

## The Red river basin and flood disasters (紅河流域における水害)

宮崎大学工学部

○学生会員 NGUYEN LE TUAN

正会員 杉尾哲

### 1. Introduction

The Red river basin is one of the largest basin in Vietnam. It is considered as the cultural cradle of Vietnamese nation. It also contains the capital Ha Noi and the growth triangle Ha Noi- Hai Phong - Quang Ninh. The river rises in the southern mountain region of China and flows to the South China Sea. It forms the Red River Delta, one of the largest deltas in Vietnam (Fig. 1). Flood disasters is the frequent threat to the development in the basin. This paper presents the flood disasters, the most frequently occurred water-related disasters in the basin, with the purpose supplying more information about this problem.

### 2. Flood disasters in the basin

#### (1) Climate and drainage network of the basin

The Red river basin is located next to subhumid tropic region of South East and has therefore a climate regime of tropical to subtropical. It is dominated by the monsoon wind of East Asia. Climate regime is differentiated profoundly from a subregion to another in the basin. There are about 8-10 typhoons hit the coastal line of Vietnam every year. Many years, Vietnam is struck by 10 or more typhoons, for instance in 1964 (18 typhoons), 1973 (12), 1978 (12), and 1989 (10). In the Red river basin, it is estimated that on the average about 15 typhoons affect the coastal region every 10 years. The months of July and August experience the highest incidence of typhoons in the basin.

Typical characteristic of the rivers is that all rivers are steep in upstream regions and the mean value of river bed slope is greater than 0.2%. In the downstream regions, there are many tributaries join to main stream and the rivers open widely with reduced bed slope and become very flat (Fig. 2). They are meandering and changing complexly in morphology. Most of delta region is lying between 0.4m and 12m above mean sea level, with 56% lying below 2m. The river has been divided by many drainage branches for distributing water. Table 1 shows length and catchment area of the Red river and other main tributaries.

#### (2) Flood disaster

The worst damage in the basin is usually caused by floods, particularly when accompanied by typhoons. In addition to the floods caused by typhoons, flood are formed by tropical depressions which can bring prolonged rain over the catchments of the Red river and its tributaries. However, the weather patterns that can cause danger floods in the basin are sophisticated. The annual maximum flood usually occurs in August on all tributaries and main stream of the Red river. Sometimes, the annual maximum flood can occurred in June or October but at low frequency. Because of the large area with many type of surface conditions as well as other geographical characteristics, the basin has a non-synchronous flood regime in space and time. The flood in the Red river basin is the result of floods in three main tributaries. The synchronization of flood at Son Tay with floods in three tributaries is at low level with complicated mechanism. In the upstream rivers, there are the so-called "mountain floods" with high velocity flow, such as flash floods. After that, the flow velocity may be reduced but the discharge becomes larger. The typical place where high discharge threaten is the Ha Noi capital. The flood peak discharge in the basin is rather big with high flow velocity and quickly rising and recession. They caused serious dyke breaches and overtopping in the past. Typical ones were flood in 1913 with inundated area of 307607 ha in delta region; 1915 with 325000 ha; 1945 with 312000 ha; 1971 with 250139 ha. The flood in August 1971 was considered as the history flood in the Red river with the discharge at Son Tay (near the capital Ha Noi, in the upstream) was about 37800m<sup>3</sup>/s. The flood in August 1945 caused the worst poverty in modern history of Vietnam with millions died of starvation. Floods in 1986 and 1996 caused dyke breaches

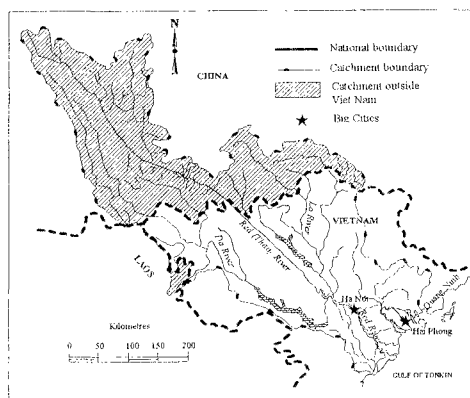


Fig. 1 Map of the Red river basin

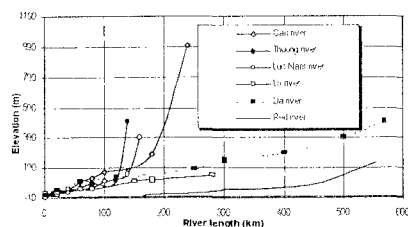


Fig. 2 Profiles along some rivers in the Red river basin

Table 1. Morphometrical characteristics of basins

Name of river	Catchment area (km <sup>2</sup> )		River length (km)	
	Total	In Vietnam	Total	In Vietnam
Red	169000	86190	1126	556
Da	52900	26800	1010	570
Lo	39000	22600	470	275
Cau	6030	6030	288	288
Thuong	3580	3580	157	157
Luc Nam	3070	3070	175	175

at some places. **Table 2** shows characteristics of some floods at some key sites in the Red river basin. **Fig. 3** shows the hydrographs at some sites in Da river during the flood occurred in August 1996.

Virtually the whole delta is protected by dykes. The dyke system in the basin is the oldest flood control structure of Vietnamese people. Archaeological evidence suggests that the first dykes were built in the third century BC. However, its elevation will be higher and higher every year. The early construction of dyke system in the basin proves that flood disaster had been a long time and frequent problem. An other structure for flood control purpose is dams. There are two main dams in the basin: Thac Ba dam on Chay river and Hoa Binh dam on Da river. They are multi-purpose dams but main purposes are flood control and power generation. According to utilizing the flood storage provided by these dams, it is expected to ensure that the water level at Ha Noi does not rise above elevation 13.3 m during the flood equivalent to the 1971 flood. From operation data during 1990-1996, it can be said that the water level at Ha Noi can be reduced from 0.3 to 0.6m or more by operating Hoa Binh dam. Some figures of these two dam are shown in **Table 3**.

Some typhoons hit the coastline of the basin with the wind speed of about 50 m/s and usually causes severe surges that sometimes the amplitude of surge wave is over than 2m. The typhoon on 13 August 1968 is an example. The amplitude of surge wave in this typhoon was 2.5 m. Sea dyke system is threaten by these surges especially in the period of high tides. The coastal region of the basin is the one of the highest tidal regions in Vietnam. Typhoons also cause intense and prolonged rainfalls. These rainfalls usually cause local flooding and water logging in the delta region. The typhoon on 14 September 1985 caused water logging over the area of 2830 km<sup>2</sup> of which 1750 km<sup>2</sup> in serious conditions while the total area of the delta is about 16664 km<sup>2</sup>.

Flash floods are floods of short duration with a relatively high peak discharge. During storms, heavy rains can accumulate rapidly as floodwater in steep gorges, and flood waves can travel quickly causing severe, sudden destruction. This kind of floods are difficult to forecast. The basin has some sub-regions which are estimated as the most frequently occurrence of flash flood in Vietnam. These sub-regions locates in the upstream region of the basin. In July 1990, a flash flood caused the loss of life of 70 people.

### 3. Conclusions

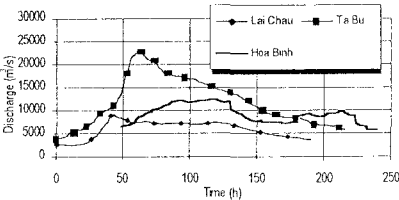
The Red river basin has a important position in development of Vietnam. However, flood disasters are the key threat for this development in the basin and cause the worst damage. The principles of flood forming in the basin is very sophisticated. It has been depended on many factors but the rainfall is the main factor. The combination of floods in the three main tributaries of the Red river basin is complex. Some unfavourable combinations have not occurred yet. The basin is still in high level of risk of flood disaster. They have to be studied more thoroughly.

### References

- 1) Binnie, SMEC, AACM, Delft (1995).Ministry of Science, Technology and Environment, Ha Noi, Vietnam.
- 2) Michael Bonell, Maynard M. Hufschmidt and John S. Gladwell (1993). UNESCO, Cambridge University Press.
- 3) Nguyen Viet Pho, Do Dinh Khoi, Vu Van Tuan (1993). Agriculture Publishing House. Ha Noi, Vietnam.
- 4) Pham Quang Hanh, Nguyen Viet Pho, Do Dinh Khoi, Hoang Niem (1994). Science and Technology Publishing House. Ha Noi, Vietnam.
- 5) Tran Tuat, Tran Thanh Xuan, Nguyen Duc Nhat (1987). Science and Technology Publishing House. Ha Noi, Vietnam.

**Table 2. Characteristics of some floods at some key sites in the Red river basin**

Station (river)	Year	Time of flood (h)	Average intensity		Flood volume (bil. m <sup>3</sup> )	ΔH (cm)	
			Rising (cm/h)	Recession (cm/h)		Rising limb	Recession limb
Lai Chau (Da river)	1969	462	8.71	4.54	10.02	1281	1430
	1971	610	10.90	3.06	13.17	1324	1419
	1986	324	15.20	3.99	6.72	852	1068
	1996	178	56.50	9.05	4.03	1639	1349
Ta Bu (Da river)	1969	498	4.96	3.33	14.42	913	1046
	1971	650	6.39	2.07	21.60	888	1058
	1986	510	15.20	3.99	6.72	526	962
	1996	214	21.30	6.83	9.27	1278	1052
Yen Bai (Thao river)	1969	522	1.42	1.10	5.36	303	340
	1971	762	1.24	1.15	12.58	413	496
	1986	490	6.17	1.68	8.08	285	273
	1996	429	1.52	0.76	5.18	237	215
Phu Ninh (Lo river)	1969	517	1.66	3.10	1.15	558	562
	1971	906	1.49	1.40	7	547	755
Vu Quang (Lo river)	1986	453	1.83	0.95	4.29	617	656
	1996	328	3.80	3.18	4.85	475	645
Son Tay (Red river)	1969	478	1.42	1.85	31.81	398	366
	1971	818	1.04	1.03	56.30	350	498
	1986	600	1.57	1.05	30.09	340	405
	1996	759	1.53	1.32	28.40	465	529
Ha Noi (Red river)	1969	412	1.64	2.93	22.40	450	405
	1971	861	1.17	1.09	33.11	396	573
	1986	412	2.30	1.57	18.60	294	445
	1996	732	1.71	1.26	22.10	492	561



**Fig. 3 Hydrographs at some stations on Da river from August 16 - 1996**

**Table 3. Some figures of two main dams**

Dam	Hoa Binh	Thac Ba
Figures		
Design capacity for flood control	5.6 bil. m <sup>3</sup>	1.2 bil. m <sup>3</sup>
Water level at normal situation (h)	115 m	58 m
Reservoir volume at h	9.6 bil. m <sup>3</sup>	2.94 bil. m <sup>3</sup>
Area of water surface at h	20300 ha	23250 ha
The height of main dam	128 m	43 m