UNIVERSITY OF TSUKUBA
GRADUATE SCHOOL OF LIFE AND ENVIRONMENTAL SCIENCES

Evaluation of groundwater and surface water resources in quality and quantity at Binh Chanh district in Ho Chi Minh city, Vietnam

CONTENT

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Introduction

- Groundwater is a reliable source of water for drinking and production both in quantity and quality if the resource is properly managed.
- However, this resource is now under stress in some Asian cities because of unregulated and excessive abstraction. *(IGES, 2007)*

Population growth Industrialization Urbanization

- Increase in water demand
- Surface water polluted

Overexploitation of GW

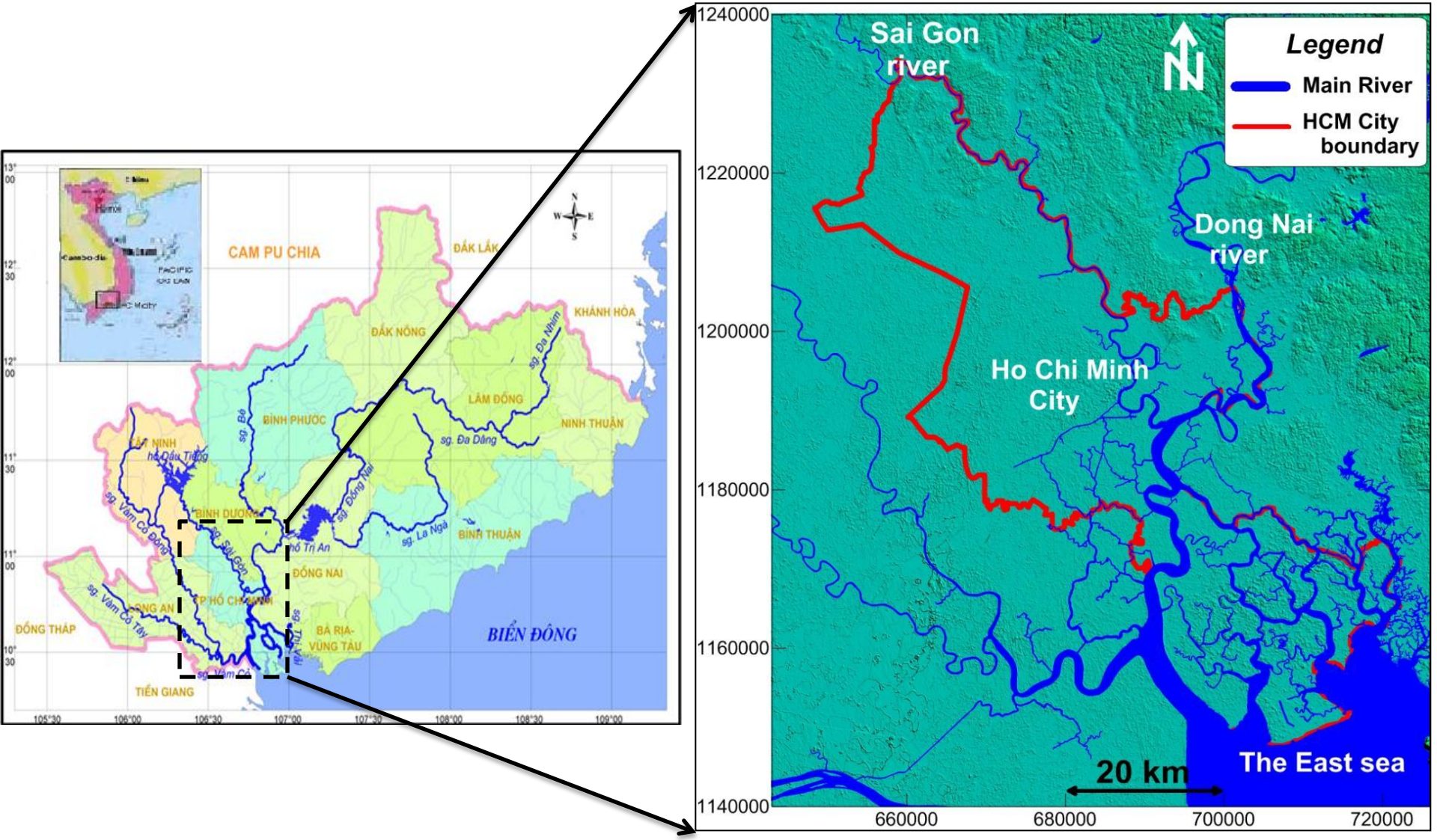
Climate change

Sustainable water management

- ✓ Drawdown of GW table
- ✓ Land subsidence
- ✓ Saltwater intrusion
- ✓ GW quality deterioration

It is important to clarify GW flow system and the interaction between surface water and GW.

Introduction



(Source: Southern Institute for Water Resources Planning)

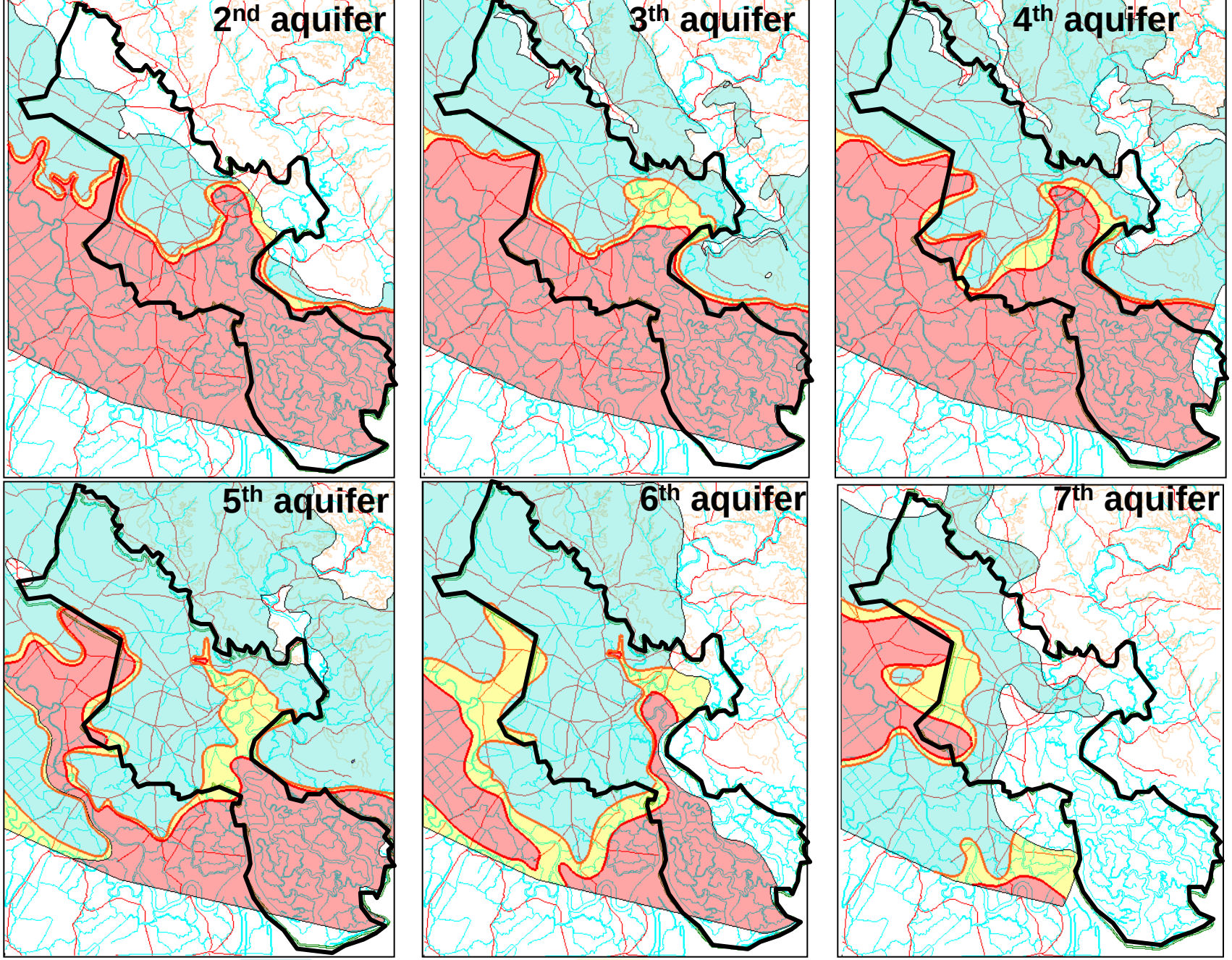
Previous researches on groundwater in Ho Chi Minh city (HCMC)

Recharge sources

No	The flow component (m^3/day)	Pleistocene aquifer (2-3-4th aquifers)	Upper Pliocene 5th aquifer	Lower Pliocene 6th aquifer
1	Flow recharged from rainwater	309,530		
2	Flow recharged from Dong Canal	156,750		
3	Flow recharged from Sai Gon river	67,500		
4	Flows from northern and western boundaries of HCMC	22,540	181,170	94,030
5	Static flow	239,480	771,090	658,970
	Total	**796,000**	**952,000**	**753,000**

Source: Department of Industry, 2002

Distribution of fresh water of aquifers

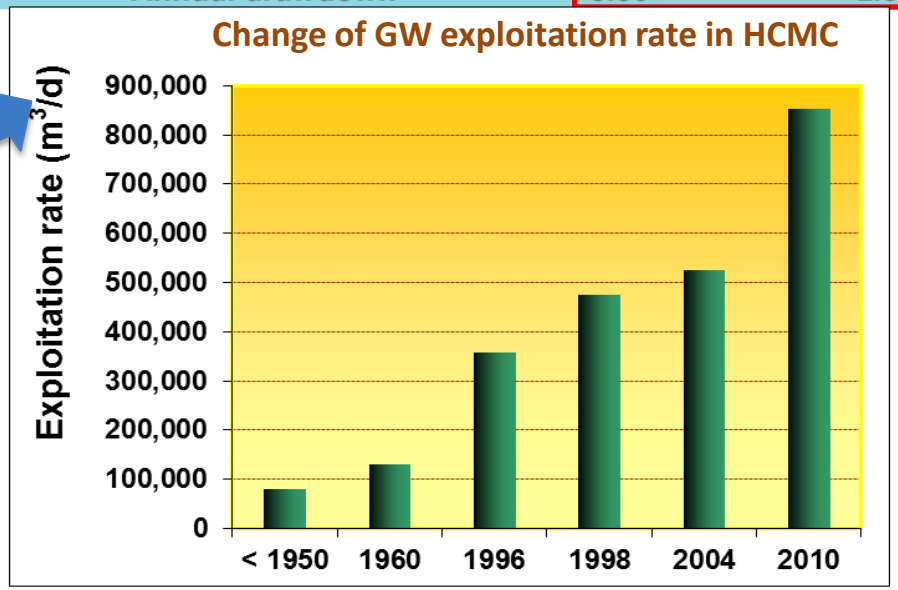


Source: Division for water resources Planning and Investigation, 2010

Drawdown of water table at monitoring stations in high well density area

Aquifer	Year	Ground water table (m)				
		Binh Hung (Binh Chanh Dist.)	Tan Tao (Binh Tan Dist.)	Tan Son Nhat (Phu Nhuan Dist.)	Phu Tho (Dist.11)	Tan Chanh Hiep (Dist. 12)
Pleistocene	2000	-2.69	-2.61	6.76	-5.27	4.85
	2004	-5.6	-7.8	1.23	-7.96	3.8
	Total drawdown	*2.91*	*5.19*	*5.53*	*2.69*	*1.05*
	Annual drawdown	***0.73***	***1.3***	***1.38***	***0.67***	***0.26***
Upper Pliocene	2000	-8.18	-9.25	-11.58	-15.79	-7.71
	2004	-14.99	-18.57	-22.56	-23.67	-19.26
	Total drawdown	*6.81*	*9.32*	*10.98*	*7.88*	*11.55*
	Annual drawdown	***1.7***	***2.33***	***2.75***	***1.97***	***2.89***
Lower Pliocene	2000	-14.36	-8.94	-12.49	-15.85	-8.5
	2004	-29.75	-19.01	-23.12	-28.77	-19.9
	Total drawdown	*15.39*	*10.07*	*10.63*	*12.92*	*11.4*
	Annual drawdown	***3.85***	***2.52***	***2.66***	***3.23***	***2.85***

Source: Dan et al. ,2007



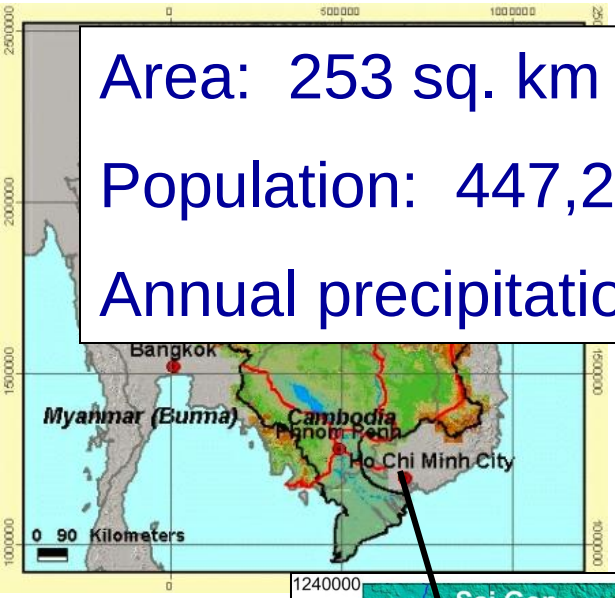
The total recharge volume is only one-third of the extraction rate due to accelerated growth of impermeable urban surfaces and hydrological changes associate with rapid urbanization (Vo, 2007)

Study area: Binh Chanh district

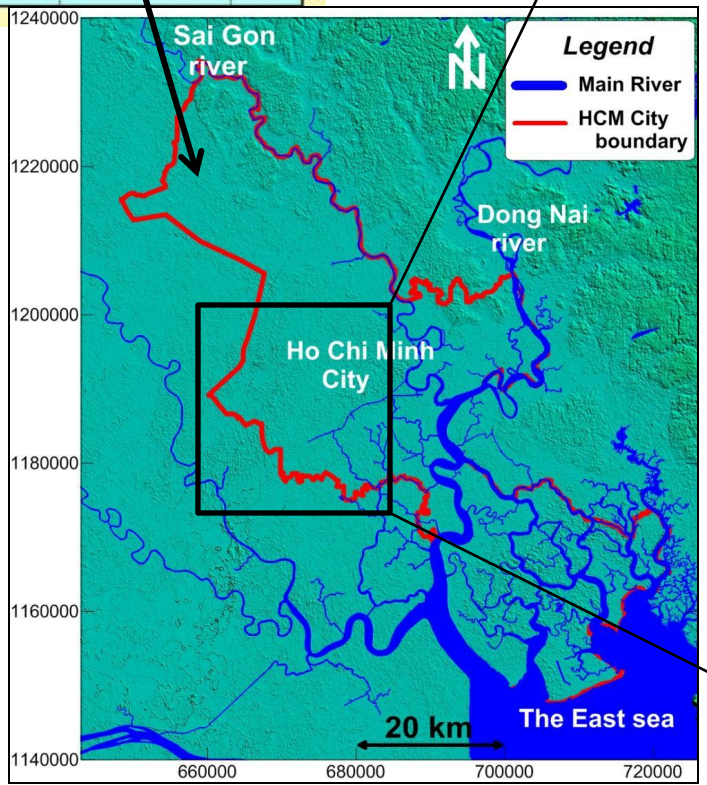
Area: 253 sq. km

Population: 447,291 people

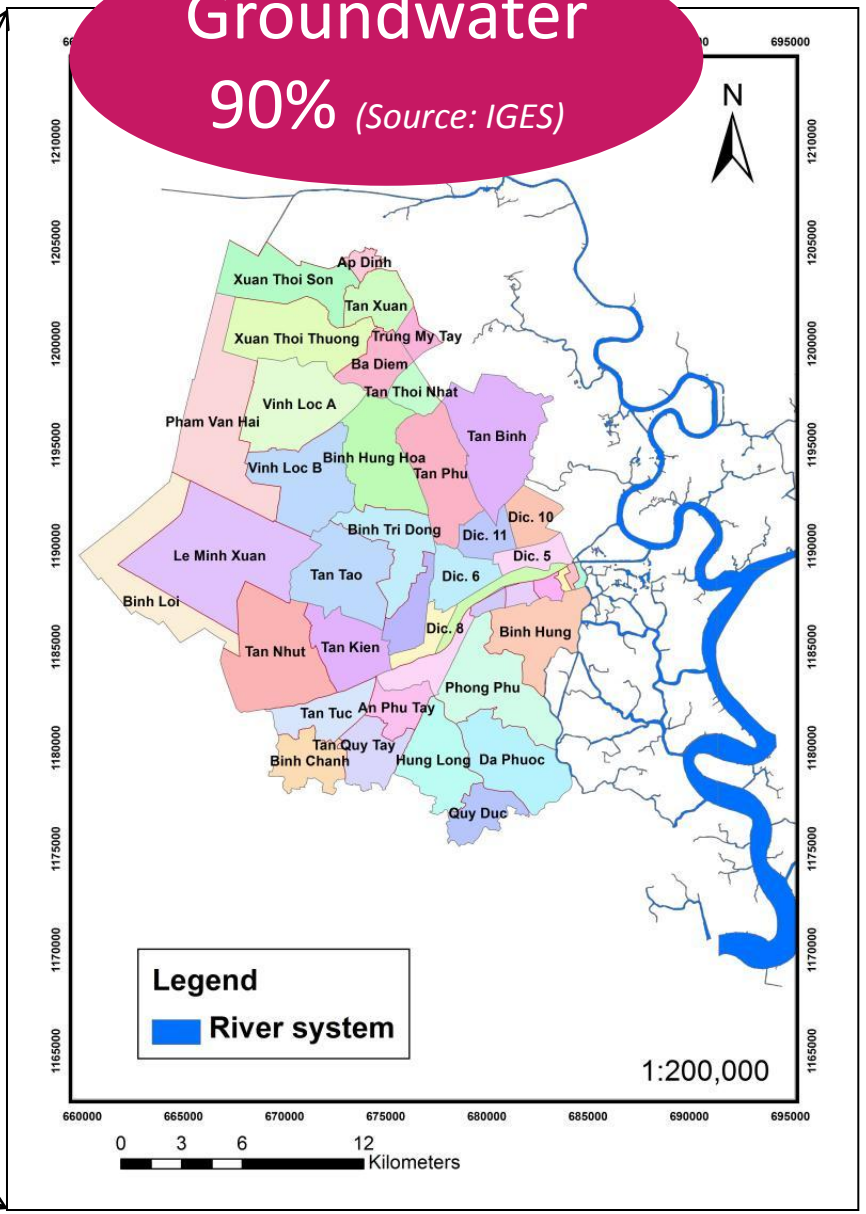
Annual precipitation: 2.000 mm



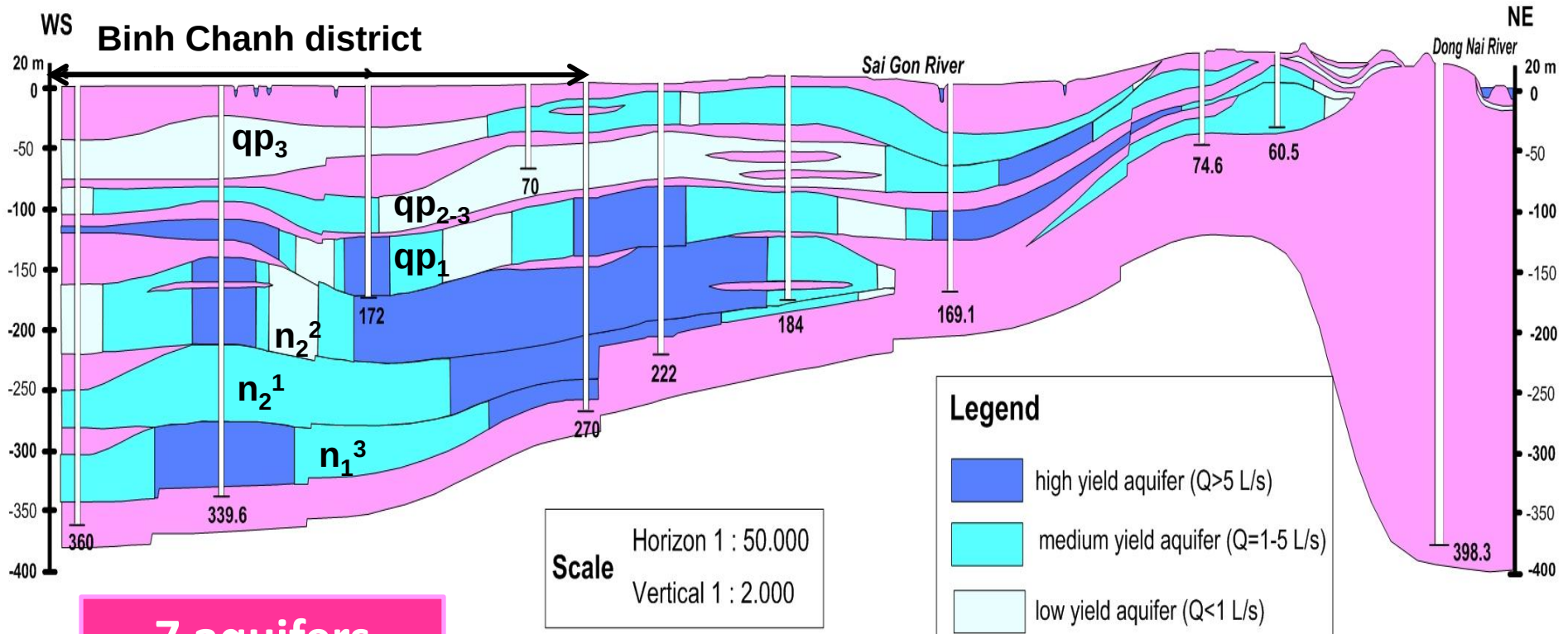
Source: MRC



Groundwater 90% *(Source: IGES)*



Hydrogeological cross section



7 aquifers

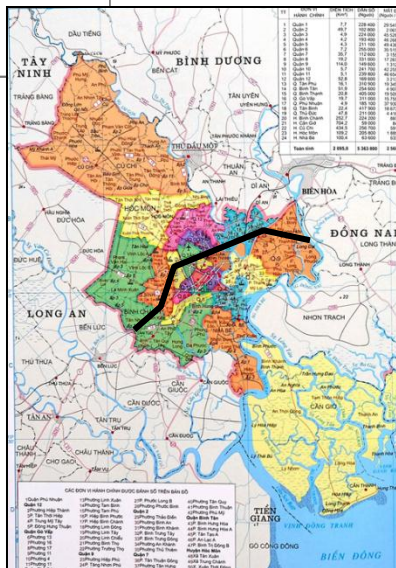
- **qh : Holocene**
- **qp_3 : upper Pleistocene**
- **qp_{2-3} : mid-upper Pleistocene**
- **qp_1 : lower Pleistocene**

Shallow groundwater (0 – 140 m)

- **n_2^2 : upper Pliocene**
- **n_2^1 : lower Pliocene**
- **n_1^3 : Miocene**

Deeper groundwater (>140 m)

(Researches of the Union No.8)



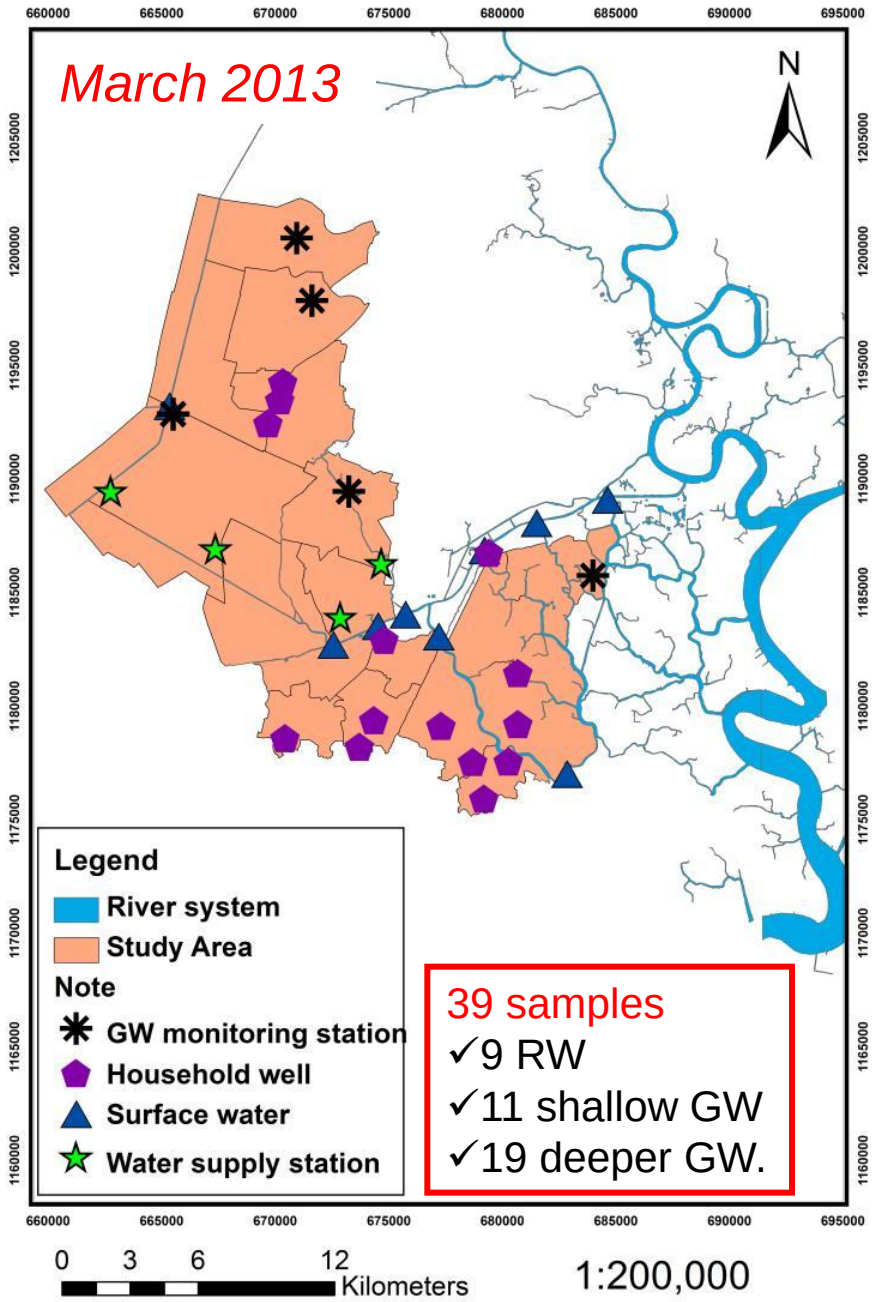
Objectives

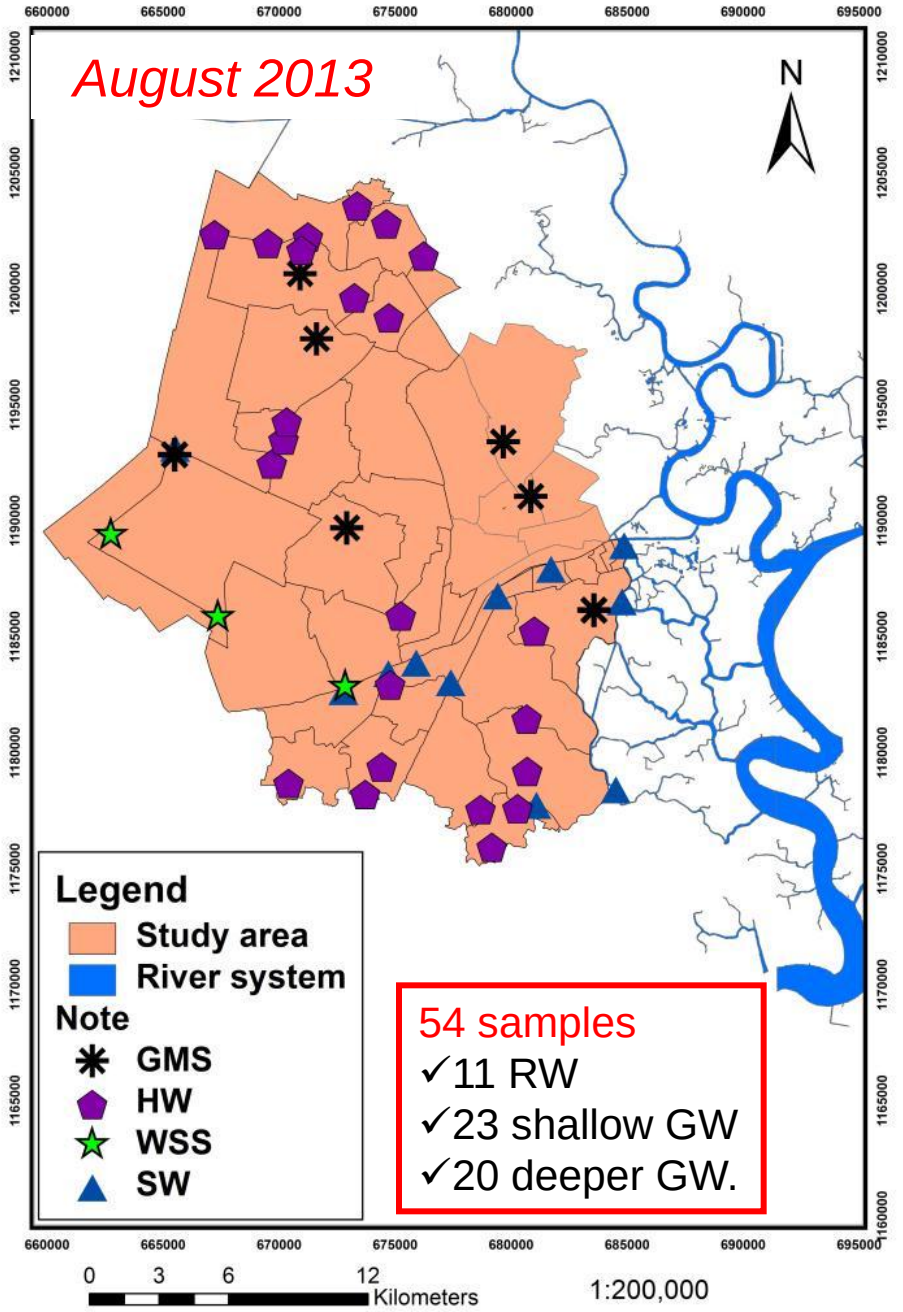
- To investigate the GW flow system of Binh Chanh district.
- To consider the stable isotopic compositions and ion concentrations in surface water and groundwater in both the dry and rainy season (March and August, 2013).
- To clarify the interaction between surface water and groundwater as well as among aquifers.

Methodology

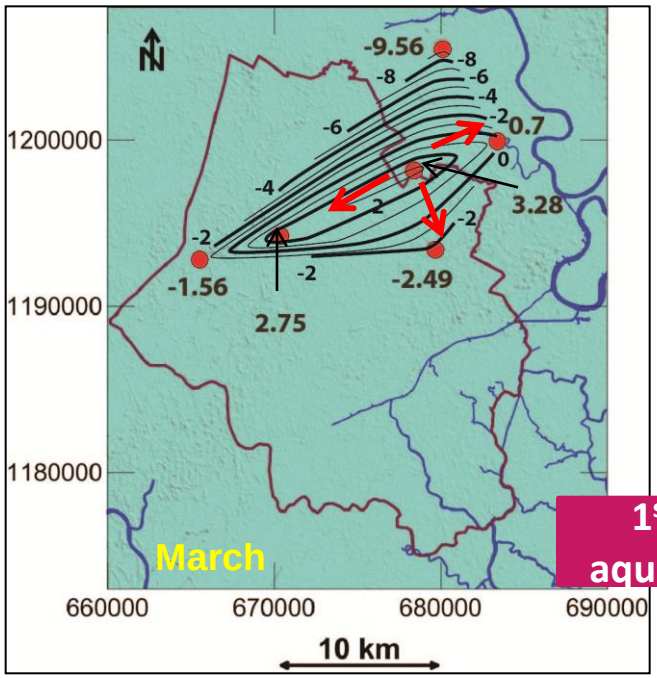
- **Sampling:**
  - ✓ Dry season (March 2013): 39 samples
  - ✓ Rainy season (Aug. 2013): 54 samples
- **Field measurement:**
  - ✓ Air and Water temperature, pH, EC.
  - ✓ GW level (the depth of GW table from ground surface)
  - ✓ Location of samples: using GPS meter.
- **Analysis in laboratory:**
  - ✓ Inorganic ions: Na^+, K^+, Mg^{2+}, Ca^{2+} and HCO_3^-, Cl^-, NO_3^-, SO_4^{2-}
  - ✓ Stable isotope: $\delta^{18}O$, δD

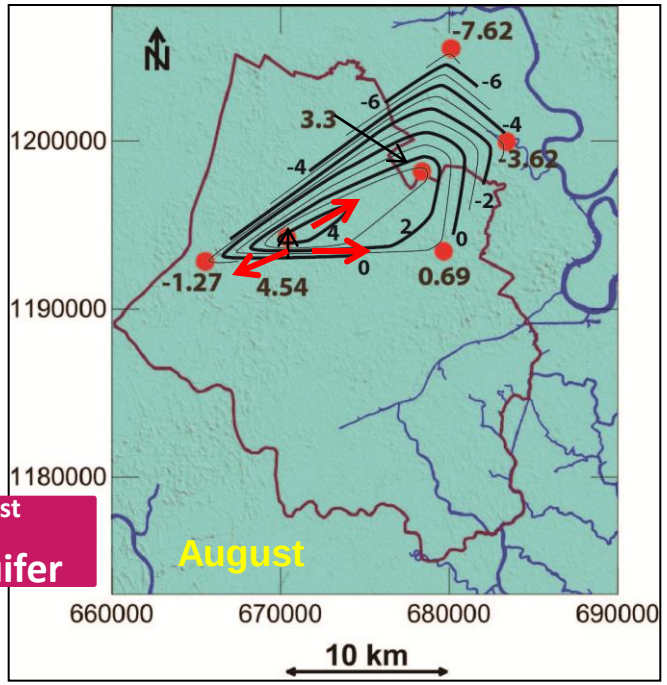
Location of sampling points





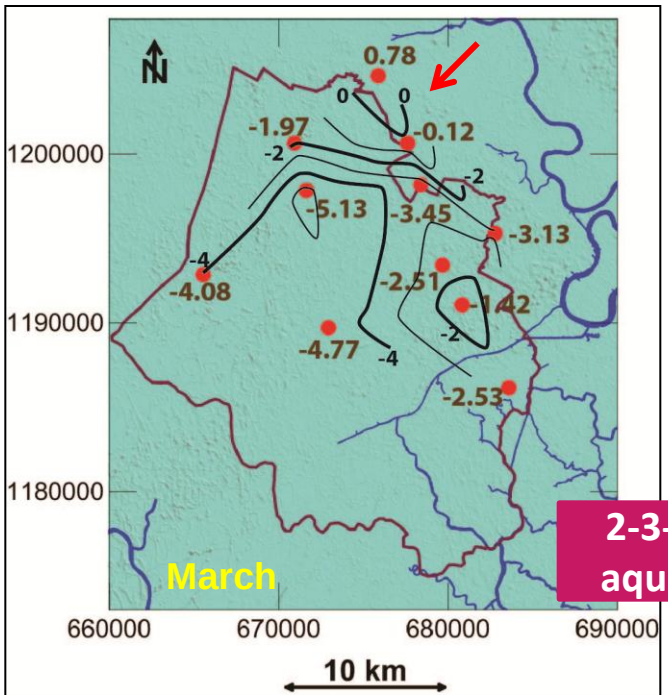
Result – Groundwater table of shallow aquifers in dry and rainy seasons (2013)

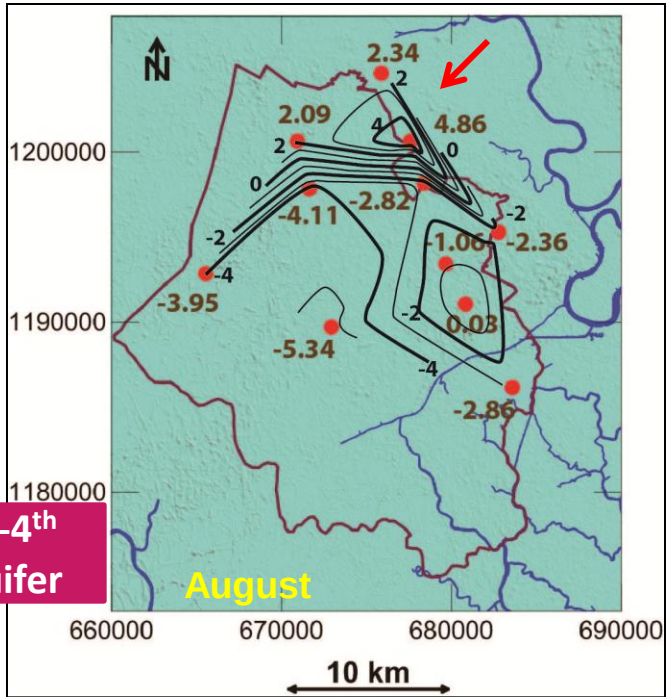




1st aquifer (4 – 25 m)
Dry: -9.56 ~ 3.28 m
Rainy: -7.62 ~ 4.54 m

1st aquifer





2-3-4th aquifer

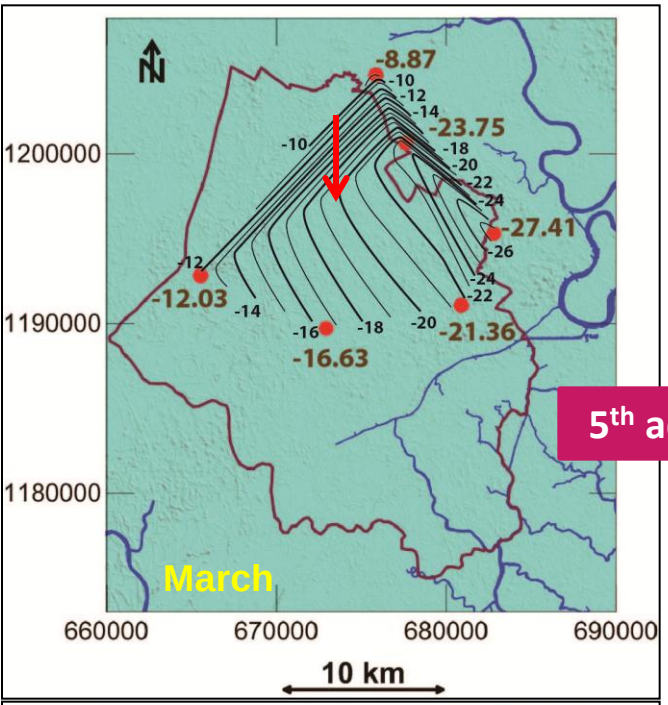
Legend

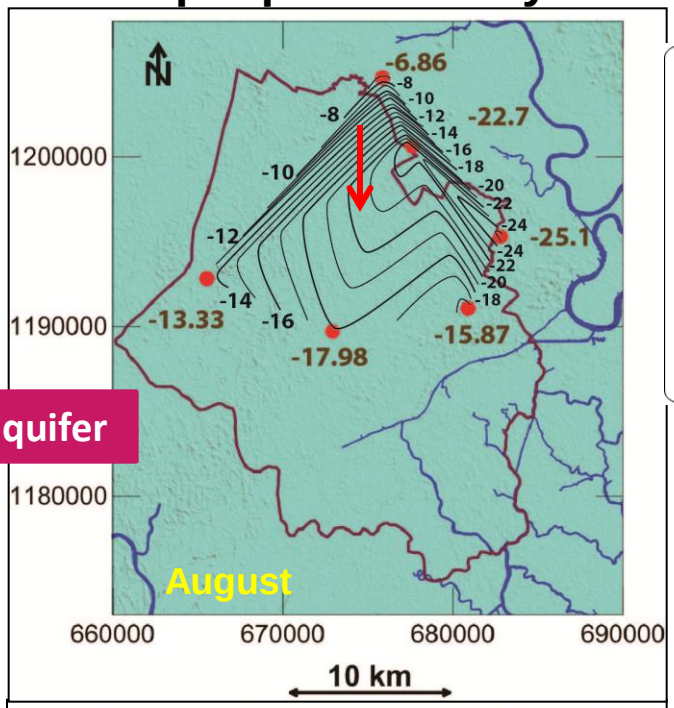
- Main River
- Study area boundary
- GW monitoring station
- GW table line

→ Water flow direction

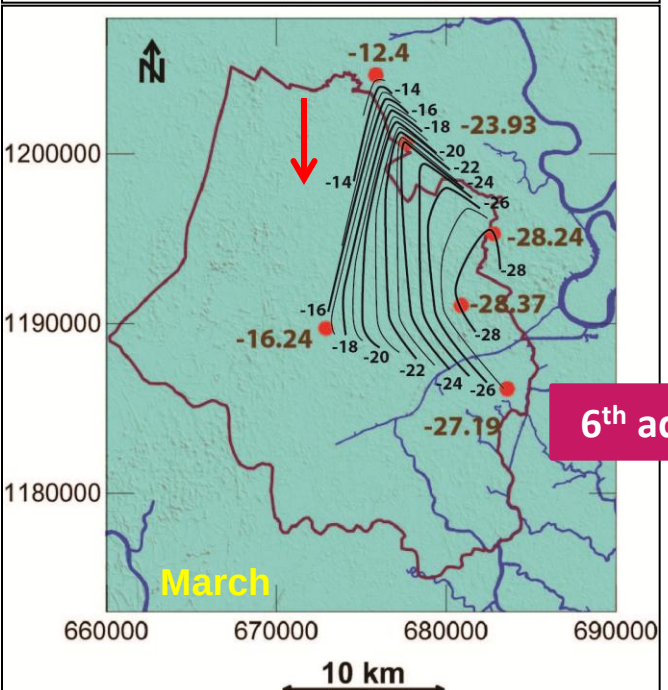
2-3-4th aquifers
(27 – 120 m)
Dry: -5.13 ~ 0.78 m
Rainy: -5.34 ~ 4.86 m

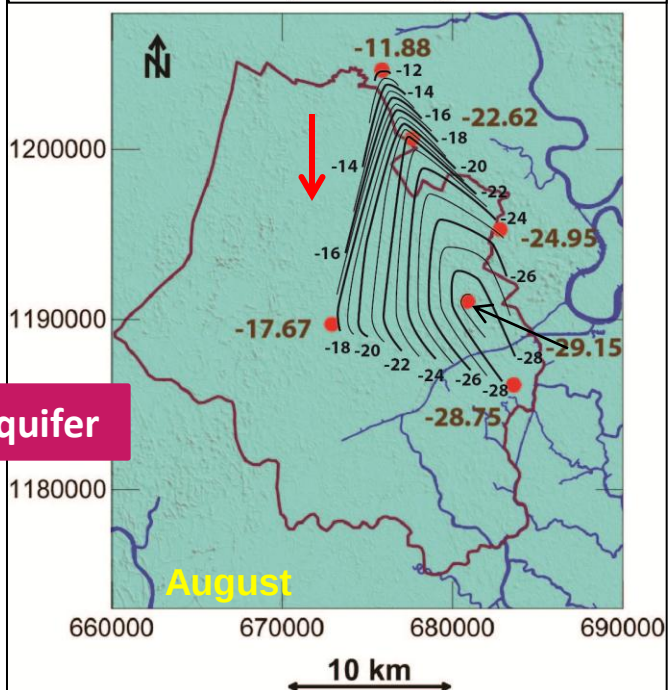
Result – Groundwater table of deep aquifers in dry and rainy seasons (2013)





5th aquifer





6th aquifer

Legend

- Main River
- Study area boundary
- GW monitoring station
- GW table line

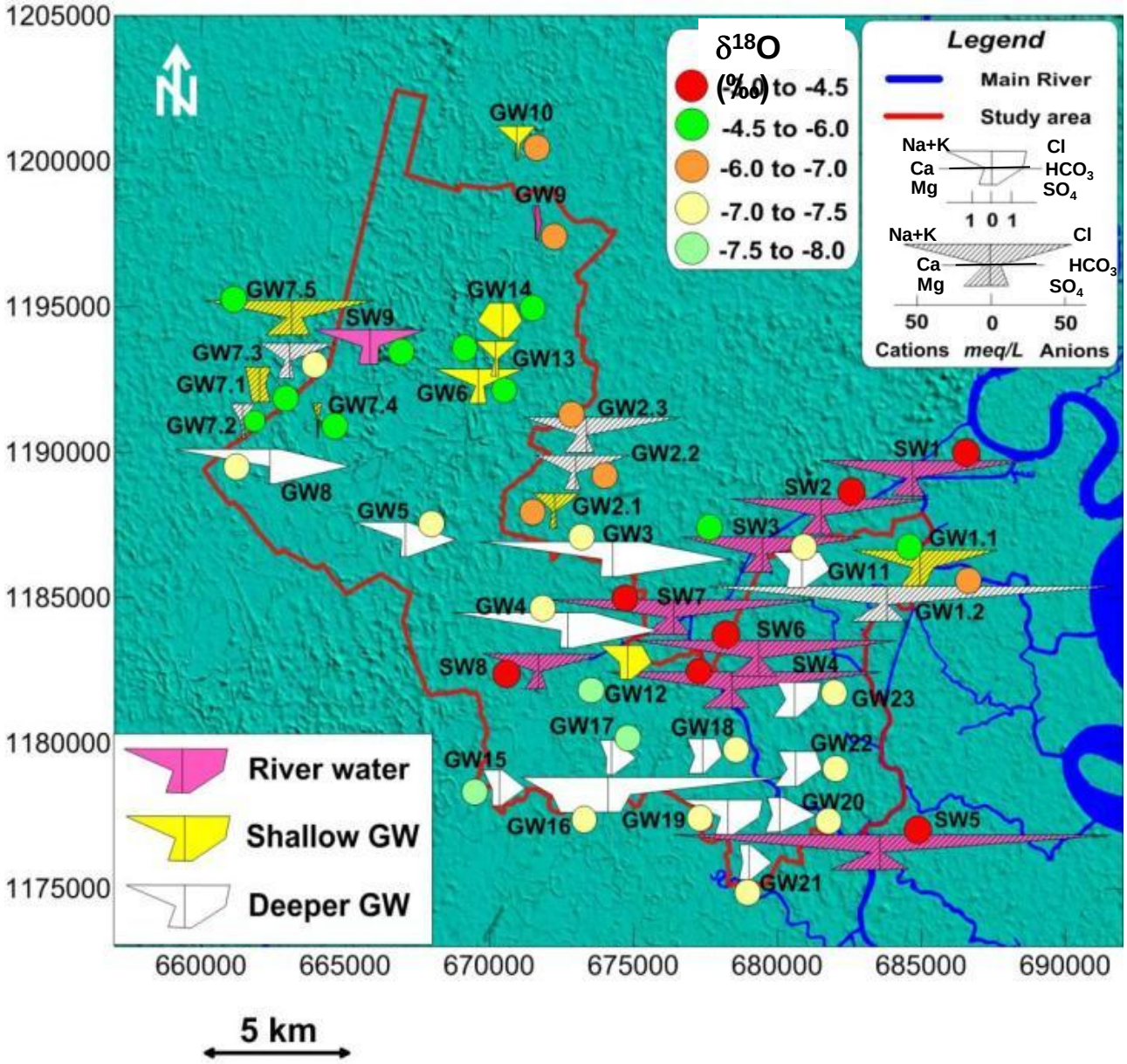
→ Water flow direction

5th aquifer
(120 – 150 m)
Dry: -27.41 ~ -8.87 m
Rainy: -25.1 ~ -6.86 m

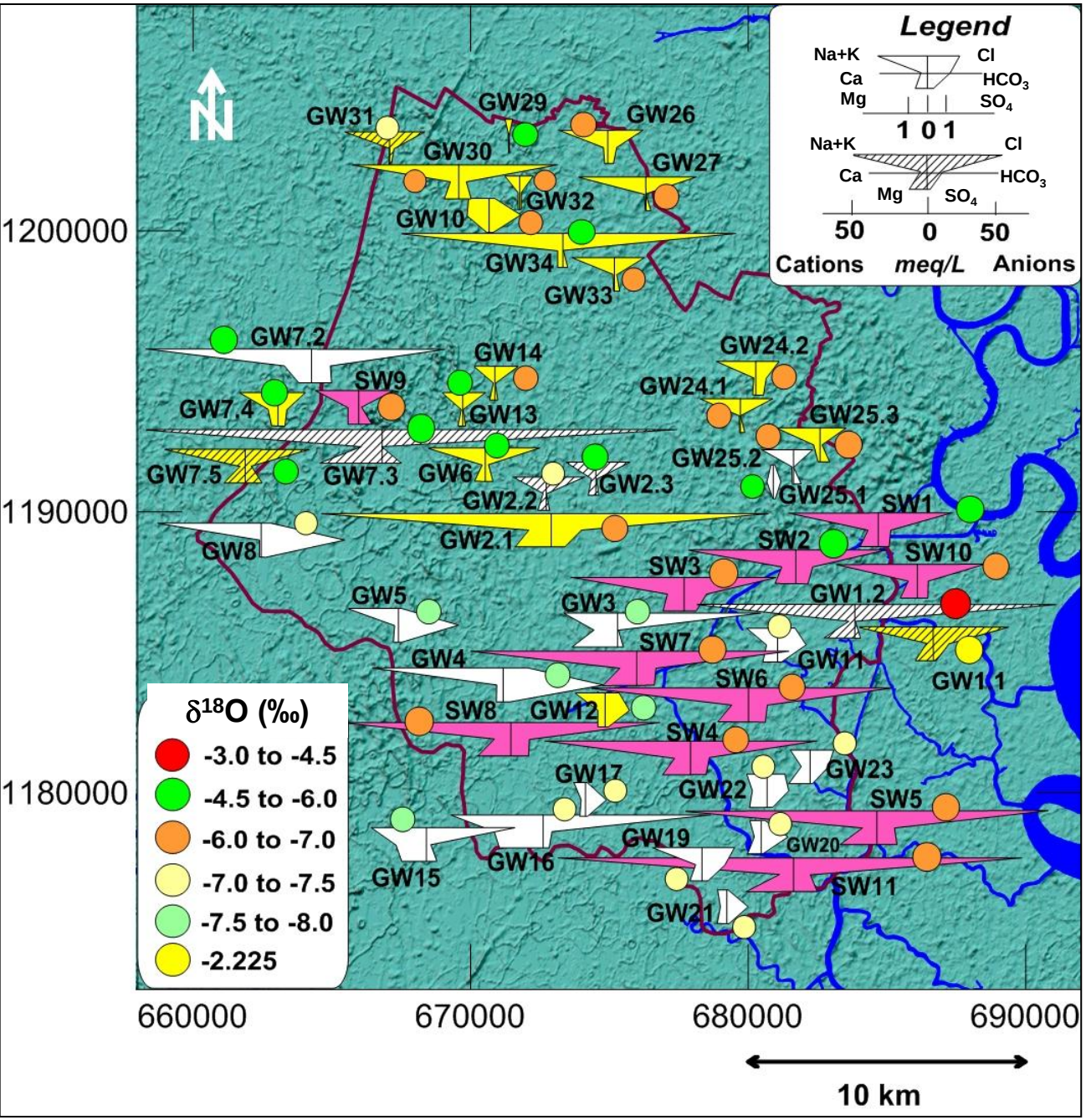
6th aquifer
(160 – 215 m)
Dry: -28.24 ~ -12.4 m
Rainy: -29.15 ~ -11.88m

Result - Spatial distribution of geochemical composition and $\delta^{18}O$, March 2013

- The north: exploited GW from shallow aquifers because of good quality.
- The south: exploited GW mainly from deep aquifers



Result - Spatial distribution of geochemical composition and $\delta^{18}O$, August 2013



River water

Shallow GW

Deeper GW

In the rainy season:

- Ion concentration and stable isotopic values of river water decreased.
- Ion concentration of deeper GW located in the south changes a little, while $\delta^{18}O$ (‰) remained in dry and rainy season.
- Ion concentration of sample GW1.2 &7.3 (deeper GW) is too high → an effect of saltwater intrusion

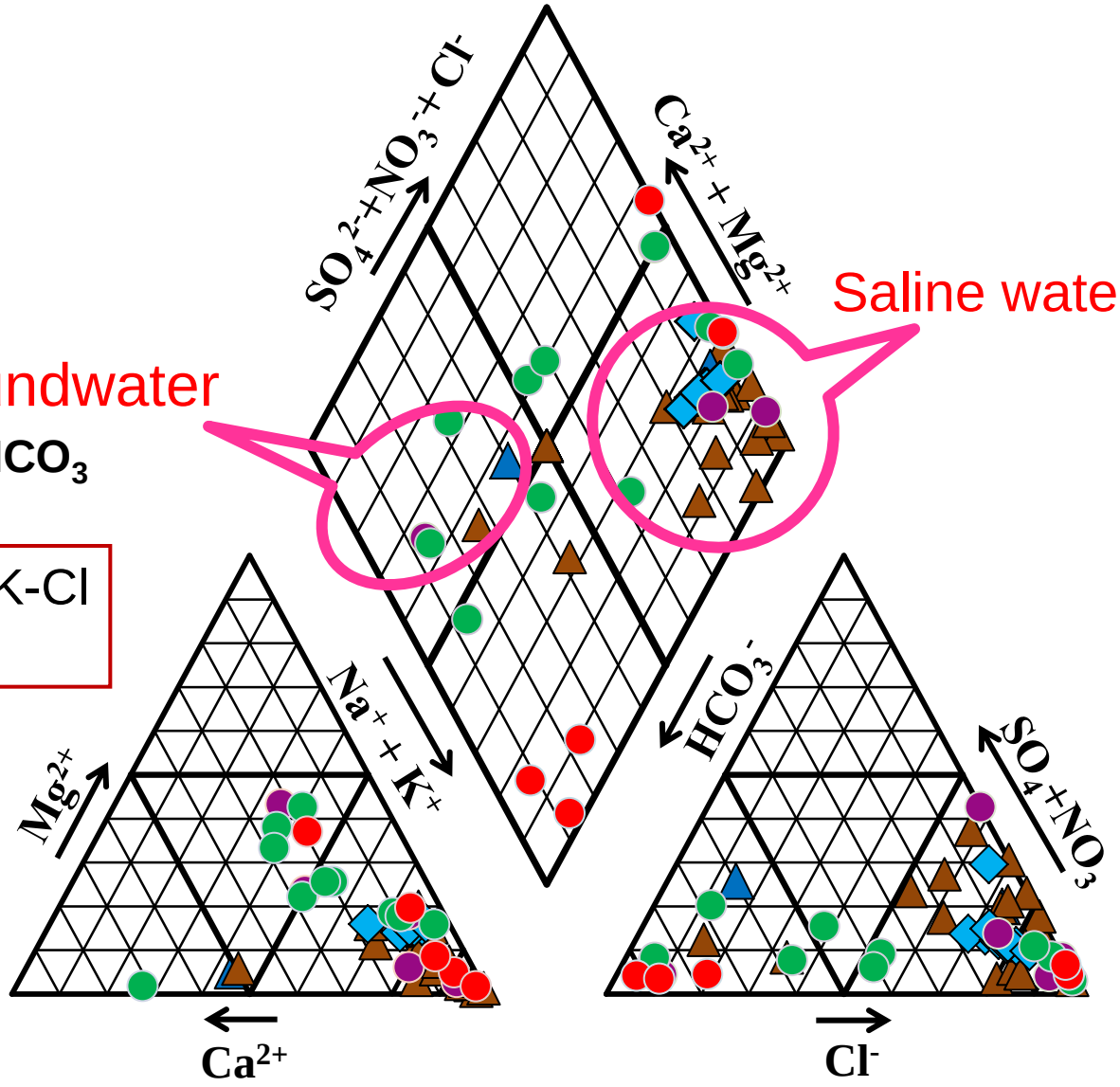
Result - Piper diagram of inorganic ions in rainy season (August)

- River water
- Holocene
- Pleistocene
- Upper Pliocene
- Lower Pliocene
- Miocene

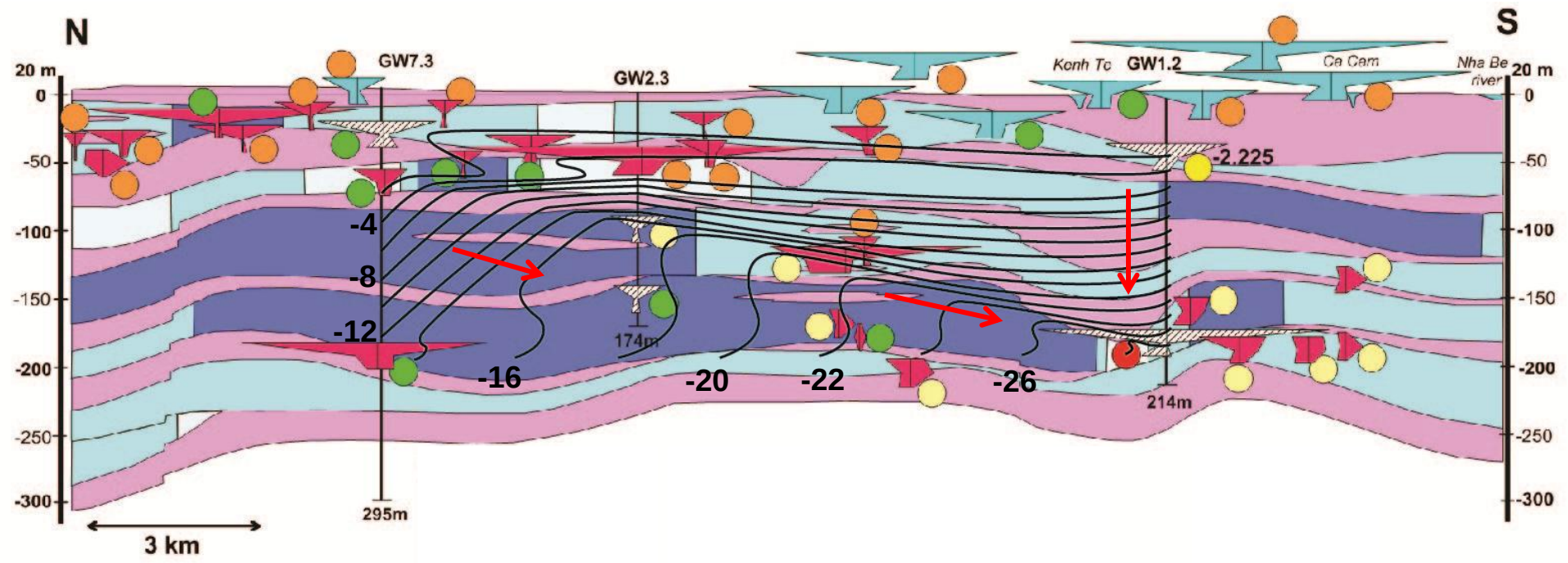
fresh groundwater

Ca-Mg-HCO_3

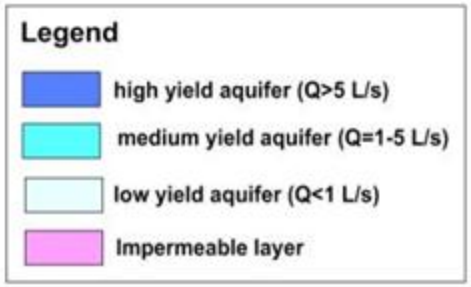
Shallow GW: Na-HCO3, Na-K-Cl
(similar to river water)

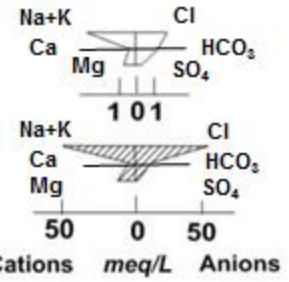


Result - Distribution of geochemical composition and $\delta^{18}O$ in August




River water

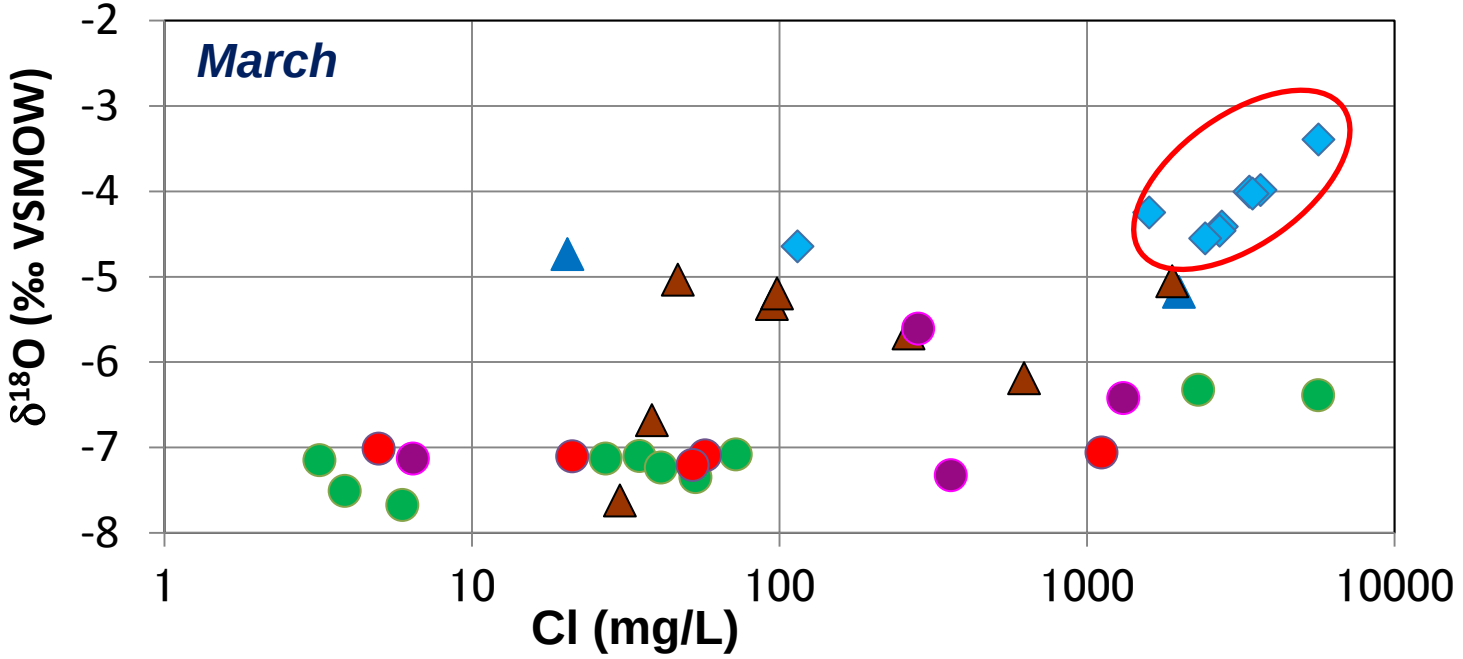


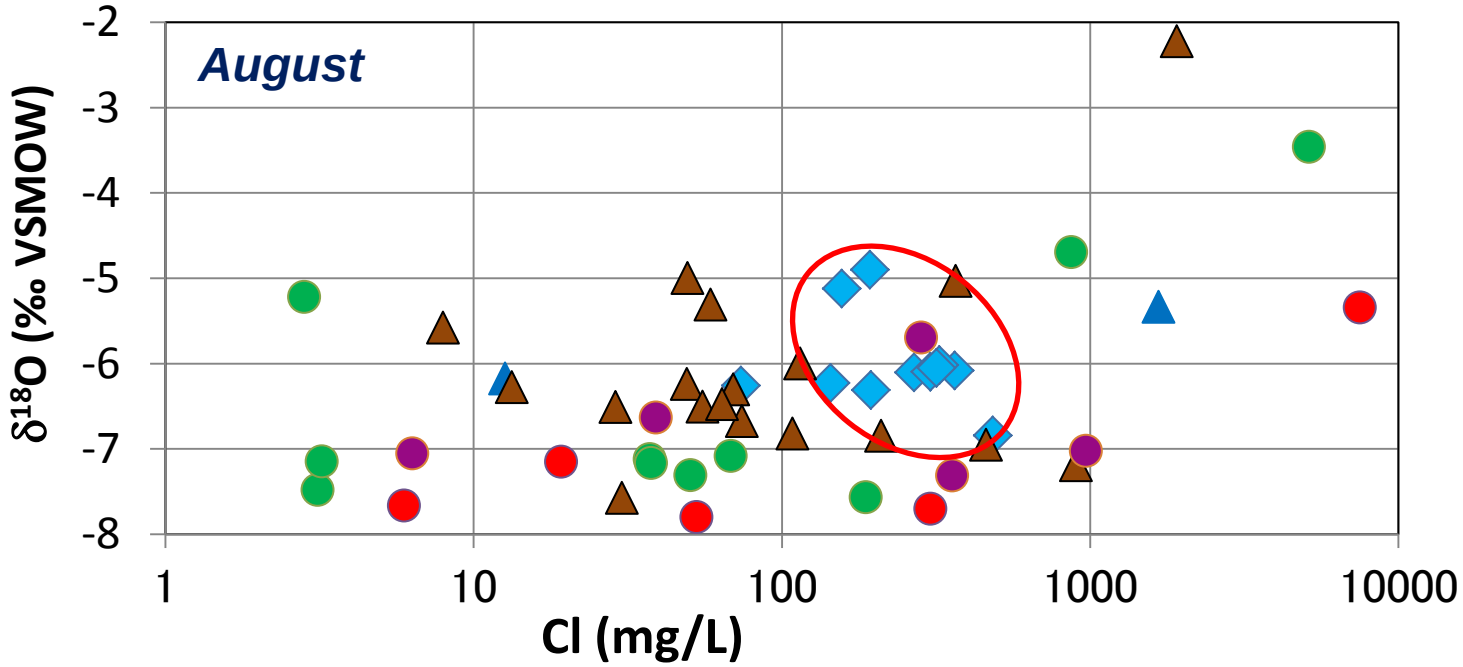


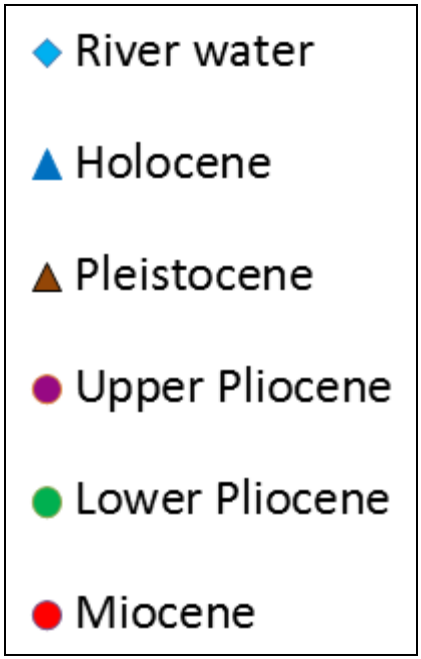
Hydraulic head contour line


Water flow direction

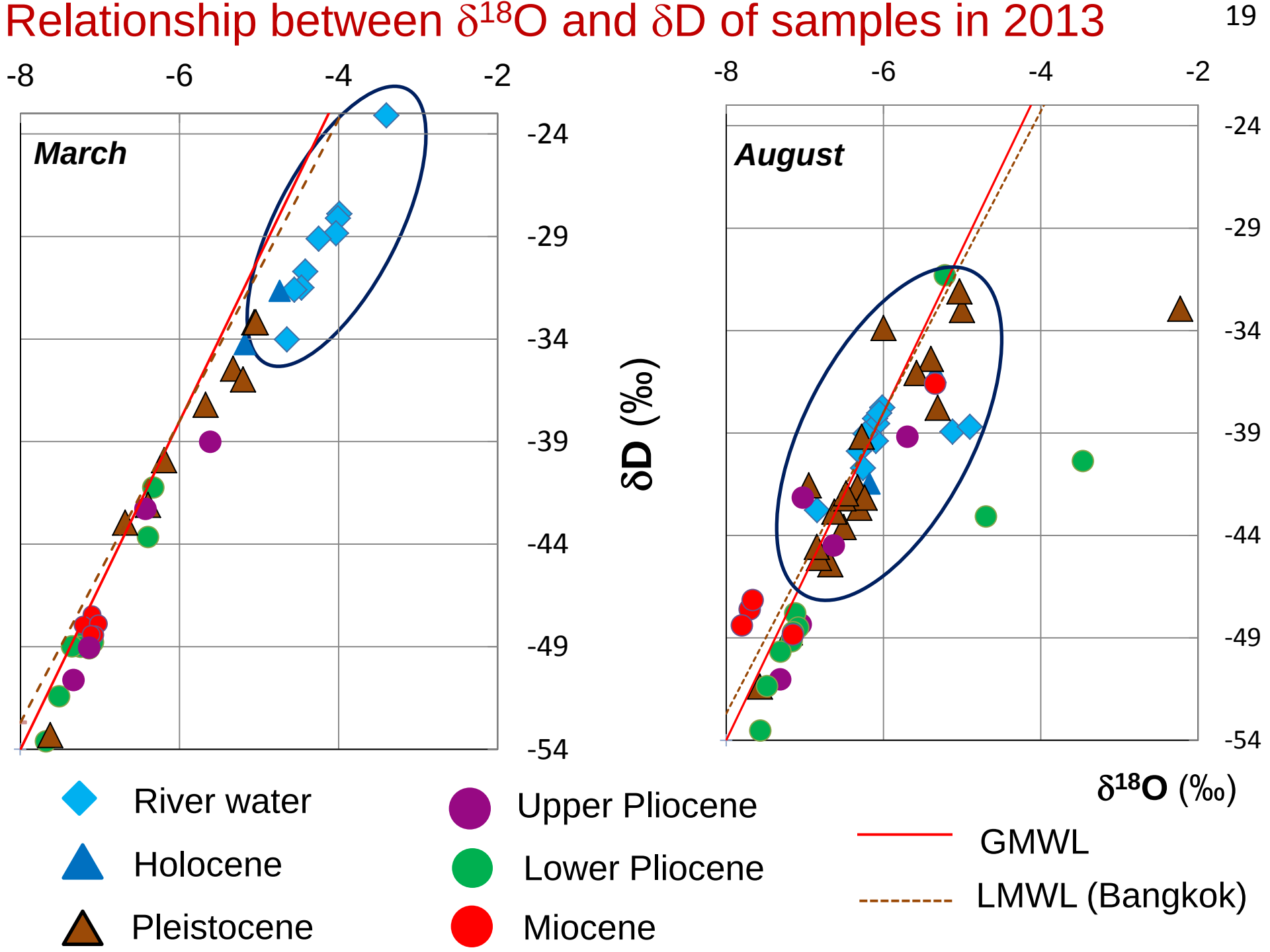
Result - $\delta^{18}O$ and Cl^- concentration in 2013







Relationship between $\delta^{18}O$ and δD of samples in 2013



Conclusion

- Almost river water samples are influenced by seawater intrusion.
- Some groundwater samples show high Cl^- and Na^+ concentrations in both shallow and deep aquifers, suggesting an effect of salinized water intrusion to the fresh groundwater.
- Stable isotope value changes significantly between dry and rainy seasons.
- It is necessary to compare the data in dry and rainy seasons.

Future work

- Literature review
- Interpret deeply all results.

Thank you for your attention !