Environmental problems associated with groundwater flow system in the North China Plain

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Environmental problems in the North China Plain (NCP) have arisen since 1980s, when the national economy started to recover from a long time of stagnation. Population, resource, environment and development are four factors closely integrated, and environmental problems may occur when these four factors are not well balanced. Groundwater, as itself a factor of environment and resource, plays a key role in the sustainability of a certain area. Located in the eastern part of China, the North China Plain (NCP) is a very important region of agriculture in China. The project of water transfer from the South to the North is to be implemented to solve the water shortage problem of the area in this year, and great environmental impacts on water cycle and groundwater flow system are expected. Three environmental problems are to be discussed in a detail: nitrate pollution in the groundwater, salination, and groundwater level draw down.

1. Nitrate pollution

Nitrate pollution in groundwater is related not only to excessive application of N-fertilizer, but also closely to geological background, groundwater flow system and land use change. The former provides N source, while the later affects the flow and accumulation patterns of nitrate. Nitrate pollution patterns of groundwater in the different hydrogeological zones in NCP are varied based on the field survey and laboratory work.

2. Salt accumulation in the unsaturated zone in lower reach of the Yellow River

Saline land distributes extensively in the North China. The lower reach of the Yellow River is basically a discharge zone with high content of salt, and the study area of Yucheng in Shandong Province became arable only after diversion project from the Yellow River was implemented in 1972. The sustainability of agriculture in this area is examined through the redistribution of soil moisture and solute in the vertical profile based on the measurement of soil moisture, potential and solute content of a maize field inside Yucheng Station

The redistribution profile of soil moisture and solute shows clearly the accumulation of solute and moisture in the layer of 120 cm depth with Cl concentration above 1000 mg/l, however, the root extracts water mainly above this layer, preventing the salt from harming the crop. This could be the reason why the agriculture has been sustainable 30 years after the diversion project was carried out.

3. Groundwater level draw down in the North China

The piedmont zone of the North China is an area with high crop yield since early 1980s. Unfortunately, groundwater table is going down continuously since 1978 due to excessive exploitation of groundwater for irrigation together with the dry tendency in recent 20 years. The groundwater level of this area is now about 25 m above sea level. Seawater intrusion may occur in the coastal area where groundwater level is lower than sea level, such as the case in Laizhou city of Shandong Province.

The groundwater table in Luancheng station of Chinese Academy of Sciences goes down at a rate of about 1m/y, and the agricultural sustainability of this area is vulnerable due to water shortage. Water balance was calculated for this area, yielding a rational groundwater exploitation rate, by which annual average draw down of groundwater table is estimated to be zero.

Conclusion

Many environmental problems are closely related to groundwater in terms of either flow system or resource in the North China Plain. The accumulation of salt in the unsaturated zone and regional salination may become worse under the condition of extra water transferred from the south though the groundwater level is expected to recover to some extent. Nitrate pollution pattern and nitrate transport along groundwater flow system under new condition remain to be resolved as complicated biochemical processes are involved in nitrogen cycle.