TRANSBOUNDARY WATER CONFLICT RESOLUTION MECHANISMS:

TOWARD CONVERGENCE BETWEEN THEORY AND PRACTICE

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Abstract

This research examines transboundary water conflict resolution mechanisms. The academic literature has brought various mechanisms for resolving transboundary water conflicts. However, there has been a gap between these theoretical mechanisms and the techniques used in reality. This research maps this theory-practice gap and identifies the reasons behind it. To bridge this gap, the study recommends that researcher use various resolution mechanisms when analyse any particular conflict. This allows them to provide practitioners dealing with this conflict with various settlement options. This set of options would help practitioners to identify the most convenient mechanism to address the conflict in question.

Introduction

Transboundary water resources are expected be one of the biggest challenges for human development over the next decades. The growing global water scarcity and interdependence among water-sharing countries have created tensions over shared water resources around the world. Therefore, interest in studying transboundary water conflict resolution has grown over the last decades. This research focuses on transboundary water resources conflict resolution mechanisms. A more a specific concern is to explore the mechanisms of allocating of transboundary water resources among riparian states.

The literature of transboundary water resources conflict has brought various approaches for allocating of transboundary water resources among riparian countries. Some of these approaches have focused on the negotiation process, such the Alternative Dispute Resolution (ADR). Other approaches have analysed the economic dimension of transboundary water disputes, in an attempt to identify optimal economic criteria for water allocation, such as the "social planner" approach and the "water market" approach. A more comprehensive approach has been provided by game theory that has brought together the economic and political dimensions of the water dispute management. Unfortunately, despite all these efforts, there has been a gap between these theoretical approaches and the techniques used in reality to resolve transboundary conflicts.

This study attempts to provide a map for the relation between theory and practice in the field of transboundary water conflict resolution. Therefore, it examines the theoretical approaches that have been suggested in literature as mechanisms of transboundary water conflict resolution. Moreover, it explores the techniques that have been used in resolving real transboundary water disputes. Subsequently, it identifies which of the theoretical approaches proposed by literature have been used in practice to solve transboundary water conflicts, in an attempt to assess the gap between the theory and practice. Finally, the research identifies the reasons behind this gap and provide some recommendations to bridge the theory-practice gap in transboundary water conflict management.

Transboundary Water Conflict Resolution Mechanisms: Definition

An essential starting point is to deconstruct the term “transboundary water conflict resolution mechanisms” to clarify the subject of this study. This task is done in three steps. First, the various perspectives of situations considered as conflicts will be discussed in order to establish a definition of conflict. Subsequently, the main features of conflict resolution process are examined. Finally, these feature are used to present a working definition of conflict resolution.

Transboundary water conflicts are usually contentious as it usually includes various conflicted issues. In general, the complexity of conflict structure is significantly determined by the range of disputed issues in conflict. Issues become a substance of conflict when they are scarce (Mack and Snyder, 1957). Therefore, a conflict may erupt as a result of competition over status, power, position, resources and other scarce values (Himes, 1980). In general, conflict issues could be grouped into five basic types: resources; sovereignty; survival; honour and ideology (Mitchell, 1981). Transboundary water resources are surface water and ground water resources that cut cross political borders of states. Transboundary water conflicts are usually contentious due to the fact it crosses three overlapping issues: resources, survival and sovereignty. Water is most precious resource for human survival and therefore it has been always a matter of competition. Moreover, transboundary water resources create a conflict of sovereignty between riparian countries over water use. The ways one riparian country uses its water affect its use in other countries. These cross-border effects are transmitted through four main mechanisms: the available quantity of water; the quality of water; the timing of water flows, and the environmental consequences of human activities (Watkins, 2006). These cross-border effects usually create conflicts between the countries that share rivers.

The resolution of transboundary water conflicts needs sophisticated efforts because of the multiplicity of conflict boundaries. In such type of conflicts, the conflict resolution process becomes more complex because it needs to address multiple physical and social constraints that regulate transboundary water. These constraints are enrooted in various disciplines that include hydrology, international relations, international law, economics, engineering and climate science among others.

Consequently, a conflict resolution mechanism is defined, for the purpose of this study, as a scientific representation of a conflict resolution process, delineating the conflict parties and their activities in the process that led to the resolution of the conflict. If the mechanism is used for explanatory purpose, its main objective would be to explain the process structure and dynamics that led from the given initial conditions the terminal conditions. On the other hand, the predicative mechanisms can be categorised into two types. In the first type, the initial conditions and the process structure and parties activities are given while the terminal conditions are to be predicted. In the second, the initial conditions and the terminal conditions are given while the process structure and parties’ activities are to be predicted. However, in reality, it’s very often that analysts have only the current status identified, but neither the optimal process nor the optimal terminal conditions are known. It becomes their tasks to identify both the optimal outcome and the optimal negotiations process to achieve that outcome.

Literature has developed various mechanisms for dealing transboundary water conflict resolution over the past decades. These mechanisms are rooted in three main disciplines: Economics, Engineering and negotiations studies. The following section explore these theoretical mechanisms and examine their implementation in practice

Transboundary water conflicts: Economic analysis

In general, long-term sufficiency of natural resources has been a major concern for economists since the emergence of economics. The concern has risen because many of these natural resources can diminish either because they are non-renewable or because its renewable supply is not enough to meet the growing demand (Hackett, 2006). Since human survival rely on these natural resources, its scarcity has been a major concern for early economists. Three main mechanisms has been used by researchers to analyse transboundary water conflicts. The first mechanism is called *social planner*, which is enrooted on the Keynesian interventionist line of thinking. The other mechanism is *water market*, which introduced by neo-classical economists. The third mechanism is *Game theory*, which has been applied extensively to water conflicts since the 1960s.

Social Planner

A social planner mechanism assumes a hypothetical benevolent decision maker whose objective is to maximise the overall economic welfare of the water basin. Generally, when resources are allocated in a way that it is impossible to make any one individual better off without making at least one individual worse off, this allocation is called social or Pareto optimal allocation. To achieve a Pareto optimal allocation, a social planner would allocate based on overall efficiency of water use in the basin regardless of the individual interests of water sharing parties. For example, in transboundary river basin, a social planner establishes social welfare function by assigning weights for riparian countries based on their efficiency. Consequently, water is allocated among riparian countries based on these social welfare weights. This implementation of water allocation yields the highest basin welfare and hence is considered to be a social optimal allocation.

Although this mechanism has extensively been used by researchers as a planning tool, its application has been limited in reality. These studies addressed conflictive management and planning issues in various transboundary water basins, such as Columbia River basin (Canada. Dept. of External Affairs et al., 1964) , the Nile River Basin (Garstin, 1901, Garstin and Dupuis, 1904, MacDonald, 1920), Ganges-Brahmaputra River Basin (Rogers, 1993), Great Lakes between the United States and Canada (Becker, 1995), the Caspian Sea (Madani et al., 2013). However, in practice, academic efforts were partially translated into policy actions only in two cases. The first case was the development plan of the Nile Basin in the first half of the Twentieth Century. The United Kingdom, the major colonial power in the basin at that time, commissioned its experts to conduct a series of studies to maximise the utilisation of the Nile water, mainly in agriculture to provide its textile industry with the necessary cotton supplies. These results of these studies were partially implemented through a series of treaties and projects in the first half of the past century. The second case was a plan developed by a joint governmental committee between the United States and Canada to solve the pending water question between the two countries over the Columbia River. This plan was materialised in the agreement signed between the two countries in 1964.

The main strength of this mechanism is the fact it provide the most efficient yield for the whole group of conflicting parties. However, it faces two key challenges that limits its application as a mechanism resolving real conflicts. First, it assumes the possibility of establishing a water management system based on a basin-wide objective function, ignoring the difference in preferences, with its political, economic and cultural determinants, among riparian countries (Delli Priscoli and Wolf, 2009). Second, its assumption of the existence of some central decision making ignores the sovereignty of parties in transboundary water conflicts. It assumes a passive attitude of parties with full obedience and commitment to the decision of the central planning entity. More importantly, this mechanism replaces the process of conflict resolution by a single decision maker. These dynamics include the parties' interests, strategies and actions during the process of conflict resolution. By excluding the conflict resolution process, social planner mechanism has been reduced to water allocation criteria. This reduction limited its full application in reality. However, it still provides a benchmark outcome that can guide parties during their negotiation process.

Water Markets

This approach has emphasised the importance of establishing a clear structure of appropriation rights to natural resources that can support an efficient allocation of shared resources. This approach was adopted by Coase (1960) who emphasised that given a well-defined structure of property rights, a costless transferable and enforced exchange will eliminate all externalities and the resource allocation will not be determined by the pattern of the assignment of property rights (Coase, 1960). This idea of using the market mechanism to manage resource appropriation rights of common-pool resources was extended to water resources management, resulting in the introduction of what has been known as water market.

Therefore, water economists have argued that a market could represent an efficient mechanism for water rights allocation. The market mechanism that has been proposed is allocate-and-trade, which is a market mechanism relying on two-step procedure (Nigatu and Dinar, 2011). The first step is establishing an initial allocation of water rights among the water-sharing countries. The second step would be auctioning the water surplus of the potential supply countries to the potential demand countries. This auction can take either of two forms: a percentage-claim auction or priority-claim auction (Zeitouni et al., 1994, Becker, 1996). In percentage-claim auctions, potential demand countries bid for a share of an uncertain water surplus from potential supply countries. In priority-claim auctions potential demands countries bid for a slot in a queue for the water surplus of possible supply countries. This last form of auction can be conducted as one-stage auction or as a multi-stage auction to allow the bidder to increase their bids (Zetland, 2013). Although various studies have used this mechanism to propose efficient allocation of water in various basin or region, such as the Nile Basin (Whittington et al., 1994, Nigatu and Dinar, 2011), Middle East Region (Zeitouni et al., 1994, Becker, 1996, Fisher et al., 2002) and Ganges- River Basin (Bhaduri and Barbier, 2008), no evidence that any of these studies has been materialised.

Although Water market mechanism has been celebrated by various academics as an efficient solution for transboundary water conflicts, it has been challenged by three realities. Firstly, transboundary water basins needs to have a large number of agents to yield an efficient equilibrium. One of the main conditions necessary to yield an efficient allocation of resources is having a large number of sellers and buyers. The number of riparian countries sharing any basin, even in the case of large river basin, can't satisfactorily meets this condition. This market failure is compounded by the fact the most basins are characterised by a difference bargain power among sharing countries. Secondly, another necessary condition of efficient allocation of resources is the independence of actor's actions. Actions by agents should not affect other agents except through the price mechanism. However, in transboundary water basins, actions of agents may affect each other as a result of the interdependence that characterise transboundary water basins. Finally, it is difficult to establish well-defined property rights when dealing with countries with cultural difference and traditional systems that have regulated these basins for long time, especially in the absence of a robust international law doctrine on transboundary water resources management. These market failures has limited the power of water market approach as a transboundary water conflict resolution mechanism as it assumes an idealised process of water allocation. These limitations has induced researchers to resort to another theoretical framework used to analyse imperfect-competitive market structures, which is game theory.

Game Theory

Game theory differs from traditional economic analysis in that it is multi-objective multi-agent interactive decision theory. It does not deal with decision situations in which actors are isolated, to avoid the impact from the influence of other actor's decisions and actions (Dixit, 1996). These interactions are claimed to be strategic due to the fact that participants in such interactions are mutually aware of the mutual-effects of others' actions and actions are taken as a result of such cross-awareness (Dixit et al., 1999). Game theory has been used for three main types of analysis: explaining the development and outcome of real and experimental events, predicting the evolution and the outcome of already developing situations, and providing recommendations to influence future interactions (Dixit et al., 1999).

Games are classified into a few categories according to the features of their context. For instance, they can be classified according to the sequence of play, the availability of information or the degree of conflict or coincidence of interests of players. One important classification that is worth emphasising is categorisation of games into cooperative and non-cooperative games. This classification is used to distinguish between situations in which actors establish an enforceable joint-action agreement and those in which they are not. The game is considered cooperative when players can make such enforceable joint agreement (Dixit et al., 1999). This cooperative game is a benefit-sharing situation in which players take into consideration not only their own payoff but also the total payoff of all players (Cerdá, 2011). Non-cooperative games materialise when players act only in their own interests, even if cooperation among them emerges as a result of coincidence between their interests (Dixit et al., 1999).

Game theory has provided a strong mechanism for addressing transboundary water resources conflicts. It has three main advantages over the conventional economic methods. First, it provide an analysis tool that map the conflict resolution process, linking its dynamics to its potential output. Second, it has the capacity to analyse multi-criteria multi-decision maker interaction processes (Medani, 2010). In game models, each player optimises his objective while remaining aware that others' decisions affect his payoff and that his decisions affect others' payoff. Last, the framework has strong tools and broad concepts that are capable of analysing not only individuals' action but also state and organisational actors (Axelrod, 1984). Actions are not necessarily performed by a unified actor, they might be the outcome of complex bureaucratic procedures or complicated tactics and changing political coalitions (Allison and Zelikow, 1971). Therefore, the application of game-theoretic frameworks as mechanisms for addressing the problem of transboundary water resources has generated considerable research interest in the past three decades. Some researchers have resorted to cooperative game theory to tackle transboundary water basins, such as Columbia River Basin (Dufournaud, 1982), Nile Basin (Wu and Whittington, 2006, Wu, 2009, Waterbury, 2002), Euphrates and Tigris rivers (Kucukmehmetoglu, 2009, Kucukmehmetoglu, 2002) , Jordan River Basin (Atwi and Chóliz, 2011) and Ganges River Basin (Kilgour, 2001). Others have used the non-cooperative game theoretical mechanisms to analyse shared water resources, such as the Hirmand River (Madani and Hipel, 2011), the Great Lakes between USA and Canada (Becker, 1995) , the Caspian See (Sheikhmohammady and Madani, 2008b) and also the Nile Basin (Elimam et al., 2008, Madani et al., 2011).

However, although a significant share of these studies aim at predicting the future evolution of the water conflicts in these basins and suggesting solutions to settle it, there is no evidence that any of them was put into action. This can be attributed to some limitations of he studies that adopted game theory as their analytical framework. Firstly, these studies adopted the conventional game theory that has inherited the full-rationality assumption from the neoclassical economics. Laboratory experiments show that the analyses of games based on rational assumption sometimes fail to conform to the real events and situations (Ostrom et al., 1994). “Polls and laboratory experiments indicate that people often fail to conform to some of the basic assumptions of rational decision theory” (Aumann, 1997). Self-interest maximisation is often quite difficult; most individuals and even specialists cannot conduct them in reality(Simon, 1955).

Transboundary Water Conflicts: Engineering Approaches

The early attempts to address water management problem relied on conventional sectorial approaches. Gradually, attempts have been made to use more comprehensive approaches to address the complexities of water resources management. Two main paradigms have dominated the water resources management during the few past decades: the uncertainty paradigm and the complexity paradigms (Simonovic, 2012). The uncertainty paradigm focus on the availability of water related data and its variability. The complexity paradigm deals with complexity of water resources planning and management. This approach perceives water resources management as a complex process that should take the social, economic, political and environmental dimension into consideration. The increasing complexity of water, the rapid increase in computer processing power, and the growing ease of use of modelling tools have given rise to a solid and comprehensive approach for water resources management, which is referred to as systems analysis. Some of the systems models focuses on the mathematical optimisation models, other relied on simulation models to provide practitioner a more interactive platform.

Optimisation Models

Since 1960s, various studies have attempted to analyse water resources in the framework of systems analytical concepts. These studies mapped water resources as a set of various components or subsystems that interact in a logical manner (Nandalal and Simonovic, 2002). The interconnections of the subsystems impose constraints upon each other thus limiting the range within which the individual inputs could be assigned. Consequently, scholars redefined the water systems elements and interactions by means of mathematical or logical functions. These mathematical models have been used to find the combination of components and interactions that satisfy a desired objective or achieve an optimal output. In other words, systems approach has been concerned mainly with prediction and control. This focus on prediction and planning was extended to the conflict resolution field.

Various studies have addressed water resources conflict using optimisation techniques as conflict resolution mechanisms. The Danube River (Nachtnebel, 2001), the Nile Basin (Sreenath et al., 2002), Ganges River Basin (Rogers, 1969), Caspian Sea (Madani et al., 2013) and Nestos River (Ganoulis, 2006) have been analysed using different optimisation techniques, including multi-objective multi-participant optimisation, linear programming and dynamic programming. Almost all these studies were conducted with the aim of providing policy advice to facilitate solving the pending problems, there is no evidence of having been used by decision makers. These optimisation methods implicitly reduce economic actors into a single decision maker with a composite objective, such as social welfare function, then attempt to optimise such composite objective. The weakness of these technique is that it assumes perfect cooperation among the actors or the existence of a social planner, which is an assumption that is far from being realistic. These techniques focused on identifying the possible conflict settlement, terminal conditions, under ideal conditions, while it ignored the dynamic resolution process.

Simulation models

One of the main challenges that face transboundary water conflict resolution is the need to analyse a vast amount of physical and social data. This analysis is necessary for evaluating the available the available alternatives during the negotiations process. Optimisation models have been used mainly to analyses the milestones of the conflict resolution process, providing alternatives for decision makings at these decision nodes. However, there has been a need for tools that can analyse dynamic changes during the conflict resolution process rather than snapshots of it.

Therefore, another type of the Engineering models that relied on the gigantic computer processing power. One variant of these models attempted to simulate transboundary water management under different conditions to provide the possible future scenarios of conflictive water resources. A good example of these studies is the one conducted by Siegfried and Kinzelbach (2006) to analyse the future of the transboundary northwest Sahara aquifer. The Conflict Resolution Support System (CRSS) is similar simulation modelling tool was developed by Rajasekaram et al. (2003) to implementation of a systemic approach to help parties in water conflicts. However, although such types of models succeeded to provide prediction of the evolution conflicted water resources management process under different initial conditions, it failed to account for the continuous changes that occur during this evolution process as a result of external or internal forces. Moreover, these models focus on modelling the process initial and terminal conditions and give less attention to the agents' preferences and decisions.

These continuous changes were internalised by another computer-based systems approach, known as system dynamics that was developed during 1960s. System dynamics provide a strong analysis platform that can map the interrelationships between the physical systems and social systems (Nandalal and Simonovic, 2003). These relationships are captures using the feedback linkages among the different parts of the system. This system dynamic relationships can be mapped using either mental models in the form of causal loop diagrams or formally modelled using computer-based simulation tools. System dynamics has provided a powerful tool for analysing water management and conflicts within national boundaries (Yang et al., 2008, Sánchez-Román et al., 2010, Madani and Mariño, 2009, Madani, 2007, Sehlke and Jacobson, 2005). However, it has lacked a clear conceptualisation of the parties involved in the conflict. Most system dynamics models assumed full collaborative conflict resolution process, which again assume full cooperation among parties. This assumption reduce the conflict resolution process from a multi-objective multi-agent process to a multi-objective process. Such reduction limited the explanatory and the explanatory power of these models on the case of transboundary water conflicts. Some recent studies attempted to include the conflicting parties through representing by their utility functions (Nandalal and Simonovic, 2003, Siegfried and Kinzelbach, 2006, Madani and Mariño, 2009, Keith et al., 2013). These studies pave the way for a wider application of system dynamics in the field of transboundary water conflict resolution.

Transboundary Water Conflicts: negotiations perspective

The Field of negotiations and conflict management has focused on the process of negotiations with less attention paid to the substance of conflict. Among the different perspectives of negotiations, the Alternative Dispute Resolution (ADR) approach can be considered as the line of thought that has provided new insights to negotiations (Delli Priscoli and Wolf, 2009). Generally, ADR attracted has generated considerable research attention among professional mediators and negotiator. However, recently, the contribution of academic researcher has been growing. The increasing importance of environmental conflicts has played an important role in the recent development of growing body of ADR literature.

The ADR literature focuses on re-centring negotiations around interests not positions (Delli Priscoli and Wolf, 2009). ADR aims at reshaping the process of negotiations from distributive, or zero-sum, negotiations into collaborative negotiations. In collaborative negotiations, all parties cooperate to increase the overall outcome of the process, allowing every party to gain from negotiations. Various frameworks of negotiations have been developed by the scholars of this field, but most of them rely on four main principles: defining the problem; focusing on interests and positions, getting parties together to generate new options, providing objective criteria for allocating the gains among parties.

As a process-based mechanism, ADR provides a detailed analysis of conflict resolution process. It deals with the micro dynamics of the negotiations process in order to get the optimal results of it. However, it does provide a concrete conceptualisation of the criteria that determine the optimal results. By providing one-size-fits-all remedies, the ADR virtually excluded the conflict substance from the determinants of the evolution path of the process (Bruce and Madani, 2015). Therefore, The ADR could be considered as a partial conflict resolution mechanism that can serve as process facilitation tool but not as resolution mechanism that can guide the participants to optimal terminal conditions. Therefore, The ADR could be used as complementary mechanism with other substance-based transboundary water conflict mechanisms.

Taking into consideration the complexity of transboundary water conflict resolution, ADR, as a process facilitator, has potential to support the transboundary water resources negotiations. However, water conflicts generally has not attracted much research attention in this field. Few studies have addressed the conflicts in the Jordan River Basin (Susskind and Islam, 2012), Caspian Sea (Sheikhmohammady and Madani, 2008a), the Nile Basin (Dinar and Alemu, 2000), The Mekong River Basin (Browder, 2000). These studies have focused on explaining the past or ongoing negotiations without giving concrete recommendation to facilitate solving these problems.

Conclusions

In general, it has been shown that the focus of studies that addressed transboundary water conflicts has been influenced by the field of enquiry. While economic studies have focused on explanation and prediction, the engineering literature has been concerned with prediction and planning. Negotiation studies have rarely addressed water conflict resolution.

Moreover, none of the mechanisms developed by the different disciplines has the explanatory power to address all the dimensions of transboundary conflict resolution. Substance-focused mechanisms such as social planner, optimisation and water market have failed to map the macro and micro processes of conflict resolution. Process-based mechanisms such as ADR and simulation models needs to integrate the conflict substance in its structure to be capable of providing effective guidance to decision making. Game theory and IAD have the capacity to link the process and substance of conflict resolution. More research is needed to develop game theoretic frameworks integrate efficiently institutions in conflict strategic games and to link the micro-processes of negotiations to the wider conflict resolution process.

The literature reviewed revealed the gap between theory and practice in the field of transboundary water conflict resolution. Although numerous studies have addressed the problems of transboundary water conflicts, very few of them have been used in reality for planning of water resources management. This gap is evident between theory and practice is evident in engineering and economic studies of transboundary water conflicts.

This theory-practice gap can be attributed to two main reasons. The first is the nature of the mechanistic approach as a "sometimes-true" theory. Each mechanism is true in some situation and not in others. Second, as have been indicated above, none of the theoretical mechanisms has a comprehensive structure that can address all the dimensions of conflict resolutions. Therefore, it can be more useful when academic research address a transboundary conflict to apply various conflict resolution mechanisms. In this way, literature can provide practitioners with an array of settlement options to choose of them the most feasible one in the case in question.

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