

THE RED RIVER DELTA, VIETNAM: AN OVERVIEW OF GROUNDWATER RESOURCES

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1. Introductions

Globally, sustainable management of groundwater resources is one of the essential objectives for the future of developing countries, especially when the rising demand for clean drinking water. In Vietnam, the Red river Delta, the biggest delta of the northern Vietnam with area of about 15500 km², is also facing this regard because: (1) this Delta is the most densely populated area of Vietnam, clean water demand for rapid expansion of industries, residents, and services has been getting extremely urgent; (2) It belongs to tropical region dominating by a short, five-month flood season from May to Oct but occupying 70-80% of year-total rainfall and has rich sediment in surface water resources; (3) Water supply heavily depends on, and excessive exploitation of groundwater resources have caused some serious problems such as decline of groundwater level, land subsidence, saltwater intrusion in several largely groundwater-exploited cities of the Delta. Thus, the principal objectives of this study were: (1) Provide a general overview of delta-wide groundwater conditions in brief including groundwater system, available data, as well as availability and uses; (2) Provide a preliminary assessment of research progress, and main problems, further needed studies of groundwater resources which serve as basic reference for future hydrological studies in the Red River Delta.

2. Groundwater system and monitoring network

The Red River Delta is comprised by Quaternary-age unconsolidated sediments in thickness of from several tens to 100 meters, overlying directly on the bed rocks aged Neogene-proterozoi. The development of plain are relating to the accommodation, marine transgression, and regression, tectonic activities, so the sediments are mainly river bed facies, lacustrine, ... and the thickness varies in large range. Groundwater of the Quaternary-age sediments mainly exists as porous water and forms unconfined (QH) and confined aquifers (QP) sandwiching with aquitards while cleft and karsts water in consolidated or semi-consolidated formations. The distinctive hydrogeological framework of the Delta reflects the harmonious pattern of different deposits that form unconfined, confined or locally confined aquifer. In which, river-origin deposits commonly are aquifers, but sea-origin deposits are aquitards or aquicludes.

To gain a better understand and management of groundwater resources system, Vietnam government has greatly invested

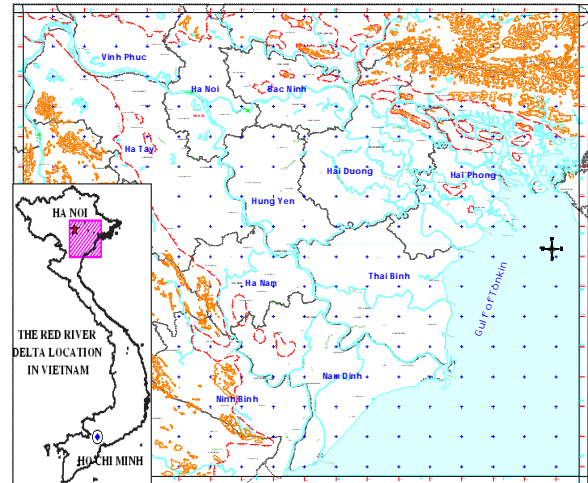


Figure 1: Location of the Red river Delta

on setting up a National-wide Groundwater Monitoring System (NGMS) since 1987 whereby 77 stations with 140 observation wells over the Red river Delta belonging to the NGMS were basically completed and started their operation by 1995. Average distribution of observation wells is about 1 station/220km² over the Delta but about 1 station/12km² in Hanoi city. So far, most of observation wells have about 13-year recorded data including groundwater level, temperature, chemical components (Na, Ca, Mg, Cl, HCO₃, S); micro-quantities (As, Hg, Se, Be, Cr, Cd, Pb, Cu, Zn, Mn, Ni, I, F, Phenol, CN) and other water contaminants (pH, Eh, NH₄, NO₃, NO₂, PO₄, BOD, COD, residual pesticide).

3. Available data

Data availability also is essential to develop complicated, integrated approaches for groundwater management and monitoring (Rossetto et al., 2007). In Vietnam in general and the Red River Delta in particular, however, hydrogeological data are not only poor but also sparse, seldom systematically organized, and accessible for very limited groups of users. These primary data come from numerous and various sources as water regulators, water supply companies, from local to national environmental agencies, industries, Vietnam geological survey, public and private research, academic institutions, consultants and many others. Various sources have strong dissimilarities in data format, quality and storage media. This often prevents the application of integrated groundwater management methodologies especially in large and basin scale.

Table 1: Amount of groundwater pumping across provinces of the Red River Delta (unit: m³/day)

	HaNoi	HaiPhong	ThaiBinh	NamDinh	Hanam	NinhBinh	Hatay	VinhPhuc	BacNinh	HungYen	HaiDuong	Total
Type I	500 000	-	-	-	-	-	70 000	28 500	11 200	5 000	13 000	627 700
Type II	150 000	10 000	-	-	-	8 200	15 500	18 000	7 200	2 600	12 800	274 650
Type III	150 000	12 000	20 350	30 000	20 000	20 000	80 000	35 000	50 000	15 000	16 000	398 000
Total	800 000	22 000	20 350	30 000	20 000	28 200	165 500	81 500	68 400	22 600	41 800	1 300 350

4. Groundwater Availability and Uses

The Red River Delta is the most populated area of Vietnam. Groundwater has been being a main source of clean water supply and exploited with rapidly increasing volume. There are three typical types of groundwater exploitation: (Type I)- Public exploitation wells: These are large diameter and pumping-capacity well fields, typically in cities such as Hanoi, HaiDuong, VinhPhuc, NamDinh, managed by Clean Water Supply Companies; (Type II)- Private Wells: They are medium diameter and pumping-capacity well fields and directly managed and operated by the owners (school, hospital, institute, and so on) for their own uses; (Type III)- Household wells: This type includes shallow, small diameter wells with simple treatment methods managed by the households like hand drug wells.

According to preliminary estimation by 2005, the total amount of groundwater pumping over the Delta was about 1 300 350 m³/day, a 20-fold increase of pumping amount in 1910. Of which, type I was about 627 700m³/day; type II was 274 650 m³/day; and type III was 398 000 m³/day (table 1). The recognized potential groundwater reserve was about 3 849 700 m³/day, almost three times of total groundwater pumping. However, un-matching distributions of both groundwater reserve and groundwater exploitation have caused some serious groundwater problems in over-exploited-groundwater areas.

5. Groundwater research progress

Since the 1990s great deal of complicated methodologies and sound techniques for groundwater analyses and management have been investigated in developed countries, which are increasingly being applied GIS, database, and modeling. (Mende et al., 2007). In Vietnam, however, very few original groundwater investigations for Delta areas exist in the literature and just focused on groundwater pollutions and land subsidence due to excessive groundwater withdraw in small urban portions of Hanoi (e.g. Helm., 1996; Gupta et al., 1999; Trinh et al., 2000; Duong et al., 2003; Kiyoshi et al., 2006). Although there have been some our earlier studies addressing to aquifer system identification, temporal-spatial groundwater level variation, saltwater intrusion, groundwater modeling, groundwater balance but these findings were rather qualitative, disperse, local, based on limited number of boreholes, and not yet officially documented. Further, most

current studies have been carried out rather on administrative boundaries than basin concepts.

6. Groundwater Issues

Recognized practical matters needed to address in the Red River Delta are: (1) Over-exploitation and ill-management of groundwater resources and their negative impacts in urban areas; (2) Lack of available data, information, and officially documented references. (3) Sparse monitoring networks and short time of recorded data. (4) Limitation of scientific studies, especially complicated techniques, and integrated managements in regional or basin scale; (5) Groundwater pollution, especially Arsenic.

7. Conclusion

The presented overview of groundwater resources in the Red River Delta including groundwater system, monitoring network, available data, and groundwater availability and use, and research progress demonstrates the existing situation, main issues, and further needed researches of groundwater development and management in the Delta. The review also reflected the big gap between groundwater studies in Vietnam and those in the world.

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