Journal of APF Command and Staff College (2025), 8(1), 113-135

Game Theory: An Overview of Natural Resource Conflict and its Resolution

Sajin Kunwar[a]
sajinkunwar@gmail.com

DOI: https://doi.org/10.3126/japfcsc.v8i1.77603

Article History:
Received: 19 December 2024
Accepted: 18 March 2025
Published: 20 April 2025

Keywords:
Conflict, natural resource conflict, game theory, water conflict, irrigation conflict and resolution

To cite this article:
Kunwar, S. (2025). Game theory: An overview of natural resource conflict and its resolution. *Journal of APF Command and Staff College, 8*(1), 113-135. https://doi.org/10.3126/japfcsc.v8i1.77603

To link to this article:
https://doi.org/10.3126/japfcsc.v8i1.77603

Corresponding Editor
Ramesh Raj Kunwar
kunwar.sangla2@gmail.com

Abstract

This article illustrates the concept of irrigation conflict and its resolution practices in the Khageri irrigation project that lies in the Chitwan district of Nepal. The author collected data from the informants of the study area who were farmers, members of water user associations, civil society, and local government officials. Some issues of conflict while managing the irrigation project were the denial of riparian rights, resource rights dilemma, water scarcity, human encroachment of the canal, park control, legal restrictions and raising water fees, called 'pani pot' in its colloquial term. The resolution of such conflict, as per the findings of this paper, reflects the importance of co-management and cooperation among all the users. Some elderly farmers act as a mediator to resolve the conflicting issues. There were some farmers who adjudicate cases of conflict for the local administration and police station. Author highlighted the game theory model that is effective for the wise use of natural resources in general and irrigation management in particular.

Introduction

This paper is an attempt to illustrate the concept of irrigation conflict and its management practices. It is an urgent issue of study in a sense it helps to improve the agricultural production in a long run. The author has taken it necessary and inevitable as it gives a scholarly attempt to solve the problem that exist in the sector of irrigation and crop production. This is a newer approach in the arena of natural resource management cases because this issue has been covered shading light with the concept of game theory.

Managing, consuming and processing natural resources is just like playing a game. If the players i.e. resource users are rational while using the resources that can mark a sustainable use and protection of those resources. This paper shows authors serious concern for the protection of natural resources. It is designed with the aim of becoming self-sustained in terms of resource use. There are various problems in the sector of agricultural production. It is therefore, this paper is a tiny effort to come out with such problems and address it. In this concern, the author has conducted the study related to the irrigation project as it is one of the major components inevitable for the effective crop production in the field.

In general understanding, conflict is a state of disagreement between and among different parties while making a decision. Steele (1976, p. 222) explained conflict as a condition involving two parties, having a mutual problem of position or resource scarcity, in which there is certain behavior developed through the exercise of power to gain control. It is Wright (1951, p. 194) who provided an etymological meaning of the word conflict as it is derived from the Latin word '*confligere*' which means to strike together.

Ercoskun (2021, p. 4) highlighted Galtung's definition of conflict as a dynamic process in which structure, attitudes, and behaviors continuously change and affect each other. Conflict cannot be isolated and studied independently since it is directly or indirectly linked with various disciplines, which is a set of understanding knowledge. It is studied in terms of human behavior, economic management, anthropology, sociology, linguistics, cultural traits, life sciences etc.

In this paper, irrigation conflict is considered as a unit of water resource conflict. Ayling and Kelly (1997) stated that "resource conflict is a serious issue in which certain resources like water scarcity have more concern" (p. 182). Postal (1992; in Wall, 1998, p. 69) pointed out the water crisis as one resource conflict that seems likely to emerge during the 21st century. According to the UN, water scarcity affects more than 40% of the global population: 2.2 billion people around the world lack access to safely

managed drinking water, including 875 million without basic drinking water (UN, 2018; in Pham, 2022). Starr warned that "increasing demand, decreasing supplies and declining quality have all been given as a factor behind water wars" (Starr, 1991; in Giordano et al., 2005, p. 54).

Water is a precious resource that invites conflict at all levels. In this vein, this study articulates the concept of irrigation conflict as a unit of water conflict. The author has specified irrigation conflict because water conflict covers a vast area which is necessary to narrow into a particular issue. Moreover, this study illustrates some possible ways for irrigation conflict resolution practices using the game theoretical approach. It is a response to the research questions, 'What are the issues that induce conflict while managing the irrigation project? and how does game theory help to resolve those issues of conflict?

Review of Literature

This review shades knowledge related to the issues for an example, natural resource management, natural resource conflict, irrigation management, irrigation conflict, and its resolution practices. It covers the concept of game theory and its implications in the national and international context. Hasan and Mulamoottil (1994, p. 145) stated management is "to control the course of affairs by one's action". They added that management also refers to the exploration, appropriate use, and protection of natural resources and to prevent waste. Resource management is the actual decision concerning policy or practice regarding how resources are allocated and under what conditions or arrangement resources may be developed.

According to the annual report of the World Trade Organization (WTO), natural resources are "stocks of materials that exist in the natural environment that are both scarce and economically useful in production or consumption, either in their raw states or after a minimal amount of processing" (Bacchetta et al., 2010; in Bayramov, 2018, p. 5). Ratner et al. (2017, p. 878) stated collective action or inclusion in natural resource management is necessary but various factors for example socio-ecological and governance context; and natural resource management institutions affect the incentives for conflict or cooperation for sustainable resource use and management. In the similar context, it is explained that "equitable engagement by marginalized groups in dialogue and negotiation over resource access and use is needed while managing natural resources".

Tsing et al. (1999, p. 197) illustrate the concept of community-based natural resource management with the proposition that "local populations have greater interest in the sustainable use of resources".

Kattel (2006) highlighted irrigation management, like the process related to water production, water acquisition, water allocation, water distribution and water appropriation. Similarly, Uphoff (2015, p. 44) included decision-making, resource mobilization, communication, coordination and conflict resolution as the major entities that come under irrigation management. Shukla and Sharma (1997) shed some light on irrigation management like the arrangement of membership, water and resource mobilization, repair and maintenance.

Upreti (2001, p. 5) claimed irrigation management as a form of resource management which included resource development, maintenance, functioning of users' committees, people's participation, use of technology, application of rules and sharing of benefits. Ratna Reddy (2003, p. 1184) pointed out water user's association, irrigation networks and stakeholder participation as some of the integral parts of irrigation management. Facon (2000, p. 2) focused on the physical infrastructure and the improvements that are necessary for the management of irrigation. Hafied et al. (2018) illustrated human resources, institutional organization, sustainable operation and maintenance and Jehangir et al. (1999, p. 639) presented the well-functioning of canals and other irrigation infrastructures as the integral aspects of irrigation management.

It is (Guo, 2001; walker, 2008; So, 2007; Lian, Glendining & Yin, 2016; in Heurlin, 2020, p. 401) highlighted that "natural resource conflict in-terms of land conflict is caused due to the greed and grievances of the villagers in the form of economic insecurity". He took the reference of Paul and Hoeffler (2004) and added even civil war is caused due to the nature of greed and grievances (p. 401). Suliman's (1999; in Heurlin, 2020, p. 888) study of conflict in Sudan pointed out that "a combination of draught, Baggara expansion into Nuba territories, and state allocation of productive lands to absentee landlords undermined the Nuba's customary land and water rights contributed to the outbreak of violence between these two groups during the civil war".

Beyene (2017, p. 19) brought the reference to Ethiopia and stated that sometimes ethnic diversity, the systems of governance, associated competition for land, and control of water points have contributed to violent conflict between ethnic groups over natural resource management issues. The relationship between natural resources and conflict is rather complex and often predictable (Bhavnani, 2009; in Beyene, 2017, p. 21). Humphrey (2014, p. 511) explained natural resource conflict is induced because of its values and wealth. It is caused due to horizontal inequalities. Fearon and Latin (2003, in Humphrey, 2014, p. 511) warned that "natural resources increase the prize value of capturing the state

and lastly there is conflict in the name of secession if natural resources are concentrated in a particular region of a country".

Natural resource conflict is caused due to the poor governance system, weak institution capacity, and rent-seeking tendencies of the common people (Ogwang, et al., 2019, p. 25). Rent-seeking is the exploitative activities that bring personal benefit to the individuals and negative outcomes for society. It can take many forms including bribery, corruption, smuggling, and black market sales. Upreti (2004, p. 60) explained resource conflicts were an inevitable part of Nepalese society. In his study related to land, water, and forest conflict, he concluded conflict was the product of human relations.

Bayramov shaded two schools of thought on the natural resource conflict. One is the theory of greed, i.e. abundance of natural resources leads to violence, inequality, and conflict and another is the theory of grievances, i.e. scarcity of natural resources contributes to conflict and instability. Collier and Hoffler (2004; in Bayramov, 2018, p. 75) claimed that "resource-abundant countries have a high potential to witness rebel movements and civil war the wealth available from non-renewable resources offers a financial opportunity for rebellion group and such individuals are identified as greedy rebels". There are other scholars who believe that resource abundance increases the chance of grievances when a particular group controls the resources it causes conflict (Ross, 2004; Wick & Blute, 2006; in Bayramov, 2018, p. 72).

Some scholars (Collier & Hoeffler, 2004; Fearon, 2005; Ross, 2006; in Bayramov, 2018, p. 73) argue that natural resources lead to intrastate conflicts. Some believe natural resources induce interstate conflict (Burgerson, 2009; Kleveman, 2004; Klare, 2001a, 2001b; Moyo, 2012; in Bayramov, 2018, p. 73) and those emphasize both intra and interstate conflicts (Colgan, 2014; De Soysa, 2007; in Bayramov, 2018, p. 73).

Getirana and Malta (2010, p. 2893) claimed conflict in irrigation arouse due to hydraulic constraints of the canal and lack of social and cultural cooperation, coordination and unity also lead towards irrigation conflict. Sometimes, lack of clear water rights, lack of incentives for the water users and ambiguous role of authorities can cause irrigation conflict (Merry, 1998, p. 57). Easter (2000, p. 370) illustrated some of the issues that create conflict in the irrigation project. They are lack of maintenance of irrigation infrastructures, users' reluctance to pay water fees and less interest in user participation. Menon et al. (2006, p. 894) stated that poorly maintained irrigation infrastructure and water availability to farmers were the cause of irrigation conflict. Sometimes rivalries between upstream and downstream riparian can lead to the destruction of infrastructure, which may bring the

situation of conflict (Hussain & Hanjra 2004, p. 4, Bijani & Hayati 2015, p. 564, Taher & Zamani, 2009, p. 859).

Irrigation conflict is caused mostly due to the access and control of water distribution patterns (Celio et al., 2010; in Devkota et al., 2018, p. 2). Bossenbroek and Zwareveen (2014, p. 271) explained that irrigation conflict is caused due to the differences of opinion between the water user groups in the name of consumption. Aboub and Haruyama (2016) highlighted the causes of irrigation conflict due to not having a managed power structure among local groups, lack of support from the government, breakdown of traditional rules, unequal water distribution etc. Similarly, Angelakis et al. (2021, p. 22) mentioned some of the ways to resolve conflicts related to irrigation. According to them, it is necessary to understand the proper needs and position of upstream and downstream water users.

Ostrom and Gardener (1993, p. 99) illustrated the concept of a proper water rotation system as a form of conflict resolution. Giordano et al. (2005, p. 50) examined some aspects like operation and management, resource mobilization patterns and water user efficiency as an integral aspect that should be considered for the resolution of irrigation conflicts.

Seabery et al. (2016) prepared a review of game theory applications in natural disaster management and stated that "managing resources is just like playing a game. It can be similar as they involve players, attackers, defenders, agencies/ individuals, interaction, etc.". Natural resource management involves strategic interactions among various decision makers, different levels of government, private sectors, and nonprofit organizations. This makes game theory an applicable methodology to study the case. They define game theory as a branch of applied mathematics that attempts to mathematically capture behavior in strategic situations by structuring them into game-like elements. These elements include players, rules, outcomes, payoffs, information known to the players, and game duration. Solutions can be determined which may give insights into optimal decision-making strategies for the players involved.

Various scholars have studied natural resource management and crisis from the perspective of the game theory model. Hausken et al. (2019), Haphuriwat and Bier (2011), Zhuang and Bier (2007), Rahman et al. (2012), Chan (2015), Zhuang et al. (2012), Hamilton and Mc Cain (2009), Liu et al. (2012), Rubas et al. (2006), Lai et al. (2015), Vasconcelos et al. (2015) as cited by Seabery et al. (2016) conducted their study by applying game theory into different components of natural resource management; for an example, climate forecast, in global climate change, in determining weight of flood risk, etc. They categorized game theory applications into cooperative and non-cooperative game theory model.

According to them, Wang et al. (2024) and Gupta and Ranganathan (2007) use a non-cooperative game model in resource management, whereas Chakravarty (2015) and Yang et al. (2008) analyze a cooperative game model. Pham (2022) uses the game theory model for water resource management and opined that "rational players who pursue well-defined objectives and assume knowledge of others would accordingly form expectations of other decision makers' behaviors". Bailey et al. (2010) applied game theory as a tool for "explaining and analyzing problems of strategic interaction for fisheries management. It uses mathematics to describe players' strategies in sources of conflict and common interest, and what rational players should do, and they do not actually do".

A game consists of a set of players, a set of strategies available to those players, and a set of possible payoffs for each combination of strategies. A strategy refers to any option that a player can take, and it must specify what action will happen in each contingent state of the game. Nash (1953; in Bailey et al., 2010, p. 3) defined cooperation occurs when players in the game are able to discuss and agree upon a joint plan. It is identified from the review that game theory is applicable in various research disciplines. Podimata and Yannopoulos (2015, p. 272) offer game theory insights into an economic, political, and social situation that involves individuals who have different goals or preferences. It is a young branch of mathematics and has been widely used in many other disciplines, such as political science, computer science, biology, psychology, sociology, and other fields (p. 274).

There are two branches of game theory. One is non-cooperative game theory and another is cooperative game theory. Non -cooperative game theory analyzes games where players interact with others in order to achieve their own goals without any coalitions or binding agreements and they act competitively. Cooperative game theory analyzes games where players are driven into mutually binding agreements (Gura and Maschlev, 2008; in Podimata & Yannopoulos, 2015, p. 275).

In game theory, there are winners and losers. One player wins only if the other loses. It is called zero-sum games. In non-zero-sum games, the gain by one player doesn't necessarily correspond with a loss by another (Webb, 2077; in Podimata & Yannopoulos, 2015, p. 275). Madani (2010, p. 225) applied game theory to water resource management. According to him, game theory provides a framework for studying the actions of individual decision-makers to develop more broadly acceptable solutions. Game theory is a mathematical tool-pumping groundwater game introduced by Madani (2010), which follows the concept of the Prisoner's Dilemma game.

> *There are two farmers. Each farmer has to choose between the cooperative and the non-cooperative rate. Pumping costs at a cooperative rate are lower than in a non-cooperative one. The higher the pumping cost, the lower the groundwater table and the lower the net benefit outcome for each farmer, the other farmers commit to pumping at a low pumping rate, then their payoffs will be lowered. While the best strategy for both farmers is to cooperate. GT suggests that the two farmers lack trust in each other and each individual farmer finds non-cooperation as a strictly dominant strategy.* (Madani, 2010)

Ostrom and Gardner (1993) sketched asymmetries in irrigation systems between farmers located near the source of water (head-enders) and farmers placed at a distance from it (tail-enders) and paid attention to the design of irrigation institutions and work. Janssen et al. (2011) studied asymmetries in strategies between head enders and tail enders in irrigation systems.

Game theory applications address issues associated with the concept of fair and equitable water allocation, balanced cost, allocation among irrigators, equilibrium on water withdrawals, and environmental sustainability. The game theory model has been used by different scholars in its different forms for the resolution of conflict. Meta-game analysis (Howard, 1987); hyper-game analysis (Bennett, 1980; in Wang et al., 2024), conflict analysis (Fraser and Hipel, 1984), the graph model of conflict resolution (Kilgour et al., 1987; in Fang et al., 1993), and the theory of moves (Brams, 1994), all having game theoretical roots (Kilgour, 1995; in Madani, 2010, p. 226).

Various scholars studied water conflict in terms of game theoretic framework. For example, (Carraro et al., 2005, Parrachino et al., 2006, Zara et al., 2006 in Madani, 2010). Du et al. (2019, p. 5) highlighted the resource-based theoretical model for dealing with valuable natural resources. Wei et al. (2010; in Du et al., 2019) built a game theory model to solve conflicts during water allocation. Du et al. (2019) discussed the way to realize optimal cost allocation between monopolistic upstream enterprises and downstream enterprises.

Brams (2004, p. XV) stated game theory is a branch of mathematics that is effective for the rational decision-making process. Pham (2022) applied the game theory approach to the management of water resources. “The basic assumptions of game theory emphasize that rational players who pursue well-defined objectives and assume knowledge of others would accordingly form expectations of other decision makers’ behavior.

Game theory provides a framework for situations of conflict and cooperation between rational decision-makers (Tadelis, 2013; in Pham, 2022). Raquel et al. (2007, p. 561) stated that to reduce conflict and arrive at a socially acceptable compromise, the decision-makers should seek an optimal trade-off between conflicting objectives that reflect the priorities of the various stakeholders. They applied game theory to a multi-objective conflict problem in the Alto Rio Lerma irrigation district located in the state of Guanajuato in Mexico. Lenjano and Davos (1995), Lund and Plamer (1997), Lippai and Heaney (2000), Nakas et al. (2002), Supalla et al. (2002), Carraro et al. (2005), Brown Weiss et al. (2005), Coppola and Szidarovszky (2004) cited by Raquel et al. (2007, p. 561) illustrate different water conflict resolution from game theory models citing the example of different cases.

Nepal is an agrarian country, its agriculture is still largely subsistence-based with poor technology adoption, lack of infrastructure and low productivity. Most of its farmland is still dependent on rain-fed irrigation, i.e. totally dependent on natural rain for any irrigation and water requirement (Malla & Khadka, 1997, p. 93). According to Gajmer (2014), "major impediments to agricultural productivity in Nepal include a lack of irrigation management". A study by Shukla and Sharma (1997) showed that improved water delivery at the farm level, in terms of both time and quantity, enhances agricultural performance. Water is a basic need for society and for agricultural productivity for improved livelihoods and well-being (Kumar et al., 2015).

Chaudary (2018, p. 5) stated that the agricultural sector accounts for the largest share of GDP. But its contribution has been continually declining since the 1990s (Regmi, 2007). Pradhan and Belbase (2018, p. 58) projected data that out of 2.7 million ha of agricultural land in Nepal, only 1.4 million ha has some sort of irrigation facility. A report by the Department of Irrigation (2018; in Regmi, 2007, p. 9) reported that about 1.7 million ha of Nepal's cultivated land is irrigable, of which about 75% has been provided with some irrigation infrastructure, while about two-thirds are irrigated during the monsoon season. During winter, when the water demand is high, only 30% of the total cultivable land can be irrigated. Just 18% of the total cultivated land receives year-round irrigation. Even so, 40% of the country's food requirements come from these irrigation systems. This indicates the high level of productivity that irrigated farmlands have. Thus, irrigation projects can play an important role in food security, and their contribution to the Nepalese economy is crucial (ADB, 2006; WB, 2007; in Ostrom et al., 2011, p. 9).

The concept of irrigation management and its practices is a widely studied discipline in global academia, but it has been studied less often in the context of Nepal. This study is an effort to understand the concept of irrigation conflict and its resolution in the KIP which

is the first-hand study in the field. This is novice and makes a special value. It is because this study contributes to bringing higher crop production by solving the issue of water scarcity in the study area. There is the possibility of increased crop production if enough water is available at the required time interval. Lack of or low access to irrigation facilities in farmland is one of the major problems in Nepali agriculture.

Uphoff (1986; in Pradhan, 1989, p. 4) stressed the need for further research to identify factors that are important for effective irrigation management. In this regard, this study is an academic effort to explore the causes behind ineffective irrigation management in Nepal. Understanding the causes and exploring various dimensions of conflict that arise in an irrigation project has significance for overall food security and national agricultural growth. Therefore, this paper addresses the causes of irrigation conflict and its resolution practices, integrating the game theoretic approach in the study area.

Research Methodology

The author conducted this study in the Khageri irrigation project (KIP) located in Bharatpur municipality, Chitwan district of Nepal and collected data through in depth interviews, focus group discussion with the key farmers, members of water users' associations, local government officials and through the close observation of the study area as a participant observer. Boyce and Neale (2006) stated that "in-depth interviewing is a qualitative research technique that involves conducting intense individual interviews with a few respondents to explore their perspectives on a particular idea, program, or situation" (p. 3).

Crotty (1998; in Creswell, 2011, p. 8) identified several assumptions and expressed that qualitative researchers tend to use open-ended questions. The basic generation of meaning comes with social interaction. Kuper et al. (2008, p. 404) stated that reality in qualitative research is generated through social, historical and individual perception of reality. They added that in qualitative research, ideas are drawn through the in-depth study of individuals and groups by talking with them, watching their behavior and analyzing their artifacts (such as diaries, meeting minutes, photographs). Qualitative studies are effective in understanding the values, opinions, behaviors and social contexts of participants (Mack, Woodsong, Mac queen, Guest & Namey, 2005; in Kunwar & Karki, 2020, p. 152).

The author marked minute attributes, behaviors, and levels of cooperation of those water users and other related groups in KIS. In this study, the author is value-neutral. He applied theories based on grounded facts.

In this study, the author adopted a systematic area purposive sampling method. According to Parahoo (1997) purposive sampling is a method of sampling where

the researcher deliberately chooses who to include in the study based on their ability to provide necessary data. It entails selecting participants based on ease of access. Under area sampling, the author divided the study area into a number of smaller non-overlapping areas generally called geographical clusters. The participants were selected based on a specific need or purpose of the study.

Reliability is made through rigorous attempts while checking transcripts. As per the knowledge of the author, those transcripts do not contain mistakes. Codes, themes, and patterns were frequently cross-checked. As pointed out by Creswell (2011, p. 192), good qualitative research includes comments by researchers about how their interpretation of the findings is shaped by their background, gender, culture. To reduce such biases, interpretations were made as per the existing findings from the field. Events were analyzed openly and honestly. The author spent prolonged time in the field and developed an in-depth understanding of the phenomena under study.

Findings and Discussion

This study illustrates the concept of irrigation conflict and its resolution practice using the game theory approach. The author collected data from the informants who were farmers, members of water user associations, civil society, and local government officials in the Khageri irrigation project. Some issues of conflict that were explored in the study area were the denial of riparian rights, resource rights dilemma, water scarcity, human encroachment of the canal, park control and legal restrictions and raising water fees, called '*pani pot'* in its colloquial term. The issues covered by this paper was sensitive. Therefore, the names of the informants were kept confidential.

One of the major issues that brought a situation of conflict in the study area was the denial of riparian rights. In principle, every farmer, whether from the head, mid or tail end section, should have the right to get water on an equal and equitable basis. But in Khageri irrigation project, mostly farmers of the head end section were enjoying water access, and they were not found to be very cooperative towards the needs of mid and tail end section farmers. So, the middle and especially the tail end farmers were denied their riparian rights. In this study, some of the examples of riparian conflict are illustrated below.

Physical assault between Dil Rojaiya (pseudonym) and Rohit Rojiya (pseudonym) shows the conflict in irrigation that is concerned with riparian rights as follows:

> *There was a physical assault between Dil Rojaiya (pseudonym) and Rohit Rojiya (pseudonym). Both were members of the main canal committee. Dil represented the Gitanagar section whereas Rohit represented the Shivanagar section. Gitanagar lies*

> *in the head section whereas Shivanagar lies in the mid-section of the KIP. In this case, farmers from the Gitanagar side were using the water as it was their turn. Rohit wanted to take water to Shivanagar by force because it was not yet the turn of Shivanagar to use the water. Dil refused to provide water to Shivanagar. Rohit forcefully tried to take the key to the water gate. Rohit pushed Dil Rojiya. Dil lost his gold chain in that mishap. Friends of Dil were about to beat Rohit, but Dil pleaded with joined hands not to beat Rohit with his friends. Later on, Rohit was taken to WUA office, and he apologized to Dil Rojiya.* (D. Rojaiya, personal communication, May 20, 2022)

There was a recorded physical fight between Ram Rojiya (pseudonym) and Shyam Rojiya (pseudonym), who represented Subidhanagar (pseudonym) and Silkhola (pseudonym) sections respectively. It was Ram's turn to use water, but Shyam prevented Ram from diverting water into Ram's field. This resulted in a physical altercation between Ram and Shyam. One of the informants, aged 55, who belonged to the mid-section of the KIP revealed in an interview that

> *Ordinary farmers were deprived of water access in their fields but powerful or "elite" farmers who were in power and authority enjoyed water access in their fields* (M. Rojaiya, personal communication, May 20, 2022).

Such kinds of biased practices during the time of water distribution induced a situation of conflict in irrigation management. He mimicked a situation between two farmers to show the problem of water distribution. The first farmer said that

> *He wanted to plant his field first, and it was his turn as per the rotation to get water. But another farmer claimed that it was not possible because the paddy he planted in his field some days ago was already dying, and he needed water that day. The first farmer again said that was not possible, and that it was his turn.* (M. Rojaiya, personal communication, May, 15, 2022)

These kinds of conversations and tussles were common in KIP. According to Gopal Rojaiya (pseudonym)

> *The source of much conflict was because of not following a proper rotation system and ethical values.* (G. Rojaiya, personal communication, May, 17, 2022)

During the field observation in the pre-monsoon in KIS, there was no water flow in the canal. All the main and branch canals remained dry. Instead of water, the canals were littered with garbage, dirt and water bottles. Many farmers were deprived of water. Most of the farmland remained barren. It could be speculated that, had there been enough water,

there would have been increased agricultural production leading to higher income for farmers. So, lack of water in KIS was a serious issue. Almost all the farmers had complaints about the scarcity of water that led to their land turning barren in the KIP area. In the past, they used to sow paddy twice a year, but now it is difficult to get water even once a year for sowing paddy.

After Nepal became a federal state, different levels of government have their ownership and responsibilities to manage the natural resources and mitigate conflicts. Studies have shown that in the name of the distribution and consumption of resources, there exists a conflict in the natural resources in federalism. In KIP too, this has occurred which was revealed by many of the farmers and WUA during interviews. Dil Rojaiya (pseudonym), one of the main canal committee members who represented the Geetanagar section, stated the issues as follows:

> *Once Ratnanagar municipality, one of the municipalities of Chitwan, denied providing water of Khageri River to Bharatpur in West Chitwan claiming that Khageri lies in Ratnanagar municipality. They said that it was only the right of people who live in Ratnanagar to consume and utilize water from the Khageri River. It brought a situation of conflict between the farmers of Ratnanagar and Bharatpur. Later on, Dil and others negotiated the situation explaining that if Ratnanagar denied providing water to Bharatpur, Bharatpur would deny Ratnanagar people to come to their area.* (D. Rojaiya, personal communication, May 22, 2022)

Another major conflict-inducing factor in KIS was human encroachment of the irrigation canal. According to Bill Rojaiya (pseudonym), many people have constructed their houses or barns without following the legal provisions of the irrigation canal. He further added that

> *Some squatters with no legal ownership of land had settled near the bank of irrigation canal area* (B. Rojaiya, personal communication, May 25, 2022).

Such constructions and settlements blocked the free flow of water in the canal. These impede the flow of water and also cause a shortage of water. So, they are also inducing factors of conflict.

Dil Rojaiya (pseudonym) pointed out that

> *The plotting of land that takes place to open any area for development is also a source of conflict. In the name of plotting, the original canal structures are either damaged, misaligned, or destroyed completely* (D. Rojaiya, personal communication, May 26, 2022).

He explained that

> *One of the major inducing factors of conflict in KIP was the restriction to entering the Chitwan National Park* (CNP)" (R. Rojaiya, personal communication, May 25, 2022).

It required various legal procedures if one had to enter CNP. Almost 8 km long main canal of KIP falls inside CNP. Many farmers complained that they were restricted or made to face hassle from entering the CNP when they were doing their regular sanitation, repair, and maintenance of the canal. This has also created a big problem for the farmers.

Water fee is a major economic backbone for the effective management of irrigation projects. In the past KIP was AMIS, and so there was no financial burden to farmers because it was handled solely by the state. After KIP became an FMIS, except for maintenance of the main canal and some major issues of the branch canal, all kinds of economic management needed to be performed by the farmers themselves. Farmers have to pay water levy to the WUA. WUA manages all sorts of financial requirements to repair, maintain, and manage the project from the money thus raised. In this way, water fees or levies or *paani pot* is a major dimension of irrigation management which is necessary to fulfill economic needs. Daniel Rojiya (pseudonym), a member of the main canal committee of KIP, stated that

> *The participation of water users during repair, maintenance, and cleanliness activities have been half-hearted* (D. Rojaiya, personal communication, May 28, 2022).

So far the conflict resolution process in KIP is concerned, several informal discussions, open-ended interviews, and observations helped find several existing practices to settle irrigation conflict. Dil Rojaiya (pseudonym), a member of the main canal committee of KIP, said in an interview that

> *Conflict related to irrigation was generally solved through discussion and agreement* (D. Rojaiya, personal communication, May 19, 2022).

Members of WUA would go to the conflicting area to resolve it. If they were not able to settle the conflict, then the case would be registered at the police station. He said that conflict in irrigation was resolved through the presence of members from WUA. Those members acted as guardians and they mediated and arranged for peaceful talks to resolve the conflicting environment. He quoted some of the words spoken by WUA members during such mediation

> *Look dear young one, everybody needs water. We cannot say that only I have the right to use this water. We have to distribute it to everyone* (G. Rojaiya, personal communication, May 21, 2022).

Tul Bahadur Gurung, the office secretary of KIP said

> *Conflicting issues in KIP were handled by a management committee of 3-5 members. If that committee cannot handle the situation, then the chairperson, vice-chairperson, and ward representative manage such cases* (Tul Bahadur Gurung, personal communication, May 20, 2022).

Dilasha Rojaiya (pseudonym) added that

> *Chairperson, vice chairperson, and secretary of KIP negotiate with conflicting groups if any conflict arises. She said that minor conflicts were settled in the presence of elderly farmers and branch canal committee representatives* (D. Royaiya, personal communication, May 24, 2022).

Dilasha Rojaiya (pseudonym), a farmer from KIP explained that

> *Members of WUA call disputing parties to the WUA office. Then long discussion ensues in which the real cause of conflict and the culprit are investigated. After this, the offenders are either penalized with cash or they are made to apologize to the innocent party* (D. Royaiya, personal communication, May 24, 2022).

The protection of common pool resources is difficult. It is possessed by all but cared for by none. People try to get as much benefit as possible but they fail to protect resources or make wise use of it. There is less participation of farmers in repair, maintenance, and other such activities in the KIP. Many farmers blamed that there was a tendency of 'rent-seeking' and 'free riding' among the water users. Findings provoked the importance of stakeholder engagement as an approach to overcome the issue. WUA must empower farmers and other water users.

There is less engagement of the farmers and water user association members in the field. Even though management authority is with the WUA which is a farmer's association, they have not been able to handle it well. There is a need to integrate local and scientific knowledge and institutionalization of participants in KIP. It is owned by all but there are only a few farmers who work seriously to protect and conserve it. It is a situation in which individuals use and consume resources for their interest but they do not care about the over-consumption of these resources and their impact on society. It is hard to exclude any user from the consumption of common pool resources. KIP is a common resource used by all. But the condition of KIP is degrading day by day.

This situation is linked with the tragedy of the commons put forth by Garret Hardin (1968). Users show concern about its proper management only during their time of need. In KIP, water users seem to be alert about KIP's status only a couple of days before the

onset of the monsoon. That is a time when they sow paddy, their most important harvest, and when they need water from KIP the most. Then they start cleaning, maintenance, and repair activities. Rest of the year, mostly during the lean season, users do not pay attention to its protection and preservation. This is a serious problem. This problem can be solved in two ways. One is privatization or turning the common resource into private property and another is government regulation. Managing irrigation, its cooperation, and coordination is just like a game. If those water users are cooperative, then irrigation will be managed properly. But instead, if water users especially farmers are competitive with each other, irrigation cannot be managed properly. This context of irrigation management as a game is linked with game theory.

Galtung (1973, p. 12) showed the importance of game theory as one way of reducing conflict. In game theory, the situation of win and lose is determined by the choice of actors. The cooperative nature of farmers in KIP leads to effective management of irrigation projects and the competitive nature of farmers in KIP leads to ineffective management of irrigation projects. The essence of co-management has also been proven after observing the case of KIP. It focuses on the cooperation that is needed between government and people usually in the case of utilizing resources. Farmers like Jack Rojiya (pseudonym), and Daniel Rojiya (pseudonym) represent the strong moral, ethical, and social support of farmers whereas the local-level government officials and people's representatives from different ward offices represent government concern over the project.

The theory of co-management is a concept illustrated by Armitage et al. (2009). This is also called the principle of alternative co-management. It is concluded that only proper coordination between farmers and local bodies will not be enough to manage the KIP properly. Despite the efforts of both government and farmers, the performance of KIP is still not satisfactory. It is essential to have a private firm or an individual who can buy the ownership of KIP from the government for a fixed-year term and sell water to the users. Having various shortcomings, neoliberalism has some advantages. In the case of KIP, if it is owned by any firm or an individual, farmers need to pay money to get water. It helps to control conflict in irrigation projects. It ensures effective management of KIP. Its infrastructure will be in a good condition. Questions related to ultra-poor farmers below the poverty lines may arise as they cannot pay much but they still need water for their farm. As an option, these farmers can be put in a category or given some cards that enable them to receive water in subsidy.

Watson (2004, p. 43) mentioned that liberalism emphasizes a number of individual rights and freedom. He added it is not a typical problem-solving strategy for management

of the global political economy rather it is a crisis management strategy. In a situation of water crisis in KIP, this practice of economic management would play a significant role for its effective use.

There is a theory of liberal globalization which asserts that capitalism is a natural culmination of historical progress. Callinicos (1993, p. 284; in Watson, 2009, p. 44) brought reference to Francis Fukuyama to show the importance of liberal globalization which can maintain a strong civil society, capital states, and international system. Taking it as a reference point, the author analyzed the KIP. This study concluded that the current problem of KIP will be solved if the maximum utilitarian approach is adopted for maximum individual control. The utilitarian approach gives satisfaction to a greater number of people. There can be a tender process or bidding which may help to increase the standard and effectiveness of KIP. Liberals believe that capitalism is best for securing humanism and individual human work. Watson (2009, p. 56) opined "as a crisis management strategy, neo liberalism approaches the plight of the global majority from the angle of debt management and poverty alleviation".

Conclusion

This paper digs out some of the issues that induce conflict and its resolution practices in the Khageri irrigation project. Some of the major conflict-inducing factors in the study area are the denial of riparian rights, scarcity of water, resource rights dilemma, human encroachment to the canal, park control, legal restrictions, raising water fees, etc. In addition, mediation, talks, discussions, negotiation, and arbitration are the ways of conflict resolution in the study area. The author visualized the case of KIP from a different theoretical lenses. It includes the theory of co-management, the tragedy of commons, and stakeholders' engagement. The most important aspect of this paper is the illustration of the game theory approach for the management of natural resource conflict. It is a novice attempt in academia in which few scholars in Nepal aligned this theory to reflect the issue of natural resource management.

From the study, it is concluded that natural resource management is a collaborative approach. It is like playing a game. If the players are found cooperative, there comes a situation where no players lose the game. It is called a win-win situation. It depends upon the mutuality among the players which is directly proportional to the resulting outcome.

The theory applied to analyze the situation and condition in this paper is effective. For example, the application of the theory of co-management to study the KIP is valid, on the other hand, it assesses how it could have a better management system. The arrangement between government and community to manage resources is a failure in the particular case

of KIP. This study infers the need for maximum privatization of such resources transferring ownership either to an individual or registered business firm. It protects against the wrong and careless use of resources. State will get a regular tax therefore it increases state revenue. The author concluded that there is a need for political economy required for the protection and long-term sustainable consumption of such resources. It gives concern for the maximum profit to a large number of satisfaction while distributing the resources. Every farmer needs to pay for the use of water which will systematize the resource consumption.

Author Introduction

a. **Sajin Kunwar** is a Ph.D. research scholar of Tribhuvan University, Nepal.

References

Angelakis, A. N., Valipour, M., Ahmed, A. T., Tzanakakis, V., Paranychianakis, N. V., Krasilnikoff, J., Drusiani, R., Mays, L., El Gohary, F., Koutsoyiannis, D., Khan, S., & Giacco, L. J. D. (2021). Water conflicts: From ancient to modern times and in the future. *Sustainability, 13*(8), 4237. https://doi.org/10.3390/su13084237

Armitage, D., Plummer, R., Berkes, F., Arthur, R., Charles, A., Davidson-Hunt, I., Diduck, A., Doubleday, N., Johnson, D., Marschke, M., McConney, P., & Pinkerton, E. (2009). Adaptive co-management for social-ecological complexity. *Frontiers in Ecology and The Environment,7*(2). 95-102. https://doi.org/10.1890/070089

Ayling, R. D., & Kelly, K. (1997). Dealing with conflict: Natural resources and dispute resolution. *The Common Wealth Forestry Review*, *76*(3). 182–185. https://www.jstor.org/stable/i40096693

Ayoub, A., & Haruyama, S. (2016). *Conflict of Irrigation Water Management in Local Water: Traditional Irrigation Water Management in Afghanistan*. Annual Meeting of the Association of Japanese Geographers, Graduate school of Bio-resource. https://doi.org/10.14866/ajg.2016s.0_100176

Bailey, M., Rashid Sumaila, U., & Lindroos, M. (2010). Application of game theory to fisheries over three decades. *Fisheries Research, 102*(1-2), 1-8. https://doi.org/10.1016/j.fishres.2009.11.003

Beyene, F. (2017). Natural resource conflict analysis among pastorals in Southern Ethiopia. *Journal of Peace building and Development, 12*(1), 19-33. https://www.jstor.org/stable/48602933

Bhatta, K., Ishida, A., Taniguchi, K., & Sharma, R. (2006). Performance of agency-managed and farmer-managed irrigation systems: A comparative case study at Chitwan, Nepal. *Irrigation and Drainage Systems, 20*, 177-191. https://doi.org/ 10.1007/s10795-005-9001-8

Bijani, M., & Hayati, D. (2015). Farmers' perceptions towards agricultural water conflict: The case of Doroodzan dam irrigation network, Iran. *Journal of Agricultural Science and Technology, 17*(3), 561-575. http://jast.modares.ac.ir/article-23-10756-en.html

Blumer, H. (1969). *Symbolic Interactionism: Perspective and Methods*. Englewood Cliffs, NJ: Prentice Hall.

Bossenbroek. L., & Zwarteveen, M. Z. (2014). Irrigation management in the Pamirs in Tajikistan : A man's domain? *Mountain Research and Development, 34*(3), 266-275. https://doi.org/10.1659/MRD-JOURNAL-D-13-00087.1

Boyce, C., & Neale, P. (2006). *Conducting In depth Interviews: A Guide for Designing and Conducting In depth interviews for Evaluation Input.* Pathfinder International Tool Series.

Brams, S. J. (2004). *Game Theory and Politics*. The Free Press.

Chakravarty, S. R. (2015). *A Course on Cooperative Game Theory*. Cambridge University Press.

Chaudhary, D. (2018). Agricultural policies and rural development in Nepal: An overview. *Research Nepal Journal of Development Studies, 1*(2), 34-46. https://doi.org/10.312/rnjds.v1i2.22425

Collier, P., & Hoeffler, A. (2004). Greed and grievance in civil war. *Oxford Economic Papers, 56*(4), 563-595. https://www.jstor.org/stable/3488799

Creswell, J.W. (2011). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches.* Sage Publications.

Devkota, K., Khatri, D., & Neupane, K. R. (2018). Water conflicts in urbanizing regions in the Himalaya: Case studies from Dhulikhel and Bidur in Nepal. *Nepal Journal of Social Science and Public Policy, 5*(1), 1-25. https://doi.org/10.53037/na.v5i1.13

Du, W., Fan, Y., Liu, X., Park, S. C., Tang, X. (2019). A game-based production operation model for water resource management: An analysis of the South-o- North water transfer project in China. *Journal of Cleaner Protection, 228* (5), 1482-1493. https://doi.org/10.1016/j.jclepro.2019.04.351

Easter, K. W. (2000). Asia's irrigation management in transition: A paradigm shift faces high transaction costs. *Review of Agricultural Economics, 22*(2), 370–388. http://www.jstor.org/stable/1349800

Ercoskun, B. (2021). On Galtung's approach to peace studies. *Lectio Socialis, 5*(1), 1-7. https://doi.org/10.47478/lectio.792847

Facon, T. (2000). Improving the irrigation service to farmers: A key issue in participatory irrigation management. *Asian Productivity organization seminar on organizational*

change for participatory irrigation management, 23-27. https://www.researchgate.net/profile/Thierry-Facon/publication/253831003

Fraser, N. M., & Hipel, K. W. (1984). *Conflict Analysis: Models and Resolution*. New York, North-Holland.

Galtung, J. (1973). *Theories of Conflict*. Transcend University Press.

Gajmer, B. (2014, April 11). Nepal: Irrigation and water resource management. *World Bank Group.* https://l1nq.com/q6ldB

Getirana, A. C. V., & Malta, F. (2010). Investigating strategies of an irrigation conflict. *Water Resource Manage 24*, 2839-2916. https:// doi.org/10.1007/s11269-010-9586-z

Giordano, M. F., Giordano, M. A., & Wolf, A. T. (2005). International resource conflict and mitigation. *Journal of Peace Research, 42*(1), 47–65. https://doi.org/10.1177/00223433050449666

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report, 8,* 597-607. https://doi.org/10.46743/2160-3715/2003.1870

Gupta, U., & Ranganathan, N. (2007). Multi event crisis management using non-cooperative multi-step games. *IEEE Transactions on Computers, 56*(5), 577-589. https://doi/10.1109/tc.2007.1023

Hafied, A. A. G., Sharma, P., & Singh, S. (2018). Global review of institutional reforms in the irrigation sector for sustainable agricultural water management, including water users associations: Institutional reforms in the irrigation sector. *Irrigation and Drainage, 68* (1). https://dx.doi.org/10.1002/ird.2305

Hardin, G. (1968). The tragedy of the commons. *American Association for the Advancement of Science, 162*(3859), 1243-1248. https://www.jstor.org/stable/1724745?origin=JSTOR-pdf

Hasan, S., & Mulamoottil, G. (1994). Natural-resource management in Bangladesh. *Ambio, 23*(2), 141-145. https://encr.pw/RHQQV

Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher- Mansuy, W., Hirsch Hadorn, G., Joye, D., Pohl, C., Wiesmann, U., & Zemp, E. (2008). Idea of the handbook. In G. Hirsch Hadorn et al. (Eds.), *Handbook of Trans-disciplinary Research* (pp. 3-18). Springer.

Howard, N. (1987). The present and future of meta game analysis. *European Journal of Operational Research, 31*(1), 1-25. https://doi.org/10.1.16/0377-2217(87) 90267-0

Humphreys, D. (2014). *Forest Politics: The Evolution of International Cooperation*. Routledge.

Hussain, I., Marikar, F., & Jehangir, W. A. (2000). *Productivity and performance of irrigated wheat farms across canal commands in the Lower Indus Basin* [Report no. 044]. International Water Management Institute. https://hdl.handle.net/10568/39831

Janssen, M. A., Anderies, J. M., & Cardenas, J. C. (2011). Head-enders as stationary bandits in a symmetric common: Comparing irrigation experiments in the laboratory and the field. *Ecological Economics, 70*(9), 1590-1598. https://doi.org/10.1016/j.ecolecon.2011.01.006

Kattel, S. (2006). Dispute management in Farmer's managed irrigation system: A case study of GeyaDanda irrigation system of Eastern Nepal. *Dhaulagiri Journal of Sociology and Anthropology, 1,* 87-96. https:// doi.org/10.3126/dsaj.v1i0.277

Katz, J. (2002). Start here: Social ontology and research strategy. *Theoretical Criminology, 6*(3), 255–278. https://doi.org/10.1177/136248060200600302

Kumar, S., Allan, R. P., Zwiers, F., Lawrence, D. M., & Dirmeyer, P. A. (2015). Revisiting trends in wetness and dryness in the presence of internal climate variability and water limitations over land. *Geophysical Research Letters, 42*(24), 10-867. http://dx.doi.org/10.1002/2015GL066858

Kunwar, R. R., & Karki, N. (2020). A study of dark (disaster) tourism in reconstructed Barpak, Nepal. *The Gaze Journal of Tourism and Adventure, 11*(1), 140–180. https://doi.org/10.3126/gaze.v11i1.26637

Kunwar, R. R., & Ulak, N. (2023). Tourism and hospitality: Academia and industry interface. *Journal of Tourism & Adventure, 6*(1), 104–139. https://doi.org/10.3126/jota.v6i1.58584

Kuper, A., Lingard, L., & Levinson, W. (2008). Critically appraising qualitative research. *BMJ, 337*. https://doi.org/10.1136/bmj.a1035

Luce, R. D. & Raiffa, H. (1957). *Games and Decisions*. Dover Publications.

Madani, K. (2010). Game theory and water resources. *Journal of Hydrology, 381*(3-4), 225-238. https://doi.org/10.1016/j.jhydrol.2009.11.045

Malla, G. L. & Khadka, S. S. (1997). Farmer managed irrigation systems in Nepal: Some issues and trends [Report No. H020128]. *International Water Management Institute,* 93-108. https://ideas.repec.org/p/iwt/bosers/h020128.html

Menon, A. (2006). Environmental policy, legislation and construction of social nature. *Economic and Political Weekly,41*. https://doi.org/10.2307/4417692

Merry, D. J. (1998). *Role of water users' associations in improved irrigation system performance.* Asian Productivity Organization. https://hdl.handle.net/10568/37620

Ngulube, P. (2015). Qualitative data analysis and interpretation: Systematic search for meaning. In E. F. Mathipa & M. T. Gumbo (Eds.), *Addressing Research Challenges: Making Headway for Developing Researchers* (pp. 131-156). Mosala-MASEDI Publisher.

Ogwang, T., Vanclay, F., & Assem, A.V.D. (2019). Rent seeking practices, local resource curse and social conflict in Uganda's emerging oil economy. *Land, 53*(8), 2-14. https://doi.org/10.3390/land8040053

Ostrom, E., & Gardner, R. (1993). Coping with asymmetries in the commons: Self-governing irrigation systems can work. *The Journal of Economic Perspectives*, *7*(4), 93–112. https://www.jstor.org/stable/2138503

Ostrom, E., Lam, W. F., Pradhan, P., & Shivakoti, G. P. (2011). *Improving irrigation in Asia: Sustainable Performance of an Innovative Innovation in Nepal*. Elagar Online. https://doi.org/10.4337/9780857938022

Parahoo, K. (1997). *Nursing Research: Principles, Process and Issues.* Palgrave Macmillan.

Pham Do, Kim-Hang. (2022). *Water resource management: Challenges and opportunities with game theory approaches.* Oxford Research Encyclopedia of Environmental Science. https://doi.org/10.1093/acrefore/9780199389414.013.763

Podimata, M., & Yannopoulos, P. C. (2015). Evolution of game theory application in irrigation Systems. *Agriculture and Agricultural Science, Procedia, 4,* 271-281. https://doi.org/10.1016/j.aaspro.2015.03.031

Pradhan, P. (1989). *Increasing Agricultural Production in Nepal: Role of Low-Cost Irrigation Development Through Farmer Participation*. International Irrigation Management Institute.

Pradhan, P., & Belbase, M. (2018). Institutional reforms in irrigation sector for sustainable agriculture water management including water user's associations in Nepal. *Hydro Nepal: Journal of Water, Energy and Environment, 23,* 58-70. https://doi.org/10.3126/hn.v23i0.20827

Raquel, S., Ference, S., Emery, C. & Abraham, R. (2007). Application of game theory for a ground water conflict in Mexico. *Journal of Environmental Management, 84*(4), 560-571. https://doi.org/10.1016/j.jenvman.2006.07.011

Ratna Reddy, V. (2003). Irrigation: Development and reforms. *Economic and Political Weekly*, *38*(12/13), 1179–1189. https://www.jstor.org/stable/4413369

Ratner, B. D., Meinzen-Dick, R., Hellin, J., Mapedza, E., Unruh, J., Veening, W., Haglund, E., May, C., & Bruch, C. (2017). Addressing conflict through collective action in natural resource management. *The Commons Journal*, *11*(2), 877–906. https://doi.org/10.18352/ijc.768

Regmi, A. R. (2007). Water security and farmer managed irrigation systems of Nepal. In F. Rotberg & A. Swain (Eds.), *Natural Resources Security in South Asia: Nepal's Water* (pp. 67-110). Institute for Security and Development Policy.

Seaberg, D., Devine, L. & Zhuang, J. (2016). A review of game theory applications in natural disaster management research. *Nat Hazards 89,* 1461–1483. https://doi.org/10.1007/s11069-017-3033-x

Shivakoti, G. P., Janssen, M. A., & Chhetri, N. B. (2019). Agricultural and natural resources management. *International Journal of the Commons, 11,* 877-906. https://doi.org/10.18352/ijc.768.

Shukla, A., & Sharma, K. R. (1997). *Participatory irrigation management in Nepal: A monograph on evolution, processes and performance*. Department of Irrigation.

Steele. J. L. (1976). Conflict resolution. *Operational Research Quarterly (1970-1977), 27*(1), 221–230. https://doi.org/10.2307/3009141

Stubbs, L., Howard, N., & Tait, A. (2011). How to model a confrontation – Computer support for drama theory. *Semantic Scholar*. https://www.decisionmechanics.com/wp-content/uploads/2009/11/ccrts1999.pdf

Taher, A. Z., & Zamani, G. H. (2009). Farmer participation in irrigation management: The case of Doroodzan Dam Irrigation Network, Iran. *Agricultural Water Management, 96*(5), 859-865. https://ideas.repec.org/a/eee/agiwat/v96y2009i5p859-865.html

Tsing, L., Peter Brosius, J., & Zerner, C. (1999). Assessing community based natural resource management. *Ambio, 28* (2), 197-198. https://www.jstor.org/stable/i399332

Uphoff, N. (2015). Understanding and utilizing the softer aspects of 'software' for improving irrigation management. In P. Pradhan & U. Gautam (Eds.), *Farmer Managed Irrigation Systems in the Changed Context* (pp. 27-48). Farmer Managed Irrigation Systems Promotion Trust.

Upreti, B. R. (2001). Conflict management in natural resources: A study of land, water and forest conflicts in Nepal [Doctoral Dissertation, University of Wageningen]. https://doi.org/10.18174/139410

Wang, D., Zhau, S., Xue, L., Addae, B.A. & Juna, W. (2024). First level hyper game for investigating two decision- maker conflicts with unknown misperceptions of preferences within the framework of GMCR. *Science Direct, 237*(B), https://doi.org/10.1016/j.eswa.2023.121619

Watson, H. A. (2004). Liberalism and neo-liberal capitalist globalization: Contradictions of the liberal democratic state. *Geo Journal*, *60*(1), 43-59. https://doi.org/10.1023/B:GEJO.0000033587.48810.ae

Wright, Q. (1951). The nature of conflict. *Western Political Quarterly, 4*(2), 193-209. https://doi.org/10.2307/443101

Yang, S., Huang, G. Q., Song, H., & Liang, L. (2008). A game theoretical approach to choice of profit and revenue maximization strategies in tourism supply chains for package holidays. *Journal of China Tourism Research, 4*(1). https://doi/10.1080/19388160802099709