Model Analysis of the Conflict between Bangladesh and India over the Ganges River Water Resources

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Abstract

Bangladesh and India conflict over the Ganges water resources. In this study, this conflict situation is described by Conflict Analysis based on Game Theory. Furthermore, to settle down the conflict situation, participation of Third Party which is treated as *the complement* is assumed, and the relationship between the role of Third Party and equilibriums of Conflict Analysis is analyzed. Based on this analysis, it is thought how international organization or another country would be concerned with this conflict problem and offer the support.

1. Introduction

The Gages is important water resources for Bangladesh and India from the old ages, and they have conflicted over the Ganges water resources. This conflict situation changed drastically in 1975 because India constructed the Farakka Barrage over the Ganges in the Indian area near the border. India and Bangladesh had no consensus about this construction at all. India made it unilaterally. They made treaty about water resources use of the Ganges after construction, in 1975, 1977, and 1996. They are sometimes operative and inoperative depending on political background of the two countries.

Three treaties are different in some points. However, those are generally advantageous to India which is placed on the upstream of the river. Bangladesh is more vulnerable to flood and drought than India because of the Farakka Barrage. Bangladesh government cannot make a plan about its national water resources utilization without considering the effect of the Farakka Barrage. From this aspect, flood and drought in Bangladesh might be said as a man made disaster.

2. History of the Ganges Conflict between Bangladesh and India

India lies upstream of Bangladesh along the Ganges. The map of the relation of two countries is shown in Fig. 1 which is made with a figure from national geographic website, http://www.nationalgeographic.com/. Both of them have been suffering lack of water resources

problem. Because of such a background, Bangladesh and India have conflicted with utilization of the Ganges River water resources. The details about the conflict over the Ganges River water resources between two countries is shown in the following.

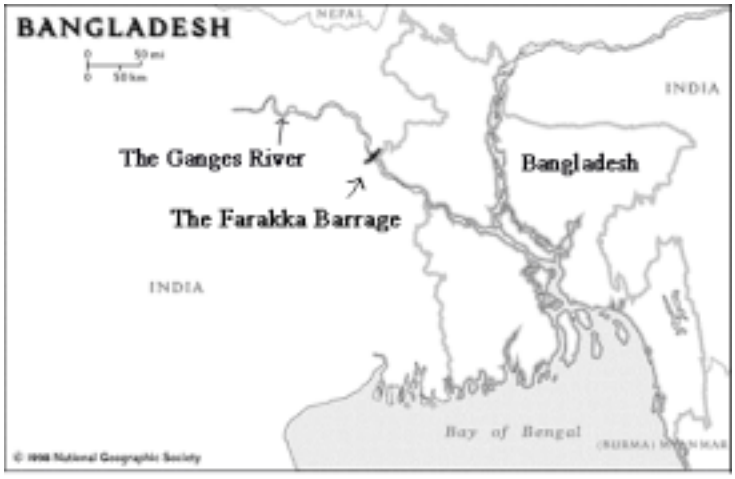

Fig. 1 The Farakka Barrage

India built the Farakka Barrage unilaterally across the Ganges River near the border of Bangladesh and India in 1975. Temporary treaty was concluded at first between two countries. In the treaty, it is said that India draws 310-350 m^3/s of water at The Farakka Barrage and discharges 1,245-1,400 m^3/s of water to the downstream from April 21 to 30, when the Ganges River has the least amount of water in a year. A few months later, the treaty was expired, and India began to draw water without any consensus until two counties came to conclude agreement in 1977 again. The content of 1977 Treaty is shown in Table 1.

Table 1 1977 Treaty (m^3/s)

Month	Day	Flow 1948-73	Withdrawal by India	Release to Bangladesh
Jan	1-10	2,790	1,133	1,657
	11-20	2,542	1,090	1,451
	21-31	2,336	991	1,345
Feb	1-10	2,244	935	1,310
	11-20	2,096	892	1,204
	21-28	1,982	871	1,112
Mar	1-10	1,848	758	1,090
	11-20	1,798	722	1,076
	21-31	1,728	708	1,020
Apr	1-10	1,671	680	991
	11-20	1,572	588	984
	21-30	1,558	581	977
May	1-10	1,600	609	991
	11-20	1,678	680	998
	21-31	1,855	758	1,097

This treaty was concerned with the Ganges River water resources allocation during dry season. At first, Bangladesh and India claimed different definition for 'dry season'. Bangladesh insisted it was from November to May, and on the other hand India insisted it was from March to May. As a result of their compromise, the definition for 'dry season' in this treaty concluded it was from January to May. India got a right to draw more water than India had had in 1975's temporary treaty. Bangladesh was obliged to large compromise. In this treaty, it was said that India had to control draw of water so that the rate of flow released to Bangladesh should not be less than 80%. This treaty was carried out until 1984.

After 1984, there was no rule for the Ganges River water resources utilization between two countries, and the treaty was concluded again in 1996 (Table 2). A general allocation rule was stipulated as show in Table 3. This treaty still carries out now.

Table 2 1996 Treaty (m^3/s)

Month	Day	Flow 1949-88	Withdrawal by India	Release to Bangladesh
Jan	1-10	3,045	1,133	1,912
	11-20	2,766	1,133	1,633
	21-31	2,553	1,133	1,420
Feb	1-10	2,445	1,133	1,312
	11-20	2,347	1,133	1,214
	21-28	2,240	1,133	1,107
Mar	1-10	2,108	1,116	991
	11-20	1,952	961	991
	21-31	1,832	991	841
Apr	1-10	1,789	798	991
	11-20	1,774	991	783
	21-30	1,727	736	991
May	1-10	1,907	991	916
	11-20	2,084	1,093	991
	21-31	2,318	1,133	1,185

Table 3 Rules of Allocation on 1996 Treaty (m^3/s)

Availability at Farakka	India	Bangladesh
1,982 less	50%	50%
1,982 ～2,124	Balance of Flow	991
2,124 more	1,133	Balance of Flow

In 1996 Treaty, Bangladesh made even more compromise than in 1977-1984's treaty because the amount of water that Bangladesh can get is sometime less than $800m^3/s$ in 1996 Treaty. Table 3 clearly says that India has certain amount of water to keep in itself, and the rest of water is discharged

to Bangladesh if it is satisfied. During the time when the total amount of flow is less than the 1,982 m^3/s, India draw totally 6,562 m^3/s, and Bangladesh draw totally 6,504m^3/s. It seems that the rule of 50% allocation between Bangladesh and India is followed.

1996's treaty over 30 years has brought settlement to the dispute of two countries for the time being, but the conflict is not seemed to be completely resolved. The treaty is advantageous in India which is upstream country, and there is much complaint in Bangladesh. The Ganges River is prospective as safe drinking water resource for Bangladesh residents who live along the Ganges River, so it is just a lifeline for them not only during dry season also all through the year. Amount of the Ganges River water flow in Bangladesh conspicuously receives consequence of amount of water drawn at the Farakka Barrage by India. Construction of positive association between Bangladesh and India is one of important ways to reduce the vulnerability of water resources management in Bangladesh. This kind of disastrous factor might be said as man-made disaster risk.

The severe guard system is spread around the Farakka Barrage now. The unilateral execution of construction and the unilateral conclusion of treaty by India seemed to be a matter of life and death for India, and it tells how important India recognizes the Farakka Barrage is. Survival of the fittest to keep water resources has been fought in Southern Asia. Bangladesh is one of the world's eminent poor countries, and it is most down stream country of the Ganges River. On the other hand, India has a great economic power comparing with its neighborhoods, and it is upstream country of Bangladesh along the Ganges River. Under such economical, political, and geographical background, how may Bangladesh turn the Ganges River water resources utilization for the better?

3. Conflict Analysis [1, 2, 3)]

Conflict analysis is the method which is systematized based on mathematical theory to classify outcomes by their character, comparing with preference vector of each player, and to analyze stability. Conflict Analysis is characterized as below when it is compared with a standard game that is formulated by a pay-off matrix like a familiar two-by-two prisoner's dilemma game. First, Conflict Analysis generally assumes any number of players, each of whom has any number of options or alternatives to be taken. Here, a set of outcomes is defined as possible combinations of all options of all players but logically or practically impossible outcomes should be deleted like an outcome that refers to a situation in which the same player attacks other player and at the same time gives up attacking, for example.

Once a set of outcomes is determined, it is investigated how each player places each outcome in the order according to preference. Here, it is allowed to give same order to any subset of outcomes and thus it is even possible to give no difference in the order to all outcomes. Reliance on preference order instead of numerical benefit/cost has both advantage and disadvantage. A research subject, a

player, can express its preference order with less difficulty and more confidence than numerical preference although it is impossible to express subtle difference in preference among outcomes.

After preference order of each player is determined, equilibrium solutions, a major output of Conflict Analysis, are obtained as follows. An equilibrium solution represents an outcome where any player cannot change its option due to the possibility that less favorable outcome might be attained by succeeding change of options by other players. In this sense, an equilibrium solution represents an outcome that is a deadlock situation from which any player cannot move to a better outcome by changing its own option alone. Generally, it is possible to find one or more equilibrium solutions. As you see in the definition of equilibrium solution above, it is one of the characteristics of Conflict Analysis to take into consideration a look-ahead of each player about possible succeeding change of options by other players.

Then, mathematical characteristic of Conflict Analysis is explained as follows.

Let S_i represents the strategy set of player *i*. A typical element of S_i is denoted by s_i. Let the set of n players be denoted by *N*. If *K* is subset of N, s_K is a joint strategy choice by the players in set *K*, and S_k is the corresponding set of joint strategies. Then, s_{N-K} is the joint strategy of the players other than those contained in set *K*, and S_{N-K} is the corresponding set of joint strategies.

To define meta-game criteria for the determination of stability thorough, the following sets of outcomes are defined.

$M_i^{+}(q)$ is the set of outcomes preferred by player *i* to *q*.

$M_i^{-}(q)$ is the set of outcomes not preferred by player *i* to *q* (set includes *q*) ;

note that $M_i(q) = \{M_i^{+}(q), M_i^{-}(q)\}$, $\forall q \in Q$. For $q = (\overline{s_i}, \overline{s_{N-i}})$, where the bar denotes the fact that the indicated strategy fixed,

$$m_i(q) = \{(s_i, \overline{s_{N-i}}) \mid s_i \in S_i\} \tag{1}$$

is the set of outcomes accessible unilaterally from *q* by player *i* (includes *q*). Define

$$m_i^{+}(q) = m_i(q) \cap M_i^{+}(q) \qquad \text{(this is a UI)} \tag{2}$$

$$m_i^{-}(q) = m_i(q) \cap M_i^{-}(q). \tag{3}$$

Note that $m_i(q) = m_i^{+}(q) + m_i^{-}(q)$.

An outcome *q* is not preferred by *i* to an outcome *p* if and only if

$$M_i^{-}(q) \subseteq M_i^{-}(p). \tag{4}$$

This means that

$$q \in M_i^{-}(p). \tag{5}$$

An outcome q $[=(\overline{s_i}, \overline{s_{N-i}})]$ is rational for player *i* if, for a fixed strategy choice $\overline{s_{N-i}}$ of the players and for all possible strategy choice for *i* ($\forall s_i$), player *i* cannot find outcome preferred to *q*. Thus

$$R_i = \{q \mid \forall s_i, (s_i, \overline{s_{N-i}}) \in M_i^{-}(q)\}. \tag{6}$$

A game is an object described by the strategy sets and preference functions of all the players.

The outcome, which is stable for every player, is called the equilibrium. Classification of stability and the definition of it are shown as follows.

a) Rational stability

If there is no outcome called *unilateral improvements* for player *i*, in other words, if player *i* cannot find an outcome preferable to *q* by a unilateral change of strategy, this type of a situation is called rational stability. More formally, *unilateral improvements* (*UI*) are

$$\exists s_i : (s_i, \overline{s_{N-i}}) \in M_i^{+}(q). \tag{7}$$

The outcomes produced by unilateral improvements are also called unilateral improvements, and are abbreviated UI. Given $q = (\overline{s_i}, \overline{s_{N-i}})$, a UI $p \in P$ from *q* would be given by

$$p \in \{(s_i, \overline{s_{N-i}}) : (s_i, \overline{s_{N-i}}) \in M_i^{+}(q)\}. \tag{8}$$

Thus, a UI from *q* is member of the set $m_i^{+}(q)$.

b) Sequential stability

Considering sequential change of outcomes, meta-game analysis indicates that an outcome can be made stable for a particular player if another player has a change in strategy from the particular player's UI that results in less preferred outcome for the particular player. If any outcomes that result from consistent improvement on the part of the other players are not preferable for a particular player to the outcome under consideration, the outcome is sequentially stable for that player. This is described mathematically by

$$\left(\exists p \in m_i^{+}(q) : m_{N-i}{}^{+}(p) \cap M_i^{-}(q) = \phi\right) \quad \Leftrightarrow \quad q \notin R_i. \tag{9}$$

c) Simultaneous stability

Sequential stability is defined based upon the deterrent effect of another player improving from the improvement made by a player. However, the mutual deterrent effect of improvements from the original outcome must also be assessed. If the outcome that results from the changes made by both players improving simultaneously is less preferred for a player, then it is a credible sanction against the possible improvement and the original outcome may be considered stable. This is defined as simultaneous stability.

d) Unstable

The player has at least one UI from which the other players can take no credible action that results in a less preferred outcome for that player. This is defined as unstable.

A player will choose a strategy that he (or she) believes will maximize his utility, veering in mind that his opponent desires to do the same for himself. If there is an ordered pair of strategies such that neither player can improve his utility payoff by changing their strategy, this outcome constitutes an equilibrium.

4. A Case Study on the Farakka Barrage Problem

4.1 GAME 1 : Description of the Actual Situation

In this paragraph, the actual situation is described by Conflict Analysis. Players and options are set, referring to the reality, as shown in Table 4.

Table 4 : Players, Options, and Outcomes or the Farakka Barrage Problem

Options	Outcomes							
Bangladesh								
Agree to use the Farakka Barrage	0	1	0	1	0	1	0	1
India								
Use the Farakka Barrage	0	0	1	1	0	0	1	1
Reconsider the rule of using the Farakka Barrage	0	0	0	0	1	1	1	1
Decimal	0	1	2	3	4	5	6	7

The execution of an option by a given player is indicated by a 1 opposite it; a 0 indicates the option is not executed. When either a 1 or 0 is written for all of the options of a given player, this constitutes a strategy for the player. An outcome is formed by all of the strategies of all players; therefore in Table 4 each column of 1s and 0s constitutes an outcome for the Farakka Barrage Problem. For example, in the seventh column from the left in Table 4, the 0 for the Bangladesh

option indicates that Bangladesh agrees to use the Farakka Barrage. Then, Bangladesh has selected the strategy (0). By using the Farakka Barrage and Reconsidering the rule of using the Farakka Barrage, India has chosen the strategy (1,1). Combining Bangladesh strategy (0) and India strategy (1,1), the outcome (01,10) is composed. The notation using 1s and 0s is designed for convenient representation of each outcome. A shorter style of symbol is developed from the outcomes by considering them as binary numbers and then converting them to decimal numbers like converting (0,11) into $1\times 2^2+1\times 2^1+0\times 2^0$. The decimal values of all the outcomes are listed below each outcome in Table 4.

The next step of the modeling process is to order the outcomes of Table 4 to reflect the preferences of the players. This has been done in Table 5 for Bangladesh. In the following tables which show players' preference vector, the outcomes are ordered with the most preferred on the left and the least preferred on the right.

Table 5 : Preference Vector for Bangladesh in the Farakka Barrage Problem

Options	Outcomes							
Bangladesh								
Agree to use the Farakka Barrage	1	1	0	0	1	0	0	1
India								
Use the Farakka Barrage	1	0	0	0	0	1	1	1
Reconsider the rule of using the Farakka Barrage	1	1	1	0	0	1	0	0
Decimal	7	5	4	0	1	6	2	3

On the other hand, preference vector for India is assumed as following 2 types. This setting is done because it is hard to decide one exact preference of India. Then, 2 types of preference vector are assumed to realize the outcome 2 as an equilibrium which describes the present situation.

CASE A : India has priority over using the Farakka Barrage, and Bangladesh's agreeing to use the Farakka Barrage is second preferred. As for the option 'Reconsider the rule of using the Farakka Barrage', India doesn't want to reconsider the rule, and this option is the least priority for India. These characteristics of India are described in Table 6.

Table 6 : Preference Vector for India in the Farakka Barrage Problem in CASE A

Options	Outcomes							
Bangladesh								
Agree to use the Farakka Barrage	1	1	0	0	1	1	0	0
India								
Use the Farakka Barrage	1	1	1	1	0	0	0	0
Reconsider the rule of using the Farakka Barrage	0	1	0	1	0	1	0	1
Decimal	3	7	2	6	1	5	0	4

From these settings of preference vector for Bangladesh and India, the outcomes '2' and '7' are achieved as equilibriums.

CASE B : India has priority over using the Farakka Barrage, and not reconsidering the rule is second preferred. As for the option 'Agree to use the Farakka Barrage', India doesn't care if Bangladesh agrees to use the Farakka Barrage or not, and this option is the least priority for India. These characteristics of India are described in Table 7.

Table 7 : Preference Vector for India in the Farakka Barrage Problem in CASE B

Options	Outcomes							
Bangladesh								
Agree to use the Farakka Barrage	1	0	1	0	1	0	1	0
India								
Use the Farakka Barrage	1	1	1	1	0	0	0	0
Reconsider the rule of using the Farakka Barrage	0	0	1	1	0	0	1	1
Decimal	3	2	7	6	1	0	5	4

From these settings of preference vector for Bangladesh and India, the outcome '2' is achieved as an equilibrium.

To help comprehending the process of Conflict Analysis to classify outcomes and define equilibriums, the stability analysis tableau for CASE A is shown in Table 8 for an example.

Table 8 : Stability Analysis Tableau for CASE A

Bangladesh								
player stability	*r*	*r*	*s*	*r*	*s*	*s*	*r*	*u*
preference vector	7	5	4	0	1	6	2	3
UIs			5		0	7		2
India								
player stability	*r*	*s*	*r*	*u*	*u*	*u*	*u*	*u*
preference vector	3	7	2	6	1	5	0	4
UIs		3		2	3	3	2	2
					7	7	6	6
						1		0

Table 9: Overall Stability for CASE A

Outcomes	0	1	2	3	4	5	6	7
	×	×	*E*	×	×	×	×	*E*

Numbers under some of the outcomes in Table 8 are 'Uis' (unilateral improvement). A 'UI' is an outcome to which a particular player can unilaterally move by a change in strategy, assuming the

other player's strategy remains the same. Under normal circumstances, UIs from an outcome are preferred by the player under consideration and appear to the left of that outcome in the preference vector. For example, consider outcome 5 for India. From the binary interpretation in Tables 5-7, it can be seen that in this outcome India has selected the strategy of not using the Farakka Barrage and reconsidering the rule; thus, this is notated as (0,1). If Bangladesh maintains the strategy (1), India could unilaterally change outcome 5 to any of 3, 7, or 1 by appropriately changing its option selections from (0,1) to (1,0), (1,1), or (0,0), respectively. Of these, outcome 3 is most preferred by India, and is therefore placed immediately under the 5 in the preference vector for India in Table 7. Outcome 1 is also preferred to 5, but it is the least preferred among UIs, 5, 7, and 1. Then, outcome 1 is written the most bottom of the column.

In Table 8, '*r*' means *rational*, '*s*' means *sequentially sanctioned*, and '*u*' means *unstable*. The definition of these stabilities is given above, in the part of explaining mathematical characteristics of Conflict Analysis.

If an outcome possesses some type of stability for all the players in a game, that is, here in Table 8, if an outcome is given '*r*' or '*s*', it is called an *equilibrium*, and this outcome constitutes a possible resolution to the conflict. For example, outcome 7 is rational for Bangladesh and sequentially stable for India. Equilibriums are indicated by an *E* placed below the appropriate outcome in Table 9. An outcome that is unstable for at least one player is marked with an ×.

4.2 GAME 2 : Analysis with Considering the *Complement*

Sakamoto and Hagihara[5] have been studied about the conflict as the changing phenomenon depending on time shifting, and we propose the flow for conflict management as in Fig. 2. In this paragraph, Third Party is assumed to analyze the relationship between equilibriums and the role of Third Party who is treated as the *complement.* 'Complement' means something that makes perfect or make whole or entire[4]. We define that 'the complement' is another party who doesn't participate in the actual situation game, and that it participates the game with the motivation for conflict management. 'The complement' is classified into 3 types by its role which can be seen in Fig. 2 ; one is 'the donor', one is ' the coordinator', and the other is 'the arbiter'. 'Donor' means a person who presents as a gift, grant, or contribution[4]. 'Coordinator' means a person or thing that combine in harmonious relation or action[4]. 'Arbiter' means a person who has the sole or absolute power of judging or determining[4].

The flow of Fig. 2 shows that if the complement has its own preference vector, the complement can be thought as one player. If it doesn't have its preference vector and offers options, the role of the complement can be classified into the donor or coordinator. The difference between them is whether it can change other players' preference vector essentially. If it can change by offering some options to other players, the role of the complement is defined as 'the donor', and if it can't, the role of the complement is defined as 'the coordinator'. The donor offers options which doesn't give the

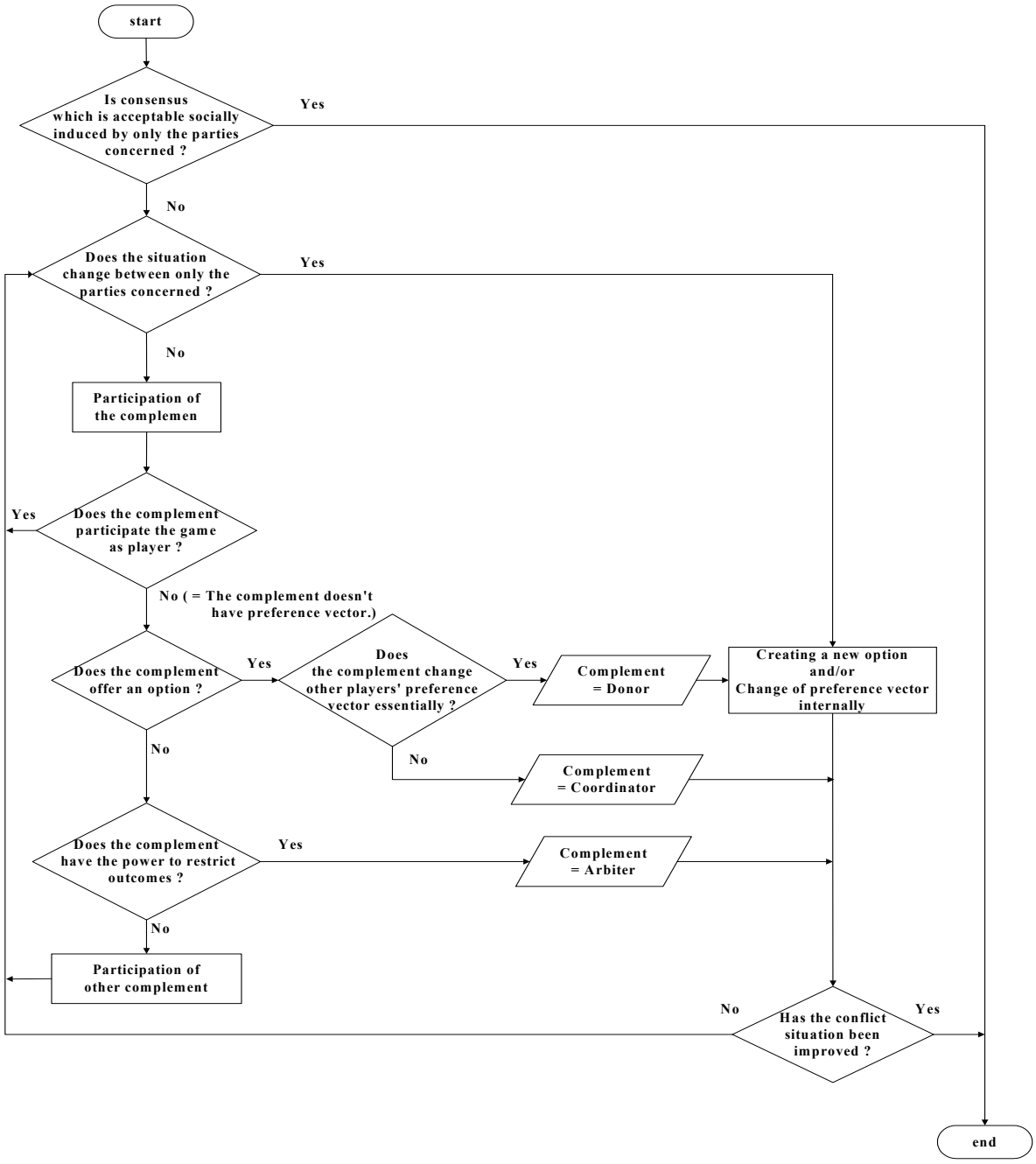

Fig. 2 : The Flow of Conflict Management with the Complement

direct influence to the conflict situation, such as funding, transferring technologies, building the education system, and in the long term they might help other players to bear a new option by themselves, or to change its lifestyle and preference essentially. On the other hand, the coordinator offers options which give some direct influence to the conflict situation, and in the short term they might help other players to change its preference not really essentially but partially.

If the complement doesn't have its own preference vector and options, the role of the complement is defined as 'the arbiter'. The arbiter has the power to exclude some outcomes, and restrict players to move to the outcomes. The donor, coordinator, and arbiter participate indirectly,

and they have no direct influence to the game. Players have their own options and preference vector in Conflict Analysis, and equilibriums are provided under each preference which is insisted on by all players. In this respect, a concept of the complement is different from ordinary Conflict Analysis.

In the Bangladesh-India conflict, there is a various possibility on the point which what kind of Third Party participates in. In this study, Third Party is not assumed as a specific organization, but it is assumed just as neutral and general party, and the role of it is focused on the coordinator. Then, the consequence which the participation of Third Party can give to the change of conflict is analyzed, and, thorough consequence of analysis, it is considered what cooperation and aid of other countries and international organization would bring to the conflict resolution.

In GAME 1, the outcome '7', the most preferable outcome for Bangladesh, can be realized when the preference vector for India is set as in CASE A. As for CASE B, if India prefers the outcomes '7' to '2', and '5' to '0', the preference vector for India can be changed to the same one as in CASE A where the outcome 2 is achieved as equilibrium. This change of preference can be interpreted that India comes to want more strongly Bangladesh to agree to use the Farakka Barrage than not to reconsider the rule of using the Farakka Barrage. In CASE A, India prefers Bangladesh's agreeing to not reconsidering the rule, and it is opposite in CASE B. If adverse change of preference for the outcomes '2' and '7', and '0' and '5'is produced, the conflict might change from stiff situation to compromise under mutual agreement.

However, if the actual situation is taken into consideration, it is hard to occur that India changes its preference under setting of GAME 1. Therefore, when a conflict becomes stiff among parties, a breakthrough of the situation is considered by participation of Third Party.

Players, options are set as in Table 10.

Table 10 : Players, Options, and Outcomes with Considering the Coordinator

Options	Outcomes															
Bangladesh																
Agree to use the Farakka Barrage	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
India																
Use the Farakka Barrage	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
Reconsider the rule of using the Farakka Barrage	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
Third Party																
Take an Action	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Origins of outcomes in GAME 1	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

In the following, the model analysis is done with eliminating the outcome '10' because the outcome '10' in GAME 2 seems not to change comparing to the actual situation described in GAME 1, nevertheless Third party takes the action. This means that Third Party's action has no executive

power. Therefore, the outcome '10' is eliminated to give the meaning to participation of Third Party.

It is assumed that Bangladesh prefers that Third Party takes an action rather than it doesn't, and that essential preference of Bangladesh for other options is not different from that in GAME 1. Under such an assumption, the preference vector for Bangladesh is set as in Table 11. Seeing the bottom of Table 10, origins of outcomes in GAME 1, it can be understood that the preference vector of Bangladesh doesn't change essentially.

Table 11 : Preference Vector for Bangladesh with Considering the Coordinator

Options	Outcomes															
Bangladesh																
Agree to use the Farakka Barrage	1	1	1	1	0	0	0	0	1	1	0	0	0	1	1	
India																
Use the Farakka Barrage	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	
Reconsider the rule of using the Farakka Barrage	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	
Third Party																
Take an Action	1	0	1	0	1	0	0	1	0	1	1	0	0	0	1	
Decimal	15	7	13	5	12	4	0	8	1	9	14	6	2	3	11	
Origins of outcomes in GAME 1	7	7	5	5	4	4	0	0	1	1	6	6	2	3	3	

As for India, it is assumed that India prefers that Third Party takes an action rather than it doesn't, and that essential preference of India for other options changes comparing to that in GAME 1. Under such an assumption, the preference vector for India is set as in Table 12.

Table 12 : Preference Vector for India with Considering the Coordinator

Options	Outcomes															
Bangladesh																
Agree to use the Farakka Barrage	1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	
India																
Use the Farakka Barrage	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	
Reconsider the rule of using the Farakka Barrage	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
Third Party																
Action	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	
Decimal	11	15	14	3	2	7	6	9	8	13	12	1	0	5	4	
Origins of Outcomes in Game 1	3	7	6	3	2	7	6	1	0	5	4	1	0	5	4	

Seeing the bottom of Table 12, it can be understood that the preference vector of India has partially changed; in GAME 1, the option which India makes the most of is 'use the Farakka Barrage', and the option 'reconsider the rule' is the second, and on the other hand in GAME 2, the option which India makes the most of is 'use the Farakka Barrage, and the option 'take an action' given by Third

Party is the second, and the option of 'reconsider the rule' is the third. This changes can be interpreted that the preference of India has transformed as a result of mediation effect by Third Party's predicating.

Under above setting, equilibriums are analyzed through Conflict Analysis with the coordinator, the outcomes '2', '11', '14' and '15' are obtained as equilibriums. The outcome '2' means that Bangladesh doesn't agree to use the Farakka Barrage, India uses the Farakka Barrage and doesn't reconsider the rule, and Third Party doesn't take an action. This equilibrium is almost similar to the actual situation. The outcome '11' means that Bangladesh agrees to use the Farakka Barrage, India uses the Farakka Barrage and doesn't reconsider the rule, and Third Party takes an action. The outcome '14' means that Bangladesh doesn't agree to use the Farakka Barrage, India uses the Farakka Barrage and reconsiders the rule, and Third Party doesn't take an action. The outcome '15' means that Bangladesh agrees to use the Farakka Barrage, India uses the Farakka Barrage and reconsiders the rule, and Third Party takes an action. Then, the outcome '15' which means dissolution of the conflict is provided as one of equilibriums.

On the other hand, if analysis is done without the elimination of the outcome '10', the outcomes '2' and '10' are provided as equilibriums. This is interpreted as that Third Party's action is not beneficial for dissolution of conflict if it has no executive power.

4.2 Summary of Model Analysis

It is difficult for Bangladesh to offer a new effective option for dissolution of the conflict because Bangladesh is disadvantageous economically and topographically. As for India, it is hard to think that India changes its preference internally. Therefore, the conflict between Bangladesh and India will exist if they negotiate between only them with the preference described as in GAME 1 - CASE B. However, as shown in this study, if the preference of both two countries doesn't change essentially, and if Third Party can offer the option which is more attractive to India than the option 'reconsider the rule' and it has enough executive ability, mediation effect of Third Party's participation as the coordinator can bring possibility of dissolution to the conflict.

Some kind of action which is executed by Third Party will lead the present situation to either of 4 equilibriums. However, equilibriums can change among them, and time scale and uncertainty can't be known. Letting preference of players change essentially is thought one of the ways to realize conflict dissolution as only strong stable state. On the other hand, it seems to be another way to let equilibriums, which are described as stable state, circulate, and if one of the stable states which is not expected by community is realized, let the cycle accelerate by giving the some social change as external force.

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