A GIS-AIDED MONITORING SYSTEM OF GROUNDWATER LEVEL IN WIDE LAND SUBSIDENCE AREA

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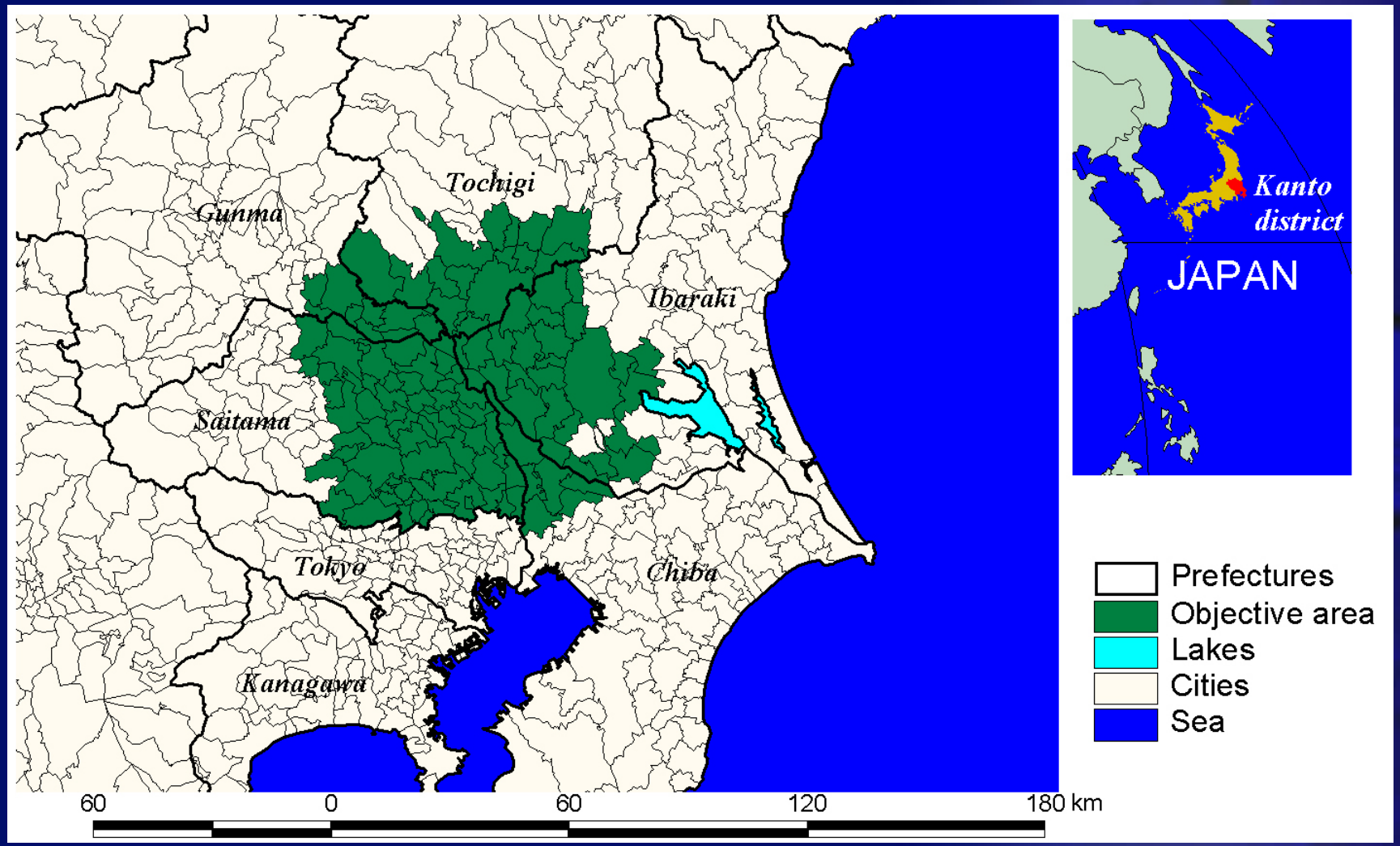
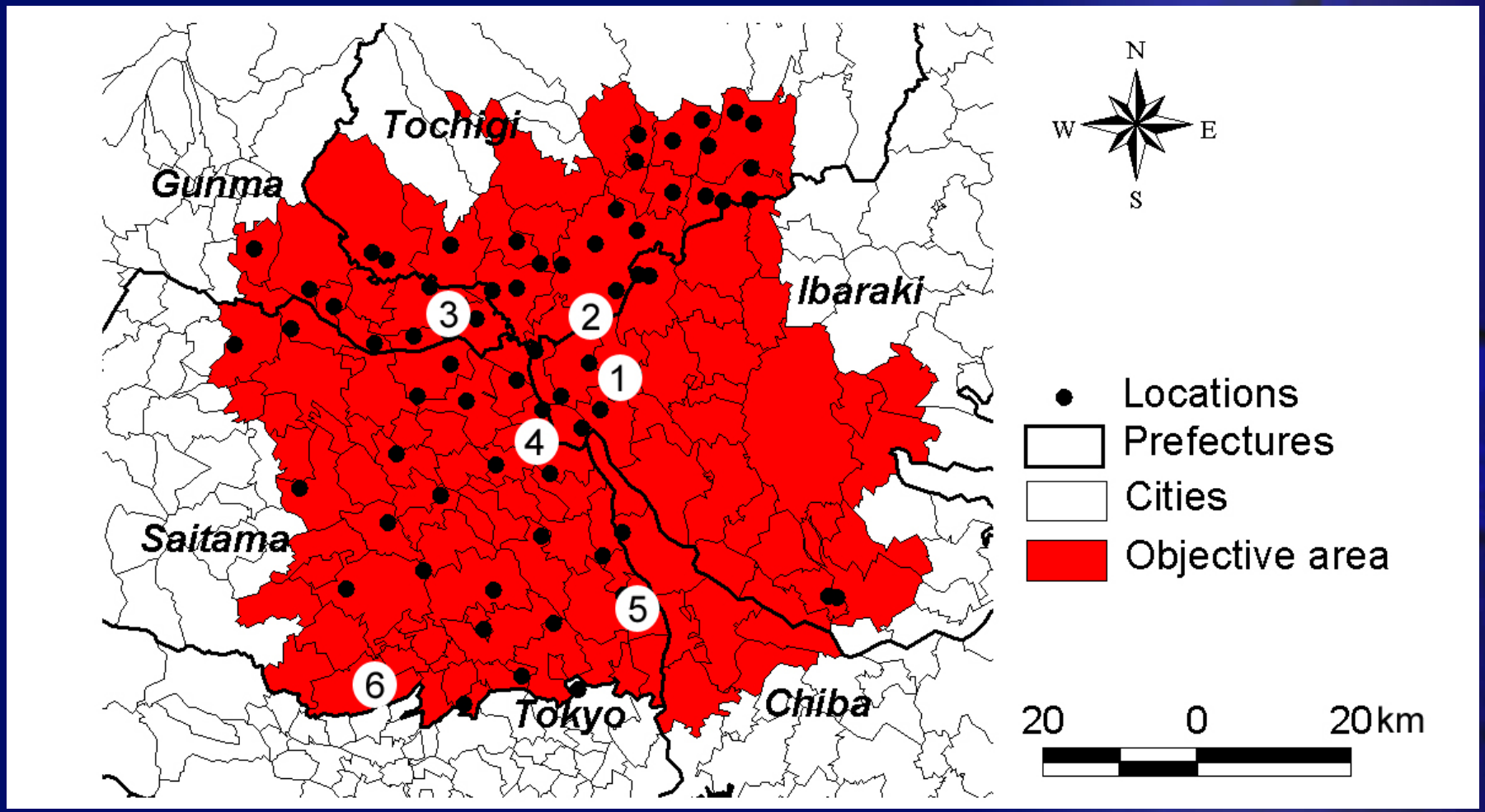
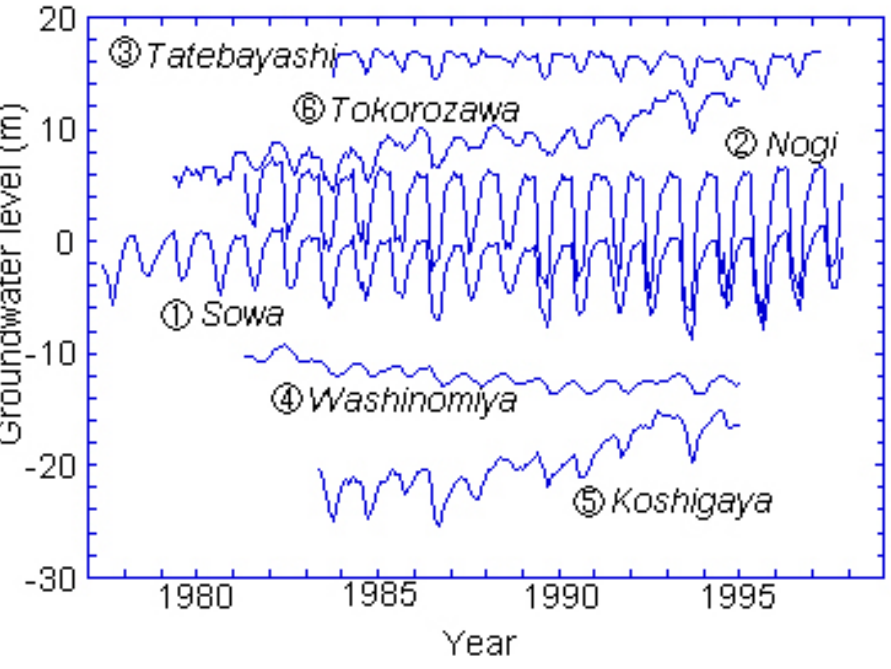
Objective Land Subsidence area in the Northern Kanto Plain, Japan

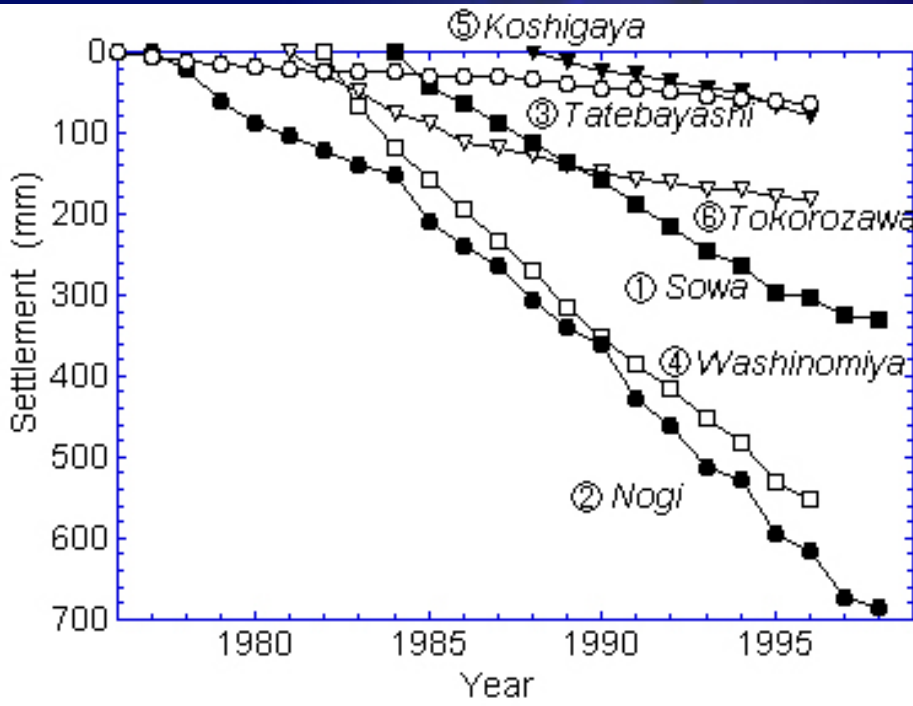


72 locations where variations of settlement and GWL over time have been observed



Land Subsidence Features in the Northern Kanto Plain, Japan





Damage due to Land Subsidence

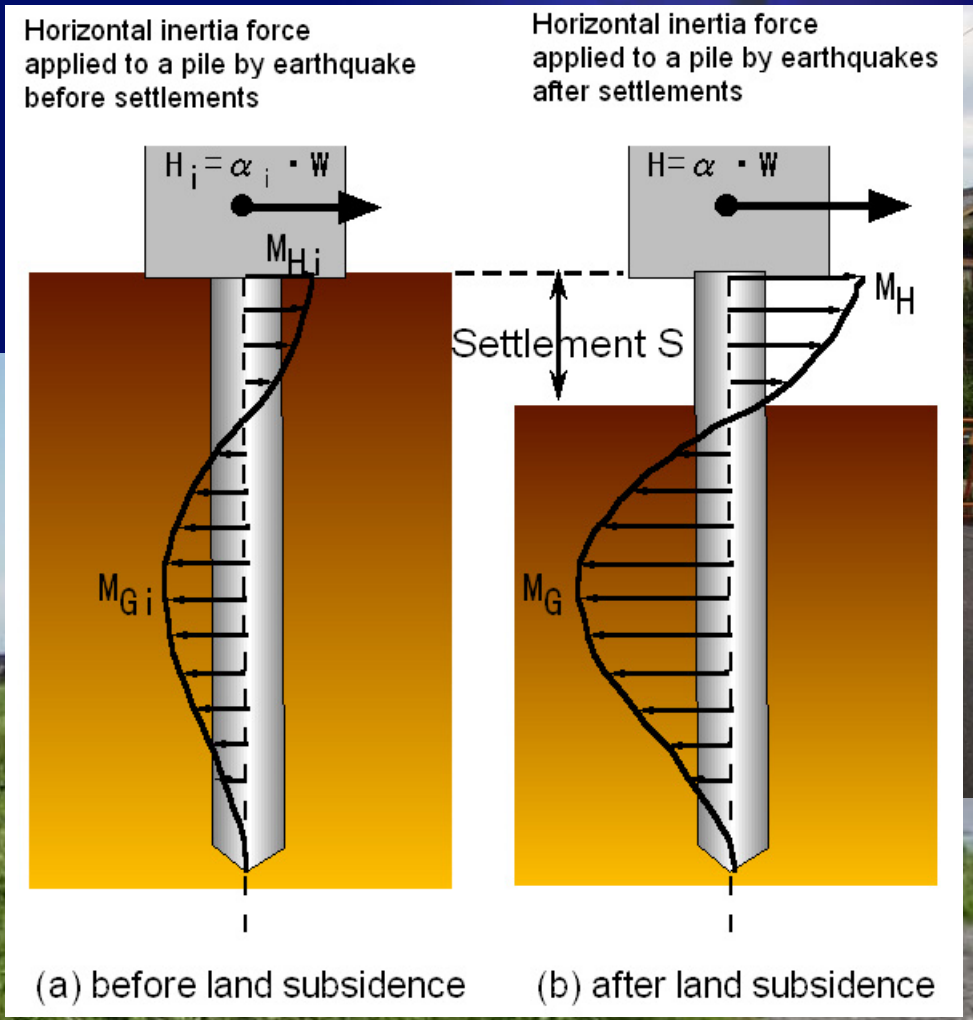
Direct damage

- Structures
- Roads
- Lifelines, etc…..

Damage due to Land Subsidence

Potential damage

- Earthquake
- River Flooding
- Heavy Rain, etc…..



Infrastructures in wide land subsidence area

- Maintenance plan with consideration of damage due to land subsidence
  - Forecasting land subsidence
  - Regulating land subsidence

A new system for regulating land subsidence for the infrastructure maintenance

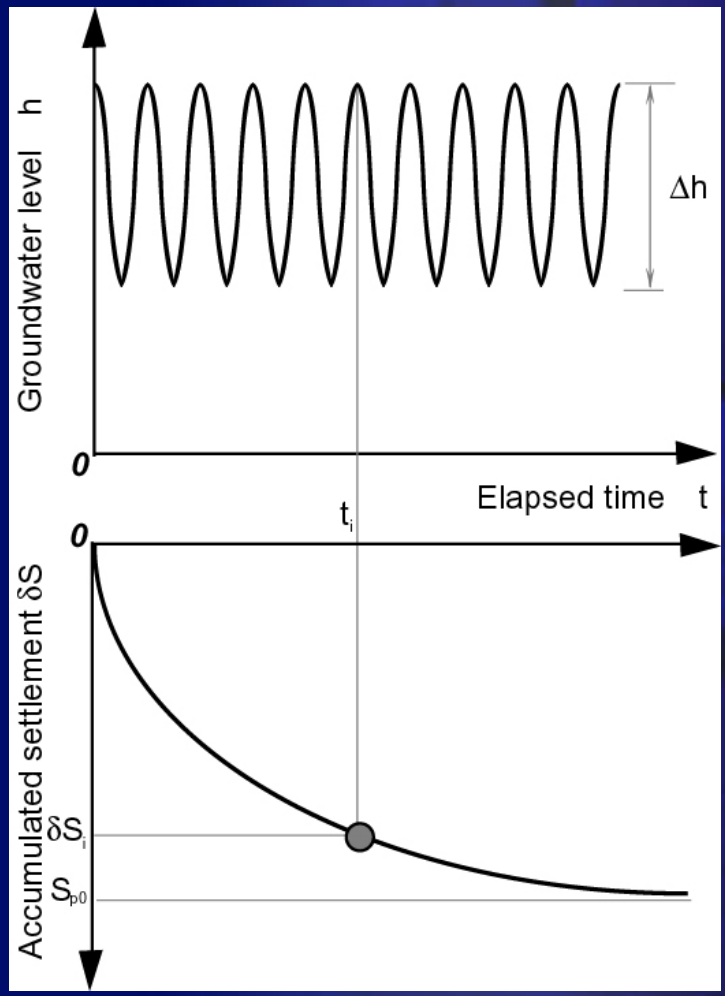
- Features
  - To use the previously observed settlements and GWL records for predicting future settlements
  - To use Geographical Information System for systematically monitoring and transmitting from time to time

Observational Prediction of Land Subsidence with Consideration of GWL fluctuation

A Simplified Prediction Model of Land Subsidence (Murakami et al.,1998,2000)

- Features
  - In the case of the constant range of GWL fluctuation
  - On the basis of 1D consolidation theory
  - Using previously observed settlement records

$$\delta S_i = S_{p0}\left\{1 - \exp\left(-C_R \cdot t_i\right)\right\}$$



A Prediction Model with Consideration of GWL Fluctuation

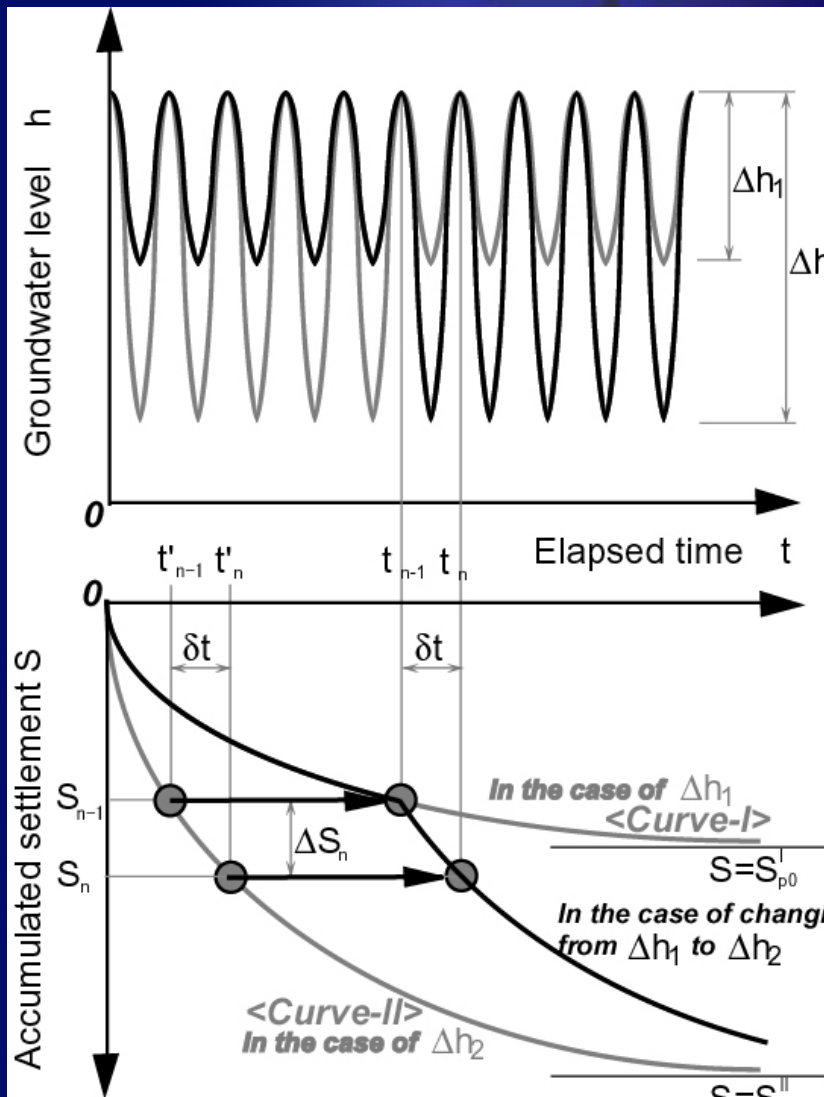
- Settlement-Time Relationships
  - Type I

$$S_i^A = S_{p0}^A \left\{1 - exp\left(-C_R \cdot t_i\right)\right\}$$

  - Type II

$$S_i^B = S_{p0}^B \left\{1 - exp\left(-C_R \cdot t_i\right)\right\}$$

$$S_{p0} = A_w \cdot \Delta h + B_w$$



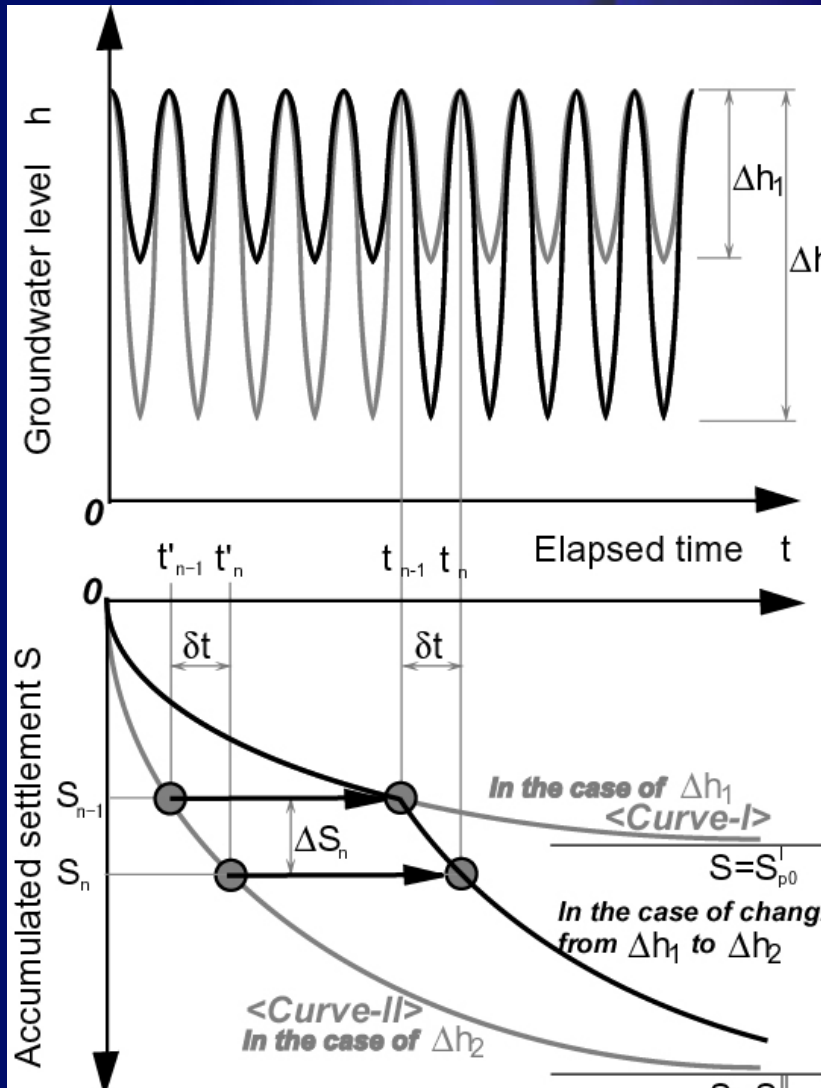
A Prediction Model with Consideration of GWL Fluctuation

$$\delta S_{n+1} = A \cdot \Delta h - B \cdot S_n + C$$

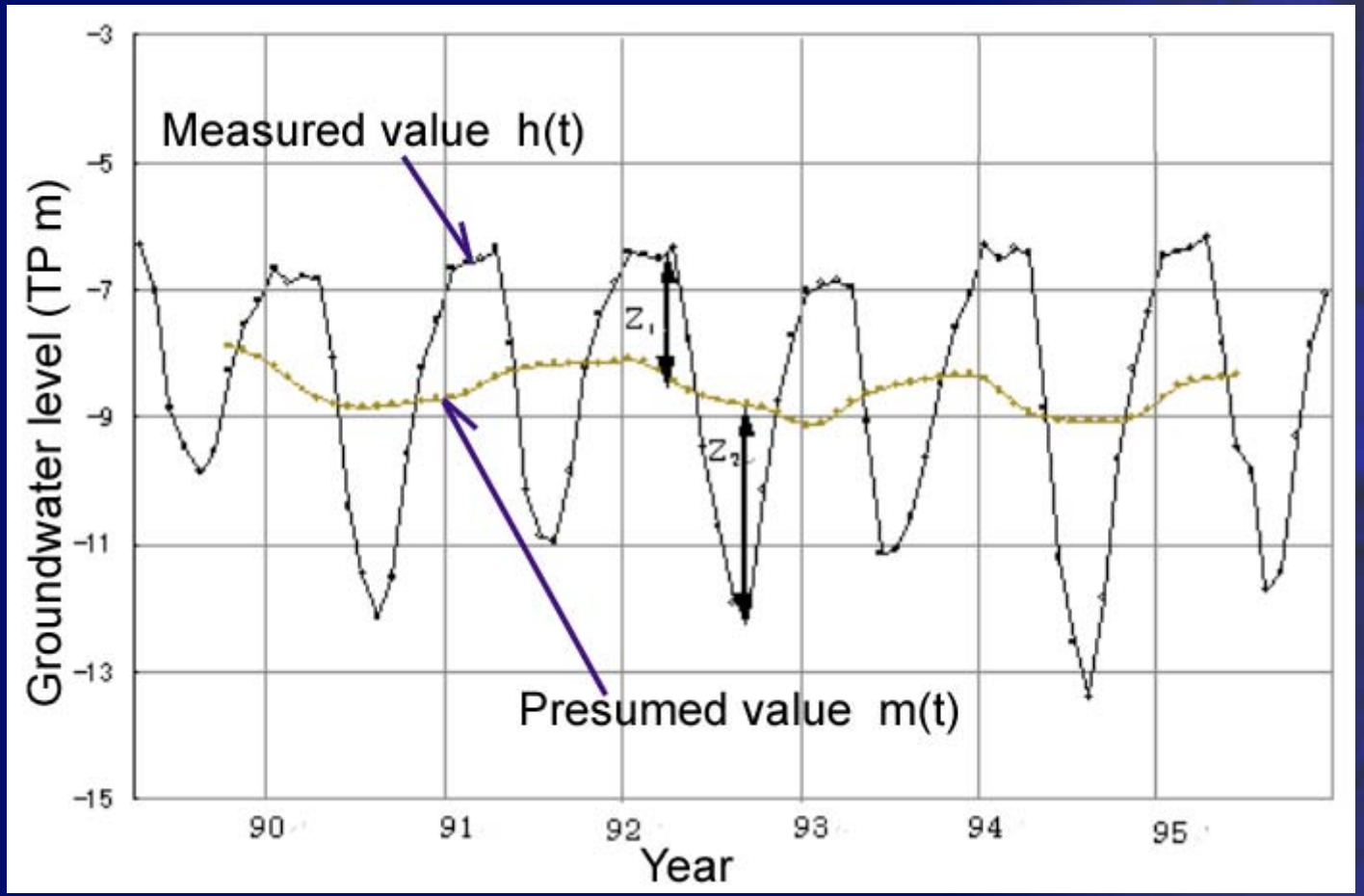
$$A = A_w \cdot \{1 - exp(-C_R)\}$$

$$B = 1 - exp(-C_R)$$

$$C = B_w \cdot \{1 - exp(-C_R)\}$$

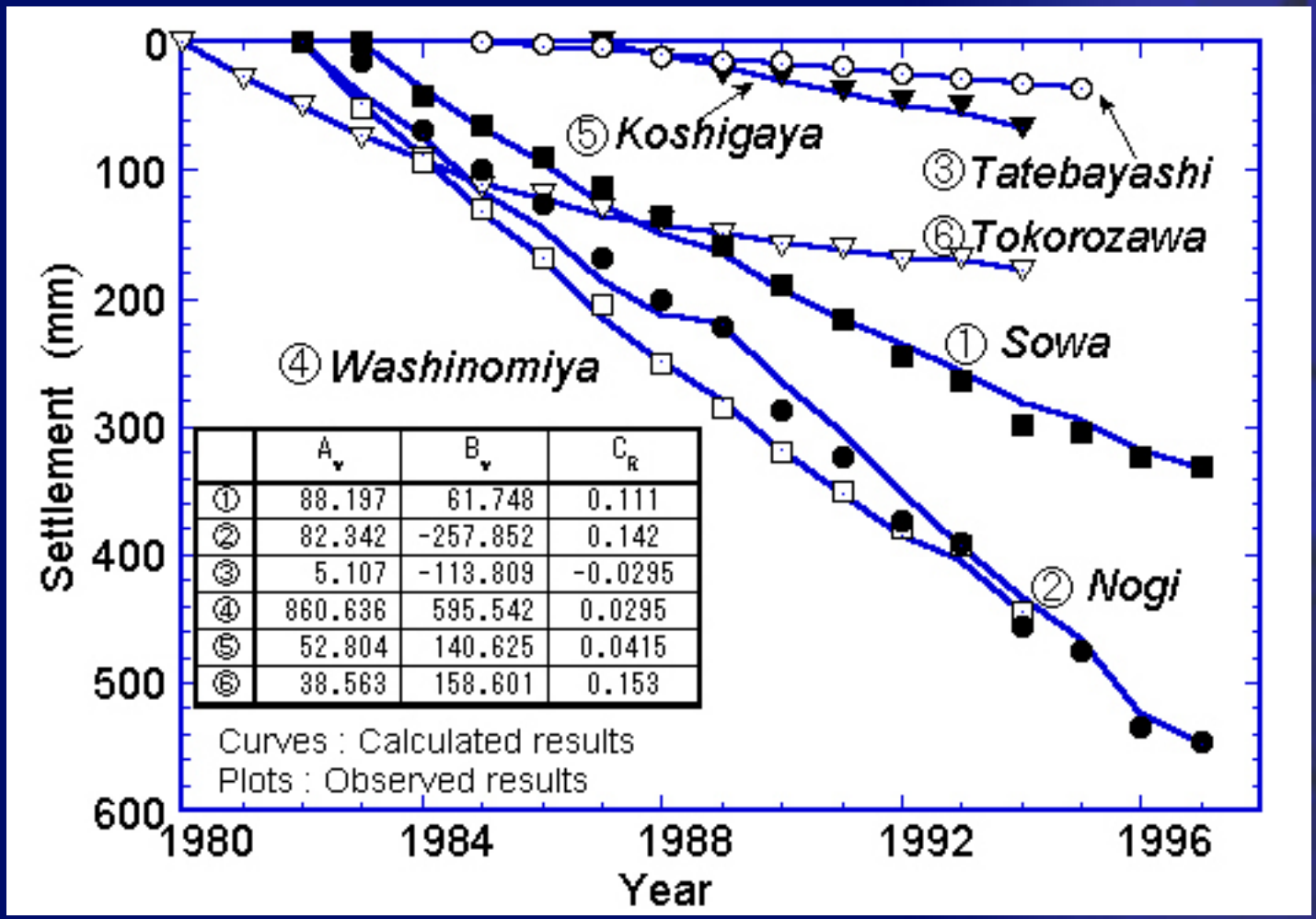


Determination of Range in GWL Fluctuation using Time Series Analysis



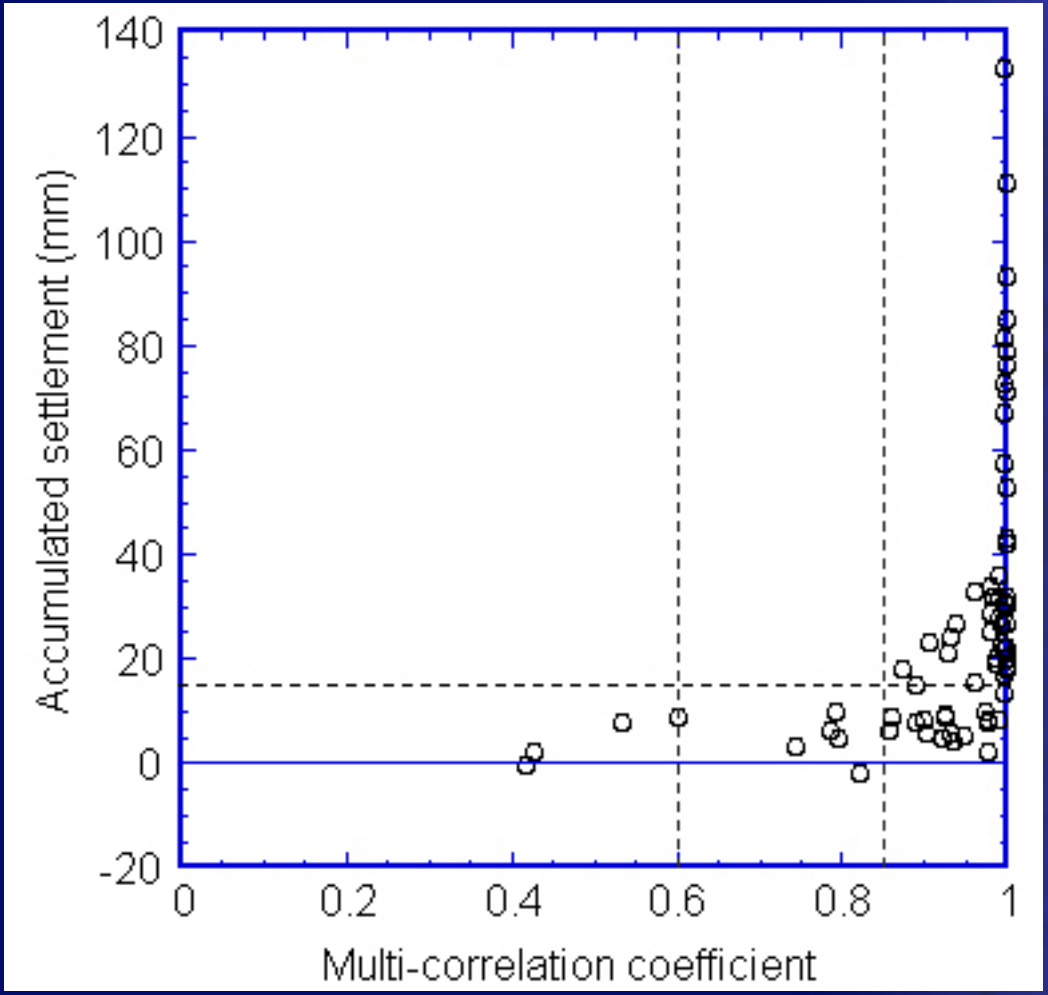
Application of the Proposed Method to Land Subsidence Prediction

Application to the representative 6 locations



	A_v	B_v	C_R
①	88.197	61.748	0.111
②	82.342	-257.852	0.142
③	5.107	-113.809	-0.0295
④	860.636	595.542	0.0295
⑤	52.804	140.625	0.0415
⑥	38.563	158.601	0.153

Application to all the Locations (72 locations)



The multi-correlation coefficients are detected from calculated and observed settlement for 3years from 1992 to 1994

GWL fluctuation for regulating land subsidence

- Proposed Land Subsidence Prediction Model

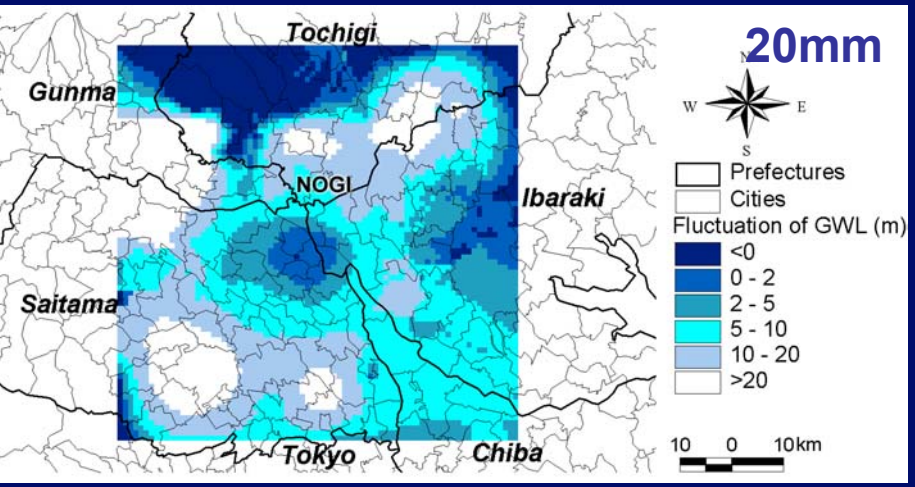
$$\delta S_{n+1} = A \cdot \Delta h - B \cdot S_n + C$$

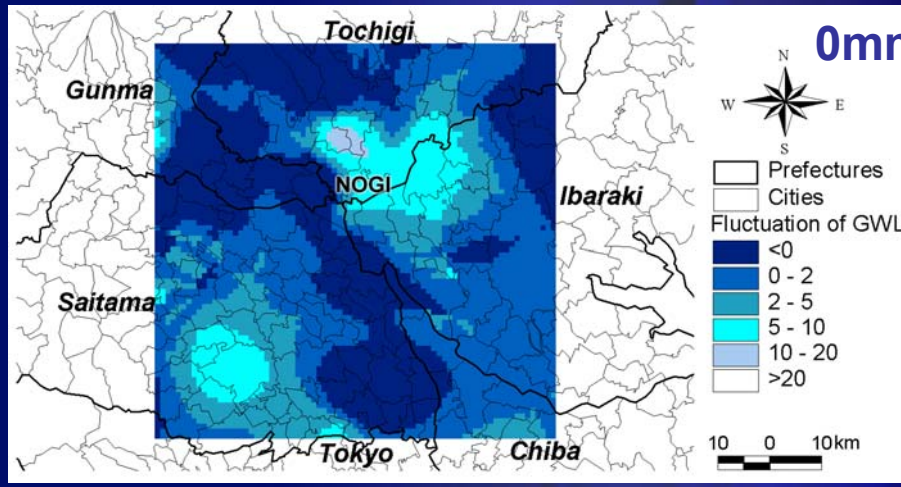
$$\Delta h = \frac{1}{A}\left(\delta S_n + B \cdot S_{n-1} - C\right)$$

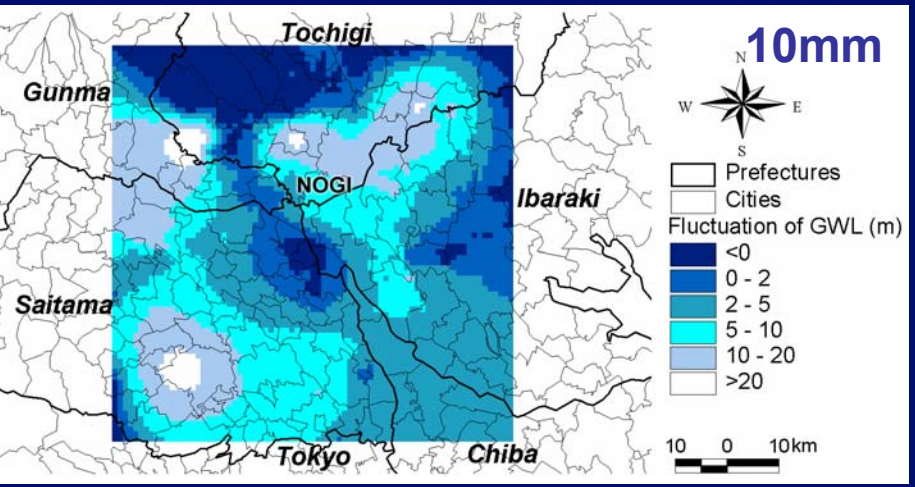
- Permissible range of GWL fluctuation for regulating land subsidence

A GIS-aided GWL Monitoring System for Regulating Land Subsidence

GWL Fluctuation Map for Regulating settlement

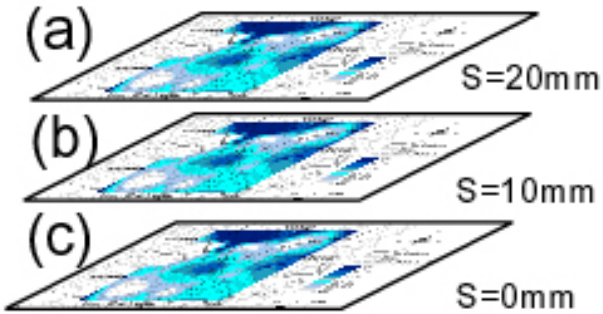






GWL Monitoring System

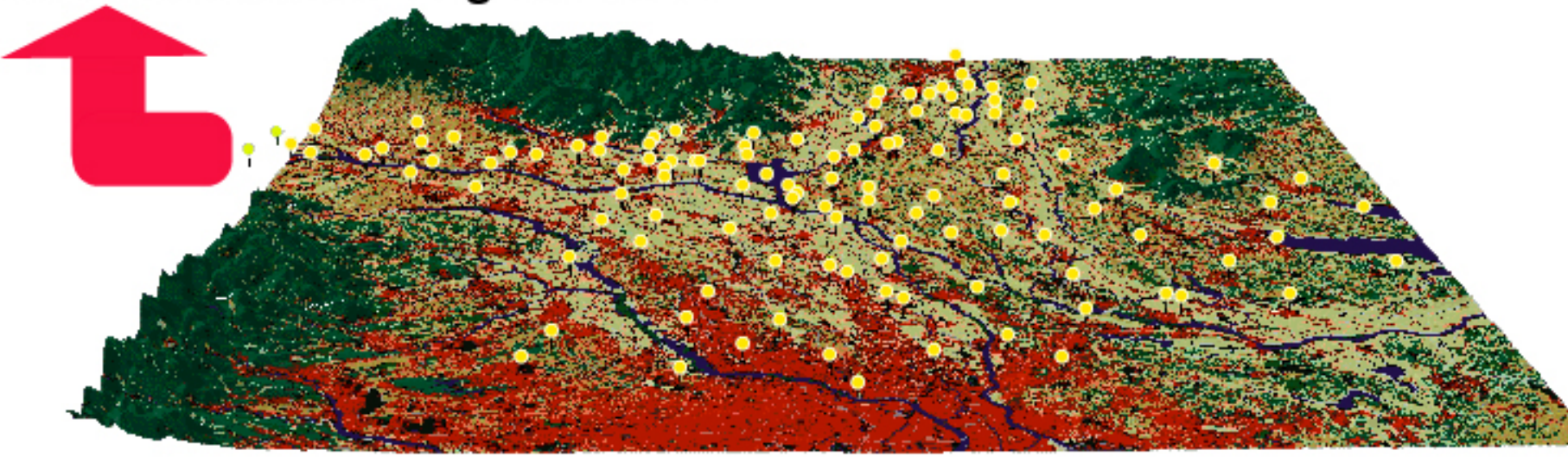
Realtime monitoring for GWL



Distribution maps of GWL fluctuation such as shown in Fig.10

Warning

Caution



Network for monitoring GWL

CONCLUSIONS

- An observational prediction method of land subsidence with consideration of GWL fluctuation by using previously observed settlements and GWL records is proposed.

- A GIS-aided monitoring system of GWL in wide land subsidence area is proposed.