

5. Water Resources Demand and Allocation Associated with Human Survival and Food Production, and the Role of Agro-Environment Education in Vietnam

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1. Introduction

Vietnam is located in the tropical monsoon of Southeast Asia. The total area of Vietnam measures approximately 333,000 km² with 62 provinces in seven officially declared socio-economic zones. The seven zones are the Northern Mountain and Midlands (NMM), Red River Delta (RRD), North Central Coast (NCC), South Central Coast (SCC), Central Highlands (CH), Southeast (SE) and Mekong River Delta (MRD). The total population of Vietnam is about 79.93 million people in 2002.

Mean annual rainfall ranges from 1,700 mm in the north to 2,000 mm in the south. The temperature ranges from 13° to 35° C, which is favorable for agricultural production, especially paddy rice cultivation.

2. Major river basins

In Vietnam, there are 16 river basins larger than 2,000 km², 10 of which have catchments areas of over 10,000 km² (Figure 1.) and mean annual discharge ranging from 9-520 BCM. These 10 river basins represent 80 percent of the country's area, 70 percent of its water resources and more than 80 percent of the total population; activities in these areas contributed more than 80 percent of GDP.

i) Ky Cung river-Bang river system

The river system consists of 16 rivers. The catchment's area of which varies from 116 - 6660 km². The average annual rainfall is 1000- 2000 mm. The average annual flow is 9.0 BCM of which 7.3 BCM is born in Vietnam and 1.7 BCM flowing from China. The annual flow of river Ky Cung - river Bang system accounts for around 1%

Table 1 Vietnam Socio-Economic Regions (1998)

Regions	Land (1000 ha)				Population (1000 pers.)
	Total	Agricultural	Forestry	Aquaculture surface	
Whole country	32894.3	8080.2	11985.3	336.5	76327.9
NM	10318.6	1200.3	3402.6	32.8	13088.3
RRD	1266.3	671.8	80.9	48.7	14800.1
NCC	5130.4	675.9	2122.2	15.6	10007.2
SCC	3301.6	446.8	1397.6	11.9	6525.9
CH	4464.5	737.0	2755.1	1.8	3062.2
SE	4447.6	1644.4	1918.3	17.5	12710.9
MRD	3965.3	2704	308.6	208.2	16133.3

Source: GSO, 1999; 2000

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of the total flow of all rivers in Vietnam

ii) Red river - Thai binh river system

The river system consists of 32 rivers. The catchment's area of which varies from 287 - 155000 km². The average annual rainfall is around 1100 - 4000 mm. The average annual flow is 136 BCM accounting for 16% of the

annual flow of all rivers in Vietnam. The flow from China and Lao is 45 BCM, occupies 33%. The flow originated within Vietnam territory is 91 BCM, occupies 67% of total flow.

iii) River system in North Central Region

The river system consists of 21 rivers, the catchment's area of which varies from 617 - 28400 km². The average annual rainfall is 1400 - 3000 mm. The average annual flow amount volume is 84.5 BCM of which the flow amount volume from Lao is around 10 BCM.

Ma river basin

The Ma basin, located in the north-central Vietnam and borders with Laos, covers an area of 24,400 km². 63% of the basin area lies in Vietnam. Mean annual discharge is 20 BCM, occupies 2.3% of total VN flow.

Ca river basin

As in the Ca river, Ma river, located in north central Vietnam, flows from Laos. Mean annual discharge is 24.2 BCM, occupies 2.7% of total VN flow.

iv) River system in South Central Region (South Central Coast and Central High Land)

The river system consists of 19 rivers. The catchment's area of which varies from 511 - 13900 km². The average annual rainfall in the coastal zone is 600 - 800 mm and is 3000 - 5000 mm in the Western part of Quang Nam, Quang Ngai provinces. The average annual flow is 64.7

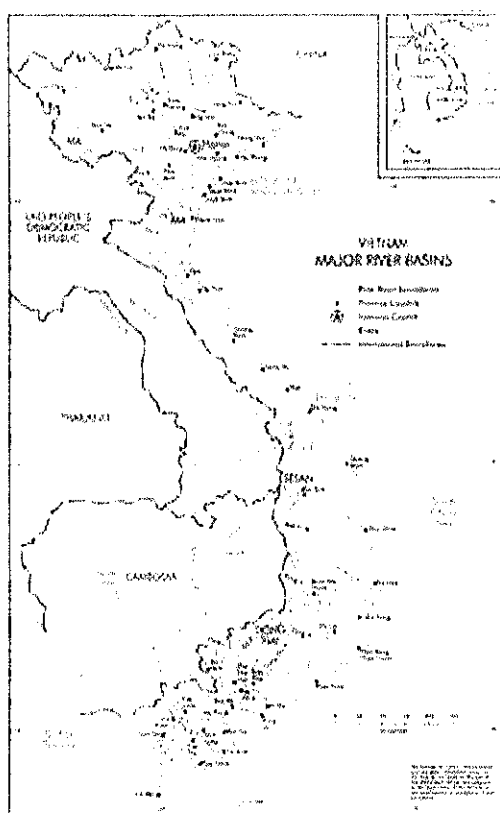


Fig. 1 Vietnam major river basins

Table 2 Catchments Area and Discharge of Major River Basins

River basin	Catchments Area (km ²)			Mean Annual Discharge (bcm)		
	Total	In VN	%	Total	% VN/Flow	% Flow/In VN
Bang-Ky Cung	12,880	11,220	87	8.9	1.0	81
Red/Thai Binh	169,000	86,660	51	137.0	15.6	68
Ma	28,490	17,810	63	20.1	2.3	78
Ca	27,200	17,730	65	24.2	2.7	80
Thu Bon	10,496	10,496	100	19.3	2.2	100
Ba	13,900	13,900	100	10.4	1.2	100
Dong Nai	42,655	36,261	85	30.6	3.5	95
Mekong(Total)	795,000	72,000	9	520.6	59.2	10
- Delta	ns	(39,000)	ns	ns	ns	ns
- Srepok	ns	(18,200)	ns	ns	ns	ns
- Sesan	ns	(14,800)	ns	ns	ns	ns
Others	ns	ns	ns	108.0	12.3	100
Total	ns	ns	ns	879.0	100.0	40

Source: WB, 1996

BCM accounting for 7.6% of the total annual flow amount volume of all rivers in Vietnam.

Thu Bon river basin

Thu Bon river is contained entirely in Vietnam. It originates in the high plateaus of central Vietnam. Mean annual discharge is 19.3 BCM, occupies 2.2% of total VN flow.

Srepok river basin

The Srepok River, which originates in the southern highlands of Vietnam and flows into Cambodia, is one of the main tributaries of the Mekong River. The climate is of monsoon and bi-seasonal nature. Rainfall ranges from 1400-2200 mm. Flows vary greatly within a year.

Ba river basin

The Ba River is contained entirely in Vietnam, south of Thu Bon. It originates in the high plateaus of central Vietnam. Mean annual discharge is 10.2 BCM, occupies 1.2% of total VN flow.

v) Dong Nai River System

The river system consists of 41 rivers. The catchment's area of which varies from 206 - 44100 km². The average annual rainfall is 1400 - 1700 mm. The average annual flow amount volume is 36.3 BCM accounting for 4.3% of the annual flow amount volume of all rivers in Vietnam. The flow from Campuchia is 3.5 BCM, meanwhile the flow originated within Vietnam territory is 32.8 BCM.

vi) MeKong River System

Me Kong River's catchment's area is 795000 km², of which the catchment's area in Vietnam accounts for 8.6% of total catchment's of Me Kong River. The Mekong River consists of 47 rivers. The catchment's area of which varies

from 150 -30100 km². The average annual flow amount volume is 500 BCM accounting for 59% of the annual flow amount volume of all rivers in Vietnam. The annual flow originated within Vietnam is 23 BCM. The annual flow from outside Vietnam is 478 BCM.

3. Water Resources

In Vietnam, water resources are defined to consist of rainwater, surface water and ground water within its territory. The water resources in Vietnam is estimated relatively rich. However, the rain water and ground water significantly changes in time and in space. Approximately 70 - 80% of annual flow concentrates in 3-4 rainy months, and the remaining flow in 6-7 dry months.

Surface Water Resources

Vietnam annual average annual rainfall is 650 BCM, mean annual flow totals 880 BCM and the mean annual flow at 75% probability is 720 BCM (Table 2, Table 3).

This large annual water flow makes the water availability in term of total annual runoff in Vietnam is about 12 thousand m³/capita, approximately 6 times higher than China (Fig. 2).

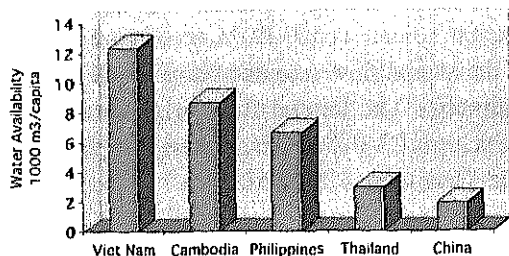
Groundwater Resource

The natural dynamic capacity of ground water is estimated around 2000 m³/s. Vietnam's hydro-geological formations are unconsolidated, carbonate and basaltic. Unconsolidated, carbonate and basaltic. Preliminary investigations estimate these reserves contain a total of 48 BCM, and the exploitable groundwater is estimated at about 6-7 BCM a year. Only 15 percent of exploitable groundwater reserves have been tapped because surface water has generally been

Table 3 Total Runoff at 75% Probability by Region (BCM)

Region	From VN	Outside VN	Total	%
North mountain/midland	79.3	2.9	82.3	11.5
Red river plain	5.3	10.7	16	2
North central	51	7.4	58.4	8.2
South central coasts	27.9	0	27.9	3.9
Central highlands	43.2	0	43.2	6
South east	12.1	10.8	22.9	3.2
Mekong delta	15.5	450	165.5	65
Total	234.3	481.9	716.2	100

Source: WB, 1996



Source: WB, 1996.

Fig. 2 Cross Country Comparison of Theoretical Water Availability

plentiful and inexpensive most of the year.

4. Water Use and Demand

Reports from UNDP, UNEP, WB, WRI,

show that Vietnam is in the 6th place among 20 largest water users in the world. Off-stream withdrawals support agriculture, industry and domestic consumption while in-stream water is used mainly by fisheries and for navigational, hydropower generation and waste assimilation purposes.

Agricultural sector is the largest water user, using 75 to 90% of the total water volume used in Vietnam. In 1990, the agricultural sector, including cultivation, aquaculture and animal husbandry, used approximately 60 BCM of water, accounting for around 90% of the total water amount volume used in Vietnam. In 2010 it will use approximately 90 BCM, accounting for around 75% of total water use. Industrial and service water use has increased from 3 BCM, occu-

Table 4 Water demand forecast (MCM)

Region	Domestic		Industry	Service	Agricultural			Total
	Rural	Urban			Cultivation	Aquaculture	Animal husbandry	
1990								
NM	128.6	20.2	233.5	97.9	8563	12.6	148.8	9205
RRD	226.6	61.3	222.5	249.6	9828	56.4	93.4	10837
NCC	146.6	22.5	119.0	85.0	8215	75.0	221.0	8884
SCC	94.6	42.5	137.8	63.5	7566	58.0	81.6	8044
CH	53.4	14.3	19.9	9.0	1439	341	27.7	1905
SE	68.0	224.0	604.0	333.0	1499	61.2	73.6	2863
MRD	178.0	60.0	465.0	107.0	20968	1132.0	198.0	23107
Total	879	445	1803	946	58078	1736	845	64845
	1324		2749		60659			64845
2000								
NM	241.1	110.6	474.0	347.6	11804	311.7	199.5	13485
RRD	352.5	161.5	849.0	753.0	10953	578.0	102.5	13749
NCC	218.0	22.5	119.0	85.0	9562	76.0	221.0	8884
SCC	112.1	67.9	504.2	178.1	10380	101.6	143.0	11487
CH	32.2	14.3	50.39	31.8	4111.0	501.2	42.1	4790
SE	90.6	361.0	3090	1074	2761.0	61.1	109.5	7551
MRD	217.0	83.0	769.0	564.0	27193	1230.0	274.0	30327
Total	1263	860	6023	3034	76764	2860	1202	92116
	2123		9057		80826			92116
2010								
NM	256.3	258.2	1376	1265	13162	300.6	306.3	16975
RRD	311.6	310.2	3521	3296	11582	578.0	201.4	19800
NCC	327.6	210.6	967.7	811.0	11804	79.2	443.9	14434
SCC	148.9	103.3	2279.3	827	11842	142.5	200.6	15544
CH	40.30	29.94	107.68	75.9	8520	504.7	68.2	9347
SE	136.0	547.0	6836	2567	4332.0	101.3	176.6	11798
MRD	237.3	131.0	2240.0	1910.0	27650	1184.0	323.0	33584
Total	1458	1590	17328	10752	88892	2890	1720	121500
	3048		280280		93503			121500

Source: IWRPM, 1996

pied 4%, in 1990 to 28 BCM, occupied 23% in 2010. Domestic water use has increased from 1.3 BCM, occupied 2%, in 1990 to 3 BCM, occupied 2.5% of total water used in 2010 (Table 4)

5. Degradation of water resources

Deforestation causes the increase of the water peak flow and reduces low flow. As a result, flood, drought, soil erosion, land slide and reservoir sedimentation occur.

Urbanization: The level of urbanization has been increased rapidly. In 1954, the capital Ha Noi had the population of 250,000 people within the urban area of 1,200 hectares. In 1990, the population of Hanoi increased over 1 million people within the urban area of 4,300 hectares. In 1954, the population of Ho Chi Minh City, was only 400,000 people within the urban area, by 1990 the population was over 3.5 million people.

Agricultural production: Due to the objective of increasing food production, the cultivation has been using so much the fertilizer and pesticide that leads to the contamination of surrounding water bodies. The inappropriate farming system causes soil erosion and degradation. The excessive irrigation increases the water loss and water logging

The over-exploitation of ground water has caused the settlement of the ground surface and salt intrusion into aquifers in the coastal delta.

Water pollution: Vietnam suffers from several problems with regard to the quality of surface water, with biological contamination, salinity, and sedimentation being the three major ones.

The biological contamination of surface water in the urban sector has become the most serious water related environmental problem in Vietnam. The problem arises from an increase in sewage and drainage flows from areas of rapid urban and population growth, which has not been matched by increases in the capacity of sewerage/drainage systems. The lack of sewerage treatment has led to wastewater being discharged directly into rivers.

The pollution of water in cities and industrial zones of Vietnam has been in alarm situation. Most of the surface water (ponds, lakes, rivers, ..etc) is directly receiving the waste water without any treatment. Thus, the high concentration of

the pollution substances, such as: VSS (volatile solid substance), BOD (bio-oxidized demand), COD (chemical oxidized demand), $-\text{NO}_2$, $-\text{NO}_3$, ..etc. are 5 times to 20 times higher than permissible level.

Salinity intrusion along the coast the low-flow season is the main water quality problem in the south, affecting irrigation (damaging crops), and rural water supply. In the Mekong Delta, the area affected by salinity is expected to increase from 1.7 million to 2.2 million hectares, if preventive measures are not taken.

6. Localized water shortage

Vietnam would seem to have an advantageous water situation, given the extensive network of rivers, favorable topography and rainfall patterns and in relation to its population size. However, Vietnam lies downstream for most of the Mekong, Red, Ma, Ca, and Dong Nai Rivers, thus, the availability of water, especially during the dry season when the upstream countries withdraw large amounts, is often beyond Vietnam's control. The amount is also limited because of degraded and inadequate storage capacity. As a result, the country is experiencing wider localized and seasonal water shortages, particularly as demand increases.

The problem of water shortages centers largely around irrigation. While the climate in most regions favors year-round paddy cultivation, irrigation is required during seven to eight months of the year due to an uneven distribution of rainfall. Rapid population growth creates pressures for higher agriculture production, which has been achieved by intensifying cultivation through developing more irrigation schemes. The demand for water at the end of the dry season unfortunately coincides at the same time as the minimum monthly flows in the rivers. Conflicts in water demand have been intensified by the need to maintain adequate flows during the dry season for navigational purposes, to maintain in stream quality (chiefly to prevent saline water intrusion), and to support fisheries (typical in the Mekong delta).

Drinking water shortages can be looked from two aspects: (i) lack of provision of water supply; and (ii) lack of supply of satisfactory water quality. While the first kind of problem is

critical in the remote areas of Bang Ky – cung, Se San/Srepok basins, the second kind is more urgent due to human health impact of water quality. The problem of safe drinking water is especially a major concern in Ho Chi Minh city, DaNang, the rural areas of the Mekong delta, given the large number of population affected.

Water demand forecast shows that the total demand for water will reach more than 121 BCM in 2010. By 2040, the water demand will be 260 BCM, accounting for 34% of the total water flow in Vietnam at 75% of probability.

Considering water demand and water availability, by 2040, some regions of Vietnam will be under the average - high water shortage pressure (the ration of total water use to total available water ranging from 20-40%), by WMO and UNESCO classifications, especially in the dry season (Pho et al, 2003). Considering the water contamination, Vietnam will face with more acute water shortage pressure in the near future.

7. Water allocation and poverty

In Vietnam, the rate of poor households (according to the international standard) has decreased dramatically from 51% in the early 1990s to 37% in 1997-1998 (Table 5).

Recent data shows that 61% of Vietnam's population is engaged in agriculture and that people in agriculture account for 79% of the nation's poor (GSO 1999). As a rice-based production country, land and irrigation are the two most important factors effecting farm production in rural Vietnam. Cropping intensity in the irrigated

land is 5.4 times higher than in rain-fed areas (Svendsen, 1995). Many studies have pointed out a very close correlation between farm size, irrigated area, and farmer welfare status within the country. Generally, the more well off is a group, the larger are their landholdings and irrigated land areas (World Bank, 1995).

Rural poverty is associated with mono-culture practices and low yields due to a lack of water resources and water control infrastructures. Lack of safe water supplies and irrigation were the biggest issues related to the poor (MOLISA, 2000)

8. The Role of Agro-environmental Education in Vietnam

At present there work 331 thousand staff members in agricultural and rural development, of which in agriculture-211 thousands, forestry-80 thousands and water resources-40 thousands.

In Vietnam agriculture and rural development is taught in approximately 70 universities, colleges, and technical schools. These institutions are mainly under the ministry of agricultural and rural development and ministry of education and training

Under Ministry of Agriculture and Rural Development alone there are 37 educational organizations, of which 2 are for card training, 2 universities, 2 colleges and the remaining 31 are technical schools. In 2002 approximately 230 postgraduate students, 1800 graduate students, 7500 students of technical schools and 11300 workers of trade-schools, under MARD, gradu-

Table 5 Poverty incidence by regions in Vietnam (1993-1998)

Regions	% of poor of the total population		% of the poor of total population		Population of 1998	
	1993	1998	1993	1998	Million	%
1. Northern mountain	21	28	79	59	13.5	18
2. Red River Delta	23	15	63	29	14.9	20
3. North of central part	16	18	75	48	10.5	14
4. Central sea coastal	10	10	50	35	8.1	11
5. The Highland	4	5	70	52	2.8	4
6. East of the South	7	3	33	8	9.7	13
7. Mekong Delta	18	21	47	37	16.3	21
National	100.0	100.0	58	37	75.8	100

Note: Poverty level = Expenditure per capita in 1993 is VND 1.2 million (US\$83)/person/year. In 1998, it is VND 1.8 million (US\$128)/person/year

Source: (World Bank 1999)

ated.

Human resources training for agriculture and rural development is also conducted by various research institutes, and experimentation stations. Taking VIWRR, for example, around 30 staff are trained as post graduate students annually of which 15 are trained at VIWRR.

Facing with the emerging water shortage and natural resources degradation, the agricultural environment management is an urgent matter in Vietnam. Thus, the human resources training for this field has played an important role in the development, in which, the community and gender issue training has to be considered and is essential to improve their knowledge and understanding on water resources demand and the agro-environment.

Vietnam is trying to increase the human resources training in this field through the training programs in the international cooperation such by-lateral, multilateral, fellowship program.

9. Conclusion

Despite its abundant water resources, looking into the future, the development pressure will make the problem of water shortages in Vietnam more critical. Development additional storage facilities, improving basin planning, and developing groundwater as an alternate source are recommended so that new supplies cannot match the demand.

Being an agricultural country relies heavily on cultivation; rural poverty in Vietnam is associated with mono-culture practices and low yields due to a lack of water resources and water control infrastructures. Lack of safe water supplies and irrigation were the biggest issues related to the poor. Improving water supply to the poor would be a measure for poverty reduction in Vietnam.

Facing with the emerging water shortage and natural resources degradation, the agricultural environment management is an urgent matter in Vietnam. Thus, the human resources training for this field has played an important role in the development. Vietnam are trying to increase the human resources training in this field through the training programs in the international cooperation such by-lateral, multilateral, fellowship program.

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VIETNAM: DISCUSSION

Question: Will the government hire all the technical graduates?

Answer: The government will hire most of the graduates, some of them can find a job in the private sector

Question: What is the land ownership status by the farmers?

Answer: The government owns the land. The farmers can get a land use right for a period of 25-50 years. The right is renewable.

Question: What are the government policies to reduce the poverty?

Answer: Various policies and national target program have been implemented. Below are major ones:

Poverty reduction strategy 2001-2010:
Reducing poverty households, no re-poverty, and active participation in completion of national target: rich citizen; strong nation; justice, democracy, civilization society. Better access by the poor to social basic services.

National target programme on HEPR and employment for the period 2001-2005:

Reducing poverty households, no-re-poverty
Supportive policies in medical care:
 Improving health care services for the poor
Supportive policies on education: To
 improve education and training for the poor
**Supportive policies for especially difficult
 ethnic minority people:**

Question: What are the causes of over exploitation of G.W?

Answer: In big cities such as Hanoi: for domestic and industrial uses. For central high land: for cash crop, such as coffee, irrigation.

Question: Of the 40%, which has no access to clean water, how do they get the drinking water?

Answer: They derive water from rainwater, pond, lake and river

Question: Could you please discuss flood information in your country?

Answer: Typhoons and floods cause massive damage and loss of life every year. The problem is particularly serious in the densely populated

Red River and Mekong Deltas

Question: Have you considered water allocation for environmental and ecology? What is the percentage in comparison to the water demand?

Answer: In Vietnam, public awareness on water allocation for environmental and ecology is in the first stage and water allocation is considered mainly for salinity intrusion and environment protection. To my knowledge we still do not have the data, as to how much water is required for environment and ecology.

Question: How do you identify the poor people?

Answer: The poor is identified using various poverty lines. The official Vietnamese poverty line for the mountainous and coastal areas is below 80,000 VND per capita monthly income; for the lowland rural areas – below 100,000 VND, for the urban areas – 150,000 VND. However international donors use other poverty line, for Vietnam, such as cited in my report.

Table. Flooding and typhoon losses, 1971-1994 (WB, 1996)

Year	value of losses	deaths	rice field submerged	lost production	houses damaged
	US\$m		km ²	1000 ton	1000
1971	78	594	na	288	158
1973	57	138	na	400	18
1977	5	153	928	222	163
1978	20	676	12976	1343	652
1980	10	403	27783	324	225
1983	19	818	3932	186	357
1984	na	464	4174	na	282
1985	na	1013	5304	na	344
1986	110	797	3543	1079	787
1987	28	120	1332	166	242
1988	35	292	1429	169	284
1989	74	484	6428	805	1290
1990	17	354	1722	169	220
1991	44	480	2019	na	398
1992	62	352	na	na	277
1993	82	387	2300	na	257
1994	260	507	5739	1000	634

Flood is one of major causes of poverty in Vietnam.