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A negotiation support system for resolving an international trans-boundary natural resource conflict

Kaveh Madani [a,*], Omid M. Rouhani [b], Ali Mirchi [c], Sona Gholizadeh [d]

[a] Centre for Environmental Policy, Imperial College London, London SW7 2AZ, UK
[b] School of Civil and Environmental Engineering, Cornell University, Hollister Hall, Ithaca, NY 14853, USA
[c] Department of Civil and Environmental Engineering, Michigan Technological University, Houghton, MI 49931, USA
[d] School of Teaching, Learning, and Leadership, University of Central Florida, Orlando, FL 32816, USA

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ABSTRACT

Post-Soviet legal governance regime of Caspian Sea – the largest inland body of water on earth – remains a source of conflict among the five coastal states of Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan. Although different division methods have been suggested for sharing the sea and its valuable resources, the actual gain of the countries is unclear as the proposed methods focus either on the oil and gas or the areal share of the parties. The Caspian Sea Negotiation Support System (Caspian Sea NSS) is developed in this study to delineate optimal boundaries for sharing the sea through simultaneous consideration of the countries' areal and resource shares under different sharing methods. This NSS is a complex optimization model, with a solver engine that provides reliable results with a reasonable computational effort using a heuristic method. The model is run under different division scenarios to evaluate the sensitivity of each party's gain and locations of nautical boundaries to the division rules and the economic values of the resources. Results show a high sensitivity of the optimal nautical boundaries to the division rules and an indirect relationship between the allocated area and resource shares. The findings highlight the necessity for considering utility shares in negotiations as opposed to adopting areal division rules which ignore the utilities and might result in unfair resource allocation. The main policy implication of the study is that clarification of the countries' resource and areal gain under any suggested legal regime for governing the Caspian Sea is essential to the success of the negotiations.

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1. Introduction

The multinational conflict over the legal status of the Caspian Sea, with its unique physiographic attributes and significant share of the world's energy and ecosystem resources, has remained unresolved since the breakup of the Soviet Union in 1991 (Mehdiyoun, 2000; Peimani, 2001; Zonn, 2001; Bahgat, 2002; Blum, 2003; Madani et al., in press). Lying between the Caucasus Mountains and Central Asia, the 376,000-km^2 sea is considered to be the largest inland body of water in the world. The proven and potential oil and gas deposits in the Caspian Sea are a significant proportion of global reserves (Blum, 2003). Additionally, the Caspian Sea is a valuable environmental resource that supplies local food and almost all of the world's black caviar (Zonn, 2001). Currently, redefining the Caspian Sea's legal status has become the subject of one of the world's insurmountable disputes, involving five littoral states of Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan. The dispute is mainly over selecting a legal regime for allocation of the Caspian Sea's surface area as well as its precious oil and gas resources. Furthermore, the strategic importance of controlling the crossroad of energy and perhaps military power in the Central Asia adds a geopolitical dimension to the problem (Amirahmadi, 2000; Haghayeghi, 2003; Kaliyeva, 2004). After two decades of fruitless efforts, the negotiations to reach an agreement regarding the ownership of the sea should be expedited to prevent tragedy of the commons and to help alleviate environmental degradation and ecosystem deterioration due to overfishing and increased pollution from oil extractions (Zonn, 2001; Sheikhmohammady et al., 2010).

To this date, none of the various methods that have been proposed for allocating the Caspian Sea and its resources has gained full support from all of the involved parties, and a universal consensus over the sea's legal status is yet to be established (Kaliyeva, 2004; Sheikhmohammady and Madani, 2008b,c). Before the collapse of the Soviet Union, the Caspian Sea was governed based on two historical treaties between Iran and the Soviet Union.

* Corresponding author. Tel.: +44 20 7594 9346; Fax: +44 20 7594 9334.
E-mail addresses: k.madani@imperial.ac.uk (K. Madani), om67@cornell.edu (O.M. Rouhani), amirchi@mtu.edu (A. Mirchi), sona@knights.ucf.edu (S. Gholizadeh).

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The 1921 Treaty of Friendship between Iran and Russia guaranteed free navigation for both parties and the 1935 Treaty of Establishment, Commerce and Navigation, which was reaffirmed in 1940, stipulated a coastal strip of 10 nautical miles from the shoreline as the territorial waters and exclusive fishing zones of the two states. (Mehdiyoun, 2000; Madani and Gholizadeh, 2011; Imen et al., 2012). However, after the fall of the Soviet Union, these treaties were no longer recognized by the new sovereign states which called for establishment of a new legal status for the sea to protect and promote their interests and prosperity (Mehdiyoun, 2000). One reason for failure of the dialogues for finding an acceptable legal regime to govern the sea is, perhaps, the ambiguity over the parties' obtainable benefits under each proposed division method. Although some proposed methods implicitly consider the gas and oil shares of each country, e.g., the 'Condominium' regime which allocates equal oil and gas shares to all countries (Sheikhmohammady et al., 2011, 2012), total gains of the parties are not very clear under other division methods such as median lines and equal shares of surface and seabed. The primary reason is that, typically, these division methods do not provide robust solutions to the problems associated with sharing the non-uniformly distributed energy resources. Furthermore, the division methods proposed in the scientific literature (O'Lear, 2004; Janusz, 2005; Askari and Taghavi, 2006; Sheikhmohammady and Madani, 2008a; Madani and Gholizadeh, 2011; Imen et al., 2012) focus mostly on determining the resource share of each country without suggesting appropriate nautical boundaries to secure the suggested resource shares.

Over the years, perhaps due to national, regional, and global geopolitical dynamics, Iran and, especially, Russia have changed their stances from supporting the 'Condominium' regime to the 'principle of sectoral division of the seabed' which is more favorable to the new sovereign states. As such, the nature of disputes over the legal regime of the Caspian Sea has shifted from whether the sea should be divided to how the division should be done (Mehdiyoun, 2000; Bahgat, 2002; Mojtahed-Zadeh and Hafeznia, 2003; Blum, 2003). Thus, to assist the negotiating parties, there is a need for developing an evaluation framework for simultaneous examination of different aspects of possible division methods, including the oil and gas shares, the areal shares, and the location of nautical boundaries.

Decision Support Systems (DSS) and Negotiation Support Systems (NSS) have been developed for transboundary water and environmental conflicts. Identifying and exploring the possible effects of alternative decision options and understanding the tradeoffs between their impacts through development of DSS and NSS can facilitate reaching an agreement among negotiators (Jelassi and Foroughi, 1989; Thiessen and Loucks, 1992; Kilgour et al., 1995; Thiessen et al., 1998; Nandalal and Simonovic, 2003; Janssen et al., 2006; Kersten and Lai, 2007; Kronaveter and Shamir, 2009a). Example cases include the acid rain negotiation between European countries (Hordijk, 1991), the Flathead River conflict between Canada and USA (Hipel et al., 1997), the conflict over Euphrates and Tigris rivers between Iraq, Syria, and Turkey (Kucukmehmetoglu and Guldmann, 2004), negotiations on the Canada-US Pacific salmon treaty (Noakes et al., 2005), the Jordan River conflict (Madani and Hipel, 2007), the Nile River conflict (Elimam et al., 2008; Madani et al., 2011), and international global warming negotiations (Heitzig et al., 2011), among others.

Optimization frameworks can facilitate the conflict resolution process (e.g., Kronaveter and Shamir, 2009a,b), using appropriate visuals to present the outcome of modeling for consensus building among multiple stakeholders (Kasprzyk et al., 2013). Analysis of trade-offs and stakeholders' gains under different proposed scenarios can be accomplished conveniently by formulating a representative optimization problem (e.g., Kucukmehmetoglu and Guldmann, 2010). Kasprzyk et al. (2013) developed an optimization framework for identifying and visualizing Pareto-approximate tradeoff sets for complex many-objective environmental problems, facilitating consensus building among a broad range of decision maker preferences. Arciniegas et al. (2013) demonstrated the importance of using graphical components to create appropriate visuals (e.g., map) in a spatial decision support system for effective communication of integrated knowledge obtained from multi-criteria spatial analyses. Barnaud et al. (2013) suggested that adding the spatial dimension is necessary for resource allocation negotiations (Barnaud et al., 2013).

This paper presents the Caspian Sea Negotiation Support System (Caspian Sea NSS), which is comprised of an optimization component along with an agent-based swap component working based on heuristic algorithm concepts. The proposed method facilitates obtaining optimal allocation of the sea, and determining the location of borderlines while addressing the allocation challenges posed by the presence of economically and strategically important energy resources. The novelty of the Caspian Sea NSS is in the use of a combination of optimization and map-based graphical components to facilitate the Caspian Sea negotiations by enabling the parties to estimate their gains under different division rules, and to find optimal nautical boundaries to secure their shares. While the focus of this study is on developing a tool for facilitation of the Caspian Sea negotiations, the proposed method is applicable to a class of common pool resource problems characterized by complex, multi-party negotiation over optimal allocation of area and valuable, heterogeneously distributed resources offered by the common.

In the next sections we explain the components of the Caspian Sea NSS along with different division scenarios. We then provide a discussion of the results, i.e., gains of negotiating parties in terms of areal and utility shares, and limitations of the proposed methodology, followed by conclusions.

2. The Caspian Sea Negotiation Support System

The developed allocation method consists of two modules, i.e., the Share Distribution Module (SDM) and the Swap Module (SM). Fig. 1 shows the flowchart of the proposed methodology.

The SDM provides an efficient initial optimization solution that will be used by the SM to find an improved optimal solution with respect to total transportation costs using a heuristic agent-based approach. First, the negotiating parties define their minimum required share of the sea summing up to 100%, which is provided to the SDM as an input. Furthermore, the SDM takes the digitized map of the sea as input and uses a solution merely based on minimum distance rule (as will be explained later) to match each country's allocated utility share to the corresponding pre-specified share of that country. This module is purely an allocation model whose outcome provides an efficient initially acceptable solution that can be further improved using the next module. Thus, the allocation algorithm does not necessarily incorporate some important elements of human decision making such as geographic optimality of the obtained solution, as well as feasibility of nautical borders. To address this shortcoming, the SM is developed to add an agent-based component to the NSS, increasing the flexibility of share allocation in the conflict resolution process.

The SM provides a platform for considering interactions among the littoral states in order to increase, among other things, the economic and strategic efficiency of the proposed solution by creating smooth marine borderlines at an optimal distance from their shores. This module incorporates insights from agent-based modeling by allowing to trace how the solution evolves in light

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