

A legal obligation to adapt transboundary water agreements to climate change?

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Abstract

Climate change disrupts the water cycle, jeopardises the security of water, food, and energy systems, and forces states to rethink water management practices to adapt to the new hydrological realities. When states share a water resource, adaptation to climate change proves to be more burdensome, especially if the resource in question is governed by a transboundary water agreement that fails to incorporate flexibility. The focus of this paper is on transboundary water basins with more than two riparian states, where only part of the co-riparian states are party to a transboundary water agreement. The paper discusses whether the recognition of the principle of equitable and reasonable use of water as a principle of customary international law creates an obligation for the party states to such agreements to adapt the terms of their arrangement to climate change. It argues that the principle of equitable and reasonable use of water establishes an obligation of conduct for the states to respect non-parties' riparian rights to a fair share of beneficial uses of water and protect the environment. Therefore, the nature of disruptions caused by climate change may make it imperative for the party states to take all possible measures that allow them to modify their water practices under an agreement to the implications of climate change in order to comply with the principle of equitable and reasonable use of water.

Keywords: Adaptation; Climate change; Flexibility; Transboundary water agreements

Highlights

- The paper discusses the possibility of the existence of an obligation to amend transboundary water agreements to implications of climate change.
 - Adherence to the principle of equitable and reasonable use of water requires ability to adapt water management practices to new hydrological realities created by climate change.
 - Riparian states of a transboundary water basin are free to define their share of beneficial uses of a shared water resource, as long as such definition does not compromise the status of the water and the right of non-party states.
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Introduction

Historically, states have always found it useful to define their rights over their shared water resources through treaties. Concluding transboundary water treaties has many advantages for the co-riparian states. These agreements stabilize the relations of the states concerning their shared freshwater systems (McCaffrey, 2003); they clarify property rights over water and prevent states from moving towards coercion and grabbing resources from others (Ansink *et al.*, 2015); they pave the way for information exchange; and they create the potential for the establishment of joint management mechanisms. Moreover, basins with institutional mechanisms, like treaties, are less prone to conflicts (Yoffe *et al.*, 2003).

However, climate change is altering the hydrological cycle and shaping a new reality for water resources. If agreements governing these resources fail to allow for flexibility to the new hydrological reality, their stability and effectiveness will be compromised.

Increase in greenhouse gas concentration has already changed the precipitation and snowmelt patterns, and the intensity and the extremes of rainfall (Jiménez Cisneros *et al.*, 2014). New findings of the Intergovernmental Panel on Climate Change (IPCC) suggest that this trend is likely to continue, intensify and accelerate in the upcoming years, should the attempts to limit global warming to 1.5 °C until 2030 fail (Masson-Delmotte, 2018). Therefore, states face a highly uncertain future of water availability from both qualitative and quantitative perspectives and need to adapt the governance regime of their transboundary water resources to ensure their needs are met.

There is little debate on the importance of adapting transboundary water agreements to climate change. Transboundary water basins contain nearly 60 per cent of the global freshwater supply. Water stress in these basins is already high under current climate variability. Climate change will only add to such pressure and could render agreements that are in place obsolete unless effective steps are taken to adjust these agreements to flow variability and availability of clean water (Benvenisti, 1996; Koremenos, 2001; Vinogradov *et al.*, 2003; Fischhendler, 2004, 2008; Bhaduri, 2006; Drieschova *et al.*, 2008).

Experts have prescribed various mechanisms that could help to adapt water agreements to climate change. McCaffrey (2003), Fischhendler (2004) and Cooley & Gleick (2011) have argued that adjustable allocation strategies, amendment and review procedures, joint management institutions, and response strategies for extreme water events could lead to higher flexibility of water agreements to climate change. Drieschova & Fischhendler (2011) have developed a tool kit for identifying uncertainty management strategies that can reduce the vulnerability of water agreements to uncertainties arising from climate change, amongst others. Drieschova *et al.* (2008) have looked into the incorporation of indirect allocation mechanisms in water treaties and their potential to create open-ended rules for water regulation that allows adaptation to changes while accommodating the sovereignty and power concerns of riparian states.

Beyond academia, the Guidance on Water and Adaptation to Climate Change¹ (Kirby & Edgar, 2009) suggests that any provision aimed at increasing climate change flexibility of transboundary water agreements should consider water variability and hydrological extremes and allow for temporal and spatial redistribution of water and periodic review of water allocation schemes.

¹ The Guidance on Water and Adaptation to Climate change was drafted following a mandate from the Meeting of the Parties to the Convention on the 1992 Protection and Use of Transboundary Water Courses and in the spirit of such convention.

Moreover, the current body of literature includes extensive discussions on the practicality of provisions suggested for adapting transboundary water agreements to climate change. [Ansink & Ruijs \(2008\)](#) have discussed the stability of water allocation agreements to climate change. They showed that although proportional allocation schemes are more efficient in the face of climate change, their inclusion in water allocation agreements compromises the agreements' stability. Furthermore, in my earlier work ([Jafroudi, 2018](#)) I assessed how conditioning a treaty's water allocation arrangements on updateable historical mean precipitation values may contribute to climate change adaptability of water allocation agreements.

However, as confirmed by UNECE's study ([2015](#)), many transboundary water agreements existed before adaptation to climate change entered the discourse of water management, and therefore assume relatively fixed water conditions in their relevant basins. Such agreements could be revised and amended with the consent of the states, and states may consider revising and amending them if changes make the treaties obsolete. However, in this paper, I argue that states not only *can* consent to adapt the terms of their transboundary agreements to the implications of climate change for their own benefit, but also may be under an *obligation* to do so, if continuing to abide by the terms of such agreement would risk them to breach their non-treaty related obligations under international law.

The main question of this paper is whether the recognition of the principle of equitable and reasonable use of water as a principle of customary international law creates an obligation for the party states to a transboundary water agreement to adapt the terms of their arrangement to climate change. My focus in the paper is on transboundary water basins with more than two riparian states, where only part of the co-riparian states are party to the transboundary water agreement. Conclusions of this study are therefore only applicable to about one third of transboundary rivers ([UN-Water, 2018](#))².

Through a textual analysis of various international treaties, judicial decisions, and soft law instruments, I first identify the goal of the principle of equitable and reasonable use of water. I particularly focus on three categories of documents: (1) international conventions and soft law instruments that are known to have codified the principle of equitable and reasonable use of water; (2) multilateral and bilateral basin-specific treaties invoking the principle of equitable and reasonable use of water; (3) the rulings of the International Court of Justice (ICJ) and its predecessor the Permanent Court of International Justice (PCIJ) in interpreting the principle of equitable and reasonable use of water.

After identifying the goal of the principle of equitable and reasonable use of water, I argue what obligations arise from this principle for the behaviour of riparian states of a transboundary basin towards each other and towards the basin itself. I then discuss whether compliance with such obligations under climate change could require adaptation of water use practices. I argue that if non-flexibility of an international water agreement prevents the party states from adapting their use from a transboundary water resource to the implications of climate change, they will be under an obligation to amend such agreement.

Deciphering the principle of equitable and reasonable use of water

The principle of equitable and reasonable use of water is one of the cornerstones of international freshwater law ([de Chazournes et al., 2019](#)). Not only it is reflected in numerous national and

² Note that a study by [Wolf \(1998\)](#) on transboundary water treaties showed that multilateral basins are, almost without exception, governed by bilateral treaties.

international judicial decisions³, and non-binding instruments dealing with navigational and non-navigational uses of water resources⁴. It is also captured by landmark treaties such as the Convention on the 1992 Protection and Use of Transboundary Water Courses and International Lakes⁵, and the 1997 United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses⁶.

Like most principles of customary international law, the definition of the principle of equitable and reasonable use of water is largely vague to allow for flexibility (Dellapenna, 2006). It requires the states to take into account considerations of fairness in exercising their rights and performing their obligations while using the freshwater resources which they share with others (Sands & Peel, 2018).

The majority of international instruments interpret the fairness in exercising riparian rights concerning a transboundary basin as the equal entitlement of each riparian state to beneficial uses of the water of such basin. This reading of the principle of equitable and reasonable use of water comes from the notion of ‘perfect equality of states’ enshrined, inter alia, in the judgment of the PCIJ in the case relating to the Territorial Jurisdiction of the International Commission of the River Oder. In this case, the court ruled out any preferential privilege of any one of the riparian states over others in using the water of the basin for navigational purposes. In the case of Gabčíkovo-Nagymaros, the International Court of Justice (ICJ) confirmed the extension of the equal entitlement of riparian states to non-navigational uses of waters.

Many basin-specific agreements confirm that the equal entitlement of riparian states to beneficial uses of water resources sits in the centre of the principle of equitable and reasonable use of water. Examples include the Nile River Basin Cooperative Framework⁷ and the Agreement on the Sava River Basin⁸.

In contrast, under some other international instruments, fairness in water use is obligation-based. For example, the Watercourse Convention establishes an obligation for the states to ‘utilize’ and to ‘participate in the use, development and protection’ of an international watercourse in an equitable and reasonable manner. The convention further clarifies that to attain the criteria of equitability and reasonability states must take into account (1) the interests of co-riparian states and (2) adequate protection of the basin in question⁹.

The Water Convention takes the same approach and requires states ‘... to ensure that transboundary waters are used in a reasonable and equitable way, taking into particular account their transboundary character, in the case of activities which cause or are likely to cause transboundary impact’¹⁰.

³ For international decisions, see the judgment of the International Court of Justice in the case concerning Gabčíkovo-Nagymaros Project. For national judicial decisions, see the US Supreme Court decisions in cases *Idaho ex rel. Evans v. Oregon* (1980), *Wyoming v. Colorado* (1922).

⁴ See the Resolution on the Use of International Non-Maritime Water of 11 September 1961 by the Institute of International Law and the Helsinki Rules on the Uses of the Waters of International Rivers of August 1966.

⁵ Herein after, Water Convention

⁶ Herein after, Watercourse Convention

⁷ See article 4.

⁸ See article 7.

⁹ See article 5.

¹⁰ See article 2(2)(c).

Amongst soft law documents, the principle of equitable and reasonable use of water under the ILA's Berlin Rules¹¹ (ILA, 2004) requires states to use their shared water resources with due regards to the rights of the other co-riparian states and consistent with adequate protection of waters.

The ICJ seems to have tackled the principle of equitable and reasonable use of water from both right-based and obligation-based perspectives. In the *Gabčíkovo-Nagymaros* case, the ICJ first refers to the basic right of Hungary to an equitable and reasonable share of the Danube basin, and then immediately addresses the corresponding obligation of Czechoslovakia by classifying Czechoslovakia's action in putting Variant C into operation as an internationally wrongful act. Similarly, in the case concerning *Pulp Mills on the River Uruguay* the Court recognizes the parties' rights as co-riparians to an equitable and reasonable share of the beneficial uses of the river. However, it maintains that such use 'could not be considered to be equitable and reasonable if the interest of the other riparian State in the shared resource and the environmental protection of the latter were not taken into account.'

This ruling by the ICJ allows for the reconciliation of the right-based and obligation-based approaches in interpreting the principle of equitable and reasonable use of water. Accordingly, the principle of equitable and reasonable use of water may be defined as a principle of customary international law, whose goal is to establish fairness amongst the riparian states in the absence of an agreement between them. To achieve this goal it is necessary to:

1. Recognize the rights of individual basin states to the beneficial uses of waters of a shared resource
2. Acknowledge that water use practices by each riparian state shall be consistent with environmental protection
3. Establish a harmony between the rights of each riparian state to the waters of a shared basin and the obligation of each of them to protect the environment.

The obligation of the states to equitable and reasonable use of transboundary water resources should be understood in line with these three points. This implies that in making use of their transboundary water resources, riparian states are obliged to take all measures to ensure their use from their transboundary water resources does not interfere with the right of the co-riparian states to beneficial water use, and will be consistent with the requirements of environmental protection of the transboundary water resource.

In line with the law of treaties, when two or more states enter into an agreement over the use of a shared water resource, their relationship towards one another concerning such resource is no longer in the realm of the principle of equitable and reasonable use of water. However, their obligations towards non-party riparian states remain to be subject to such principle. Thus, to establish whether parties to a transboundary water agreement that does not allow flexibility to climate change need to amend their agreements under the impacts of climate change, we first need to establish whether climate change could impede such parties from fulfilling their obligations to respect the right of non-party co-riparian states to beneficial water use, or to protect the environment of the transboundary water resource.

¹¹ The Berlin Rules is a document adopted by ILA to summarize international law customarily concerning freshwater resources. These rules build upon the Helsinki Rules on the Uses of the Waters of International Rivers. The Berlin rules oblige each basin state to manage the waters of an international drainage basin in an equitable and reasonable manner. Furthermore, under Berlin Rules, the obligation of the states to manage the waters of an international drainage basin in an equitable and reasonable manner is subject to having due regard for the obligation not to cause significant harm to other basin states. See [Salman \(2007\)](#).

Challenges resulting from climate change for the beneficial uses of water

The principle of equitable and reasonable use of water implies that all riparian states have a right to the beneficial use of a transboundary water resource. The legal literature defines the concept of beneficial use vaguely. However, it is generally accepted that a beneficial use of water is a water usage resulting in appreciable gain or benefit to the user (Paulson, 1991; Toll, 2011). As such, beneficial uses of water include consumption of water for irrigation, mining and industrial applications, stock watering, and domestic and municipal uses amongst others.

The ability of a state to realise a gain or benefit from using water depends significantly on the quantity and quality of the water available. Freshwater is a critical resource for many purposes, and it has no substitute for most of its uses, such as drinking and agriculture (Cullen, 2009). Even where substitution is possible, states often find it more attractive to use water instead of any alternatives for beneficial purposes. Examples include the use of water in the thermoelectric power industry for improving plant efficiency and economic viability of power production (Feeley *et al.*, 2008).

The importance of water quality for the ability of states to realise their right to beneficial uses of water is well understood. The largest percentage of freshwater worldwide is used in agriculture. Irrigated agriculture is dependent on an adequate water supply of usable quality in terms of salinity, water infiltration and ion toxicity amongst others. Salts in water reduce water availability to the crop to such an extent that yield is affected. High sodium or low calcium concentration in water prevent the water from infiltrating the soil and supplying the crop adequately from one irrigation to the next. High content of sodium, chloride and boron in water can cause crop damage. Furthermore, excessive nutrients in water may lead to excessive corrosion of equipment used for agricultural purposes and thus increase the costs of maintenance and repair (Ayers & Westcot, 1994).

Water quality is important for domestic and industrial use. The water used for domestic purposes should at least meet some minimum quality standards from microbiological, physical and chemical aspects (WHO, 2011). High coliform bacteria content and increased salinity decrease palatability of water and make it undesirable for domestic usage. Moreover, if water used in industry does not have a minimum quality it could cause damage to equipment through corrosion and abrasion, cause problems in the manufacturing processes and impair product quality (Fewtrell & Bartram, 2001).

Climate change is a stress factor for all beneficial uses of water. Over the past decades, the global mean surface temperature has continuously increased, causing a global change to climate, mostly as a result of the anthropogenic emissions of greenhouse gases. This has triggered alterations in the hydrological cycles by changing precipitation patterns, intensity and extremes; reducing snow cover and changing the soil moisture and runoff.

Decrease in total annual rainfall, snowpack in the mountains and earlier snowmelt due to climate change is projected to lead to a decrease in water availability in many areas of the world (Backlund *et al.*, 2008). This is while changes in precipitation, temperature and radiation caused by climate change can increase water demand, in particular within the agricultural industry (Jiménez Cisneros *et al.*, 2014; Betini *et al.*, 2016). The combination of shrinking water resources and increasing demand restrict the states' access to water.

Climate change affects the quality of water and poses a challenge for the beneficial uses of water resources. It increases the frequency and intensity of extreme weather events that can cause pollution due to storm-water overflows and flooding of contaminated sites, or result in harmful or unwanted temperature variations. Increasing water salinity due to climate change, could impede using water for

drinking (Vineis *et al.*, 2011) and impact the sustainability of irrigation systems (Yeo, 1998). Increase in water temperature encourages algal blooms and increase risks from cyanotoxins and natural organic matter in water sources. This subjects the potential use of water to domestic purposes to employing additional or new treatment. Changes in the mean annual streamflow, shifts of seasonal flows, and increases of streamflow variability, and increased evaporation from reservoirs and changes in sediment fluxes can affect the performance of hydroelectric and thermal power plants (Golombek *et al.*, 2012).

The ability of states to beneficially use water resources would shrink, unless water management practices are adjusted to the implications of climate change. Within an international basin, where the actions of one state towards the shared water resource impact the quality and quantity of water available to the other riparian states, failure to adapt water use practices to climate change by one state may come at the expense of others.

Challenges resulting from climate change for environmental protection of a freshwater basin

The principle of equitable and reasonable use of water departs from the traditional ‘mankind versus nature’ paradigm which focuses on the exploitation of natural resources and requires the demands of human societies to be considered in relation to ecological needs. This implies that any interference with the natural state of a freshwater resource shall allow for sustaining the natural ecosystem of such basin. The sustainability of river ecosystems is related to flow, water quality, physical habitat and the naturalness of the biological communities (Petts, 1996). Any use from a water system is consistent with the requirements of environmental protection as long as it does not interfere with the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems, and the human livelihoods and well-being that depend on these ecosystems (Richter *et al.*, 2012).

Maintaining quality and quantity of the flow required for the sustainability of a freshwater system under climate change is challenging. Climate change is likely to alter river flow regimes significantly, and may pose serious threats to river and floodplain ecosystems. Research supports that the impacts of climate change on ecologically relevant river flow characteristics may exceed the impacts of dams and water withdrawals (Poff & Zimmerman, 2010). Freshwater ecosystems are highly vulnerable to climate change due to high levels of exposure and sensitivity to flow alterations and extreme events (Arthington *et al.*, 2006). Ecological responses to climate change are very likely to involve shifts in the composition and structure of freshwater ecosystems which will affect the ecological functions, goods and services these provide. Many of the ecological processes supporting the provision of clean water will be influenced by higher water temperatures, altered flows and primary production in streams is well known to be very sensitive to these two factors (Palmer *et al.*, 2009).

Scientists generally agree that to protect the sustainability of freshwater resources, we need to mimic components of natural flow variability, taking into consideration the magnitude, frequency, timing, duration, rate of change and predictability of flow events (Arthington *et al.*, 2006). However, climate change makes the hydrological future highly uncertain and unpredictable. Differences in approaches used to characterize the potential range of impacts on water resources indicates that analysts do not know, or cannot agree on, how the climate system may change. Furthermore, climate change models are often criticised for not having enough robustness and reliability to provide a basis for hydrological predictions (Stakhiv, 2011).

The uncertainties regarding the impacts of climate change on the ecosystem of freshwater resources has led many to believe that protecting the environment of these resources requires an adaptive water management approach. In particular, decision making for water use under adaptive water management requires learning from experience, evaluating the appropriateness of current water practices based on the lessons learned, and adjusting water use behaviours based on newly available information (Matthews & Wickel, 2009). Thus, if riparian states engage in transboundary water agreements that do not allow for such level of flexibility, they will fail to effectively protect the environment.

Achieving balance between the obligations of states under transboundary water agreements and customary international law in the face of climate change

As sovereign, riparian states have control over the natural resources located within the boundaries of their territory¹², including the waters of a transboundary system. The exertion of such control entails the right to freely dispose and exploit such waters. It also allows them to independently engage in negotiations and enter into agreements with other sovereigns (Hathaway, 2008), inter alia over the use of their shared water resources. However, as found by the Arbitral Tribunal in *Lake Lanoux Arbitration (1957)* when a single water resource traverses or separates the territory of more than one state, sovereignty is no longer the only guiding principle, and must bend before all international obligations of the state. Consequently, one could argue that, while as sovereigns, riparian states have the authority to engage in agreements over the use and management of their shared resources, their authority to do so is subject to restrictions arising from their other international obligations.

In particular, riparian states can engage in bilateral and multilateral agreements that do not engage all basin states over the use of their shared water resources. However, in doing so, they are limited by the obligations arising from the principle of equitable and reasonable use of water. This means that they have to take all possible measure to ensure that agreements concluded between them do not: (1) deprive non-party riparian states from their right to beneficial use of the waters of the resource; (2) pose a threat for the sustainability of the freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these.

Currently, there are more than 260 transboundary agreements between riparian states (Puri & Aureli, 2009), many of which are agreements reached between only part of riparian states sharing a river. Unless there is already an existing objection against each of these agreements, it is reasonable to assume that as long as the future hydrological reality remains static, all these agreements comply with the obligations of their party states towards non-party co-riparians rights and environmental protection. However, climate change is altering the hydrological reality and may require water practices under

¹² The principle of state sovereignty on natural resources is closely related to arrangements between states and foreign private companies for exploitation of natural resources in developing countries. The original aim of the principle was to create a balance between the rights of the sovereign state and the desire of private companies for legal certainty in the stability of investments during the 1950s decade. Ultimately, a landmark UN General Assembly Resolution in 1962 recognized the permanent right to permanent sovereignty over national resources as an international legal right of states. Accordingly, states permanent right to sovereignty must be exercised in the interest of their national development of the well-being of the people of the state concerned. The principle of permanent sovereignty over natural resources is recognized by international tribunals as reflecting a principle of customary international law.

an agreement to change accordingly. If impacts of climate change on freshwater resources are severe enough to require an adjustment of the terms of a transboundary water agreement in line with obligations of party states under customary international law towards third states and protection of the environment, and the state parties fail to perform such adjustments, then state parties will be in breach of their international obligations and could be held responsible for an international wrongful act.

There are various examples of how climate change may require state parties to adjust the terms of their transboundary water agreements to remain compliant with their obligations towards non-party riparian states under the principle of equitable and reasonable use of water. Climate change can potentially create asymmetry in the ability of the states to exercise their right to beneficial use of water resources. For example, in an upstream–downstream context, an increase of demand for water within an international basin due to climate change may leave downstream states with increasingly fewer resources to use. If within a multi-riparian transboundary context, two of the upstream states engage in a water allocation agreement with fixed proportions that does not allow for adjustments to water availability under climate change, their agreement will be in breach of their obligations towards the non-party downstream states.

In an upstream–downstream context, the failure of parties to an agreement to include provisions on controlling extreme water events may create a flood risk for the states located at the downstream. Directive 2007/60/EC on the Assessment and Management of Flood Risks (European Commission, 2007) was drafted with such risk in mind, and requires states to coordinate their flood management practices in shared river basins, taking into consideration long term developments such as climate change. Thereby, if within a multi-riparian transboundary context, that is in danger of increased flood events due to climate change, two or more of the upstream states engage in a water agreement that fails to allow for accommodation of increase in water flow, their agreement potentially deprives a non-party downstream state from its right to beneficial uses of water.

As another example, assume a situation where a transboundary water agreement allows a party state to use the water of a transboundary basin for thermal cooling purposes, where the waste heat is released directly into the transboundary water system. Because of such use, the temperature of the water in the basin increases. Such increase may not initially deprive non-party co-riparian states from using the water. However, if combined with the increase of temperature from climate change, it may make the water unusable for others through negatively affecting its quality. Under such circumstances, the use of water for cooling purposes under the transboundary water agreement would lose the criteria of equitability and reasonability, as it deprives non-party states from their rights to the beneficial use of water.

Achieving the goal of the principle of equitable and reasonable use of water requires the riparian states to reconcile their uses from a basin with the requirements of sustainability. Climate change alone is a stress factor for water ecosystems. It affects them not only by increasing water temperature and changing water quality, but also by altering ecologically important characteristics of hydrologic regimes in rivers and wetlands (Doell *et al.*, 2015). Thus, in the face of climate change, environmental protection of transboundary river basins requires a rigorous approach under which water use practices may need to be adjusted to allow for the minimum flows, and temperatures necessary to support basic ecosystem functions in water resource planning.

There are several examples of how the obligation of states to protect the environment of transboundary water resources may require them to adjust the terms of their water agreements to adapt to the implications of climate change. Transboundary water agreements with fixed water allocation provisions may clash with the obligation of states to uphold the environmental flow that is required to maintain a

river ecosystem in its desired state. Growing concerns about the deteriorating health of river ecosystems may require agreements regulating the operations of dams to be adjusted to benefit the river (Aldous *et al.*, 2011). Agreements that have no provisions for responding to extreme water events may destabilize the ecosystem of rivers. In regions prone to more frequent floods due to climate change, flooding events and landslides could remove important woody debris from rivers and destabilize river channels and dependent ecosystems. On the other hand, in regions prone to more frequent droughts, failure to provide for emergency runoffs can lead to a decrease in the concentration of organic matter in the river, and thus change the ecological composition of the basin.

It is therefore reasonable for all riparian states that are party to international water agreements to evaluate the flexibility of said treaties to the implications of climate change for their ability to comply with their obligations under the principle of equitable and reasonable use of water, and consider possible adjustment to allow for climate change adaptation.

Mechanisms to incorporate flexibility into water agreements under climate change

With impacts of climate change on water availability and environmental conditions, states' failure to adjust their transboundary water agreements to the implications of climate change could harm both non-party riparian states and the sustainability of said water system. Climate change-induced alterations in the hydrology of a basin without appropriate adjustment of water use and discharge practices could reduce water quality and quantity, potentially putting in danger the ecology of the resource and the whole basin. Similarly, not adapting water withdrawal practices to implications of climate change could restrict water availability to the third states in both quantitative and qualitative terms.

Therefore, it is expected from state parties to take all reasonable measures at their disposal that allow them to adjust their transboundary water agreements to the implications of climate change, when such change becomes necessary to safeguard the rights of non-party states and the basin's sustainability. Failure to do so will constitute an internationally wrongful act¹³. This implies the existence of an obligation of conduct¹⁴ for the states to adapt their transboundary water agreements to climate change in such a way that the agreed water management practices be compatible with the rights of the non-party states and environmental protection under the newly emerged climate conditions.

Climate change is foreseen to disrupt flow-regimes, biological communities and sever ecological linkages in any given locale by altering rainfall, temperature, and runoff patterns. Reasonable

¹³ According to the principles of international responsibility of states, state responsibility may arise as a result of an action, omission or a combination of both which (i) is attributable to the state and (ii) constitutes a breach of an international obligation. See: *Dickson Car Wheel Company (USA) v. United Mexican States*, UNRIIAA, vol. IV (Sales No. 1951.V.1), p. 669, at p. 678 (1931).

¹⁴ An obligation of conduct is an obligation to make an honest endeavour to achieve a particular aim, notwithstanding the outcome. The term was used by ICJ in *LaGrand* case, where the Court considered that its previous order on provisional measures calling the United States to 'take all measures at its disposal to ensure that Walter LaGrand is not executed' established an obligation of conduct rather than an obligation of result. ICJ dealt with the concept or an obligation of conduct in the case of *Pulp Mills*, interpreting the treaty obligation 'to adopt regulatory or administrative measures either individually or jointly and to enforce them' as an obligation to endeavour to avoid changes in the ecological balance. See: *LaGrand (Germany v United States of America)* (Judgment) [2001] ICJ Rep 466 para 111 (*LaGrand*); *Pulp Mills on the River Uruguay (Argentina v Uruguay)* (Judgment) [2010] ICJ Rep 14 para 187 (*Pulp Mills*).

measures that would allow adapting water management practices to such changes, in a way consistent with the rights of third parties and environmental protection under the principle of equitable and reasonable use of water, should include a proactive strategy capable of anticipating the patterns of such disruptions (Palmer *et al.*, 2009), assessing the consequences of continuing the agreed water management practices on the resource under the new climate conditions¹⁵ and identifying possible adjustment to current practice required to ensure due compliance with the principle of equitable and reasonable use of water¹⁶.

This implies the necessity for putting river flow and climate forecasting mechanisms in place to detect and predict changes in the climate and hydrology of the basin. It further implies a requirement to assess the compatibility of the water practices agreed under the treaty with the obligation to protect the environment and respect the rights of non-party riparian states under the principle of equitable and reasonable use of water as result of the foreseen climate conditions. If the result of such assessment reveals the arrangements to be incompatible with the rights of non-party states and environmental protection, states will be expected to negotiate in good faith to revise the agreement's provisions.

Strictly speaking, international law does not oblige the riparian states to jointly implement the mechanisms that would allow them to appropriately adjust their agreements to the implications of climate change. However, from a practical point of view, the transboundary characteristics of shared freshwater resources create inevitable interdependencies and linkages between the states that are better addressed through joint action¹⁷.

Information sharing is the most basic measure that states can embrace in successfully facing the need for adapting their transboundary water agreements to climate change¹⁸. It does not only facilitate monitoring the river basin and its trends under the shadow of climate change, but it also alleviates disputes over data, prevent conflicts (Tir & Stinnett, 2009), creates confidence and transparency between co-riparian states, and reduces the costs of research.

Establishing joint monitoring and climate forecasting programs is a more elaborate step that states can take to discharge their obligation to adapt their transboundary water agreements in the face of climate

¹⁵ Projecting freshwater-related impacts, vulnerabilities and risks of climate change is an important step towards climate change adaptation, through understanding human impact on nature. One objective of such projections is to quantify what may happen under current water resources management practice, and another is to indicate what actions may be needed to avoid undesirable outcomes (Jiménez Cisneros *et al.*, 2014).

¹⁶ The need for modification of water use and management practices in the face of climate change has been repeatedly recognized by the IPCC. IPCC report in 2007 concludes that 'current water management practices are very likely to be inadequate to reduce impacts of climate change on water supply reliability, flood risk, health, energy and aquatic ecosystems'. The panel's report in 2014, calls for 'low-regret' solutions to be part of management practices.

¹⁷ It is well accepted that coordination in transboundary basin development can yield greater benefits than would be available to co-riparian states pursuing unilateral actions. An example of successful cooperation leading to significant economic benefits for the states is seen in the case of Columbia Basin in North America. The Columbia River Treaty signed in 1961 allowed the countries to face flood damages in a more cost-friendly way. In Central Asia the joint implementation of hydrometeorology systems by Aral Sea Basin Riparian states significantly reduced the cost of extreme events.

¹⁸ Information exchange is at the heart of many prominent international instruments dealing with climate change. The 1992 Climate Change Convention calls on the parties to promote and cooperate in the 'full, open, and prompt exchange of relevant scientific, technological, technical, socio-economic and legal information related to climate systems and climate change'. Similarly, the Paris Agreement emphasizes the need for states to strengthen their cooperation on enhancing action on adaptation, inter alia by 'sharing information, good practices, experiences and lessons learned, including, as appropriate, as these relate to science, planning, policies and implementation in relation to adaptation actions'.

change. Joint monitoring programs allow for the riparian states to observe and align climate change projections and impacts on water resources through an integrated approach (Rieu-Clarke & Moynihan, 2015). They further expand the parties' access to geological, meteorological, legal, social, engineering and other expertise required to deal with different aspects of climate change and climate change adaptation (Cooley & Gleick, 2011).

The creation of joint water management commissions is a more elaborate step that would allow riparian states to exchange information and monitoring activities more efficiently. These commissions have the potential to create an institutional framework for parties to regularly discuss and manage the water resource in line with their international obligations (Drieschova & Fischhendler, 2011). They help members to implement adjustments required to their water use under the agreement in a more timely fashion (Duda & La Roche, 1997; McCaffrey, 2003). Furthermore, such institutions have the potential to remove the need to codify rules on current and future resource sharing, thereby reducing the transaction costs of amendment procedures (Drieschova & Fischhendler, 2011).

However, it must be noted that in practice, while joint management institutions have a very high degree of flexibility suitable to face the uncertainties arising from climate change, in practice, the extent of their powers and responsibilities varies considerably by treaty (UNECE, 2009) and may hinder their ability to assist agreement adaptation to climate change.

Most joint bodies are facilitators of intra-basin cooperation towards climate adaptation through advising and assisting riparian states in their activities to implement the agreement, collecting, compiling and evaluating data, elaborating joint monitoring programs, easing information exchange between the parties, proposing plans for improving water conditions, and participating in the implementation of environmental impact assessments relating to transboundary waters. Nevertheless, they often lack enforcement authority and are highly dependent on consent of the states for their proposals to become binding.

As creating joint water management commissions with effective implementation and enforcement power continues to prove challenging (Fischhendler, 2004), adaptation of agreements to climate change due to the obligation of the parties to equitable and reasonable use of water remains to be highly dependent on their will. However, experience shows that the will over cooperation in transboundary basins is usually not triggered because states are compelled by an ethic of cooperation. Rather, river basin cooperation seems to occur when the net benefits of cooperation – including in terms of national security and social and environmental well-being – are seen to be greater than the net benefits of non-cooperation and when the distribution of these net benefits is perceived to be fair.

The same principle applies when the subject of transboundary cooperation is adaptation to climate change. For flexibility to climate change to become a feature of transboundary water agreements, and for the adaptation measures to be implemented in practice, the co-riparian party states need to see positive gains for climate change adaptability. However, the trade-off between cost and benefits of climate change adaptation of transboundary water agreements is not always clear.

Uncertainty surrounding future climate change impacts and future socio-economic developments constrains the assessment of the costs and benefits that adapting a transboundary water agreement to new hydrological realities could bring about. Social, environmental and security costs and benefits of adaptation are not always readily quantifiable; clarity on the application of discount rates to future cost and benefits is not always present; and the distribution of the benefits of adaptation of the agreement to climate change is not always perceived as equitable, especially due to the linkage of water resources to national security. These reasons result in the inclusion of climate change adaptability measures into

transboundary water agreement, and agreements' adaptation to the implications of climate change to remain difficult in practice.

Finding an effective solution to solve this challenge requires further research. Nevertheless, one could think of possible options such as nudging riparian states towards incorporating climate change adaptability in their water agreements through the use of economic incentives provided by third parties, mounting diplomatic pressure on parties that fail to adapt their transboundary water agreements to climate change when such change is required, and finally, using more coercive forces including international sanctions and litigation measures against those states which through failure to adapt their transboundary water agreements to climate change amounts to a violation of their obligations toward environmental protection and non-party third riparian states.

Conclusion

Under international law, sovereignty of states over transboundary natural resources is not absolute. It is rather subject to restrictions arising from the rights of other states and due regards to environmental protection. In the field of international water law, such restrictions are captured through the customary principle of equitable and reasonable use of water. Accordingly, all riparian states within a basin are entitled to an equitable and reasonable share of the water. However, in exercising such right, they should respect the right of other riparian states and environmental well-being of the resource in question.

Such considerations are relevant when states use their sovereign right to negotiate and ratify a treaty over the use from a transboundary water resource. While states can define their own share to the beneficial uses of a transboundary water system under an agreement, such definition may not compromise the well-being of the source in question or the rights of non-party riparian states to beneficial use of water.

Impacts of climate change on precipitation and snowmelt patterns, resulting in alteration in quality and quantity of water, could change the standards of environmental protection, and the benchmark for assessing the equitability and reasonability of non-party states' share. If states fail to take all possible measures that allow them to adjust their transboundary water agreements to such changes, they run the risk of failing to meet their obligations to protect the environment and violate the rights of non-party basin states to a beneficial use of water, thereby committing an internationally wrongful act.

To avoid such risk, party states need to continuously monitor and assess the impacts of their treaty water arrangements on non-party riparians and the environment in light of different climate change scenarios, ensure that current practices are in line with their obligations towards environmental protection and the right of non-party basin states, and adapt the terms of their agreements to implications of climate change, should the need arise.

International law does not prescribe specific provisions on how states should provide for climate change adaptability of their transboundary water agreements in order to comply with their obligations under the principle of equitable and reasonable use of water. However, it offers a variety of measures that could help states to successfully discharge such responsibility. These measures include establishment of climate change focused information sharing mechanisms, creation of monitoring programmes and setting up joint commission for the management of the transboundary basin.

Joint river basin commissions that possess management and enforcement authorities to adjust agreements are best positioned for increasing climate change adaptability of treaties, as they can amend provisions on water management based on the changing conditions whenever necessary. However,

commission with such broad powers are often perceived as a threat to national sovereignty, and therefore rare in practice. This brings us back to the reality that water management remains to be a highly political issue, which is often linked to national security. This means that despite the existence of rules on how states shall manage their transboundary water basins, compliance does not always automatically happen. River basin cooperation seems to occur when the net benefits of cooperation are seen to be greater than the net benefits of non-cooperation and when the distribution of these net benefits is perceived to be fair. Consequently, agreements' adaptability and adaptation to climate change can be encouraged through provision of economic incentives by non-party basin states, and increasing the cost of non-adaptability through diplomatic pressure, sanction or even litigation.

Data availability statement

All relevant data are included in the paper or its Supplementary Information.

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