Axiomatic Solutions to Transboundary River Conflicts

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There are more than 250 international transboundary rivers and much more when one considers rivers that cross federal state-, provincial- and other sub-national borders. Many transboundary rivers are located in regions where demand exceeds supply. Existing transboundary allocation regimes, if present, are under pressure due to increasing demand caused by population growth, and developments in industry and agriculture. Simultaneously, in many river basins, water supply is negatively affected by climate change, both in average runoff and in variability of runoff. Widening gaps between demand and supply imply increasing scarcity of water. Increasing scarcity, in its turn, implies that countries are under pressure to increase or at least preserve their share of the available water.

While wars over water have not occurred yet – albeit some predict they will – this situation of increasing water scarcity may lead to increasing tensions, disputes and negotiation deadlocks on the distribution of available water. When supply is fixed, at least to some extent, any increase in water allocation to one country implies a reduction of some other country's allocation. This is a standard example of a zero-sum game, following from the `game' being perceived as, or based on, physical units of water. In fact, in the vast majority of reported negotiations on river sharing, the subject of negotiation is the allocation of such physical units of water, rather than the benefits derived from water use. One well-known example is the 1959 Nile Waters Agreement which allocates at least 48 BCM/year to Egypt (at that time the United Arab Republic) and 4 BCM/year to the Sudan. Economists have advocated negotiating water-sharing based on the benefits of water use, that is, the value placed on these physical units of water. This may, at least in theory, lead to cooperative surpluses so that the zero-sum game can be escaped. Yet, Wolf (1999), in an early contribution concluded that "… in practice, economic criteria have influenced water allocations only in the exception." Also values placed on water do not often differ much between countries within one transboundary river basin, so that the resulting game boils down to, again, a zero-sum game.

Given this characteristic of transboundary river-sharing, and given the absence of a supranational authority that can enforce property rights to river water, the next question is whether any tools or mechanisms to resolve conflicts over scarce water exist. From a legal perspective, there is some hope with the very recent entering into force of the UN Watercourses Convention. Nevertheless, this convention sketches only broad principles for river sharing, emphasising the arguably ambiguous *principle of equitable and reasonable utilisation*, whilst leaving specific details of sharing agreements to the riparian countries involved (Salman, 2015), based on a list of factors and circumstances to be taken into account. Including, but not limited to, hydrological, economic, and social factors, this list is rather comprehensive, and can be used by negotiating countries to aid their negotiations. This very same comprehensiveness may obstruct applicability since each country may press to select factors that will work out in its own advantage (cherry-picking).

There is a small emerging literature that circumvents this focus on outcomes (and cherry-picking of factors) by analysing those factors that should ideally play a role in order for riparian countries to choose cooperation over conflict (Moes, 2013). This literature uses an *axiomatic* approach to analyse agreements on transboundary river water. The axiomatic approach is a mathematical methodology used to assess multi-person interaction that is gaining increasing popularity in various fields of economics (Thomson, 2001). In abstract terms, the axiomatic approach uses *axioms* to determine *solutions* to a *problem*. In our setting, the problem is how to share available river water when there is not enough to satisfy each riparian's need (i.e. a transboundary river conflict); the solution is a sharing rule (like the one for the Nile introduced above); and the axioms are factors that influence the specific details of such a

sharing rule. One option, albeit prone to cherry-picking, is to employ a subset of factors proposed by the UN Convention. This approach is adopted, for instance, by Van der Zaag et al. (2002), who consider factors like population and basin area to determine a sharing rule. More recent studies seek to identify other factors that are less prone to cherry-picking but, instead, may lead to cooperation rather than conflict.

One such axiomatic study, by Ansink and Weikard (2015) is highlighted here. In this paper the so-called *Composition* axioms are employed, that pertain to the possibility that the available amount of river water turns out to be different from what was expected. Doing so, these axioms relate to variability and uncertainty of river flow, the main drivers for countries' defection from agreements or choice for non-cooperation in the first place. Enforcing these composition axioms is then similar to mitigating the incentive to retreat from any agreement based on a sharing rule that satisfies these axioms.

To give an idea of what these axioms look like, consider the following *River Composition* axiom which, in plain, non-mathematical language, says:

Suppose that additional water arrives in the river after the initially available river flow has been allocated. River Composition requires that in such cases there is no difference between (i) cancelling the initial allocation and reapplying the same rule to the situation with more river water; and (ii) letting agents keep their initial allocation, reducing their claims accordingly, and applying the same rule to the additional water.

At first sight, this sounds like a very reasonable requirement for the sharing of river water. Well, it turns out that there exists only one solution to the river sharing problem that satisfies this axiom, and which thereby is resilient to variable river flow. This solution implements the (widely disputed) Harmon Doctrine (McCaffrey, 2007) which says that countries are free to use any water available on their territory, without concern for downstream impacts. Obviously this sharing rule contrasts sharply with the *principle of equitable and reasonable utilisation* put forward by the UN Convention. This contrast illustrates that the good intentions of this convention, and approaches, could lead to agreements on river water that may not be desirable from a realist perspective.

This does not in any way imply advocacy of the Harmon Doctrine as the solution to conflicts over transboundary river water. There are other sharing rules proposed in the study by Ansink and Weikard (2015) and related axiomatic studies that result from other desirable axioms; and these alternative sharing rules are more favourable to downstream countries. Examples include the UTI incremental solution (Van den Brink et al. 2014), the downstream incremental solution (Ambec and Sprumont, 2002), the sequential equal surplus division (Béal et al, 2015) and the class of sequential sharing rules (Ansink and Weikard, 2012; Béal et al, 2013; Ansink and Houba, 2015). What these solutions have in common is that they are able to translate desirable properties (such as resilience to river flow variability) into sharing rules for river water.

Obviously the axiomatic approach is not only applicable to transboundary conflicts over scarce river water. It can be applied to other distributive conflicts as well. Many axiomatic papers focus on topics like fair allocation, redistribution and apportionment, but usually in abstract contexts with a focus on contributions to theory rather than contributions to add to the understanding and resolution of distributive conflicts. This focus on theory does not imply that real-world contributions are absent. Instead, the axiomatic approach can be put to practice and has characteristics that make it relevant to real-world conflicts.

In the leading example of transboundary river conflicts, the axiomatic approach can be easily put to use in negotiations on river sharing because many axioms (and certainly those employed by Ansink and Weikard, 2015) can generally be interpreted as describing characteristics of a negotiation procedure. Such procedures can be implemented by the negotiating parties themselves, by the members of a joint river basin committee, or perhaps even by an intervening third party when conflict over water occurs. The benefit of solutions that are supported by relevant axioms is that such solutions, when formalised in an agreement, are not likely to be broken so that cooperation can be sustained and conflict, avoided.

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