Norway grants

EVALUATING GROUNDWATER RECHARGE\DISCHARGE

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Project is coordinated by:

Project is implemented in partnership with:

NORD universitet

GEOLOGICAL SURVEY OF NORWAY - NGU -

Outline of Presentation

- **Part I:**

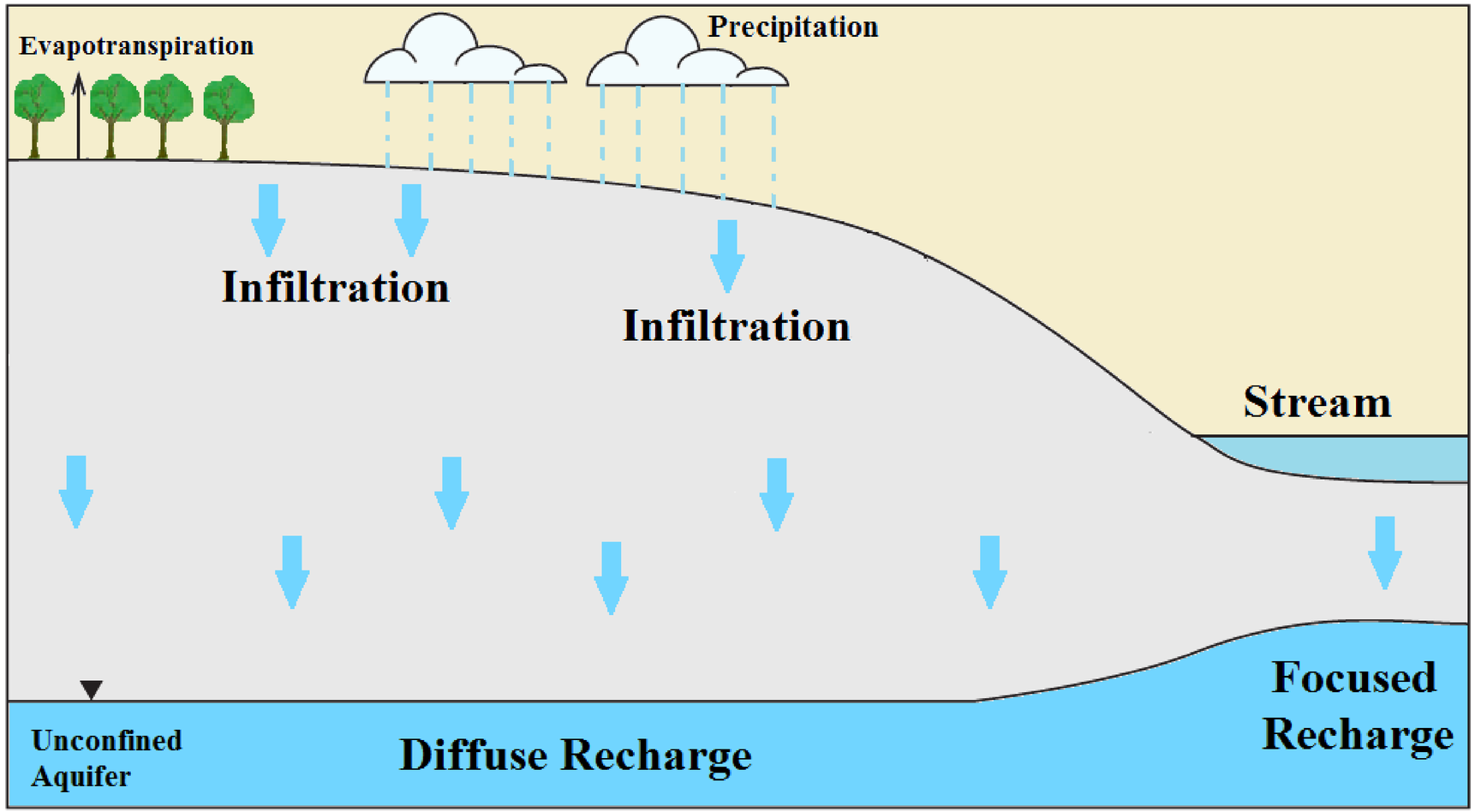
  Evaluating Groundwater Recharge Using Multiple Approaches

- **Part II:**

  Arctic SGD: Submarine Groundwater Discharge in a Changing Arctic Region: Scale and Biogeochemical impact

Groundwater Recharge

Introduction



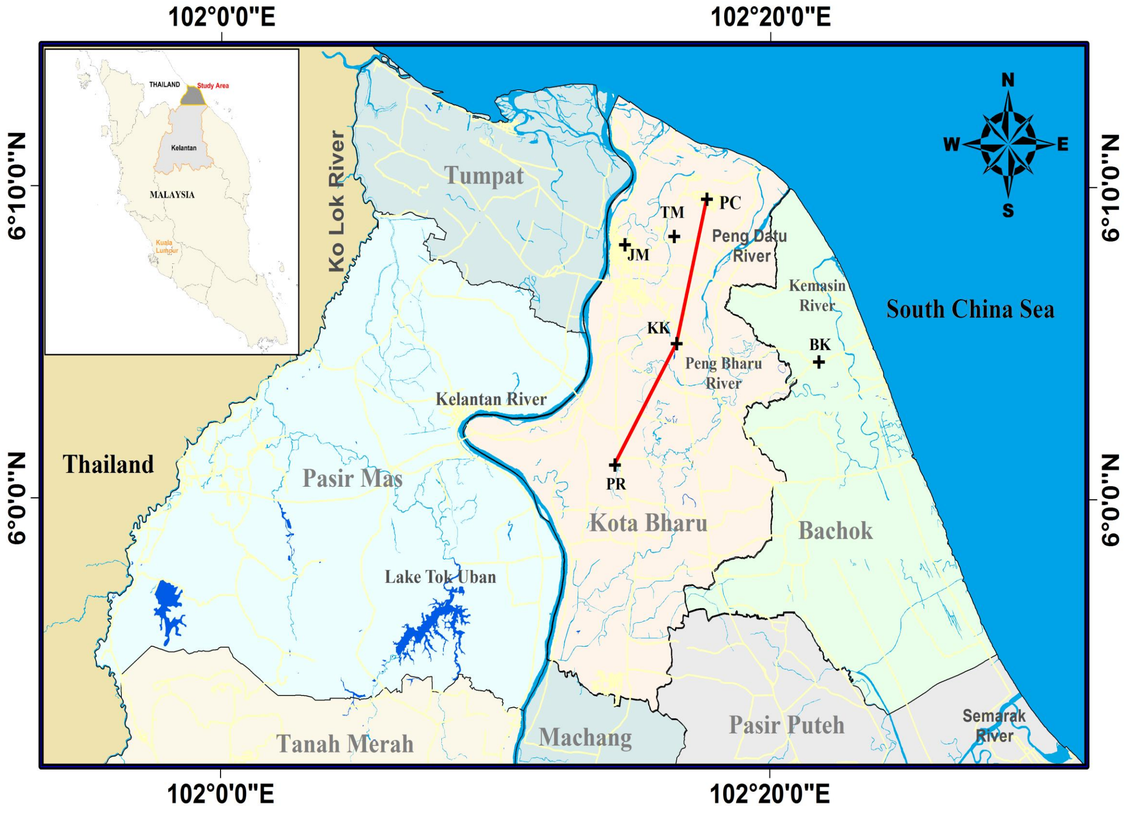
Schematic depiction of processes associated with water cycle emphasizing types of recharge.

Arrows indicate water movement.

Objectives

- To infer recharge rate based on water table fluctuation method
- To evaluate chloride/sulfate mass balance in the unsaturated zone
- To identify isotopic compositions and geochemistry of aquifers in saturated zone.

Study Area

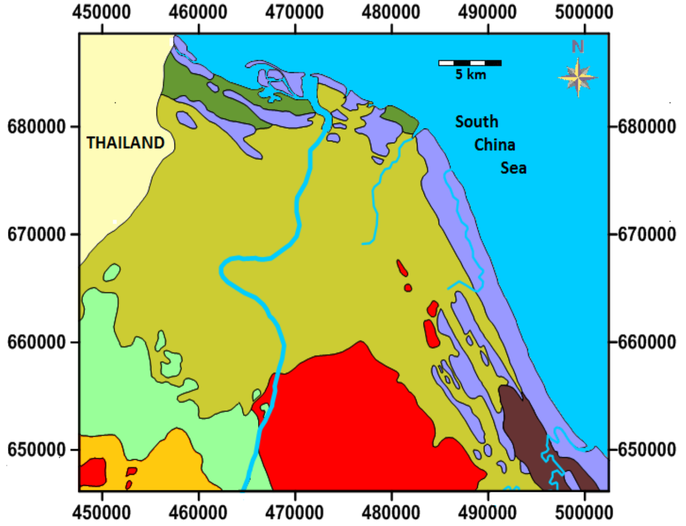


Legend

Road | Cross Section | River

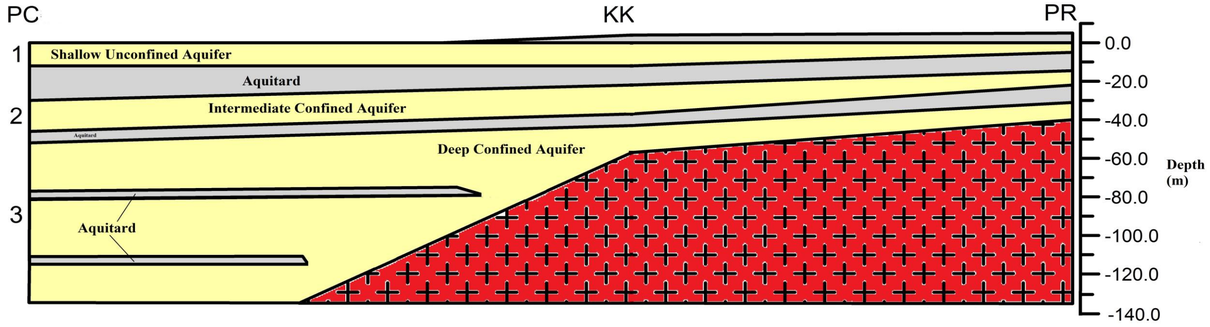
Boundry | Site Location | Lake

0 8 Kilometers

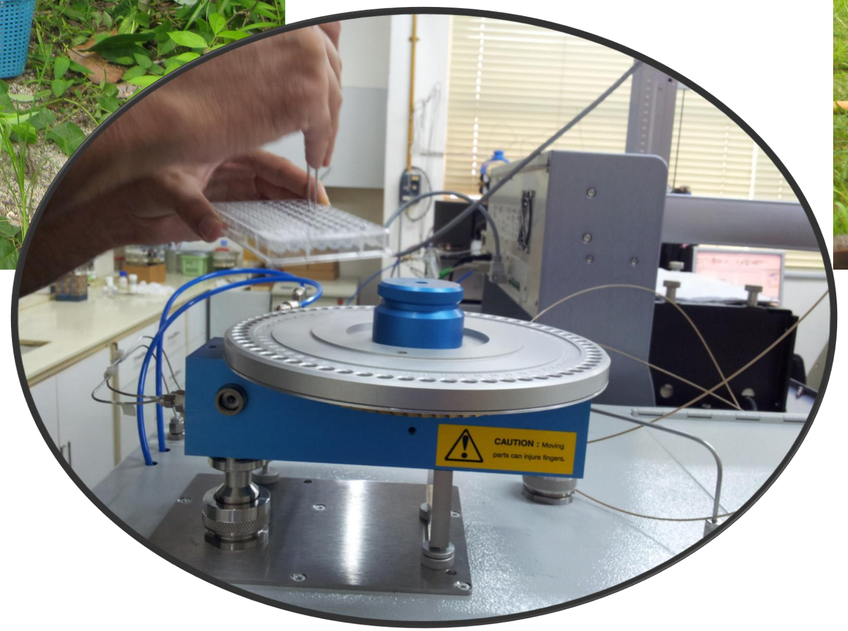


LEGEND

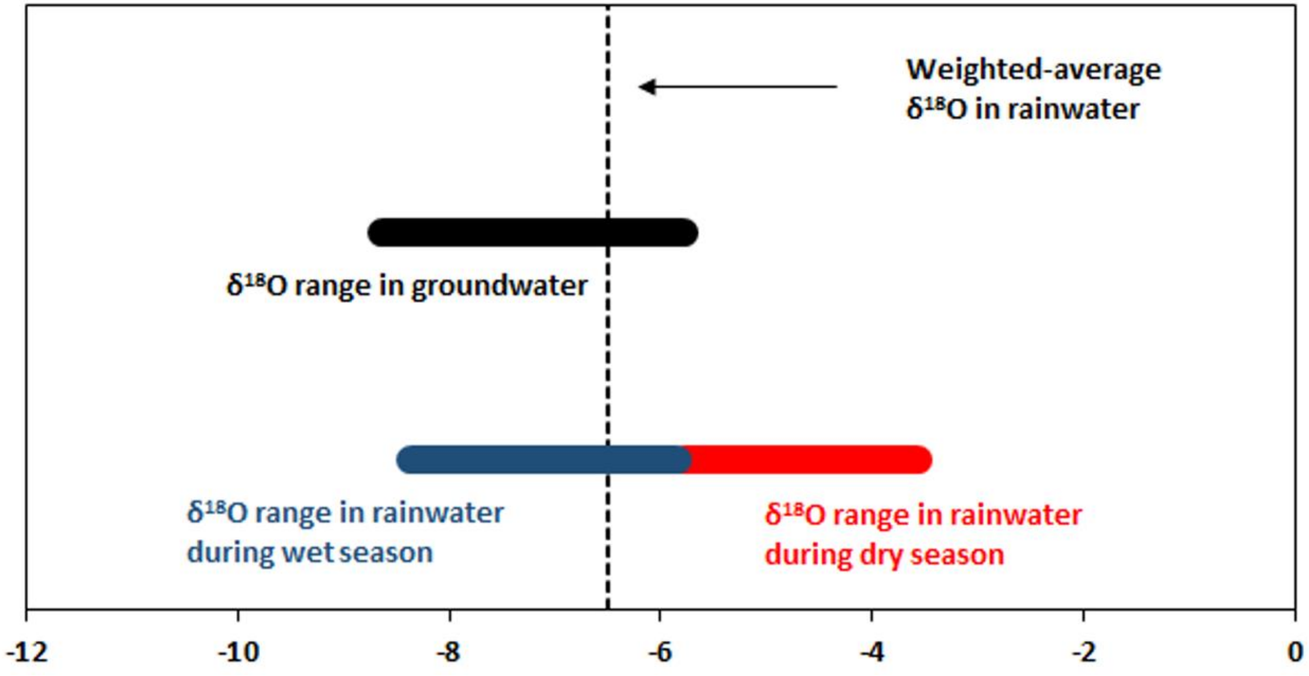
- Matang Gelugor Memeber (Gula formation, Quaternery deposits)
- Port Weld Member (Gula formation, Quaternery deposits)
- Organic Soil (Quaternery)
- Simpang Fomation (Quaternery)
- Marine shales, limestones, andesitic-rhyolithic volcanics (Permian)
- Schists (Permian)
- Granite

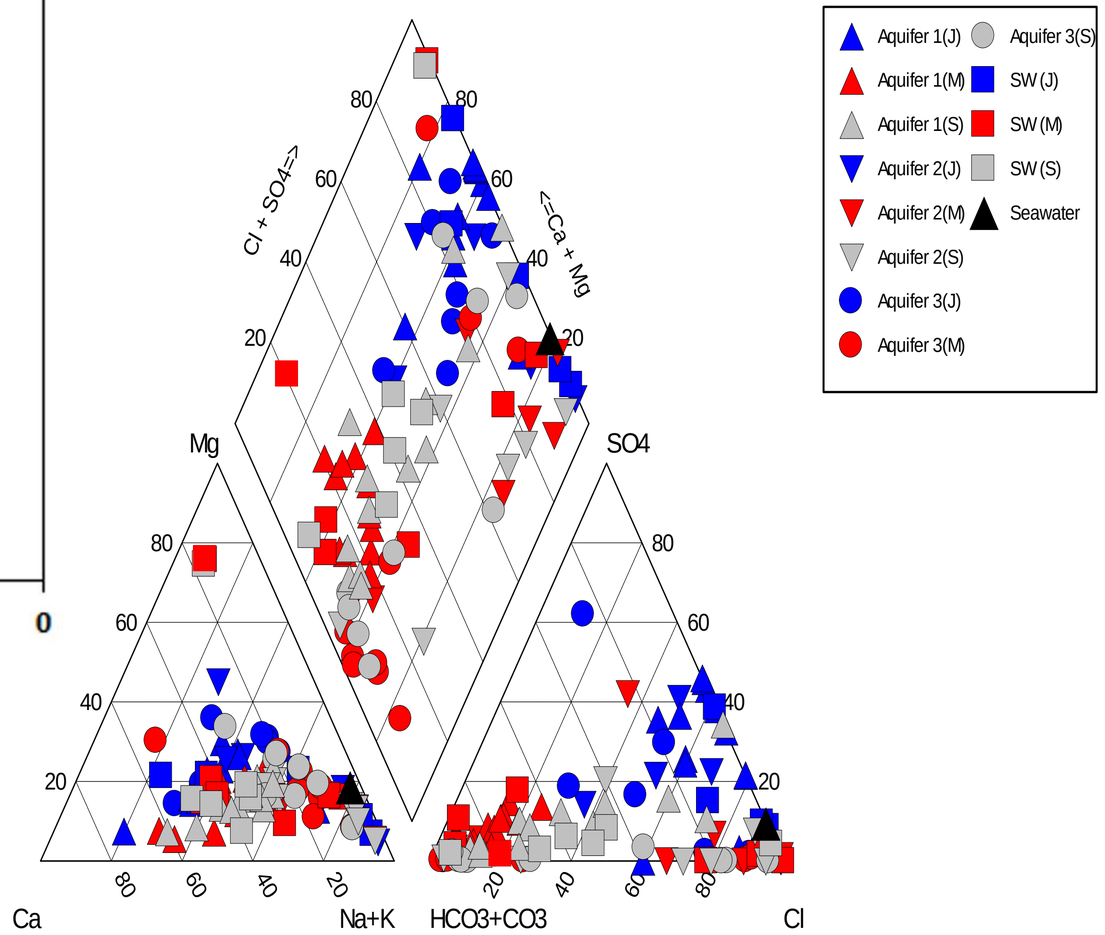


Field Work/Lab Work



Groundwater Geochemistry and Isotopes

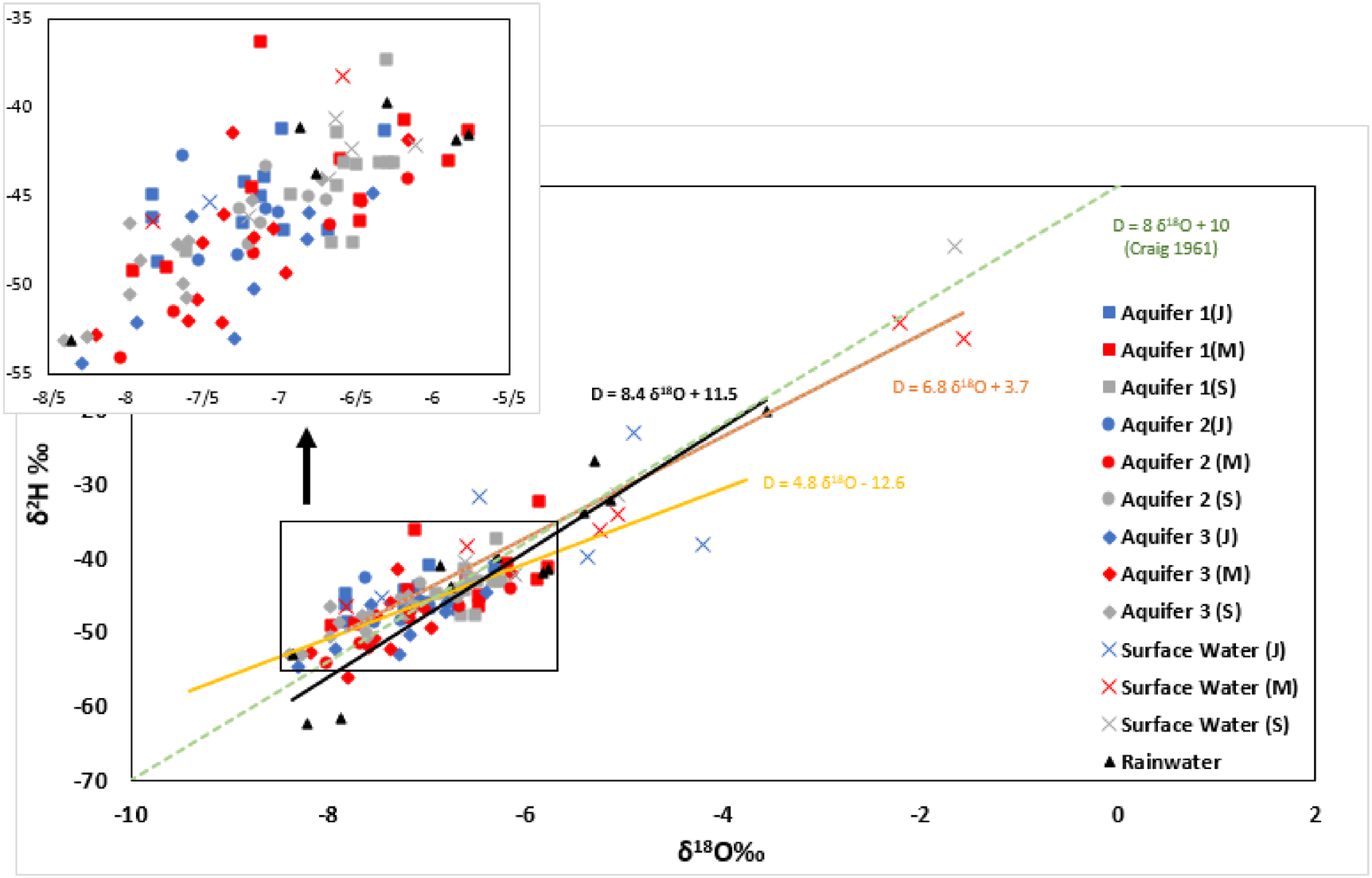




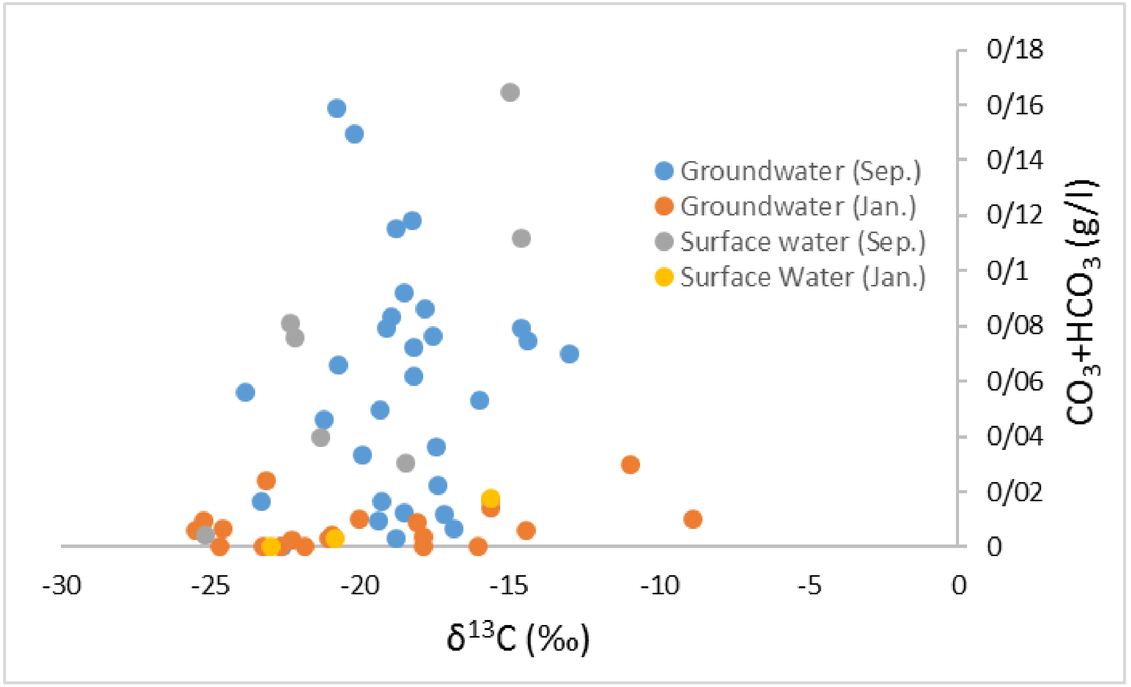
Groundwater Geochemistry and Isotopes

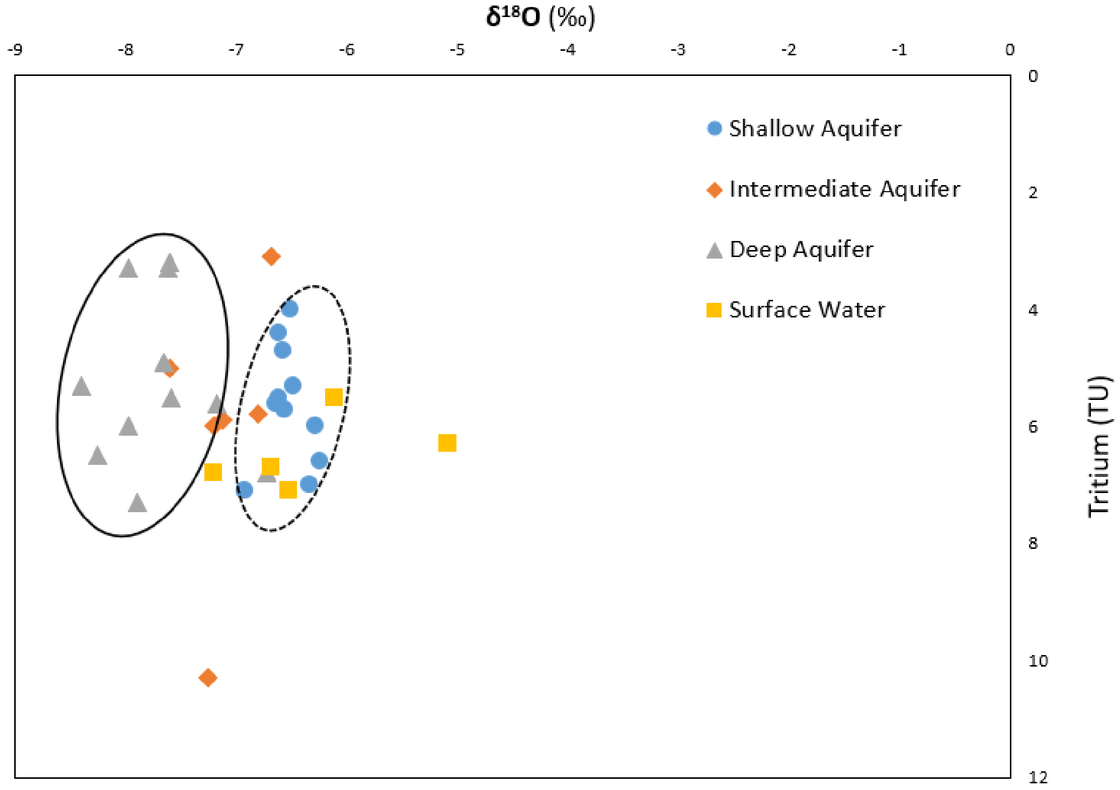
Plot of $\delta^{18}O$ (‰) vs. $\delta^{2}H$ (‰) for groundwater, surface water and rainwater.

The samples are categorized based on seasonality and aquifer system. GMWL and NKMWL, NKGWL, and NKSWL are presented.

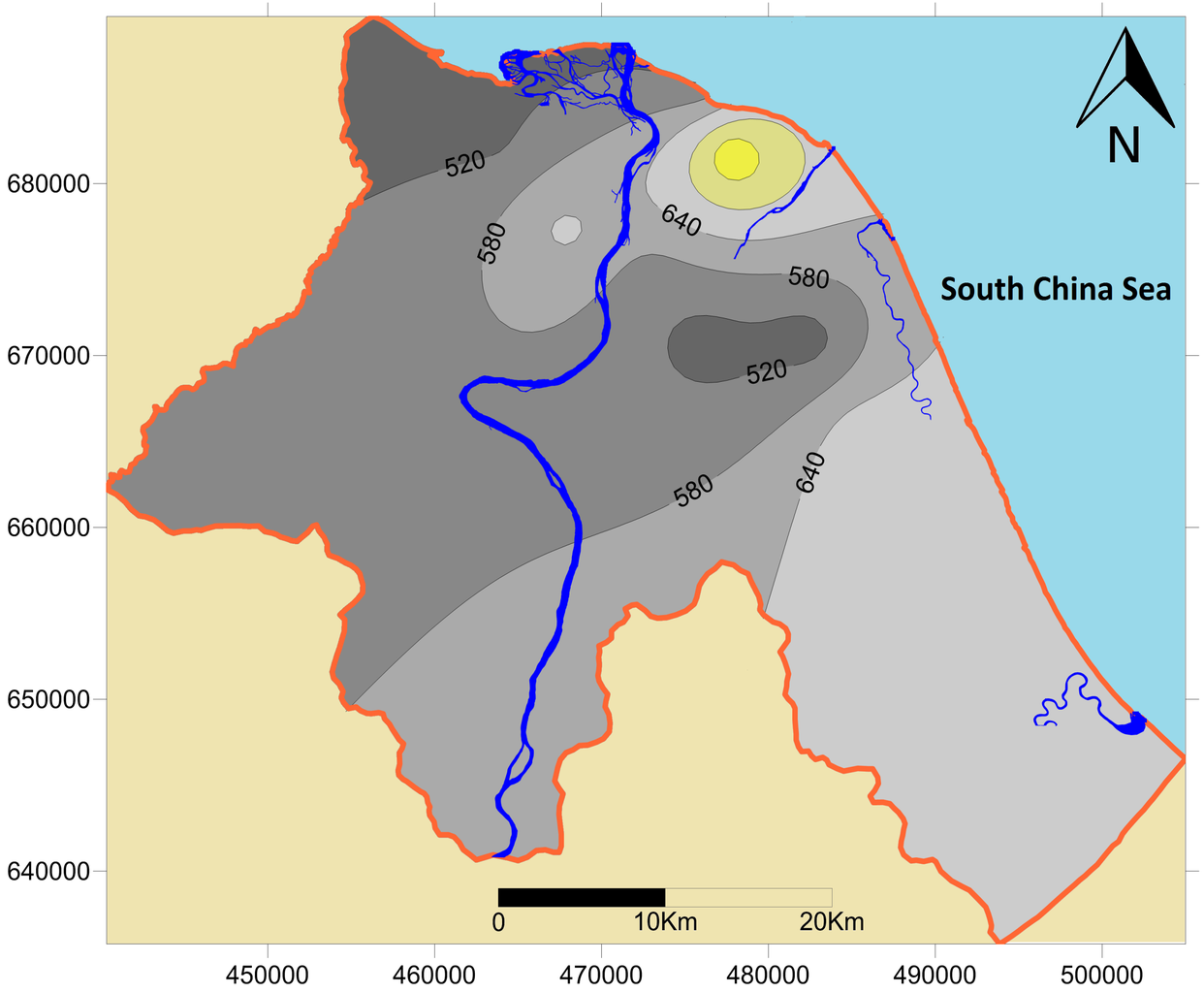


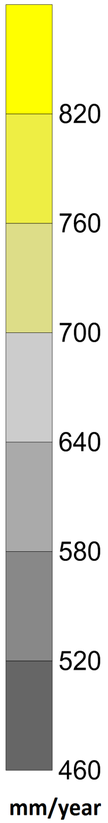
Groundwater Geochemistry and Isotopes





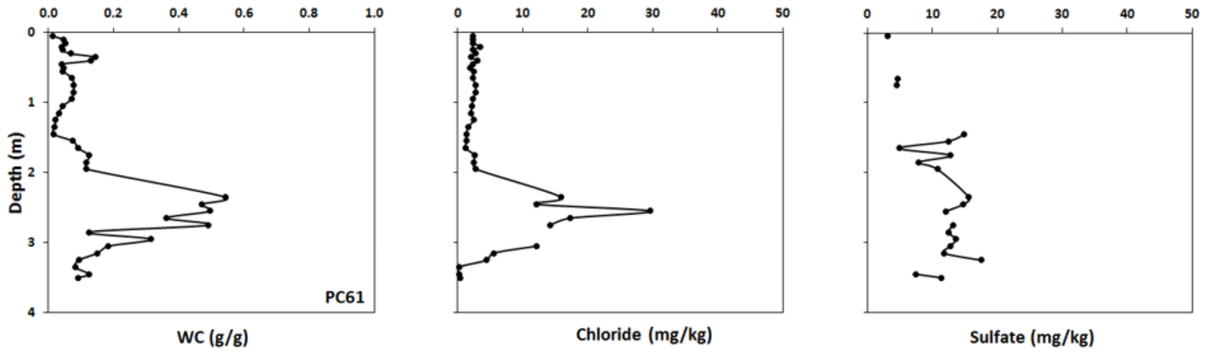
Water Table Fluctuation Method



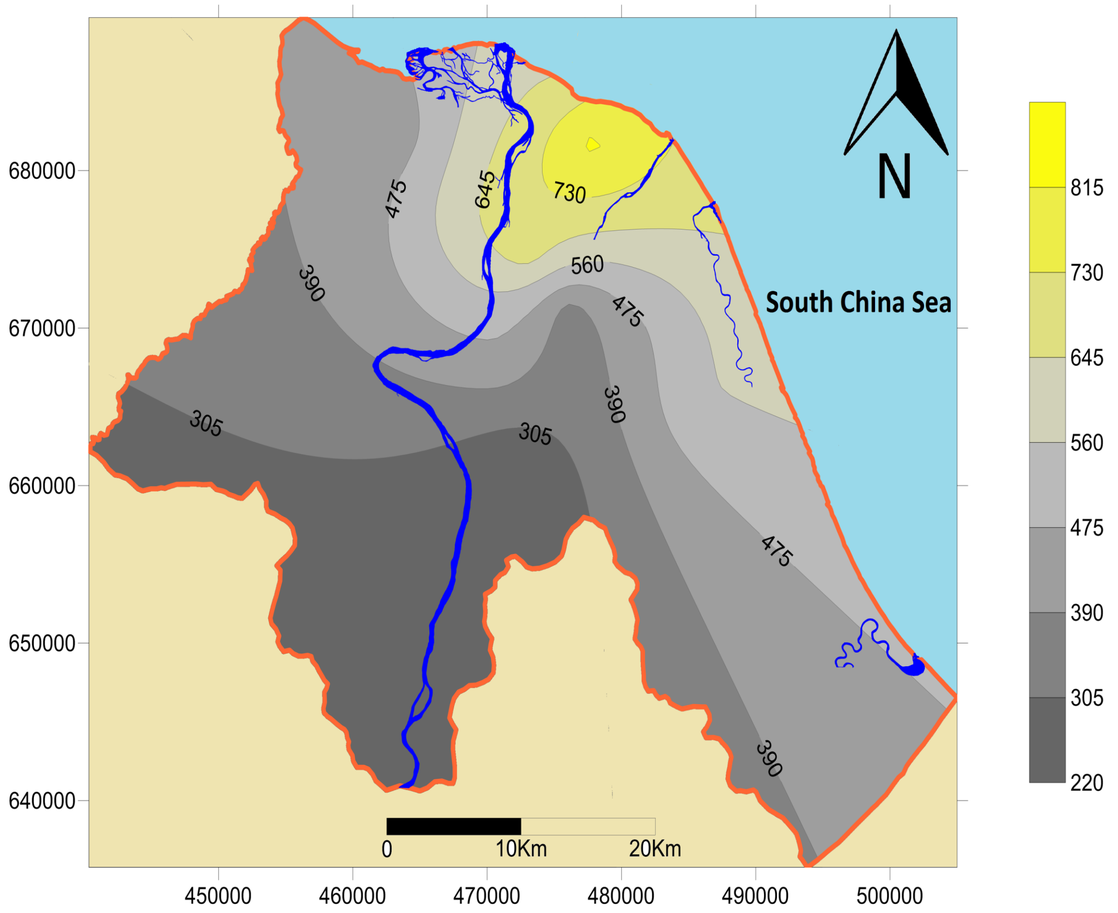


The model presented here is a procedure to calculate recharge from monthly water table fluctuation and rainfall in a time series framework with a specific yield that changes with sites and drainage rate is determined based on fallen water table in periods of no rainfall (Crosbie et al., 2005).

Mass Balance Method



The recharge is ratio of average of chloride in atmosphere to average chloride contents in the soil profile (G. Allison & Hughes, 1978; G. Allison, 1988).



Summary

Unique aspects of the study

- The time period of climate and groundwater examined
- The range of soil and aquifer characteristics studied
- The variety of methods in saturated and unsaturated zones have never been reported before and were applied for first time in the region.

Publications

1)Saghravani, S.R., Ismail Yusoff, Wan Zakaria Wan Md Tahir, Zainudin Othman (2016) Estimating groundwater recharge based on mass balance evaluation of unsaturated zone in a coastal catchment characterized by tropical rainforest weather conditions. Environmental Earth Sciences, 75: 668.

2)Saghravani, S.R., Ismail Yusoff, Wan Zakaria Wan Md Tahir, Zainudin Othman (2015) Estimating recharge based on long-term groundwater table fluctuation monitoring in a shallow aquifer of Malaysian tropical rainforest catchment. Environmental Earth Sciences, 74(6): 4577-4587.

3)Saghravani, S.R., Ismail Yusoff, Wan Zakaria Wan Md Tahir, Zainudin Othman (2014) Comparison of water table fluctuation and chloride mass balance methods for recharge estimation in a tropical rainforest climate: a case study from Kelantan River catchment, Malaysia. Environmental Earth Sciences, 73(8): 4419-4428.

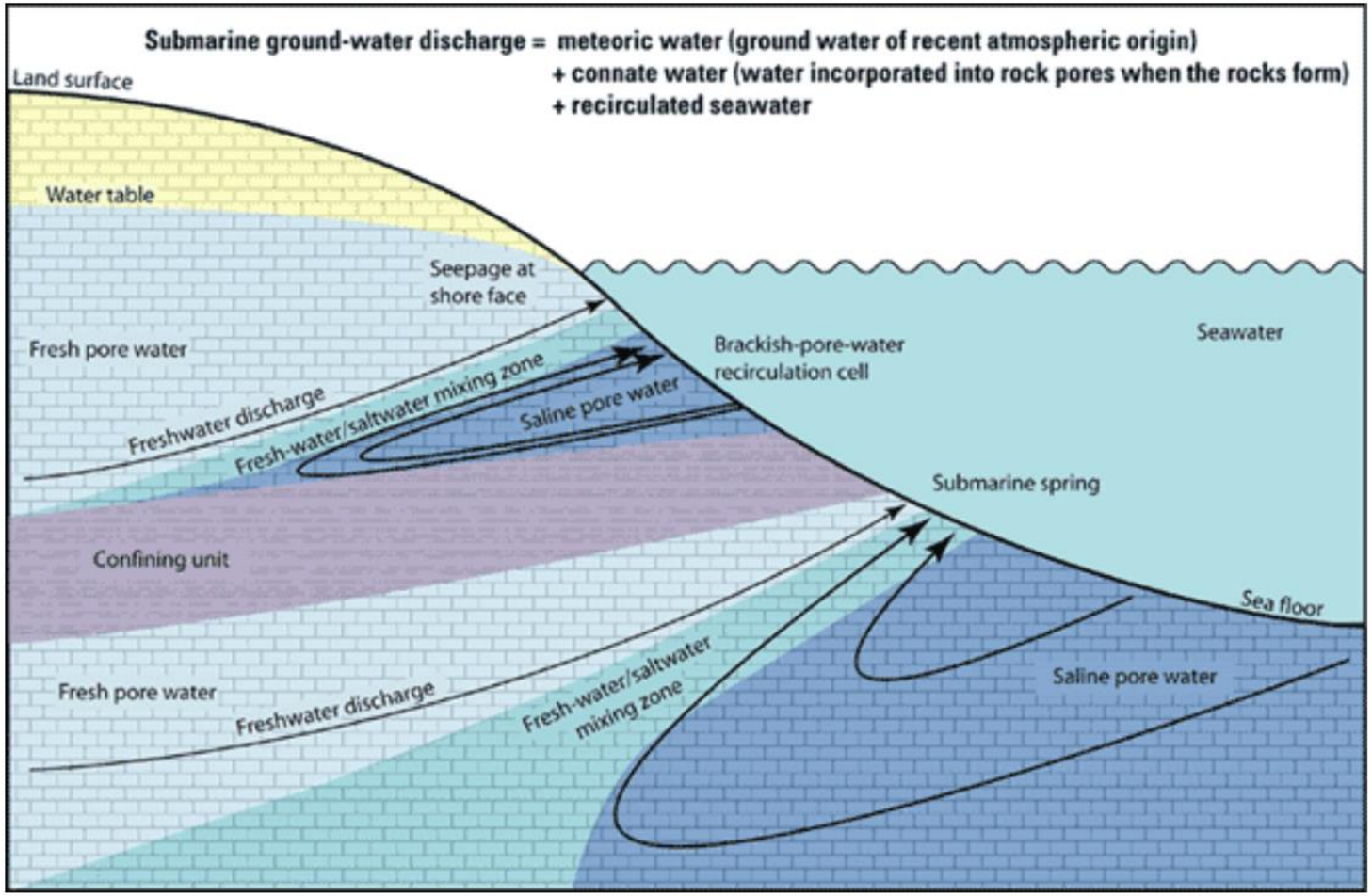
4)Saghravani, S.R., Ismail Yusoff, Sa'ari Mustapha, Saghravani, S. F. (2013). Estimating Groundwater Recharge Using Empirical Method: A Case Study in the Tropical Zone. Sains Malaysiana, 42(5):553–560.

Arctic SGD: Submarine Groundwater Discharge in a Changing Arctic Region: Scale and Biogeochemical impact

Vision and Mission

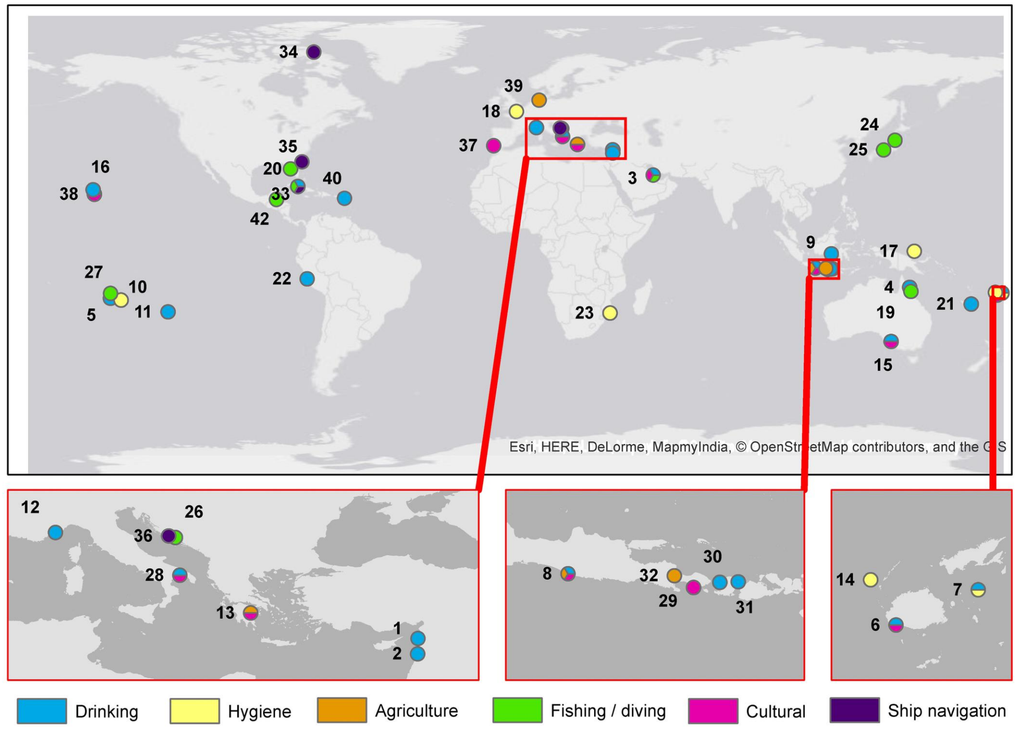
General

Submarine groundwater discharge (SGD) schematic

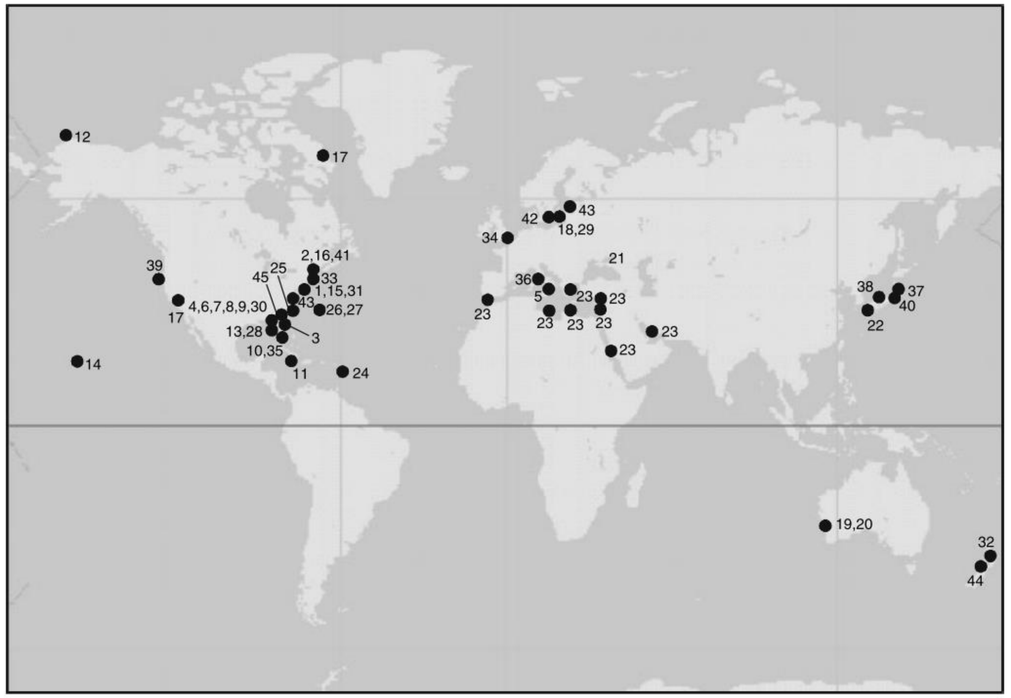


Source: [Submarine Groundwater Discharge project site]

SGD sites

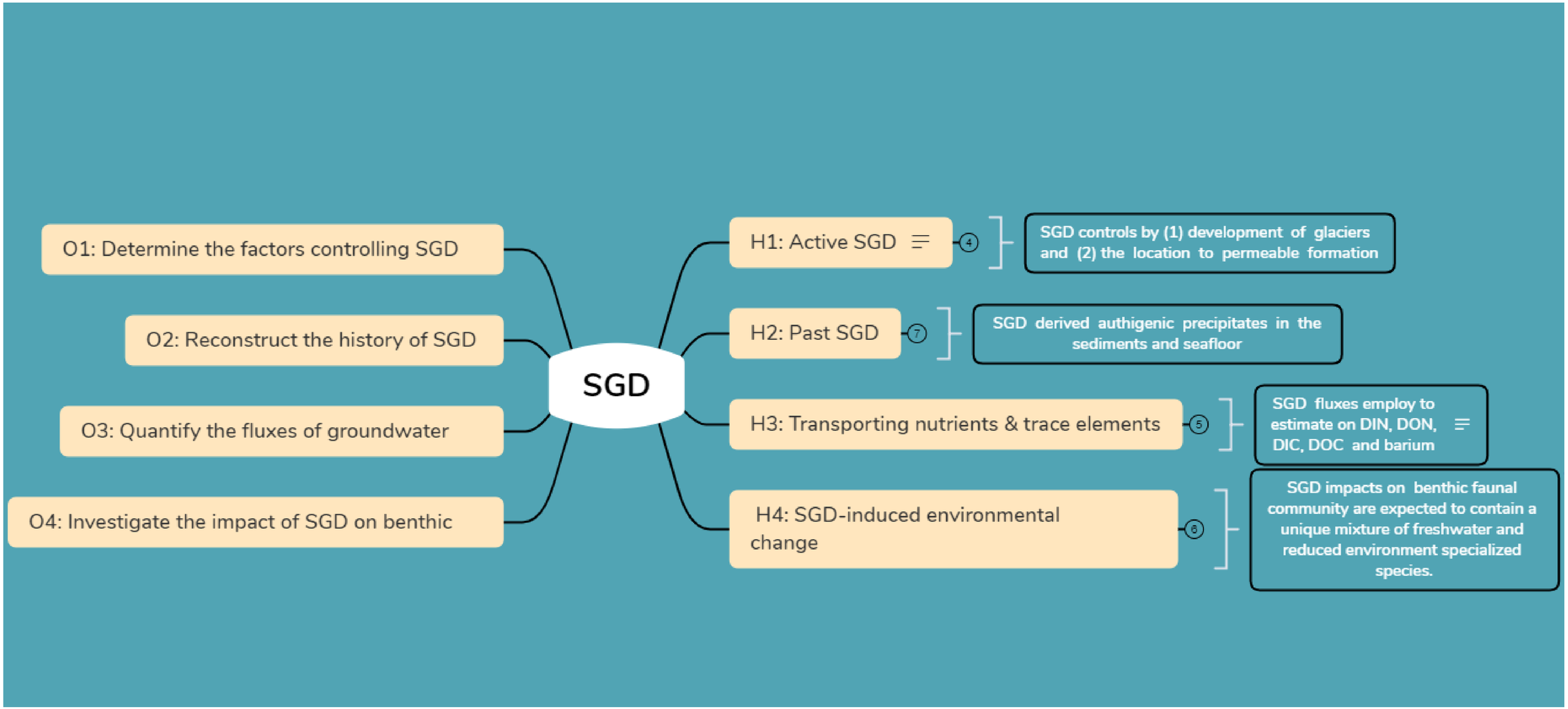


Moosdorf&Oehler, 2017

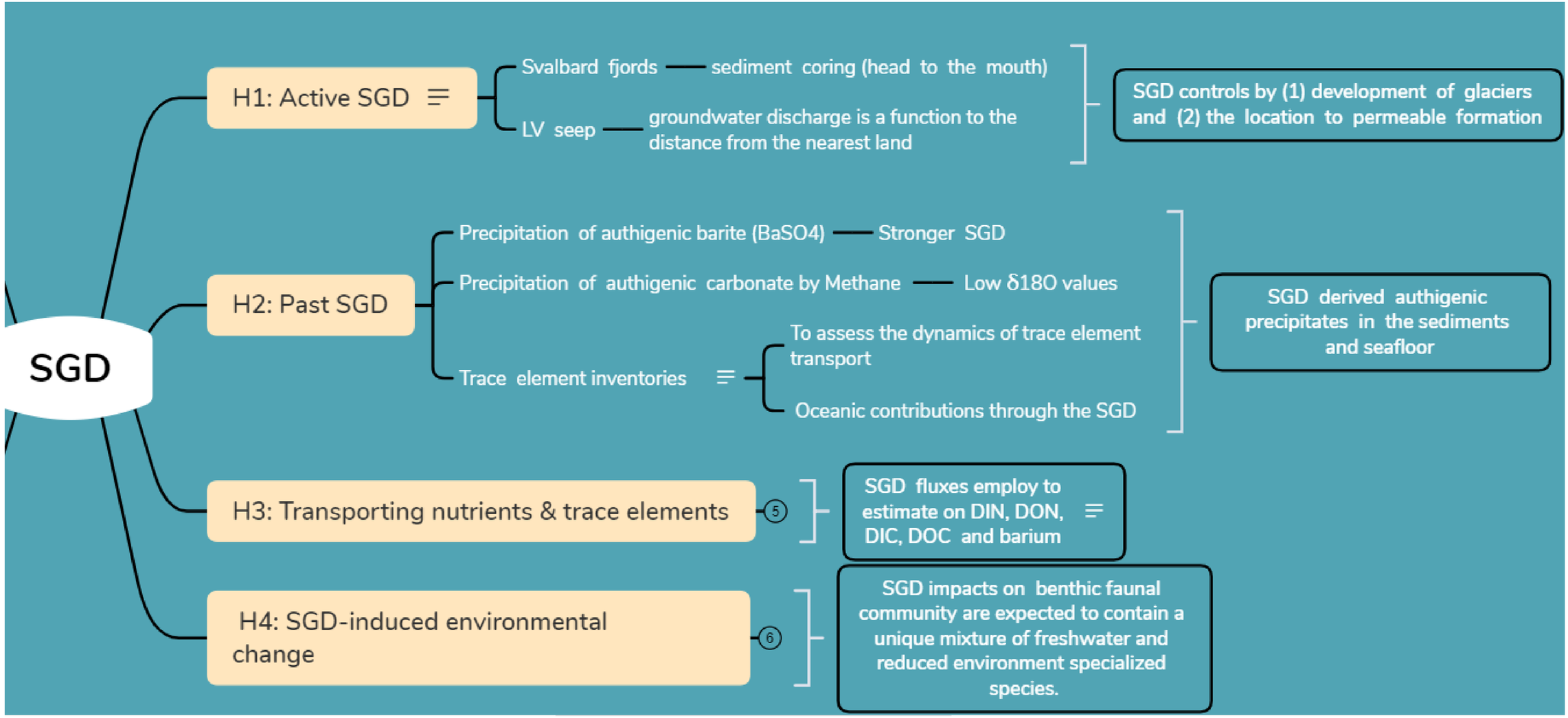


Taniguchi et al. 2002

Objectives, Hypotheses, Work Packages



Objectives, Hypotheses, Work Packages



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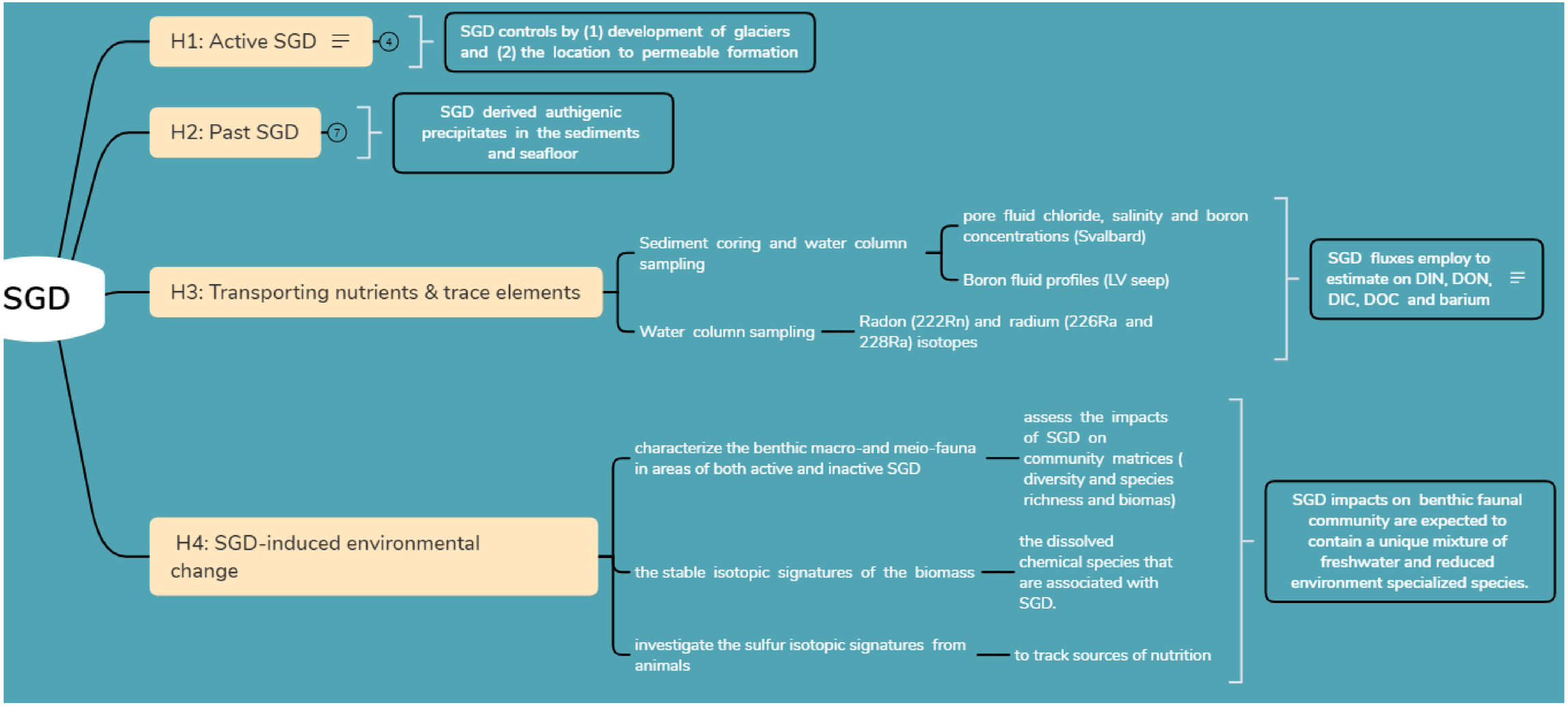
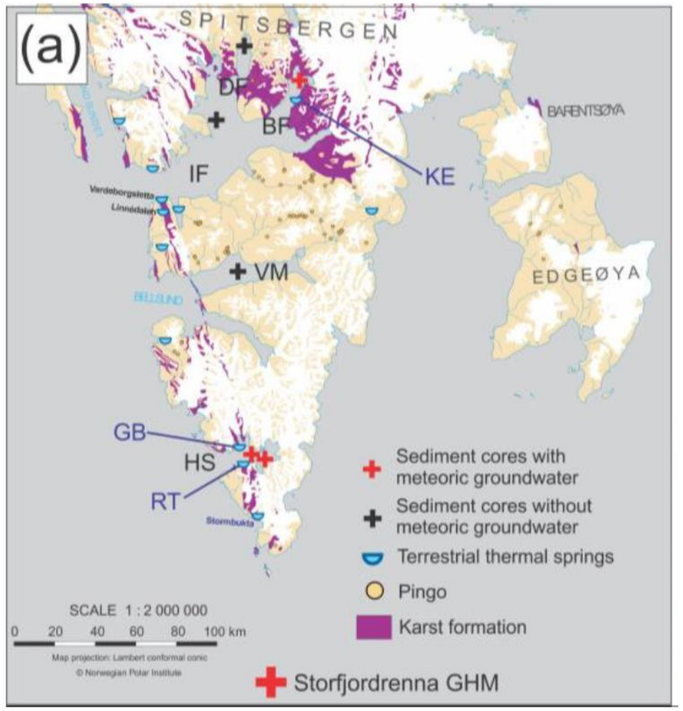
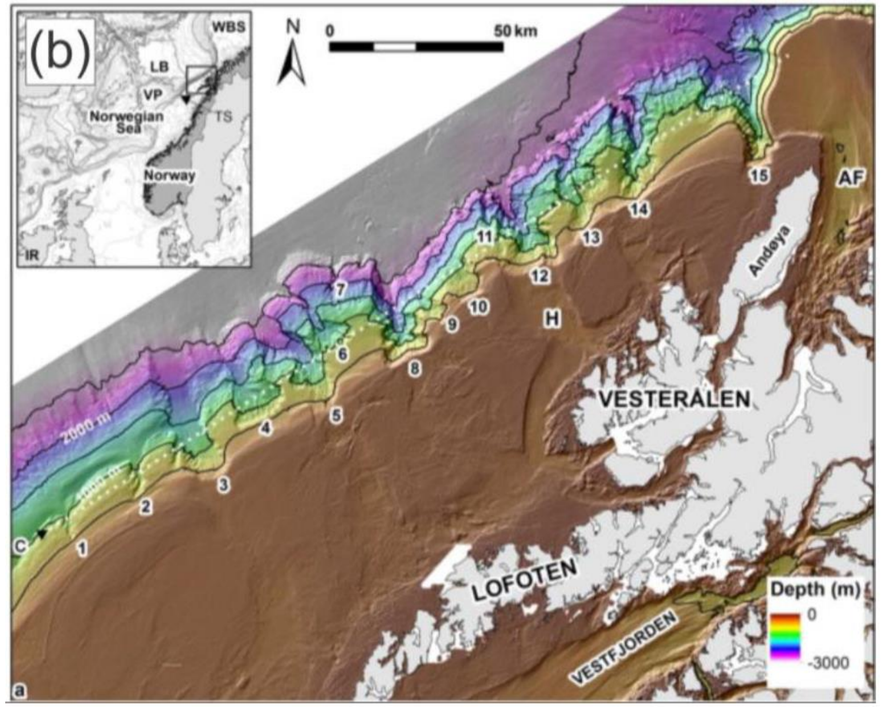


Study Sites





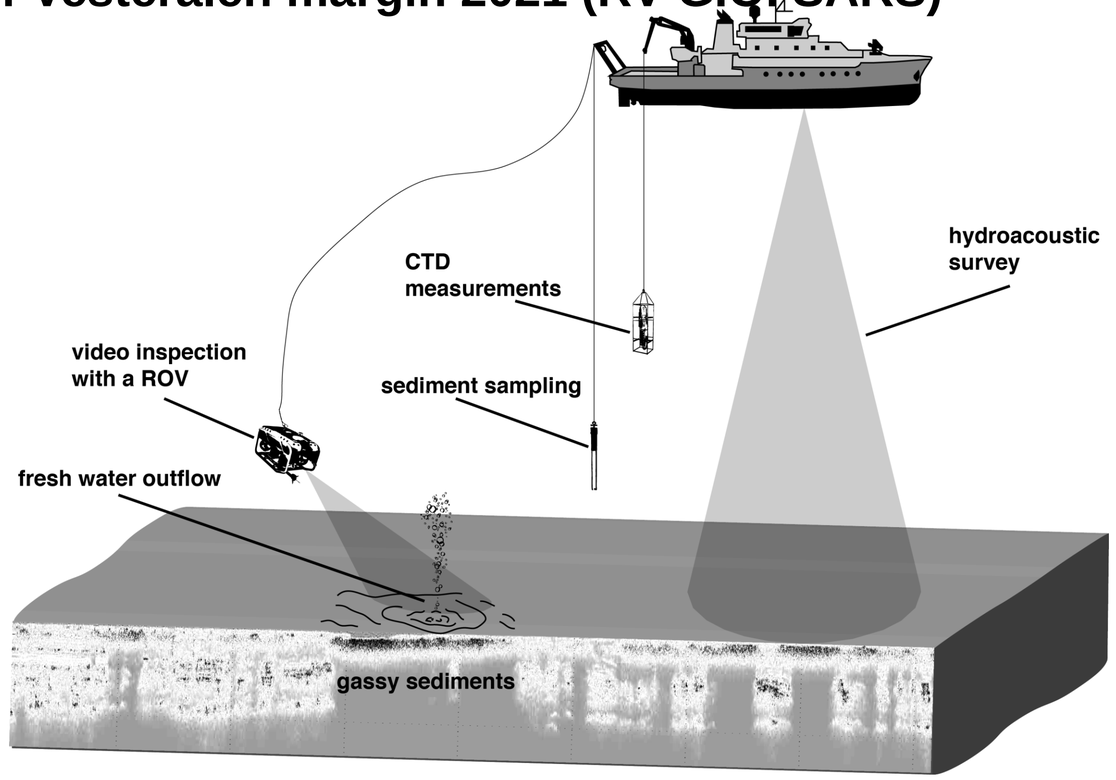
(a) Study areas around Svalbard. The Svalbard base map was modified from Dallmann (2015). The locations showing offshore meteoric groundwater coincide with both the karst formations and terrestrial springs from Svalbard (DF: Dicksonfjorden; BF: Billefjorden; IF: Isjforded; VM: Van Mijenfjorden; HS: Hornsund; KE: Kapp Ekholm; GB: Ghalberget; RT: Rasstupet).

(b) Along the Lofoten-Vesterålen (LV) margin. LV bathymetry is from Rise et al. (2013) with numbers 1-15 mark the canyons with different scales.

Research Methods

Cruises

2 cruises to Spitsbergen 2021,2022 (RV Oceania)
1 cruise to Spitsbergen 2022 (RV G.O SARS)
1 cruise to the Lofoten-Vesterålen margin 2021 (RV G.O SARS)



Research Methods

Analyses

Salinity, Major and Minor Constituents

Salinity (Handheld salinity meter)

Cl^- and SO_4^{2-} (IC and titration for chloride)

Ca^{2+}, Mg^{2+}, K^+, Sr^{2+}, Li^+, B, Ba^{2+} (ICPOES, ICPMS)

Carbon Characterization

DIC and DOC (Total Organic Carbon Analyzer TOC-L, Shimadzu)

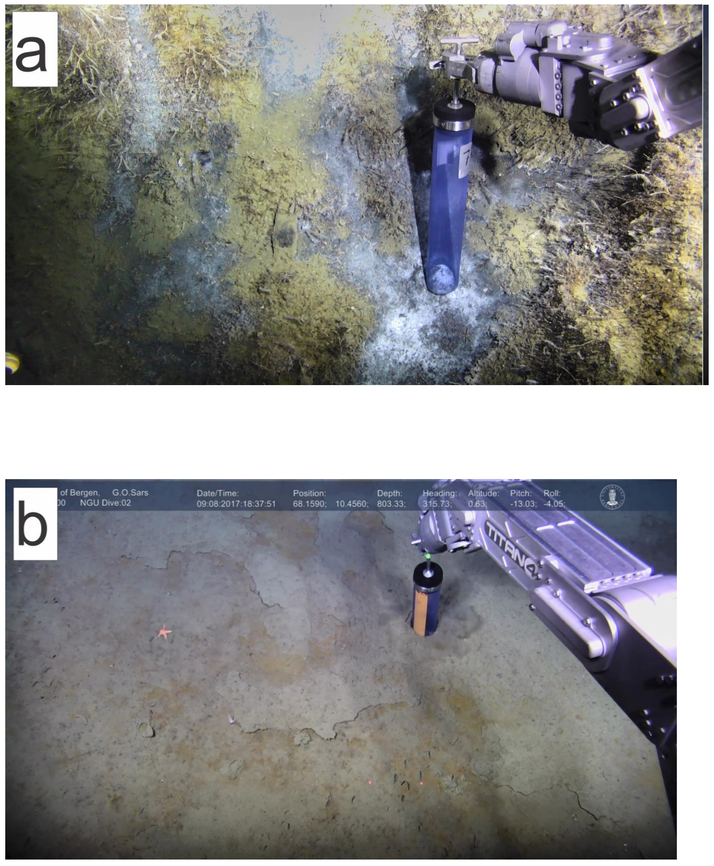
Total Alkalinity (Titration)

Nutrient Characterization

DIN and DON (Nutrient Flow Analyzer and Total Organic Carbon Analyzer TOC-L (Shimadzu) for DON)

Rn Isotope

^{222}Rn (Thoron and Radon detector; DURRIDGE Rad7)



Images from LV seep showing the influence on seafloor fauna at locations (a) with and (b) without SGD. (Source: Geological Survey of Norway, Photos were collected by the remote operated vehicle ROV ÆGIR 6000 during NGU 1710 cruise onboard RV G.O. Sars, 2017).

Norway
grants

Thank you!

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"Submarine Groundwater Discharge in a Changing Arctic Region: Scale and Biogeochemical impact"
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