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# Geological Environment Problems Caused by Controlling Groundwater Exploitation in Jiangyin City

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**Abstract:** Geological environment effects caused by the control of groundwater exploitation in Jiangyin city are discussed thoroughly, including the dynamic variation of groundwater levels and quality and the development of land subsidence and ground fissures. According to the dynamic characteristics of groundwater levels, some advice about groundwater exploitation is offered. Our research will provide a basis for using groundwater resources and the prevention of geological disasters in Jiangyin city and the Suzhou-Wuxi-Changzhou area. The following results are deduced from our research. First, groundwater levels vary with the exploitation of groundwater in Jiangyin city and are affected by hydrogeological conditions. The groundwater levels remained rather stable before and after the implementation of control of groundwater exploitation in the northwest of Jiangyin city along the Yangtze River. A suitable level of exploitation should be allowed. In the southeast, the speed of recovery of the groundwater level has been rather rapid after the control of exploitation. We conclude that groundwater might be exploited locally after the groundwater level has recovered. In the southwest, the speed of recovery of the groundwater level is rather slow and exploitation of groundwater should be prohibited. Second, groundwater quality is stable in Jiangyin city and the contents of the main chemical indices of groundwater varied only slightly before and after the control of exploitation. Third, after controlling the exploitation, the speed of land subsidence has clearly slowed down and the development of ground fissures has been controlled effectively.

**Key words:** controlling groundwater exploitation; dynamic effects; geological environment effects; Jiangyin city

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## 1 Introduction

Groundwater levels have declined significantly owing to long-term over-exploitation in the Suzhou-Wuxi-Changzhou area, which caused some environmental geology problems<sup>[1-2]</sup>, such as land subsidence, ground fissures and deterioration of groundwater quality. To the south of Jiangyin city a serious land subsidence has developed, which has become a depression area<sup>[3-4]</sup>. In order to protect limited groundwater resources and completely solve the environmentally challenging geological problems caused by over-exploitation of groundwater, deep groundwater exploitation in the area of Suzhou-Wuxi-Changzhou was prohibited.

Long-term over-exploitation of groundwater is the main extrinsic factor causing land subsidence and ground fissures. Many investigations focused on the effects of exploiting groundwater on land subsidence and ground fissures<sup>[5-6]</sup>, the mechanisms for land subsidence<sup>[7-8]</sup> and establishing interrelated models<sup>[9-10]</sup>. Only a few studies were conducted about the effect of controlling the exploitation of groundwater and on controlling the development of land subsidence and improving the geological environment. The prohibition of groundwater exploitation will be helpful for controlling the development of land subsidence and ground fissures, but it is not a scientific method<sup>[11]</sup>. In order to evaluate efficiently its effect and practicability, the environmental effects in geo-

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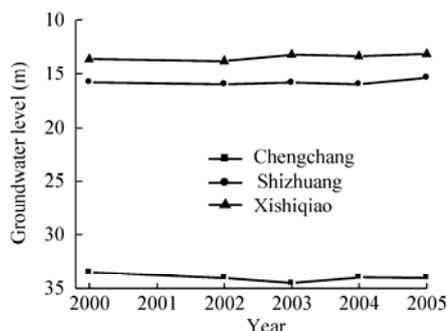
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logical terms caused by controlling the exploitation of groundwater were investigated in Jiangyin city by studying the dynamic change in the level and quality of groundwater and the development of land subsidence and ground fissures. A reasonable evaluation on controlling groundwater exploitation in Jiangyin city will be given, which will provide bases for using groundwater resources and preventing geological disasters in the Suzhou-Wuxi-Changzhou area.

## 2 History of Groundwater Exploitation and the Process of Sealing Wells

Deep groundwater has been exploited since the 1980s. There were 21 deep wells in Jiangyin city in 1984, distributed over more than ten villages and towns. Since then, with rapid industrialization and improvement in the standard of living of people, the demand for water has increased. There were 140 wells for exploiting deep groundwater in 1990. In the 1990s, the scale of deep groundwater exploitation had reached a climax; the number of new wells had increased to an average of 50 wells each year; in 1994, the number reached 82. Little by little, groundwater exploitation began to be controlled in Jiangyin city by 1995, which slowed down its acceleration. Since 1998, the Jiangyin government has enhanced its management of groundwater exploitation and exploitation began to reduce slowly. Because of unsustainable groundwater exploitation over long periods, the groundwater level continued to decline, which caused some environmental geology problems, such as land subsidence, ground fissures, deterioration of groundwater quality and so on. In order to solve these problems completely, the Jiangyin government began to forbid the exploitation of deep groundwater. The last deep groundwater well was sealed on Sept. 2, 2005. During the period from 2001 to 2005, a total of 465 wells were sealed off and the exploitation of deep groundwater declined from  $2.945 \times 10^4 \text{ m}^3$  in the end of 2002 to about zero in the end of 2005 (see Fig. 1).



(a) In the north

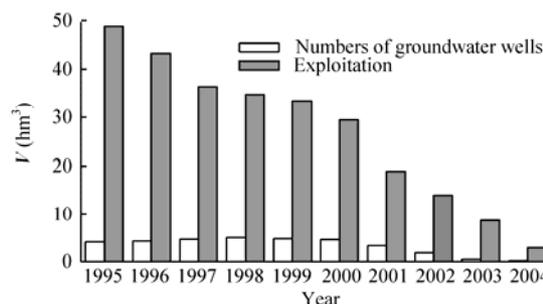
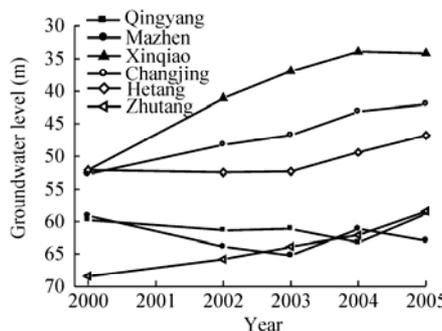


Fig. 1 Development of groundwater exploitation in Jiangyin city

## 3 Dynamic Effects on Groundwater After Control of Exploitation

### 3.1 Dynamic variation in groundwater level

Pore water in a loose rock mass is the main source of groundwater in the area, which is divided into a phreatic aquifer, the first confined aquifer, the second confined aquifer and the third confined aquifer. It is the second confined aquifer which has experienced the greatest exploitation in Jiangyin city and therefore the dynamic variation of its water level has largely been studied in our research. As the main exploited aquifer in Jiangyin city, its water level is controlled mainly by exploitation, but because of its variable hydrogeological conditions, there are clearly different dynamic characteristics at play in the south and the north of the area. Owing to the lateral supply of the Yangtze River water, the groundwater level declines slowly and is rather stable in the north for years (Fig. 2 a). In the south, because of the shortage of groundwater supplies, the water level declined rapidly due to a long-term extra-exploitation over a number of years, at a speed of more than 3 m/a in most areas. Since 1998, the Jiangyin city government has enhanced its management of groundwater exploitation and the extra-exploitation was controlled effectively. Especially after beginning to implement its prohibition of deep



(b) In the south

Fig. 2 Variation of groundwater levels in Jiangyin city

groundwater exploitation, the water level of the second confined aquifer has, on the whole, recovered slowly in the south (Fig. 2b).

Given recent dynamic changes of groundwater levels in Jiangyin city, except for a few zones, the water levels are recovering rather quickly, such as in Xin-

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