Assessment of Hydrological Environment of Surface Water and Groundwater in Ninh Thuan Region, Coastal Vietnam

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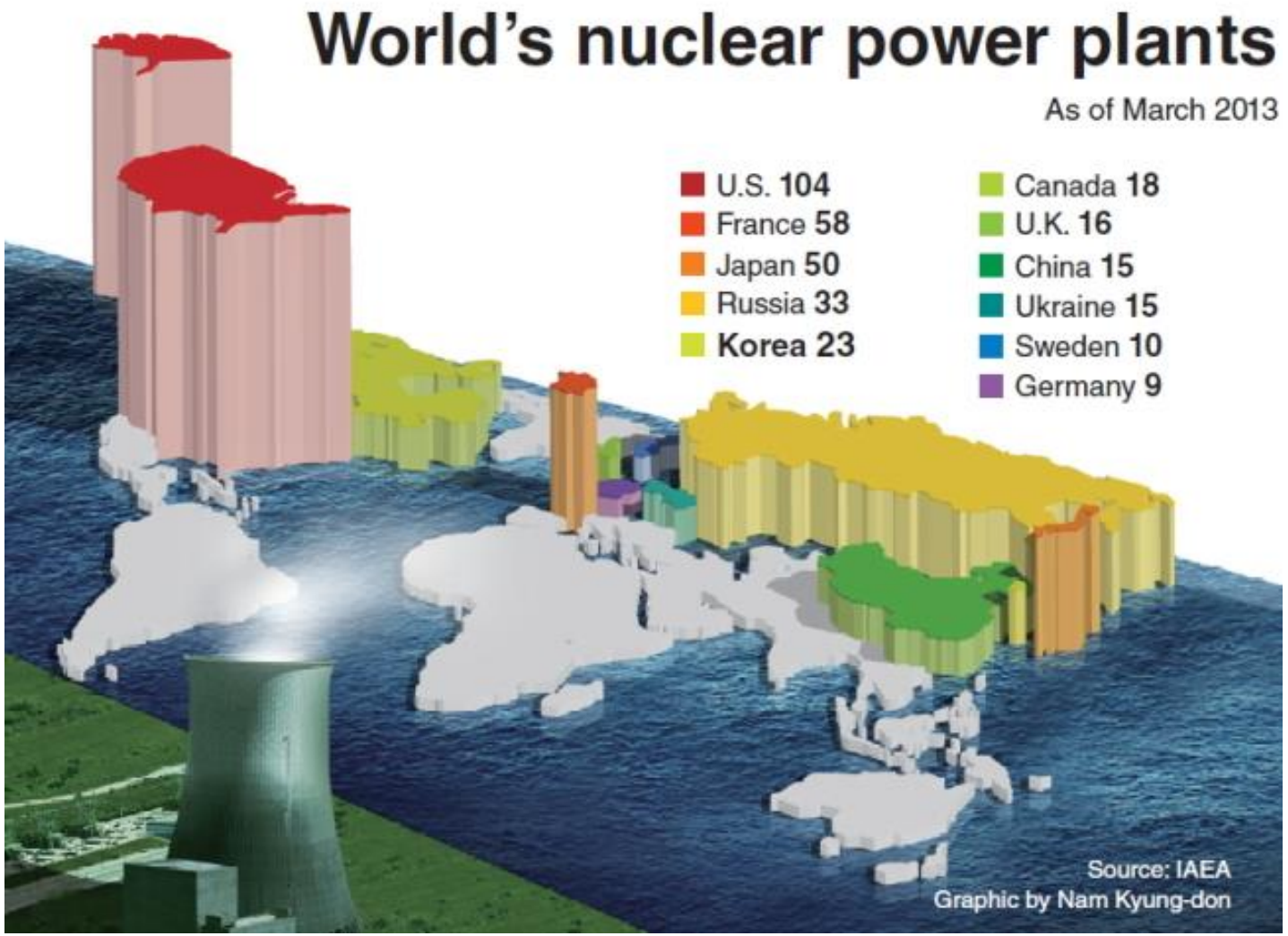
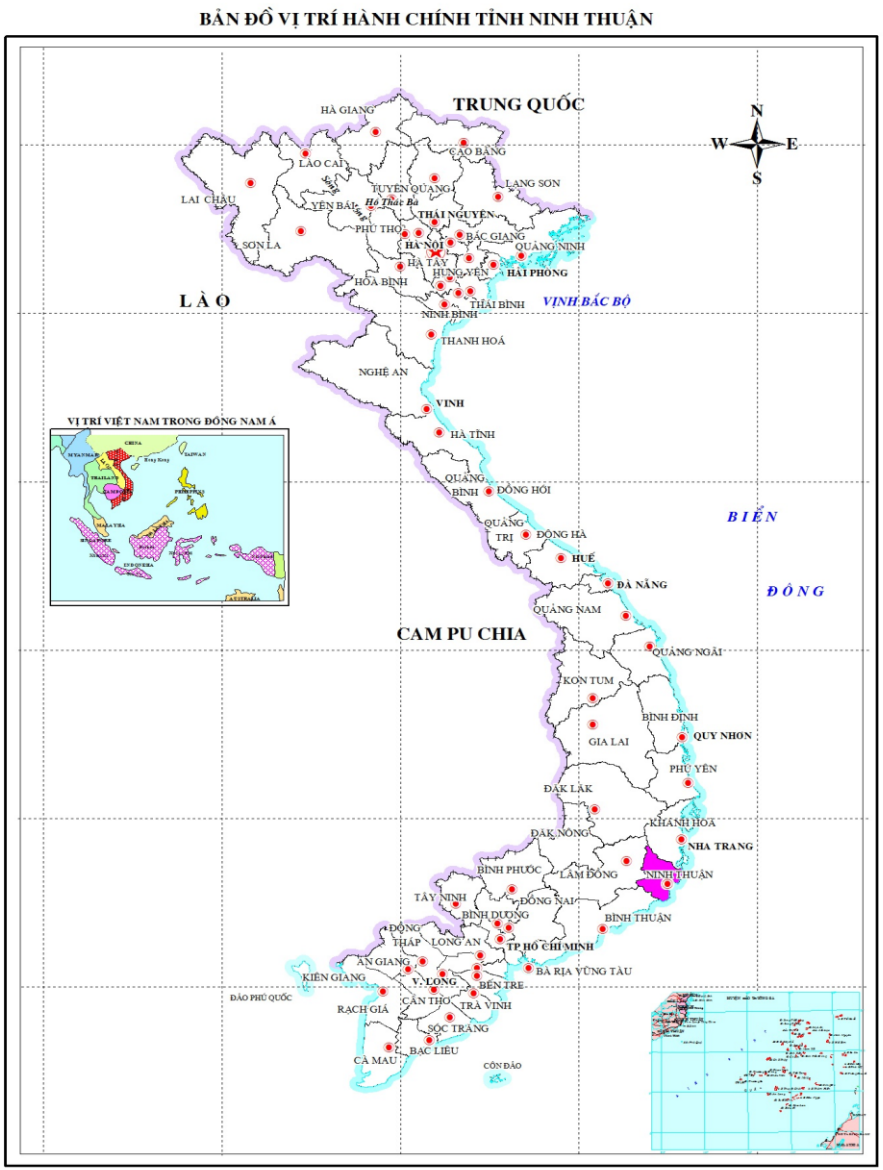
Introduction

- Energy is a prerequisite to economic development (WEO, 2004);
- Nuclear energy plays a significant and growing role in our world's (Anastasio, 2008);

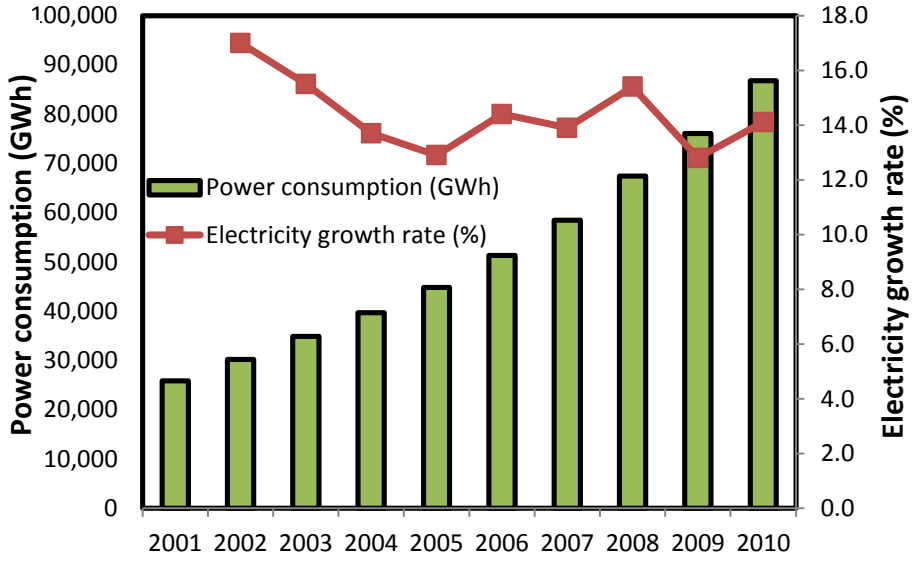


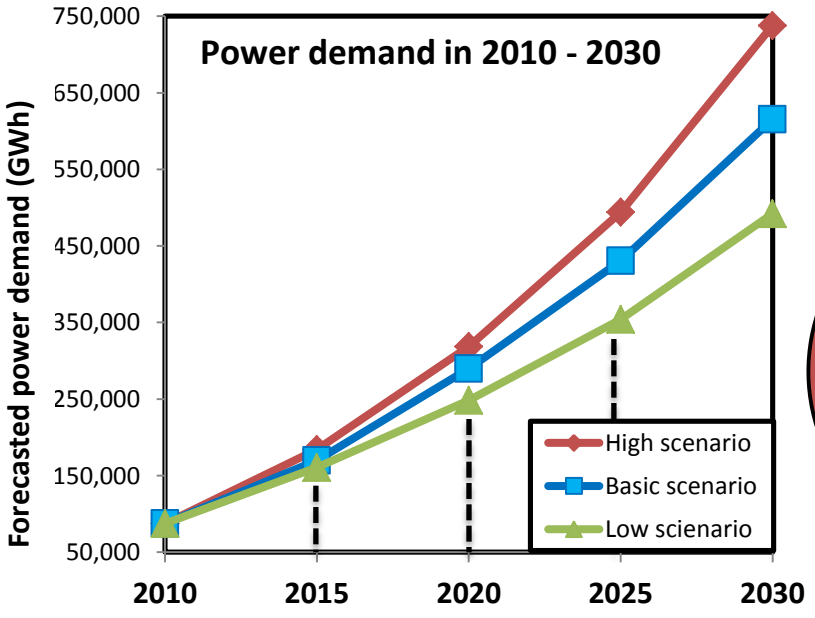
Introduction

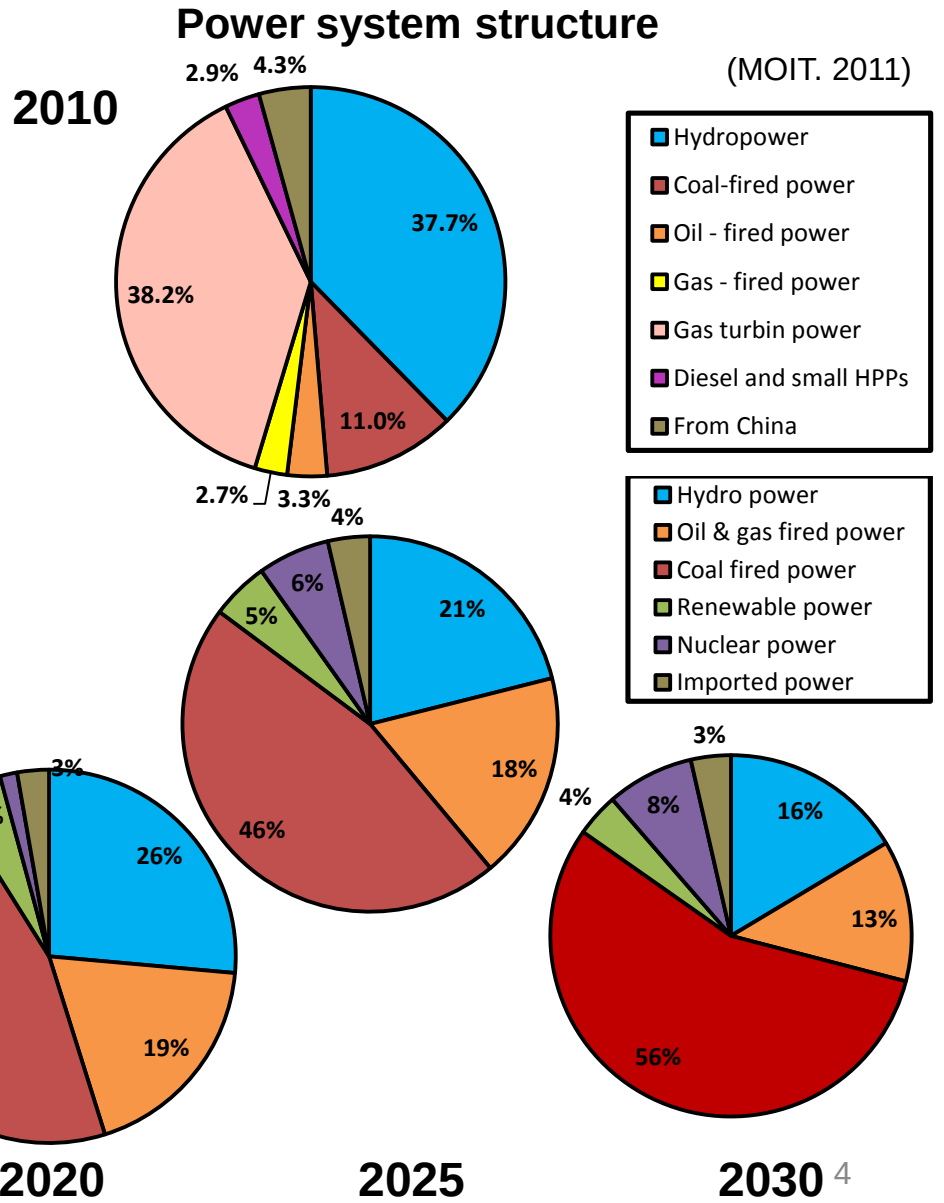


Introduction

Vietnam Power system structure







Introduction

Water resources in NPPs

(EVN. 2013)

Input

- Water sources
- Fossil fuels
- Radio fuels

Output

Radioactive waste

- Gaseous waste
  - γ rays of noble gases
  - Iodine
- Liquid waste
  - Radio materials
  - Iodine
- Solid waste
  - Condensed liq waste
  - Spent radio fuels

Non – radio waste

- Air pollutants
- Waste water
  - Technical WW (~ 3800 m^3/day)
  - Cooling water (~ 1.5 mill m^3/h)
- Solid waste
  - Technical waste
  - Hazardous waste

Surface water | **Groundwater** | **Seawater**

Coastal and Semi-arid areas

- Surface water scarcity
- Groundwater becomes primary sources (Scanlon et al. 2006)
- Decline of GW levels
- Salinization
- Degradation of GW quality (Lee et al. 1999)

Sustainable water use

- Detailed studies on water resources
- Regular monitoring
- Regulation management

Objectives

Unsolved problems

- Few information on water resources (SW and GW) in both quality and quantity;
- Interaction between GW and SW;
- GW evolution and flow system;
- Seawater intrusion in GW.

Objectives

1. To investigate the hydrochemical characteristics of surface water and groundwater;
2. To clarify GW chemical evolution and flow system;
3. To provide a background information for environmental impact assessment.

Methodology

Data collection

Meteo-hydro conditions	Geological conditions	Water resources (volume and quality)

Field survey

Investigation of water uses	Sample taking	In-site monitoring (pH, EC, T°C and GWL)

Laboratory analysis

Stable isotopes (^{18}O and ^{2}H) by MASS spectrometer	Inorganic solutes by IC and ICP (Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, SO_4^{2-}, NO_3^-) and HCO_3^-

Data processing

Defining GW and SW characteristics	Investigating the interaction between SW and GW	Assessment of hydrological environment

Study area

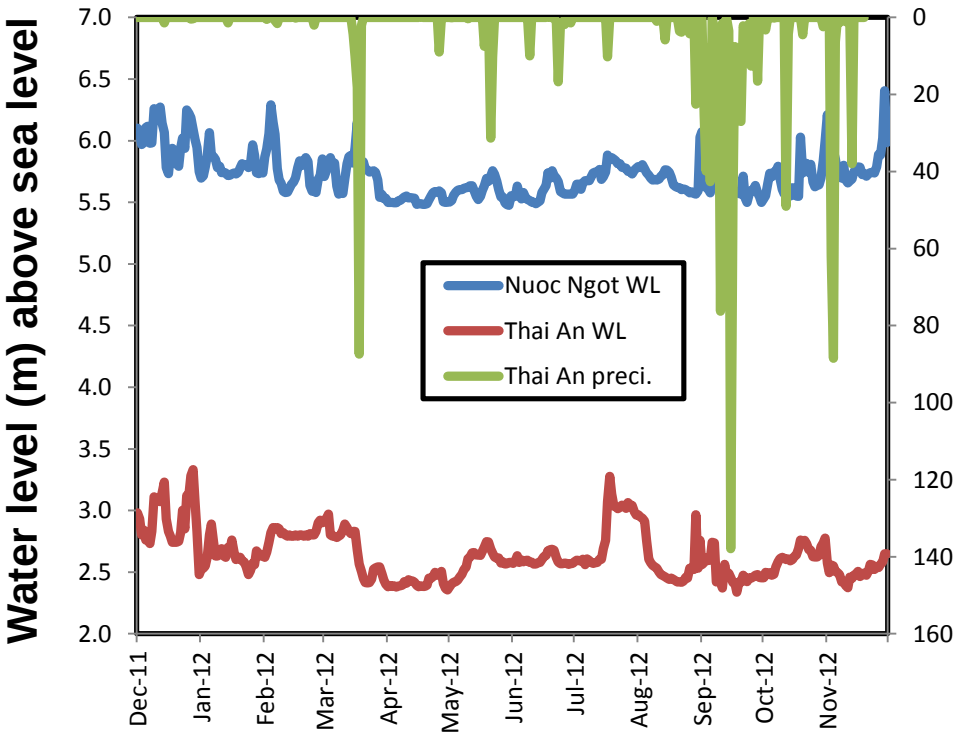
Hydro – meteo conditions

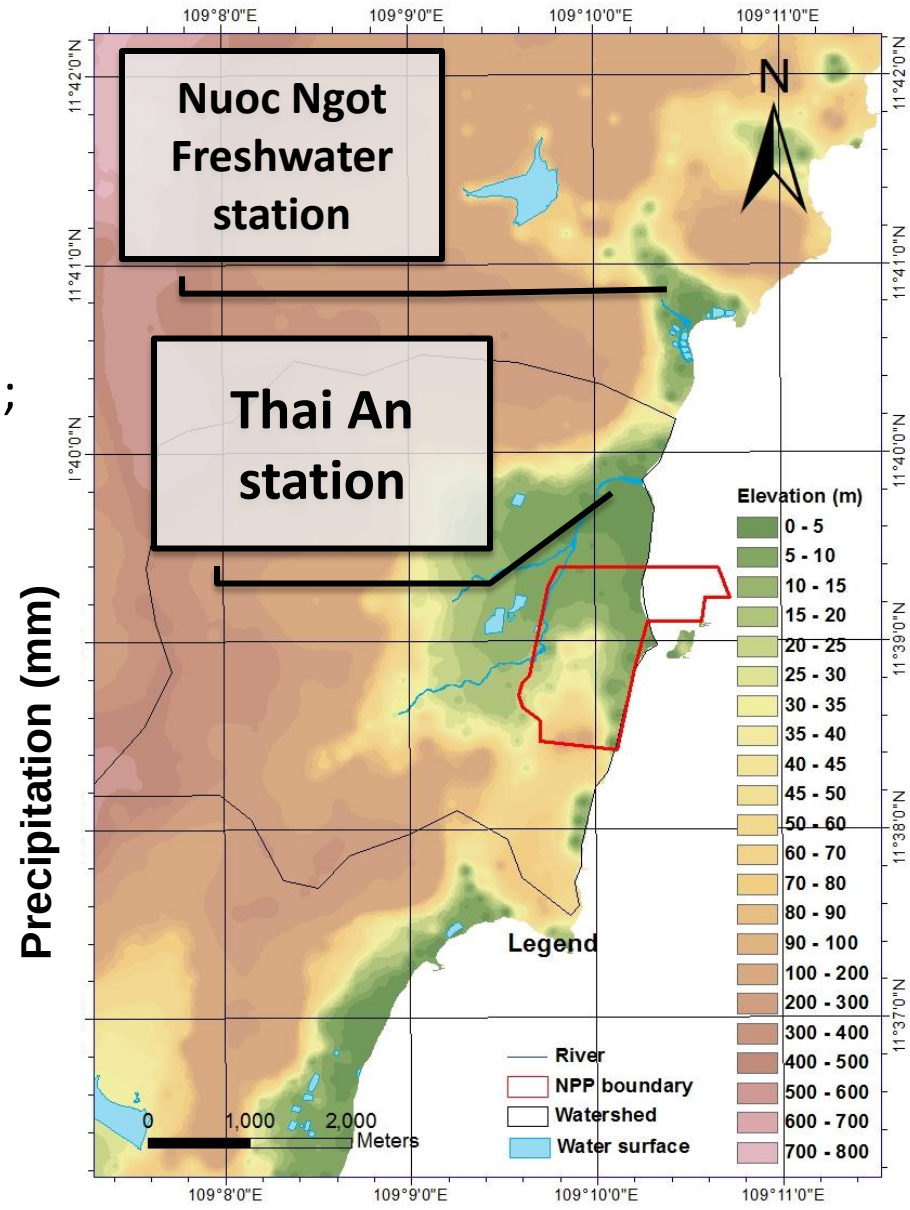
- **Climate:** semi - arid;
- **Temperature:** 16 – 39 deg. C
- **Precipitation:** approx. 900 mm;

Dry season: Jan. – early Sep.

Rainy season: Sept. – Dec.

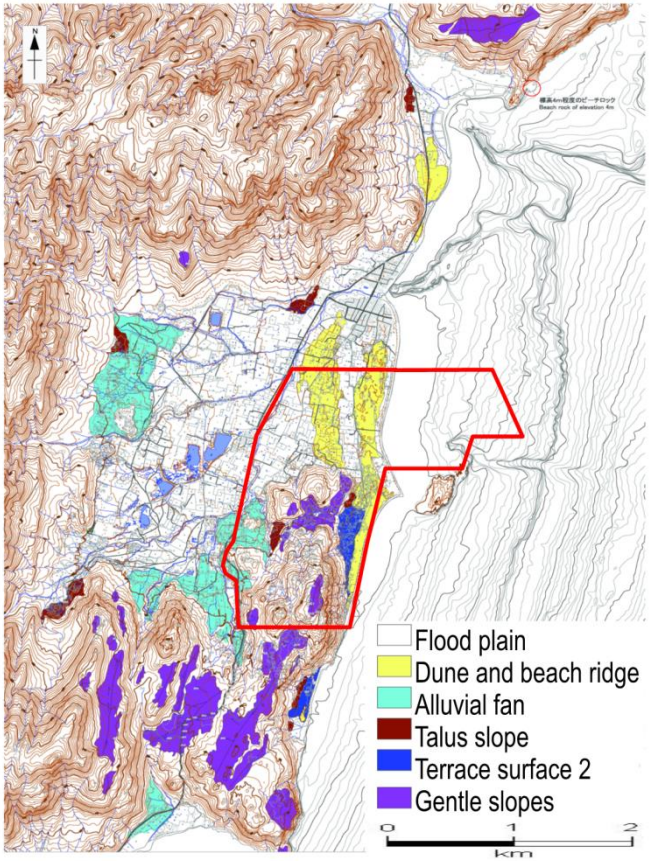
Rainfall in dry season: 30% of total annual ;

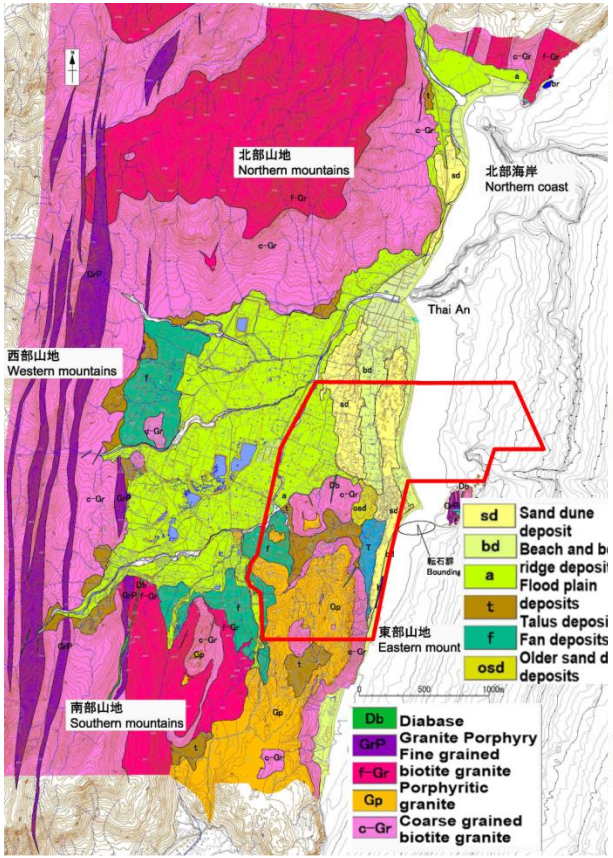


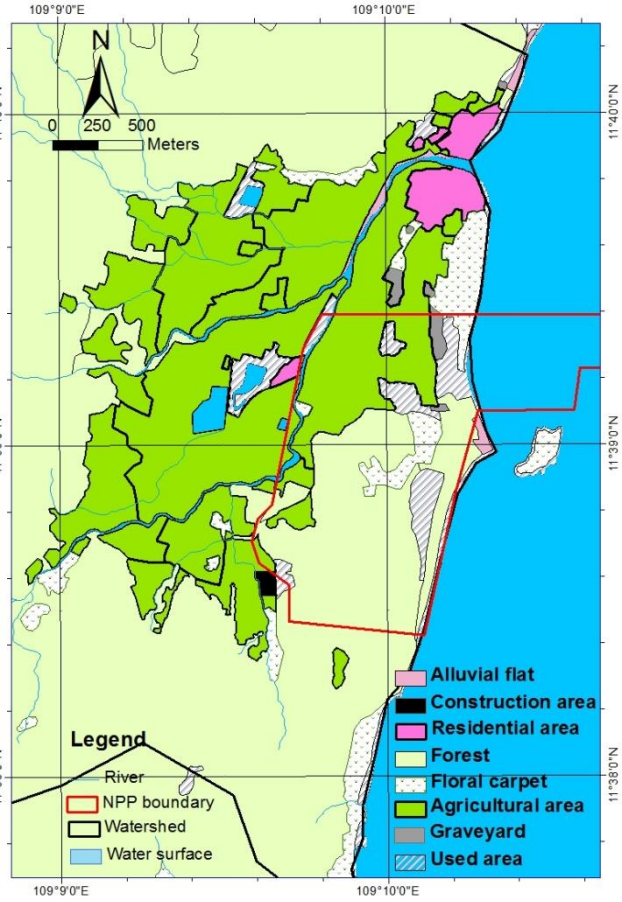


Study area

Topo-geological conditions

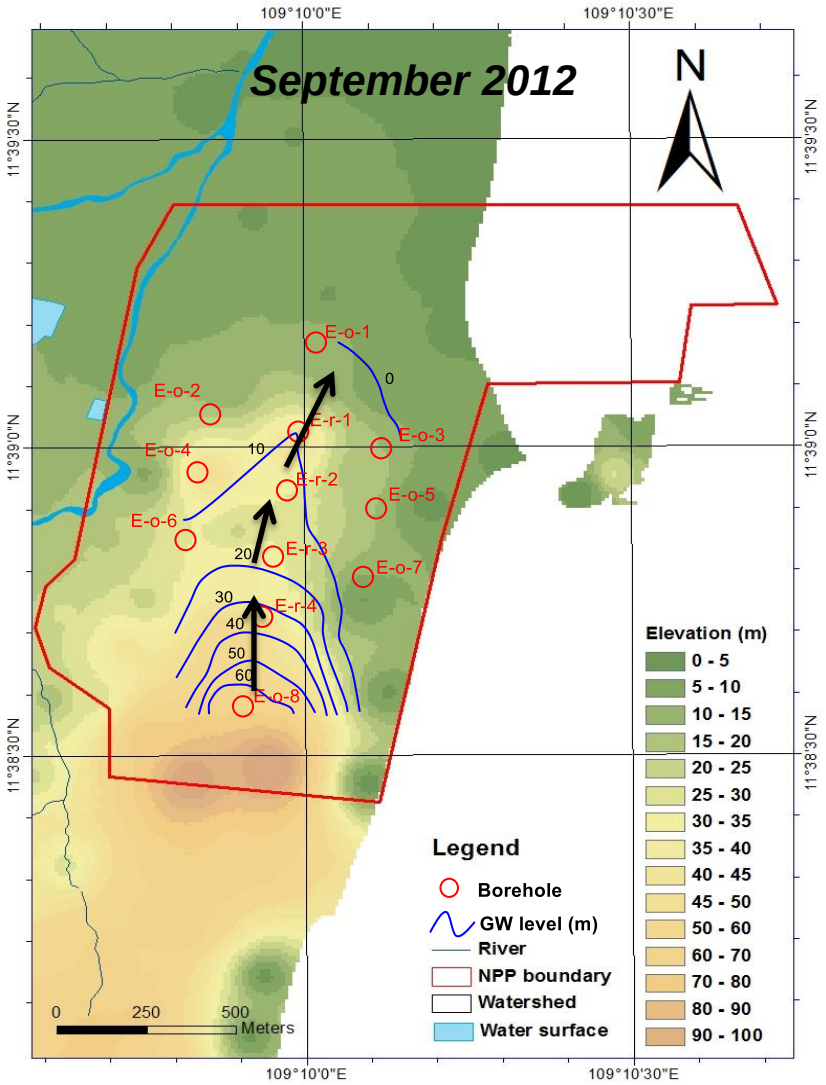


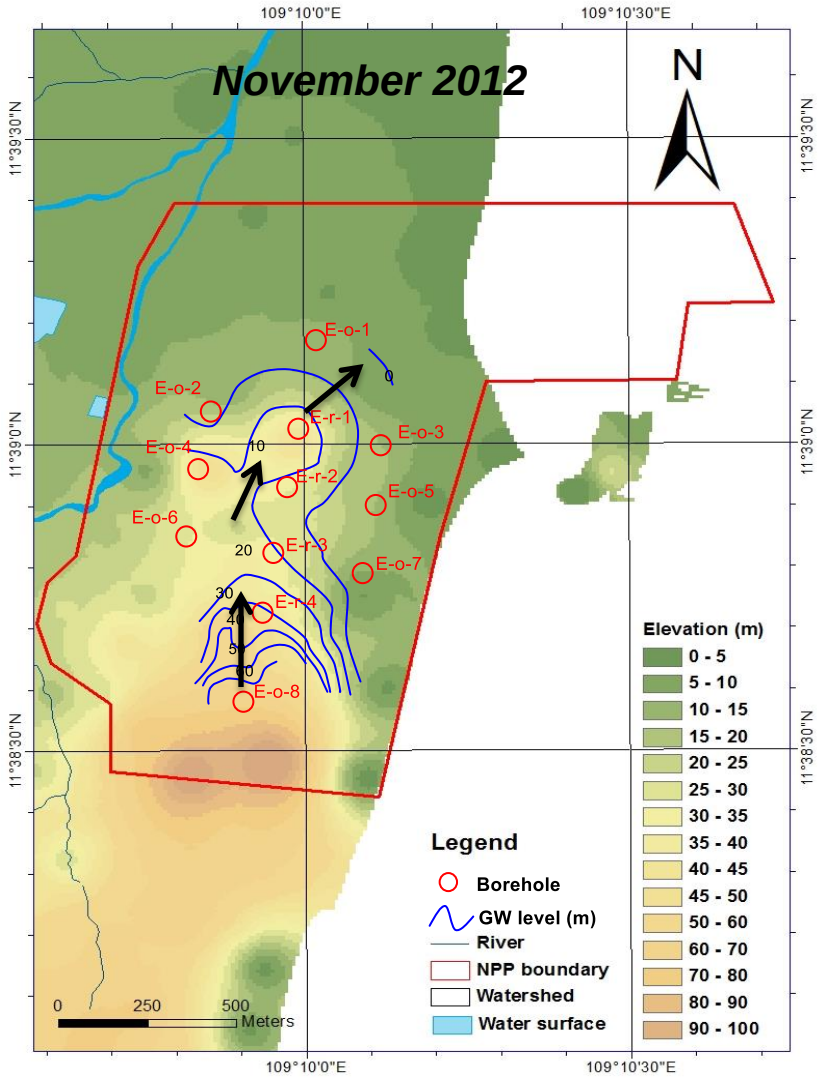




- Average altitude of 20m, on the valley surrounded by high mountains;
- Coarse-grained biotite granite is distributed over the site area and porphyritic biotite granite is laminated at altitude of 40m in the south.
- Poor floral carpet with grass and agricultural crops.

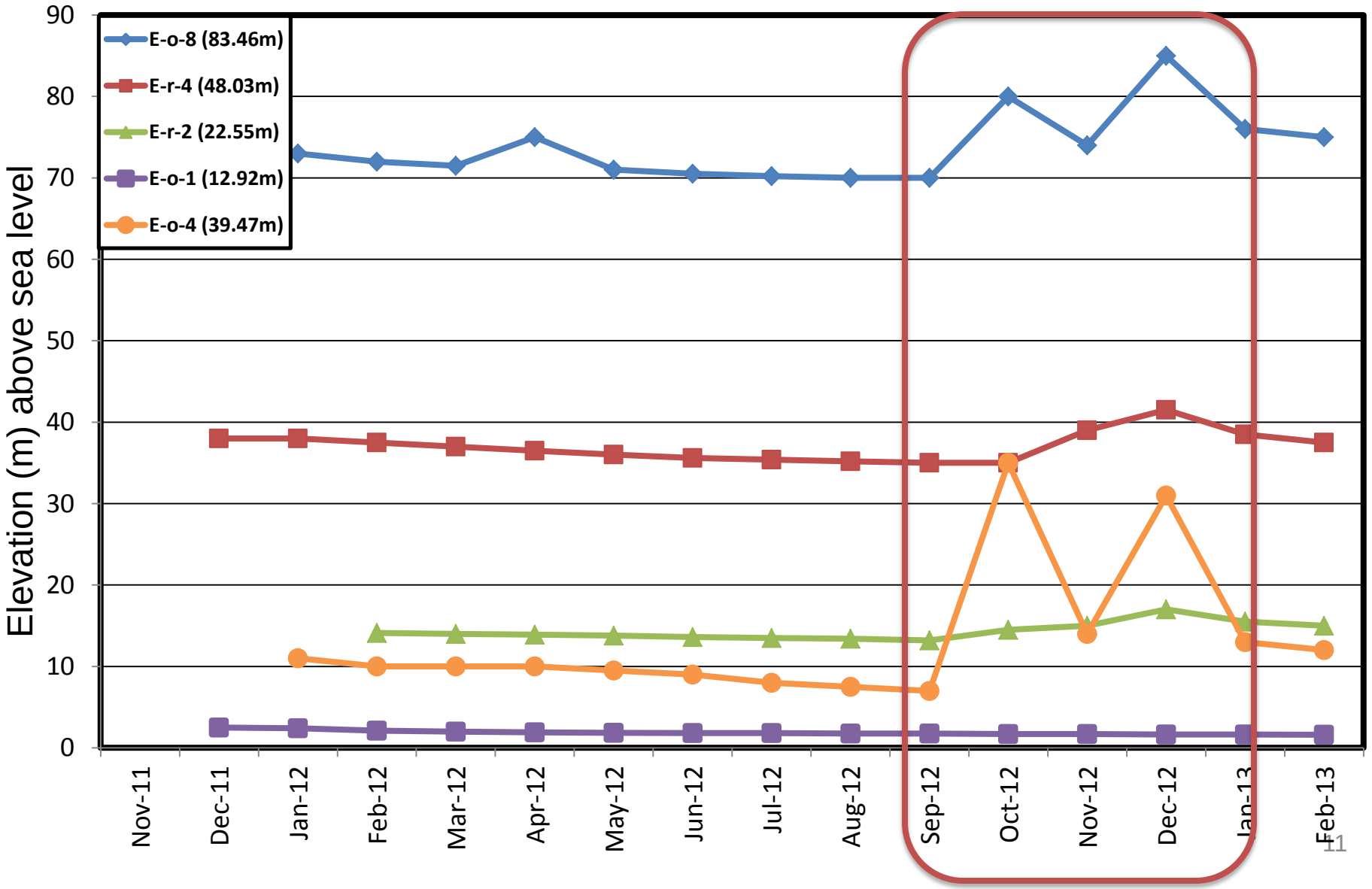
Previous studies





- GWL increases from dry to rainy season, 1-2m in low land and 5 – 25m in high land area;
- GWL reaches the peak level after raining 1 – 20 hours.

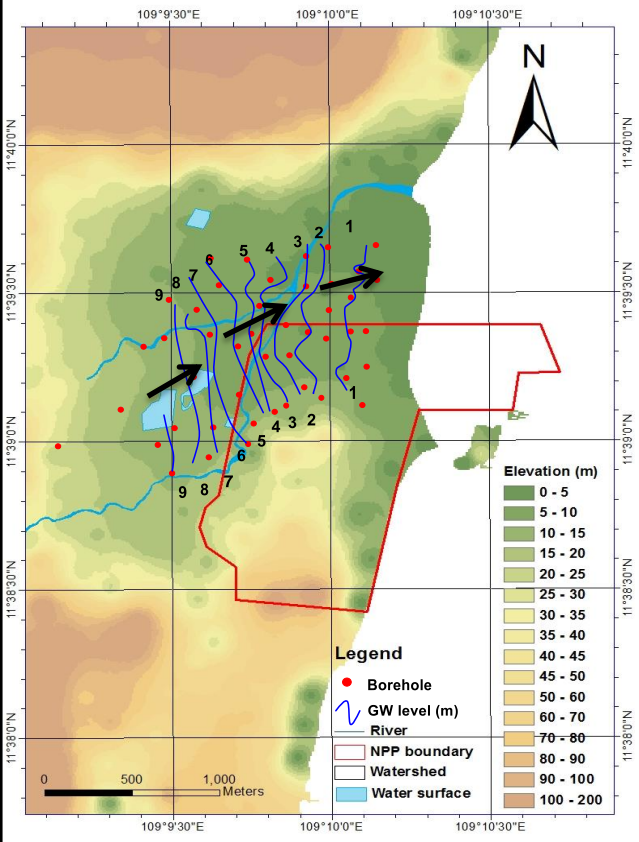
Previous studies



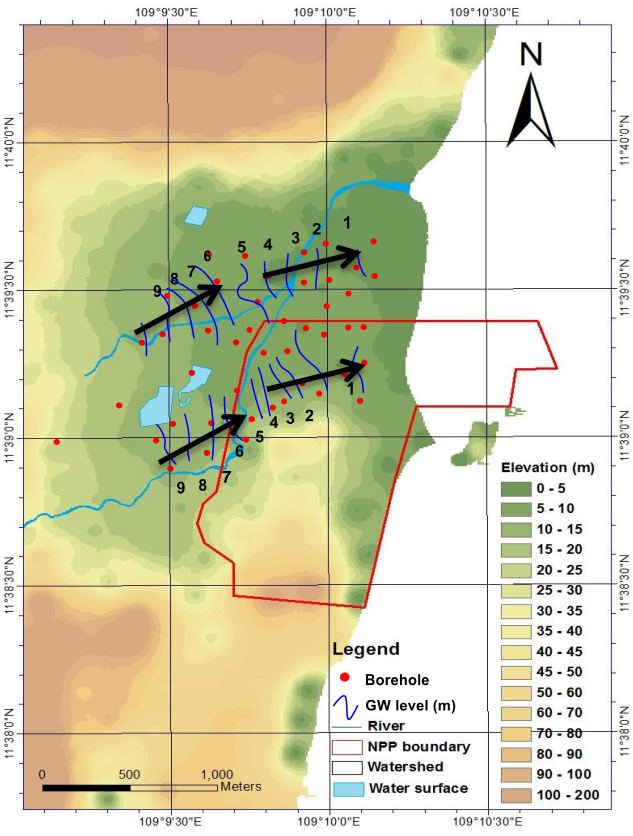
Previous studies

(Data from private households' wells)

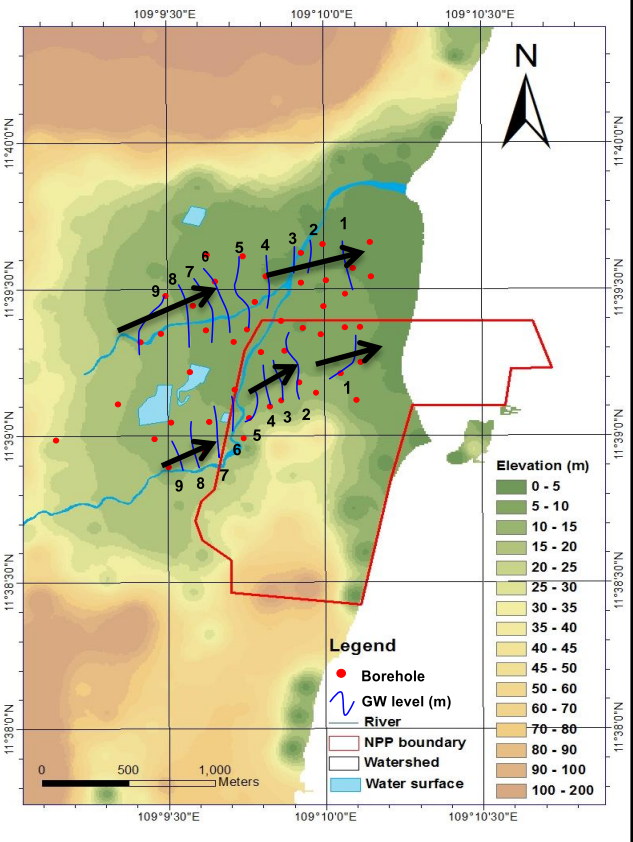
June 2011



November 2011



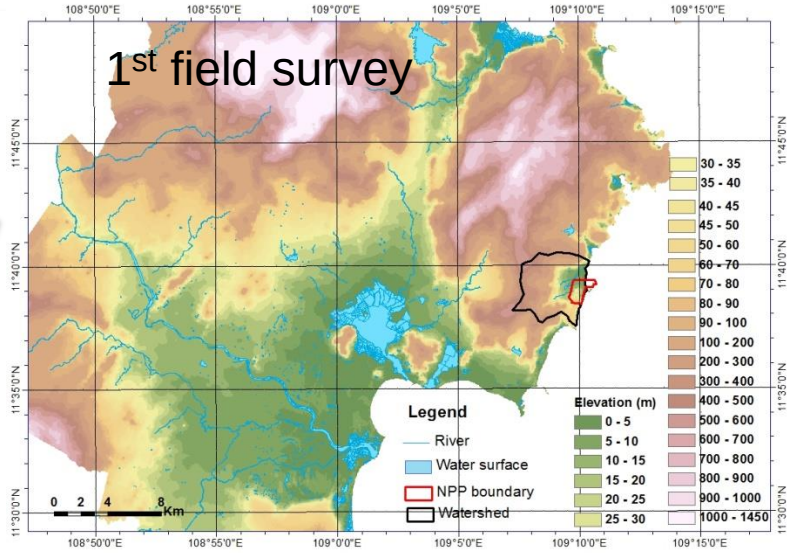
January 2012

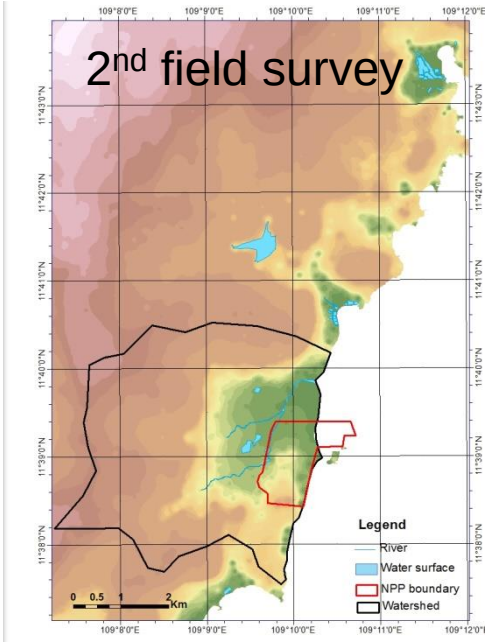


- Groundwater flow from SW to NE, is suitable with river flow direction;
- Near the coastal line, GWL is approx. 1m;
- In rainy season, GWL reaches to the ground level.

Results and analysis

Field surveys





Results and analysis | 1st field survey | Water sampling locations | Analyzing results

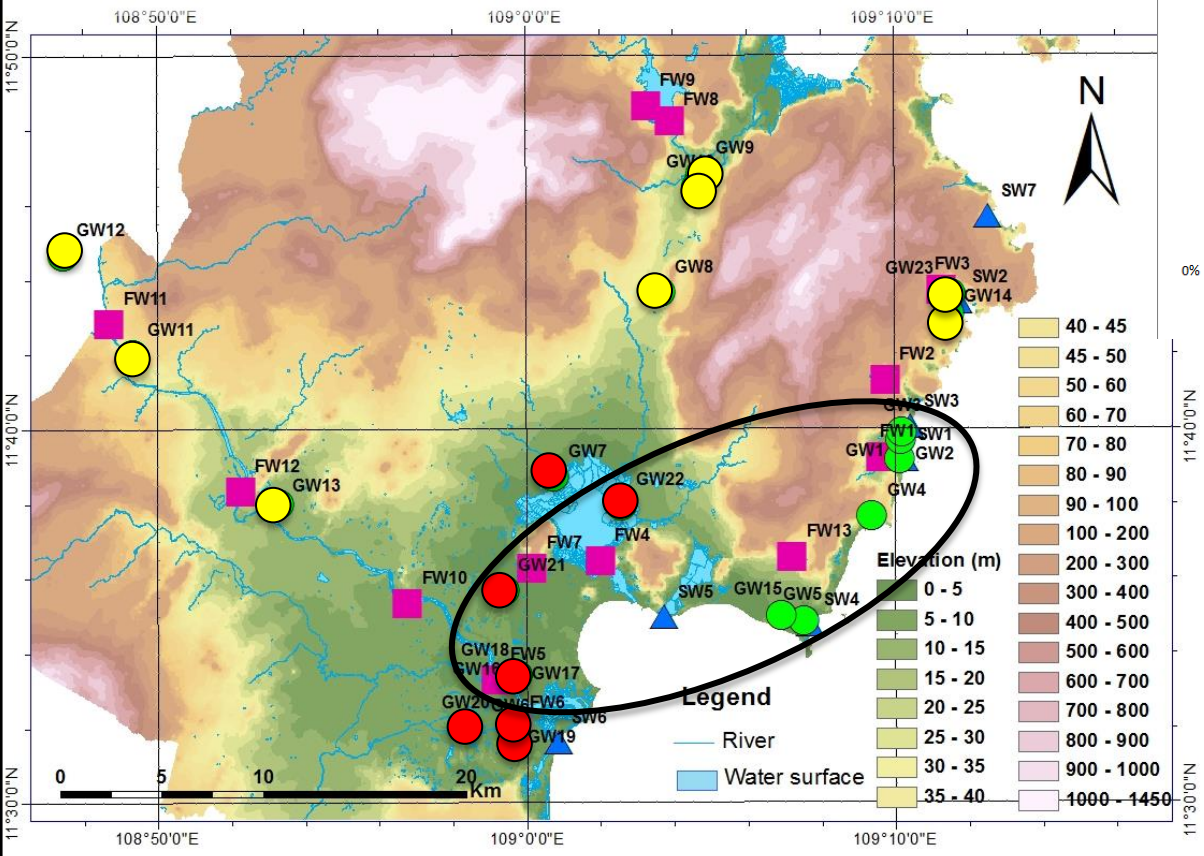
Time: February 2014

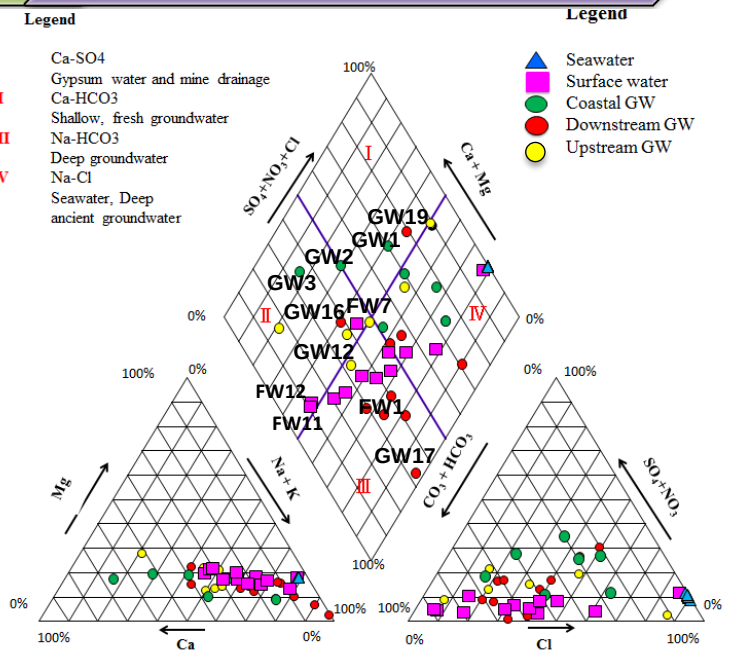
Scale: 30 km

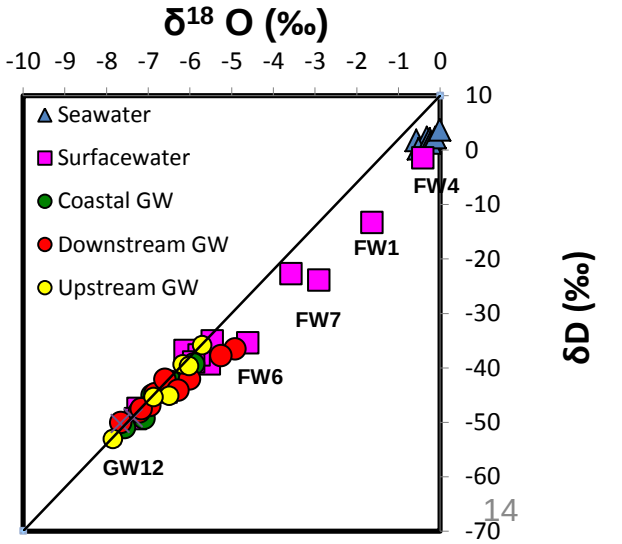
Sample: 13 surface water (river, stream, lake & reservoir)

23 groundwater (HH wells and monitoring wells)

8 seawater

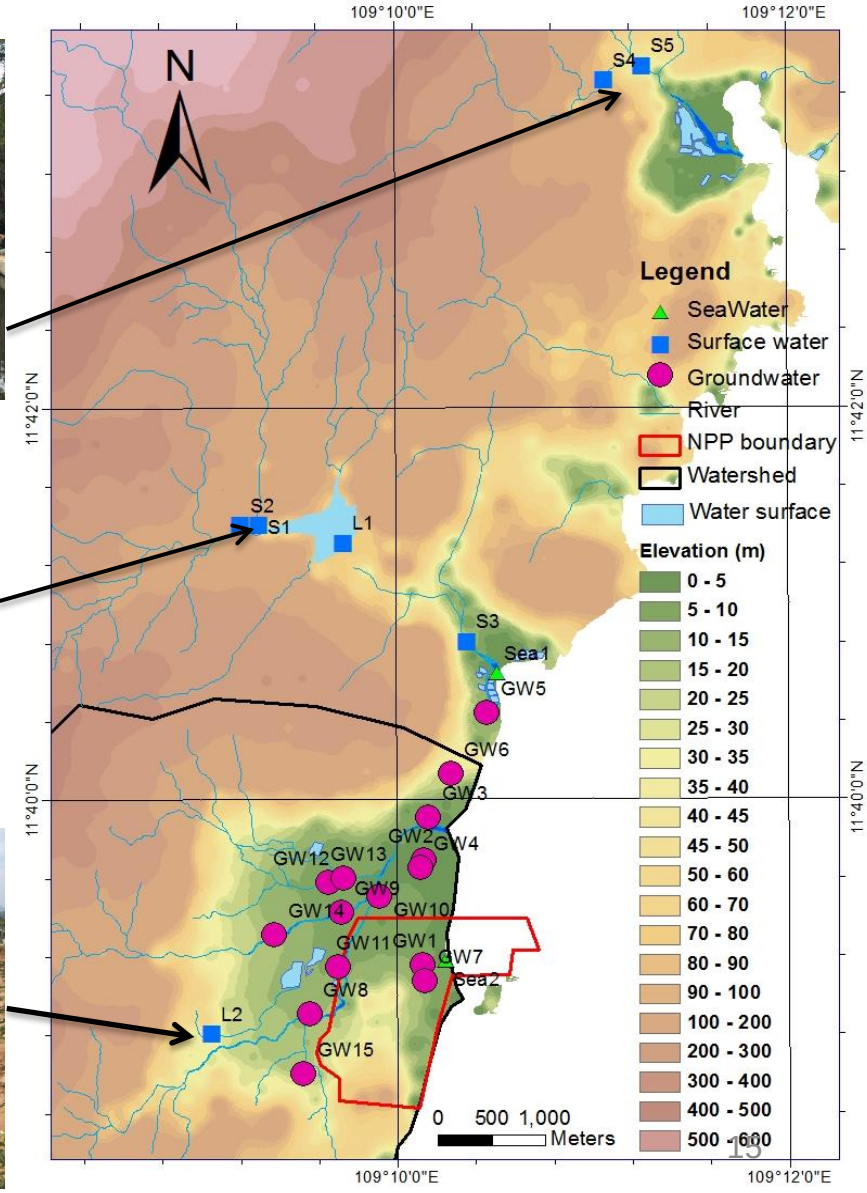


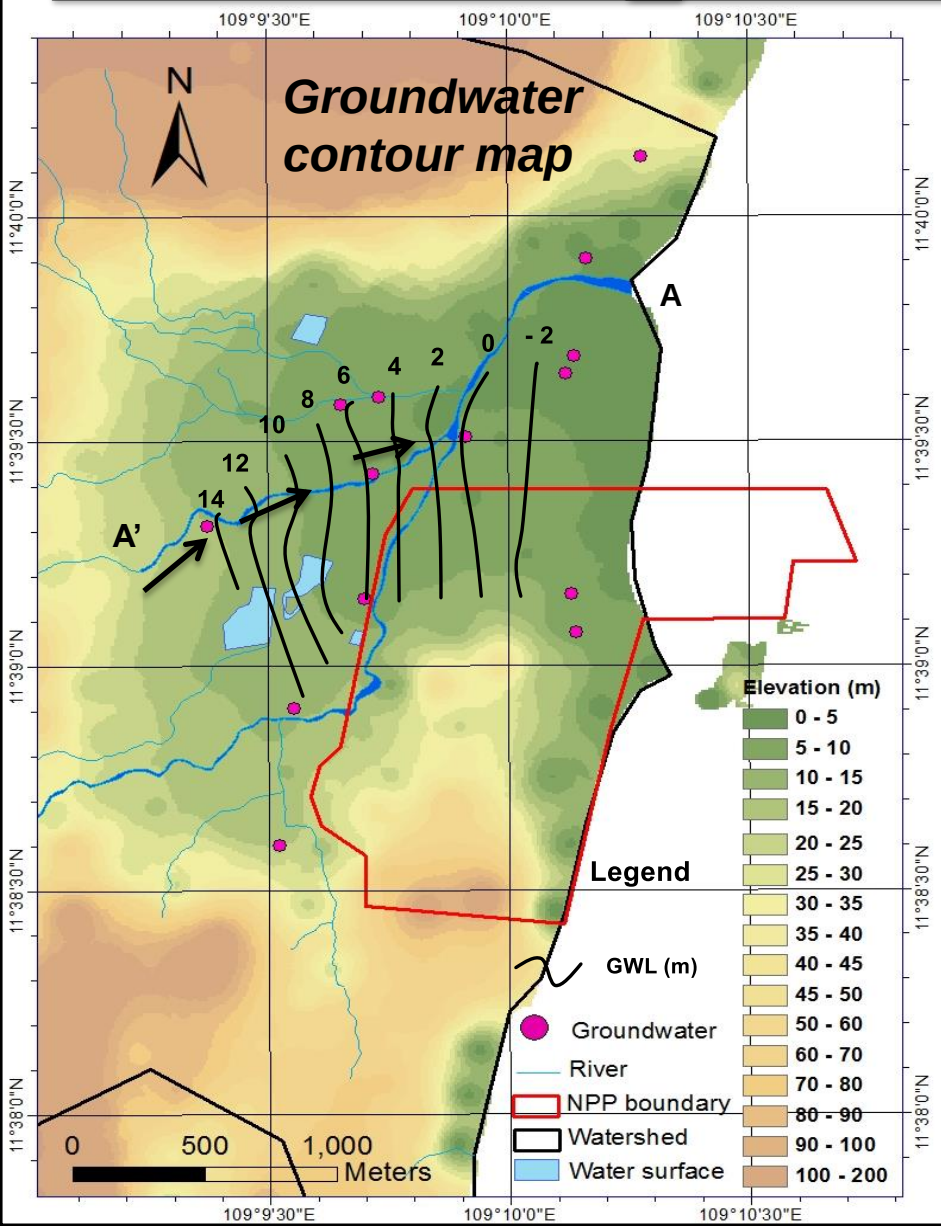


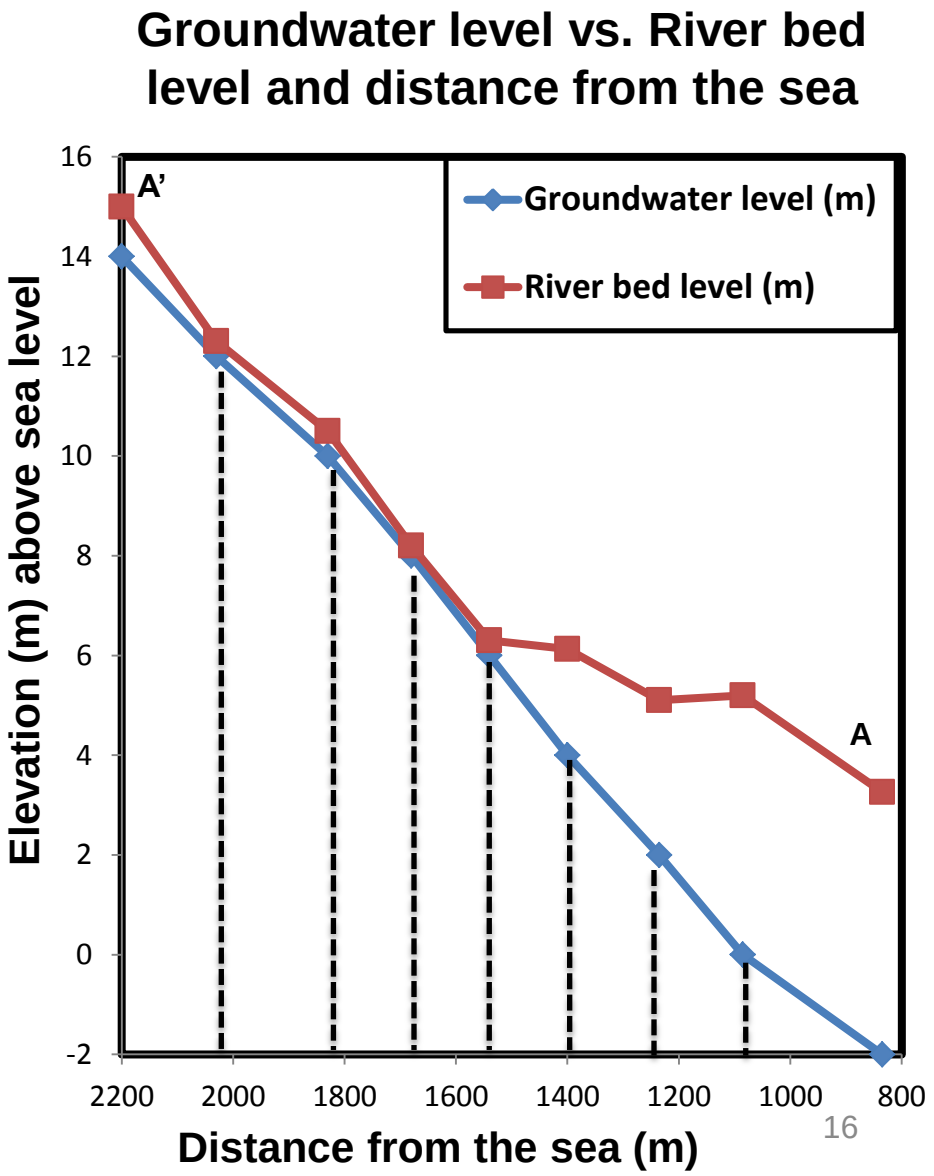


Results and analysis | 2nd field survey | Water monitoring locations

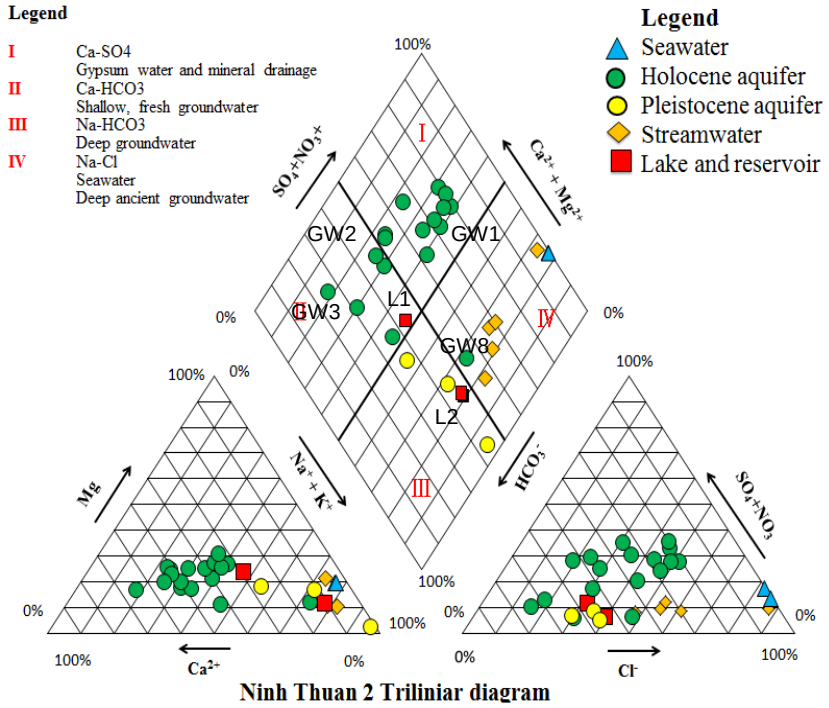
Time: August 2014
Scale: 7 km
Sample:
- 7 surface water
- 20 groundwater
- 2 seawater




Groundwater contour map
N
A
A'
0
- 2
2
4
6
8
10
12
14
Legend
GWL (m)
Groundwater
River
NPP boundary
Watershed
Water surface
Elevation (m)
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100
100 - 200
0
500
1,000
Meters
109°9'30"E
109°10'0"E
109°10'30"E
11°40'0"N
11°39'30"N
11°39'0"N
11°38'30"N
11°38'0"N

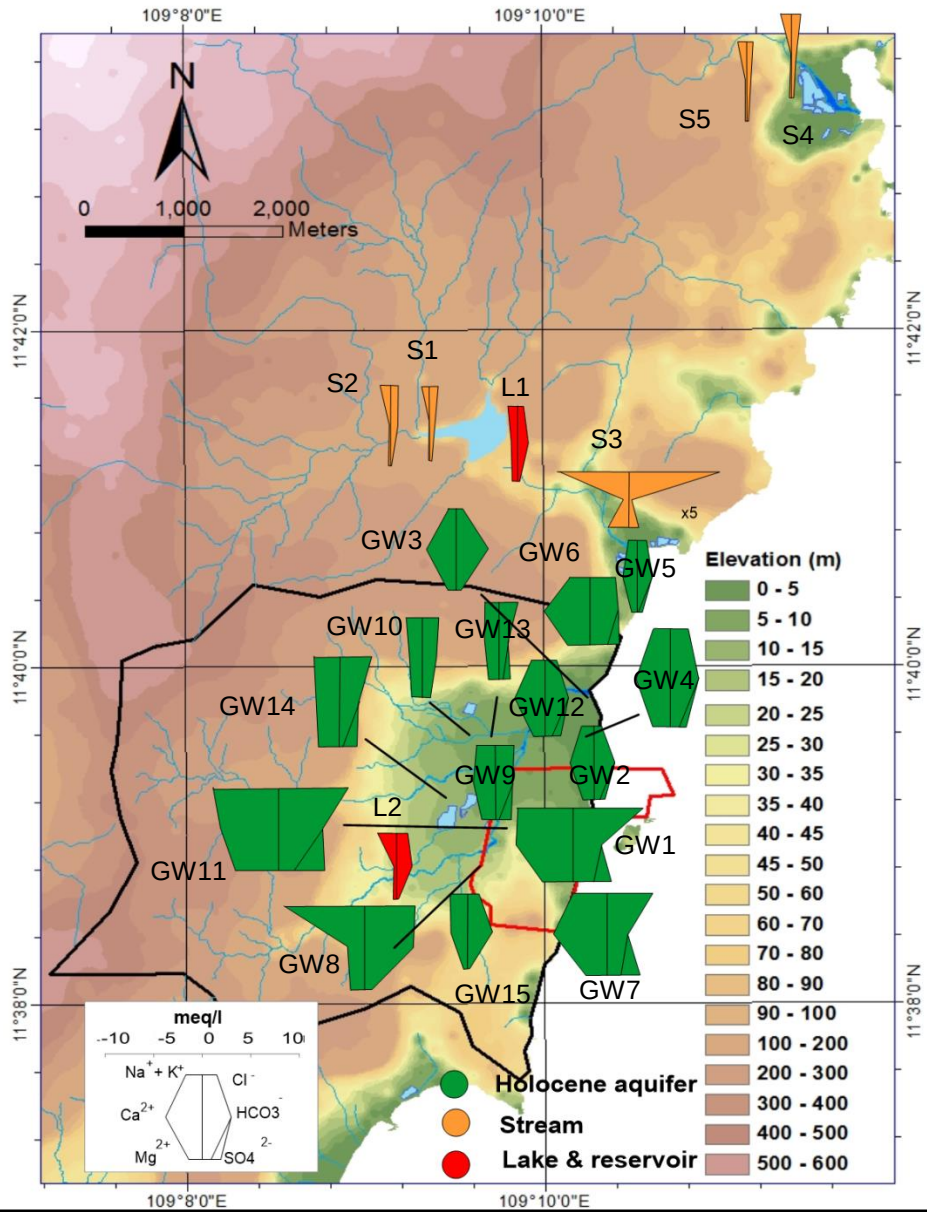

Groundwater level vs. River bed level and distance from the sea
Groundwater level (m)
River bed level (m)
A'
A
Elevation (m) above sea level
16
14
12
10
8
6
4
2
0
-2
2200
2000
1800
1600
1400
1200
1000
800
Distance from the sea (m)

Results and analysis | 2nd field survey | Analyzed results

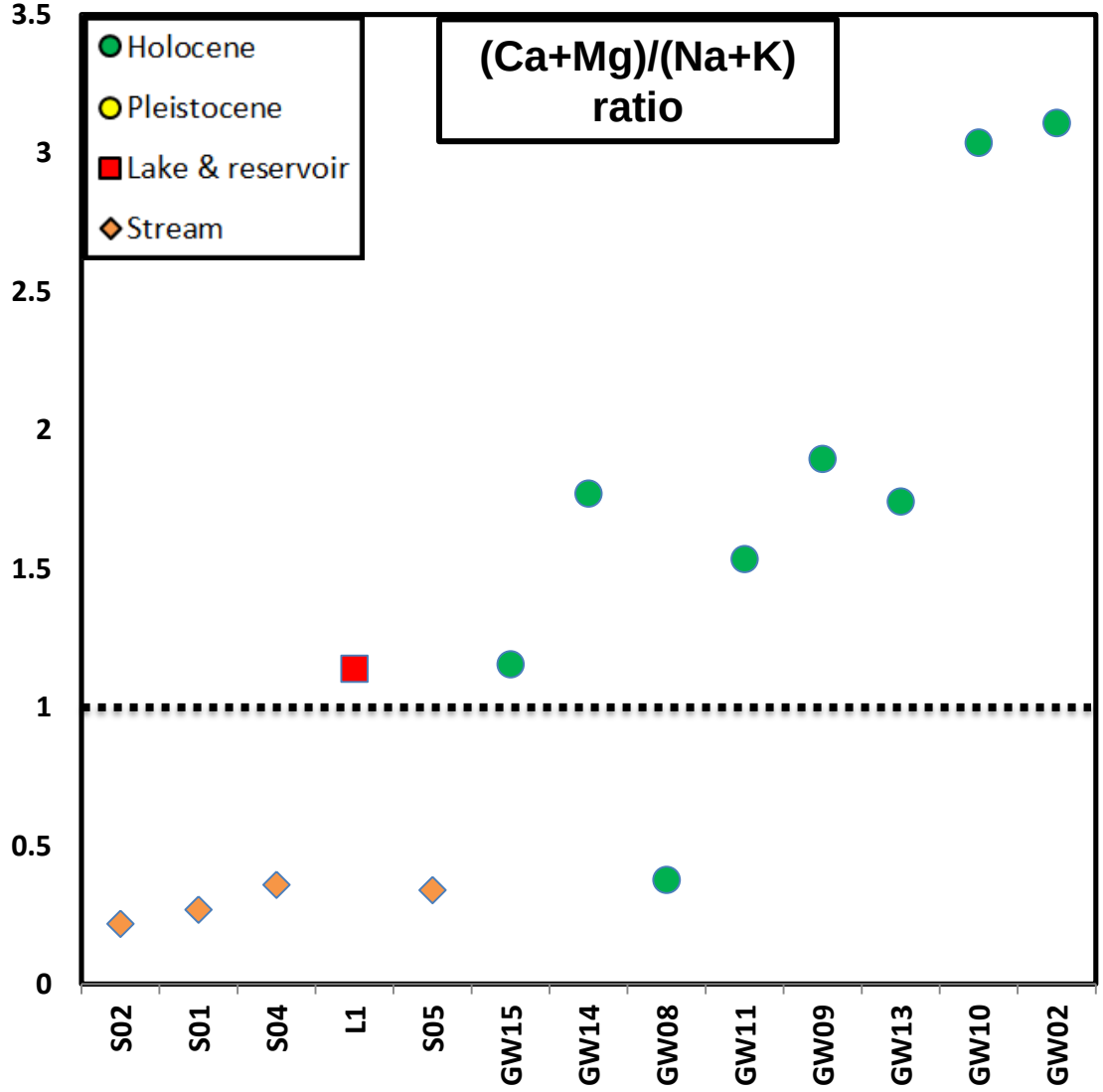


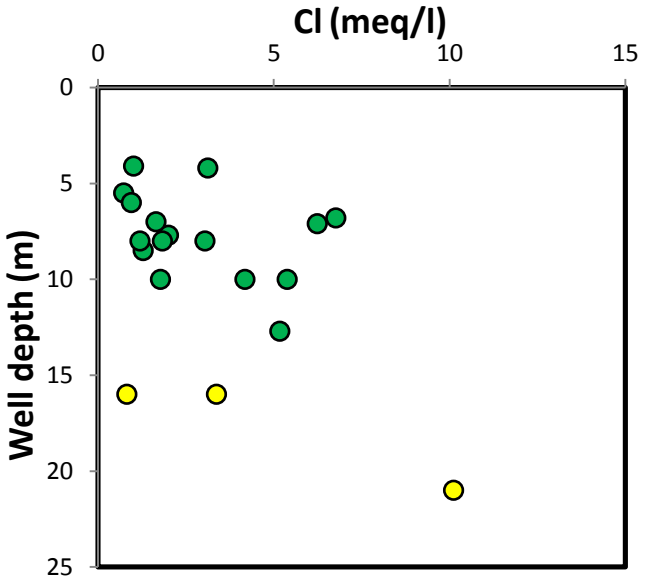
Ninh Thuan 2 Triliniar diagram

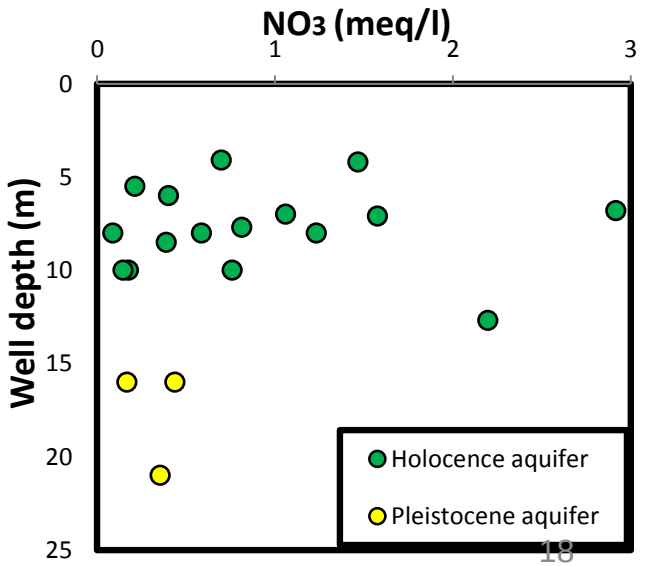
- GW in Holocene aquifer near the foothill is characterized by Ca-SO_4 water type;
- GW in Holocene aquifer at low land area is characterized by Ca-HCO_3 water type;
- GW in Pleistocene aquifer is characterized by Na-HCO_3 water type;
- Streams and GW near the shoreline is characterized by Na-Cl water type.

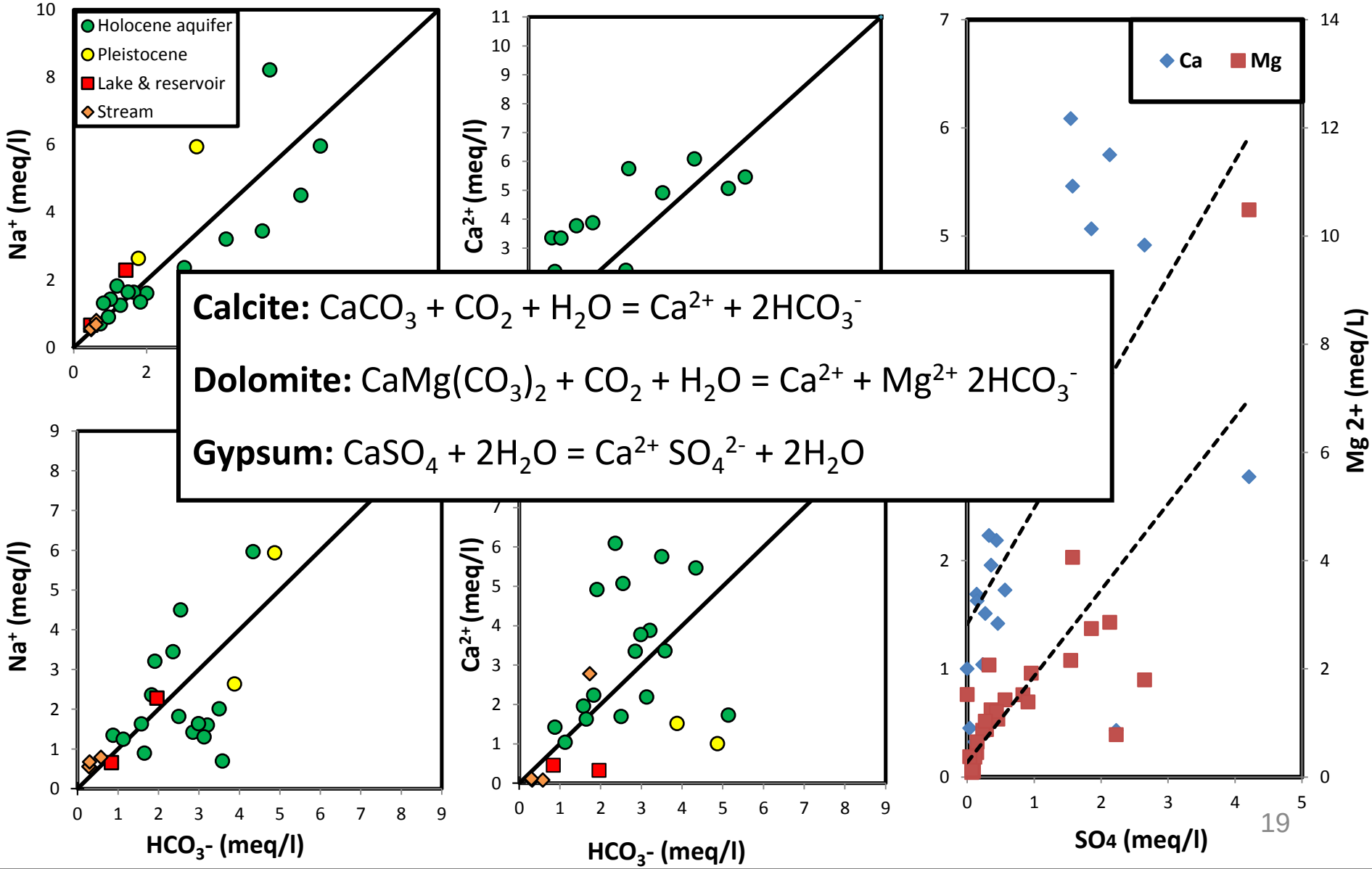


Results and analysis | 2nd field survey | Analyzed results









Calcite: $CaCO_3 + CO_2 + H_2O = Ca^{2+} + 2HCO_3^-$

Dolomite: $CaMg(CO_3)_2 + CO_2 + H_2O = Ca^{2+} + Mg^{2+}\ 2HCO_3^-$

Gypsum: $CaSO_4 + 2H_2O = Ca^{2+}\ SO_4^{2-} + 2H_2O$

Results and analysis

Concluding remarks

1. GW flows in the same direction with stream flows (SW – NE) but GWL in dry season 2014 is 2-3 m lower than in 2012;
2. GW in Holocene aquifer shows characteristics of Ca-SO_4 and Ca-HCO_3 water type;
3. GW in Pleistocene aquifer shows characteristics of Na-HCO_3 water type;
4. GW in shallow aquifers is not affected by seawater intrusion;
5. Streams and GW near the shoreline shows characteristic of Na-Cl water type, similar to seawater.
6. Water constituent is caused by freshwater – saline water mixing and weathering process.

Future works

- Analyze stable isotopes (^{18}O and ^{2}H);
- Study on EMMA method and apply for the research;
- Define groundwater recharge and discharge sources.

Thank you for your attention!

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