Salt Water Intrusion in the Mekong Delta: Its Impact on Vietnamese Rural Coastal Communities

T. D. Thang[1], N.P. Dan[2] and C. Visvanathan[1]

1 Urban Environmental Engineering Program, Asian Institute of Technology, Bangkok, Thailand

2 Centre for Environment Technology & Management, National University of Ho Chi Minh City, HCMC, Vietnam

Rural communities along the 3,200 km coastline of Vietnam generally have severe water quality and quantity problems. Whilst traditionally, these coastal communities were dependant on water obtained from dry wells, boreholes with hand pumps, rainwater harvesting and surface water, the increase in population density coupled with improper water resource management has resulted in the majority of these sources being contaminated with high total dissolved solids (TDS), elevated iron content and organic pollution.

These adverse water conditions have resulted in many communities relying on rainwater harvesting. However, as this source is often both insufficient and erratic, communities are forced to purchase water from neighbouring communities. The water usage in Vietnamese rural areas was investigated in an extensive field study of the Can Gio and Go Cong Dong districts of southern Vietnam. This article summarizes the major observations and possible future strategies for the long-term sustainability of potable water production in the rural coastal communities of Vietnam.

Figure 1: The Mekong Delta Region of Southern Vietnam

The Can Gio district, a suburb of Ho Chi Minh City, lies in the catchment area of the Nha Be River. This region spans 73,360 ha, 32 % of which are rivers and canals and the remaining land occupied by agriculture, aquaculture and mangrove forests. The district of Go Cong Dong, Tien Giang Province, is surrounded by the Cua Dai, Cua Tieu and Soai Rap River estuaries, which form part of the Mekong Delta. In both these areas, more than 80 % of the population live in rural coastal communities with the primary occupation being agriculture and aquaculture.

Available water sources in these areas are derived from ground water, rainwater harvesting and surface water. None of these can supply sufficient water throughout the year mainly due to high salinity concentrations. Fresh water shortage is a severe problem, especially during dry season. Thus, it is common to have a combination of these water sources in each rural household.

Sand dunes scattered along coastal areas are typical sources of rainwater that percolates and is stored in the dunes. Generally, this water source has low TDS (< 1 g/L) and thus utilized by rural coastal communities. Of late however, salt-water intrusion in these sources during the dry season has indicated elevated salt content of 6 g/L in Can Gio and thus rendered this source unusable. Possible reasons for this may be due to overexploitation or the shifting and erosion of sand dunes.

Moreover, the Can Gio and Go Cong Dong districts these are low-lying areas with extensive river and canal systems that are affected by semi-diurnal tide resulting in high salinity in all surface water sources. An analysis of surface water revealed that salinity decreased inland from 19 to 4.6 g/L over 40 km and from 11.3 to 2 g/L over 30 km in the Can Gio and Go Cong Dong regions, respectively. Hence, due to the highly saline nature of surface water, this source has been deemed unsuitable for household use.

Groundwater is generally a favoured water source for rural households in Vietnam. However, exploitation of groundwater in coastal areas is hindered due to high salinity in all aquifers. The Division of Hydrogeology and Engineering Geology reported that the TDS of the aquifers in Can Gio and Go Cong Dong ranged from 1.0 to 25 g/L up to a depth of 20 m and from 2.0 to 7.0 g/L for depths between 100 to 140 m (figure 2) In addition, the water contains very high iron concentration ranging from 25 to 32 mg/L.

Whilst TDS of all deep boreholes further inland (20 km) is less than 1 g/L, the iron concentrations are higher than 40 mg/L. The groundwater is thus treated with a simple iron removal system that produces effluent with iron concentrations exceeding 0.5 mg/L and TDS of 0.3 to 0.5 g/L. In comparison to rainwater quality, this is an unattractive water source for

drinking and cooking. Therefore, rural residents use the treated water for secondary functions such as: bathing, washing, flushing and cleaning.

Figure 2: Salinity in deep wells versus distance

Rainwater is a major fresh water source for cooking and drinking in rural areas, with average annual rainfall in the Can Gio and Go Cong Dong districts ranging between 1,200 to 1,300 mm. The majority of this (80 %) is during the rainy season that lasts six months of the year. In the rural communities, earthen jars and brick tanks are used for rainwater harvesting however insufficient storage tanks and contamination of this source by solids and coliform bacteria excreted from birds, insects and animals makes rainwater harvesting unsafe for human consumption as postulated by the Rural Sanitation and Environment Department of Tien Giang Province.

Figure 3: Earthen Jars alongside dwellings for Rainwater Harvesting

Typical rainwater usage for drinking and cooking is approximately 1.5 litres per capita per day, while other sources such as ground water, surface water and conveyed water are used for washing, bathing, cleaning and flushing in the dry season. Based on the drinking and cooking water demand of 2 Litres/capita/day, the required annual storage capacity per household with 6 persons is 4.5 m^3 of rainwater. Therefore, only 11 to 14 % total households in the region have sufficient storage capacity for drinking and cooking demand throughout the year.

Figure 4. Percentage of annual storage capacity per household

In order to provide rainwater storage, UNICEF supported earthen jars and concrete tanks to rural households in Go Cong Dong and Can Gio. However, this does not meet the storage demand. In addition, poor residents in remote areas in Go Cong Dong use dug ponds lined with plastic sheet and covered by thatch (Figure 5). This may result in the pollution of harvested rainwater by rainfall runoff.

Figure 5. Dug pond lined with plastic sheet

In Go Cong Dong, there are seven central water treatment systems using surface water from an irrigation system. Each system with design capacity of 12 to 20 m^3/h can supply 500 households through pipe networks. Currently the plant is operating at 40 % of its design capacity due to increased operational costs and poor effluent quality. Possible reasons for this are ineffective operation and poor raw water quality. The results of analysis in January 2002 revealed the effluent contained 9 mg TOC/L, turbidity of 6 JTU and TDS of 0.4 to 0.6 g/L and thus eliminating this option as a long-term solution to the water shortage problems experience in the region.

In rural areas, surface water treatment is rudimentary with treatment in the form of coagulation by alum for turbidity removal. However, this does not address the problem of organic or coliform removal and hence unsuitable for drinking purposes.

Current Trends in Water Collection and Usage

Water consumption of rural coastal people in both areas investigated was evaluated by means a of questionnaire survey. The survey results of existing water consumption in the coastal rural areas is reflected in Table 1.

Table 1. The existing water consumption in the coastal rural areas

Clean water consumption (L/capita/day)	Percentage of total households (%)	
	Go Cong Dong	Can Gio
< 20	26	20
20 to 30	30	24
30 to 40	40	32
40 to 60	4	16
>60	0	8

The results show that the highest percentages of households consume 30 to 40 L/capita/day of water, which is less than Vietnamese criterion of water supply in rural areas (60L/capita/day).

Thus, lack of fresh water quantity is an essential problem in the coastal rural area. Therefore, fresh water conveyed from neighbouring areas supplement water supply during the dry season. This option is not a feasible long-term solution since water purchased is expensive ranging from 10,000 to 40,000 VND/m^3 and dependant on transportation and distribution costs. Further, water quality is often compromised during conveyance.

Figure 6. Tricycle mounted with tank using for freshwater conveyance

The People's Committee of Can Gio District invested four boats for freshwater conveyance from Nha Be district and a central water supply system consisting storage, pump station and distribution networks with capacity of 400 m^3/d. This system supplies two centralized residential communities of Can Thanh and Long Hoa.

The Rural Sanitation and Environment Department of Go Cong Dong reported that in 2001, 67% of total households use water from various sources. Central water treatment plants provided 27 % of this whilst the rest is derived from neighbouring communities and rainwater harvesting. In Can Gio the central water distribution system using conveyed freshwater can only provided for 17% of total households. Other freshwater sources such as rainwater and water conveyed by private services can serve approximately 38 % the total households. This highlights the shortage of fresh water in the studied areas.

Can Gio and Go Cong Dong are the coastal zones where adequate reliable sources of freshwater are unavailable. The selection of an abundant brackish water source coupled with feasible desalination techniques can be a reasonable approach in rural coastal areas. Reverse osmosis (RO) is at present the most suitable and economically feasible desalination technology that provides high quality potable water at an estimated unit cost of 9,500 VND/m^3. The adoption of RO technology together with a suitable pre-treatment step offers the advantages of low installation and maintenance cost and high organic and inorganic contaminant removal with minimal chemical usage ensures its long-term sustainability in potable water production from brackish water sources. In comparison to unit cost of fresh water conveyance, this cost is acceptable for rural coastal households.

Community awareness on clean water demands is also significantly contributed to the success of an investment of new water treatment technology. Therefore, public education programs and outreach activities for public health awareness and water quality should be implemented.

Acknowledgement : This field research work was sponsored by DANIDA under Integrated Coastal Zone Project, AIT