Nitrate pollution in groundwater in the Pearl River delta, China

Jianyan CHEN1, Xinfeng ZHAO1,
Yintao Lu2, Changyuan Tang2

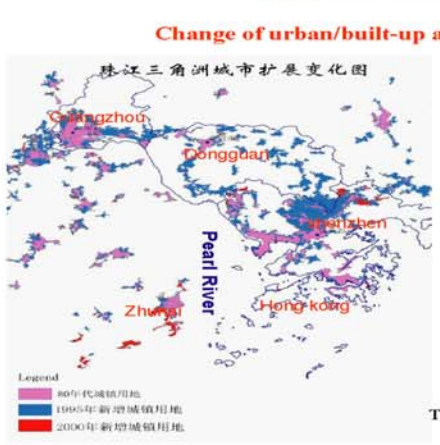
1 Dept. of water resources and environment, Sun Yat-sen University, Guangzhou, China
chenjyao@mail.sysu.edu.cn or chenjianyao@hotmail.com
2 Chiba University, Japan

1 Background and Objectives

The Pearl River delta, with population more than 4.0x10^7, is one of the most developed regions in China with extremely rapid expansion of urban area in the last 30 years. Groundwater pollution is becoming an important issue because of its unique role for water supply in the emergent situation. Environmental tracers (stable isotopes, CFCss and other hydrochemistry) have been used to assess the extent and rate of nitrate contamination of the aquifer system beneath the city of Zhuhai, a typical urban area of Pearl River Delta, China. The objectives are given as follows:

*Spatial and temporal change of nitrate in groundwater in the Pearl River delta
*Sources and processes related to N
*Linkage of processes research with groundwater protection and management

2 Location of study area



Change of urban/built-up area in the Pearl Delta

	Urban/built-up km^2	
1980	1832	
1990	2819	4.4%
2000	4141	3.9%

Total area of delta: 31000 km^2

Fig 1 Study arae and change of land use in the Pearl River delta, Guangdong Province, China

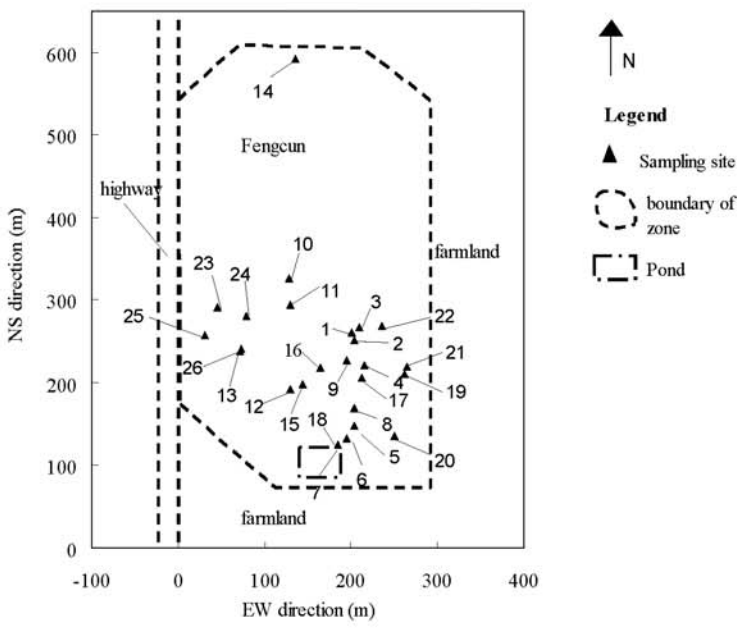


Fig 3 Sampling sites inside Guanghua Basin for the specific research on the sources of nitrate in groundwater (Lu et al, 2007)

3 Methods

Water samples were collected during the dry season (March) and wet season (July) for isotopic and chemical analyses in 2005, 2006 and 2007 from two study areas: Zhuhai and Huadu as indicated. EC, temperature, pH, DO and Redox potential were measured in situ. Major ions of Cl, SO4, NO3, Ca, Mg, K, Na were analyzed in the laboratory of Sun Yat-sen University, while stable isotopes were analyzed in the laboratory of Chiba University of Japan. Water table data and water quality data in Huadu were collected from the Guangdong Station for Environment and Geological Monitoring.

4 Results

4.1 Nitrate pollution in Huadu Basin of Guangzhou

Generally, nitrate increased in the Huadu basin, but decreased after 1993 when the water use was shifted from groundwater to surface water (Fig. 2). In order to get more information related to water sources and the sources of nitrate in groundwater, water sampling was carried out in Huadu Basin (Fig 3). Groundwater comes principally from the modern precipitation based on the isotopic evidences (Fig 4). Evaporation effect during the recharge can also detected clearly from the relationship between oxygen 18 and deuterium. Nitrogen 15 in groundwater was measured in a range from 15-20 per mill AIR, indicated the anthropogenic sources, namely septic tanks in the basin (Fig5). The relationship between N-15 and nitrate concentration (Conc(NO3-)) was given as:¦Ä15N£½27.77-3.08ln Conc(NO3-), showing the possible denitrificataion process involved.

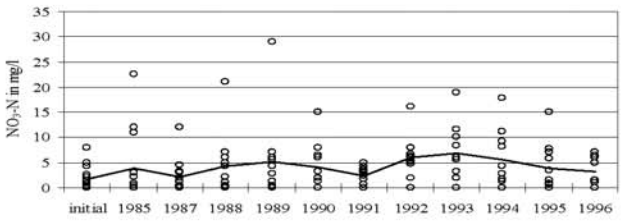


Fig.2 Change of nitrate in the Karst aquifer based on observation wells in Guanghua basin in Guangzhou.

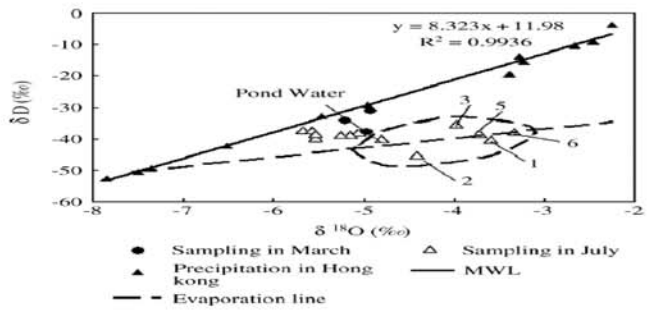


Fig 4 Identification of water sources based on the environmental isotopes in Huadu Basin (Lu et al, 2007)

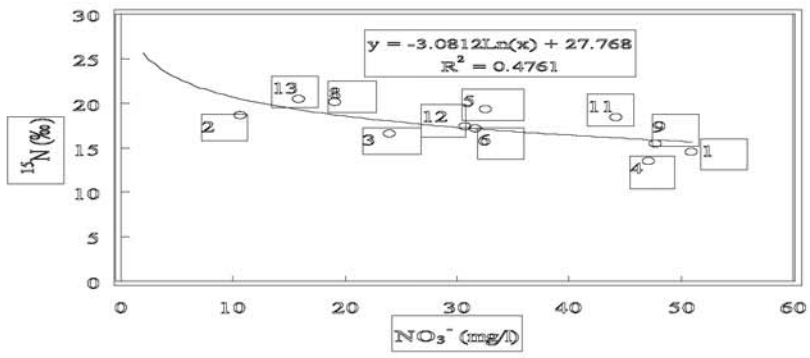


Fig 5 Relationship between nitrate and nitrogen 15 in Huadu basin

4.2 Nitrate pollution in groundwater in Zhuhai

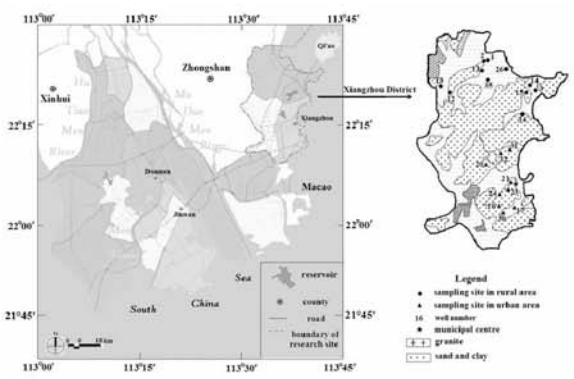


Fig 6 Location and groundwater sampling sites in Xiangzhou District, Zhuhai City

Groundwater samples were collected in different seasons, April and October, i.e., before and after rainy season (during the period of April - October) in the Pearl River delta. Basically, no big difference was detected for the nitrate content in groundwater in terms of average value. The percent of samples exceeding the WHO nitrate standard (45 NO3- mg/l) in April and Oct.were 33.3% and 28.9% respectively, indicating the dilution effect of rainfall in water quality. Stable isotopes of 18O and deuterium (D) confirm again in Zhuhai that modern rainfall predominate as a source of aquifer recharge. The age of groundwater in the discharge area is older than that of recharge area, and horizontal transport rate of approximately 110-132 m/y was obtained by using CFCs. The calculation by Darcy's law gave a rate of 126.3 m/y in a similar order of magnitude (Fig 7). The high level of nitrate concentration in groundwater occurred in suburb residential area, for which poor condition of local sewage system and leakage of septic tank were blamed. 15N in nitrate (delta15N-NO3-) values above 10 per mill, in most groundwater samples were indicative of contamination mainly from human wastewater sources such as sewage effluent and septic tank leachate, which was also confirmed by delta 18O of NO3- values ranging from 5.3 to 14.6 per mill. Comparison of nitrate in groundwater between suburb residential area and city center, where sewage system was well constructed was carried out, showing a low level of nitrate in the city center.

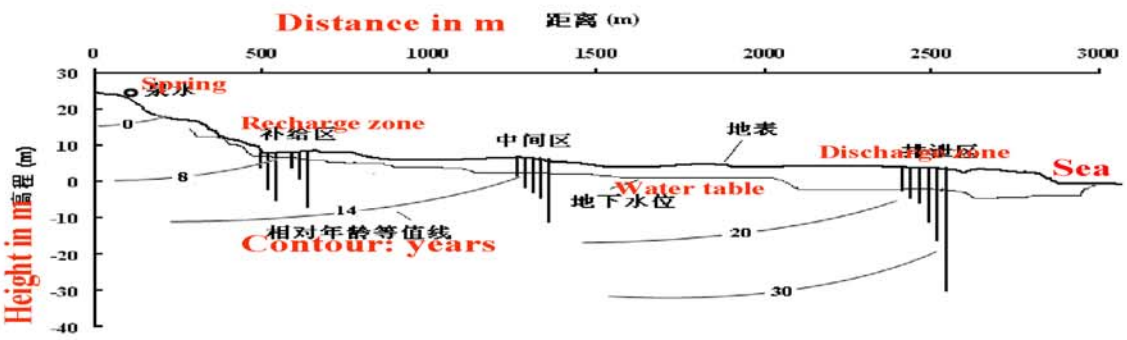


Fig 7 Groundwater flow inside Zhuhai campus of Sun Yatsen University by using CFCS

5 Conclusions

By classifying the type of residential area, groundwater pollution area can thus be delineated. In order to sustain groundwater use, especially in the case of emergency, the policy and/or counter measurements should be proposed to deal with nitrate pollution, e.g., water source planning and protection, development and use of sound technique to build septic tanks.