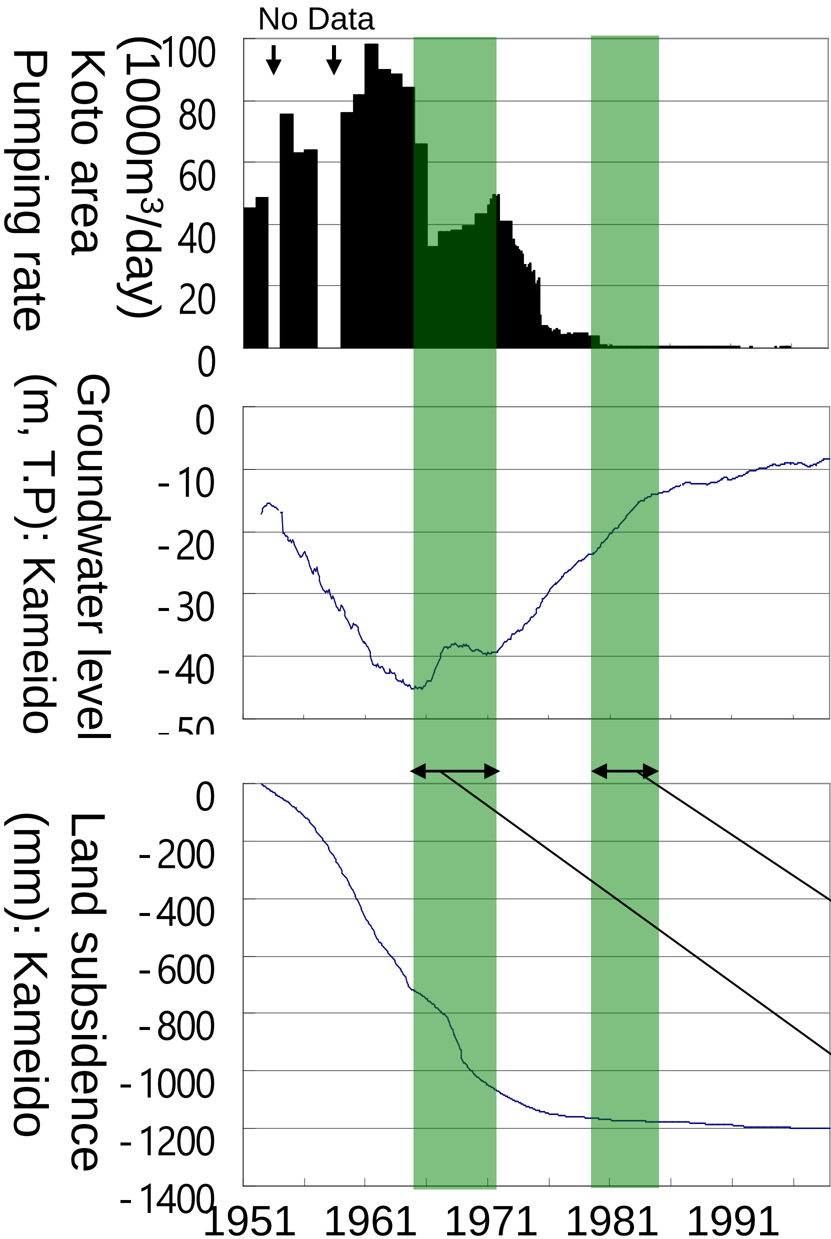
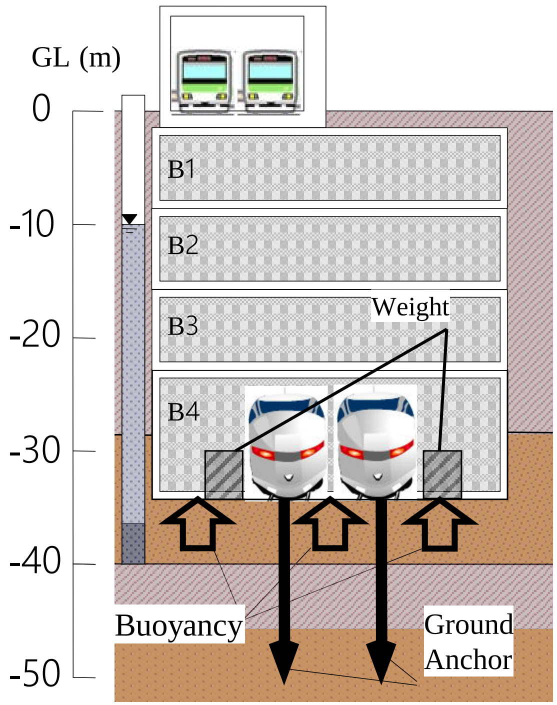
Present Groundwater Issues

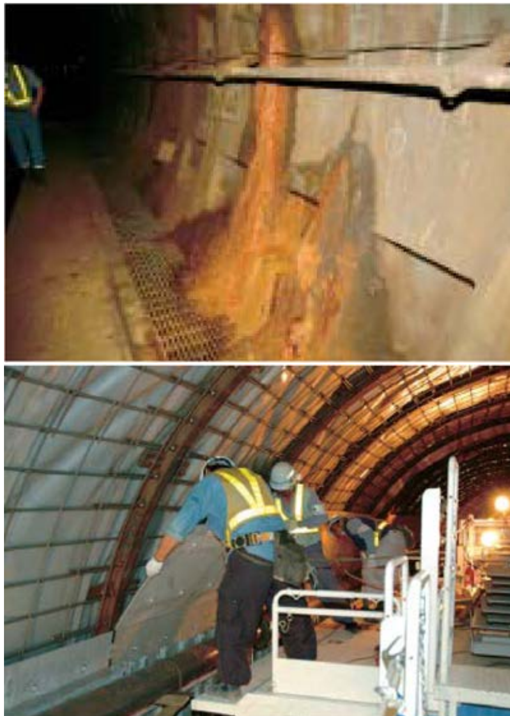


Constructing Ueno Station (Shinkansen)

Constructing Tokyo Station (Sobu line)

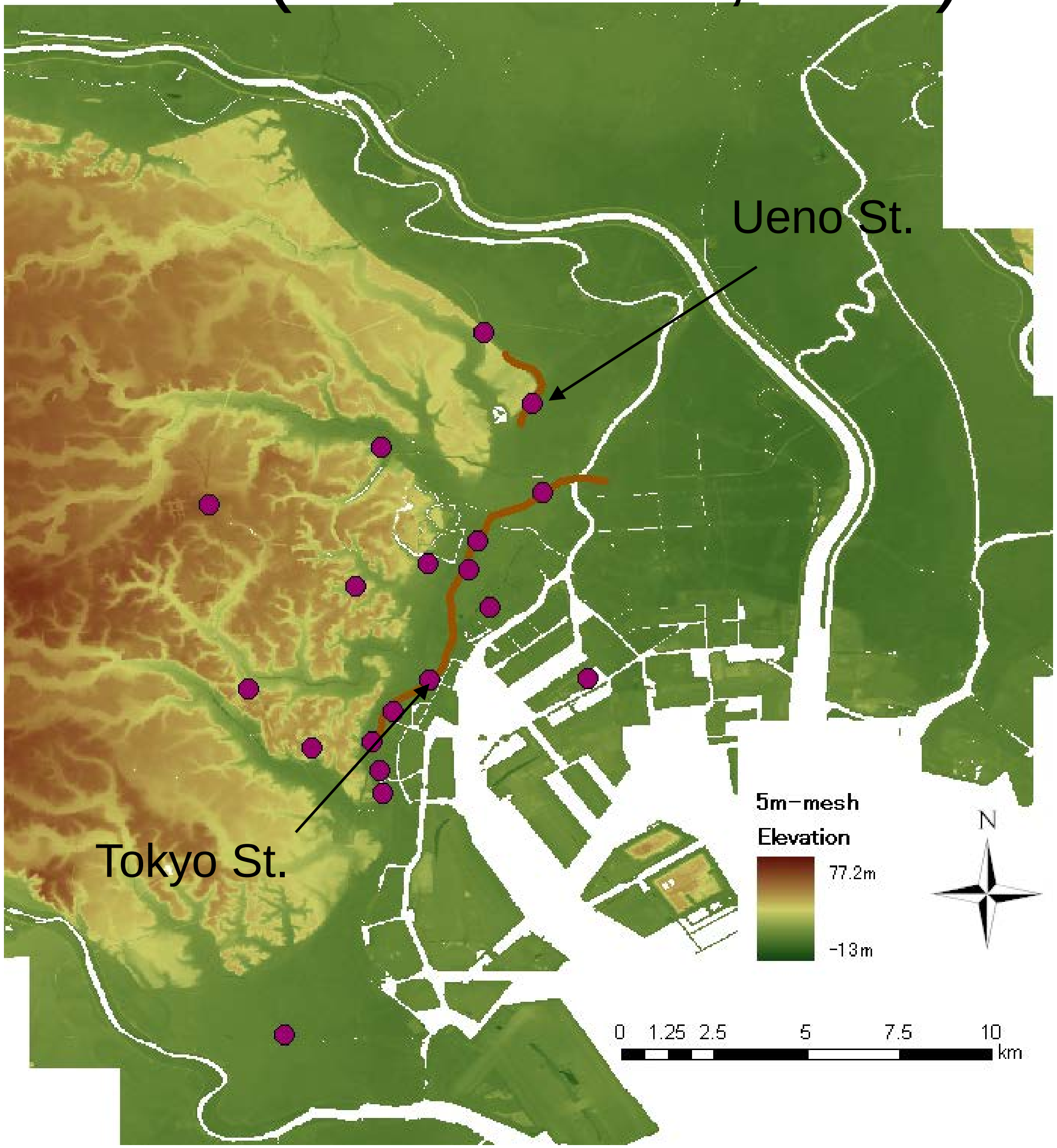


Buoyancy problem
(Ueno Station)

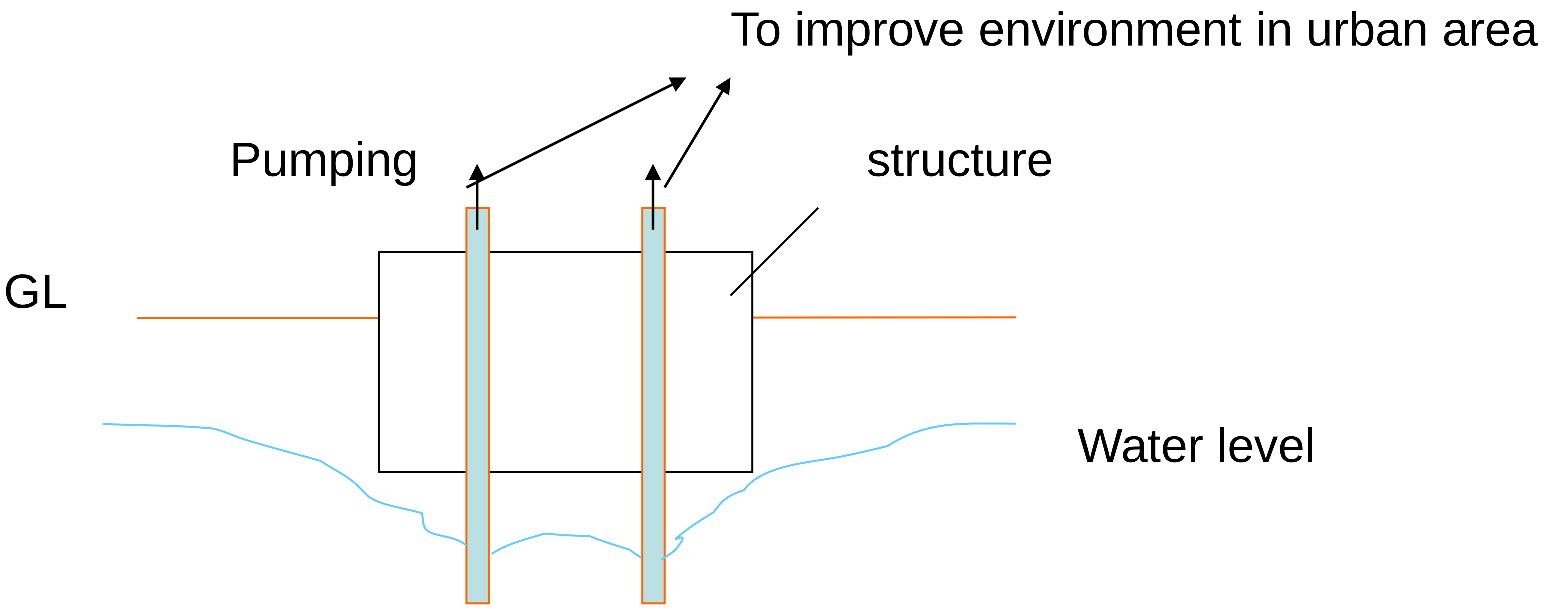


Seepage problem
(Sobu line)
(Nikkei Const., 2004)

Countermeasures against high groundwater level (after Hirose,2004)

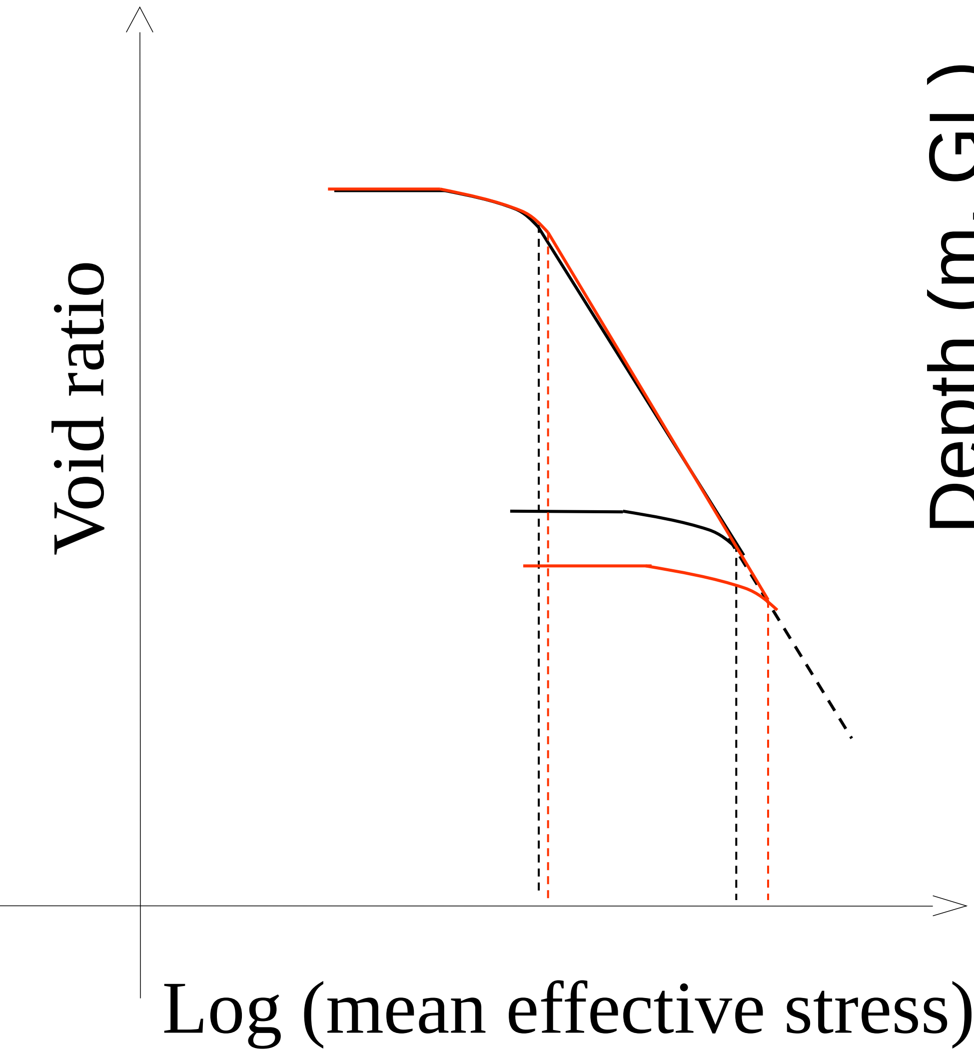


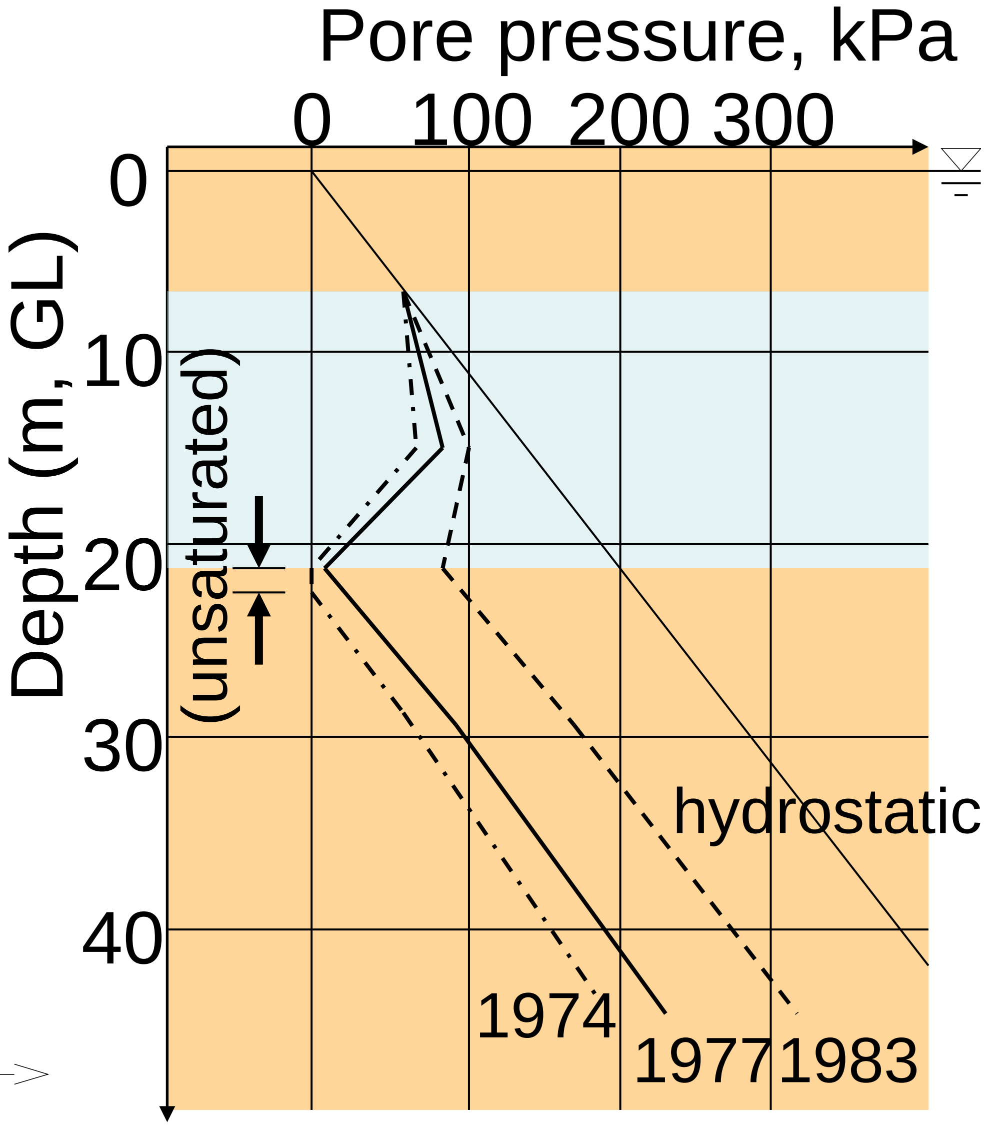
(Background map is 5m-mesh topography)



An image of improving high groundwater level problem and environment by extracted water

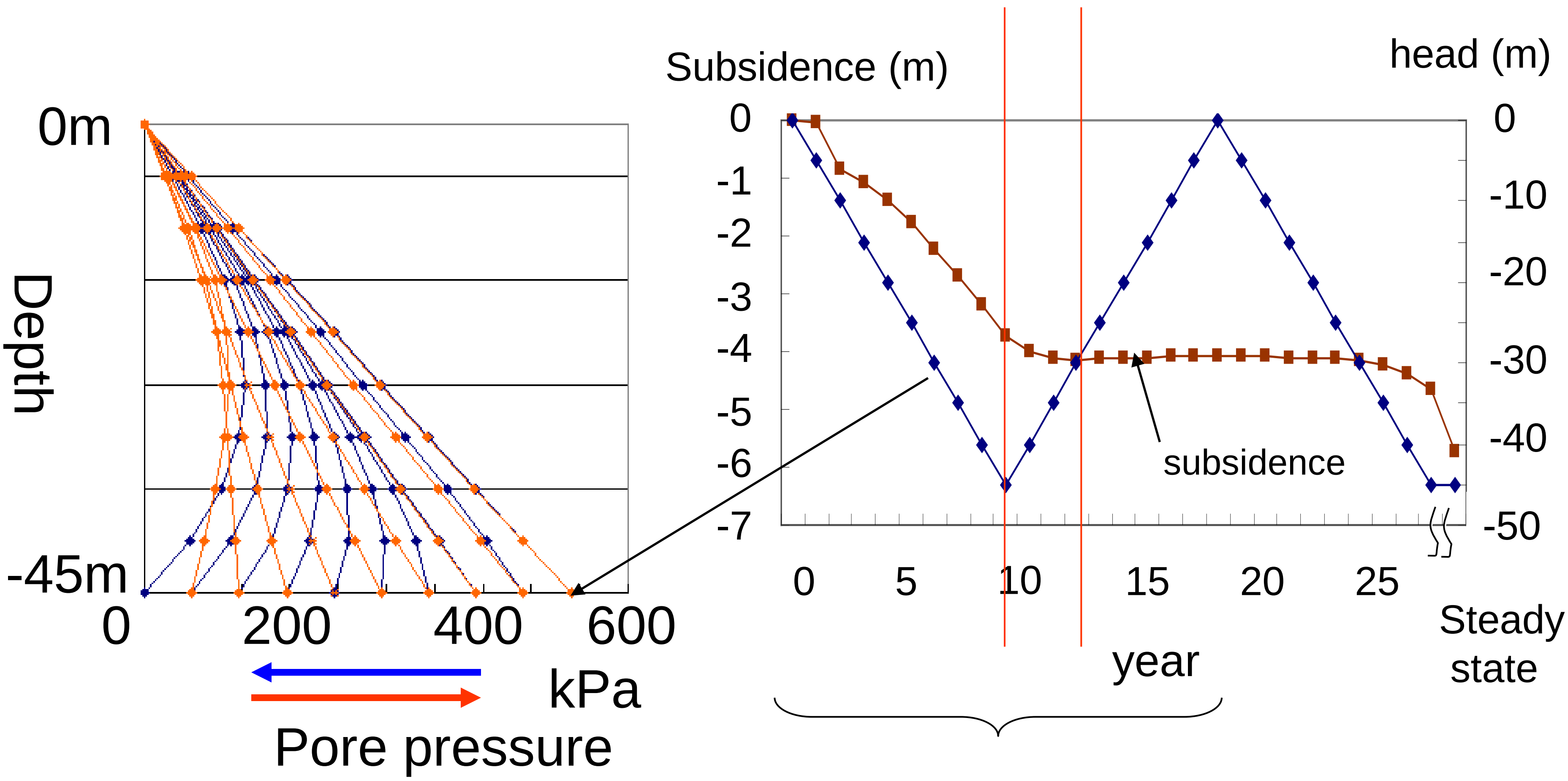
Land re-subsidence is small enough?



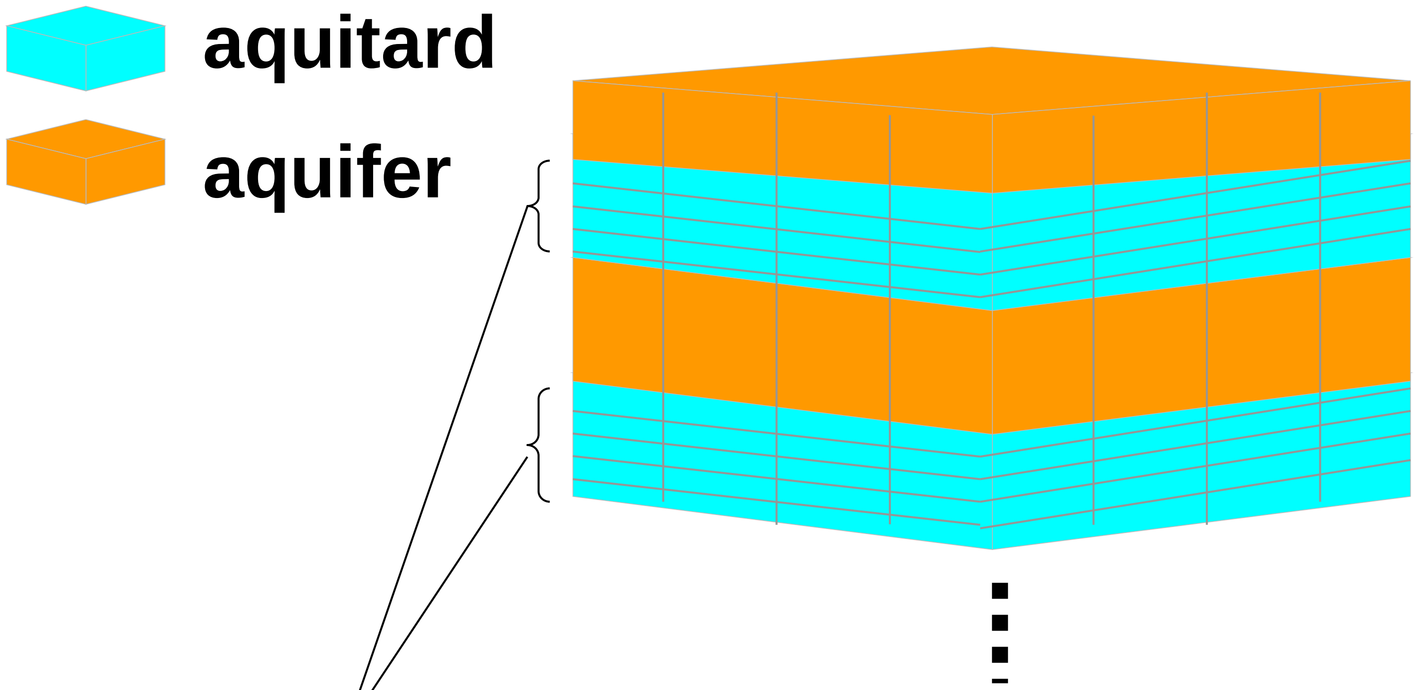


A history of pore pressure profile
in the aquitard. After Hirose et al. (2004

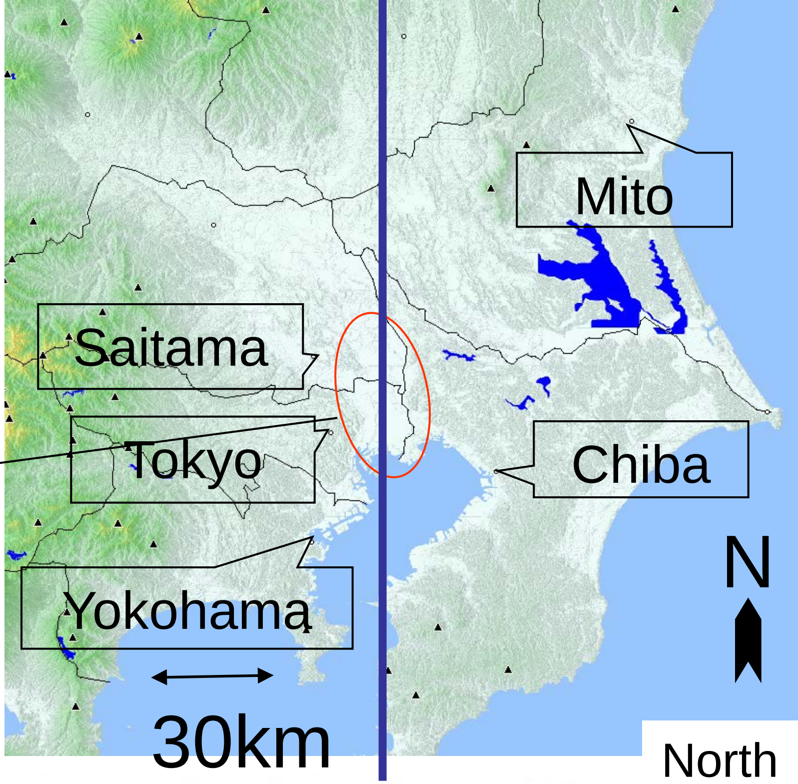
Importance of high resolution



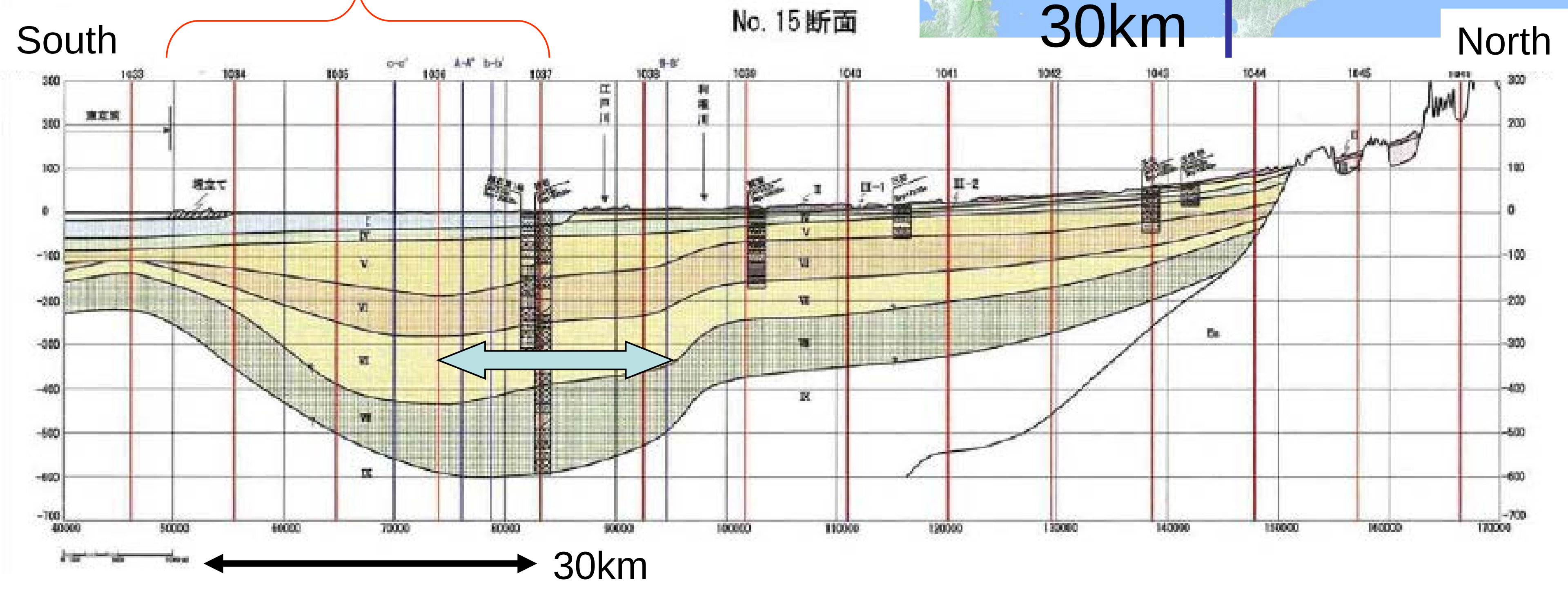
Meshing aquifer-aquitard system



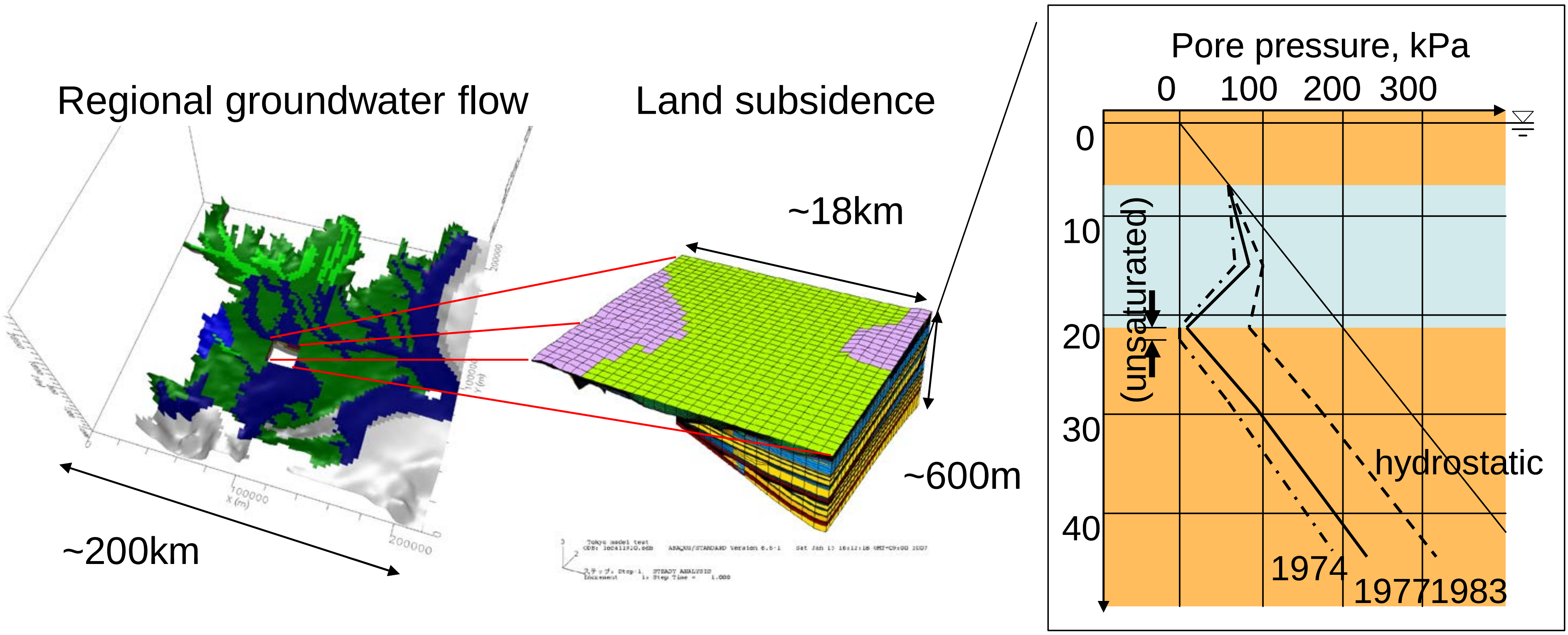
High resolution is necessary



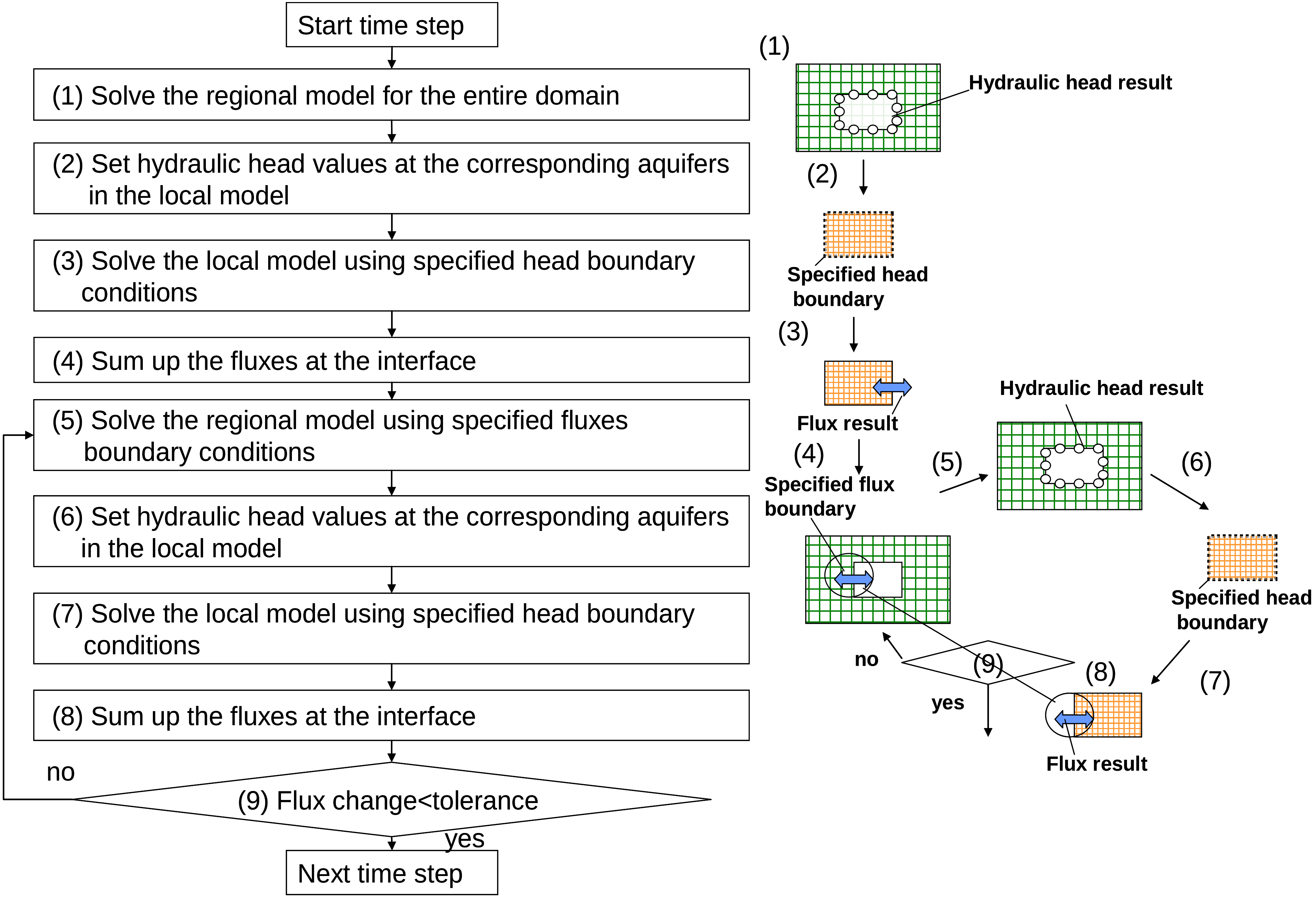
Significant land subsidence



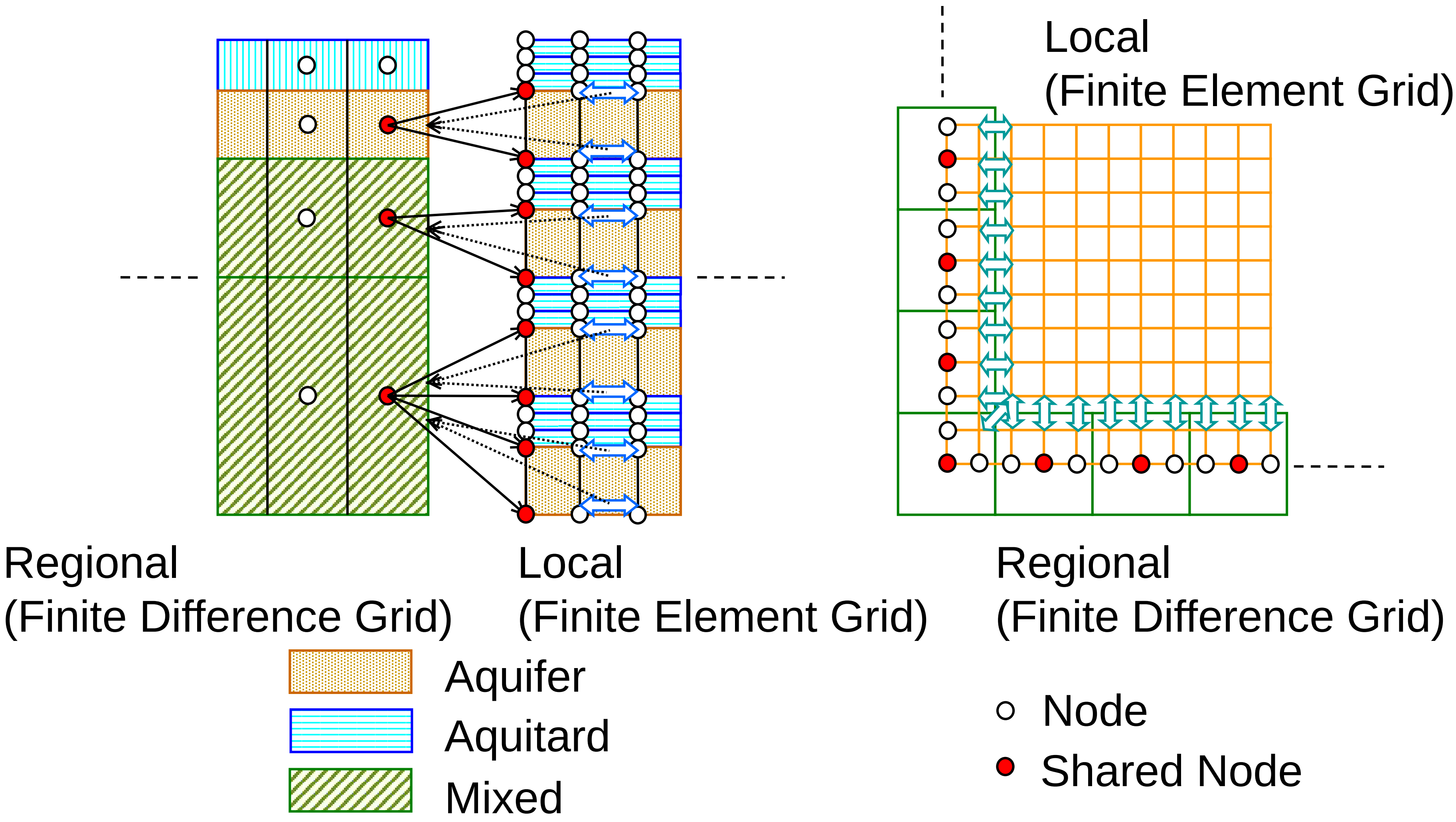
Spatial dimension of the problem



Nesting model is effective



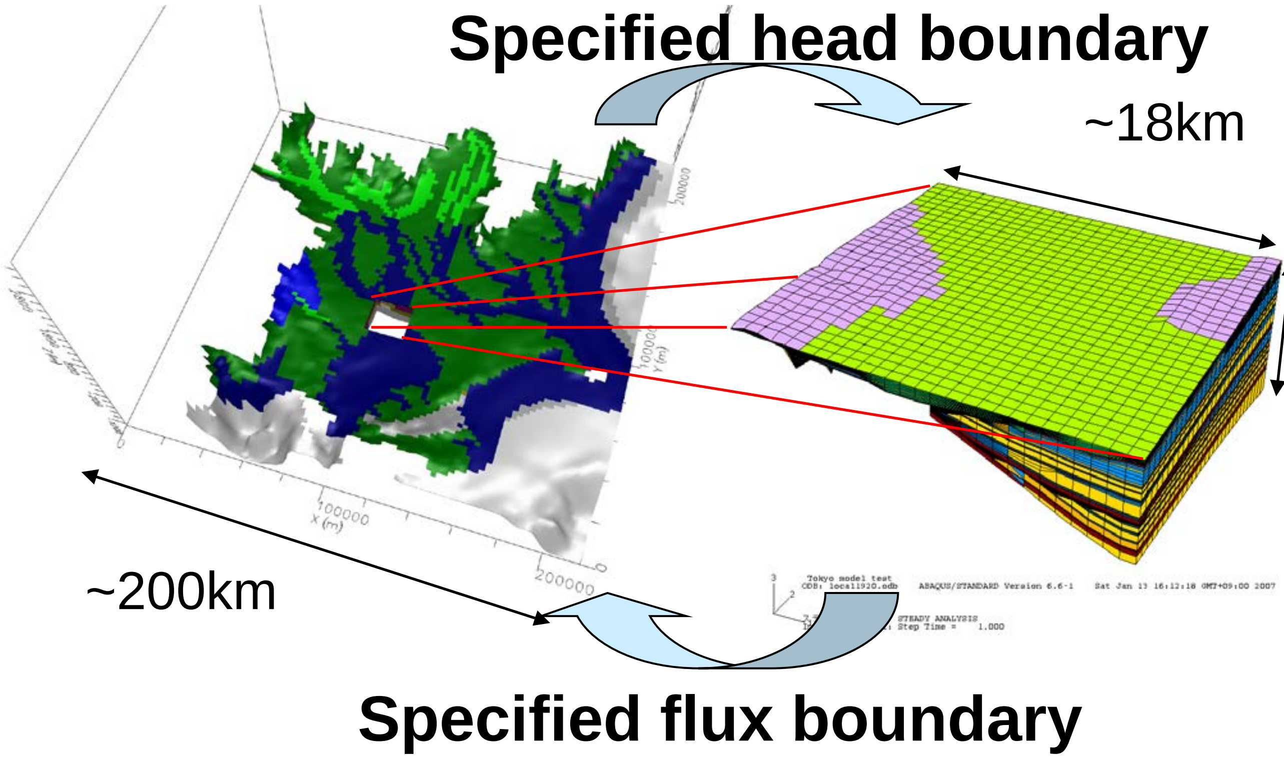
Start time step
(1) Solve the regional model for the entire domain
(2) Set hydraulic head values at the corresponding aquifers in the local model
(3) Solve the local model using specified head boundary conditions
(4) Sum up the fluxes at the interface
(5) Solve the regional model using specified fluxes boundary conditions
(6) Set hydraulic head values at the corresponding aquifers in the local model
(7) Solve the local model using specified head boundary conditions
(8) Sum up the fluxes at the interface
no
(9) Flux change<tolerance
yes
Next time step
(1)
Hydraulic head result
(2)
Specified head boundary
(3)
Flux result
(4)
Specified flux boundary
(5)
Hydraulic head result
(6)
Specified head boundary
(7)
(8)
Flux result
(9)
no
yes

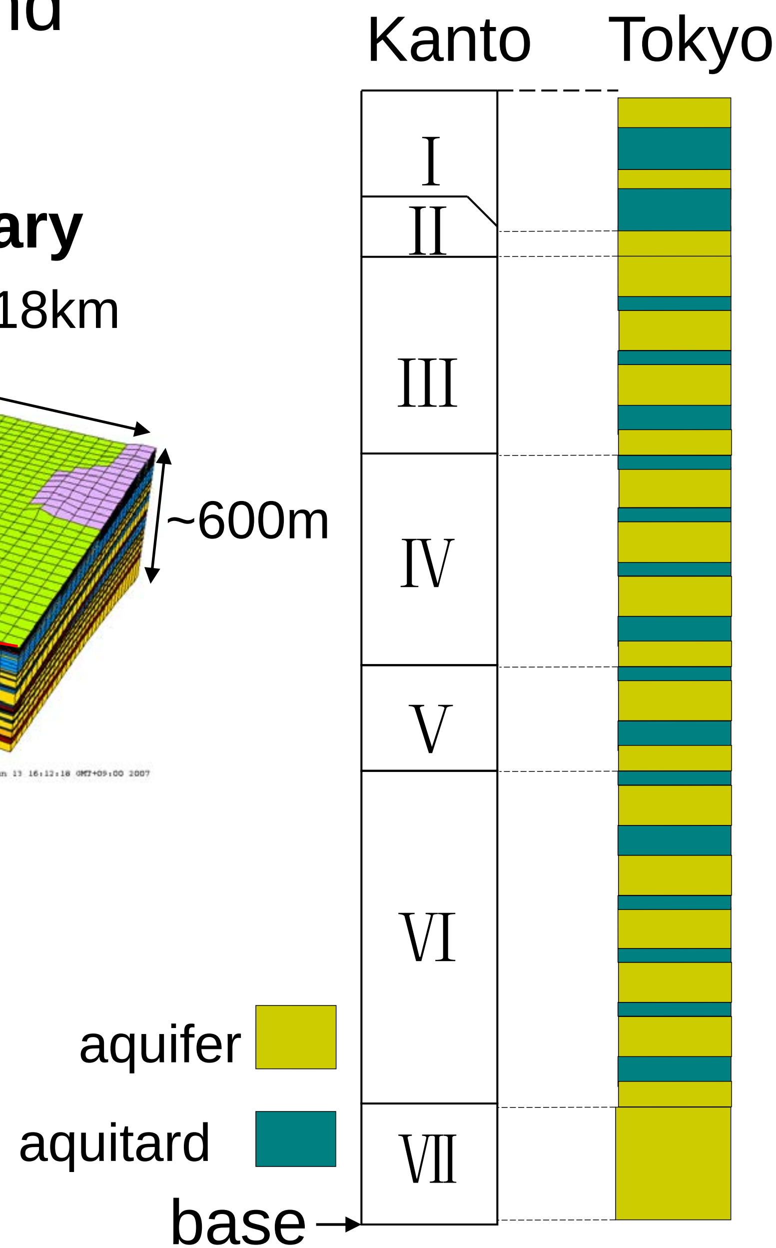

Local
(Finite Element Grid)
Regional
(Finite Difference Grid)
Local
(Finite Element Grid)
Regional
(Finite Difference Grid)
Aquifer
Aquitard
Mixed
Node
Shared Node

Groundwater flow model for the Kanto Plain

Coupled model for the Tokyo lowland

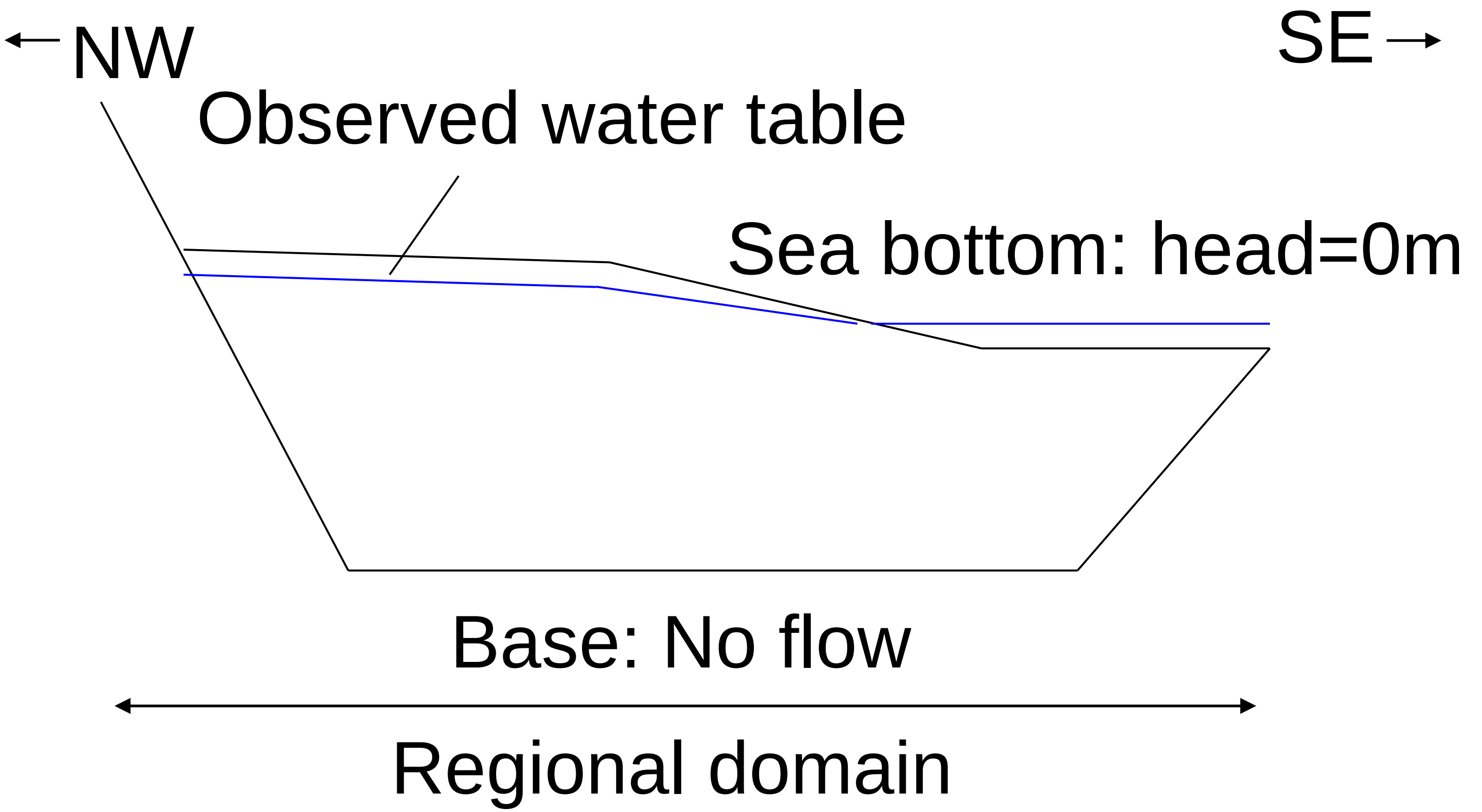
Resolution



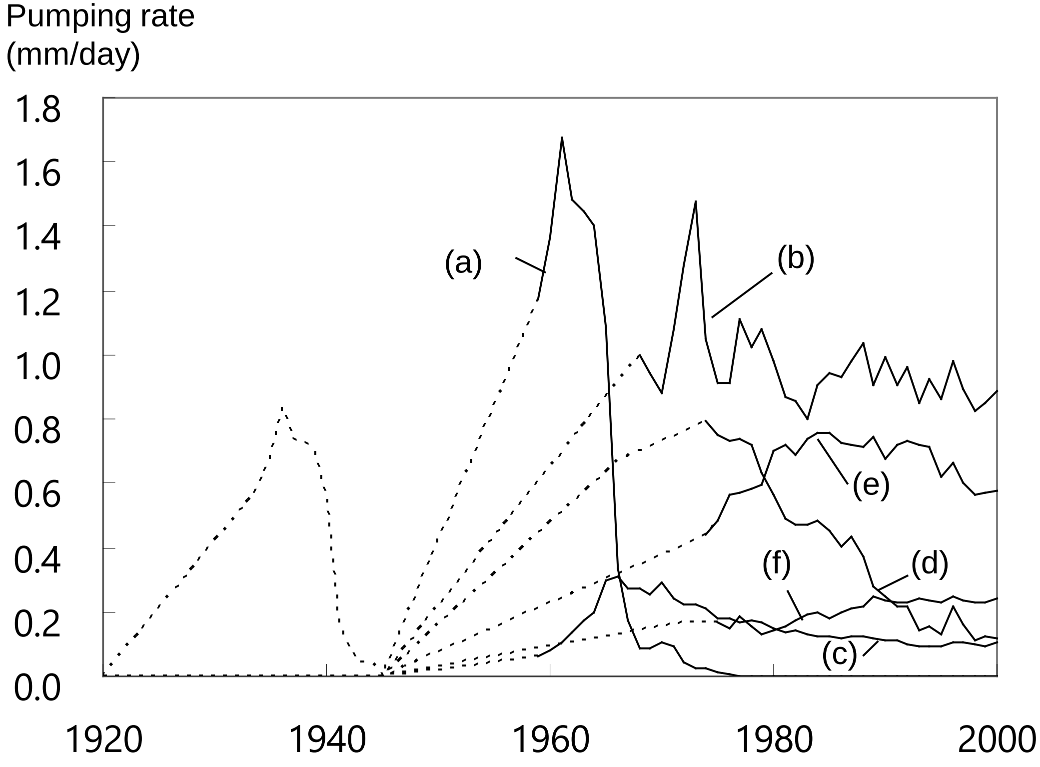


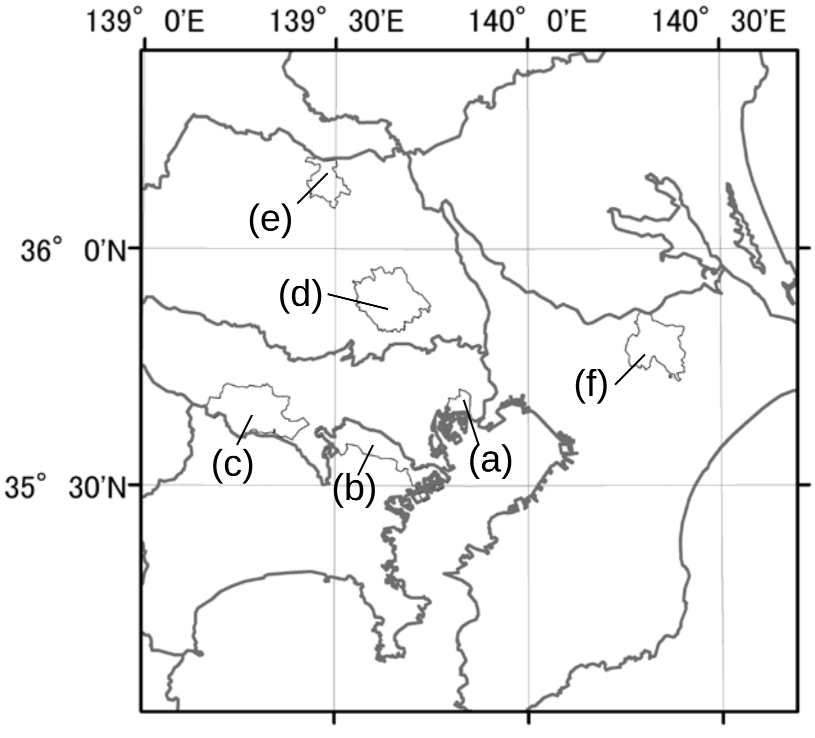
Iterative procedure assures the continuity of groundwater flow at the boundary of two models

Boundary condition



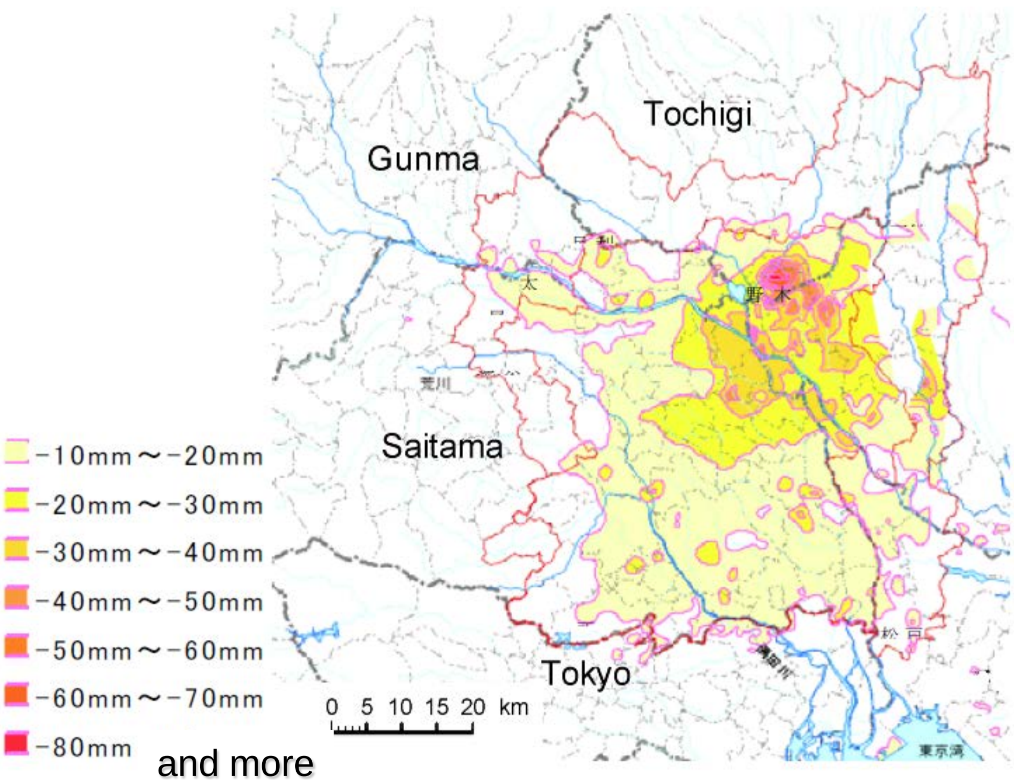
Groundwater abstraction data





Small subsidence in other area of the Kanto Plain

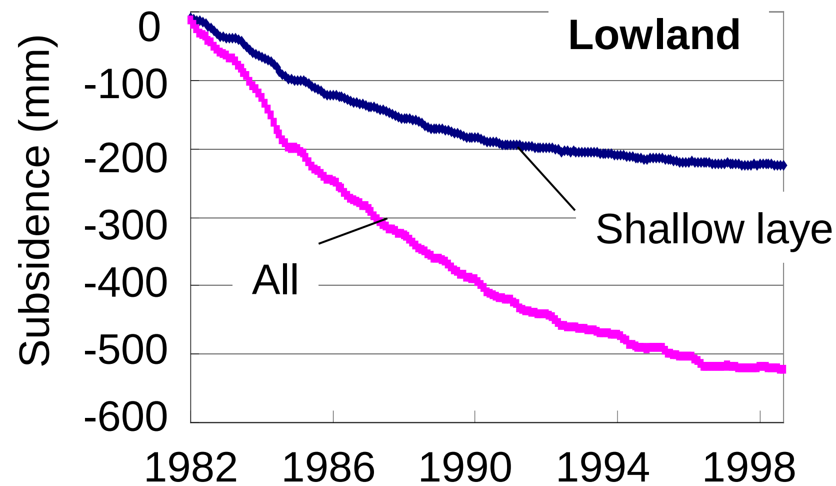
Horizontal distribution

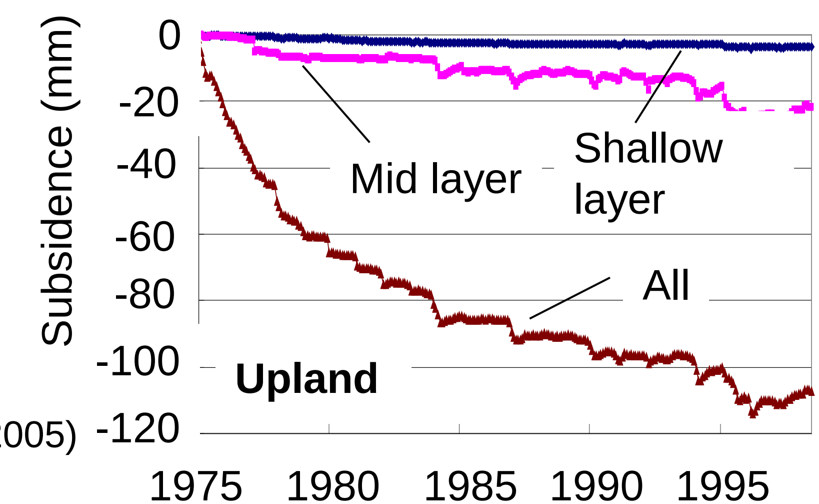


Land subsidence Map

Ministry of Land, Infrastructure and Transport (2005)

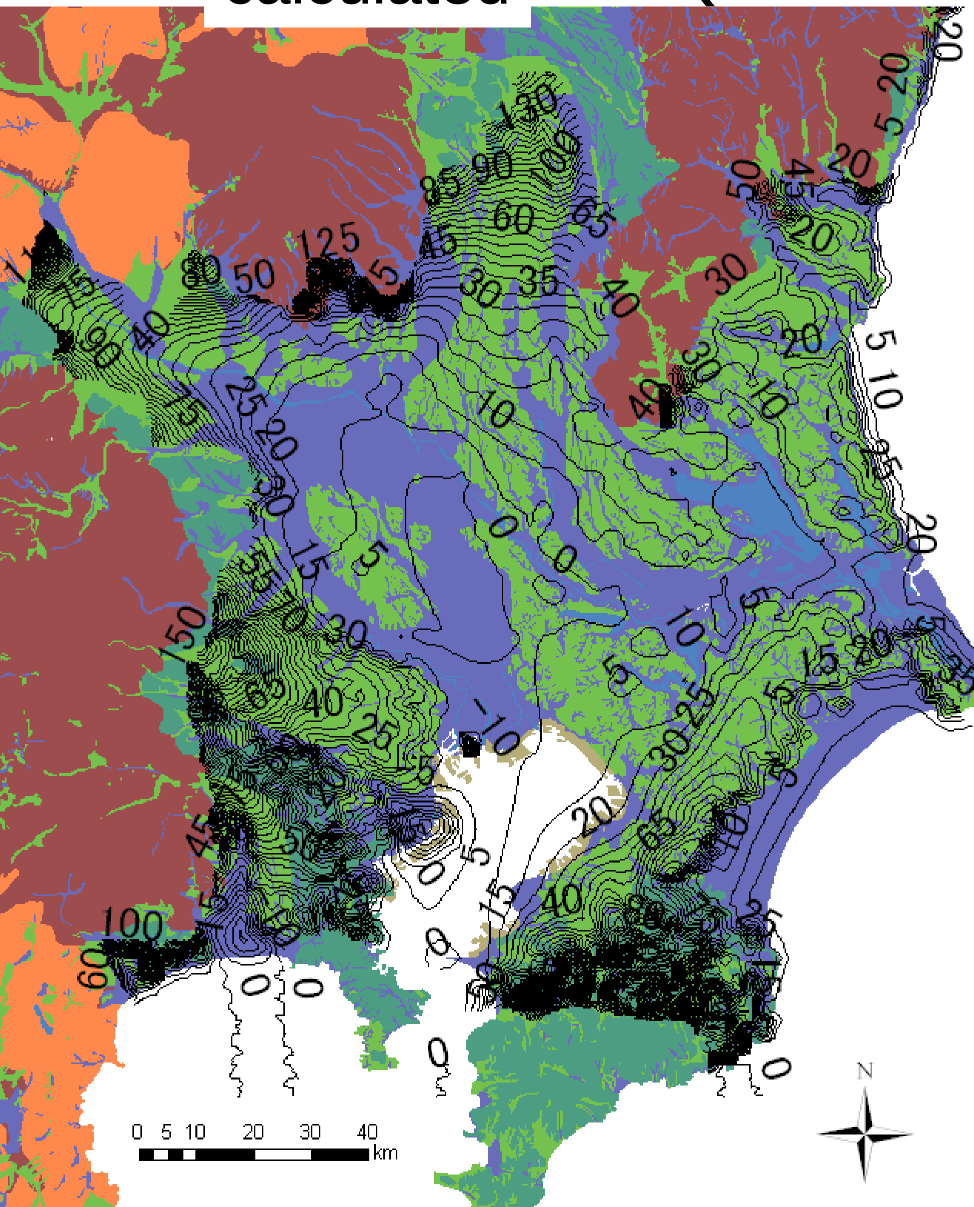
Vertical distribution



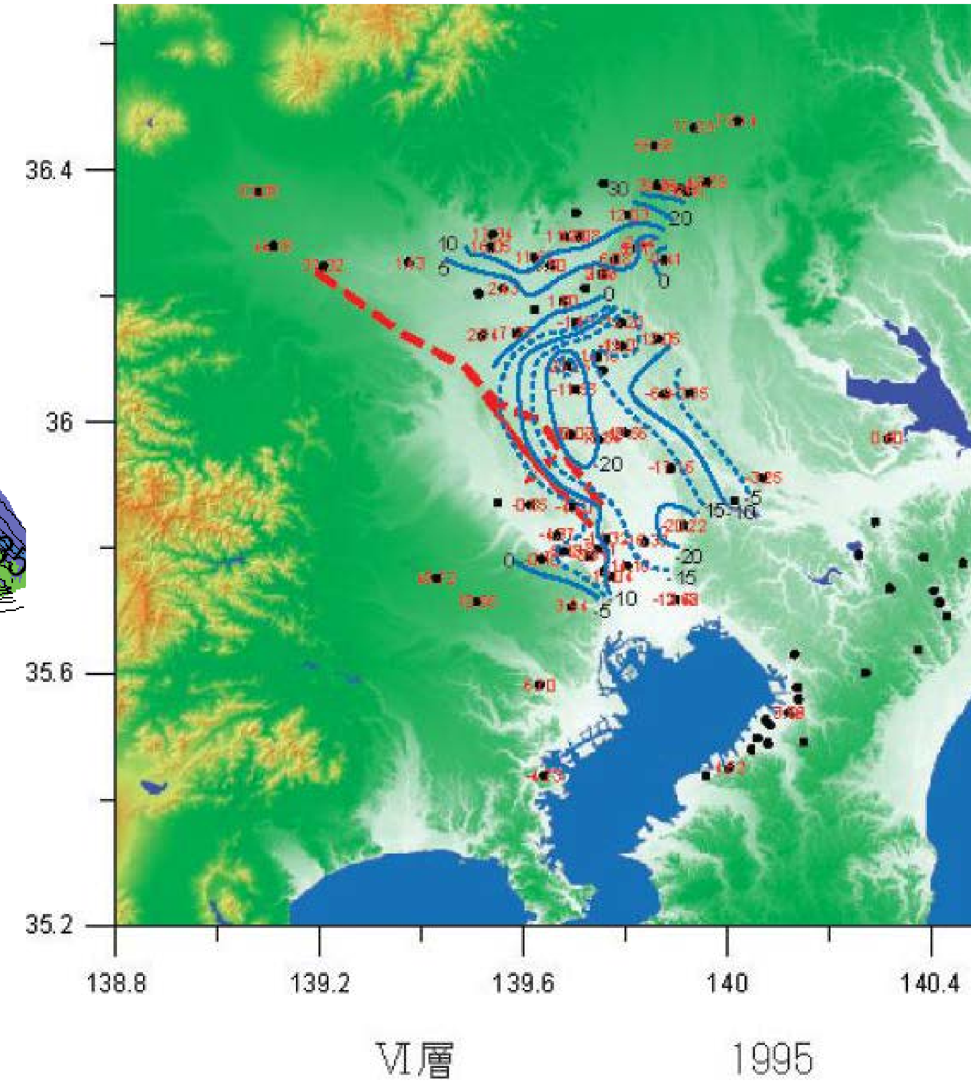


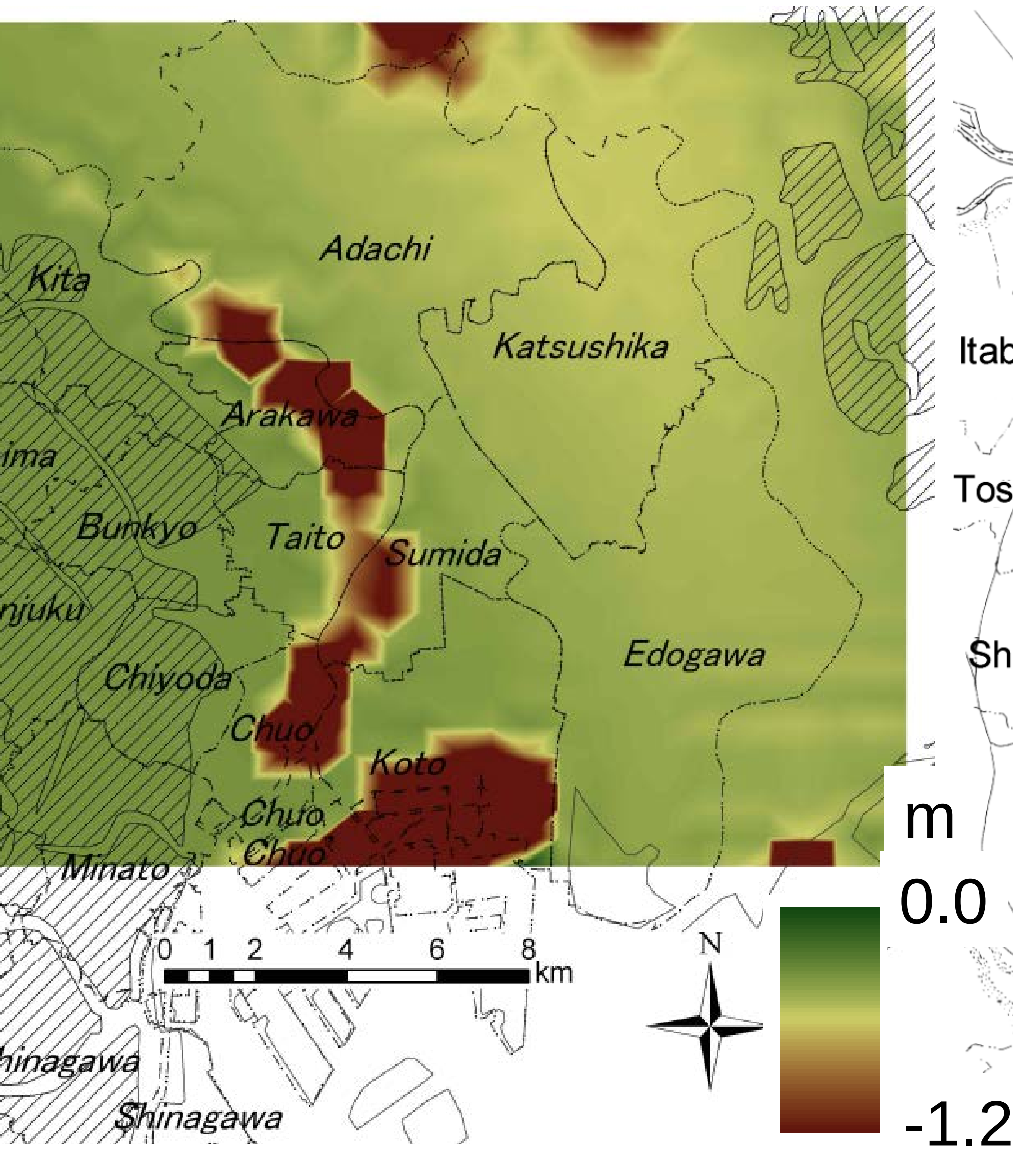
Spatial distribution of hydraulic head (Plain scale)

calculated

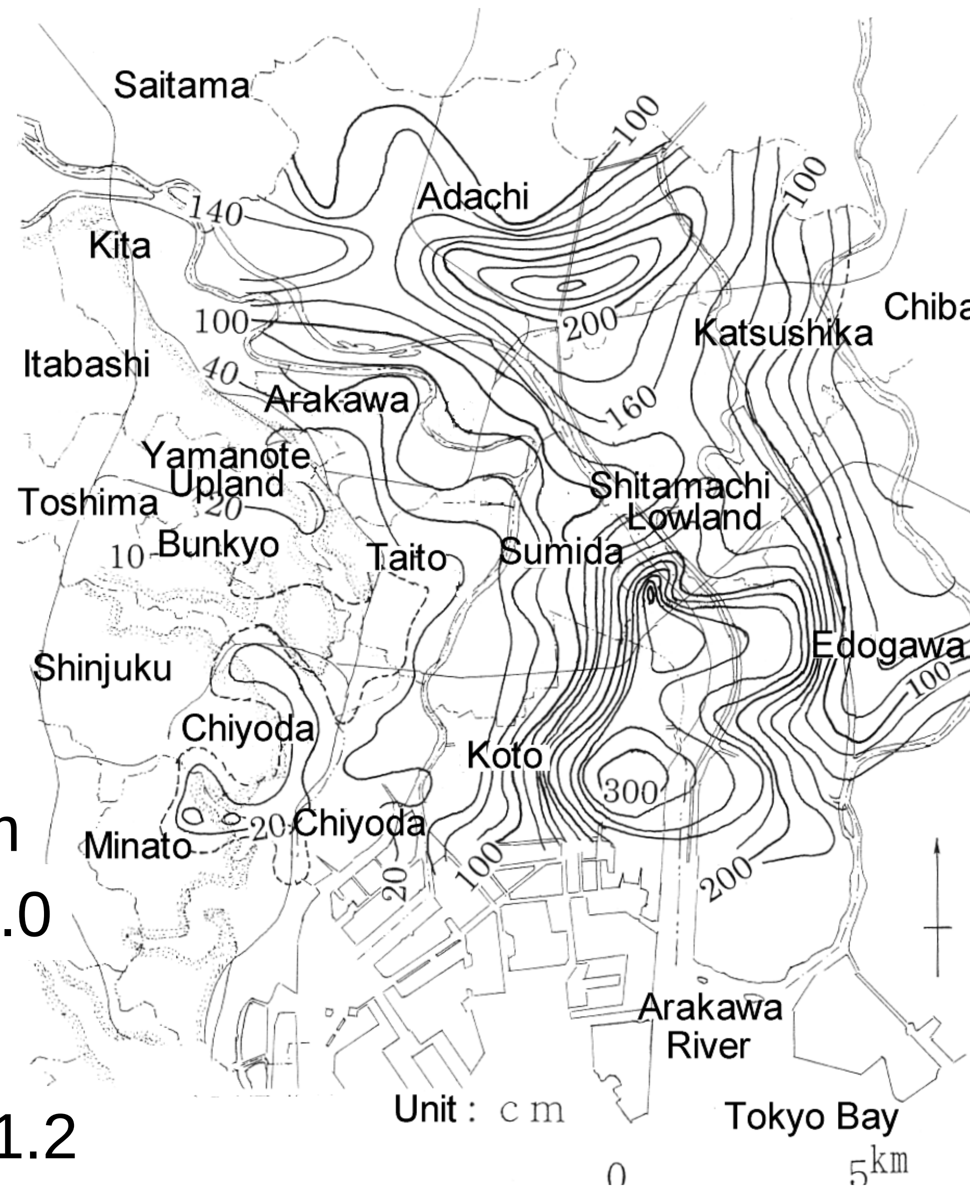


Observed (Hayashi, 2006)

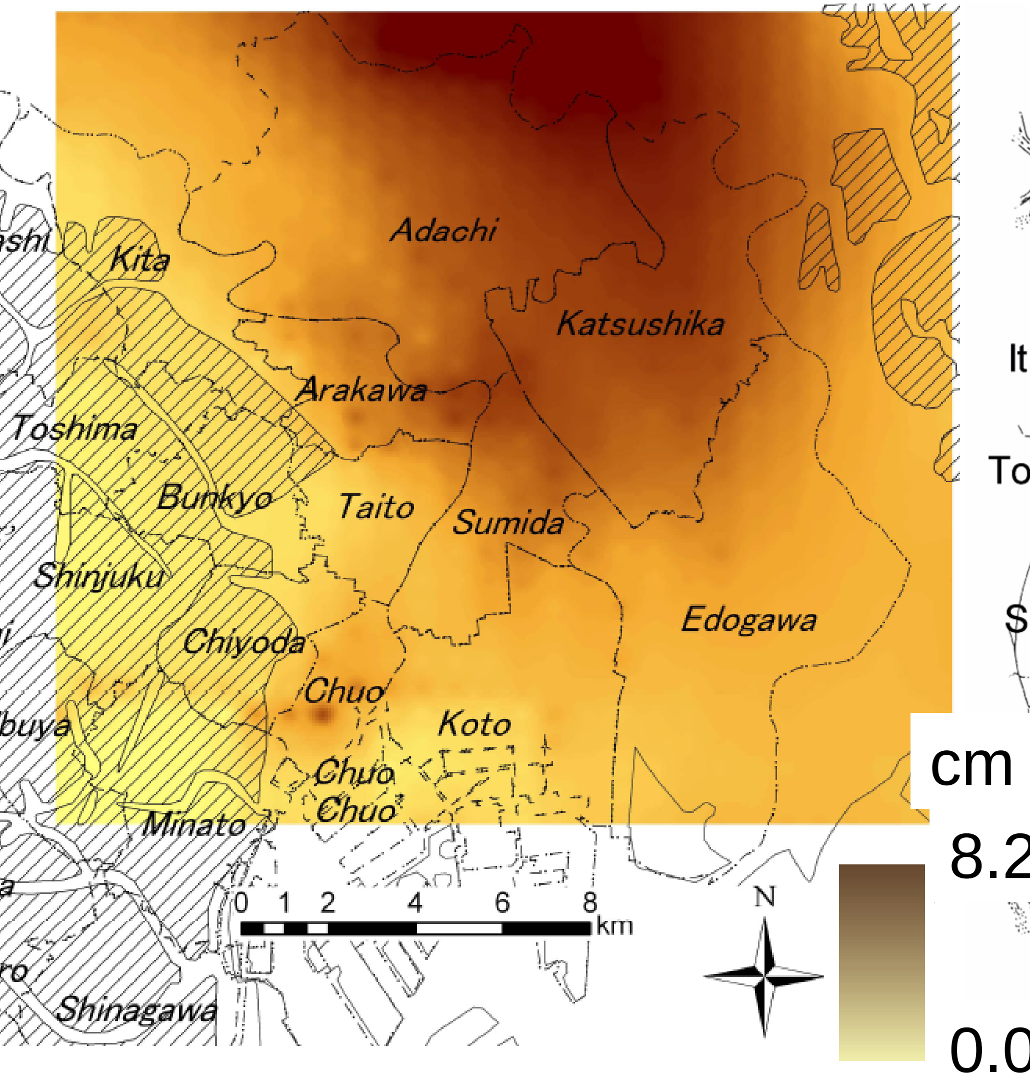




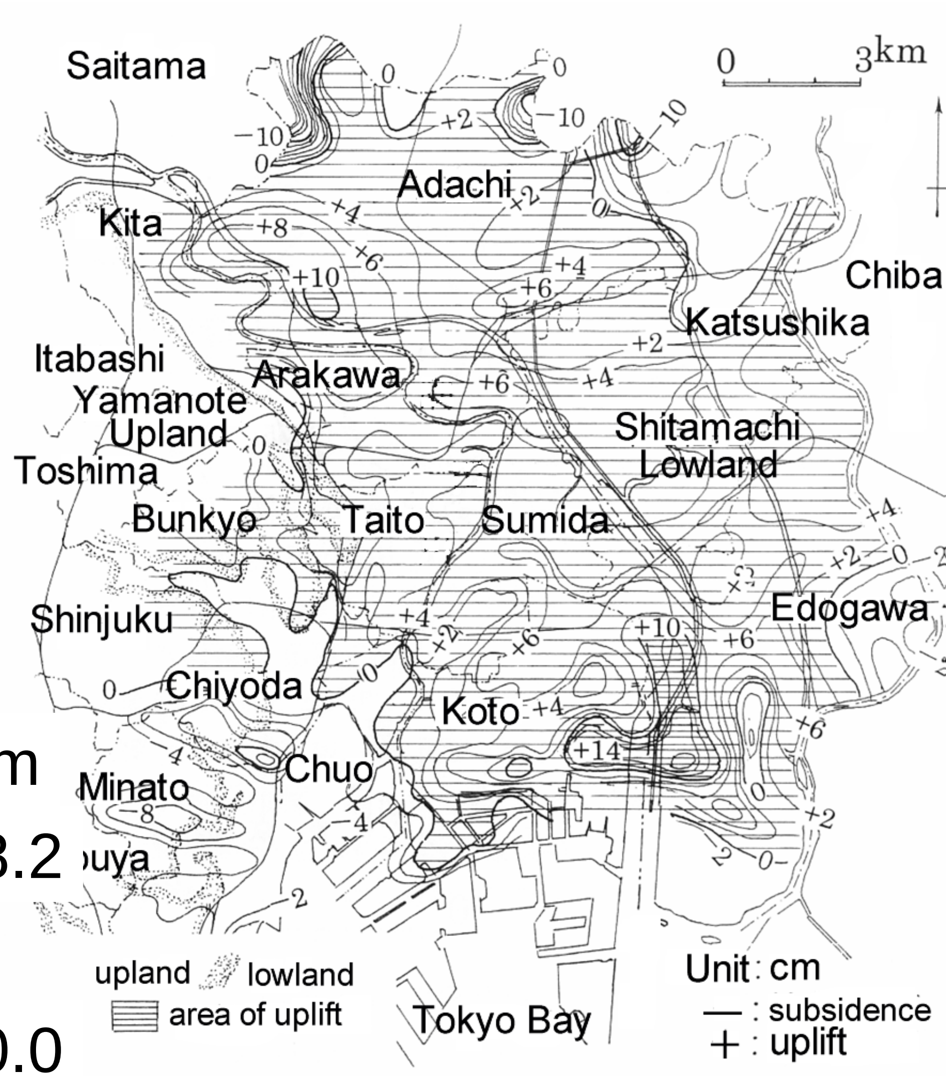
Calculated land subsidence
(1938-1977)



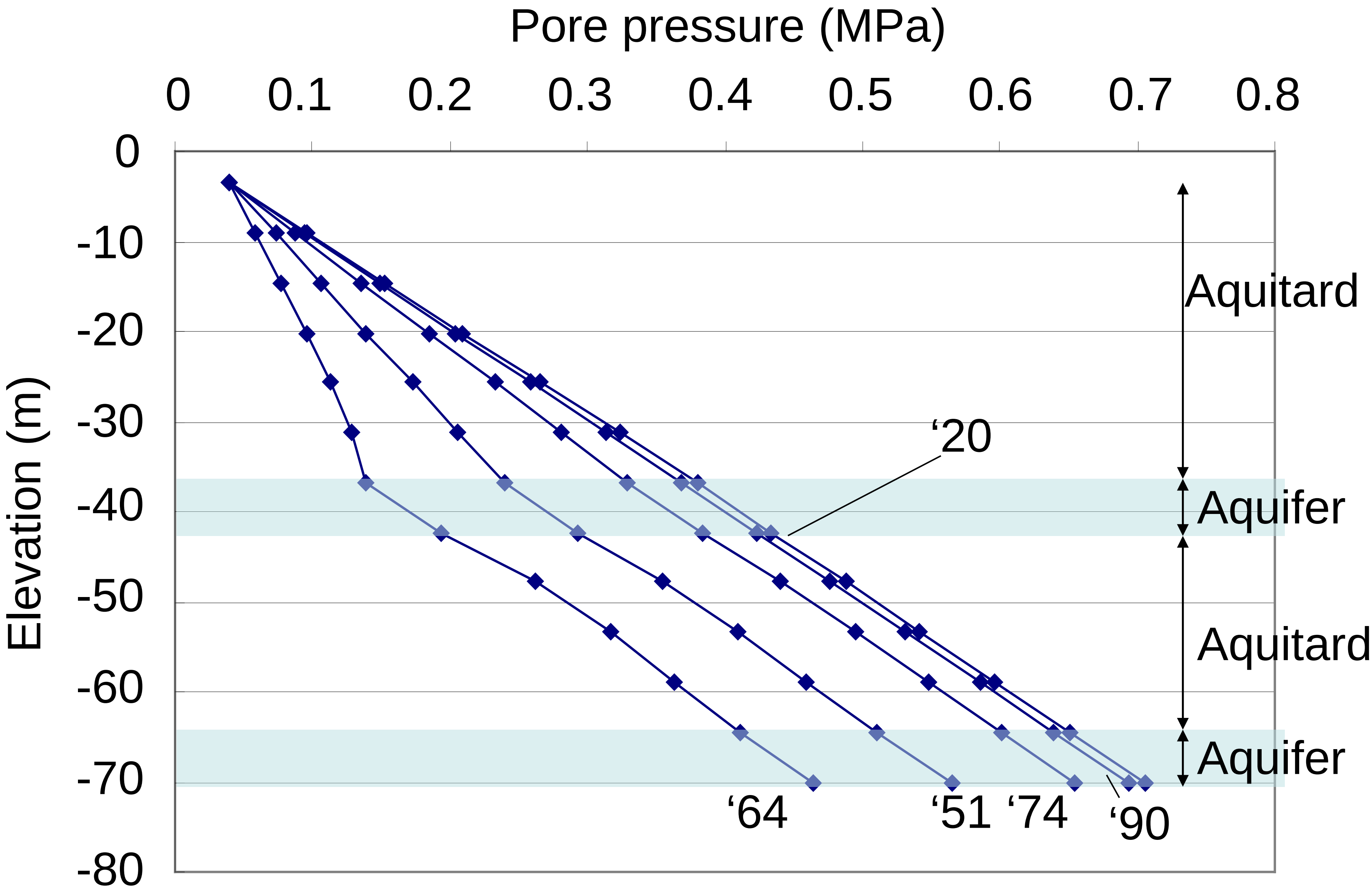
Observed land subsidence (1938-1977)
（Endo et al., 2001）



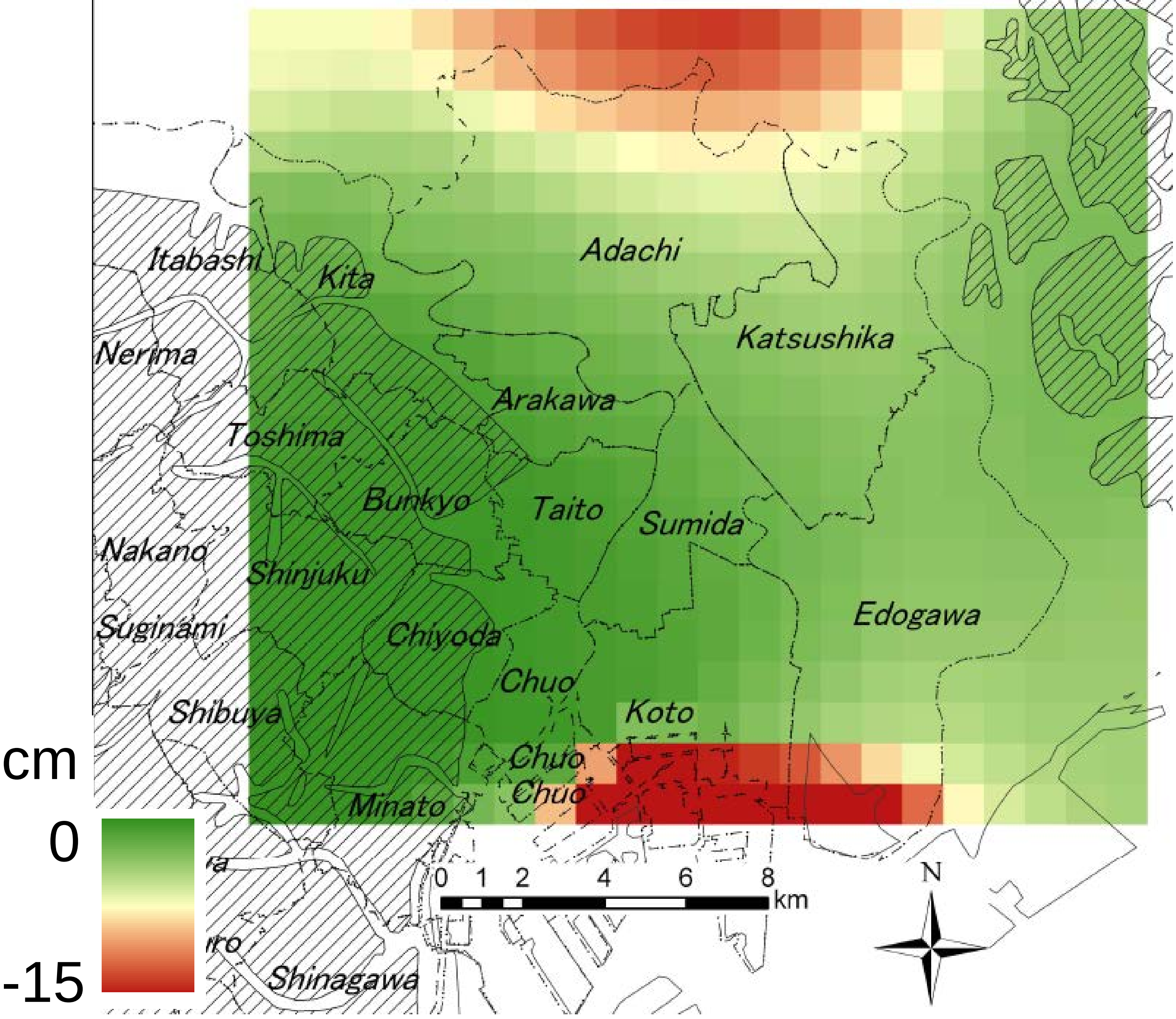
Calculated land uplift (1974-1997)



Observed land uplift (1974-1997)
（ Endo et al., 2001 ）

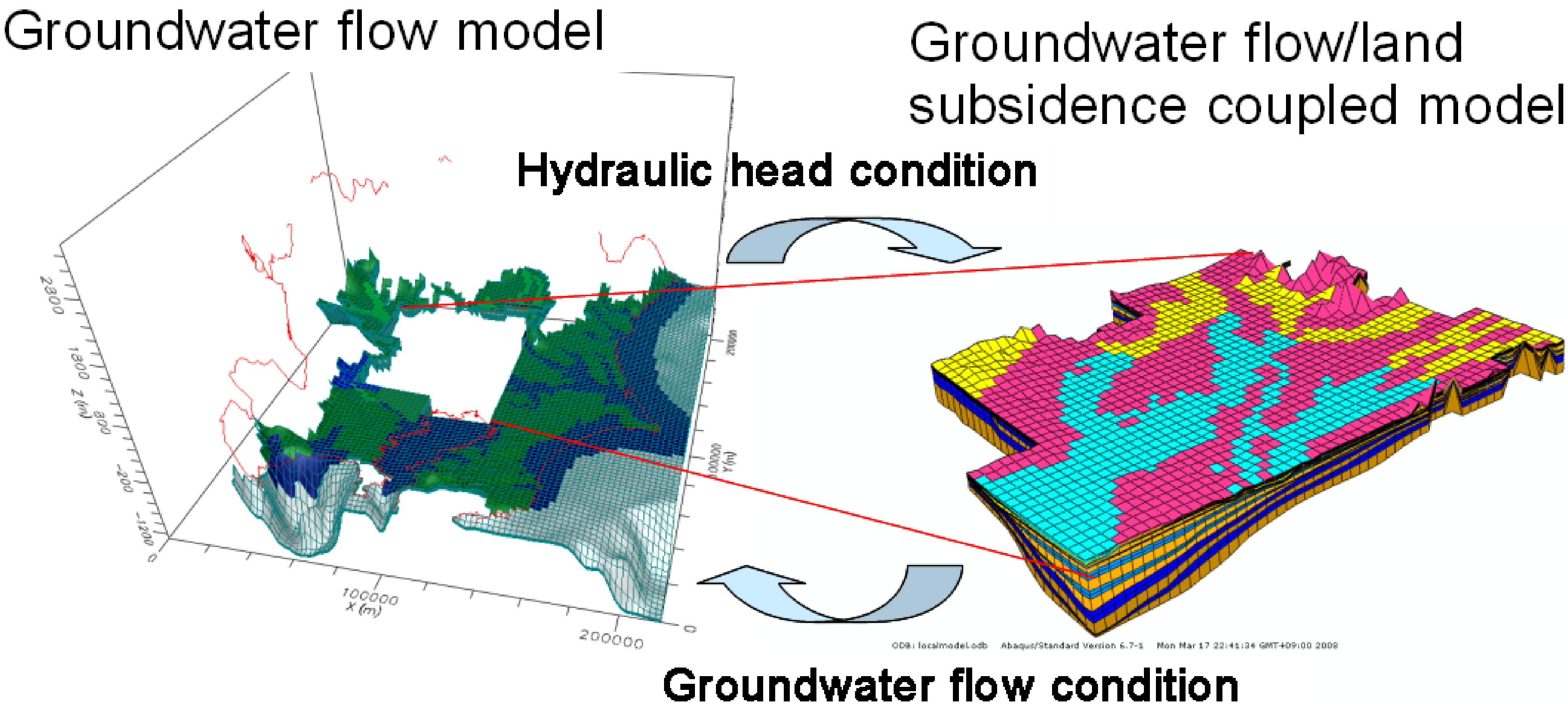


An example of the temporal change of the pore pressure profile



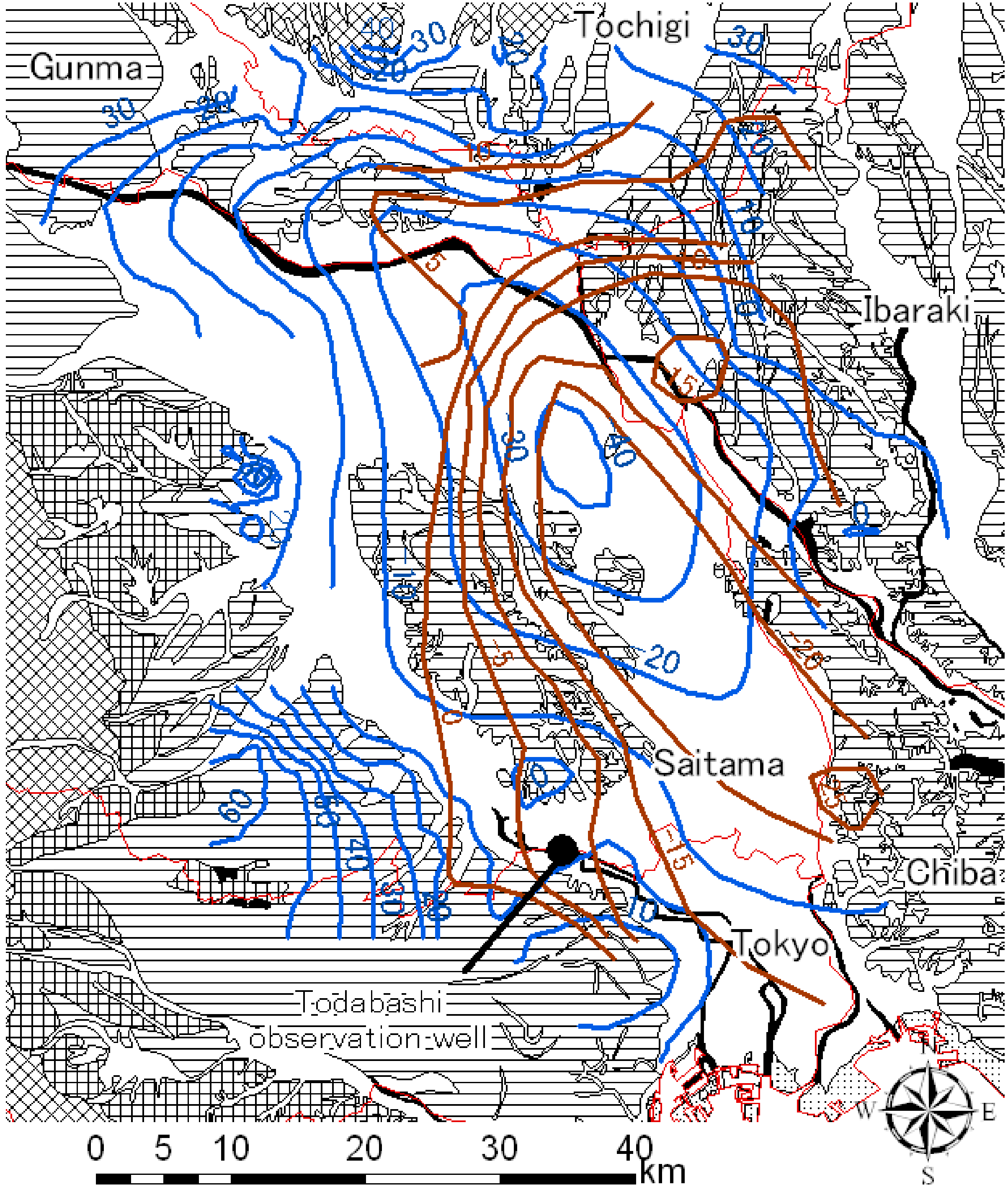
A possible re-subsidence due to the future groundwater extraction as much as 1960's

Integrating regional groundwater flow and local groundwater flow/land deformation models

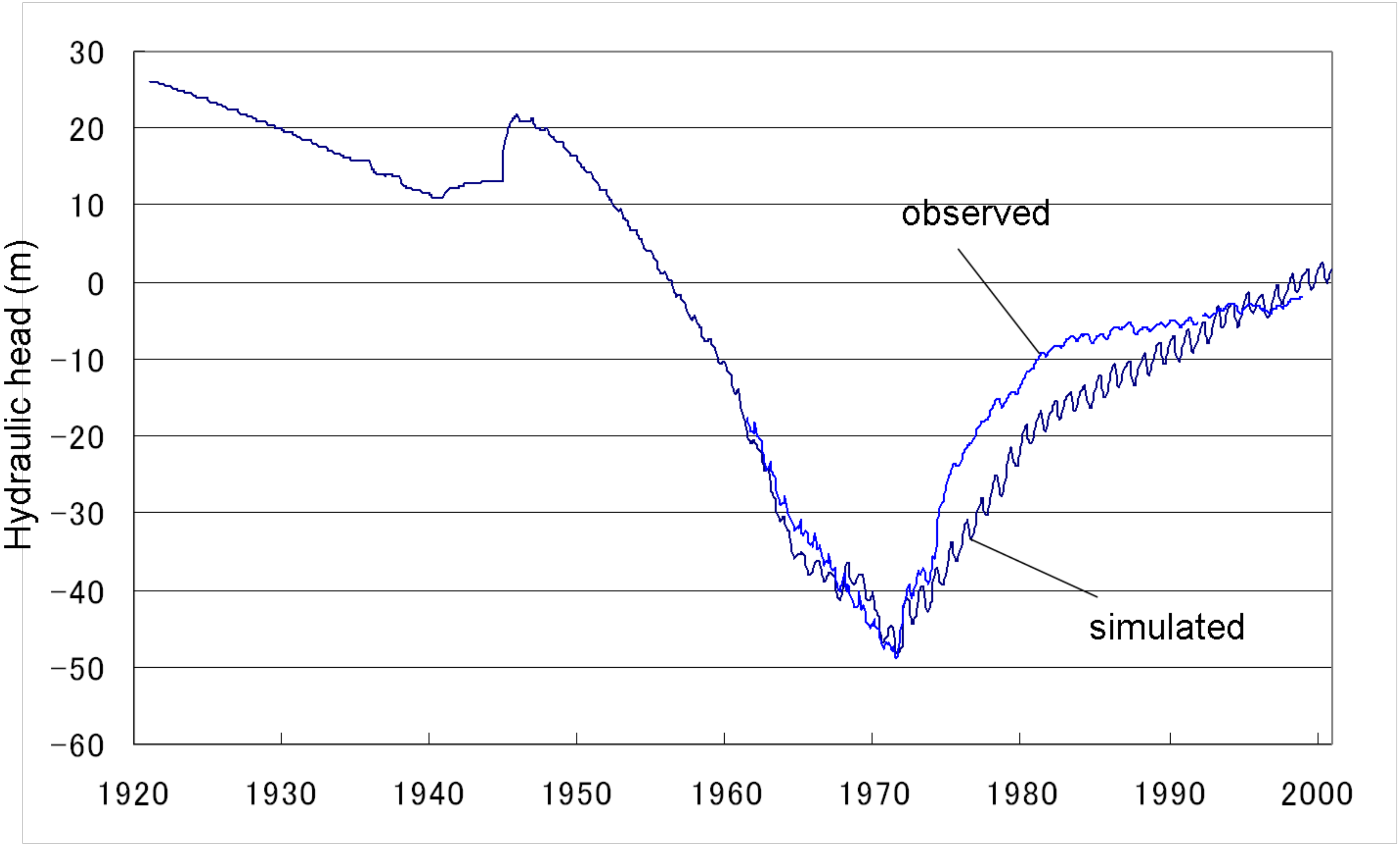


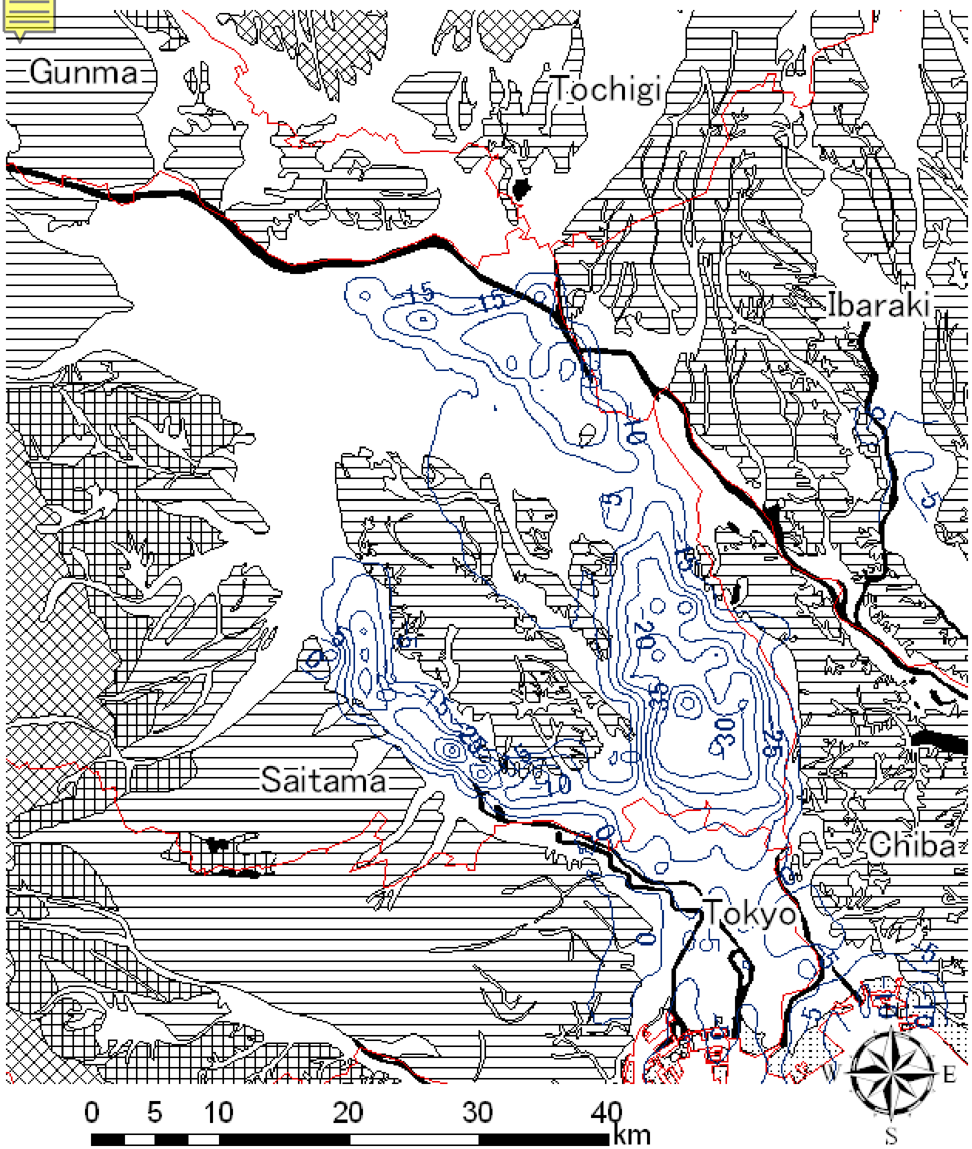
Comparison between the calculated and observed hydraulic potential

(Layer VI, 1985)

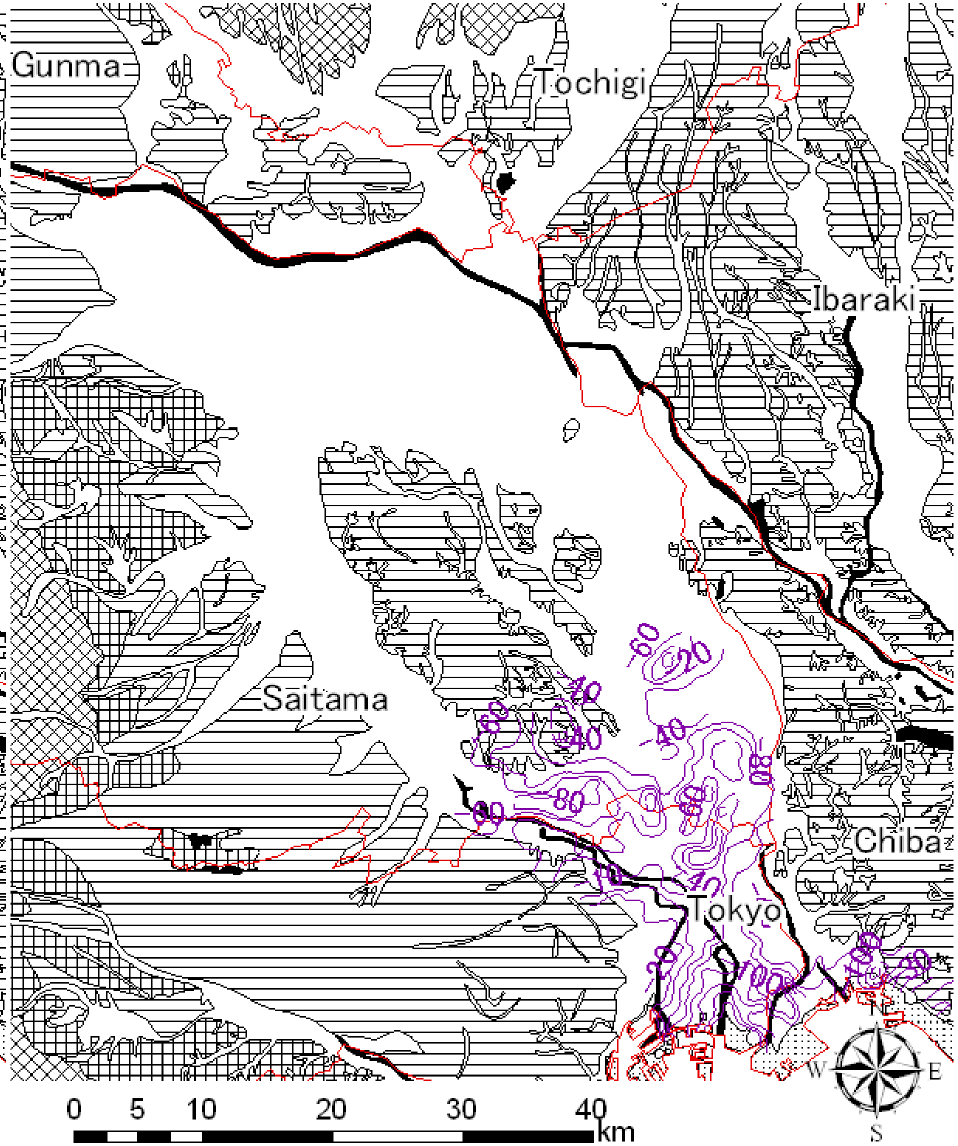


Reproducibility of the hydraulic head at the northern part of Tokyo



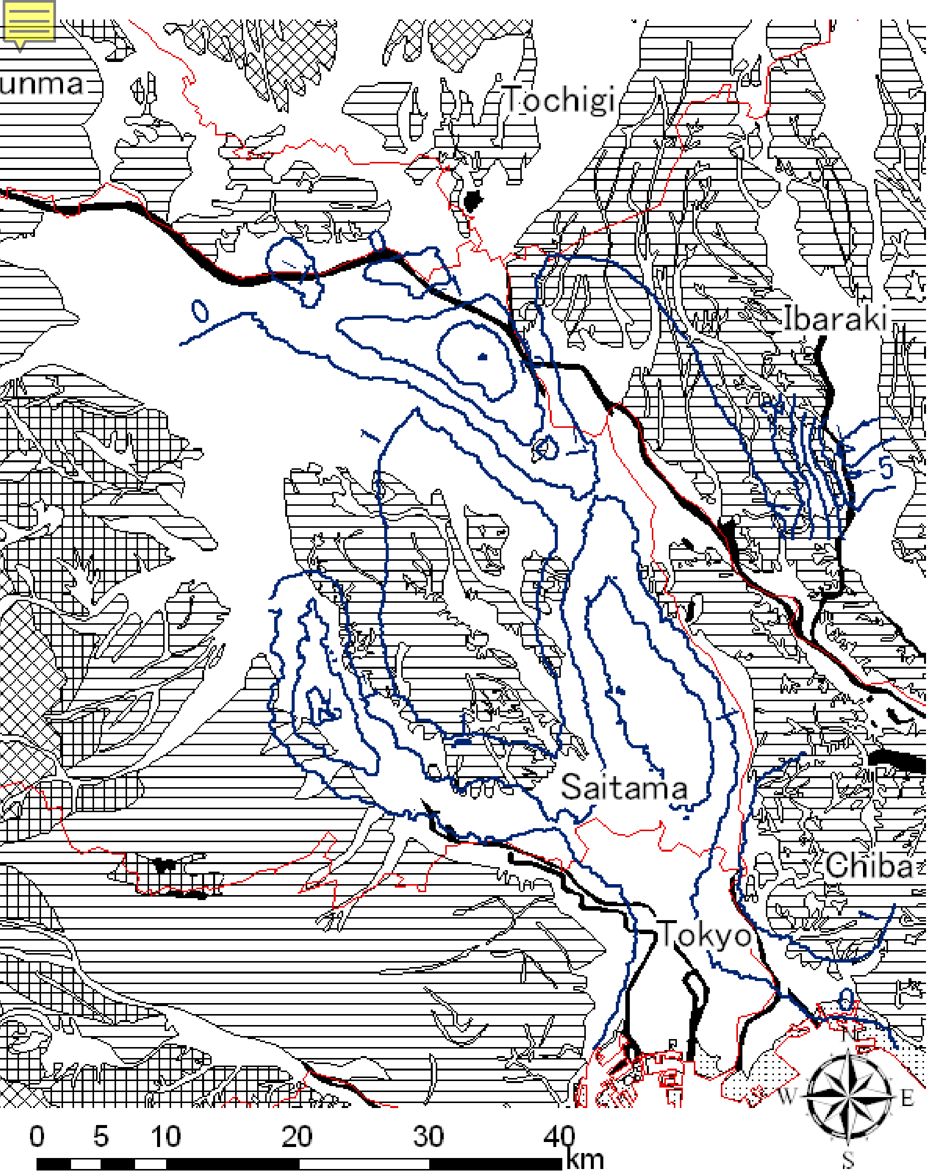


Simulated land subsidence from 1963 to 1973.

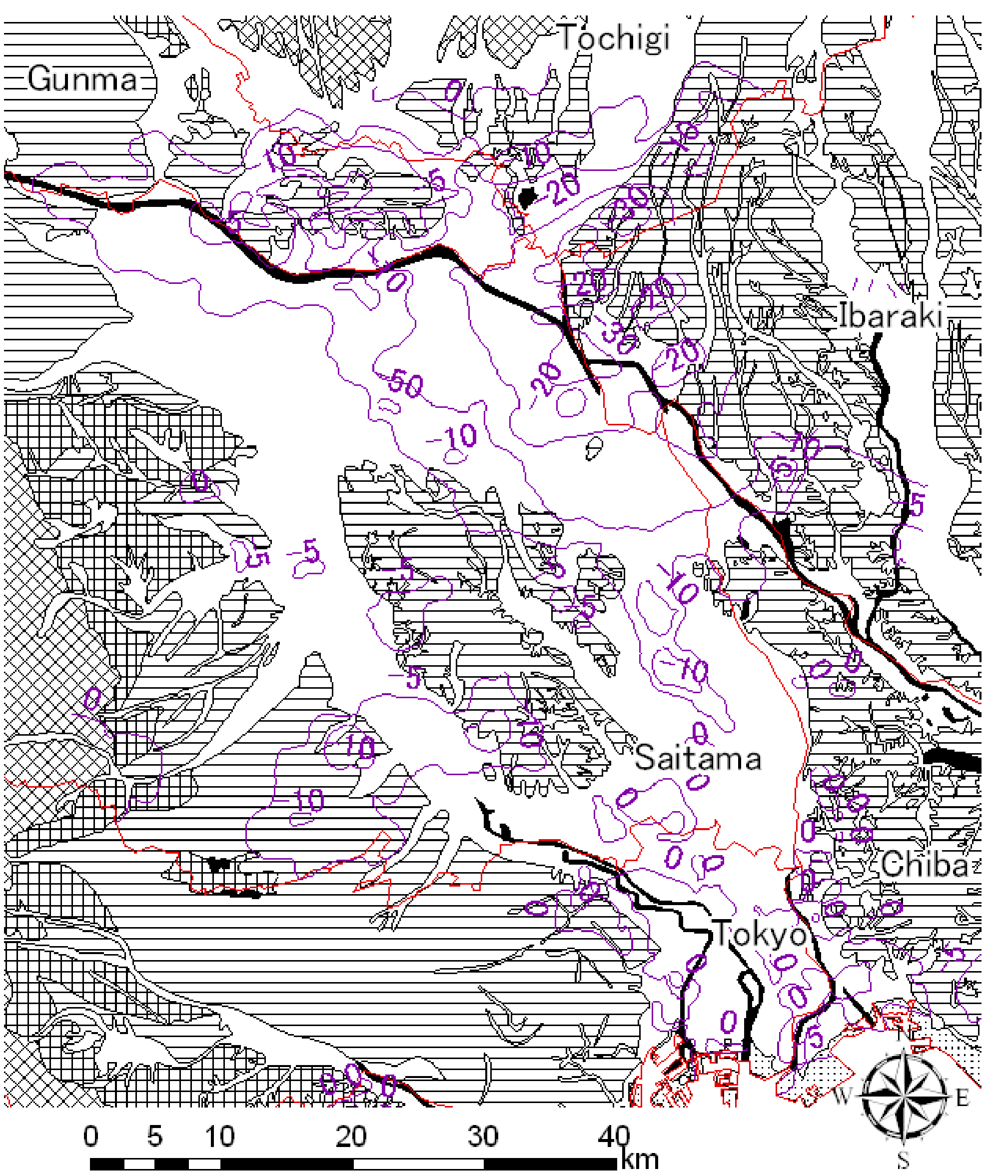


Observed land subsidence from 1963 to 1973. (after the data from Saito (2008))

Unit is in cm.



Simulated land subsidence from 1988 to 1998.



Observed land subsidence from 1988 to 1998 (after the data from Saito (2008)).

Unit is in cm.