Ⅱ-343 An Approach Based on Telemeter Data to Mitigate Land Subsidence during Drought Season in Saitama Basin

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Introduction

The increasing trend of land subsidence in Northern Kanto region has clearly pointed out the inadequacy of traditional approaches for the suppression of subsidence appearing in a relatively short period during drought season [1]. The essential requirement of developing an integrated groundwater monitoring and management system to measure, record, and transmit groundwater level fluctuation and land subsidence data automatically in real time has been emphasized in recent years [2]. In this paper, the concept and operational procedure of recently introduced telemeter system are briefly outlined and feasibility of applying this system to mitigate heavy land subsidence caused as a result of abnormal pumping during drought periods is also discussed.

Concept of Telemeter Data Transmission System

There are many traditional observation wells in Saitama basin. At present, five of them have been equipped with the telemeter system to cover the most widely affected parts in the region.

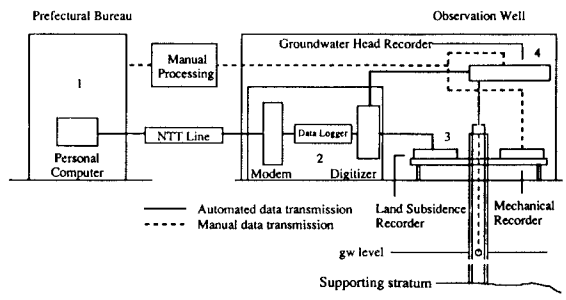

Figure 1. Schematic representation of telemeter system

All traditional observation wells consist of a mechanical float in the inner pipe of two circular tubes and a displacement meter mounted on the inner tube separated from the movement of the outer tube and record data using a mechanical plotter. In the 5 observation wells equipped with telemeter system, the groundwater level and land subsidence data sensed by the float and the vertical displacement meter, respectively, are directed to an A/D converter and temporarily stored in a digital data logger in each well. These data in binary format are periodically sent by a modem through a telecommunication line to a personal computer in Atmosphere and Water Quality Protection Section of Saitama Prefectural Government to update existing data files. **Figure 1** gives a schematic diagram of an observation well equipped with telemeter system.

Analysis and Distribution of Data

The data sent through the telemeter system are initially received by a storage unit attached to the computer. The records are then converted into text format, and the rearranged data files are stored in separate folders according to different observation stations and data categories. These data are necessarily modified by several softwares prepared for data processing to merge records in a serial order. The computer can display the graphs of time series records as observed individually at the five stations. The present trends of groundwater level and land subsidence in each locality are evaluated on line and fed for the decision making for necessary management, such as pumping volume reduction, redistribution of local pumping rates, etc.

Information containing management steps along with data on groundwater level and land subsidence rate and trend is distributed to all well operators and other related organizations through internet via a data server at Saitama Prefectural Government Bureau, as shown in **Figure 2**. Facsimile system is also available.

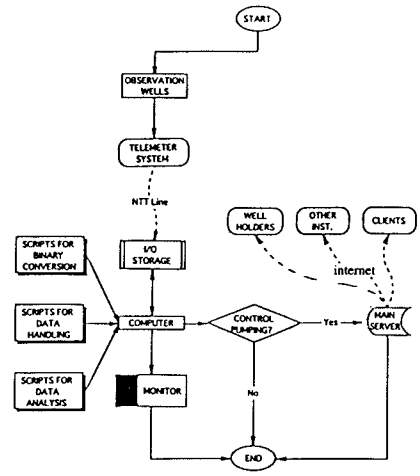

Figure 2. Analysis and distribution of data

Key words : telemeter system, groundwater management, land subsidence, drought season
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Mitigation of Land Subsidence during Drought Season

The theoretical goal of the groundwater management approach in the study is summarized as follows : The groundwater basin under consideration is assumed to be divided into several sub-basins, each sub-basin covering an approximately equal area of similar hydrogeologic characteristics. The boundaries of these basins are generally defined in reference to natural geography and geology of groundwater basins and sub-basins rather than by political boundaries of cities, towns or prefectures. An observation well equipped with telemeter system in each sub-basin is used to identify the characteristics of groundwater level fluctuation and land subsidence rate and trend in real time. The number of wells are expected to be increased in future to improve the reliability of operational accuracy.

The critical groundwater depths, land subsidence rates and pumping rates for the first and second warning distribution and, in the most severe case, for the temporary reduction of further pumpage, during drought period in each sub-basin are specified by referring to past records, extent of damage to environment and infrastructure, and other socio-economic and political restraints. In year 1994, a drastic trend of subsidence was observed due to the most prevalent drought conditions occurred in the past hundred years, and this has been referred to as a target period to ascertain management criteria in this study. The safe operating values are decided to be in accordance with the duration of the management period as well as the future administrative plans. These critical values will be modified in future depending on feedback of response analyses and accumulation of on-line telemeter data. To realize the short term management mothodology, a most fitting duration for posing optimal operation has to be suggested.

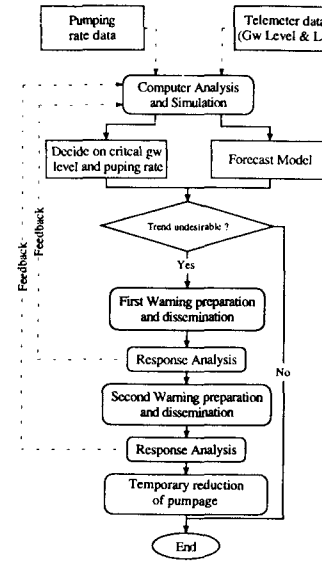

Figure 3. Management approach

An operational manual is drafted to establish the following stages of water management in response to different groundwater conditions in different basins. The less restrict stage imposes a slight reduction of pumping rates. More restrictive measures are applied to regions where groundwater level and land subsidence trends are unacceptable. The most restrictive approach with substantial pumping rate reductions is applied to regions where groundwater overdraft is very severe. The decision making is made clear to all groundwater users and the possible distribution of information concerning groundwater and subsidence is carried out through internet, e-mail, facsimile, etc. Self control of groundwater pumping is expected to be achieved through the Groundwater Users' Association in Saitama. In adopting pumping volume reduction procedures, all users have to obey a rule of equality sharing for pumping volume reductions and acceptable reduction volumes will be decided beforehand according to their groundwater requirements. This approach will be imposed only during drought seasons against heavy land subsidence. Schematic representation of the management approach is shown in **Figure 3**.

Groundwater management practice through telemeter data transmission system requires the cooperative participation of groundwater users, and the popularization of the system will also be necessary.

Conclusive Remarks

An approach based on telemetry to manage groundwater resource and to mitigate land subsidence during drought season is discussed. The real time operation through telemeter system in Saitama basin will attain a positive measure to optimize groundwater resources in future. The approach provides the stable groundwater use not only for short term groundwater management but also for long term to develop a sustainable groundwater use policy.

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