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Large dams : a challenge to balancing " benefits - costs " for the " needs " ?

I - The needs.

* Water is essential and vital to all life, humans, animals, plants and other living organisms. Water is also essential to other human activities, such as agriculture, industry, transportation, recreation..

The world's water supply is enormous, but only its 0.003% is available as fresh water for human use. If we compared the total amount of water in the world as equivalent to 100 liters, then fresh water available for human population would be only 0.003 liter, just equivalent to one-half teaspoon!

Besides, this supply is unevenly distributed over space and time. In some places on the Earth there is too little water, and in other places there is too much. Even in one area, there is too little water in dry season that creates drought; but in rainy season there is too much water that creates flood.

So that, the major water problems are: a/ **water shortages for production, especially agriculture;** b/ **periodic flooding;** c/ **lack of safe drinking water;** d/ **salinization and water logging..**

* For increasing fresh water supply people can build dams and reservoirs for capturing surface water run-off, transfer water from water-rich to water-poor areas and drill wells for ground water, but dams and reservoirs have been used since millenia for relatively large-scale storage of water (in comparison with swallow wells).

The oldest dam might be built in Ancient Egypt in 3000 BC, with a height of 15m and a length of 450 m.

Beside of these purposes, with the era of industry, since the 1800s the kinetic energy in the falling and flowing water of streams has been used for **producing electricity**.*

Hydropower occupies some 20% of the total electricity produced in the world, but 50% in developing countries, 67% in Austria, 74% in Switzerland and 95% in Norway.

According to the classification of the International Commission on Dams (ICOLD) of "large dams" (height ≥ 15 m or resrvoir volume > 1 million m3), there are about 40,000 large dams in the world and an estimated 800,000 small dams.

Global demand for water has historically increased at a rate of about 2.3% per year, doubling every 21 years, but supply can no longer keep up with this rate of growth. By the year 2025, some 34 countries will be below the 1,000 m3 threshold of annual renewable fresh water available per person per year. Thus, it may be possibly that dams and reservoirs would not be built mainly for energy generation, but also for supplying water.

- Viet nam is not rich in water resources, with an annual average run-off of 880 km3, but with an annual average internal renewable water of 376 km3, which is equivalent to 5,040 m3/per cap. The average figure of 27 selected countries in Asia and the Pacific is 4,410 m3/per cap.

The three biggest users of water in Vietnam are the agriculture, industry and domestic sectors, occupying 78%, 9% and 13% of the total fresh water withdrawals respectively.

It is estimated that, with the annual growth rate of 5%, by the year 2030 the total demand for water will be only 25% of the water withdrawals, but because of the very uneven distribution of rainfalls, **water shortage and saline intrusion** will be more serious in dry season. About 70-75% of precipitation is concentrated in 3 or 4 months of the rainy season, in which the maximum amount reaches 20-30% in 1 month. On the other hand, **floods** still are the permanent threat to production and human life (see Tab. 1).

Concerning electricity, Vietnam is among the lowest consumers on a per capita basis (only around 200 kWh per year, in 1995). Since 1981 the annual consumption growth rate has been about 9%. It is expected that instalment capacity will double in the coming 15 years. **Hydropower** occupies a large part of the total production of electricity. The figures of the year 1995 were: total production – 14,867 million kWh, in which hydroelectricity --- 12,342 million kWh, occupying 83% of the total (*Source: World Resources 1998-99*). Hydropower will continue to have an important role in satisfying the demand for electricity, because the actual production still is much lower than the potential capacity of hydropower of the country.

Table 1 : Damages caused by floods and typhoons (1971-1994)

Year	Total Damages ($ million)	Death	Inundated Rice Field (km2)	Lost Harvest (1000 t)	Destroyed House (1000)
1971	78	594	na	288	158
1973	57	138	na	400	18
1977	5	153	928	222	163
1978	20	676	12,976	1,343	652
1980	10	403	27,783	324	225
1983	19	818	3,932	186	357
1984	na	464	4,174	na	282
1985	na	1,013	5,304	na	344
1986	110	797	3,543	1,097	787
1987	28	120	1,332	166	242
1988	35	292	1,429	169	284
1989	74	494	6,428	805	1,290
1990	17	354	1,722	169	220
1991	44	480	2,019	na	398

1992	62	352	na	na	277
1993	82	387	2,300	na	257
1994	260	507	5,739	1,000	634

(Source : Vietnam: Water Sector Review:WB, ADB, FAO, UNDP,1996)

Multipurpose water reservoirs still are a need for Vietnam in the coming period for meeting the demand in various sectors, and Vietnam has also to make the best use of the potential capacity of its water resources.

But, drawing lesson from the past in analyzing the main benefits and damages/costs of water reservoir is also of most interest and necessity. Let us take as an example the case of Hoa Binh hydropower plant, which is so far the largest one in Vietnam.

The building of this plant has lasted 15 years from the commencement to the completion (1979-1994) and there was no EIA prior to the design and the construction stages. Studies on EIA have been carried out mainly since the beginning of the 1980s. There was neither EIA of the Thac ba hydropower plant, which is smaller, but earlier-built one.

Some characteristics of Hoa Binh reservoir :

- Surface of the **reservoir F**=200 km2
  Length **L**=230 km
  Average width **B**=1 km
  Average depth **H**=50 m
  Volume **V**=8.5 billion m3
- Capacity **P**=1,920 MW

Average annual production of electricity **E**=8 billion KWh

II- The Benefits.

1- Water supply for Production, especially Agricultural Production, and Domestic Use.

- Water reservoir allows people to collect fresh surface water during rainy season and storing it for use in dry season, providing a controllable supply of water for irrigating lands, industrial and domestic uses in downstream areas.

- In Vietnam, the economy still depends on agriculture which is largely based on wet rice cultivation.

Water demand for the spring rice crop is 5,500-6,200 m3/ha, for the autumn rice is 5,500-6,000 m3/ha. Increased irrigated areas in these last years have been helping raising notably agricultural production.

Dau Tieng Reservoir with the capacity of 1.5 billion m3 is providing water for irrigation to more than 135,000 ha.

To deal with water shortage in dry season, Thac ba Reservoir (V= 3.6 billion m3) releases a water flow of 160m3/sec, Hoa Binh Reservoir (V= 9.5 billion m3) ---- 240 m3/sec

2- Electricity generation.

- Hydropower is cheap. Looking back at the history, one can see that almost all developed countries have been making the maximum use of their hydropower potential.

For example, France built the first hydropower plant in 1880. In 1994 hydropower production reached 80 TWh, exceeding the economic hydropower potential of the country which is 72 TWh (Tab. 2).

Table 2: Electricity Production in France (in TWh)

Year	Total	Hydropower	Hydro%of Total
1938	20.7	10.3	49.7
1950	33.2	16.2	48.8
1960	72.3	40.5	56
1970	140.7	56.6	40
1975	178.5	59.8	33.5
1980	245.8	69.8	28.4
1985	265.1	63.4	23.9
1990	399.5	57	14.3
1991	433.3	60.9	14.1
1992	441.4	71.6	16.2
1993	450.6	67.6	15
1994	454	80	17.6
1995	471.4	75.8	16.1

- In Vietnam, since 1981 the annual growth rate of electricity consumption is of 5%,hydropower occupying 75% of the total electricity production.

Some major hydropower plants are: Thac ba (108 MW), Da nhim (160 MW), Tri an (420 MW) and Hoa Binh (1920 MW). The latest is presently a largest one. It alone is producing in average 7-8 billion kWh per year. These plants are playing very important role in supporting the economic development of the country. Besides, hydropower provides an alternative to the conventional thermoelectricity, avoiding the burning of fossil fuels and reducing significantly air pollution.

7 new hydropower plants have been planned with the total instalment capacity of 3,000 MW.

3-Flood control

Because Hoa Binh Reservoir has a greater and greater effect on downstream flow, during floods season in the period 1987-1997, it has positive impacts by regulating water levels in downstream areas. For ex., with major raising floods, it reduced water level in Hanoi by 2m max.

4- Improvement of microclimate

With its big volume of water and large surface, reservoir can help to regulate climate in surrounding areas. In the case of Hoa binh reservoir, observations are showing that the air temperature in these areas are a bit lower in summer and higher in winter, compared to that was before the formation of the reservoir.

5- Improvement of fluvial navigation. Opportunity for recreation and tourism

Water reservoir creates opportunity for improving fluvial navigation by overcoming obstacles (for ex. water falls), therefore makes the former river more navigable. Hoa Binh reservoir is 230 km long and gives access to new sites, inaccessible in the past (landscapes, caves..). The tourism company there is receiving an increasing number of visitors every year. Tourism has also been developed in other reservoirs, such as Dau tieng, Tri an, Thac ba..

III-The negative impacts/costs

1- Inundated areas and the resettlement of the local people.

It is usually the heaviest environmental and social impacts of the dam.
In the case of Hoa Binh reservoir :

- Inundated areas : 19,800 ha, in which 2,700 ha of rice field, 2,400 ha of crop land.
- Resettlement : 8,000 households with 51,600 people.

(Source : Institute of Energy- Ministry of Industry)

Or : 10 ha/MW (inundated areas) and 27 people/MW (resettlement).

- The compensation and resettlement process has lasted from 1981 to 1994 with big efforts of the government and the local population. There were many problems, such as : disruption of traditional agriculture practices, some households have had to move many times, difficulties in stabilization of resettled people in new localities and its affects on those present there, shortage of water in some areas, threat to remaining forests near the resttlement sites .Not all resettled people have the opportunity to enjoy electricity from Hoa Binh reservoir, although for which they had been relocated, etc..The government has taken later measures for remedying the situation. Drawing lesson from Hoa Binh reservoir, EIA has been carried out for other reservoirs, for ex. Tri an (by Vietnamese institutions), Yali (by foreign consultancy firm), and now the on-going study for a new and much larger dam in Son la.

2- Hydrologic Impacts

- Scouring of riverbed below dam (for Hoa Binh reservoir, 30-40- km below the dam) and siltation in other sections.

- Suspended particles carried from upstream (especially when deforestation is continued in river watershed) by river flow settle in the reservoir, therefore limiting its storage capacity and shortening its lifespan. According to survey data, average annual siltation in the Hoa binh reservoir has reached 60 million m3 (1990-1995), but in 1990 and 1991 the figures were 90 million m3. Compared to the design, siltation speed has just doubled.

3- Ecological Impacts

- Deforestation in watershed areas are becoming a real threat, not only to biodiversity, but also to the lifetime and the normal and sustainable function of the reservoir itself.

Local inhabitants and newly relocated people are logging and burning forests for their survival. Such practice engenders also forest fires, exacerbating the situation. It is reported that during the period from 1985 to 1989, there were around 200 forest fires per year, damaging thousands of hectares.

- Loss and fragmentation of habitats have been causing deterioration of species and populations. (see Tab.3).

Table 3: Number of species in Hoa Binh reservoir watershed

	(Period 1960-1973) Before the formation of the reservoir	(Period 1990-1992) After the formation of the reservoir
Bird	183	91
Mammal	70	52
Fish	80	21

(Source: Proceedings of the Workshop on EIA of Hoa Binh Reservoir, Hanoi, Dec. 1998)

4- Other Impacts

The decomposition of organic matter on the flooded lands, on one hand creates a nutrient-rich environment supporting an active reservoir fishery, but on the other hand stimulates the growth of aquatic weeds which can clog dam outflows and irrigation canals, negatively affect fisheries and recreation, increase water treatment costs.

- Changes in nutrient levels and decrease of the river water quality can have major impacts on the productivity of estuaries

- Increase in humidity and fog locally creates favourable conditions for insect disease vectors and leads to the increase of water-related diseases, especially malaria.

- Possible disruption of indigenous groups.

IV - The Challenges to balancing "Benefits-Costs" for "Needs"

1. Every country has to make the best use of its water resources. Relating to large dams/reservoirs, major needs are: energy, irrigation, water supply, flood control and regional development.

   Needs are imperative. Every need is satisfied with a cost. One **has to regulate the needs rationally in order to satisfy basic needs while having to pay less.**

   Comprehensive policies, technologies and good management could help to save energy and water for production and domestic uses.

   Reforestation policies, protection of forests and promotion of sustainable agriculture could help to mitigate floods.

2. Concerning **Benefits** and **Costs**, it is evident that people is always trying to **maximize the benefits** and to **minimize** the **costs**. The wording is good and simple, but the realisation is much more difficult.

   Major dam/reservoir is not only large in size, but its benefits and costs are also externalized over space and time.

   Comprehensive development policy; intersectoral co-ordination, integration of economic, social and environmental issues in planning process; methodologies, tools and supporting facilities for making costs-benefits analysis; following strictly EIA procedures; strong management during the implementation process could be helpful to balance Benefits and Costs.

3. For all mentioned above, deep awareness and strong political will among decision makers and managers, effective contribution scientists and experts, sensibilization of the population (including private sector) are crucial.

V - On-Going Study in Vietnam: The Son la Large Dam

(*Source: Proceedings of the Workshop on Methodologies for EIA of Development Projects, Hanoi, July, 1999).*

1. <u>Some characteristics</u> (Option 1 : higher dam)

- Normal water level: 265 m
- Dam height : 177 m
- Volume of reservoir : 25.4 billion m3

- Surface of reservoir : 440 km2
- Installment capacity : 3.600 MW

2. Positive Effects of Son la Dam

- Energy production : 14.16 billion KWh/year
- Regulation flood stream : very important for Hoa binh Dam and downstream areas, including Hanoi (ensuring water level in Hanoi during flood season not to exceed 13 m).
- Water supply : providing to the Red River Delta about 6 billion m3; during dry season will ensuring a sanitary run-off of 300-600m3/sec
- Creating new opportunities for regional socio-economic development.

3. Negative Impacts of Son la Dam

    - Inundated areas : 40,500 ha, in which 9,650 ha are agriculture land, 3,900 forestry land.
    - People to be resettled: 95,600
    - Loss of infrastructures: houses (1,600,00 m2), roads (300km)
    - Loss of biodiversity : some increase in aquatic populations and deterioration of other, but most important would be the potential exploitation of bioresources near new resettlement sites.
    - Serious changes in dowstream areas
    - Loss of mineral resources : not serious
    - Some geological problems needs further study: potential loss of water stability of the dam.