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Pakistan's Water Vulnerability and the Risk of Inter-State Conflict in South Asia

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Abstract

The paper addresses the issue of water scarcity and water vulnerability in Pakistan. It appears that wasteful agricultural practices; the dam centered internal politics and the recent construction of dams by the Indian government on the shared rivers has caused concern amongst certain quarters and created fears in some sections of society in Pakistan that India could redirect some of the water which rightfully belongs to Pakistan under the Indus Basin Treaty. If this indeed happens there could be serious water shortages in parts of down-stream Pakistan. A game theoretic analysis of the situation suggests that, given the nature of induced water stress, the law of unlimited territorial sovereignty, if implemented in this case, could result in a Nash equilibrium of bilateral aggression for these nuclear neighbors. Institutional mechanisms therefore have to be put into place for monitoring river flows on both sides of the border and information sharing as stipulated under the Indus Basin Treaty to prevent tensions and develop a cooperative approach to the problem of growing water scarcity related with climate change.

Keywords: Shared Waters, Conflict, Game Theory

JEL classification: Q25

1. Introduction

According to a recent World Bank report, only 3% of the world's water is fresh water and most of it is not directly available for use because it is either locked up in icecaps or deep aquifers or because it is polluted. At present, about 700 million people today live in countries experiencing water stress or scarcity and by the year 2035, the number is expected to reach 3 billion[2]. Countries and regions with limited water availability often depend on shared water resources. Water demand is growing with population growth and

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[2] Water Resource Management:
http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTWAT/0,,contentMDK:21630583~menuPK:4602445~pagePK:148956~piPK:216618~theSitePK:4602123,00.html

economic development and tensions over water rights are increasing at the national and international level. At the same time water quality is deteriorating as water sources; such as rivers, lakes, aquifers and wetlands are encroached upon.

This study addresses the issue of water scarcity and water vulnerability in Pakistan that has emerged due to a number of factors such as reduced river flows related with climate change; increased water requirements resulting from population growth and economic development; and low water use efficiency in Pakistan. The decline in river flows resulting from global warming as predicted by the Inter-Governmental Panel for Climatic Change[3] and inter-provincial disagreements that have hampered the construction of important dams in down-stream Pakistan are significant factors in creating the problem of reduced water availability at the farm level. These factors combined with low irrigation and application efficiencies and inappropriate agriculture practices drawn from a period when Pakistan was a water surplus country have further exacerbated the problem of water scarcity. This qualitative study on the subject analyzes the issue in a game theoretic framework and proposes a solution that might prevent this environmental scarcity from further deteriorating the already strained relations between the two countries jeopardizing regional stability.

The study begins by reviewing some of the previous studies related to water induced conflict. Section 2 provides background detail on the ongoing conflict and presents a review of the outstanding agreement over water resources between India and Pakistan. Section 3 presents an analysis of the situation using a game theoretic framework and discusses the possibility of cooperatively solving the dispute between the two countries. The final section concludes with policy prescriptions for reaching an agreement over shared rivers; a problem that is likely to affect millions of people in both countries in the coming decades.

[3] Climate Change 2007, Impacts, Adaptation and Vulnerability, Working Group-II, Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, New York, NY, 2007, Page 13. The likelihood of reduced river flows in South Asia resulting from global warming effects is also pointed out more recently by R.K. Pachauri, The Impact of Global Warming and the Imperative of Mitigation, Chapter 23.8, in, Akmal Hussain and Muchkund Dubey (ed), Democracy, Sustainable Development and Peace: New Perspectives on South Asia, Oxford University Press, New Delhi, 2014.

2. Shared Rivers and Alternative Theories

During the last two decades a significant number of studies have addressed the issue of scarcity or abundance of natural resources and their correlation with the likelihood of militarized or non- militarized interstate disputes (Gleick, 1993; Rogers, 1997; Beaumont, 1997; Haftendorn, 2000; Gleditsch, 2001; Klare, 2001; Lonergan, 2001; Renner, 2002; Yoffe et. al., 2004; Kalpakian, 2004; Abbink et. al., 2009; Molen & Hildering, 2005; Hensel & Brochmann, 2008). Since water is one of the most essential resources, its relationship with the likelihood of conflict has been explored in a number of studies.

Studies of international water management focus mainly on water scarcity as a trigger for either conflict or cooperation (e.g. Dinar, 2007; Hamner, 2008; Dinar, 2009; Brochman & Hensel, 2009; Dinar, 2010). The existing studies on the subject can be divided into two categories on the basis of their ideology. According to the first group of researchers disagreements that emerge because of the environmental scarcities and degradation of resources are likely to result in violent disputes both within and across borders. Homer and Dixon (1994) posited that among the renewable resources water has the greatest potential for stimulating armed conflict. Hence the poor societies that are already suffering acute hardship from shortages of water, forests, and especially fertile land, will be particularly affected from environmental scarcities in general and water scarcity in particular. In a recent study Raleigh & Kniveton (2012) tested this claim using rainfall variability in East Africa to explore the marginal influence of the climate on conflict. Their study shows that in periods of extreme rainfall variation the rebel and communal groups often use force and violence to compete for scarce water resources.

Scholars such as Gleick (1993) and Rogers (2002) made similarly pessimistic forecasts, especially for countries that are highly dependent on water that originates beyond their borders; for example Egypt, Hungary, Mauritania and Pakistan. In this regard Haftendorn (2000) also identifies various sources of conflict over fresh water sources. Among them, misuse of the resource, pollution and altering the distribution of water via construction of a dam or the channeling of river flows, are the major sources of water instigated disputes.

Klare (2001) argues that the danger of international competition for adequate water resources will grow 'inevitably' and by the year 2050, the

increased demand for water could produce 'intense competition for this essential substance almost everywhere on the planet. Several empirical studies (Toset et. al., 2000; Furlong, Gleditsch & Hegre, 2006) found that sharing a river increases the probability of an armed conflict in pairs of countries over and above mere contiguity. It was also pointed out that water scarcity is associated with conflict, particularly when a river is shared across rather than along a border creating an upstream-downstream relationship among the riparian states.

The second group of researchers believes that cooperation over shared waters is a more likely outcome than conflict (e.g. Keohane & Ostrom, 1994). Wolf (2002) noted that more than 3,600 water-related agreements were signed between the years 805-1984; a statistic that offers substantial support to this argument. Countries sign treaties for various reasons, such as externalities relating to pollution, flood control, or hydropower (Just and Netanyahu, 1998); or for reasons such as economies of scale where parties anticipate being better off acting in a coalition rather than acting alone when faced with certain water scarcity situations (Dinar, 2009).

Several case studies from Nile, Tigris and Euphrates also suggested that water disputes do not cause serious conflicts and may actually initiate positive interaction and cooperation among countries (Kalpakian, 2004; Yoffe, Wolf, and Giordano, 2004). Other studies suggest that sharing a river is related to several general measures of positive interstate interaction (such as trade, alliances etc. and river-related treaties and institutions) increase peaceful efforts to resolve river claims reducing the risk of militarization (Brochmann and Gleditsch, 2006; Hensel and Brochmann, 2008, Hensel, Mitchell and Sowers, 2006).

Studies also explore the impact of different water availability levels on the stability of treaties and cooperation between states (Ambec and Sprumont, 2002; Ambec and Ehlers, 2008; Beard and McDonald, 2007; Janmatt and Ruijs, 2007; Bernauer and Tobias, 2012). Tir and Stinnet (2012) argue that the probability of armed conflict over fresh water decline when the river in question is governed by a formal agreement. The authors note that joint monitoring, conflict resolution; treaty enforcement and delegation of authority to inter-governmental organizations will reduce the risk of armed conflict over shared rivers. Assessing the impact of water supply variability on treaty cooperation between international bilateral river basin riparian states, Dinar, Blankespoor & Kurukulasuriya (2010) argue that small to moderate

increases in water supply variability induced by climate change creates an impetus for cooperation, however large increases in water variability would reduce incentives for treaty cooperation. Using large scale economic and international relations data the authors prove that stronger diplomatic and trade relations support cooperation, while uneven economic power inhibits cooperation across the basin riparian states.

2.1 A Brief History of Water Conflict between India and Pakistan

When the Indian subcontinent was partitioned in 1947, the Indus river basin which was previously serving the entire sub-continent was divided between India and Pakistan. The rivers serving Pakistan's irrigation supplies originate on the Indian side of the border. In 1948 India claimed sovereign rights over the waters passing through its territory and tried to divert the waters away from Pakistan. Pakistan tried to resolve the issue through dialogue but failed and the dispute threatened war. At that point the World Bank resolved the dispute via arbitration and the Indus Water treaty was signed between the two countries in 1960.

According to the treaty, India was offered the three Eastern rivers (Ravi, Beas and Sutlej)[4], while Pakistan was offered the three Western rivers (Indus, Jehlum and Chenab)[5]. The Chenab River in Pakistan combines the waters of four rivers, the Jehlum, the Sutlej, the Beas and the Ravi, to form a single river system which then joins the biggest Indus River in Pakistan. The Indus River is hence considered the lifeline of Pakistan's economy and livestock industry. The treaty also allowed the construction of storage dams and link canals in Pakistan to divert water away from the Eastern rivers and replacement works were supposed to be financed by Australia, Canada, Germany, New Zealand, United Kingdom, Italy and United States.

The three rivers that serve the Indian agricultural system contain only about one-fifth of the system's total flow. To boost India's share of the resource up to around 30 per cent of the total, the World Bank arbitrators proposed that the Indus Water treaty also let India extract a certain amount of water from two of Pakistan's rivers before they departed Indian Territory.

[4] The Sutlej originates in Tibet, flows through Himachal Pradesh and Punjab before joining the Chenab, while Beas and the Ravi originate in Himachal Pradesh state and flow into Pakistan, emptying into the Chenab

[5] The Indus River originates in Chinese-controlled Tibet and flows through Jammu & Kashmir. The Chenab originates in India's Himachal Pradesh state, travels through Jammu & Kashmir whereas the Jehlum originates in Jammu & Kashmir and flows into Pakistan, finally joining the Chenab.

This proposal was reluctantly accepted by Pakistan. The Indus Water treaty established a permanent Indus Commission made up of one commissioner from each country. The commission is required to meet regularly and both parties are required by the rules to notify the other of plans to construct any engineering works which might affect the other party (Barret, 1994).

2.2 Water Stress and Pakistan's Vulnerability

The signing of Indus Treaty paved the way for construction of Mangla and Terbela dams in Pakistan, which were commissioned in 1967 and 1974 respectively. Mangla dam has a storage capacity of 5.88 million acre feet and a power generating capacity of 1000 megawatts. Terbela on the other hand has a storage capacity of 9.7 million acre feet and can generate 3478 megawatts of power. Both dams contributed towards development of Pakistani agriculture and industry and helped bring a "Green Revolution" in Pakistan during 1960s and 1970s. However since 1974 no dam capacity has been added in Pakistan. With a very low 9% of water storage, the per capita, per annum availability of water has dropped from a high of 5000 cubic meters to 1329 cubic meters[6], very close to the danger level of 1000 cubic meters which will categorize Pakistan as a water-scarce country.

The Kalabagh dam project on the Indus River was proposed in the KPK and Punjab provinces of Pakistan during 1960s and approved by the World Bank experts for funding during 1970s and 1980s. The dam is expected to have a storage capacity of 6.1 million acre feet and a power generation capacity of 3600 megawatts. However, serious concerns were shown over the project by several political groups from Sindh and KPK provinces of Pakistan[7]. Since the last thirty years, multiple studies have been done to address the proposed dangers and findings have ruled out almost every objection posed by the politicians from the area. Nonetheless, the intransigent attitude of some political groups is hampering the construction of this important dam which could easily prevent Pakistan from turning into a desert.

[6] Leena Srivastava, The Environmental Challenges in South Asia: Regional Cooperation for Adaptation Strategies, chapter in, Akmal Hussain and Muchkund Dubey, Democracy, Sustainable Development and Peace: New Perspectives on South Asia, Oxford University Press, New Delhi, 2014, Table 4.

[7] It has been alleged that the dam is designed to deplete the normal flow of water in the river Indus and will deprive the Sindh province of its due share of water. It is also propagated that the reduced water flow will have an impact on the sea water intrusion, ground water quality, and mangrove forests and fish production in the Indus delta. In addition the KPK politicians assert that lands in the Peshawar valley and Nowshera town would be inundated in the event of recurrence of flood as a result of this dam.

Water scarcity in Pakistan is made worse by the outdated and obsolete irrigation and agricultural practices still prevalent in Pakistan. As compared to other countries in the region, Pakistanis use ten times more water for growing the same amount of crops. When India and Pakistan signed the Indus Water Treaty there was still plenty of water in the Indus river system for both countries. But due to the rapid population growth and expanding agricultural requirements particularly on the Pakistani side of the border, per-capita supply of water in Pakistan has fallen from over 5,000 cubic meters per person per year in 1947 to only about 1329 cubic meters per person, per year today[8] which is close to the level defined by the United Nations as "high stress" (1000 cubic meters). In addition it was discovered about a decade ago that the glaciers up on the top of the Tibetan Plateau that feed the Indus river system have started to melt and according to the Chinese Academy of Sciences, some of the glaciers are expected to melt in less than 20 years (Wu & Zhu, 2008; Wei, 2008). Should this happen, river levels will drop permanently and the resulting increase in stress will touch both countries that are highly dependent on this system. By the year 2030, glacier melting is expected to reduce the flow of the Indus to almost half. Almost all of this loss will occur in Pakistan's river system since the smaller Indian shared rivers do not depend heavily on glacier melt (Dyer, 2010).

The climatic change is expected therefore to increase India's total share of the Indus water, while Pakistan's agriculture has already begin to suffer[9]. In the 1990s India started the construction of Baglihar dam (a 450-megawatt hydroelectric power project on the Chenab River in the Doda district of Jammu & Kashmir). Furthermore the construction of Baglihar dam provides India a certain degree of control over Pakistani waters making it a "defense security concern" for Pakistan (Ahmad, 2009). The Government of Pakistan at the time thought that this was a storage dam (which would be in violation of this Indus Waters Treaty)[10] and hence would adversely affect 13 million acre feet of irrigated land around the Chenab and Ravi rivers in the Punjab province of Pakistan, creating serious food shortages. Accordingly,

[8] Leena Srivastava, Op.cit.

[9] Dyer, Gwynne (2010): Pakistan: A Question of Water, http://gwynnedyer.com/2010/pakistan-a-question-of-water/http://gwynnedyer.com/2010/pakistan-a-question-of-water/ Published on Aug 20, 2010

[10] According to the Indus water treaty India is not permitted to build storage dams on the Indus, Chenab, and Jehlum rivers. It can only make limited use of their waters, including developing run of the river hydroelectric power projects. India is also obligated to provide Pakistan with the technical details of any water project it might want to undertake on the shared rivers before starting construction.

Pakistan challenged this project in the International court of Justice which initially ruled in favor of India in the key issue of spillway design but later halted the construction of this dam.

Pakistan also filed a 'dispute' in 2010 against the Kishanganga dam project, which is being constructed on the Kishanganga River in the Gulrez valley in India. Since the Kishanganga River is a tributary of the Jehlum River, which is a part of Indus Water System, the Kishanganga River also comes in the domain of the Indus Water Treaty. Pakistan decided therefore to challenge the construction of this dam in the third and highest category of contention in the Indus treaty's language. A seven-member international arbitration panel is being assembled to hear the case, the first to be taken to such a level. The ruling is not expected for several years. However, in response to the request for interim measures, the international court of arbitration has barred India beginning September 2011 from any permanent works on this project. The discussion of water easily ignites popular passion in Pakistan and a failure to resolve the outstanding dispute on part of the World Bank can result in a political deadlock and even a potential outbreak of conflict between the two countries at some stage.

3. The Water Game

The games in this section are typical of games based on Haftendorn's (2000) idea of transforming the non-cooperative games into the cooperative ones. Idea is to explore the possibility of cooperatively solving the fresh water conflict between India and Pakistan.

With regard to property rights, the law of international water resources offers two extreme rules. The doctrine of unlimited territorial sovereignty states that a country has exclusive rights to the use of waters within its territory. This means that a country may use its rivers as much as it wishes and in whichever way it wants. In contrast the doctrine of unlimited territorial integrity states that the quantity and quality of water available to a country cannot be altered by another country (Caponera, 1983). This rule implies that the upstream country cannot pollute or misuse the water of a shared river.

Now these two doctrines clearly imply very different pre-bargaining positions and several alternative normal form games are possible in this scenario. The Nash equilibrium depends upon the associated payoffs with every possible action that players take. The payoffs are assumed on the basis of the analysis done in the last section. The strength of choices made by each

player and the resulting pay-offs are conditioned by the volatile sentiments in the situation[11]. For the Pakistan side, a sense of being deprived of its right to use fresh water, a feeling of being dominated and concerns over security determine its assumed pay-offs.

India on the other hand has a stance that the Indian water projects currently undertaken do not contravene the provisions of the 1960 Indus Water Treaty and that India can construct dams within the technical specifications outlined in the Indus Water Treaty[12]. In the India-Pakistan interaction gamed in this paper it is assumed that India aims to establish supremacy over the neighbouring countries by controlling the water resources in the region while at the same time maximizing its hydro electric capacity and agriculture productivity. These assumed considerations are the main determinants of the assumed pay offs in the game theoretic model of this paper. The asymmetric nature of pay-offs indicate differences in international credibility, the structure of governance, internal political stability and an ability to pursue economic gains in the agriculture sector in the two countries.

The games described in this section turn out to be *"mixed motive"* and non-constant sum games in general. It is assumed that each player has perfect information about the strategies and pay-offs of the other player. There is however some exogenous un-certainty involved in this game. This uncertainty is attributed to the actions of a third party which in this case would be "nature". Severe water stress can be the result of natural phenomena such as glacier melting and a reduction in rainfall and will affect the outcome of the game. These natural phenomena are beyond the control of the players and "nature" is indifferent to the outcomes of the game. The probability of water stress can be predicted somewhat by the meteorologists but it is assumed that this knowledge is common to both players.

Consider the game form described by the Matrix 1 in the appendix section. In the simplest "*one shot*" game, we assume that both players have perfect information and decisions are taken in real time. The two strategic

[11] Lately Pakistan has expressed deep concern over the fact that the 1960 Indus Water Treaty has been working primarily to the advantage of India especially in phase of changing climatic conditions. India is controlling the water flow of the Indus, Chenab and Jhelum rivers, seriously affecting Pakistani agriculture increasing its dependence on imported food and deteriorating the balance of payments.

[12] In compliance with the treaty therefore India has so far not constructed any storage dam on the Indus, Chenab and the Jhelum rivers. The hydroelectric projects India is developing are on the run-of-the-river waters of these rivers, projects which according to India, it is permitted to pursue according to the treaty.

players are the government of Pakistan and the government of India. Each player has more than one possible strategy to choose from. The available strategy profiles to the government of India are:

1) Simply abide by the Indus Water Treaty and leave the growing water demands to "nature" hoping that it will work to the advantage of India. This strategy has been termed as "Do Nothing" in the matrix.

2) Engage in dialogue with Pakistan and call for World Bank mediation to resolve the water issue peacefully via dialogue and arbitration. This strategy is termed as "Arbitration" in the matrix.

3) Pursue the storage dam projects as and when desired, regardless of the Indus Basin Treaty and thereby indirectly implementing the idea of unlimited territorial sovereignty. (The Indus Basin Treaty implies the idea of limited sovereignty in the case of water sharing between upper and lower riparian states). In the matrix this strategy is termed as "Build Storage Dams".

In response to these actions, the available action profile to the government of Pakistan is:

1) Simply ignore the problem of water scarcity. This action profile assumes that the government takes no action to improve irrigation and application efficiencies; and ignores the possibility of increasing water use efficiency through new institutional mechanisms. These include pricing water and changing relative prices of crops for incentivizing farmers to generate a higher GDP per unit of water used. The strategy is termed as "Do Nothing" in the matrix.

2) Continue political dialogue with India on the subject and try to resolve the matter peacefully by seeking arbitration from World Bank and other international agencies. This strategy is again termed as "Arbitration" to signify peaceful resolution of the problem.

3) Retaliate against construction projects at all levels to prevent hegemonic control over water resources by the Government of India, which is assumed to be the basis of its water policy. This strategy is termed as "Aggression" on the part of Pakistan.

The game in Matrix 1, assumes that there is no severe water stress affecting the strategies chosen by the players. Consider the pay-offs associated with each action. It is assumed that being upstream India does not face the

danger of resource depletion to an extent that Pakistan does. Hence "doing nothing" leads to a negative pay-off for Pakistan in contrast to India who gets zero points by not reacting in any way. Under normal circumstances India gains a highest pay-off of 20 points by building dams to ensure ample water supplies for future generations. If India abides by the Indus water treaty, unilateral aggression will not benefit Pakistan in any way since it only leads to a loss of credibility on the international front and will yield negative pay-offs of -20 and -10 respectively. This pay-off from aggression increases to 0 points if India decides to carry out its projects, yet it is still not as superior a strategy for Pakistan as compared to arbitration i.e. challenging the projects in the international court of justice or going to the world bank. Therefore Nash equilibrium in this case is (Arbitration-Arbitration) as it maximizes the joint pay-offs for both countries.

The real problem arises in Matrix 2, which assumes a situation of severe nature induced water stress. In this case the pay-offs change in a way so that if India violates the agreement by building dams, Pakistan will gain more by taking aggressive retaliatory measures instead of unilaterally insisting on arbitration.

Matrix 3 has been obtained by multiplying the payoffs from the first two matrices with their respective probabilities (assuming that the probability of low stress is only 0.4 and the probability of high stress is 0.6) and summing up the respective payoffs. For example the payoff (16, 16) has been obtained by multiplying (10*0.4 + 20*0.6). It can be observed that even-though bilateral aggression still yields a lower pay-off for both countries as compared to dialogue, the game leads to a situation of multiple Nash equilibria; (Arbitration-Arbitration and Build-Aggression).

Arbitration-Arbitration is clearly a superior equilibrium if each country seeks to resolve the matter peacefully via arbitration giving the other its due share of water. However, in the games with multiple Nash equilibria the available information acts as a signal or clue that enables a unique equilibrium point for the players. Given the history of the armed conflict in the region, it seems probable that bilateral aggression might become a Schelling point[13] in this case where India will continue to build dams and storage facilities on the shared rivers and Pakistan will retaliate to this

[13] If signal or clue based on the available information or past behavior enables the players to determine a unique equilibrium for the game, the equilibrium that is more likely than the other is called the Schelling point.

exercise aggressively even though doing so would lower the joint pay-offs for both countries.

Actually bilateral aggression in this case also generates a risk dominant Nash equilibrium as by choosing aggression each party will be trying to avoid a lower pay-off just in case the other one chooses to take aggressive measures. Even if there were no clues to establish Schelling points, uncertainty becomes a predominant motive in the game and, according to some game theorists, there is a strong case for using the "maximin" solution as a rational response to uncertainty[14]. Applying "maximin" approach in this case we observe that the minimum pay-off from arbitration is 0 for each country and the minimum pay-off from aggression is -20 for each country (see Matrix 2). So the "maximin" solution to this game also becomes bilateral aggression even though it is the worst of the two equilibriums.

It is possible to derive a unique dominant strategy Nash equilibrium when the game is setup in an extensive form. In a finitely repeated extensive game India has an option to move first and it can choose to build or not build the dams on the shared waters. In response to the choices made by India, Pakistan has an option to react passively or aggressively on the choices made. Also nature enters in the extensive setup as a third player inducing water shortages.

Consider the game form described in Figure 1. To understand how the nature affects the associated pay-offs, suppose that the probability of stress is higher and assumed to be 0.6 as compared to low stress probability which is 0.4. The extensive game is setup in the appendix section. Using the simple pruning method we can derive a unique Nash equilibrium for this game[15]. The final pay-offs are obtained by multiplying the probabilities for high and low water stress with the final pay-offs after unreasonable equilibria are deleted from the gaming tree. It is reasonable to conclude that if India chooses to go for dialogue and arbitration, Pakistan will also opt for such a strategy. Nonetheless aggression remains the only option for Pakistan if water stress leads to crop failures and severe food shortages. Matrix 4 has been generated to help understand how resource abundance will change this situation. The payoffs in Matrix 4 have been obtained by assuming a low probability of water stress, multiplying the payoffs from the first two matrices with the respective probabilities (0.8 and 0.2) and summing up the results. Once again

[14] Maximin approach implies avoiding the minimum pay-offs
[15] See Figure 2 & 3 for visual inspection of the game

a unique Nash equilibrium (Arbitration-Arbitration) results, validating Haftendorn's idea that cooperation can be achieved if the dominant state relinquishes its hydrological advantage in return for specific rewards or payments thereby reducing the resource scarcity problem.

The games described in this section therefore validate the idea that whenever a state controls a river's source or upper flow, it places the lower lying riparian state at a disadvantage. In this particular case, India has so far opted to carry out the construction projects on the shared rivers, a situation that could lead to increased tensions and further deterioration in their already strained political relations.

4. Conclusion and Policy Implications

The increasing water scarcity in South Asia is an early warning and indication of the potential for increased political tensions in the region. Under the circumstances, peaceful sharing of the rivers is mandatory but becomes a complicated task when an upstream country has a superior economic, political and military capability. The paper presents a case study of Pakistan and India where such a relationship is analyzed in a game theoretic framework. Simple non-cooperative game theory models have been used to analyze the ongoing dispute and concerns over shared rivers in both countries. The more complex models of co-operative game theory which generate gains for both countries through collaboration for more efficient management of water resources and effective adaptation to the shared dangers of global warming, are not considered in the present study.

The analysis indicates that a high degree of water stress could entrap the countries in the Nash equilibrium of bilateral aggression. Even though a peaceful resolution of the problem could maximize the joint pay-offs for both countries. The direct or indirect violations of the Indus Water Treaty by the Indian government could still lead to an armed conflict between the two countries, jeopardizing regional stability.

To reduce the possibility of conflict arising out of the perception by the low riparian state that the upper riparian state is engaged in "water theft" in violation of the Indus Basin Treaty, Article III, Para 3 of this Treaty can be activated which stipulates that "….Each party agrees to establish such discharge observation stations as may be considered necessary by the Commission for the determination of the component of water available for the

use of Pakistan on account of the aforesaid deliveries by Pakistan"[16]. Using new satellite linked technologies for continuous real time monitoring of river flows in the discharge observation stations on both sides of the border, can objectively establish whether or not river water is being illegally appropriated[17]. One prospective solution for reaching an agreement between the two countries therefore is linking this conflict to other aspects of bilateral or multilateral relationship. This could mean raising the stakes of aggression for both sides via increased direct or indirect opportunity cost (in terms of trade) etc. to coax the countries to cooperate with each other. If this kind of understanding develops between the involved parties the associated pay-offs will change in a way so as to reduce the gains from non-cooperation. To achieve such an outcome, India would need to help Pakistan to solve its domestic water mismanagement problems by providing financial assistance as well as technical support for this purpose. Pakistan in turn could compensate India for the reduced agricultural productivity by providing them trading routes to the central Asian states. Increased trade between both countries will also reduce incentives for military escalation on both sides. The role of arbitrators also becomes important in this case. If the arbitrators play their role responsibly a peaceful resolution of disputes that can arise on the water issue, will become the most likely outcome of this game. A multilateral effort is therefore required for the peaceful resolution of the potential for conflict between these two upper and lower riparian states. If tensions on this issue are allowed to build up, it could have disastrous consequences for millions of people in both countries in the years ahead.

[16] The Indus Waters Treaty 1960, Article III, Para 3.

[17] For a discussion on cross border dissemination of hydrological data, see, Connecting the Drops: An Indus Basin Roadmap for Cross-Border Water Research, Data Sharing, and Policy Coordination, Indus Basin Working Group, Stimson Centre, SDPI and Observer Research Foundation, 2013, page 25.

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Appendix

Matrix 1: The Payoffs Associated with Low Water Stress

		Pakistan		
		Do Nothing	Arbitration	Aggression
India	Do Nothing	(0,-10)	(0, 0)	(-10, -20)
	Arbitration	(10,-10)	(10, 10)	(0, -10)
	Build Dams	(20,-20)	(0, 10)	(10,0)

Matrix 2: The Payoffs Associated with High Water Stress

		Pakistan		
		Do Nothing	Arbitration	Aggression
India	Do Nothing	(0,-10)	(0, 10)	(-20, 0)
	Arbitration	(10,-10)	(20, 20)	(0, 10)
	Build Dams	(20,-20)	(10, 0)	(10,10)

Matrix 3: Resulting Payoffs when the Probability of High Water Stress = 0.6

		Pakistan		
		Do Nothing	Arbitration	Aggression
India	Do Nothing	(0,-10)	(0, 6)	(-16, -8)
	Arbitration	(10,-10)	(16, 16)	(0, 2)
	Build Dams	(20,-20)	(6, 4)	(10,6)

Matrix 4: Reduced Overall Likelihood of Water Stress Results in a Unique Nash Equilibrium Probability of High Water Stress (0.2)

		Pakistan		
		Do Nothing	Arbitration	Aggression
India	Do Nothing	(0,-10)	(0, 2)	(-12, -16)
	Arbitration	(10,-10)	(12, 12)	(0, -6)
	Build Dams	(20,-20)	(2, 8)	(10,2)

Figure 1: Extensive form Payoffs: (India, Pakistan)

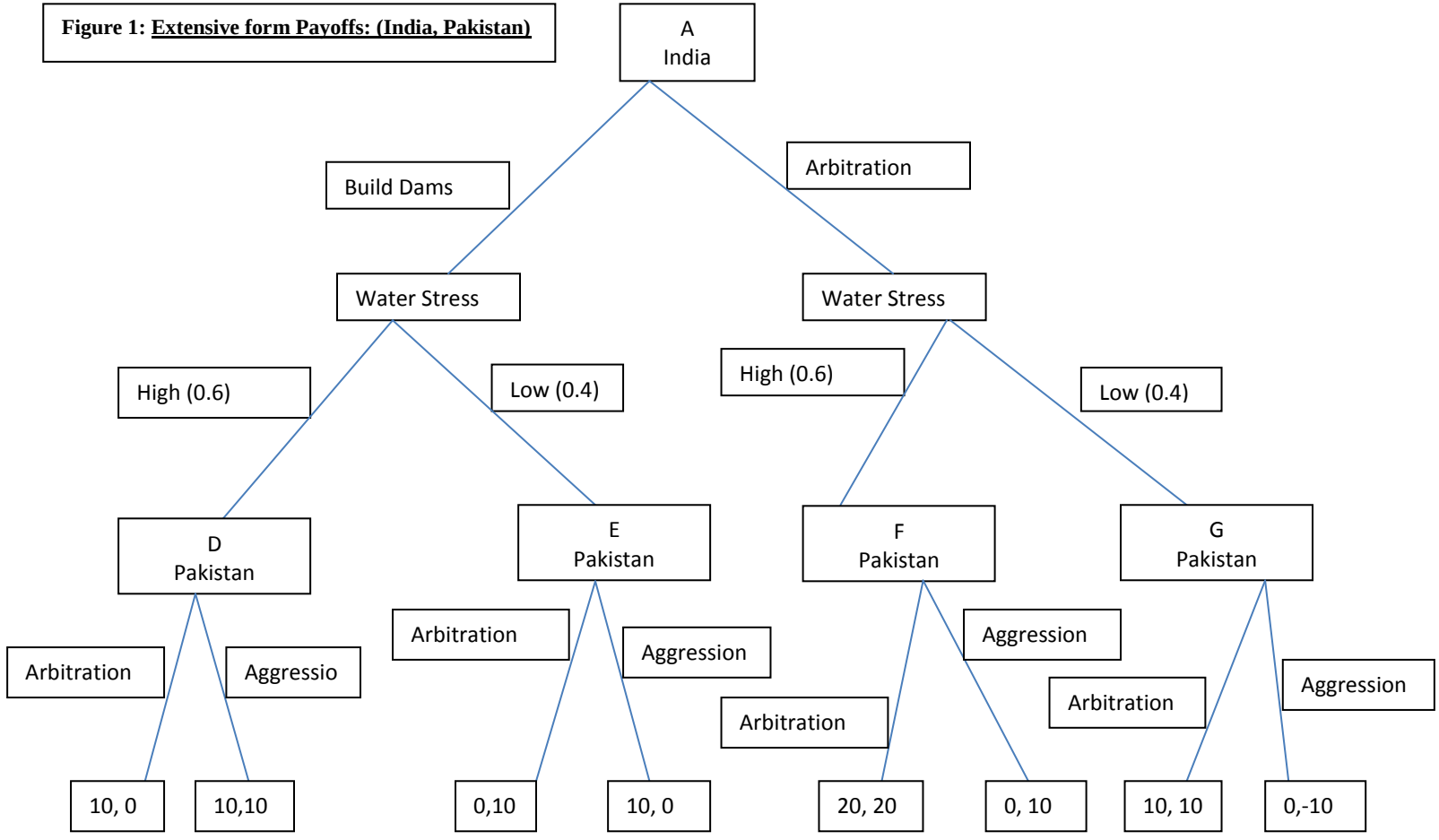

Figure 2: Finding the Equilibrium Payoffs: (India, Pakistan)

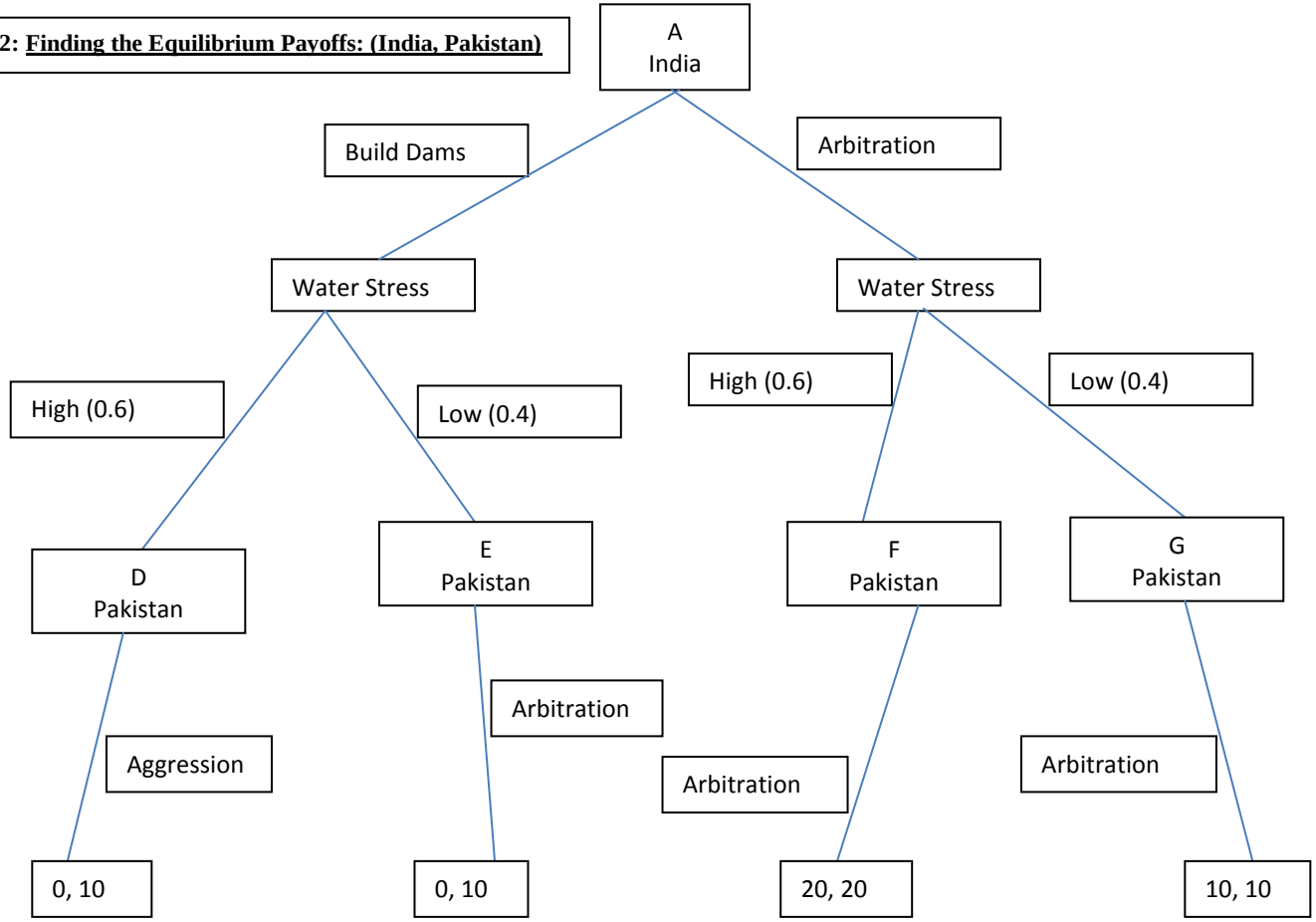

Figure 3: Unique Nash Payoffs: (India, Pakistan)