Climate Change Challenges Transboundary Water Resources Management: Drawing from the Case of Vietnam

Pham Quy Giang, Kosuke Toshiki, Shoichi Kunikane, Masahiro Sakata

***Abstract*—** Being a lower riparian state along most of its international rivers, with over 60 percent of its surface fresh water originating from outside its territory, Vietnam is currently facing increasingly negative impacts from the water use and water policies of upstream countries, especially in relation to dam-building activities. The problems of river flow fluctuation, artificial flooding, dramatic decline of flow in the dry season, salinity intrusion, and other related problems, have become more and more considerable. As global climate change is expected to strongly affect the country's water resources, causing more severe flooding, drought, and sea level rise, the above problems are likely to be seriously aggravated. This paper analyzes these conditions of Vietnam. We emphasize the importance of Vietnam cooperating with its neighbours in managing shared river basins in response to climate change impacts.

***Keywords*—**Climate change, cooperation, transboundary water resources, water conflict.

I. Introduction

NOWADAYS, approximately 40 percent of the world's population lives in river and lake basins that are shared by two or more countries, and more than 90 percent lives in countries that share basins. The world's 263 existing transboundary river basins cover approximately a half of the Earth's land surface and account for around 60 percent of global freshwater flow [1]. Tranboundary water resources create an opportunity for cooperation between riparian countries. However, increasing water demands within each country, and conflicting interests of water use between riparian countries are expected to bring about increasing challenges to cooperation, possibly even increasing conflicts and tensions. Global climate change is projected to inevitably alter water availability, quality, timing, flows, etc., resulting in additional pressures on water resources management. For countries whose basins lie wholly within their own territories, adapting to increasingly severe climate change will be difficult enough; however, when those basins cross borders, bringing in multiple political entities and actors, sustainable management of shared water resources in a changing climate will be especially challenging [2]. Vietnam is a typical example of this second case. It is bordered by China to the north, Laos to the northwest, Cambodia to the southwest, and the East Sea to the east, and is located in the lower course of most of its international rivers. As more than 60% of its water resources are inflows from other countries [3], Vietnam is especially sensitive to the water use of the upstream countries. In addition, the topography and location of Vietnam make it very likely to be one of the countries in the world to be most strongly affected by global climate change. This paper deals with such issues and discusses a way towards cooperation in transboundary water resources management.

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II. Characteristics of Water Resources in Vietnam

Vietnam possesses a dense river network, with 2,372 long rivers (over 10km), comprising 13 large river systems, of which 9 are major rivers and 4 are tributary rivers [4]. This river network includes many international rivers that originate in other countries, with only 28 percent of the total catchment area and 40 percent of the total annual volume of water flow belonging to Vietnam (Table I). This dependency on upstream countries has made Vietnam's ranking low in Southeast Asia's water availability per capita: 4,170 m^3/person compared to the average 4,900 m^3/person in Southeast Asia [5].

Despite the high total annual runoff of over 800 billion m^3, water shortages happen in many areas due to uneven regional and seasonal distributions in water resources. More than 60% of river water is concentrated in the Mekong River Delta, which covers only 12% of the total area of Vietnam, while the remaining less than 40% is spread over an area containing nearly 80% of the nation's population and over 90% of its production, trade and service activities [3]. The average volume of water in the wet season, which lasts for 4-5 months,

accounts for 75-85% of the total volume, while the dry season (7-8 months) receives only the remaining 15-25% [3], [6].

TABLE I
CHARACTERISTICS OF MAJOR RIVER SYSTEMS IN VIETNAM (SOURCE: [4])

River system	Share basin with	Basin area (km^2)			Total annual volume (billion m^3)		
		Outside Vietnam	Inside Vietnam	Total	Outside Vietnam	Inside Vietnam	Total
Bang Giang—Ky Cung	China	1,980	11,280	13,260	1.7	7.3	9.0
Thai Binh			15,180	15,180		9.7	9.7
Hong (Red)	China	82,300	72,700	155,000	45.2	81.3	126.5
Ma	Laos	10,800	17,600	28,400	5.6	14.0	19.6
Ca—La	Laos	9,470	17,730	27,200	4.4	17.8	22.2
Thu Bon			10,350	10,350		20.1	20.1
Ba			13,900	13,900		9.5	9.5
Dong Nai	Cambodia	6,700	37,400	44,100	3.5	32.8	36.3
Mekong	China, Myanmar, Laos, Thailand, Cambodia	726,180	68,820	795,000	447.0	53.0	500
Other rivers			66,030	66,030		94.5	94.5
Total		**837,430**	**330,990**	**1,176,000**	**507.4**	**340**	**847.4**

III. TRANSBOUNDARY ISSUES AND CLIMATE CHANGE

As Vietnam is a downstream state along most of the international rivers that flow through it—including the Mekong and Red rivers, its two most important rivers—the country is susceptible to the effects of water use in upstream countries. Its major concerns are dam-building activities and flow regulation. For example, in the mainstream of the upper Mekong, China has finished building four of the series of 14 hydroelectric dams in Yunnan, while Laos, Thailand and Cambodia are planning to build 11 other dams in their territories [7] (Fig. 1). In the upper tributaries of the Red River in Chinese territory, known there as the Lixian, Panlong, and Yuan Rivers (Fig. 2), 20 hydropower plants have been or are being built, of which many are large-scale projects [8], [9].

Fig. 1 Hydropower dams on the mainstream of the Mekong River (adapted from: [7])

Fig. 2 Transboundary rivers in the Red River Basin.

The construction of dams will block rivers, causing a series of direct impacts. Firstly, it is clear that international navigation along rivers passing those dams will become impossible. During the dry season, when water is stored in upstream dams, water level downstream will decrease and this may interrupt local navigation to a certain extent. For the rivers which are significant for waterway transportation such as the Red River and the Mekong River, this is a considerable concern. Secondly, upstream dams will trap a big portion of the nutrient-rich sediment that rivers should naturally transport to downstream deltas, leading to the reduction of fertility of the deltas, and finally causing decline in agricultural productivity. For example, it is estimated that if all 11 main-stem dams on the lower Mekong River are built, the annual flow of sediment through Vietnam's Mekong Delta will be reduced from 26 million tonnes to 7 million tonnes [10]. Thirdly, dam construction will also block critical migration routes of migratory fishes, leading to a greatly serious impact on fisheries. For instance, if all 11 main-stem dams and 78 tributary dams in the lower Mekong River Basin (in Laos, Thailand, Cambodia, and Vietnam) are completed (expected to be operational by 2030), 328,320 tonnes of migratory fish biomass, corresponding to 51.3% of its current

total amount, would be lost [11]. With approximately 14 million people in the Mekong River Delta relying on agriculture and fisheries, the reduction of agricultural productivity and fish biomass will lead to a national socio-economic concern of Vietnam.

Other direct impacts to downstream water may come from flow regulation, which is a usual activity of upstream dams. Flow regulation can be seen through the difference between a river's regulated flow and its naturally restored flow. Fig. 3 presents flow regulation in the Lixian River as an example. The Lixian River is the Chinese part of the Black River, which is the most important tributary of the Red River. The Vietnamese part of the Black River is known as the Da River.

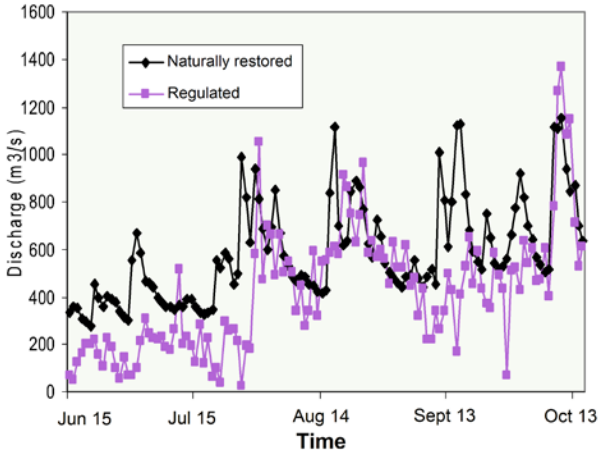

Fig. 3 Naturally restored daily flow and regulated daily flow in the Lixian River, 2010 (Source: [8])

The immediate and clear impacts of upstream flow regulation in Lixian River on downstream flow are already being felt through a large fluctuation in daily water level of approximately 1.5-2.0m (at Muong Te station) in the Vietnamese part of the river [8]. The instability of water flow from upstream countries could have serious impacts on hydrology and water utilization in Vietnam. The timing and flow of rivers have become difficult to predict, resulting in problems for irrigation water planning and management.

The "upstream problem" becomes an even greater concern when extreme weather events such as flooding and drought occur, because in such cases flow regulation is entirely in the hands of the upstream countries. In the case of flooding, the normal upstream dam policy is to open the sluice gates, engendering potentially serious consequences downstream. In the case of drought, upstream countries may store as much water as possible, aggravating the situation of downstream Vietnam [12]. For example, it was reported that there were two extreme floods in October 2006 and October 2010 in Northwest Vietnam, with flood peaks nearly twice usual levels due to flood releases from upstream dams [8]. On the other hand, in the dry season, the Red River Delta has suffered from historic drought in recent years; the minimum flow of the Red River has declined dramatically to its lowest level in the past 100 years (Fig. 4).

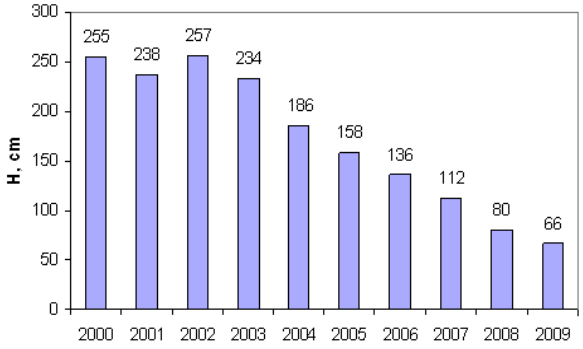

Fig. 4 The decline of minimum water level of the Red River at Hanoi station (source: [13])

Under the effects of future climate change, given the predicted variability of rainfall in the upper part of river basins, the potential effects of upstream countries increase. In general, rainfall tends to increase in the rainy season with more intensive rainfall events, and decrease in the dry season with longer dry spells than in the past [3]. Flood peaks in most rivers are predicted to increase, while minimum flows in the dry season are predicted to decrease [14] (Fig. 5).

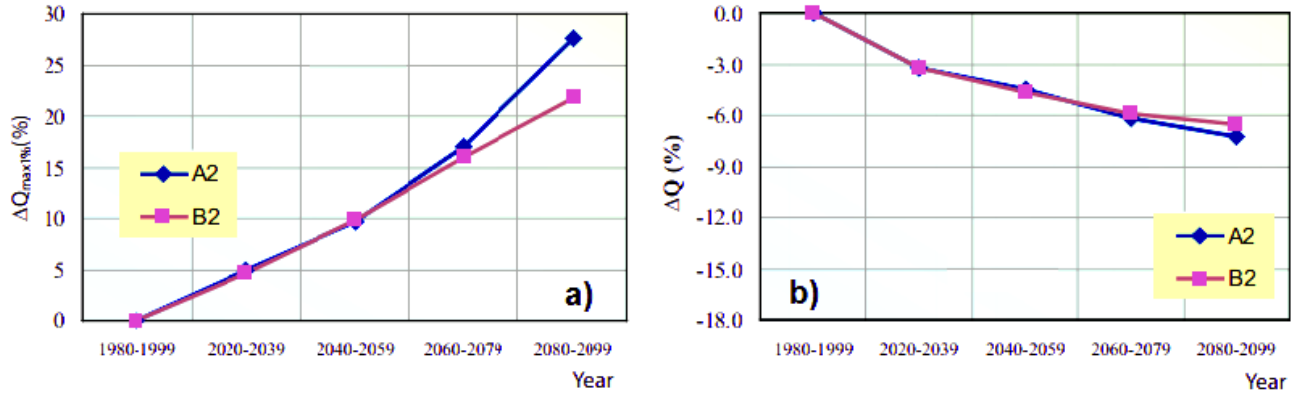

Fig. 5 Predicted change in (a) food peak and (b) dry season's flow of the Red River (at Yen Bai station) relative to the period 1980-1999 based on climate change scenarios A2 (high CO_2 emission) and B2 (medium CO_2 emission) (source: [14])

In addition, with the increasingly severe dry season, it has become more necessary for upstream farmers to shift from rainfed to irrigation agriculture, and to use much of the water that is stored upstream. Large water requirements or water shortages have even lead to a need to divert river flows. For example, Thailand has revealed ambitious plans to divert

water from the Mekong basin for use outside of the basin. The Kon-Ing-Nan and the Khong-Chi-Mun schemes are planned for the irrigation of fields in the dry northeast of the country [12]. This is expected to also contribute to the upstream-downstream problem.

The problem of decreasing flow due to storages and over-exploitation of water resources upstream is likely to lead to more salinity intrusion downstream, which is currently a great concern in Vietnam. With a long coastline of 3,260 km and hundreds of river mouths along the coast, Vietnam is greatly affected by salinity intrusion, especially in its two river deltas: the Red and the Mekong River Deltas. Research shows that, at present, salinity intrusion at the level of over 4‰ extends along the Red River to a point 22 km from the sea. Along the Mekong River, it extends approximately 50 km, and it extends much further along other rivers such as the Dong Nai (71.1 km) and the Vam Co Tay (95km). As the average rate of sea level rise is predicted to be 6mm/year in this century, by the middle of the century those distances will increase to 23.6 km along the Red River, and 58.1 km along the Mekong River. Over the next 30 years, the area of the Mekong River Delta under salinity intrusion at > 4‰ will be more than 1.6 million hectares, occupying 41% of the total area of the delta [14]. These salinity intrusion predictions, however, do not take into account the potential construction of more dams, water diversion, and changes in the water usage of upstream countries. If it were to do so, the predicted trend of salinity intrusion would be considerably higher. As the deltas are the rice bowl of Vietnam, and salinity intrusion reduces cultivated land area and crop productivity, the country may object strongly to the water use policies of the upstream countries [12].

Vietnam's growing concerns related to transboundary water resources involve not only water quantity, but also the quality of that water. Increases in fertilizer and pesticide use in agriculture, and increasing industrialization upstream are likely to contribute to the deterioration of water quality downstream to a certain extent. Recent reports show that water quality in most rivers in Vietnam is poor [6]. Most rivers are burdened with large amounts of pollutants. For example, it was recently reported that in recent years, the yearly tonnage of pollutants flowing down the Red River past the Ba Lat estuary to the Gulf of Tonkin has been 232,000 tonnes of biochemical oxygen demand (BOD), 353,000 tonnes of chemical oxygen demand (COD), 31,000 tonnes of nitrogen, over 7,000 tonnes of phosphate, 29,000,000 tonnes of total suspended solid (TSS), over 4,000 tonnes of heavy metals, 210 tonnes of pesticide, 343 tonnes of chemical fertilizer and about 13,000 tonnes of oil [15]. Although it is unclear how much pollution has been produced in the upstream part of the river due to insufficient data and lack of monitoring, the contribution of pollution from upstream countries must be considerable.

IV. Existing Agreements and New Opportunities for Cooperation

Recently, there has been increasing recognition of the importance of the transboundary water resources problem, to date, however, only a few international agreements related to transboundary water resources management have been made between Vietnam and its neighbours, and all of these have focused on the Mekong River (Table II). Also, the Mekong River Commission (established in 1995 with four members: Laos, Thailand, Cambodia, and Vietnam) is the only international river basin organization of which Vietnam is a member state. To some extent, the Commission has been the core institution of cooperation in management and conservation of the water and related resources of the Mekong River Basin, which includes some other Vietnam's major international rivers, such as the Sekong, the Sesan, and the Srepok. However, as China and Myanmar—the 2 upstream states in the basin—are not members of the commission, the commission has been facing many challenges when dealing with water use policies upstream, especially dam-building programs in China [7].

TABLE I
International Water Agreements between Vietnam and other countries (source: [16])

Name of agreement	River	Country	Year
Statute of the Committee for Coordination of Investigations of the Lower Mekong Basin established by Cambodia, Laos, Thailand, and Vietnam in response to the decisions taken by the United Nations Economic Commission for Asia and the Far East	Mekong	Cambodia, Laos, Thailand, Vietnam	Oct 31, 1957
Joint declaration of principles for utilization of the waters of the Lower Mekong Basin, signed by the representatives of the governments of Cambodia, Laos, Thailand, and Vietnam to the Committee for Coordination of Investigations of the Lower Mekong Basin	Mekong	Laos, Thailand, Vietnam	Jan 31, 1975
Declaration concerning the Interim Committee for Coordination of Investigation of the Lower Mekong Basin	Mekong	Laos, Thailand, Vietnam	Jan 5, 1978
Agreement on the cooperation for the sustainable development of the Mekong River Basin	Mekong	Cambodia, Laos, Thailand, Vietnam	Apr 5, 1995
Decision adjusting and supplementing a number of mechanisms and policies in order to speed up the construction progress of population clusters and lines as well as dwelling houses in frequently flooded provinces in Mekong	Mekong	Cambodia, Laos, Thailand, Vietnam	May 7, 2004

In view of the predicted serious impacts of climate change on its water resources, Vietnam would be well advised to start more effective negotiations with its neighbours, creating concrete cooperation in management and utilization of shared water resources in response to the common problem of climate change. Negotiations, especially with China, will not be easy

for Vietnam as it is a downstream country, and an agreement, if signed, may not appear at first to bring much immediate benefit to upstream states but will limit their use of upstream water resources to a certain extent. A related issue, and an unfortunate one from Vietnam's point of view, is the failure to come into force of The Convention on the Law of the Non-Navigational Uses of International Watercourses adopted by the United Nation General Assembly in 1997, which is considered to be the first global water law. Thus, Vietnam will have to take the initiative to actively improve its cooperative frameworks and increase diplomacy to be ready for more effective negotiations.

Based on the current situation, we suggest the following future scenario. On the one hand, global climate change is likely to bring more conflict and tension over shared water resources in the Mekong River Region; however, on the other hand, climate change will also produce a common feature of climate condition that will need to be faced by all nations in the region alike, and that will need to be solved through negotiation. Increasing severity in weather events globally or regionally will have to be solved by increasing degrees of institutional preparedness and organizational flexibility, leading to enhanced political cooperation. If negotiations can be successfully started, joint monitoring programs should be set up immediately to increase understanding of common vulnerabilities. Exchanging information provides a number of benefits, including: helping each country to establish a suitable water allocation plan, especially for irrigation; preventing unexpected artificial flooding; and improving the accuracy of hydrological and socio-economic models for predicting climate change impacts. Transboundary cooperation in the context of climate change can be broadened through developing a common climate change scenario for each shared basin in order to assess potential impacts, propose adaptive strategies for the whole basin, and share responsibilities.

In case of the existing agreements, none of them were originally designed to cope with climate change impacts. Thus, it is necessary to re-evaluate these agreements so as to expand their scope and amend their content to include climate change impacts and increase their flexibility. Vietnam and its neighboring countries should take the following mechanisms into account when amending existing agreements: (1) Prediction on overall potential impacts of climate change on all elements of hydrological cycles, including water quality; (2) preparedness for extreme events; (3) flexible water allocation strategies; (4) clear amendment and review procedures; and (5) establishing joint management institutions and sharing responsibilities.

V. Conclusion

Climate change is likely to impact strongly on Vietnam's already-stressed downstream water resources. The country's current serious water situation of large flow fluctuations, flooding, drought, salinity intrusion, pollution, and stressed ecosystems is related to water use policies upstream, especially dam-building projects, and is likely to be exacerbated by more severe climate change in the near future. Current transboundary water cooperation initiatives, however, are considerably weak, and are mostly based on the Mekong River Commission, which focuses on the Mekong River Basin only. As the country is expected to be more strongly affected by climate change in the coming decades, Vietnam will need to be more active in negotiating new cooperative frameworks for managing shared water resources with its neighbours. The success of responses to climate change in a common basin depends not only on the capacity of each nation alone, but also on the ability of all nations in the basin to communicate, coordinate, and cooperate to tackle this increasingly serious problem.

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