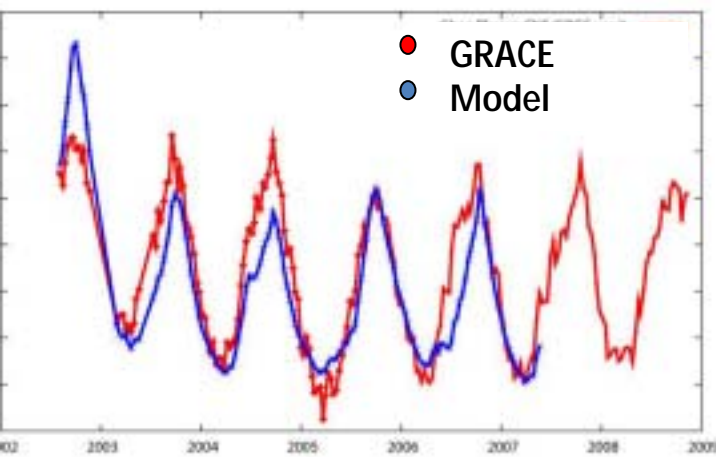
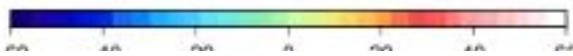


Change in land water storage during 2002-2008

90° 95° 100° 105° 110° 115° 120° 125° 130° 135° 140° 145° 150°

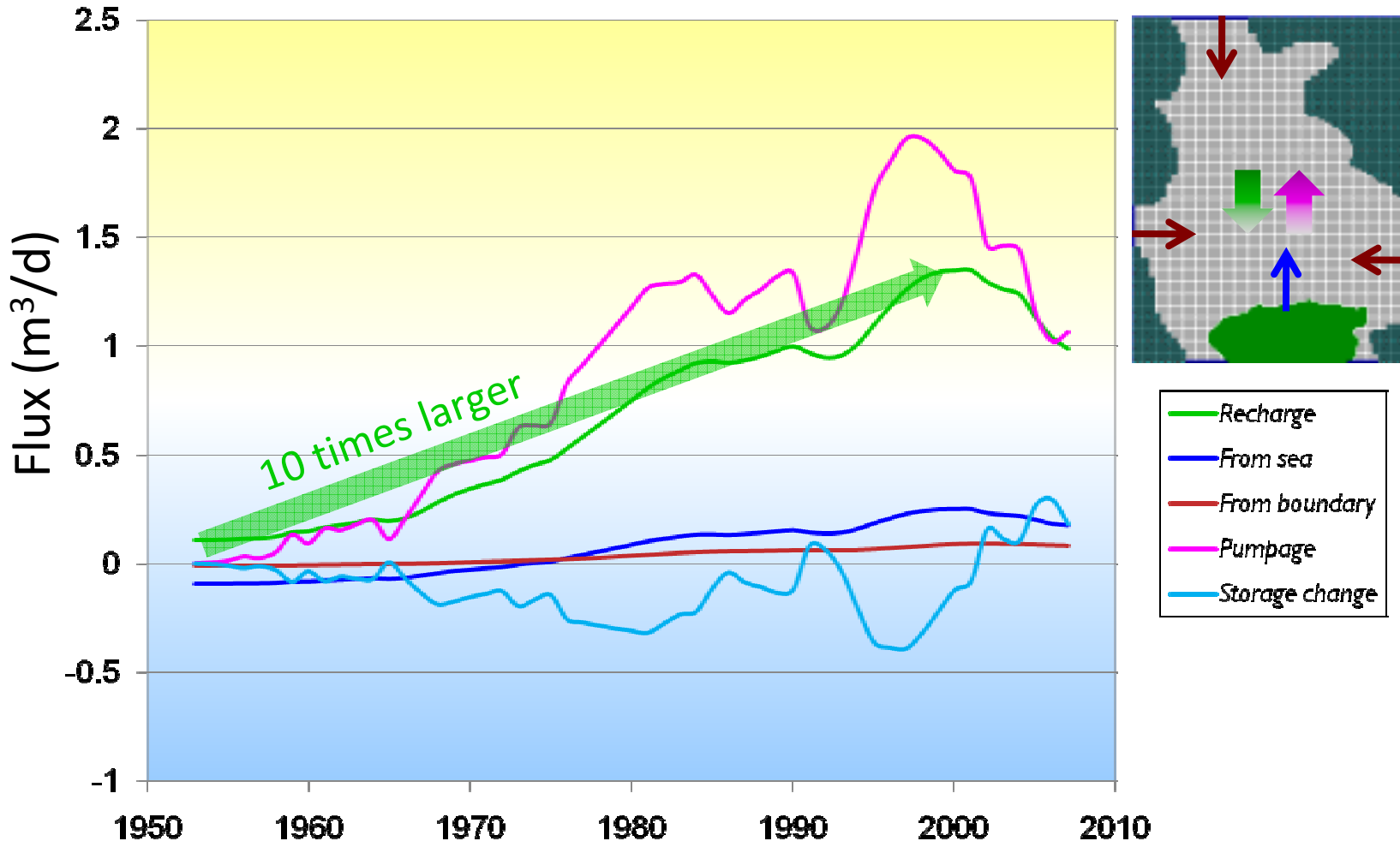


● GRACE  
● Model

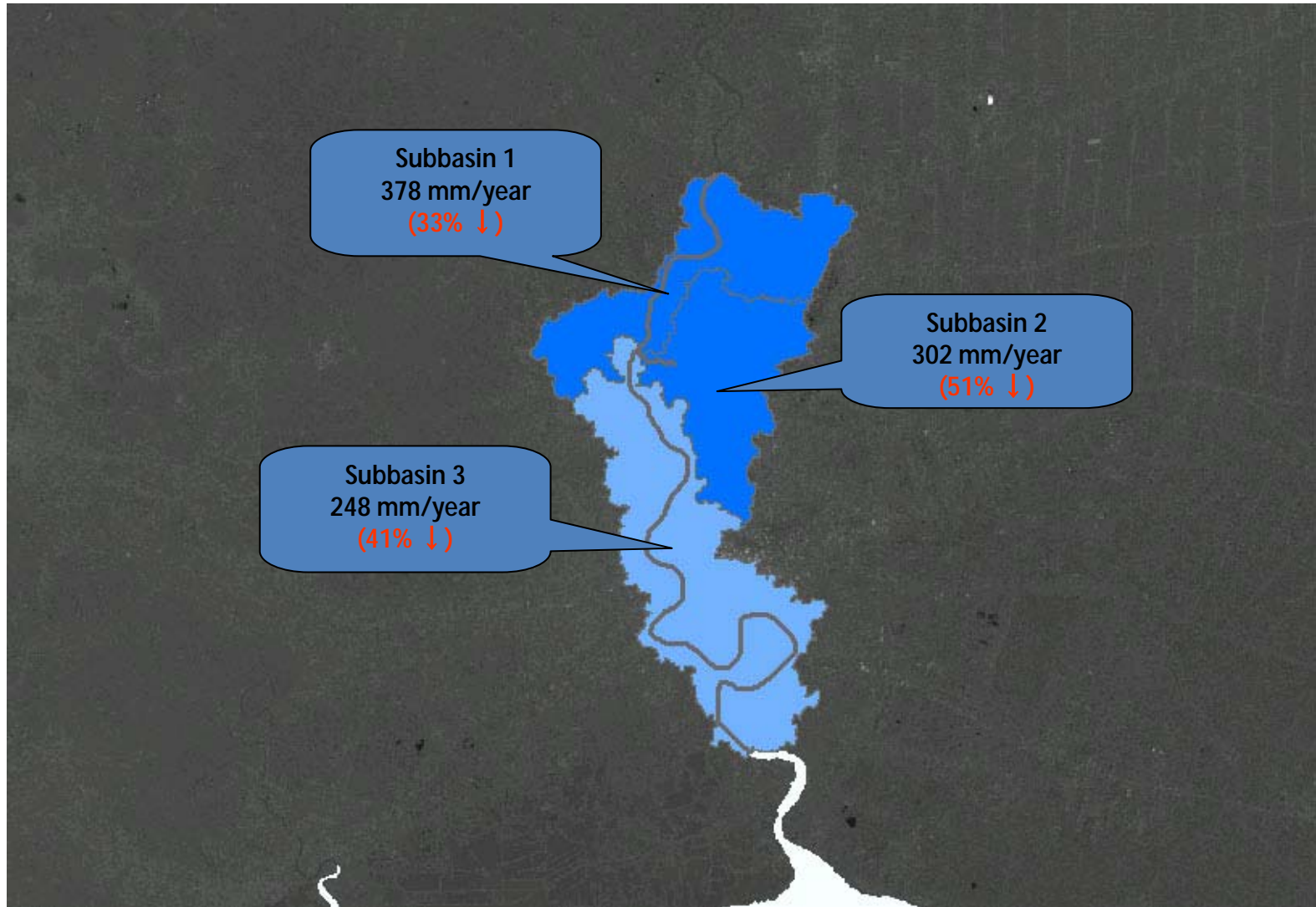


Chao Phraya basin

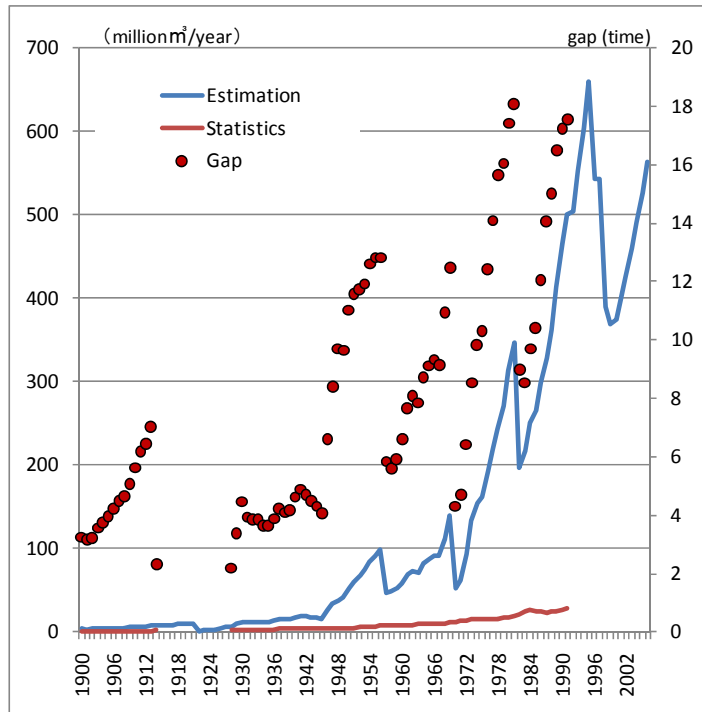
# Water budget of model domain



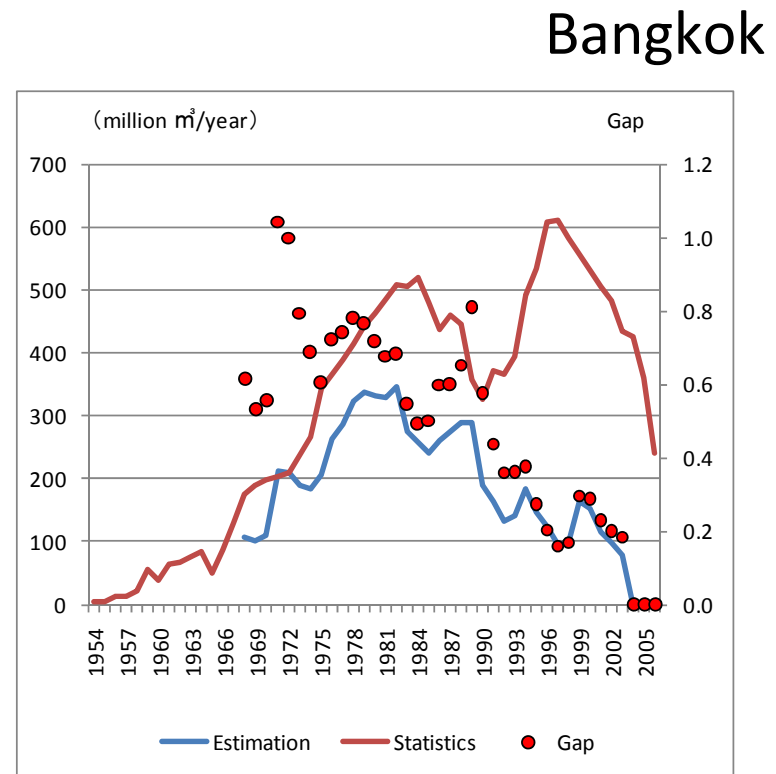
# Simulated recharge to shallow aquifer in 2000



# Estimated groundwater abstraction and the real data



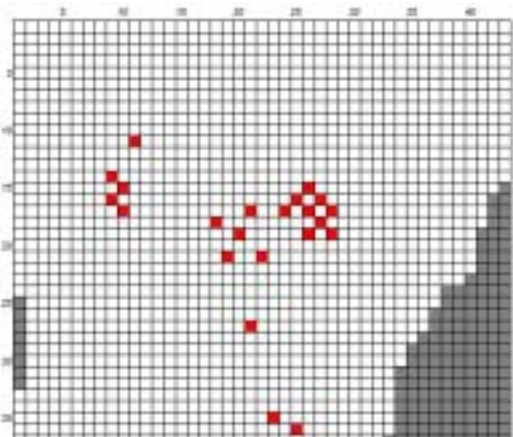
Jakarta



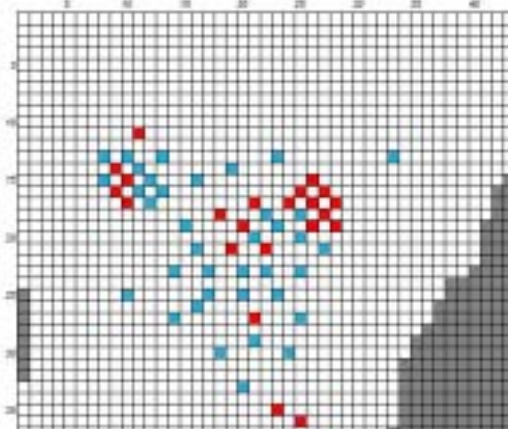
Bangkok

# The amount of groundwater pumping

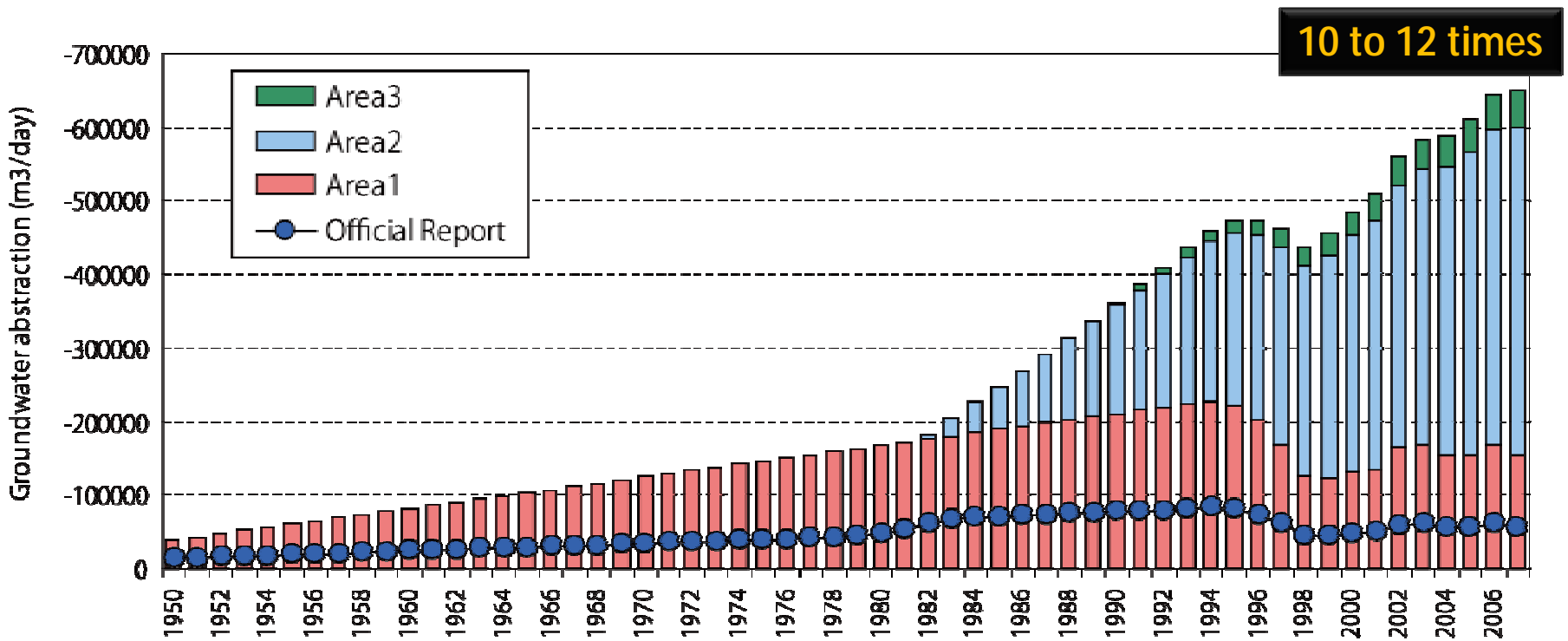
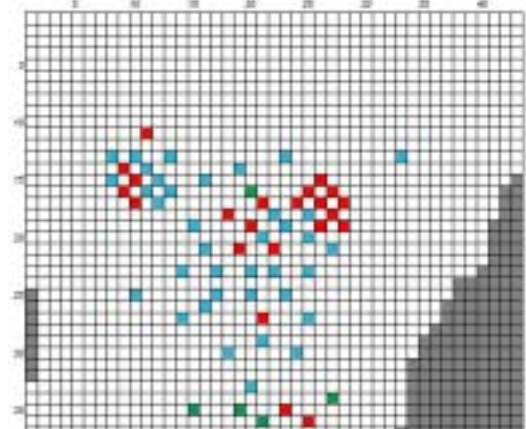
Area 1



Area 2



Area 3



# Connection between Urban Development and Water Environment Changes

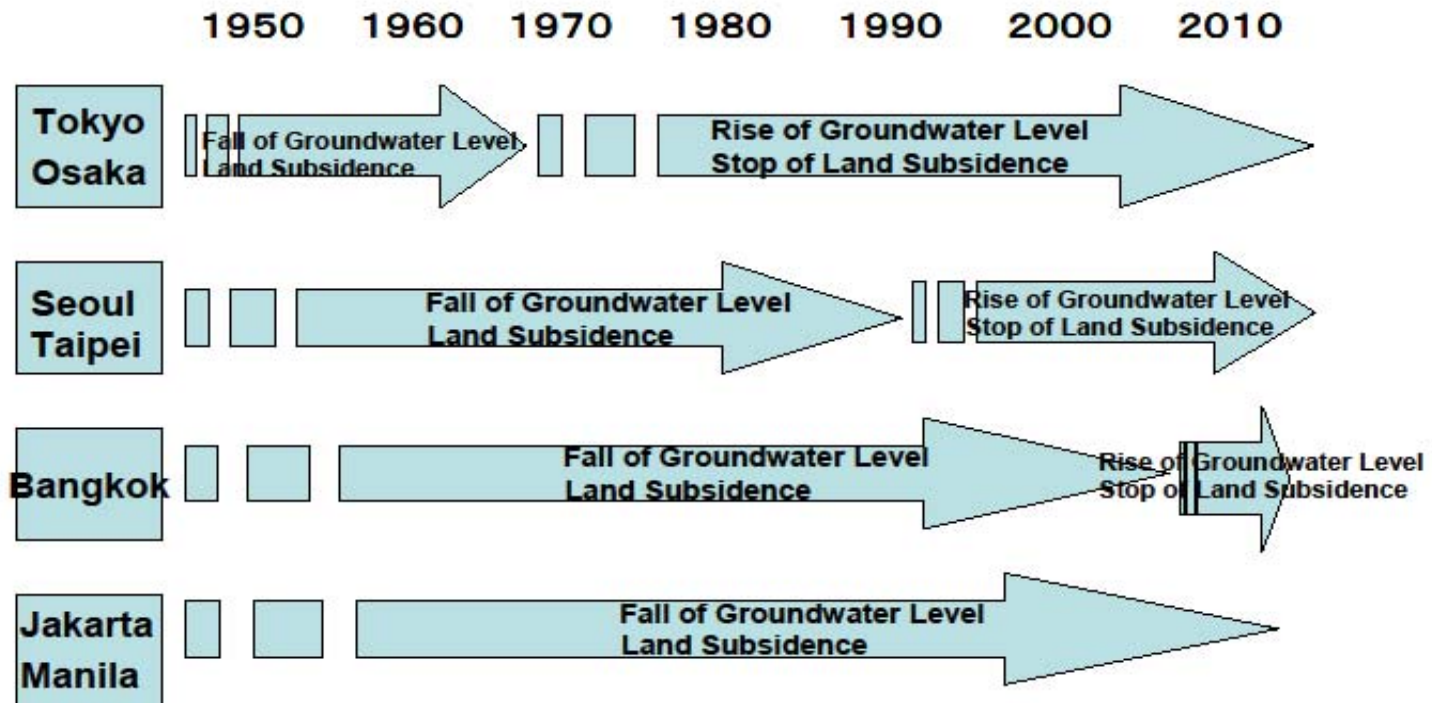
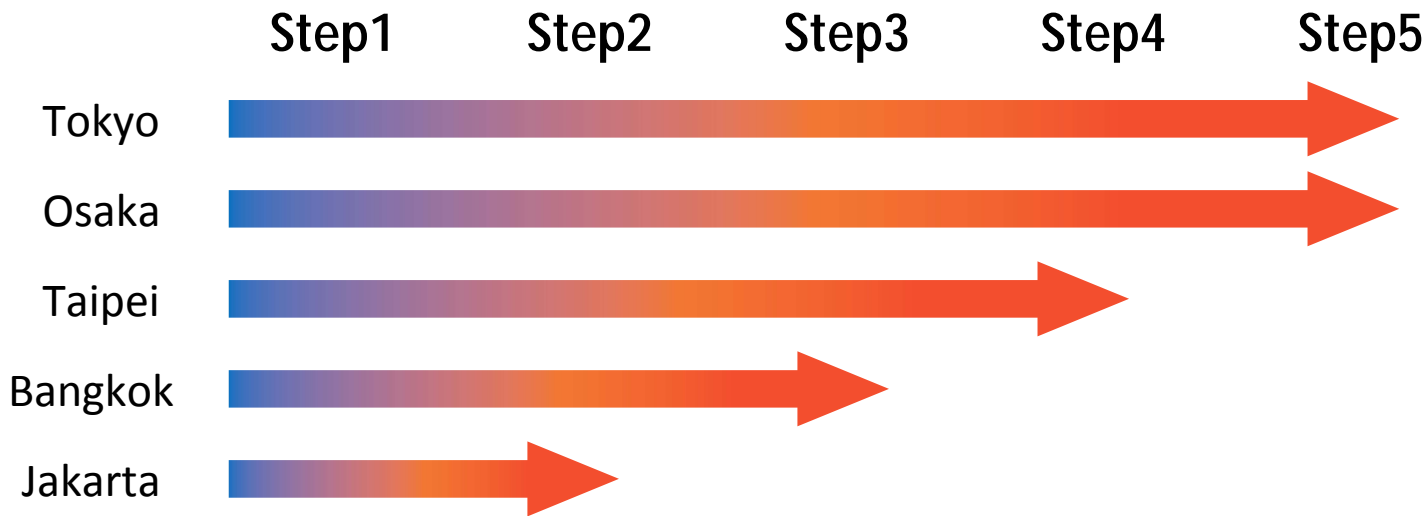


Fig.12 Change of water environment issues



Step 1

Groundwater demand for the city water  
(cheap, easy access, stable, clean)

Step 2

GW disaster followed by urban expansion  
(land subsidence, salinization, oxygen deficit air accident, etc)

Induced recharge  
(shallow aquifer, river & sea water)

Step 3

Enforcement of GW regulation  
(groundwater disaster → regulation)

Infrastructure of surface water supply  
and National groundwater act  
(public water of private property ?)

Step 4

Recovery of regulated area ⇔  
Maximum potential recharge ⇔ Hydro-meteorological setting of the city

Step 5

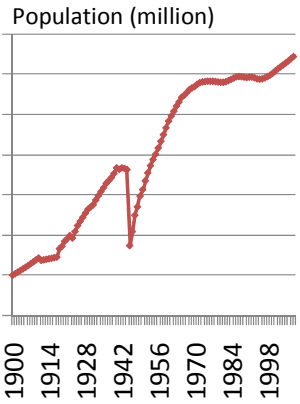
New GW disaster caused by abrupt recovery  
(Floating problem of subsurface station)

Sustainable GW management  
considering potential recharge rate

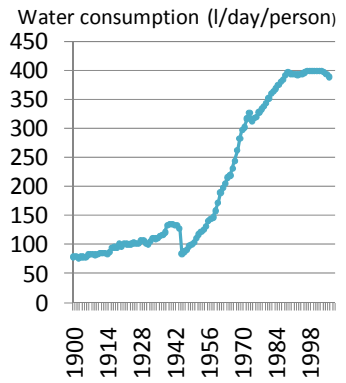
# Stage model with DPSIR framework

## B: Changing society and environment

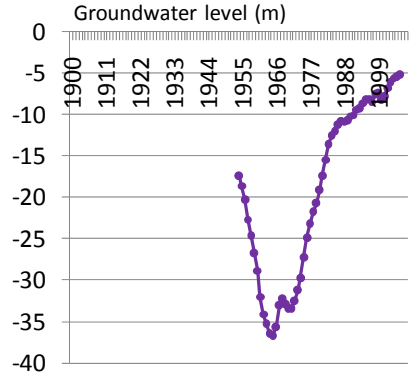
**D**



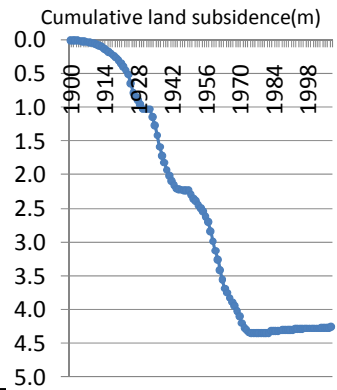
**P**



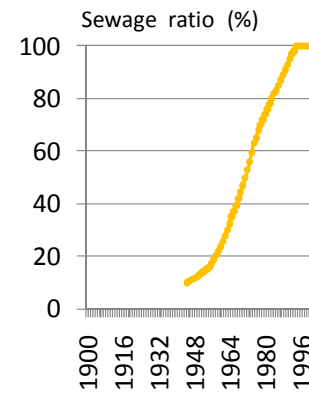
**S**



**I**



**R**



	1 <sup>st</sup> Stage	2 <sup>nd</sup> Stage	3 <sup>rd</sup> Stage	4 <sup>th</sup> Stage	5 <sup>th</sup> Stage
Tokyo	1900-1923	1923-1947	1947-1962	1962-1975	1975-2000
Osaka	1900-1936	1936-1950	1950-1962	1962-1975	1975-2000
Seoul			1947-1965	1965-1977	1975-2000
Taipei	1900-1955	1955-1965	1965-1977	1977-1982	1982-2000
Bangkok	1900-1960	1955-1965	1965-1977	1983-2000	
Jakarta	1900-1928	1928-1978	1978-2000		
Manila	1900-1965	1965-1985	1985-2000		