EQUITABLE SHARING OF INTERNATIONAL WATERS: A PROPOSAL FOR OPTIMAL UTILIZATION OF THE TEESTA RIVER

M. Fakrul Islam
Yoshiro Higano

ABSTRACT

Sharing water of international rivers is of great concern among the people living in the basin areas. The international river with which we are concerned in this paper is the Teesta River. It has its upstream in India and downstream in Bangladesh. The Teesta Barrage Project at Dalia point in Bangladesh started its operation in 1993 for the purpose of irrigation. Three years after the beginning of the operation of the Dalia Barrage, India began to withdraw most of the water during the dry season and release excessive water during the rainy season through a barrage built at the upstream. The efforts to increase crop production by the Teesta Barrage at Dalia Point went in vain after the operation of the barrage in India. This paper focuses on an analytical framework specified by objective data in order to propose an optimal cooperative solution to the controversy regarding sharing of Teesta water, which would be beneficial to both India and Bangladesh.

Introduction

Bangladesh is a very small country in South Asia with an area of 144,000 square km. (BBS 1998). The country shares most of its borders with India and is crisscrossed with over 200 rivers (Rahman et al. 1994). Two or more countries share more than 57 of these river basins. There are many rivers in Bangladesh which have their upstream in India. Among them, the Ganges and the Teesta are the most important.

The idea of using the Teesta River for irrigation came about during the British period in 1935 (BWDB 1994). Most of the area found suitable for gravity irrigation falls in the territory of Bangladesh. Due to the partition of India (1947), implementation of the project was delayed. [1] Afterwards, India and East Pakistan (the name of the Bangladesh territory before independence) started to formulate the project on their own.

For the Bangladesh territory, the preliminary feasibility report of the project was prepared in 1960 by M/s. Haigh Zinn and Associates in collaboration with A.C.E Ltd. (Pakistan) and Ms. Binne and Partners Ltd. prepared the second one during 1968-70 (BWDB, 1994). After the independence of Bangladesh, the Government promoted the project, and the barrage was completed successfully in August 1990. Irrigation began in January 1993 and during that year an area of about 65000 bighas (16000 acres) was brought under High Yielding Variety (HYV) paddy cultivation in the dry season. The project also had the aim of flood control and drainage for a target area of 750,000 hectares, of which 540,000 hectares were irrigable. The project covered seven districts of northern-Bangladesh. In the meantime, India constructed a Barrage at Gazoldoba over the Teesta, which is located 65 km upstream of the Dalia Barrage[2] (Bangladesh) site.

In the rainy season India releases excessive water through the Gazoldoba barrage causing floods in the Bangladesh area. In the dry season, on the other hand, India withdraws water from the Teesta River for her own use. The Bangladesh area of this basin has become dry due to this upstream diversion and the socio-economic and environmental problems of the area are becoming more serious each day.

In this paper, we discuss the mean monthly water flow in the dry season and the rainy season before and after the operation of the Gazoldoba barrage. The relationship between the flow of water in the Teesta River (Bangladesh area) and amount of crop production has also been addressed. Most importantly, we propose an optimal cooperative solution to the problem of water sharing of the Teesta River that would be beneficial for both Bangladesh and India. We also mention some examples of peaceful water sharing between states and sharing of common river basins and propose solutions to the problem.

Review of Literature

There has been little or no research conducted specifically on the optimal sharing and use of the Teesta River basin area. However, findings of relevant studies are presented below.

Hanif (1995) states that variegated geomorphic processes and forms, bank erosion, and historical course shifting patterns, floods, droughts, siltation and landforms mark the Teesta River and its adjoining

catchment areas. He provides details about hydro-geomorphic characteristics like water discharge, course shifting pattern, water level, duration of floods, sediment characteristics and ground water conditions of the Teesta flood plain. His thesis was completed before the operation of the Gozaldoba barrage. Therefore, issues relating to water sharing were not discussed.

Abbas (1984) has written a brief history of the talks between India and Bangladesh on the establishment of barrages and sharing of the Teesta water (1955-83). During the 1950s, the then East Pakistani authorities intimated the Indian authorities regarding the Teesta Project. India at that time asked for more detailed data. During the 1960s, India informed Pakistan about its plans regarding the Teesta water and protested against Pakistan's plans to build a barrage, assuming negative effects (inundation's etc.) in her territory. However, Pakistan replied that it was possible for India to use other rivers to irrigate the proposed command area.

After the independence of Bangladesh in 1971, talks on the Teesta water sharing continued in the Indo-Bangladesh Joint River Commission. Bangladesh objected to India's designs to divert the water of the Teesta to the Mahanada basin area. The talks continued without any result until 1983, when the two parties reached an adhoc allocation agreement according to which India was to get 39 percent, Bangladesh 36 percent and the remaining 25 percent was to be reserved for reallocation later, after further study. Abbas argued that as the irrigation command area is overwhelmingly within the Bangladesh territory, it should get the lion's share of the water. Moreover, the location of the apportionment had not been specified, which was very important from Bangladesh's point of view in getting the due amount of water.

Schachter (1977) discusses the equitable apportionment of freshwater resources to some extent and emphasizes the concept of the 'drainage basin', which implies integral development, giving a high priority to maximization of benefits for the basin as whole, by reducing wasteful uses and developing a comprehensive and unified scheme to be followed by all those who are concerned. He also cited some points on the equitable use of world's water resources from the report of the Fifty-second Conference (1966) of the International Law Association held in Helsinki. These are quite important for the issues raised in this paper. The points are:

(1) Water utilization of the river basin at present and in the past has to be considered;

(2) The extent to which the population of each basin state is dependent on the river water has to be taken into account;

(3) Research on the comparative costs of alternative means to meet the economic and social needs of the people of the basin states should be carried out;

(4) Care must be taken to avoid unnecessary wastage when utilizing river water;

(5) Availability of other resources has to be considered;

(6) The extent to which compensating one or more of the co-basin states for adjusting conflicting uses is practicable has to be evaluated;

(7) The extent to which the necessities of a riparian state can be met without causing substantial harm to a co-basin state has to be taken into consideration (Schachter 1977).

Smith (1931) presents several cases of controversies related to using rivers (for economic purposes), which run through more than one state. The cases include the Meuse and its canals, the Zwillikon dam case, the Rio Grande irrigation problem, apportionment of the Nile and ten others. He draws some general principles by saying "In the law of rivers there is no place for any purely legal doctrine derived from any single abstract principle, whether that principle be the absolute supremacy of the territorial sovereign or the old private law doctrine of riparian rights", (p.144). Smith called upon all to realize that every system of river forms an indivisible physical unit and to do whatever needs to be done (e.g. agreements) to determine and ensure the maximum possible development of river resources and their equitable distribution between the people concerned (p.71).

Giannias and Lekakis (1996) analyze various aspects of a policy model explaining that in the case of surface water resources, which are gradually becoming scarcer, sustainable utilization implies the need for policies aiming at providing adequate water supplies for everyone in both national and international contexts. They argue that many international river basins are shared without any formal intergovernmental agreement, while bilateral agreements guaranteeing amicable cooperation amount to a handful. They present a simple economic-ecological model within which they examine input-output controls, social input prices, bilateral water trade, a water market for all water users, and a fixed water allocation agreement as possible water policies for cross-border river water sharing. They also strongly argued that, all of these

policies could satisfy the conditions for maximum joint economic benefits, while working towards maintaining the functional integrity of river ecosystems. Their analyses indicate that bilateral water trade can prove a workable, efficient and sustainable water policy for a transboundary water allocation of an international river.

Two Barrages on the Teesta: Dalia and Gazoldoba

The Dalia Barrage is the largest irrigation project of Bangladesh. It stands across the Teesta River at Doani-Dalia point in the Lalmonirhat district of Bangladesh. Although the project was started in 1960, its actual implementation began in 1979. The building of the canal system started in 1984-85. The barrage was completed successfully in August 1990 and its operation commenced in 1993.

The Dalia Barrage is a concrete structure, 615 meters long, fitted with 44 radial gates having a discharge capacity of 12,750 cusecs of water. The barrage diverts water through a canal head regulator (110 meter long) with a discharge capacity of 280 cusecs. There is a 4,500-km long network system of canals for supply of irrigation water to the fields. It is a gravity irrigation project and there is an automatic flow of water at all stages through the barrage regulation; no pumping cost is involved.

The Gazoldoba Barrage stands across the same Teesta River in the Jalpaiguri district of India. After e independence, when the Bangladesh Government gave serious thought to undertaking the Dalia project, India began to construct a barrage at Gazoldoba, which began to be used for irrigation in 1993. The Gazoldoba barrage started to withdraw water excessively in the dry season in 1996, when the Dalia barrage (Bangladesh) was in full operation for irrigation. Consequently, according to the Bangladesh Water Development Board (BWDB), the water flow of the Teesta River decreased significantly, threatening the situation in Bangladesh. Exclusive control of Teesta's water in the dry season at Gazoldoba makes the Dalia Barrage useless and furthermore, sudden release of excessive water through the Gazoldoba Barrage (India) in the rainy season causes floods and bank erosion, and leads to serious sufferings by the people in the Bangladesh basin. We can see the water situation of Teesta River in the following Figure 1.[3] (please see appendix).

Figure 1 clearly shows that the minimum flow at the Dalia point in the dry season has drastically decreased after Gozaldoba barrage began its operation, while the maximum has been maintained in the rainy season. According to the figure, we can see that the present situation of water flow at Dalia point is very severe, especially during the dry season and the barrage is essentially useless with the Teesta River remaining dry. This affects the people of Bangladesh adversely and makes the environmental situation worse.

The Potential for Increased Agricultural Production after the Dalia Barrage Project in Bangladesh

Northern Bangladesh is a plain and 90% of its population relies on some form of agricultural production. Due to lack of water, they cannot cultivate the land in the dry season. Every year they face drought and lose a high proportion of crops that increases levels of poverty. The successful implementation of the Teesta Barrage (Dalia) Project was a dream come true for the poverty-stricken people who should have had been able to hope for a better future. The trend of increasing crop production can be shown as in Table 1. (Please see appendix).

Table-1 calculates the marginal productivity of the targeted land area in Bangladesh in terms of various agricultural products. The above trend of crop production has been calculated as $\frac{\Delta Q_1}{\Delta L_1}$ = The rate of change of production by using additional land in period-1; $\frac{\Delta Q_2}{\Delta L_2}$ = rate of change in production by using additional land in period-2 which estimates the marginal productivity of the land in terms of various agricultural products and these values are calculated in the last column in terms of US dollars. The result shows an increasing trend in crop production using additional land and its monetary value increased approximately upto US$ 27 million in the period -2. This trend is observed when only 22% of the total target area was brought under cultivation. If the total target area of 750,000 hectares could be cultivated, then the average dollar value would increase upto more than US$ 230 million per year.

Preliminary Estimation of Marginal Productivity of Land of the Dalia Barrage Water Users

Table 2 shows the marginal productivity of various agricultural products in terms of US$ at various usage levels of water resources in cusecs of water based on a recalculation of Table-1, (please see appendix) which focuses on data of the Bangladesh barrage site. This is shown in figure 2 (please see appendix).
In Figure 2 we find that when water is available at the 15,000 cusecs level, crops worth US$44 million can be produced and at the level of 14,800 cusecs, crops valued at US$41 million can be produced. The 13,800

cusecs level can produce US$23 million worth of crops and at 8,000 cusecs level, only US$20 million worth of crops can be produced. If the barrage flow is less than 8,000 cusecs, the system cannot operate. Using the data of the figure we can estimate the value of total production in the Dalia target area.

However, Figure 3 shows (please see appendix) that at the initial stage of the usage of water resources, the marginal productivity was increasing and unstable. The possible reason could be that the use of barrage water for irrigation was still at the initial stage and at a certain point, the marginal productivity is likely to be saturated and thus slow down.

From a typical marginal productivity curve, we choose four probable cases and try to observe the situations, which would bring optimal results Figure 4 (please see appendix) shows that in cases 1 and 4 marginal productivity of one country dominates over the other country, and these cases are the are the least implementable. Cases 2 & 3 are "the cases" for possible sharing.

The horizontal axis shows the amount of water and the left and right vertical axes respectively show measurement of total production B and marginal production b in Bangladesh, and the measurement of total production $\overline{B}$ and marginal production $\overline{b}$ in India.

Figure 4 shows that, for case 1 in which the marginal productivity of Bangladesh dominates that of India with any amount of sharing of water, sharing is not possible. Under this circumstance Bangladesh would take the total amount of water and India will get none. On the other hand, in case 4 sharing is not possible either. In this situation, India would take the total amount and Bangladesh will get none. These two cases are almost impossible as they are far from the optimal points. Hence 2 and 3 are "the cases". In case 2 Bangladesh gets a slightly larger amount of water than India, and in case 3 India gets a slightly larger amount of water than Bangladesh. But, considering the productivity of land and the number of affected people in the two countries, increasing the share of water at Dalia barrage is more rational, and we consider case 2 as the realistic or "true" situation.

An Optimal Water Sharing Approach to the Teesta River

We propose an optimal solution to the problem of sharing of Teesta water especially during the dry season between India and Bangladesh. During the first phase of implementation of the Teesta barrage (Dalia), using irrigation water, an increasing trend in productivity of land was observed. However, since the commencement of the Gazoldoba barrage at the upstream, the Dalia barrage project, due to shortage of water, stopped operating for irrigation. Through estimation, we have shown a possible optimal sharing of the Teesta water considering the number of affected people and productivity of land of both India and Bangladesh. This sharing can be shown in Figure 5 (please see appendix).

The total land (target area) under the Dalia barrage is 750,000 Ha. and requires at least 40% of the total water flow in the dry season to remain active. The maximum amount of land (30% of the total target area) was cultivated in the year 1996 which produced crops worth US$ 48.86 million. The sum of the total crop production during the last four years was valued at US$ 136 million. The total production has drastically decreased in the last two years (1998-1999).

The ratio of the Teesta River water shared in the dry season (1998) between India and Bangladesh is exactly 85% (32,700) and 15% (4,900 cusecs) respectively, which has rendered the barrage useless. This can be shown in Figure 6[4] (please see appendix).

Figure 6 displays an example of an optimal sharing strategy. The horizontal axis $\sigma\imath$ symbolizes the share of Bangladesh. So, $1-\sigma,$ (measured to the left from the point 1) is that of India in the context of the Teesta River basin? The left and right vertical axes measure the marginal productivity of water resources in Bangladesh and India respectively.

If the share is fixed due to some reason at the level of $\sigma\imath$ which is far less than the optimal share σ^*, there exists a social loss of triangle area ABC (the difference between the lost value of crops in Bangladesh due to the lack of water and the value of crops in India which can be produced in India by using more water than the optimal sharing) and $\sigma\imath$ is not optimal from a cooperative point of view of both countries. If the share increases from 15% to 40% then an increase equivalent to the value of triangle area can be made possible. Economically, optimal sharing of a fixed amount of resource can be shown at the crossing point of the marginal productivity curves of both parties provided that both the curves are decreasing.

Peaceful Water Sharing of Other International Rivers: Some Examples

During the late 19th century, the Harmone Doctrine was an influential doctrine. According to it, a state has

the absolute right to use the water of the rivers flowing through its territory as it wishes, without considering its effects on other states. However, this doctrine has never been followed. Rather, there are various examples of peaceful water sharing between two or more riparian states through which a river flows. Below, we point out several such treaties.

In 1909 the Boundary Water Treaty between the US and Canada was established. [5] Article 2 of the treaty reserved for each side unrestricted territorial control over the boundary water within their territory and available legal remedies.

Under the 1961 Columbia water treaty, both USA and Canada adhered to the principle of shared enjoyment and optimum utilization of common waters through international cooperation. They have jointly undertaken comprehensive and integrated regional planning for the development of the Columbia water resources.

In 1948, Austria, originally a supporter of the Harmon Doctrine, settled its water dispute with her neighbors (Bavaria, Czechoslovakia) on the basis of mutual recognition of rights (Abbas 1984). The mutual recognition of rights and accountability of all claimants in their use of common waters is also apparent even in the most extreme common water disputes. Sharing water of the Jordan River evoked a violent dispute between the Arab states and Israel. But both had unilaterally implemented or taken steps to implement schemes to utilize the Jordan River water despite the continuing protest of the other. Though there were some political problems, the parties started negotiations through the good offices of special Ambassador Eric Johnston, an envoy of President Eisenhower. The negotiation failed during the first round, but eventually the parties came to adhere to the position that each is entitled to a reasonable share of the Jordan river water and that they would not interfere with each other's share unilaterally (Lecaros 1963).

In the Rio Lauca River controversy between Chile and Bolivia, Chile the upstream state, did not assert the Harmon Doctrine in an attempt to justify its action. On the contrary, it acknowledged that, Bolivia had certain rights over the Lauca River water (Lecaros 1963).

On the question of the use of international drainage basin water, there exists a persistent pattern of state practice and community expectations of shared control. This pattern is reflected in the recurrence of identical provisions in a significant number of treaties among basin states all over the world. These treaties specify, in one way or other, the freedom of action of the signatory basin states. The multiplicity of these treaties is clear evidence that basin states have felt an obligation to work on the basis of mutuality and cooperation in the use of their common waters. The number of basin states which are parties to these treaties, their spread both over time and geography, and the fact that, "in these treaties similar problems are resolved in similar ways, make these treaties and negotiations persuasive evidence of law creating international practice" (Islam 1987). The irrefutable exercise of national sovereignty over the Teesta by the basin states would appear to be contradictory to and a deviation from existing international practice.

Some Proposals

Preservation of Rainy-season Water

During the rainy season a huge amount of rainfall occurs at the foot of the Himalayas. Besides, the ice at the peaks begins to melt in summer, causing floods. In the delta region, the river's depth gradually decreases. As a result, any excess of water in the river inundates the adjoining areas and causes a great deal of damage. However, if India and Bangladesh take up a joint program as we have seen in the case of Nile water apportionment, reservoirs can be built at the upstream of the Teesta River in India to store the excessive water during the rainy season and share the stored water during the dry season. Reservoirs can also be built along the riverside within the Bangladesh territory to store the excessive water during floods, for use during the dry season through gravity irrigation.

Integrated Control of Flood Water

Integrated flood management program have to be planned and implemented during the rainy seasons, as well as for the flash floods of summer, to save a huge amounts of crop and wealth from damage. Early forecasting of floods through remote sensing could help. Unilateral initiative by Bangladesh is not likely to work, because of the geographical situation. Most of the floodwater (except rainwater) comes to Bangladesh from the upstream over which she has no control. Therefore, taking into account all related factors—such as rainfall, melting of ice, and barrage control—an integrated and comprehensive flood control program has to be adopted and implemented.

Bilateral Trade and Business

For the betterment of the people of the Teesta River basin area (both in India and Bangladesh), we also recommend the following:

*While planning and policymaking, emphasis must be

placed on an optimal and amicable water sharing and on a suitable trade model.

* Bangladesh should make certain arrangements for Indians, using the Teesta River water (at Dalia or northern districts), to conduct business and trade in the Bangladesh territory.

*Joint ventures (co-project or bilateral agricultural projects) should be encouraged in establishing mills and factories (e.g. rice mills, tobacco husking mills, paper mills, food processing mills) dependent on crops produced in the Teesta region.

* Both Bangladesh and India are third world countries. So, both countries should try to cooperate with each other to achieve socio-economic development, rather than engage in conflict, and waste time and resources.

* Considering the number of affected people in both India (8 million) and Bangladesh (21 million)[6], we can say that, it would be quite consistent with the principle of justice for Bangladesh to get an equitable share of the Teesta water during dry season.

However, we must remember that "mutual confidence and cooperation" (Smith 1931 p.83) between the leaders of India and Bangladesh is necessary for an economic policy to be implemented properly. Leaders of both sides have to be sincere in their efforts. They must also have an open mind and be ready to accept rational suggestions given by their counterparts.

Conclusion

In a riverine country like Bangladesh, rivers and their landscapes play a dominant role in its very geo-physical existence as well as in her economic development. Hence, further studies of this nature will be helpful to economists, planners and other decision-makers both in private and government sectors, in tackling many of the current problems successfully. As far as we know, no effort has yet been made to carry out additional research on this issue, beyond the feasibility studies for the very purpose of the Teesta Barrage Project conducted by Bangladesh Water Development Board in 1986. Therefore the present study may be considered as a first in this field. We hope to develop a general model for sharing of international rivers in our future research.

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APPENDIX

Figure 1: Yearly maximum and minimum water flow.

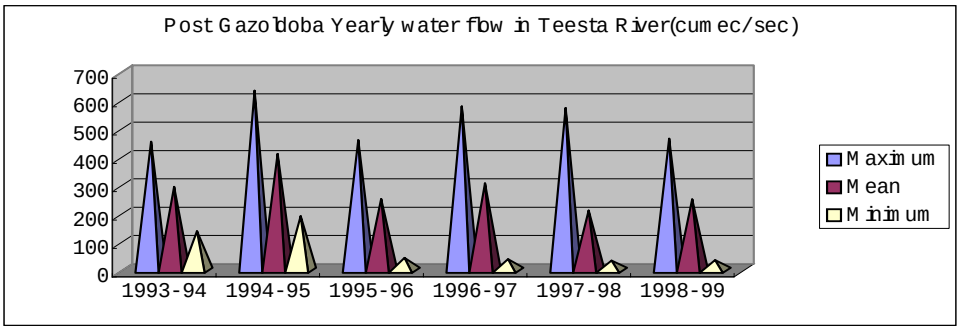
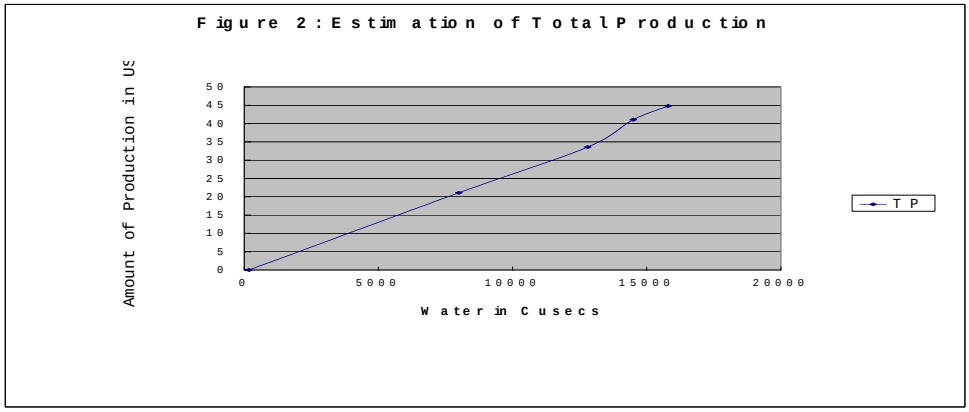


Figure 2: Estimation of Total Production.



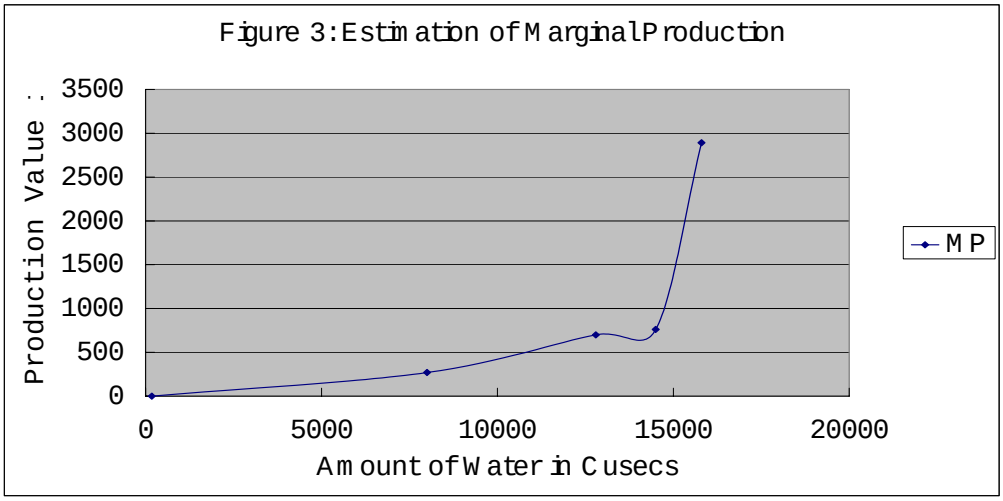


Figure 4: Probable Cases for Optimal Results

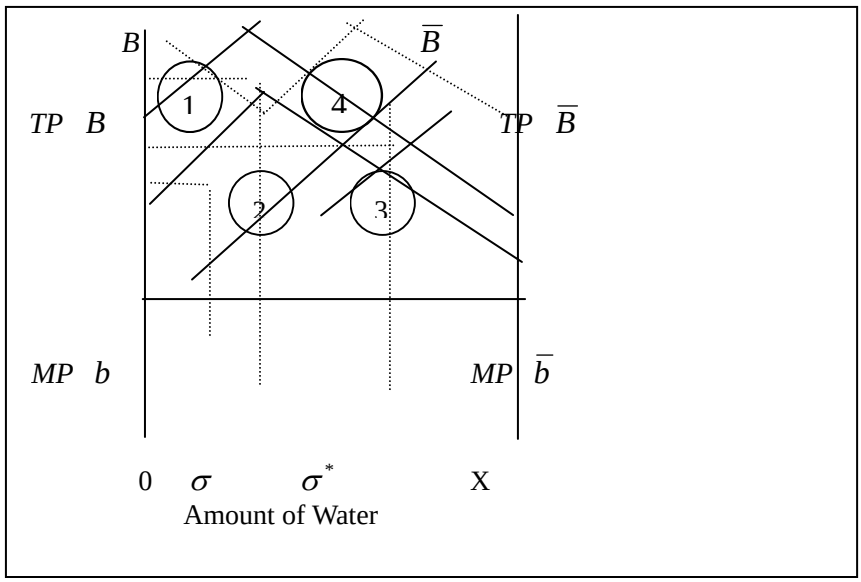


Figure 5: Sharing of Total Flow of the Teesta River Water (in cusecs) India 85%, Bangladesh 15% in Dry Season in 1998.

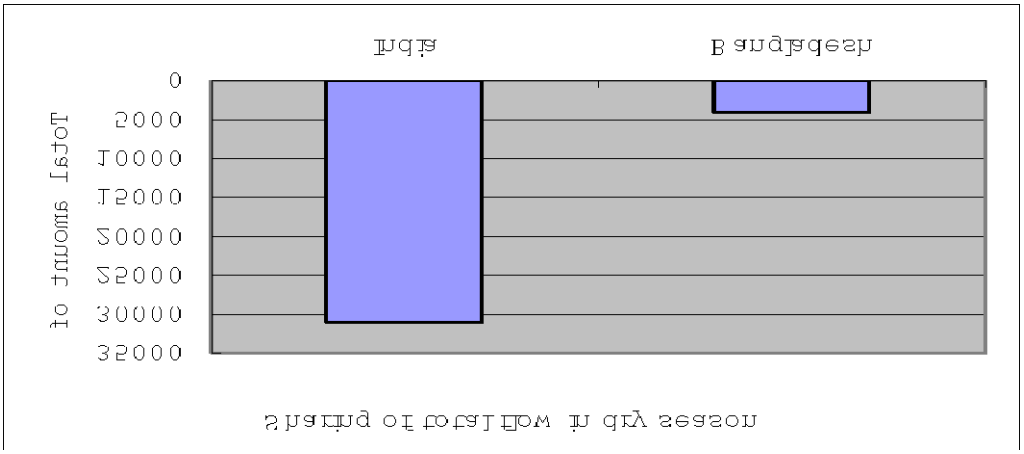


Figure 6: Optimization of Water Sharing between the Two Countries

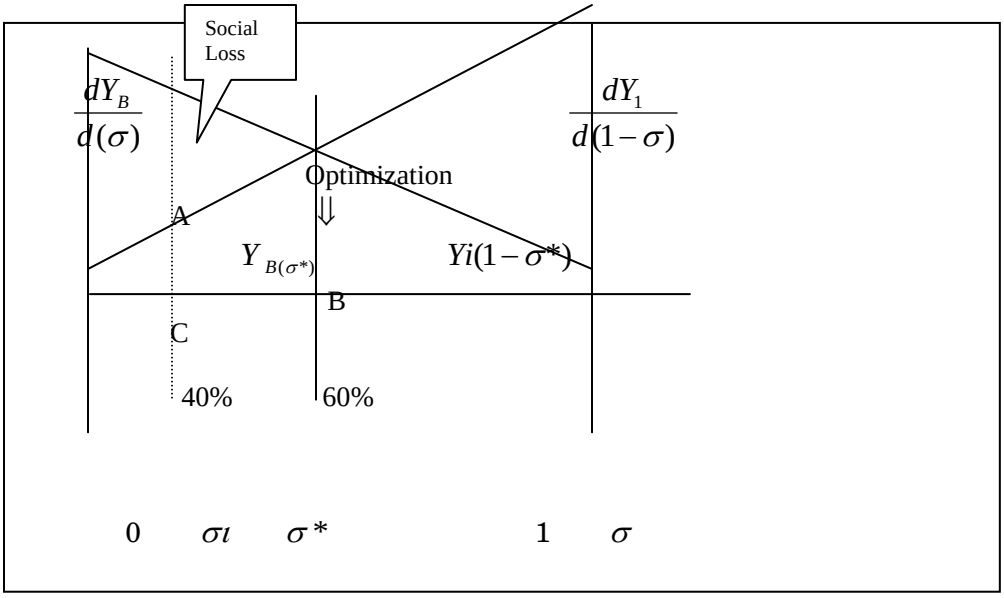


Table-1 The Increasing Trend of Crop Production after Starting the Dalia Barrage Project

Crop	Period-1 Additional land available for crop production ΔL_1 (in hectares, in 1994)	Period-2 Additional land available for crop production ΔL_2 (in hectares, in 1995)	Period-1 Increase in production ΔQ_1 (in tonnes, in 1994)	Period-2 increase in production ΔQ_2 (in tonnes, in 1995)	$\frac{\Delta Q_1}{\Delta L_1}$	$\frac{\Delta Q_2}{\Delta L_2}$	Money value increase in US$ in Period-2
Paddy(HYV)	92,000	20,000	6,500	48,000	0.07	0.42	8 million
Tobacco	50,000	22,000	1,700	3,000	0.03	0.04	12 million
Wheat	20,000	32,000	1,200	22,000	0.06	0.42	5 million
Potato	10,000	2,000	20,000	32,000	0.5	2.67	0.5 million
Ground Nut	7,000	500	1,220	1,860	0.17	0.24	0.3 million
Sugarcane	7,500	9,100	19,000	47,000	2.5	2.83	0.8 million

Table-2 Total and Marginal Production

Crop (marginal production) $\frac{\delta X}{\delta W}$ in tonnes and its money value											
Use of water in Cusecs	C_1 (paddy)		C_2 (wheat)		C_3 (tobacco)		C_4 (potato)		C_5 Others		US$ Value in million
	total	marginal	total	marginal	total	marginal	total	marginal	total	marginal	
176	0	0	0	0	0	0	0	0	0	0	0
8,000	5,800	967	1,800	300	1,700	283	26,000	4,333	26,550	4,425	21
12,800	6,500	350	1,700	-50	2,000	150	20,000	-3,000	20220	-3,165	33
14,500	48,000	2,964	3,000	93	3,000	71	32,000	429	48,860	2,045	41
14,800	53,000	5,000	3,800	800	3,500	500	40,000	8,000	53,000	4,140	44
										Total	139

Endnotes

[1] Under British colonial rule, present India, Pakistan and Bangladesh were recognized as greater India. At the end of the British period (1947), partition of Greater India took place, creating two independent countries-India and Pakistan. At that time, the area of present Bangladesh fell under Pakistan-being termed as East Pakistan. In 1971, Bangladesh became independent through winning the liberation war from Pakistan.

[2] Dalia-the name of the barrage on the Teesta river in Bangladesh

[3] The Daily Ittefaq, January 13,1998 and March 23 1999; , & The Daily Star February 21, 1998

[4] The Daily Ittefaq, January 13, 1998, Dhaka

[5] UN Legislative Series, 1963 UN Doc. ST/LG SEER/B12

[6] According to Bangladesh Bureau of Statistics (BBS) & Internet.: http://php.indiana.edu./~mduttara/wb/wb.html

M. Fakrul Islam
Lecturer in Social Work (on study leave),
University of Rajshahi, Rajshahi, Bangladesh.
islam@jsrsai.envr.tsukuba.ac.jp

Yoshiro Higano
Professor, Institute of Agricultural & Forest Engineering
University of Tsukuba, Japan.