

# DAM DEVELOPMENT IN VIETNAM: CURRENT STATUS & FUTURE PLANNING

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**ABSTRACT.** Vietnam is a South - East Asian country, which is affected by the subtropical humid monsoon climate. Its annual rainfall is high and most of its territory (especially in the North and the Central parts) is mountainous and has good potential for water reserves and hydropower. Moreover, rainfall, almost the only source of surface flow, concentrates in a few months yearly during the rainy season. Therefore, there is an urgent need to be regulated by reservoirs. The Dam Development has a key role in Vietnam economic-social programs: power generation; flood disaster mitigation; irrigation, water supply for life and industry; transport; and environment promotion. A number of dams with various sizes has been completed to have important contribution to the socio-economic development of the country. Many others are under construction and planning. Dam construction in Vietnam has got lots achievements. Besides it is facing challenges in technological, financial, socially,...

## 1. BRIEF ON WATER RESOURCES

**Location:** Vietnam is situated in South - East Asia with its main land lying between north parallels  $8^{\circ}$  -  $23^{\circ}$  and east meridians  $102^{\circ}$  -  $109^{\circ}$ . It has a territory of 331,000 km<sup>2</sup> and a population of 83 mil.. The country's mountainous topography (three-quarters are mountains and hills) and subtropical humid monsoon climate profoundly affect the quantity and distribution, both temporally and spatially, of water (fig.1).

**Water Resources:** Mean annual rainfall, which almost is the only source of surface flow, is about 2,000 mm; but about 75% accumulates in only three months (more than 30% usually in only one peak month). This occurs from July to September in the Northern and Southern areas and from September to December in the Central area. The mean annual runoff totals 880 billion m<sup>3</sup> (ranking 12<sup>th</sup> in the world), of which 70% is generated outside the border lines and flows downstream into Vietnam. The mountainous landscape offers substantial potential for hydropower and water storage.



*Fig.1. Map of Vietnam  
Mainland*

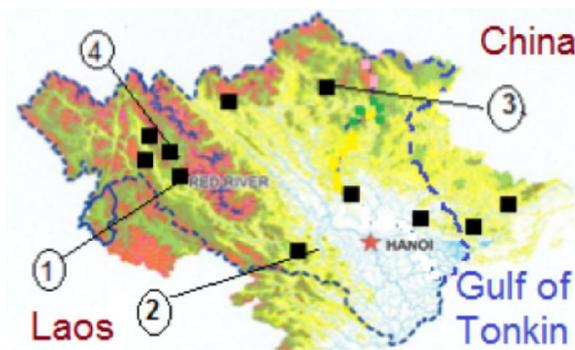
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In wet seasons this promotes rapid flood concentrations, makes heavy inundation in alluvial plains and deltas, where most big cities are located. In dry seasons, there are water shortages (the minimum monthly flow of most basins is just 1% of annual runoff) and drought, which threaten the water supply and living condition of millions people with impacts on environment, agriculture, aquaculture, etc...

## 2. MAJOR RIVER BASINS & LARGE DAMS

Reservoirs in Vietnam are of two categories, in which the first ones especially for energy and the other multipurpose reservoirs for combination of flood mitigation, water supply, irrigation and power generation.



■ Location of large dams.



2: Hoa\_Binh HPP (Rockfill Dam, H128m, W9.5bil.m<sup>3</sup>, P1920MW)



1: Son\_La Hydropower Plant (HPP) (RCC Dam, Dam Height H138m, Storage Capacity W12.5bil.m<sup>3</sup>, Power Capacity P2400MW)



3: Tuyen\_Quang HPP (CFRD, H93m, W2.3bil.m<sup>3</sup>, P342MW)

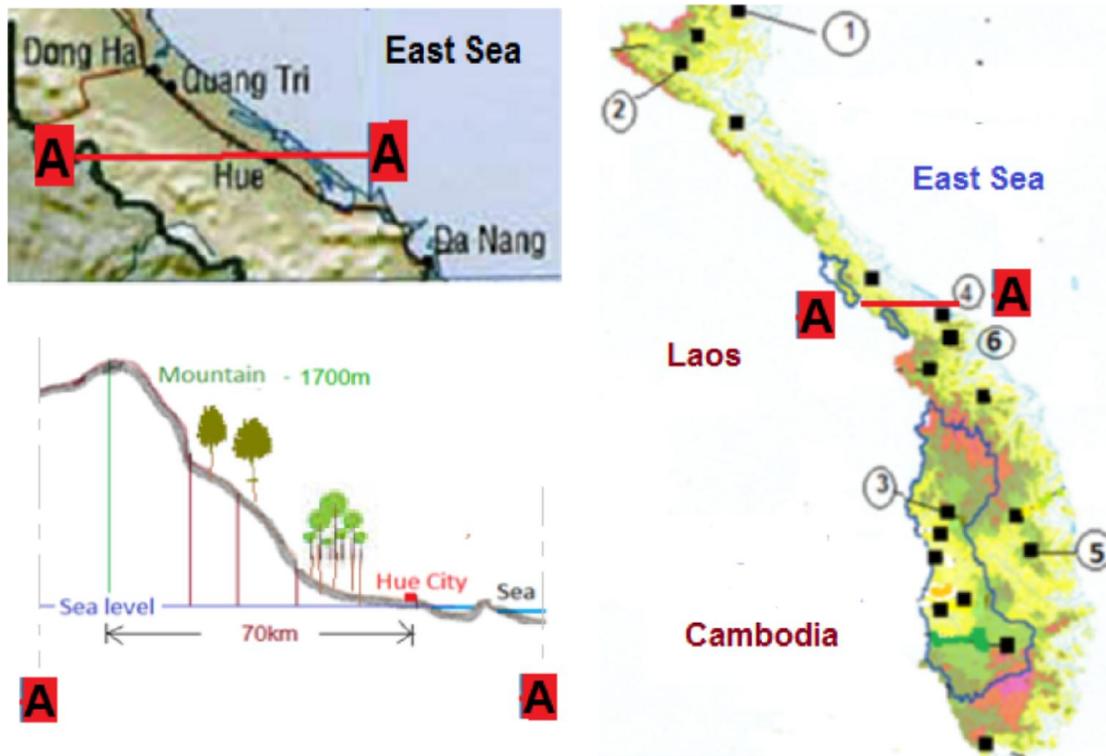


4: Huoi\_Quang HPP (Concrete Gravity Dam, H104m, W184mil.m<sup>3</sup>, P520MW)

**Fig.2.** The Red River System Basin in North Vietnam with large dams

As for characteristics of topography and river basins, Vietnam is considered to be composed of three regions: Northern, Central and Southern ones.

- Almost the *North Vietnam* belongs to the *Red River System Basin* of 87,000 km<sup>2</sup> (the rest is outside the border) and taking more than 15% of total runoff of the country. The Red River Delta is of 16,654 km<sup>2</sup> with a high density of population and big cities (fig.2). Beside the task of power generation for the whole country, big reservoirs therein must have an important part in flood mitigation in the delta together with an embankment river dyke system, which have been built for many centuries and also directly protects the delta from floods.



*Fig.3. Steep slope of rivers in Coastland Central Vietnam & location of large dams*

■ Location of large dams  
1, ..., 6: Dams index used in Fig.4

- *Central Vietnam* stretches from the North ( parallel 20°) to the South (parallel 11°) and is composed of two subregions: the *East Coastland* and the *South –West Highlands*.

The coastal subregion, a very narrow land strip between mountains and sea, is composed of a lot of small separate basins (the largest of them are less than 30,000 km<sup>2</sup>). They have considerable hydropower potential due to their high stream slopes as sources of the rivers are in the mountainous areas close to the coastline (fig.3). This subregion faces yearly 7÷10 typhoons and tropical storms coming from East Pacific Ocean with high rainfall and flood peaks. Sources of Mekong tributaries are in the highlands. They flow towards the main

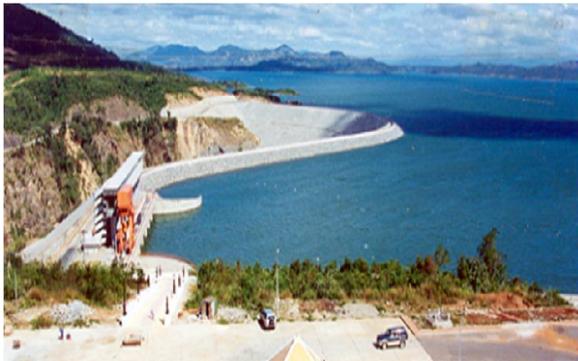
stream outside the Western border. Floods and droughts usually come suddenly right after each other. This situation can be mitigated by reservoirs only in connection with power generation (fig.4).



1: Cua\_Dat CFRD ( H118m, W1.5bil.m<sup>3</sup>, P124MW)



2: Ban\_Ve HPP (RCC Dam, H136m, W200mil.m<sup>3</sup>, P230MW)



3: Yaly HPP (Rockfill Dam, H69m, W780mil.m<sup>3</sup>, P720MW)



4: Thao\_Long Barrage (Crest Length L540m)



5: Dinh\_Binh HPP (RCC Dam, H64m, W300mil.m<sup>3</sup>, P64MW)



6: Ta\_Trach Dam (Embankment, H60m, W650mil.m<sup>3</sup>, P20MW)

*Fig.4. Some large dams in the Central Vietnam*

- The **South Vietnam** can be divided into two subregions. The East subregion is the **Dong Nai River Basin** (44,100 km<sup>2</sup>) with a big potential of power energy and water supply.

Rapid downstream industrial and urban development (including Ho Chi Minh City) urgently raises the issue of water requirements.



1: Tri\_An HPP (Embankment, H40m, W400mil.m<sup>3</sup>, P450MW)



2: Dau\_Tieng Dam (Embankment, H30m, W1.5bil.m<sup>3</sup>, Crest Length L1200m,)(left)

3: Phuoc\_Hoa Barrage (H28m, Crest Length 400m)(right)



4: Tra\_Su Rubber Barrage (Crest Length L400m,)(left)

5: Can\_Chong Barrage (H28m, Crest Length 400m)(right)

*Fig.5. The South Vietnam with water constructions*

To the West is the downstream **Mekong Delta** of 39,000 km<sup>2</sup> in Vietnam territory only (5% of the whole Mekong basin). It takes a huge water amount about 500 bil.m<sup>3</sup> (more than 60% of total runoff of the country) (fig.5).

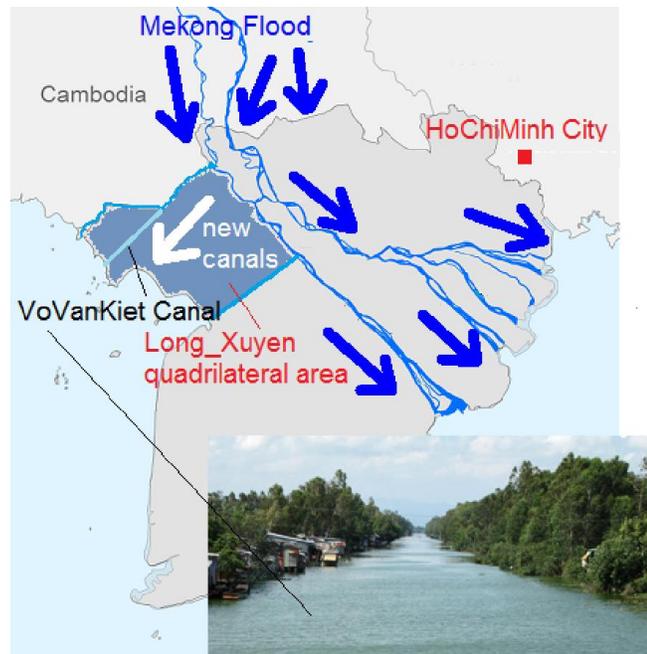
### 3. TECHNICAL ACHIEVEMENTS & SOCIO-ECONOMICAL CONTRIBUTIONS

Vietnam has a historical tradition in making water constructions. Old earth dyke systems in the Red River Basin have been built since 12<sup>nd</sup> century. First big channels were dug in the Mekong Delta 300 years ago. Some large irrigation systems composed by weirs, canals and sluices were built in the 1920s and 1930s.

- Up to now about more than 6000 pools (each of them has storage volume less than 5 mil. m<sup>3</sup>), 500 small & medium reservoirs and 30 large dams & barrages have been built. **The Dam Development** in Vietnam especially has been carried out for recent three decades. The progress has been initiated by Master Plans of the river basins, in which the most important are the Red River & the Mekong Delta. **Advanced technologies** in dam construction have been applied to *build largest dams*: Son\_La RCC Dam (138m), Ban\_Ve RCC Dam (136m), Hoa\_Binh Rockfill Dam (128m), Cua\_Dat CFRD (118m),.. mentioned above.

- **75 hydraulic systems** irrigate about 3.6 mil.ha cultivated land, protect 1 mil.ha land from salt intrusion, supply 6 bil.m<sup>3</sup> fresh water... **Hydropower plants** generate 53 GWh (43% total electric energy of the country) yearly with 13GW capacity. Dams together with dyke systems (5700km river dyke, 3000km sea dyke) in the North and canal systems in the Mekong Delta play an important role **to mitigate flood**.

Those canal systems as a dense water network irrigate the whole Delta in dry season then make flood coming rapidly to the sea. The Mekong Delta flood with 400bil.m<sup>3</sup> usually make losses of rice crop and human life. As an example, the VoVanKiet canal, one of the big flooding canals, was dug to link the Mekong River to the sea by the shortest way to reduce flood peak and effective land reclamation in



**Fig.6.** Location of the VoVanKiet flooding canal in the Mekong Delta

the Long\_Xuyen quadrilateral area 480mil.ha (fig.6). Those efforts successfully *promote the Mekong Delta* as one of the most important ‘*rice bowl*’ in the whole world.

- Really, dams & other water constructions have **great contributions to the socio-economic development** in Vietnam in general, in agricultural production and power generation in particular. 30 years ago Vietnam was in the status of food insufficient. Up to this day Vietnam is a big exporter of numerous agricultural and aquacultural products: rice, coffee, pepper, fish, shrimp,... Hydropower plants generate fully electric demands which grow up continuously. Consequently, Vietnam avoids impacts from economic crises in the region and in the world.

#### 4. TASKS & FUTURE PLANNING OF DAM DEVELOPMENT

In Vietnam, the development of dams and other water constructions in future aims at carrying out four tasks relating to water resources:

- *Firstly*, that is the **water security**. As mentioned above, 70% total runoff in the two strategic Red River Delta and Mekong Delta is generated outside the country. Water is threatened in its quantity & quality both. The situation in the Mekong Delta is much more unstable. Six riparian countries of the Mekong River mostly disagree about how to get the purpose to build a Mekong River Basin of sustainable development, sound environment, equitable benefit and happy life for all.



*Fig.7. No water flow under a bridge (above) & shoals in the Red River Delta in dry season (below)*

- *Secondly*, an essential task is the **flow regulation** between the two seasons, dry & rainy, in a monsoon country as Vietnam, especially in the condition of the climate change and water insecurity threat. This task has been partially carried out. However, it has occurred new facts.

- The *Red River* is facing big change of flow in dry season. The flow has been exhausted and the channel is lowered 3~4m than ten years ago by strong raking and erosion. Only a water limit is released from upstream reservoirs then almost nothing for



*Fig.8. Drought (above) & flood (below) are more and more serious in the Mekong Delta*

from December to March (fig.7).

It is proposed a general project to make some barrages to *improve the water level of the Red River.*

- The *Mekong Delta* is threatened by dangerous salt penetration and no fresh water in dry season due to upstream constructions and downstream sea level rising. Flood will be bigger and more prolonged (fig.8). The task is sufficient storage of fresh water in the condition of the low and plane ground surface in the Delta. It is preliminary proposed a system of sea dykes and sluices at the mouth of rivers & canals to keep fresh water inland and some nontraditional ‘*gulf embankment*’ dams to make reservoirs for fresh water storage.

- It is more and more affected by the climate change,

floods and drought occur more and more frequently and strongly in the emergent measures, it should pay Central Vietnam. Besides many much more attention to the flow regulation function of dams must be considered.

- *Thirdly*, dam development must take an important part in the **integrated management of water resources** in catchment because the water storage is the first step done In line with the expected economic development and population increase, there is a great demand for water in the catchment, and the changes in economic structure are highly relevant to water resource management. Water resource management needs to support new opportunities while avoiding undesired side effects (such as loss of conventional livelihoods in agriculture, or environmental degradation). In this connection, water use efficiency must be enhanced in all sectors, aiming at higher outputs per cubic meter of water in the short term, and higher value generated per cubic meter in the long term. It has come to conclude that water management in Vietnam is still dominated by uni-disciplinary and single issue management approaches to water. A recent Strategic Environment Access Report also states that the reservoirs planned as single purpose power generation facilities. Flood control storage and operation is not proposed in the hydropower projects. Operation procedures for flow supplementation in the dry season have not yet been prepared in these projects. Specifically, there are no guidelines for what reservoirs should release during the dry season,

or the timing of these releases. This will limit irrigation development and agricultural production since there is a high probability of water deficits. Therefore, the multiple use of water resource was not foreseen or emphasized in the project decision-making process.



*Fig.8. Pollution in the Nhue River, a distributary of the Red River in the North Vietnam*



*Fig.9. Big tide inundation in the HoChiMinh City*



*Fig.10. River bank erosion in the Mekong Delta*

Consequently, much work must focus to make a good institution for the integrated management of water resources to overcome obstacles due to a heavy and bureaucratic administration.

- *Fourthly*, it is the task to promote the **water quality and environment** which are in bad situation and declining seriously. There are *three problems* relating to the water environment:

- *Waste from industrial and urban zones* must be strictly controlled before coming to rivers. Many rivers are polluted now, particularly in dry season, when no water to carry waste away (fig.8).

- Bad phenomena occurring relating to water as inundation, erosion, sedimentation,.. must be overcome.

At present time, tidal level of the Saigon River rises every month makes deep inundation in many quarters of high density of population in the HoChiMinh City (fig.9). Various proposals including dykes and barrages have been discussing but no decision coming yet.

River bank erosion often takes place in the whole country (fig.10)

- *Ecosystem*, which changes in basin from the river source to the estuarial zone during and after dam construction, includes some improvement in one side and some deterioration on the other.

*Flow in dam downstream* including discharge value, sediment grade,..changes complicatedly. It needs much long term investigation. Erosion occurs confusedly due to

scour of clear water released by the dam, including expected vertical and horizontal erosion and new stream water surface levels. Moreover, the flow down the dam for hydropower purpose only much depends on an effective operation for energy demand. Hydroturbines won't be operated at night but fully at peaks period during the day. Water is stored even sometimes in dry season resulting in no water downstream.

*Impact of dam to environment* is a subject, which usually cause much discussion. Dams and other water constructions, which belongs human activities, always make changes of environment. It must be derived lessons from unsuccessful cases, in which *negative impacts* on the environment occur. Some ones ask the environment should have to be kept unchanged. However mankind doesn't live as before as in the prehistorical ages with wild nature and environment must be promoted for nothing else but human life. So it must pay so much effort that dams & other water constructions can create a *new, even better, ecological balance together* with anticipatedly valuable benefits in water resources regulation, such as increasing more water supply, irrigation, fishery, power generation, flood mitigation, milder climate, moderate temperature, higher evaporation, promoted ground water level in favour of cultivation and tree planting, easy fishing in reservoir. Regular flows in the dry season much improve downstream environment to protect large areas from drought, soil degradation, desertization and salinity penetration. That is good place for tourism and relaxation. It's right to say '*Environment must be for human life*'.

## CHALLENGES & CONCLUSIONS

Much work is needed to push forward the development of dams and other water constructions. It is a great contribution to the socio-economical development in Vietnam. It shows itself to be a humanistic cause. However it faces many *challenges*. It needs *much investment & innovative technologies*, which are very limited in a developing country as Vietnam. The *dam safety* is the most worried topics because more than 90% of dams in Vietnam are small & medium embankment ones, which were built by local people's handwork long time ago. Checking and rehabilitating them would take much work. Dams & water constructions are needed to regulate river flow, especially to mitigate flood, but it is hard to *choose places suitable to their sites*. *Resettlement* is more difficult than ever before because no more cultivated land for compensation. The *institution of water management* includes a lot of shortcomings. It's quite so far towards the goal of an effective integrated water management. The sector of dam technology and water management is so specific that most of staff members of management have *poor knowledge* for their work and the *public awareness* is still limited in Vietnam. Those obstacles mentioned here are considerable. Nevertheless the cause of the dam development and the promotion of water management in Vietnam is overcoming them step by step and going ahead

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