contains more than eighty million inhabitants spread over eighteen countries. [FN[FN67]] The river is important for a variety of uses, including hydropower, navigation, industrial cooling, waste disposal, irrigation, and drinking water. [FN[FN68]] Fisheries are also important sources of income and food for downstream countries, and tourism is important especially for the local economies of the Danube Delta and the Black Sea. [FN[FN69]] Water quality and conservation, primarily in terms of ecological functioning, have been severely affected due to pollution and alterations to the hydrological regime associated with storage and diversion facilities. [FN[FN70]]

Formal transboundary institutional development regarding the Danube has developed in two major areas: navigation and environmental protection. Navigation has been an important issue on the Danube from as early as 1856, when a navigation commission for the Danube was created. [FN[FN71]] A more recent agreement, signed in 1948 and ratified the following year, created a new Danube Commission for navigation. [FN[FN72]] The 1948 Danube

Commission limited free navigation to only those riparian countries and reduced the power of the commission to govern legislation and river inspection. [FN[FN73]]

Transboundary agreements on development occurred in the Danube basin throughout the 1950s and 1960s. However, these were predominantly bilateral in nature. [FN[FN74]] Despite a predominant focus on development, multilateral discussions on anti-pollution issues were ***271** initiated as early as 1966. [FN[FN75]] However, it was in 1985, with the Declaration of the Danube Countries to Cooperate on Questions Concerning the Water Management of the Danube, that a concerted effort was undertaken to develop meaningful cooperation in the field of environmental protection. [FN[FN76]] Following the break up of the Soviet Union and the declining influence of Moscow in the region, the Danube River Protection Convention was signed in 1994, coming into force in 1998. [FN[FN77]] Despite several water disputes between nations regarding the proposed infrastructure projects, the member countries have displayed relative cohesion in working to mitigate pollution and conservation problems. [FN[FN78]] While much of the international cooperation has been stimulated by international donor organizations such as the Global Environment Facility, an increasing amount of responsibility to mitigate pollution and develop sustainable use policies is being undertaken and implemented by the region itself. [FN[FN79]] Notably, the success of the environmental program for controlling pollution in the Danube River is in part due to its active inclusion of non-governmental organizations (NGOs) and public participation. [FN[FN80]] The experiences in the Danube basin provide an example of how states will undergo fairly onerous provisions for stakeholder provisions when there are benefits to do so. [FN[FN81]] Moreover, despite considerably poor relations between the East and West in post-World War II Europe, the Danube Commission's work continued uninterrupted, illustrating that political and environmental disagreements need not prove a barrier to institutional administration of a common drainage ***272** basin. [FN[FN82]]

III. Designing Appropriate Institutions To Meet Change

At the core of transboundary institutional arrangements are the agreements that outline the functions and raison d'être of the institutions. If the current agreements outlining how sovereign states share international waters are to prove effective under changing hydrodynamics, they will need to be sufficiently flexible to allow for mitigation and adaptation. At the forefront of this will be the ability to collectively make fundamental alterations to resource management as change occurs.

Agreements regarding governance of international waters to protect and promote sustainable development also serve to promote security throughout an entire area. [FN[FN83]] These international agreements tend to stabilize and enhance security at the regional level. [FN[FN84]] The security generated is independent of the concrete ecological and economic benefits produced by such agreements. Severe deforestation, soil erosion, salinization, toxic contamination, resource exploitation, habitat destruction, drought, flooding, air pollution, and water pollution are just some of the environmental calamities that can lead to increased tensions and possible conflict over international waters. [FN[FN85]] Conversely, the process of reaching accommodation creates a stabilizing and transparent atmosphere. [FN[FN86]] The view that water can act as a catalyst for cooperation [FN[FN87]] ***273** has strong support, as indicated by the burgeoning number of transboundary agreements and acts of cooperation. [FN[FN88]]

The process of negotiation usually widens political participation building political stability and spreading confi-

dence between sovereign states. [FN[FN89]] Increased confidence can emerge even in cases in which countries agree only to share information and exchange data, while disagreeing on substantive issues. [FN[FN90]]

While an agreement may strengthen ties, institutions must usually be developed to implement agreements in order to realise any benefits. The Mahakali Treaty between Nepal and India illustrates this point. [FN[FN91]] The importance of institutional development as a keystone to successful transboundary water management cannot be underestimated. [FN[FN92]] Designing the appropriate institutional architecture to administer an agreement is a critical step in the effective implementation of international waters governance agreements. This is particularly true in the case of transboundary waters, where clear upstream and downstream rivalries ***274** can often occur. [FN[FN93]] The institution developed to manage resources will ultimately define not only "sustainable use," but also uses that are reasonable and equitable and under what conditions. At the core of institutional architecture is the development of an understanding of the needs or issues driving the creation of a transboundary institution, or its "functional necessity." [FN[FN94]] Effective institutions are ones that meet social needs, or rather clearly address specific problems. [FN[FN95]] Substantive functional necessity should therefore provide the foundational design behind any institutional regime developed to implement an agreement. [FN[FN96]] For example, the design of the institution will likely be different if the context for cooperation is to address the problem of an upstream state polluting a river, as opposed to addressing the mutual problem of flood control. [FN[FN97]]

To arrive at an effective institutional mechanism for a given agreement, a significant degree of design, or architecture, needs to be present from the foundation up. Following an analysis of the context for institutional development is the identification of the underlying institutional objectives. These focus on:

1. Balancing and creating new incentives for cooperation, including removal of a significant problem, such as flooding or pollution, and the ***275** developing new benefits such as power generation;

2. Reducing uncertainty, including knowledge around resource behaviour, climate change, and behaviour of the other parties to the agreement (increasing trust and confidence building); and

3. Reducing the costs of implementation, including transactional costs of meetings and administration, capital costs if applicable, and developing the technical capacity of the parties to implement the agreement. [FN[FN98]]

Not all the objectives are of equal significance in all situations. For example, the importance of reducing uncertainty of party behaviour between the United States and Canada in the development of the Columbia River Treaty was likely less acute than between India and Nepal when they were negotiating the Mahakali Treaty. In the former, the International Joint Commission, consisting of individuals from both countries, was created to conduct independent studies and develop principles for the agreement. [FN[FN99]] In the latter, tensions were so high that Nepal requested the involvement of a neutral third party to help broker the deal and ensure an equitable arrangement. [FN[FN100]]

Institutional objectives should dictate the final institutional architecture if the regime is to be effective. [FN[FN101]] One party's possible goal in entering into an international waters treaty might be sustainable development to alleviate poverty. This was one of Nepal's principal objectives in the Karnali River project, when India build

a dam in Nepal, and required considerable balancing of incentives in the form of ***276** upstream and downstream benefit sharing. [FN[FN102]] Likewise, developing a greater understanding of the resources and reducing the uncertainty surrounding future behaviour may also be important for sustainable resource use. Other institutional objectives could include increasing confidence between parties [FN[FN103]] and developing an institutional framework that will minimize the costs of administration and implementation. [FN[FN104]] The institution's effectiveness will depend on how it meets its objectives. If there is a great deal of uncertainty related to the size of a fish stock, for example, then one of the institution's key objectives would be to reduce this uncertainty before equitable allocations (another objective) can be made. For the institution to be effective, the component of appropriately assessing the stock must be incorporated into the institutional architecture of the agreement. The Convention on the Conservation and Management of the Pollock Resources in the Central Bering Sea is an example of this. [FN[FN105]] At the core of the Pollock agreement is the annual assessment of stocks by a multinational technical committee to calculate the signatories' allowable catch for any given year. [FN[FN106]]

In the context of climate change, reducing uncertainty aids understanding and predicting the substantive issues associated with the resource in question. [FN[FN107]] This could translate to greater measurements or scientific understanding of the resource, [FN[FN108]] while acknowledging the data gaps and the limitations of science in both predicting and managing the ***277** resource. [FN[FN109]] Institutions that can behave adaptively both in terms of their approach to management (learning associated with the resource), and toward their decision-making, will be better prepared to address change than those that cannot. Moreover, the openness of the institution to developing interactions with appropriate actors, such as providing opportunities for learning between the parties, will enhance the ability of those parties to mutually and cooperatively address change.

IV. The Need for Institutional Solutions: Climate-Proofing Agreements

Part of the solution for dealing with future uncertainty in the governance of international waters will be technical and infrastructure-related. For example, the bulk of all water use in many countries is agricultural. [FN[FN110]] Improvements are expected in the agricultural sector through technology, such as drip irrigation techniques and monitoring crop demand. [FN[FN111]] Building storage has traditionally been a principle way of adapting to water insecurity. While dams have been built for the express purpose of energy generation, the majority of modern dams are either multipurpose or have been built for water supply storage to adapt to water scarcity. [FN[FN112]] Retaining flexibility through strategies that employ a mix of infrastructure and associated institutional reforms will become increasingly important to deal with the uncertainties of climate change. [FN[FN113]]

In temperate Europe, rainfall is relatively regular, and natural regulation of water flow occurs through lakes, groundwater storage and wetlands making forty percent of the runoff available for productive uses. In the semi-arid Iberian Peninsula, the situation is dramatically different, with under ten percent of runoff available through natural regulation. [FN[FN114]]

***278** This difference in natural regulation has resulted in the countries of Spain and Portugal having 150 times more storage capacity per person than do their temperate neighbors such as France, Germany, and the United Kingdom. [FN[FN115]] However, additional caution must be applied to dam building in the context of transboundary rivers, because dams will alter the flow of rivers affecting downstream states.

While technical solutions will form part of the answer, flexibility and adaptability are best institutionalized to build resilience and respond to change. As noted by Thomas Bernauer, technical solutions exist for most water problems, but it is the institutional and political dimensions that generally hinder progress toward sustainable and active adaptive management. [FN[FN116]] The challenge for international waters governance is creating institutions that adapt to change. This will require constructing management and decision-making structures that respond to changing physical conditions like increased drought or flooding. For example governance institutions can be established and maintained with built-in audit and performance evaluation requirements.

Traditional institutional approaches to governance of international waters are generally challenged when trying to deal with complexities or uncertainties associated with episodic change such as climate change. [FN[FN117]] Governance systems crafted to fit one set of socio-ecological conditions may erode as social, economic, technological, and bio-physical changes occur. [FN[FN118]] Management theory may need to abandon the perception of a steady state-human-environment interaction. [FN[FN119]] Instead, "managing complex, co-evolving social-ecological systems for sustainability requires the ability to cope with, adapt to, and shape change without ***279** losing options for future development." [FN[FN120]] Five significant requirements have been identified for successful adaptive governance in complex systems: [FN[FN121]]

1. Providing information;

2. Dealing with conflict;

3. Clear rules, equitable property rights, and inducing rule compliance;

4. Providing infrastructure--or necessary tools--to "manage resource"; and

5. Being prepared for change.

While all five issues are needed for adapting to climate change, "being prepared for change" is often compromised when designing institutional arrangements. States are often reluctant to develop institutional arrangements that may be perceived as relinquishing sovereignty over shared resources. Being prepared for change involves the ability to make decisions regarding resources as change occurs. While this can be difficult within a national context, it is compounded by the complexities of transboundary jurisdiction. [FN[FN122]] Flexibility for decision-making must be incorporated into institutional arrangements from the beginning. The degree of flexibility and how it is to be incorporated should be based on the resource in question from a bio-physical perspective.

The following list contains examples of mechanisms that have been employed internationally to deal with adaptation and change in governance of transboundary water resources (List 1). While it is by no means a complete list, it serves to illustrate the variety of mechanisms that can be incorporated when developing adaptation capability in institutional arrangements for transboundary international waters governance. [FN[FN123]]

***280** List 1: Examples of Mechanisms To Promote Adaptation in Treaties and Agreements

• Review of treaty provisions after agreed period

o Advantage: It provides parties with an official means of incorporating new concerns or reviewing effectiveness of a treaty.

o Disadvantage: The longer the period between reviews, the less flexibility the treaty will have. Review may also require high-level formal approval needing greater time and thus making it less responsive to change.

• Amendment to provisions of the treaty

o Advantage: Generally, amendments can be proposed at any time.

o Disadvantage: Amendments often have to be unanimous, or parties may often be able to make a reservation regarding an amendment, which can dilute its effect. Also, there is a high degree of formality associated with them.

• Development of protocols to an existing treaty

o Advantage: Generally, these can be done at the request of parties and can be at any time. They allow for adaptation of substantive elements of the treaty.

o Disadvantage: Like amendments, protocols may not be adopted by all parties, diluting their effects. They require high-level formal approval that can hinder adaptation if rapid change is needed.

• Development of supplementary agreements (can be temporary)

o Advantage: These can generally be executed at the request of parties at any time. They may require less formality, as they can be of limited duration and may be executed at the operational level. They can respond well to frequent or repeated events.

o Disadvantage: Supplementary agreements are less likely to be responsive to singular or extreme events, as they still require negotiation.

• Incorporate graduated scale of actions based on predicted situations

o Advantage: It is forward-looking and works to provide confidence and certainty of outcomes in potential ***281** situations.

o Disadvantage: It may not incorporate all situations.

• Use of Official Minutes to alter Treaty substantively

o Advantage: This is potentially very flexible and can be achieved without many formalities, as decisions can be made through agreement of an oversight body.

o Disadvantage: The oversight body may be limited in the types of decisions it can make.

• Provide for the convening of technical groups to review issues under extreme events

o Advantage: This can address the immediate concern in a focused way and has the potential to respond rapidly.

o Disadvantage: It may take time to form the group.

• Creation of management body with decision-making authority

o Advantage: Joint management authorities can allow for decisions, within a specified range of issues, without the need for involving discussions at the higher level. They may respond rapidly within their jurisdiction.

o Disadvantage: Influence and flexibility will depend on jurisdiction of management duties. Governments are often reluctant to allow joint authorities too much control. Joint authorities may also be expensive to run; however, national agencies would have to conduct the implementation of a treaty in any case.

• Use of scientific body to determine resource allocations/use

o Advantage: These bodies can apply adaptive management and emphasize the use of science for management decision-making.

o Disadvantage: Scientific bodies may not incorporate all aspects of information for decision-making, leaving out socio-economic and political concerns. Information may be incomplete, lacking, or have a high degree of uncertainty associated with it.

Understanding why flexibility may be needed will determine "how" it should be incorporated. In a study of thirty-five basins, Erik Mostert concludes that in "transboundary water agreements, the desire to develop and maintain good relationships [is] the most effective force behind reaching agreements." [FN[FN124]] States generally enter into agreements only when some form of mutual benefit is derived. [FN[FN125]] Good relations can be ***282** passive in the sense that there is no significant interaction, and that each is left to its own management. Alternatively, good relations can be more active, whereby states work collaboratively to better manage shared resources. In the latter, good relations are a means to more substantive ends.

The Nile Basin Initiative is an example of a relationship-building agreement: one of its goals is to help negotiate a basin-wide cooperative framework agreement. [FN[FN126]] The Nile Basin Initiative (NBI) is a regional partnership launched by Nile riparian states in 1999 to facilitate the common pursuit of sustainable development and management of the Nile basin. [FN[FN127]] Over the past decade, the NBI has promoted water management and development in the basin through training courses and creation of eight major investment projects for which it is seeking funding. [FN[FN128]] The members are Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, South Sudan, Tanzania, and Uganda; Eritrea is involved as an observer. [FN[FN129]] During its launching,

the Nile Council of Ministers (Nile-COM) agreed on a Shared Vision "to achieve sustainable socio-economic development through the equitable utilization of and benefit from the common Nile Basin water resources." [FN[FN130]]

Another example of relationship-building is the Abidjan Convention, which is a framework agreement that outlines the major areas of focus and work, but leaves the substantive details to subsidiary agreements or protocols. [FN[FN131]] The convention addresses "broad marine and ***283** coastal issues in Western, Central and Southern Africa, setting regional norms and providing a platform for implementing environmental initiatives under NEPAD (New Partnership for Africa's Development)." [FN[FN132]] Contracting members of the Abidjan Convention are Benin, Cameroon, the Republic of the Congo, Côte d'Ivoire, Gabon, Gambia, Ghana, Guinea, Liberia, Nigeria, Senegal, Sierra Leone, South Africa, and Togo. [FN[FN133]]

In dealing with response to climate change, this Article focuses on those agreements of a more substantive nature. However, regardless of whether an agreement is of a substantive or relationship-building nature, developing flexibility can be a catalyst for cooperation. States are more likely to enter into a cooperative arrangement if they know there are built-in possibilities to change either the substantive elements or the procedural aspects of the agreement to meet new needs. [FN[FN134]]

Moreover, procedural issues, such as a review of the agreement or the development of new protocols, are also important mechanisms to deal with uncertainty in future situations. Most substantive agreements will have provisions dealing with periodic reviews. For example, Article 12 of the Mahakali Treaty requires a review every ten years or "earlier as required by either party." [FN[FN135]] Another example would be the Farakka Agreement's five-year review period. [FN[FN136]]

Many agreements, such as the Columbia River Treaty [FN[FN137]] and the Mekong Agreement, [FN[FN138]] do not provide for specific review periods. The ***284** Mekong Agreement provides opportunities for updating and altering the Agreement at any time through amendments that are agreed to by all parties. [FN[FN139]] In the case of the Bay of Bengal Programme, an inter-governmental organization on coastal fisheries, amendments to the agreement require a three-quarters quorum of member states on the governing council. [FN[FN140]] Alterations or additions to the Barcelona Convention require support of three quarters of a diplomatic conference, which must be convened with no less than two thirds of the member states. [FN[FN141]] Considering that most agreements take years, or even decades, to develop, treaty amendments are not an effective way to meet situations associated with climate change, unless they are changes that occur on the scale of decades. [FN[FN142]]

Another formal method for adapting a treaty to changing situations is through the development of protocols. [FN[FN143]] The Barcelona Convention ***285** and the Caspian Sea Convention [FN[FN144]] are both framework conventions that rely on the development of protocols to implement substantive issues. Adopting a protocols to the Barcelona Convention requires a two-thirds vote from among its member states. [FN[FN145]] In many treaties or conventions, such as the Barcelona Convention, parties have the opportunity not to sign onto a specific protocol, making the process of developing protocols slightly more flexible than amendments to treaties. [FN[FN146]] However, this is not always the case. For example, under the Caspian Sea Convention, protocols must be adopted by unanimous decision of all parties. [FN[FN147]] Despite this, two protocols regarding pollution control have been developed and specify greater detail as to what substantive work is to be done and by whom. [FN[FN148]] Proto-

cols, while potentially less cumbersome than treaty amendments, still require high levels of formality and may be an impediment to adaptation unless applied to long-term changes. [FN[FN149]]

Less formal than protocols may be the establishment of supplementary agreements, as in the case of the Columbia River Treaty. [FN[FN150]] Since the Treaty was established in 1964, various agreements have been made between Canada and the United States to deal with ***286** issues as they arise. [FN[FN151]] Many environmental and social concerns, increasingly important in the last twenty years, were not at the forefront during treaty negotiations. Supplementary agreements that fill this gap between original intent and new concerns, or temporary concerns, have the benefit of "use as needed," such as the supplementary non-power uses agreements for rainbow trout and whitefish spawning. [FN[FN152]] Under the Columbia River Treaty, the supplementary agreements can be conducted between the entities, which are the power utilities operating the storage facilities. [FN[FN153]] As they are power utilities and corporations, they are able to modify the treaty over time without the formality of protocols. Because these agreements may be of a limited duration, they provide less risk for the governments than if they were to fundamentally alter the treaty. Some of the supplementary agreements have become formalized after being proved in the field. [FN[FN154]] The use of these types of short-term agreements provides a flexible response on a shorter time frame due to their informality.

Many institutional mechanisms have flexibility regarding substantive issues built into the agreement for unforeseen climatic events or uncertainty. Transboundary fresh water agreements often describe and determine allocations under low-flow levels. An example is the Komati River Agreement. [FN[FN155]] Article 4.1 of the agreement allocates different quantities of waters to Swaziland and South Africa, depending upon high ***287** or low assurances. [FN[FN156]] This style of allocation mechanism is considered relatively benign regarding the risks of climate change, as each party shares the surplus or deficits in a pre-determined way. [FN[FN157]]

The Farakka Agreement, which determines the level of flows in the Ganges River at the Farakka Barrage, demonstrates a more detailed and graduated method of prescribing resource allocation of water under varying situations. [FN[FN158]] The barrage, a kind of dam, constructed in 1975, diverts water from the Ganges into the Hooghly River to supply water for navigational use in Calcutta. First, the allocations are based on seventy-five percent of the mean annual flow measured between 1949 and 1988. [FN[FN159]] This immediately allows for some buffering in terms of variation in the hydraulic regime. The schedule to the Agreement details allocations to both India and Bangladesh for ten periods between January 1 and May 1, and these allocations are reduced in proportion to the flow, should it fall below these levels. However, the portion allocated to Bangladesh should not fall below eighty percent of its average allocation. If the flow of the Ganges falls below a specified level, Article 2(iii) of the Schedule mandates "immediate consultations to make adjustments on an emergency basis, in accordance with the principles of equity, fair play and no harm to either party." [FN[FN160]] However, it is not clear how consultations are to take place, or whether they are be done through recommendations of the Joint Commission that was set up to oversee the Treaty implementation. Nevertheless, there is a mechanism to prescribe allocations in extreme conditions.

Negotiating or determining resource allocations in extreme conditions through a technical body is used in other agreements. The 1956 Agreement on the Nile between Sudan and Egypt has an approach similar to that of the Farakka Agreement in the use of a negotiated agreement to determine new allocations under extreme conditions. [FN[FN161]] Unlike the Farakka Agreement, there is no buffer for climatic alterations as the "full" flow of the Nile

is allocated between the countries. There is, however, greater certainty of what is to occur under extreme conditions, in which event a permanent Joint Technical Committee would take up the determination of fair allocations. [FN[FN162]]

***288** Perhaps one of the most dynamic systems for altering an agreement is found in the Treaty between the United States of America and Mexico relating to the utilization of the Waters of the Colorado and Tijuana Rivers and of the Rio Grande. [FN[FN163]] Here, the Agreement is extremely flexible in that the overarching accord can be modified and updated by allowing for significant decisions to be made by the International Boundary and Water Commission (IBWC) through the creation of Minutes, which have legal standing. [FN[FN164]] In this way, modifications, both socio-political, as well as in terms of climate change and the environment, can be incorporated as needed. Significant decisions can thus reflect current and contemporary values while fundamentally maintaining the spirit and intent of the original accord. For example, Minutes have been used to adjust water allocations, as well as to address salinity issues that have arisen since the signing of the Treaty in 1944. Recently, they have been used to adjust the set delivery schedules of water allocated to Mexico due to infrastructure damage associated with an earthquake in April 2010. [FN[FN165]] The ability of the IBWC to adapt, amend, and extend the institutional arrangement between Mexico and the United States is a powerful tool to develop a resilient form of cooperation. The IBWC employs a number of technical committees to help plan and determine information needs for the commission to make its decisions. [FN[FN166]]

The use of technical committees to make informed recommendations to deal with ongoing resource change, as well as to address climate change, is well established in numerous other treaties. [FN[FN167]] ***289** Scientific determination of allocations on an annual level is less common but provides the opportunity to implement adaptive approaches, as opposed to prescriptive ones, when the resource in question changes. An example is the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea, where science and adaptive management drives decisions prior to any "extreme event." [FN[FN168]] The goal of the Convention is to maintain the pollock fish resources at maximum sustainable yield, and thus technical assessments, combined with modeling, help to determine allocations for marine resources. [FN[FN169]] The Convention has been ratified by the United States and Russia (the littoral states) and China, Korea, Japan, and Poland (distant fishing nations). [FN[FN170]] There is an annual conference of the parties to determine the allowable harvest levels for the succeeding year, based on the findings of a multi-national Technical and Scientific Committee that assesses stock availability. [FN[FN171]] The fact finding and research on which to base the "scientific" assessment is conducted cooperatively through information exchange and standardizing methodologies. [FN[FN172]] As conservation of the stock is essential for obtaining "maximum sustainable yield," and thus a maximum sustained benefit, it is in the interests of the parties to adhere to the scientific findings. Due to low stock levels in the early 1990s, a moratorium on fishing in the "donut hole" of the Bearing Seas was established and has been in effect ever since. [FN[FN173]] While the recovery of the Pollock stock is very slow, it is a testament to the Convention's adaptability that for over fifteen years the Annual Conference of Parties has heeded the recommendations of the scientific community and maintained the moratorium on fishing. [FN[FN174]]

In a similar vein, the Columbia River Treaty has flexibility of operations built into the cooperative management mechanisms of a series of dams on the Columbia River. [FN[FN175]] The Treaty was entered into to provide flood control and power generation benefits on the river, which flows from Canada into the United States, by building and operating a series of dams in Canada to maximize generation capacity in the United ***290** States. [FN[FN176]] The

Treaty outlines the principles by which the system should be operated and establishes a coordinating unit through the appointment of "entities," as opposed to government agencies. [FN[FN177]] The entities are leaders in hydro development and work very closely to coordinate operations of their respective dam facilities. Thus, the system is operated from a basin perspective to optimize benefits.

Variations in flows to accommodate changing conditions and interests can come about in a variety of ways. The Assured Operating Plan (AOP) laid out under the Columbia River Treaty determines flow five years in advance, based on current inflows. [FN[FN178]] It is the foundation for operational management; however, it can be deviated from by mutual agreement, and for mutual benefit. Each year the Detailed Operating Plan (DOP) is developed, based on the AOP, but specific to expected flow activity and needs of the year. [FN[FN179]] The DOP serves to develop more advantageous operations and has included alterations to flows that are not related to either hydropower or flood control. [FN[FN180]] More detailed alterations can occur during the establishment of treaty storage regulations for the individual dams, as well as through weekly coordinating meetings. [FN[FN181]]

V. The Way Forward

It is often difficult to shift strategies once they are initiated. This is particularly true for infrastructure. For example, populations protected by levee systems are often economically, socially, and politically difficult to move even if the levees become technically inadequate for dealing with river flows. As a result, selecting water management pathways that are resilient under the uncertainty of climate change is important from the start. [FN[FN182]] This is no less important for legal arrangements, some of which have taken decades to negotiate and may be difficult or awkward to alter. [FN[FN183]] The goal of developing flexible and resilient institutional arrangements will demand a thoughtful analysis of the resource in question, the potential impact of climate change, the political context ***291** between the parties and within countries, and the capacity of the parties to adapt, both technically and institutionally.

If institutional arrangements are to be adaptive, they must be designed from the outset to balance formal and political decision-making with more technical and operational management components. Fundamental to achieving this balance will be an assessment of the resource in question, including a determination of the time scale for change. In the case of surface water, there are generally clear seasonal variations in most rivers that reflect more or less consistent inter-annual variations. However, hydrological changes can also occur on a daily basis due to precipitation or snowmelt, as well as overall alterations of seasonal trends that may occur over periods of decades. [FN[FN184]]

Once the various scales of change of the resource have been established, the level of decision-making that should occur to deal with the specific change can be determined. In the operation of the Columbia River Treaty, weekly alterations to the flow regime are determined by the entities through a weekly "conference call" in response to unforeseen developments. [FN[FN185]] Monthly alterations to address seasonal changes in inflow, snow pack, and flood forecasting are conducted through treaty storage regulation, which is also determined by the dam operators as part of the operating procedures under the Treaty. [FN[FN186]] Seasonal variations on an annual level can also be accommodated through the development of an annual Detailed Operating Plan that can deviate from the prescribed or assured flow through mutual agreement of the entities operating the dam facilities. [FN[FN187]] This

level of flexibility in operating a dynamic system such as a river was incorporated in the original agreement such that there is no need to make any treaty alterations or protocols that demand decision-making at the national level. Rather, national interests are served though a permanent engineers' board to provide an independent review of the entities operating the dam facilities. [FN[FN188]] The flexibility in decision-making that exists in the Columbia River Treaty is not the norm ***292** for most international river agreements. However, even when flexibility is not as dynamic as in the Columbia River Treaty, it can be prescribed as in the case of the Farakka Barrage, where the levels of diversion between India and Bangladesh change according to the actual water in the river.

In ensuring that international waters governance agreements are able to meet challenges associated with climate change, and indeed changes in general, consideration should be given to the list of tools discussed in Part IV when developing new, or adapting existing, institutional governance arrangements. In designing institutional governance arrangements, a balance must be struck that addresses the functional needs of managing a shared resource on the one hand with the political and national interests on the other hand. If institutional arrangements are made to be overly adaptive and flexible, this can compromise the degree of political certainty that may be necessary. Certainty is not only important from a political standpoint, but also founded in the socio-economic needs of the resource users. Fresh water and marine resources provide economic benefits to parties that may provide important social and economic drivers for a nation. Take the Nile River in Egypt for example, which provides some ninety-seven percent of the water resources to Egypt, ninety-five percent of which originate outside Egypt's border. [FN[FN189]] An increase in the degree of certainty in the quantity of resources available each year makes economic planning that much more confident. Consequently, the desire for rigidity in arrangements or set quotas has its basis in socio-economic interests as well as political.

We are increasingly reminded that resources do not behave in a regular manner. There is increasing need to make rapid decisions regarding resource use, and to apply adaptive management techniques and decision-making. While adaptive management techniques are challenging to apply even within a single jurisdiction, they are even more difficult to apply inter-jurisdictionally. The multinational technical commission to assess Pollock resources in the Bering Sea is admirable in employing an adaptive management approach that mitigates the effects of climate change and other perturbations in the fish stock on a yearly basis. Similarly, the International Boundary and Water Commission of the Colorado and Rio Grande (Rio Bravo) rivers illustrates a high level flexibility in decision-making through the use of minutes as a way of updating obligations under the 1944 Colorado and Rio Grande agreement. In some circumstances only by a yielding of greater levels of ***293** sovereignty to an independent joint management body will successful adaptive management be achieved at the international level. While India and Nepal were negotiating the development and benefit sharing under the Mahakali Treaty, Nepal was eager to create an entity called the Pancheshwar Development Authority (PDA) to be independent of governments, with the goal to run the dam to maximize benefits and reduce operational costs. [FN[FN190]] The PDA was to be legal entity with borrowing capabilities and decision-making authority. [FN[FN191]] A relatively successful integration of joint authority can be found in the Senegal River where the Organisation pour la Mise en Valeur du fleuve Sénégal (OMVS-Senegal River Development Organization) controls and operates dams along the Senegal River for the benefit of all riparians. [FN[FN192]] The OMVS is a legal entity allowed to apply for loans, acquire property, and be a party in legal proceedings. [FN[FN193]]

Ultimately, the effectiveness of the institutional arrangement to adapt to change will depend not only on the mechanisms to create flexibility, but also the political commitment to successfully follow through and implement.

For example, it is questionable if the PDA would really have operated as an independent entity. As seen from the example of the Farakka Barrage, Bangladesh often has complaints regarding the Indian operations at the barrage that have nothing to do with the established mechanisms under the agreement, but rather with the apparent lack of willingness of India to abide by them.

Likewise in 2002, when the International Commission for the Conservation of Atlantic Tunas was determining allocations for the various nations, the overall amount allocated (total allowable catch) was significantly in excess of what was recommended by the scientific panel responsible for determining the sustainable yield. [FN[FN194]] When political interests outweigh technical and scientific knowledge at key decision points, successful implementation will usually be undermined. As most obstacles to international water management are not technical, but political, [FN[FN195]] it will be important to develop agreements over resources ***294** that are at least partially insulated from political interests.

[FN[FNa1]]. Glen Hearns and Richard Kyle Paisley, Global Transboundary International Waters Governance Initiative, University of British Columbia, Institute for Asian Research, Vancouver, Canada. The authors gratefully acknowledge the support and encouragement of a wide range of individuals and institutions too numerous to mention by name, including through a Global Environment Facility project entitled Good Practices and Portfolio Learning in GEF Transboundary Freshwater and Marine Legal and Institutional Frameworks. This three-year multi-donor project is dedicated to facilitating good governance and more effective decisionmaking in international waters through the identification, collection, adaptation and replication of beneficial practices and lessons learned from international experiences. The project also facilitates dialogue among individuals and organizations engaged in governance within, and between, freshwater, groundwater and marine international waters, with particular emphasis on "South-South" cooperation and learning. The key measurable benefit of the project is in ensuring that various lessons learned from multi-country experiences, including identification of areas where problems and delays are commonly experienced, are assimilated by various target audiences in a meaningful way through experiential learning. These target audiences include local water managers, governments, civil society groups, academics, and the portfolio of Global Environment Facility projects. The authors particularly gratefully acknowledge the support, encouragement, and research skills of our colleague Taylor Henshaw, without which this article would not have been possible.

[FN[FN1]]. Six critical aspects of good governance are benefit sharing, information exchange, resolving disputes, institutional design, flexibility and adaptability, and sustainable financing. See Int'l Waters Initiative, Univ. of B.C., Project Documents--Good Practices and Portfolio Learning in GEF Transboundary Freshwater and Marine Legal and Institutional Frameworks, available at governance-iwlearn.org/wp-content/uploads/2010/08/GEFbrochureOct2009.pdf.

[FN[FN2]]. The difference between weather and climate is a measure of time. Weather refers to conditions of the atmosphere over a short period of time (hours or months), and climate is how the atmosphere "behaves" over relatively long periods of time (multi-year). See What's the Difference Between Weather and Climate?, Nat'l Aeronautics and Space Admin. (Feb. 1, 2005), www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html.

[FN[FN3]]. Géraud de Ville, Climate Change - Bad News for Environmental Security, 10 Envtl. L. Rev. 175, 175

(2008) (U.K.).

[FN[FN4]]. Kurt M. Campbell et al., The Age of Consequences: The Foreign Policy and National Security Implications of Global Change 10 (2007).

[FN[FN5]]. Nigel W. Arnell, Effects of IPCC SRES Emissions Scenarios on River Runoff: A Global Perspective, 7 Hydrology & Earth Sys. Sci. 619 (2003) (Ger.).

[FN[FN6]]. The effects of climate alterations on fisheries have been acknowledged for decades. However, the extent and rapidity of the impact appear to be accelerating, based on marked changes in trophic structure as well as shifts in latitude and depth of fisheries. See Allison Perry et al., Climate Change and Distribution Shifts in Marine Fisheries, 308 Sci. 1912, 1912-15 (2005). Recharge of groundwater systems is affected both by river flow and precipitation and is thus heavily influenced by alterations in climate. See Z.W. Kundzewicz et al., The Implications of Projected Climate Change for Freshwater Resources and Their Management, 53 Hydrological Sci. J. 3, 3-10 (2008) (U.K.).

[FN[FN7]]. Water and Climate Change: How To Develop an Adaptation Strategy in Transboundary Basins: Report of the Workshop Held in Geneva 10-11 (2010), available at www.unece.org/fileadmin/DAM/env/water/meetings/Water.and.Climate/Geneva% 20workshop/report_workshop_climate_adaptation_transboundary_cooperation_ final.pdf.

[FN[FN8]]. See Sustaining the World's Large Marine Ecosystems iii (Kenneth Sherman et al. eds., 2009), available at www.lme.noaa.gov/lmeweb/downloads/book_sustain.pdf. LMEs are regions of ocean space of 200,000 square kilometers or more, which encompass coastal areas from river basins to estuaries to the outer margins of a continental shelf or the seaward extent of a predominant coastal current. LMEs are defined by ecological criteria, including bathymetric, hydrographic, productivity and trophically linked populations. Id.

[FN[FN9]]. Aaron Wolf et al., International River Basins of the World, 15 Int'l J. Water Res. Dev. 387, 391 (1999) (U.K.), available at www.transboundarywaters.orst.edu/publications/register/register_paper.html.

[FN[FN10]]. Id. at 421.

[FN[FN11]]. Id. at 392.

[FN[FN12]]. Climate models vary between the extent of alterations of temperature and precipitation; however, in general most agree that higher latitudes and higher elevations (such as the Himalayan mountains) will experience greater overall precipitation in the precipitation season, which may lead to increased incidence of flooding. Conversely, the traditional dry seasons are expected to experience less precipitation in the drier seasons increasing the risk of droughts. There are less clear trends closer to the equator and in arid zones, which are anticipated to experience greater changes in precipitation in general. See Arnell, supra note 5, at 640; see also Vivek Arora & George Boer, Effects of Simulated Climate Change on the Hydrology of Major River Basins, 106 J. Geophysical Res. Atmospheres 3335, 3335 (2001); see also Kundzewicz et al., supra note 6, at 5.

[FN[FN13]]. Scholars have also argued that many of water managers' assumptions, upon which water agreements have been developed, are no longer valid. See A. Dan Tarlock, How Well Can Water Law Adapt to the Potential Stresses of Global Climate Change?, in Northwestern Law Colloquium Series--Environmental Law 1-2 (2012), available at www.law.northwestern.edu/colloquium/environmental/documents/Spring2012_ Tarlock.pdf.

[FN[FN14]]. See generally International Freshwater Treaties Database, Or. State Univ., www.transboundarywaters.orst.edu/database/interfreshtreatdata.html (last visited Mar. 31, 2013). The database provides access to treaties from 1820 to present. Treaties have been categorized based on the terms in the treaties. There have been more treaties associated with quantity and infrastructure than other categories. Id.

[FN[FN15]]. Meredith A. Giordano & Aaron T. Wolf, Sharing Waters: Post -Rio International Water Management, 27 Natural Res. Forum 163, 169 (2003).

[FN[FN16]]. See History, Org. for Econ. Co-operation & Dev., www.oecd.org/about/history/ (last visited Mar. 30, 2013). OECD was founded in 1961 to stimulate economic growth and trade. As of 2013, it has thirty-four members that are high-income economies and have high Human Development Index ratings. Members include most European countries, NAFTA members, Australia, Japan, South Korea, and Chile. Id.

[FN[FN17]]. Stephen E. Draper & James E. Kundell, Impact of Climate Change on Transboundary Water Sharing, 133 J. Water Res. Plan. & Mgmt. 405, 413 (2007).

[FN[FN18]]. The Orange-Senqu River Commission was established through an agreement between the Republic of Botswana, the Kingdom of Lesotho, the Republic of Namibia, and the Republic of South Africa for the establishment of the Orange-Senqu River Commission, signed at Windhoek, Nov. 3, 2000. The institutional structure and operations of the commission itself have been considered as being adaptive and responsive to climate change. See Elizabeth J. Kistin & Peter J. Ashton, Adapting to Change on Transboundary Rivers: An Analysis of Treaty Flexibility on the Orange-Senqu River Basin, 24 Int'l J. Water Res. Dev. 3, 14 (2008) (U.K.), available at www.orangesenqurak.com/UserFiles/File/OtherV2/Adapting%20to%C20Change%C20on%C20Transboundary%C20Rivers%C20CSIR%2 008.pdf. The Commission has also been assessed as having promoted the concepts of integrated water resource management (IWRM) and adaptive management of water resources throughout the region. However, there are serious concerns that there is limited capacity within the institutions to actually implement such as management objectives. See Nicole Kranz & Rodrigo Vidaurre, New Approaches to Adaptive Water Mgmt. Under Uncertainty, Institution-based Water Regime Analysis Orange-Senqu Basin 13 (2008), available at www.newater.uni-osnabrueck.de/intern/sendfile.php? id=1199.

[FN[FN19]]. Kistin & Ashton, supra note 18, at 6. There are seven international agreements in the Orange-Senqu basin that address water management. These agreements include project-specific agreements, water sharing, and the development of management institutions, culminating in the creation of the Orange-Senqu River Commission in 2000.

[FN[FN20]]. Kistin & Ashton, supra note 18, at 14.

[FN[FN21]]. The Indus Waters Treaty between the Government of India, the Government of Pakistan, and the International Bank for Reconstruction and Development, Sept. 19, 1960, 419 U.N.T.S. 12 [hereinafter Indus Treaty].

[FN[FN22]]. Id. Under Article 2, India has virtually complete control of the three Eastern Rivers, Sutbji, Beas, and Ravi, while Article 3 gives Pakistan control of the Western Rivers, Indus, Chenab, and Jhelum.

[FN[FN23]]. Id. at art. 6-7.

[FN[FN24]]. While the Indus Treaty calls for cooperation and exchange of data, there is a very low level of cooperation and data exchange. See N. Kliot et al., Institutions for Management of Transboundary Water Resources: Their Nature, Characteristics and Shortcomings, 3 Water Pol'y 229, 243 (2001) (U.K.).

[FN[FN25]]. Reports from Pakistani newspapers in March 2012 indicated that in addition to already building fourteen dams including a hydro-power dam, the Government of India was intending take a portion of the Chenab River to irrigate lands in the area of Jammu. See Khalid Mustafa, India Plans To Use Chenab To Irrigate Jammu Land, News Int'l (Pak.), Mar. 13, 2012; see also Wajiha Butt, Stealing of Chenab, Pak. Times, Sept. 4, 2012.

[FN[FN26]]. Zafar Bhutta, Water Wars: Wullar Barrage Set To Figure in Pak-India Talks, Express Trib. (Pak.), Aug. 30, 2012; see also Zahid Milak, Is Pakistan Ready for Water Wars, Pak. Observer, Mar. 15, 2010. Major Indian projects that have been protested by Pakistan as not complying with the Indus Water Treaty include the Baglihar dam, the Kishanganga dam, the Nimo Bazgo dam, Salal, Wullar, Dul Hasti, and Uri Il. See also Shaheen Akhtar, Emerging Challenges to IWT: Issues of Compliance and Transboundary Impacts of Indian Hydro Projects on the Western Rivers, 28 Regional Stud., 3, 30 (2010) (Pak.).

[FN[FN27]]. India has long had plans to increase the storage capacity of the Wullar Lake on the Jhelum River to increase navigation. See Bhutta, supra note 26.

[FN[FN28]]. Alex Grzybowski et al., Beyond International Water Law: Successfully Negotiating Mutual Gains Agreements for International Watercourses, 22 Pac. McGeorge Global Bus. & Dev. L. J. 139 (2010); see also Glen Hearns, Analysis of Process: Mechanisms Promoting Cooperation in Transboundary Waters 17 (2010) (unpublished Ph.D. Dissertation, Univ. of B.C.) (on file with Univ. of B.C.), available at circle.ubc.ca/handle/2429/28367 [[hereinafter Promoting Cooperation].

[FN[FN29]]. The Indus Treaty is considered an agreement promoting “passive cooperation.” This is in stark contrast to the situation in the Columbia River, where the operation of dams in both Canada and the United States are highly integrated, optimizing flood control and power generation as well taking into consideration other interests such as recreation and fisheries. See Promoting Cooperation, supra note 28, at 83.

[FN[FN30]]. Aaron T. Wolf et al., International Waters: Identifying Basins at Risk, 5 Water Pol'y 29, 47 (2003) (U.K.).

[FN[FN31]]. United Nations Econ. Comm'n for Eur., Guidance on Water and Adaptation to Climate Change, at iii (2009), available at www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_ climate.pdf.

[FN[FN32]]. Ian Plimer, Heaven and Earth: Global Warming, the Missing Science (2009).

[FN[FN33]]. Intergovernmental Panel on Climate Change [IPCC], Climate Change 2007: Synthesis Report 2 (Nov. 12-17, 2007), available at www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.

[FN[FN34]]. Arora & Boer, supra note 12, at 3343-44; see also Nigel W. Arnell, Climate Change and Global Water Resources: SRES Emissions and Socio-economic Scenarios, 14 Global Envtl. Change 31 (2004) (U.K.); S. Manabe et al., Century-Scale Change in Water Availability: CO_2-Quadrupling Experiment, 64 Climatic Change 59, 65 (2004) (Neth.), available at www.gfdl.noaa.gov/bibliography/related_files/sm0401.pdf.

[FN[FN35]]. Manabe et al., supra note 34, at 75.

[FN[FN36]]. Manabe et al., supra note 34, at 70.

[FN[FN37]]. United Nations Educ., Scientific & Cultural Org., Water: A Shared Responsibility: The United Nations World Water Development Report 2, at 125 (2006), available at unesdoc.unesco.org/images/0014/001444/144409E.pdf.

[FN[FN38]]. Carlo del Ninno et al., Int'l Food Policy Research Inst., The 1998 Floods in Bangladesh: Disaster Impacts, Household Coping Strategies, and Response, at xv (2001).

[FN[FN39]]. Bangladesh Drought Threatens Rice Crop, BBC News Serv., Apr. 4, 1999, news.bbc.co.uk/2/hi/south_asia/311769.stm.

[FN[FN40]]. Id.

[FN[FN41]]. Treaty Between the Government of the Republic of India and the Government of the People's Republic of Bangladesh on Sharing of the Ganga/Ganges Waters at Farakka, Bangl.-India, Dec. 12, 1996, available at www.ssvk.org/koshi/reports/treaty_on_farakka_india_bangladesh_4_ganga_river_ water.pdf [hereinafter Sharing of the Ganga/Ganges Treaty]; see also Salman M.A. Salman & Kishor Uprety, Hydro-Politics in South Asia: A Comparative Analysis of the Mahakali and Ganges Treaties, 39 Nat. Resources J. 295, 304 (1999).

[FN[FN42]]. Bangladesh Accuses India of Not Releasing Ganga Water, Indio-Asian News Serv. (India), Apr. 4, 2006.

[FN[FN43]]. Farakka Lock Gate Washed Away, Statesman (India), Feb. 22, 2007, available at

www.thestatesman.net/index.php?option=com_ content&view=article&id=181283:Farakka%20lock%C20gate%C20washed% 20away&catid=35:page-one&from_page=search.

[FN[FN44]]. Arora & Boer, supra note 12, at 3344.

[FN[FN45]]. M. Aaron MacNeil et al., Transitional States in Marine Fisheries: Adapting to Predicted Global Change, 365 Philosophical Transactions of the Royal Soc'y B 3753, 3754 (2010) (U.K.).

[FN[FN46]]. Id. at 3753.

[FN[FN47]]. Id.

[FN[FN48]]. David Seckler et al., Int'l Water Mgmt. Inst., World Water Demand and Supply, 1990 to 2025: Scenarios and Issues, at 16 (1998), available at www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/PUB019/REPORT19.PDF; Charles J. Vörösmarty et al., Global Water Resources: Vulnerability from Climate Change and Population Growth, 289 Sci. 284, 287 (2000); see also United Nations Educ., Scientific & Cultural Org., supra note 37, at 6.

[FN[FN49]]. W. Neil Adger et al., Adaptation to Climate Change in the Developing World, 3 Progress Dev. Stud., 179, 190 (2003); Claudia Pahl-Wostl, Transitions Towards Adaptive Management of Water Facing Climate and Global Change, 21 Water Resource Mgmt. 49, 51 (2007) (Neth.).

[FN[FN50]]. Aaron T. Wolf et al., Conflict and Cooperation Within International River Basins: The Importance of Institutional Capacity, 125 Water Resources Update 1, 5 (2003), available at www.transboundarywaters.orst.edu/publications/abst_docs/Wolf_2003.pdf.

[FN[FN51]]. Of note is the work of Nils Petter Gelditsch and his team of researchers at the International Peace Research Institute's Centre for the Study of Civil War in Oslo, Norway. They have conducted statistical studies showing that countries sharing transboundary waters are more likely to enter into violent conflict with one another than those that do not. Furthermore, the risk of conflict increases as the amount of shared waters between the states increases. However, in conducting the research they did not measure degrees of cooperation but rather focused on conflict measurement. See Nils Petter Gleditsch et al., Conflicts over Shared Rivers: Resource Wars of Fuzzy Boundaries, 25 Pol. Geography 361, 361-382 (2006). According to Wolf, the record of acute conflict over international water is overwhelmed by the record of cooperation. See Aaron T. Wolf, Shared Waters: Conflict and Cooperation, 32 Ann. Rev. Env't & Resources 3.1, 3.7 (2007) [hereinafter Conflict and Cooperation].

[FN[FN52]]. Wolf et al., supra note 30, at 43.

[FN[FN53]]. The Rhine is a highly industrialized river suffering from various types of pollution, one of the most notable being chloride compounds. See Thomas Bernauer & Peter Moser, Reducing Pollution of the River Rhine:

The Influence of International Cooperation, 5 J. Env't & Dev. 389, at 392 (1996).

[FN[FN54]]. The Rio Grande and Colorado rivers in Mexico experience pollution due to upstream agricultural use. As greater quantities of water are used in irrigation, greater levels of salt are left in existing water, even to the point of rendering the water unusable. See Alberto Szekely, Emerging Boundary Environmental Challenges and Institutional Issues: Mexico and the United States, 33 Nat. Resources J. 33, 39 (1993).

[FN[FN55]]. The major causes of rapid change in hydrological systems are associated with climate variability, see United Nations Econ. Comm'n for Eur., supra note 31, at iii; dams or storage facilities that contain water, see Wolf et al., supra note 30, at 44; and large-scale extractions, e.g., for irrigation, see Conflict and Cooperation, supra note 51, at 3.8.

[FN[FN56]]. Vörösmarty et al., supra note 48, at 287.

[FN[FN57]]. Clionadh Raleigh & Henrik Urdal, Climate Change, Environmental Degradation and Armed Conflict, 26 Pol. Geography 674, 691 (2007).

[FN[FN58]]. Id. at 674.

[FN[FN59]]. For example, while the unrest of the occupied territories in the early 1990s was related to political, economic, and ideological factors, it is reasonable to conclude that water scarcity and its consequent economic effects contributed to the grievances behind the intifada. See Thomas Homer-Dixon, Environmental Scarcities and Violent Conflict: Evidence from Cases, 19 Int'l Security 5, 14 (1994).

[FN[FN60]]. Thomas Homer-Dixon, The Ingenuity Gap: Can Poor Countries Adapt to Resource Scarcity, 21 Population & Dev. Rev. 587 (1995); see also Erik Mostert, Conflict and Co-operation in International Freshwater Management: A Global Review, 1 Int'l J. River Basin Mgmt. 1, 2 (2003) (U.K.).

[FN[FN61]]. Promoting Cooperation, supra note 28, at 53.

[FN[FN62]]. See Indus Treaty, supra note 21.

[FN[FN63]]. Id.

[FN[FN64]]. India and Pakistan have a longstanding territorial dispute over the Kashmir region. Relations reached a low after India tested its nuclear weapons on May 11 and May 13, 1998. See India and Pakistan: Tense Neighbours, BBC News Serv., Dec. 16, 2001, news.bbc.co.uk/2/hi/south_asia/102201.stm.

[FN[FN65]]. Butt, supra note 25; Milak, supra note 26.

[FN[FN66]]. Akhtar, supra note 26, at 2.

[FN[FN67]]. The basin includes all of Hungary, most of Austria, Croatia, Romania, Slovenia and Slovakia, and significant portions of Bosnia and Herzegovina, Bulgaria, the Czech Republic, Germany, Moldova, Serbia and Montenegro, and Ukraine. Also, small portions of Albania, Italy, Macedonia, Poland, and Switzerland are included in the basin. See Andrea K. Gerlak, Strengthening River Basin Institutions: The Global Environment Facility and the Danube River Basin, 40 Water Resources Res. 1, 3 (2004).

[FN[FN68]]. Joanne Linnerooth-Bayer & Susan Murcott, The Danube River Basin: International Cooperation or Sustainable Development, 36 Nat. Resources J. 521, 524 (1996) [hereinafter Cooperation or Sustainable Development]; Joanne Linnerooth, The Danube River Basin: Negotiating Settlements to Transboundary Environmental Issues, 30 Nat. Resources J. 629, 633 (1990) [hereinafter Negotiating Settlements].

[FN[FN69]]. Cooperation or Sustainable Development, supra note 68, at 524.

[FN[FN70]]. Negotiating Settlements, supra note 68, at 630.

[FN[FN71]]. In 1856, the Treaty of Paris established the European Danube Commission and provided for free navigation on the Danube. See Ralph Johnson, Freedom of Navigation for International Rivers: What Does It Mean?, 62 Mich. L. Rev. 465, 470 (1964).

[FN[FN72]]. Convention Concerning the Regime of Navigation on the Danube, Aug. 18, 1948, 33 U.N.T.S. 518.

[FN[FN73]]. Negotiating Settlements, supra note 68, at 632.

[FN[FN74]]. Id. at 650.

[FN[FN75]]. German Federation and Czechoslovakia established local non-governmental commissions to address pollution and management of frontier water. See id. at 650.

[FN[FN76]]. The 1985 Bucharest Declaration focused on regional cooperation for pollution prevention. See id. at 645.

[FN[FN77]]. Convention on Cooperation for the Protection and Sustainable Use of the Danube River, June 29, 1994, available at www.icpdr.org/main/icpdr/danube-river-protection-convention.

[FN[FN78]]. One of the most notable cases of disputes was related to the Gabcikovo Dam project between Slovakia and Hungry in 1998, showing that conflicts persisted even during the implementation of the Danube Convention. See Case Concerning the Gabcikovo-Nagymaros Project (Hung. v. Slovk.), 1997 I.C.J. 7 (Sept. 25, 2007), available at www.icj-cij.org/docket/files/92/7375.pdf.

[FN[FN79]]. Gerlak, supra note 67, at 5. Since 1991, the Global Environment Facility has granted more than $70

million USD. Partnership Investment Fund, led by the World Bank, on nutrient reduction in the basin designed to catalyse an investment response to accelerate action. An initial grant of $20 million from GEF aims to leverage $210 million for nutrient reduction investments in agriculture, in the municipal and industrial wastewater treatment sector, and for wetland restoration.

[FN[FN80]]. This is particularly evident by the work of the Danube Environmental Forum, which was vital in coordinating environmental NGOs. See Alistair S. Rieu-Clarke, An Overview of Stakeholder Participation--What Current Practices and Future Challenges?, 18 Colo. J. Int'l Envtl. L & Pol'y 611, 628 (2007).

[FN[FN81]]. Id. at 631.

[FN[FN82]]. Albert Lepawsky, International Development of River Resources, 39 Int'l Aff. 533, 535 (1963).

[FN[FN83]]. James Kraska, Sustainable Development Is Security: The Role of Transboundary River Agreements as a Confidence Building Measure (CBM) in South Asia, 28 Yale J. Int'l L. 465, 466 (2003).

[FN[FN84]]. Id. at 466.

[FN[FN85]]. "[I]nstitutions, preferably, basin-wide, integrated development institutions, may prevent eventually acute conflicts as they regulate behavior in shared river basins." Kliot et al., supra note 24, at 252; see also Richard Kyle **Paisley** & Glen **Hearns**, Some Observations from Recent Experiences with the Governance of International Drainage Basins, in 2 Proceedings of the Symposium-Precious, Worthless, or Incalculable: The Value and Ethic of Water (A.C. Corrêa & Gabriel Eckstein, eds., 2006).

[FN[FN86]]. Developing a forum for information exchange is often an important first step toward creating greater transparency and confidence building. Informal exchange of information and data sharing are further steps not only in addressing mutual interests and concerns, but also in creating an atmosphere of trust and cooperation. See generally Ian Townsend-Gault, Preventive Diplomacy and Pro-Activity in the South China Sea, 20 Comp. Southeast Asia 171, 182 (1998) (discussing in detail the use of informal processes as a means of advancing cooperation in the contested areas in the South China Sea).

[FN[FN87]]. Acts of cooperation are viewed as a range of actions and can include, e.g., public political statements of support or intent, exchanging information, conducting joint studies. See Wolf et al., supra note 30, at 34.

[FN[FN88]]. There is a growing number of agreements and treaties regarding transboundary water resource management, with approximately 450 that have been developed on all continents. Interestingly, about twenty percent are on the continent of Africa. See Jonathan Lautze & Mark Giordano, Transboundary Water Law in Africa: Development, Nature, and Geography, 45 Nat. Resources J. 1053, 1056 (2005). Consequently, many academics conclude that, overall, water has been a focal point for cooperation as opposed to conflict. See, e.g., Jesse H. Hamner & Aaron T. Wolf, Patterns in International Water Resource Treaties: The Transboundary Freshwater Dispute Database, 1997 Colo. J. Int'l Envtl. L. & Pol'y Y.B. 157 (1998); Ashok Swain, Water Wars: Fact or Fiction, 33 Futures 769, 769-81

(2001); David Phillips et al., Trans-Boundary Water Co-operation as a Tool for Conflict Prevention and Broader Benefit Sharing (2006); Conflict and Cooperation, supra note 51, at 3.7; ShiraYoffe et al., Conflict and Cooperation over International Freshwater Resources: Indicators of Basins at Risk, 39 J. Am. Water Resources Ass'n 1109, 1124 (2003).

[FN[FN89]]. Kraska, supra note 83, at 467.

[FN[FN90]]. Id. at 491.

[FN[FN91]]. India and Nepal both signed and ratified the Mahakali Treaty in 1994, in which the institutions agreed to establish a joint management authority and construct the Pancheswar dam for hydro-power, irrigation and flood control. While the Mahakali Treaty resolved the issue of India using Nepalese territory to construct the Tanakpur barrage, the joint authority was never established and no construction of Pancheswar has been initiated. See Glen Hearns, The Mahakali River Treaty: Applying a New Lens to Past Efforts for Future Success, in Natural Resources Security in South Asia: Nepal's Water 141, 144 (Fiona Rotberg & Ashok Swain eds., 2007), available at www.silkroadstudies.org/new/docs/Silkroadpapers/2007/0710Nepal.pdf.

[FN[FN92]]. Mikiyasu Nakayama, Successes and Failures of International Organizations in Dealing with International Waters Water Resources Development, 13 Int'l J. Water Resources Dev. 367 (1997) (U.K.); A.P. Elhance, Hydropolitics: Grounds for Despair, Reasons for Hope, 5 Int'l Negotiation 201 (2000); Thomas Bernauer, Explaining Success and Failure in International River Management, 64 Aquatic Sci. 1 (2002) (Switz.); Frank G.W. Jaspers, Institutional Arrangements for Integrated River Basin Management, 5 Water Pol'y 77, 89 (2003) (U.K.); Claudia W. Sadoff & David Grey, Beyond the River: The Benefits of Cooperation on International Rivers, 4 Water Pol'y 389, 399 (2002) (U.K.).

[FN[FN93]]. Promoting Cooperation, supra note 28, at 45.

[FN[FN94]]. The functional necessity, or “environmental problem structure”, should lead to the regime design and institutional structure developed through regime formation. See Bernauer, supra note 92, at 4. In terms of river basins, for example, functional necessity can be seen as addressing: 1. development of joint projects for power production or flood control--this type is dominant as it tends to reflect infrastructure-oriented development, as with the Rio Grande, Columbia, and Senegal River basins; 2. allocation of water, particularly in arid areas--for example, the Incomati and the Niger rivers; and 3. water quality and pollution, such as the Danube and Rhine rivers. Analysis of the principal focus of agreements on transboundary rivers shows that hydropower and flood control account for thirty-nine percent and nine percent, respectively; water supply and allocation account for thirty-seven percent and industrial uses and pollution account for six percent and four percent, respectively. See Aaron T. Wolf, Conflict and Cooperation Along International Waterways, 1 Water Pol'y 251, 257 (1998) (U.K.) (discussing a complete breakdown on issues addressed by transboundary water agreements).

[FN[FN95]]. Thomas Bernauer, The Effect of International Environmental Institutions: How We Might Learn More, 49 Envtl. Institutions 351, 365 (1995).

[FN[FN96]]. See Bernauer, supra note 92, at 2. In assessing the success and failure of institutions, Bernauer argues that the major obstacles to effective management of transboundary rivers are not technical, but rather political. Success or failure of the institution will be determined by the societal processes (identifying the needs being addressed) through which the institutions are designed and implemented. Id.

[FN[FN97]]. The case of an upstream state polluting a river to the detriment of a downstream state is an example of "asymmetric" interests that generally make it more difficult to form an effective institutional regime for governance. In contrast, two states suffering from flooding have a common goal or "symmetrical" interests, making it relatively easier to develop an effective institutional regime. See Bernauer, supra note 92, at 6.

[FN[FN98]]. Promoting Cooperation, supra note 28, at ch. 3.

[FN[FN99]]. In 1944, the governments of Canada and the United States asked the International Joint Commission (IJC) to investigate and recommend a plan of development for the upper portions of the Columbia Basin. At the time, the United States produced 40.3 billion kWh per year on the Columbia, compared to Canada's 2.7 billion kWh. The IJC created the International Columbia River Engineering Board (ICREB) to analyse use of the waters with respect to: domestic water supply, navigation, efficient power, flood control, reclamation, conservation of fish and wildlife, and other benefits. The IJC further developed sixteen principles for equitable sharing of benefits. See Report of the International Joint Commission United States and Canada on Principles for Determining and Apportioning Benefits from Cooperative Use of Storage of Waters & Electrical Inter-connection Within the Columbia River System (1959), available at www.crt2014-2024review.gov/Files/IJC.pdf.

[FN[FN100]]. Third-party involvement in the Pancheshwar dam project was critical for Nepal on two major accounts. The first was developing the capacity to create project assessments and negotiate with India as an equal in terms of knowledge of the substantial aspects of the project. These included calculation of the potential value of benefits accruing. The second was the third-party's ability to act as a watchdog to ensure equitable sharing in developing an agreement. See Hearns, supra note 91, at 159.

[FN[FN101]]. Promoting Cooperation, supra note 28, at ch. 3.

[FN[FN102]]. Richard Kyle Paisley, Adversaries into Partners: International Water Law and the Equitable Sharing of Downstream Benefits, 3 Melb. J. Int'l L. 280, 299 (2002) (Austl.).

[FN[FN103]]. While building trust (or confidence) may not directly address a functional necessity, it does so indirectly through enhancing confidence-building structures, which allow actors to develop actions or mechanisms that can address functional needs such as biodiversity preservation, pollution control, and overfishing. Building trust among actors was one of the key objectives behind the South China Sea Informal Working Group's activities for close to ten years. Although one of the fundamental driving forces behind the project was the resolution of the Spratly Island dispute, initial discussions focused on information exchange and developing and understanding legal principles. Over time, as confidence was built, areas of mutual concern, such as biodiversity and pollution control, were also addressed. See Townsend-Gault, supra note 86, at 183-187.

[FN[FN104]]. Promoting Cooperation, supra note 28, at 128.

[FN[FN105]]. Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea, Feb. 11, 1994, available at www.afsc.noaa.gov/REFM/CBS/Docs/Convention%20on%C20Conservation%C20of%C20Pollock%C20in%C20Central%C20Bering%S ea.pdf [hereinafter Pollock Agreement]. The Bering Sea Pollock Convention is an agreement to sustainably manage the Pollock resources of the "doughnut hole" in the Bering Sea. This is an area of international waters that has traditionally been fished by Russia, the United States, and distant fishing nations. The convention is based on scientific determination of the sustainable yield of the Pollock resource each year, to set quotas for the various nations. The contracting members are Russia, Poland, China, Japan, South Korea, and the United States. Id.

[FN[FN106]]. Id. at art. 9. The signatories to the Pollock agreement include the United States, China, Russia, South Korea, and Poland. Id.

[FN[FN107]]. Kundzewicz et al., supra note 6, at 7.

[FN[FN108]]. Id.

[FN[FN109]]. Data gaps will always exist in resource management. Uncertainty about systems and lack of data should not be excuses to postpone important management decisions. Techniques such as structured decisionmaking can help make the best decisions with current data. See Julien Martin et al., Structured Decision Making as a Conceptual Framework To Identify Thresholds for Conservation and Management, 19 Ecological Applications 1079, 1089 (2009).

[FN[FN110]]. In 1995, the water used for irrigation represented approximately eighty percent of global water withdrawal and as much as eighty-six percent in developing countries. See Mark Rosegrant et al., Int'l Food Policy Research Inst., World Food and Water to 2025: Dealing with Scarcity 1, 110 (2002).

[FN[FN111]]. Id.

[FN[FN112]]. Jacques Leslie, Deep Water: The Epic Struggle over Dams, Displaced People, and the Environment (2005).

[FN[FN113]]. United Nations Econ. Comm'n for Eur., supra note 31, at 78.

[FN[FN114]]. Int'l Bank for Reconstruction & Dev./World Bank, Water Resources Sector Strategy: Strategic Directions for World Bank Engagement 6 (2004), available at www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2004/06/01/000090341_20040601150257/Rendered/PDF/28114.pdf.

[FN[FN115]]. See id. at 6-7 (citing to Ministry of Env't, Spain, Libro Blanco del Agua en España (2000)).

[FN[FN116]]. Bernauer, supra note 92, at 2. Despite cooperation over transboundary water being usually more efficient from an economic standpoint than conflict, political obstacles to negotiations of transboundary waters continue to exist. See also Aaron T. Wolf, International Water Conflict Resolution: Lessons from Comparative Analysis, 13 Int'l J. Water Resources Dev. 333, 358 (1997) (U.K.).

[FN[FN117]]. Traditional management assumptions: 1. there are single public sector decisionmakers; 2. impacts are of a manageable size; 3. values are known and static; 4. time can addressed through discounting methods of future costs and benefits; 5. uncertainty can by manageable; and 6. the system under study can be seen as linear--are not valid when addressing complexities associated with climate change. See M. Granger Morgan et al., Why Conventional Tools for Policy Analysis Are Often Inadequate for Problems of Global Change, 41 Climatic Change 271, 271 (1999) (Neth.).

[FN[FN118]]. Thomas Dietz et al., The Struggle To Govern the Commons, 302 Sci. 1907, 1907 (2003).

[FN[FN119]]. The assumptions that regional water balances will remain relatively stable over time must be abandoned, putting into question the applicability of our current governance systems. See Tarlock, supra note 13, at 2.

[FN[FN120]]. Carl Folke et al., Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations 51 (2002).

[FN[FN121]]. Dietz et al., supra note 118, at 1908-09.

[FN[FN122]]. International waters involve numerous countries and are necessarily complex in nature, due to social and political conditions in addition to the aspects of resource management. See Juha I. Uitto & Alfred M. Duda, Management of Transboundary Water Resources: Lessons from International Cooperation for Conflict Prevention, 168 Geographical J. 365, 376 (2002) (U.K.).

[FN[FN123]]. See generally United Nations Dev. Programme-Global Env't Facility, Int'l Waters Project, International Waters: Review of Institutional Frameworks (2011), available at governance-iwlearn.org/wp-content/uploads/2011/07/International-Waters-Report-White-and-Case.pdf. The following list has been developed from a study of twenty-eight transboundary freshwater and marine legal and institutional frameworks. Id.

[FN[FN124]]. Mostert, supra note 60, at 1.

[FN[FN125]]. Kurt Taylor Gaubatz, Democratic States and Commitment in International Relations, 50 Int'l Org. 109 (1996). States may also enter into one agreement that may not provide obvious mutual gains so that advantages can be leveraged in other areas. Also, a state may be coerced into signing an agreement by a more powerful neighbor through hydro-hegemony. See Mark Zeitoun & Jeroen Warner, Hydro-Hegemony--A Framework for Analysis of Trans-Boundary Water Conflicts, 8 Water Pol'y 435 (2006) (U.K.); see also Grzybowski et al., supra note 28.

[FN[FN126]]. Good Practices and Portfolio Learning in GEF Transboundary Freshwater and Marine Legal and Institutional Frameworks Project, In-Depth Case Analysis for Nile River Basin 9 (2010), available at governance-iwlearn.org/wp-content/uploads/2010/09/NILE-FORMATTED.pdf.

[FN[FN127]]. Id. at 4.

[FN[FN128]]. The Nile Basin Initiative (NBI) is an inter-governmental body established to promote cooperation within the Nile Basin. It is headed by the Nile Council of Ministers and is administered through the Nile Secretariat in Entebbe. About Us, Nile Basin Initiative, www.nilebasin.org/newsite/index.php? option=com_content&view=section&layout=blog&id=5&Itemid=68&lang=en (last visited Apr. 1, 2013).

[FN[FN129]]. South Sudan became a member in July 2012. See South Sudan Admitted to the Nile Basin Initiative, Nile Basin Initiative, www.nilebasin.org/newsite/index.php?option=com_ content&view=section&layout=blog&id=5&Itemid=68&lang=en (last visited Apr. 2, 2013).

[FN[FN130]]. The Shared Vision was announced when the Nile Basin Initiative was established on Feb. 22, 1999. Nile Basin Initiative, supra note 128.

[FN[FN131]]. The Convention for the Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region; and Protocol, Mar. 23, 1981. The Convention and its protocol concerning cooperating in combating pollution in cases of emergency came into force in Aug. 5, 1984. See The Convention, Abidjan Convention Secretariat, abidjanconvention.org/index.php?option=com_ content&view=article&id=46&Itemid=103 (last visited Apr. 2, 2013). The Convention Protocol and other articles are available on the webpage. See id.

[FN[FN132]]. Good Practices and Portfolio Learning in GEF Transboundary Freshwater and Marine Legal and Institutional Frameworks Project, In-Depth Case Study of the Guinea Current Large Marine Ecosystem 4 (2012), available at governance-iwlearn.org/wp-content/uploads/2012/06/GCLME.pdf.

[FN[FN133]]. The Contracting Parties, Abidjan Convention Secretariat, abidjanconvention.org/index.php?option=com_ content&view=article&id=49&Itemid=138 (last visited Apr. 2, 2013). Other states in the process of ratifying the Abidjan Convention are Angola, Cape Verde, Democratic Republic of the Congo, Equatorial Guinea, Namibia, and Sao Tome & Principe. Id.

[FN[FN134]]. Promoting Cooperation, supra note 28, at 89.

[FN[FN135]]. Treaty Between His Majesty's Government of Nepal and the Government of India Concerning the Integrated Development of the Mahakali River Including the Sarada Barrage, Tanakpur Barrage and Pancheshwar Project, India-Nepal, Feb. 12, 1996, available at www.ecolex.org/server2.php/libcat/docs/TRE/Bilateral/Other/bi-17432.pdf.

[FN[FN136]]. Sharing of the Ganga/Ganges Treaty, supra note 41, at art. X.

[FN[FN137]]. Treaty Relating to Cooperative Development of the Water Resources of the Columbia River Basin, U.S.-Can., opened for signature Jan. 17, 1961, 542 U.N.T.S. 244, [hereinafter Columbia River Treaty-CRT].

[FN[FN138]]. Agreement on Co-operation for Sustainable Development of the Mekong River Basin, Apr. 5, 1995, 34 I.L.M. 864 (1995).

[FN[FN139]]. Agreement on Co-operation for Sustainable Development of the Mekong River Basin, art. 37, Apr. 5, 1995, 34 I.L.M. 864 (1995).

[FN[FN140]]. Good Practices and Portfolio Learning in GEF Transboundary Freshwater and Marine Legal and Institutional Frameworks, Bay of Bengal, 199.180.129.170/watergov/index.php/Bay_of_Bengal (last visited on Apr. 2, 2013). "The Agreement on the Institutionalisation of the Bay of Bengal Programme as an Inter-Governmental Organisation ('Agreement') was signed on [[April 26, 2003] in Chennai, India (with the Maldives signing the Agreement on [[May 21, 2003])." Id. The Agreement aims to enhance cooperation among the Member States, as well as with other countries and organizations in the region, and to provide technical and managerial support for the development and management of sustainable coastal fisheries in the Bay of Bengal region. Members are Bangladesh, India, the Maldives, and Sri Lanka. There have also been discussions for other countries in the Bay of Bengal region (such as Myanmar, Thailand, and Indonesia) to join. See id.

[FN[FN141]]. Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, art. 16, adopted Feb. 16, 1976 (entered into force Feb. 12, 1978), amended June 10, 1995 (entered into force July 9, 2004), available at 195.97.36.231/dbases/webdocs/BCP/bc95_Eng_p.pdf [[hereinafter Barcelona Convention, as amended]. The convention focuses on integration of environmental priorities and economic development in national policy; assessment, prevention, and elimination of pollution; conservation of nature, landscapes, and sites of ecological or cultural value; and broadening both public awareness of threats to the Mediterranean and public participation in conservation and remedial measures. Id.

[FN[FN142]]. See Promoting Cooperation, supra note 28, at 171, tbl. 3.14. Treaty development can be a relatively slow process. The Treaty Relating to Cooperative Development of the Water Resources of the Columbia River Basin took almost twenty years to negotiate (1945-1964); Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin took ten years to negotiate (1985-1995); Convention on Cooperation for the Protection and Sustainable use of the Danube River took an nearly ten years to negotiate (1985-1994); the Treaty Between His Majesty's Government of Nepal and the Government of India Concerning the Integrated Development of the Mahakali River Including the Sarada Barrage, Tanakpur Barrage and Pancheshwar Project took eighteen years, and Article 40, Annex III, of the Interim Agreement on the West Bank and the Gaza Strip, took an estimated five years to negotiate. Id.

[FN[FN143]]. See generally Peter Malanczuk, Akehurst's Modern Introduction to International Law (7th ed. 1997); see also Philippe Sands et al., Principles of International Environmental Law (3d ed. 2012).

[FN[FN144]]. Framework Convention for the Protection of the Marine Environment of the Caspian Sea 1-12, Nov. 4, 2003, (entered into force Aug. 12, 2006), 44 I.L.M.1 (2005), available at www.jstor.org/stable/20694518. The convention promotes cooperation amongst the Caspian Sea nations for the protection of the environment including fisheries and ecosystems. The substantive actions are addressed under protocols. Contracting members are Azerbaijan, the Islamic Republic of Iran, Kazakhstan, the Russian Federation, and Turkmenistan. Id.

[FN[FN145]]. Barcelona Convention, as amended, supra note 141, at art. 15. Six protocols have been developed for pollution caused by dumping, oil spills, land based sources, ships in cases of emergency, the development of special protected areas, and integrated coastal zone management. Contracting parties include Albania, Algeria, Bosnia and Herzegovina, Cyprus, the European Community, Croatia, Egypt, Spain, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Morocco, Monaco, Montenegro, Slovenia, Syria, Tunisia, and Turkey. Id.

[FN[FN146]]. Id. at art. 23.

[FN[FN147]]. Framework Convention for the Protection of the Marine Environment of the Caspian Sea, supra note 144, at art. 24.

[FN[FN148]]. See, e.g., The Protocol Concerning Regional Preparedness, Response and Co-operation in Combating Oil Pollution Incidents to the Framework Convention on the Protection of the Marine Environment of the Caspian, opened for signature Aug. 12, 2011 (adopted and signed at the Third Meeting of the Conference of the Parties (COP3) in Aktau, Kazakhstan), available at www.ecolex.org/server2.php/libcat/docs/TRE/Multilateral/En/TRE157714.pdf; The Protocol for the Protection of the Caspian Sea Against Pollution from Land-based Sources and Activities, Dec. 12, 2012, available at www.tehranconvention.org/IMG/pdf/Protocol_on_Pollution_from_Land_Based_Sources_ and_Activities.pdf.

[FN[FN149]]. Alan E. Boyle, Saving the World? Implementation and Enforcement of International Environmental Law Through International Institutions, 3 J. Envtl. L. 229, 238 (1991) (U.K.).

[FN[FN150]]. Glen Hearns, The Columbia River Treaty: A Synopsis of Structure, Content, and Operations 22 (2008), available at www.ccrf.ca/uploads/Hearns_CRT_ Structure_and_Content_Finalrev_20091207.pdf.

[FN[FN151]]. Within the framework of the Columbia River Treaty, the parties may agree to a flow that deviates from the flow prescribed under the Treaty, providing it is mutually beneficial to do so. Both nations have applied this and have developed supplementary agreements, referred to as the non-power uses agreements. See Columbia River Treaty-CRT, supra note 137, at art. XIV(2)(k).

[FN[FN152]]. Agreements have been developed to reduce flows from Canadian storage facilities between January 1 and March 31 to reduce the possibility of Mountain Whitefish eggs being flushed downstream. Conversely, agreements have been made to increase flows between April 1 and June 30 to ensure sufficient flows for rainbow trout spawning. See Glen Hearns, Environmental Discussion Paper, Columbia River Treaty Review 10 (Nov. 2012), available at blog.gov.bc.ca/columbiarivertreaty/files/2012/07/CRT-Environmental-Discussion-Paper_-Revised1.pdf.

[FN[FN153]]. Columbia River Treaty-CRT, supra note 137, at art. XIV. The entities to the Columbia River Treaty are BC Hydro for Canada, and Bonneville Power Authority, and the Army Corps of Engineers for the United States. The entities can forgo diplomatic formalities when making decisions regarding alterations in reservoir levels for flow or flood protection.

[FN[FN154]]. See Hearns, supra note 150, at 24. An example of this is the Columbia River Treaty Entity Agreement on Operation of Treaty Storage for Non-power Uses for January 1 through July 31 (Non-Power Uses Agreements). Id.

[FN[FN155]]. Agreement on the Development and Utilization of the Water Resources of the Komati River Basin between the Government of the Republic of South Africa and the Government of the Kingdom of Swaziland, Oct. 7, 1992, available at www.kobwa.co.za/index.cfm?objectid=F94F0F82-E0C4-BB9D-74C535BB1E2E23FA. The treaty is between South Africa and Swaziland and paved the way for the Komati River Basin Development Project to jointly develop the resources of the River. Id.

[FN[FN156]]. Id. at art. 4.1.

[FN[FN157]]. Draper & Kundell, supra note 17, at 410.

[FN[FN158]]. Sharing of the Ganga/Ganges Treaty, supra note 41, at Annex II.

[FN[FN159]]. Id. at art. 2, Annex II.

[FN[FN160]]. Id.

[FN[FN161]]. Agreement between the United Arab Republic and the Republic of Sudan for the Full Utilization of the Nile Waters, U.A. Rep.-Sudan, Nov. 8, 1959, 6519 U.N.T.S. 63.

[FN[FN162]]. Id. at art. 4(1)e. No mention is made of what parameters are to be taken into consideration when determining what constitutes a fair allocation of water between them. Id.

[FN[FN163]]. Joint work conducted between the parties requires decisions or recommendations in the form of Minutes that are binding on the governments once approved by the heads of the International Boundary Water Commission. See Richard Kyle Paisley et al., Transboundary Water Management: An Institutional Comparison Among Canada, the United States and Mexico, 9 Ocean & Coastal L. J. 177, 189 (2004).

[FN[FN164]]. See Treaty between the United States of America and Mexico relating to the utilization of the Waters of the Colorado and Tijuana Rivers and of the Rio Grande, U.S.-Mex., art. 25, Feb. 3, 1944, 59 Stat. 1219.

[FN[FN165]]. Int'l Boundary and Water Comm'n, Adjustment of Delivery Schedules for Water Allotted to Mexico

for the Years 2010 Through 2013 as a Result of Infrastructure Damage in Irrigation District 014, Rio Colorado, Caused by the April 2010 Earthquake in the Mexicali Valley, Baja California, Minute 318 (Dec. 17, 2010), available at www.ibwc.state.gov/Files/Minutes/Min_318.pdf.

[FN[FN166]]. Christopher Brown, Transboundary Water Resource Issues on the US-Mexico Border, Vertig O, Hors-série
2, at 7 (2005) (Can.), available at vertigo.revues.org/1883.

[FN[FN167]]. See, e.g., Convention on the Sustainable Management of Lake Tanganyika, June 12, 2003, available at lta.iwlearn.org/documents/the-convention-on-the-sustainable-management-of-lake-tanganyika-eng.pdf/view; Agreement Revising the Agreement Concerning the Niger River Commission and the Navigation and Transport on the River Niger of 25 November 1964, art. 8, June 15, 1973, 1346 T. S. I-22674, available at treaties.un.org/doc/Publication/UNTS/Volume1 346/volume-1346-I-22674-English.pdf; see also Revised Protocol on Shared Watercourses to The Treaty of the Southern African Development Community art. 5(1), Aug. 14, 2001, available at www.internationalwaterlaw.org/documents/regionaldocs/Revised-SADC-SharedWatercourse-Protocol-2000.pdf.

[FN[FN168]]. Pollock Agreement, supra note 105.

[FN[FN169]]. Id. at art II.

[FN[FN170]]. See Pollock Agreement, supra note 105.

[FN[FN171]]. Id. at art III.

[FN[FN172]]. Id. at art X.

[FN[FN173]]. Id. at 3.

[FN[FN174]]. Id.

[FN[FN175]]. Hearns, supra note 150, at 27.

[FN[FN176]]. Id. at 1. See also Columbia River Treaty-CRT, supra note 137, at arts. II, III and IV.

[FN[FN177]]. Columbia River Treaty-CRT, supra note 137, at art. XIV.

[FN[FN178]]. Id. at Annex A, Principles of Operation.

[FN[FN179]]. Hearns, supra note 150, at 20.

[FN[FN180]]. Id.

[FN[FN181]]. Id.

[FN[FN182]]. United Nations Econ. Comm'n for Eur., supra note 31, at 36.

[FN[FN183]]. See Hearns, supra note 150, at 6. Canada and the United States requested that the International Joint Commission establish a technical committee and recommend a plan for the development of the Columbia Basin in 1944, some twenty years before the Columbia River Treaty was ratified. Id.

[FN[FN184]]. Analysis of water levels on the Coldwater River in British Columbia shows that the average commencement of the spring freshet between 1985 and 2003 was about twenty days earlier than it had been between 1965 and 1985. See Todd Hatfield Nicola, River Watershed--Water Use Management Plan Instream Flow Needs for Fish 11, at app. A (2006), available at www.nwcrt.org/downloads/Hatfield-2006-Nicolainstreamflowsforfish.pdf. While this is a smaller river entirely within Canada, it shows that there are decadal trends in river systems that need to be accounted for in agreements dealing with rivers. This is especially necessary if specific seasonal water allocations are set into the agreement with dates.

[FN[FN185]]. Hearns, supra note 150, at 20.

[FN[FN186]]. Id.

[FN[FN187]]. Id.; see also Columbia River Treaty-CRT, supra note 137, at art. XIV(2)(k).

[FN[FN188]]. Hearns, supra note 150, at 18; see also Columbia River Treaty-CRT, supra note 137, at art. XV.

[FN[FN189]]. Peter H. Gleick, Water and Conflict: Fresh Water Resources and International Security, 18 Int'l Sec. 79, 86 (1993).

[FN[FN190]]. Promoting Cooperation, supra note 28, at 262.

[FN[FN191]]. Id. at 237.

[FN[FN192]]. See Convention Creating the Organization for the Development of the Senegal River, Guinea-Mali.-Mauritania-Sen., May 11, 1972, available at www.tematea.org/?q=node/6578&PHPSESSID=8158061ce856872aeabe2b109d4aaf0c. The OMVS was established in 1972 for the cooperative development of the resources of the Senegal River. The initial member countries were Mali, Senegal, and Mauritania. Guinea is now part to the agreement as well. Id.

[FN[FN193]]. Id. at art. 1 (3).

[FN[FN194]]. Anthony Cox, Quota Allocation in International Fisheries (OECD Food, Agriculture and Fisheries Papers No. 22) 2, 16 (2009).

[FN[FN195]]. Bernauer, supra note 92, at 2.

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