Research article

Influential third party on water right conflict: A Game Theory approach to achieve the desired equilibrium (case study: Ilam dam, Iran)

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ABSTRACT

Allocating water to organizational stakeholders poses a vital challenge to water managers. Organizations which benefit from water as the primary factor input attempt to achieve their objectives using cost-effective and quick-return strategies, such as increasing the water rights. In such circumstances, lack of water probably results in the conflict. Recognizing the management approaches, organizational priorities, and the stakeholders’ influence power can play a dominant role in analyzing the future of such conflicts. In this paper, we analyzed the conflict of water allocation in Ilam dam among organizational stakeholders. We defined the strategies based on the background of the game and organizational objectives. The influence power of stakeholders and the numerical weights of strategies were quantified based on the expert judgment method. The relative priorities of strategies were then calculated for each state of the conflict. We used the GMCR+ model to study the actions of stakeholders. Results suggest that the Jihad Agriculture Organization and the Water and Wastewater Company withdraw more water; hence, there exists no water to meet the environmental water right. In this case, the participation of the third party, such as the Governorship and the Justice can change the future of the conflict, and result in moving to the optimal state. However, results from Inverse GMCR analysis demonstrate that Justice is the most influential third party that can move the conflict towards a desired equilibrium (optimal case).

1. Introduction

Over the past decades, the increasing growth of water demands and water resources limitation have caused varied challenges in terms of abstracting this vital resource as well as raising the complications of its management and allocation. Increasing limitations leads to emerging new serious managerial hardships among different stakeholders having a conflict of interest (Miles, 2012). Lack of systematic and integrated insights and attempting to maximize various utilities are the main cause of engendering controversy. Given the governmental nature of water resources allocation and management in Iran, the role and position of governmental organizations are quite determinant in supplying and satisfying the required water for social, economic, and environmental sectors. Organizational stakeholders always try to improve their performance and report impressive statistics for developmental activities, while the incompatibility of their policies and actions with the carrying capacity of resources lead to the tragedy of the commons (Jafarian et al., 2016).

Water-consuming organizations, in most cases, choose quick-return policies such as receiving more share of water (water rights) instead of paying attention to substitute alternatives including improving either the efficiency or management of the demand side. To study such conflicts, it is required to take into consideration managerial patterns, organizational priorities, and the influence power of involved organizations (Prell et al., 2009).
general, the influence power of governmental organizations in exploiting shared resources is unequal.

Regarding water resource management, organizations play varied roles to carry their responsibilities and tasks based on high-level documents such as the Low of Equitable Distribution of Water. For instance, the Water Authority is responsible for supplying and delivering water. The Jihad Agriculture Organization and the Water and Wastewater Company must distribute the delivered water to final users. The Department of Environment has a supervisory role ensuring that the quantity and quality of water is suitable enough for ecosystems. Therefore, identifying the influence power of organizations and their determinant role is of paramount significance in conflict resolution.

Game Theory is one of the well-known methods to study the conflicts. It provides the possibility of predicting the equilibrium state of the game with analyzing the behaviors and decisions of logical players (Myerson, 1991). Each game includes players, strategies, and payoff that each player obtains by selecting his own strategy. In other words, Game Theory helps to predict actors' behavior, based on their goals in the conflict (Madani, 2010). So far, Game Theory has been widely implemented to study conflicts in water resource management (Shi et al., 2016; Jiang and Hellegers, 2016; Mehrparvar et al., 2015; Li et al., 2016; Raquel et al., 2007). Application of this method has significantly helped to identify and analyze the conflicts of water rights in common rivers among countries located in the upstream and downstream (He et al., 2014; Kinsara et al., 2015; Madani et al., 2011; Wang et al., 2008; Kilgour and Hipel, 2005; Kilgour et al., 1987; Ma et al., 2011).

Using the concepts of cooperative and non-cooperative games has made it possible to deal with the issues in the area of non-quantitative management of water. Other examples of using this approach include taking environmental considerations into account in inter-basin water transfer (Mahjouri and Ardestani, 2010), water resource allocation and waste load allocation (Read et al., 2014; Saberi and Niksokhan, 2017), modeling the coalition influence on trading water pollution discharge permit (Niksokhan et al., 2009), and analyzing and solving urban runoff conflict (Ghodsí et al., 2016).

Analyzing a conflict after participation of new players (usually with significant power and influence) is always a challenging matter, especially when players' interests are intensely contradictory and the likelihood of solving the conflict among them is quite improbable (Fowler and Shi, 2016; Kinsara et al., 2012). In such cases, the participation of a third party (new player) can be in different ways. If the third party has own strategies and payoffs, he can act as a decision-maker in the game. Otherwise, his role can be in form of an arbitrator, a coordinator, or a donor. If this player can change preferences and priorities of other players, the player is a donor or coordinator and if the participation of this player leads to excluding some strategies, he has the arbitrator role (Sakamoto and Hipel, 2005).

Graph Model for Conflict Resolution (GMCR) is a methodology for assessing and understanding the non-quantitative strategic conflicts (Kilgour and Hipel, 2005). This approach provides both decision makers and mediators with a clear insight into the ways conflict can be resolved. The modeling process includes five main steps including forming the set of decision-makers (DMs), defining all possible states of the conflict based on DM's set of strategies, removing infeasible states of the conflict, specifying DMs' preference over the set of strategies, and running the model to depict possible equilibrium states and resolution. Fang et al. (1993) described the basics of the GMCR model in detail. Using the GMCR II, Hipel et al. (2013) studied three conflicts related to the Euphrates River in 1975, 1990, and 1998 among Turkey, Syria, and Iraq. Considering the role of the third party and the form of the coalition, results showed that Saudi Arabia can intervene as the donor in the conflict to achieve the desired resolution. Philpot et al. (2016) studied the water rights conflict of Snake Valley. They highlighted the players' strategies by recognizing the key decision makers (Nevada State, Utah State, and Bureau of Land Management (BLM)), their priorities, and the feasible states to model and analyze the conflict. Since the decision makers' priorities are completely opposed, the conflict moves to the state in which Nevada and Utah States wants the Supreme Court to intervene in and eventually terminates the conflict as the third party. Safaee and Mohammadi (2014) used the Game Theory and GMCR II Model to study the water conflict of Urmia Lake. They concluded that not only was the possibility of reaching a cooperative solution in this conflict minuscule, but also the only way to avoid providing new water rights can be the intervention of the cabinet as the senior decision maker.

Determining the priorities and payoffs for each strategy and state is one of the most important parts of modeling a conflict. It is often quantified based on the type of the game (quantitative or non-quantitative) (Hipel and Fang, 2005). In quantitative models, as benefits of choosing each strategy is clear to all players (common knowledge), the payoff is calculated for each state of the game based on the utility functions; however, in non-quantitative models, the states are ranked based on the ordinal number of relative preference of strategies (Fang et al., 1993). One method of ranking relative preferences is to use multi-criterion decision-making, which are widely used in water resource management (Amirkani et al., 2016; Rousta and Araghinejad, 2015; Sadar et al., 2015; Karamouz et al., 2014; Wu et al., 2012; Hyde et al., 2005). Analytical Hierarchy Process (AHP) is one of multi-criterion decision-making methods, which decomposes the decision problem to four levels of general goal, general criteria, sub-criteria, and alternatives (Saaty, 1987). It uses pairwise comparisons to derive the numerical weight or the priority of each strategy (Forman and Gass, 2001). So far, this method has been broadly implemented in the management of groundwater and surface water (Hadipour et al., 2016; Chitsaz, 2016; Sun et al., 2016; Abed-Elmdoust and Kerachian, 2014; Chung and Lee, 2009). Ke et al. (2012) studied the Canadian west coast port congestion conflict using the AHP model to rank all preferences of each DM's and GMCR II to find equilibria of the conflict.

Based on the literature review, we can come to the conclusion that using the AHP model along with the GMCR can be beneficial tools for conflict resolution. However, it is usually possible to have more than one equilibrium in a conflict and we need to find out under what circumstances the desired equilibrium would be achieved. In such cases, if the most probable equilibrium is not the desired one, intervention in the conflict is required by a third party who has no specific preferences for itself and also, is capable of either forcing the decision makers to exclude specific strategies or changing their preferences in the short or long term. In addition, there is always a chance to have some third parties. This raises the question of recognizing the most influential third party. To deal with this question, we can benefit from the Inverse GMCR analysis as an applicable feature of GMCR + which is developed by Kinsara et al. (2015) to find possible relative preferences of each DM for a specific equilibrium. Answering this question will lead to recognizing the most influential third party. Therefore, we used the GMCR + model and the Inverse GMCR analysis to achieve our objectives.

In this paper, we study and analyze the non-quantitative conflict of water rights among Iram’s dam organizational stakeholders including the Jihad Agriculture Organization, the Department of Environment, the Water and Wastewater
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