

Groundwater Quality Management in Japan

Akiko Nishimae

Groundwater and Geo- environment Division,
Environmental Management Bureau, Ministry of the Environment

Abstract

Groundwater is as a water resource characterized for its 1) convenience in obtaining water by digging a well, 2) comparatively low cost, 3) good water quality, 4) constant temperature throughout a year and so on. There is a growing demand on groundwater with these characteristics mentioned, especially in Asia facing population increase and rapid urbanization. However, as groundwater management, with its difficulty in problem findings or in monitoring, is often considered to be less prioritized than surface water management, the promotion of appropriate quality management of groundwater in the region would be among important issues related with water resource management.

This paper aims to review the groundwater quality management in Japan and clarify the basics and related issues. The appropriate monitoring and pollution prevention are the keys in groundwater quality management in Japan, in reflection of the specificity of groundwater that pollution finding is difficult with little opportunity of perception in a daily life and that its pollution is almost irreversible with its extreme difficulty of purification.

Introduction

When rainwater drops on ground, some flows into rivers or lakes, and some infiltrates into ground flowing underground at very low speed to spring out to the surface water, river or lake. In this way, groundwater together with surface water forms so-called water cycle. Groundwater is differentiated by its flow speed from surface water, as groundwater flows so slowly that it stays underground for from hundreds to thousands of years.

Groundwater is as a water resource characterized for its 1) convenience in obtaining water by digging a well, 2) comparatively low cost, 3) good water quality, 4) constant temperature throughout a year and so on. Groundwater, with the distinction mentioned, is used in Japan for a variety of purposes including domestic, industrial and agricultural use. In 2006, dependency rate of groundwater was 12.4% of all water resources in Japan, where abundant with groundwater¹.

Groundwater Quality in Japan

Monitoring of groundwater

As groundwater literally is sited underground and is unperceivable in a daily life, it is so difficult to comprehend the condition of groundwater compared with surface water that it is consequently hard for people to find problems. Therefore, appropriate monitoring is, as a basis for the groundwater management, too important to be exaggerated.

¹ “Water Resources in Japan in FY2006” published by the Ministry of Land, Infrastructure and Transport Japan

In Japan, local governments (101 prefectures and major cities, at the end of FY 2006) are required by the Water Pollution Control Law since 1989 to monitor groundwater quality according to annual monitoring plans drawn by the local governments themselves and report the results to the minister of the environment². The ministry of the environment Japan (MOEJ) put the reported results together into the Monitoring Survey of Groundwater Quality and announces it annually. Information sharing of monitoring data is the most effective tool for encouraging people to step forward for the groundwater management as the biggest obstacle for the groundwater management is the fact that groundwater is out of people's sight and consequently people's attention in a daily life. Hence, the monitoring data should be open to public by trying every means available such as the internet.

Groundwater monitoring based on the Water Pollution Control Law in Japan

Monitoring of groundwater based on the Water Pollution Control is classified into 3 categories of General Monitoring Survey to check the overall quality of groundwater, Periodical Monitoring Survey to continuously monitor pollutions and Monitoring for Identification of Pollution to delineate the polluted areas.

The details of the monitoring are as follows.

a. Target substances

It is required to monitor all of the 26 substances with Environmental Quality Standards (EQSs) established (listed at the end of this paper). The EQSs for groundwater which are identical nationwide were established to protect human health and their values are in consistent of the EQSs for surface waters. However, the EQSs to protect living environment or ecosystems, which were established for surface waters, have not been established for groundwater and the pollution by oils and so on has not been monitored so far. The establishment of EQSs for living environment/ecosystems should be discussed from the standpoint of promoting the Integrated Water Resources Management (IWRM).

b. Number of the wells monitored

Total number of the wells monitored is about 12,000 nationwide with about 5,000 wells for General Monitoring Survey and about 5,000 for Periodical Monitoring Survey. Monitoring density is about 1 well/30 km².

c. Monitoring method

Details of monitoring method is prescribed in the Notification by the minister of the environment such as measuring techniques of each substances or how to choose the monitoring points by accounting geological features, land use, drinking use, speed and direction of flow, depth of the well and so on.

Summary of the Monitoring Survey of Groundwater Quality in FY 2005

The line chart described later shows the trend in non-conformance rate to EQSs in the General Monitoring Survey of 5 items with highest non-conformance rate to EQSs of nitrate-N and Nitrite-N, arsenic, fluorine, tetrachloroethylene and trichloroethylene. Non-conformance rate to EQSs of Nitrate-N and nitrite-N has been the highest among all substances monitored. Pollution by arsenic and fluorine is often caused because they can be liquated out from rocks or soils.

² Dioxins in groundwater are monitored by the local governments under the framework of Law Concerning Special Measures Against Dioxins control. Dioxins are hardly detected in groundwater because they are easily trapped by soils.

Policies on groundwater conservation in Japan

For the characteristics of groundwater as follows,

- once polluted, it takes long time to purify, as groundwater flows so slow that we can not expect the diffusion of pollutants,
- purification of groundwater is technically difficult and is expensive,
- it is difficult to identify the source

We have reached the conclusion that the *prevention of pollution in the first place* is the most important key to the groundwater management and we have to take actions before we face severe pollutions.

Regulation under the Water Pollution Control Law

The regulation of the quality of groundwater in Japan is implemented in Japan under the Water Pollution Control Law and related ordinances set by local governments. The framework of the regulation of groundwater by Water Pollution Control Law is as follows.

a. Monitoring

Refer to 3.2 above.

b. Ban on the infiltration into ground

Infiltration of water discharge containing controlled substances from specified commercial facilities into ground is strictly prohibited regardless of whether the discharge is intentional or not. Furthermore, in order to prevent groundwater pollution, local governments are able, if necessary, to order improvement or periodical suspension of the facility with any possibility of filtration of discharge into ground. The regulation itself is strict as unintentional infiltration is prohibited and penalties are imposed in case of the violation, the scope of the regulation, however, is limited to specified commercial facilities, which is criticized to be too narrow for effective regulations. On the other hand, in case there exists groundwater pollution caused by infiltration, local governments are able to order the polluter(s) to purify the polluted groundwater if any harm on human health is identified or if there is a chance of the harm. This order, however, has never been made since it is so difficult to meet the prerequisite for implementation of the order since they require the verification of the possibilities of harm on human health in addition to the pollution itself.

c. Emergency measures

In case of accidents, owners of the specified commercial facilities are required to take emergency measures to prevent infiltration into ground and report to the local governments. If the owner does not take necessary emergency measures as required, the local governments are able to order him/her to take them.

The local governments (101 prefectures and major cities, at the end of FY 2006) are responsible for the administration of these regulations and MOEJ, on the other hand, is responsible for the promotion of and technical support for the administration by local governments by such as publication of guidelines for investigation and pollution control measures.

The regulation scheme by Water Pollution Control Law is effective especially for the pollution caused by discharges from factories (i.e. point-source). In fact, the non-conformance rate to EQSs of VOCs such as tetrachloroethylene or trichloroethylene which is, in most cases, discharged from factories has decreased since the ban on the infiltration under the Water Pollution Control went into effect in 1989

Non-regulatory measures

Regional approach to the pollution by Nitrate Nitrogen and Nitrite Nitrogen (NO_3^- and NO_2^-)³
As mentioned above, Non-conformance rate to EQSs has been the highest of all substances monitored (4.2% in FY 2005).

As groundwater pollution by Nitrate/nitrite-N has following characteristics,

- Various pollution sources such as excessive application of fertilizers and improper treatment of livestock excrement and domestic waste water
- Pollution sources are generally widely spread (non-point source)
- Number of the possible polluters and stakeholders are large and it is difficult to identify the real polluter.
- (Especially in case of the pollution by excessive application of fertilizers) it is difficult to reduce the load

The regulations under the Water Pollution Control Law, which were originally elaborated to control the pollution especially from point-source such as discharge from factories, is not sufficient to control Nitrate/nitrite-N.

For the control of the pollution by Nitrate/nitrite-N, the integrated policy to reduce the Nitrate/nitrite-N load to the ground in compliance should be implemented, which is accompanied with a careful account for the pollution sources, dignity of the pollution and natural and social circumstances, apart from the related regulations such as by Law on Promoting Proper Management and Use of Livestock Excreta. All the stakeholders including framers, the staff of the government or owners of wells should be involved in its implementation process and their activities should be well coordinated.

MOEJ has promoted such community based approach above all toward effective reduction of Nitrate/nitrite-N load to the groundwater by technically supporting by drawing up manuals and summary of case studies.

Until the end of FY 2005, 134 stakeholders meeting institutions have been established and 52 regional plans to control the pollution by Nitrate/nitrite-N plan have been elaborated. It is necessary to reinforce the promotion of the community based approach, considering that Nitrate/nitrite-N pollution has not been improved so far.

Other non-regulatory measures

Regionally, a lot of unique voluntary activities by stakeholders to conserve groundwater, i.e. setting up conservation plan, promotion of the recharging into groundwater, establishing the regional network for groundwater conservation, integration of groundwater conservation policy into land use planning and so on. These voluntary activities have worked so well accompanied by the regulations, both of which are essential and should go hand in hand for the *prevention* of the pollution, the key to the groundwater quality management.

Promotion of voluntary activities to love and take good care of the valuable groundwater

For pollution prevention, in addition to the policies to *control the BADs* (pollution), such policies are effective as to *develop the GOOD* environment by the activities to love and take

³ Intake of some amount of Nitrate/nitrite-N may causes hypoxia called methemoglobinemia among infants. Groundwater polluted by Nitrate/nitrite-N is supposed to cause eutrophications in lakes .

good care of the neighbor valuable groundwater environment within the communities. MOEJ has promoted these voluntary activities including the activities to conserve natural springs. Natural springs are water resources which have been connected very closely to everyday life and beloved for long time in Japan. Natural springs are often called “a window to groundwater” since we can recognize the groundwater through it. MOEJ aims at these characteristics of natural springs and expects that promotion of a variety of regional activities to conserve natural springs may lead to conserve the whole groundwater environment behind them.

Table 1. Environmental Water Quality Standards of Groundwater in Japan.

Item	Standard Value	Item	Standard Value
1. Cadmium	0.01mg/l or less	14. 1,1,1 – trichloroethane	1mg/l or less
2. Total cyanide	Not detectable	15. 1,1,2 – trichloroethane	0.006mg/l or less
3. Lead	0.01mg/l or less	16. Trichloroethylene	0.03mg/l or less
4. Chromium (IV)	0.05mg/l or less	17. Tetrachloroethylene	0.01mg/l or less
5. Arsenic	0.01mg/l or less	18. 1,3 – dichloropropylene	0.002mg/l or less
6. Total mercury	0.0005mg/l or less	19. Thiram	0.006mg/l or less
7. Alkyl mercury	Not detectable	20. Simazine	0.003mg/l or less
8. PCBs	Not detectable	21. Thiobencarb	0.02mg/l or less
9. Dichloromethane	0.02mg/l or less	22. Benzene	0.01mg/l or less
10. Carbon tetrachloride	0.002mg/l or less	23. Selenium	0.01mg/l or less
11. 1,2 – dichloroethane	0.004mg/l or less	24. Nitrate-N and Nitrite-N	10mg/l or less
12. 1,1 – dichloroethylene	0.02mg/l or less	25. Fluoride	0.8mg/l or less
13. cis – 1,2 – dichloroethylene	0.04mg/l or less	26. Boron	1mg/l or less

Issues for better groundwater quality management

The groundwater quality management in Japan has worked well so far as a whole. However, some issues are left for the improvement as follows. MOEJ continues to take the leadership for groundwater quality management.

- Establishment of more efficient pollution control scheme: leaving the natural-source pollution which is uncontrollable for controllable man-made pollution under the growing pressure of the budgetary cutback
- Incorporation of IWRM into groundwater quality management: establishment of EQSs for protecting living environment and ecosystems, to be harmonized with EQSs for surface waters
- Integrated policy of soil contamination control and groundwater pollution control

- Revitalization of international information sharing: since groundwater pollution is practically irreversible in most cases, it is important to share our knowledge and information with our neighbor countries for prevention purposes and WEPA database shall be the best option for it.

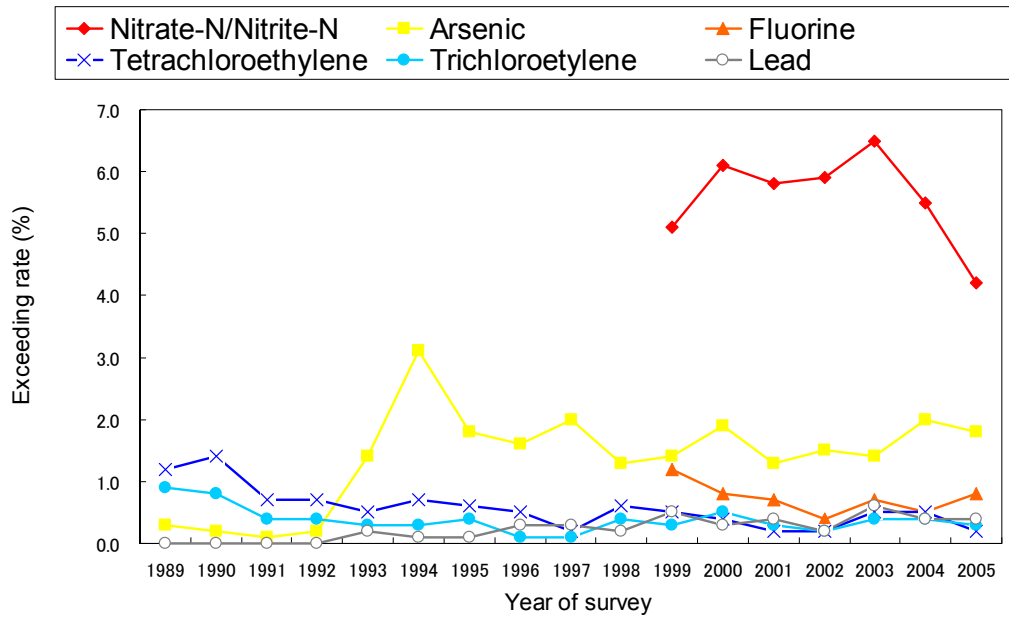


Figure 1. Trends of non-conformance rate to EQSs for groundwater in general monitoring survey.