Stockholm University

Using InSAR observations to understand effects of climate change on water resources in the Baltic Sea Basin

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The new normal of water resources

Sweden announces government investigations to better prepare for extreme weather

Ministers Isabella Lövin (L) and Mikael Damberg present the new measures. Photo: Hanna Franzén /

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Swedish drought to bring worst harvest in 25 years

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Sweden's farmers are facing the worst grain harvest in a quarter of a century, according to the latest prognosis from Lantmännen, the country's largest farming cooperative. But what does it look like out on the fields?

Sweden may be heading for a new water crisis this summer

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25 April 2019
07:54 CEST+02:00

water shortage
drought
weather
summer

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Last year's water shortage caused problems for farmers in Sweden. Photo: Andreas Hillergren/TT

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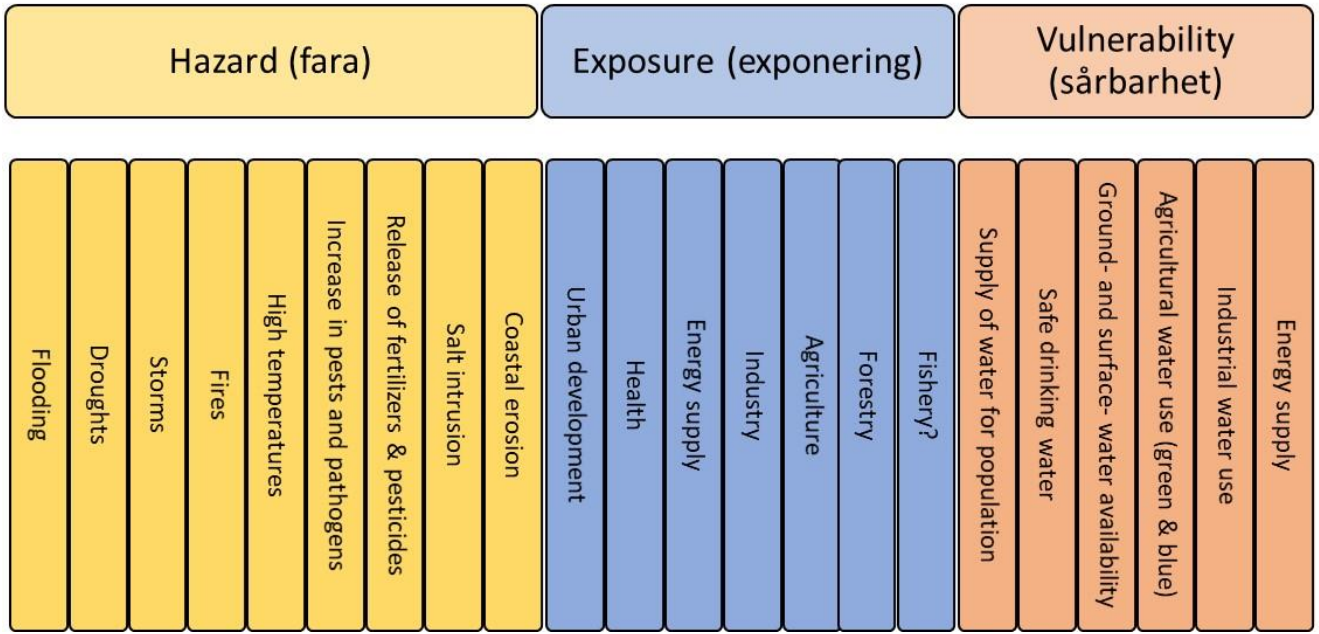
Risk assessment framework, dependent on data availability



Expected vulnerability in 2050 due to:

1. Climate change
2. adaptation/mitigation to reduce hazards and vulnerability from climate change

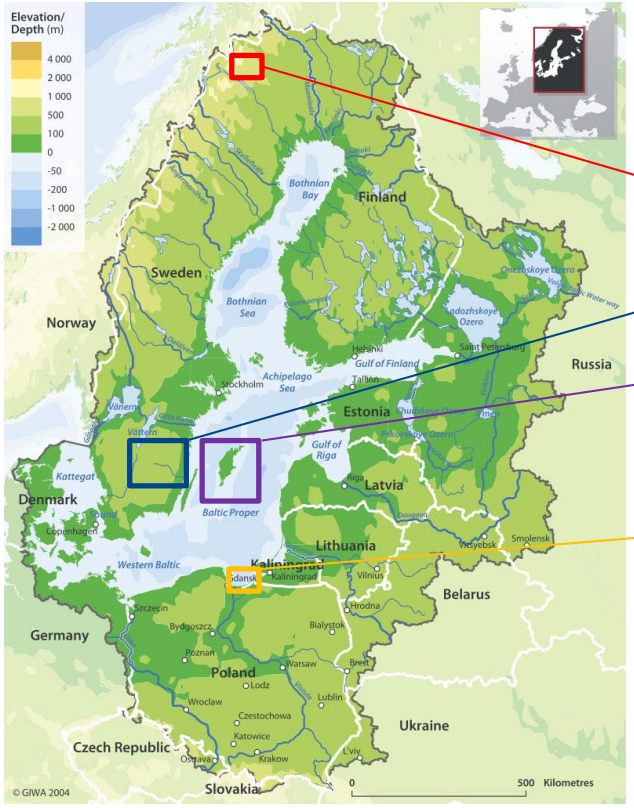
Motivation

- Understand the change dynamics of water resources in the Baltic Sea Basin with radar-based Technologies
- Understanding hydrological coastal and inland processes in the Baltic Sea Basin
- Use the unexploited potential of InSAR to understand water changes

Hydrogeodesy – The science that measures the Earth's solid and aquatic surfaces to understand the occurrence, distribution, movement and properties of water.

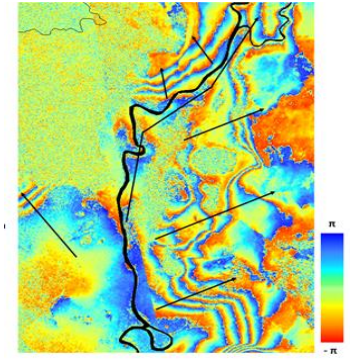
- Global Navigation Satellite System (GNSS)
- LIDAR
- Satellite gravimetry (GRACE)
- Interferometric Synthetic Aperture Radar (InSAR)

Objectives



GIWA, 2004

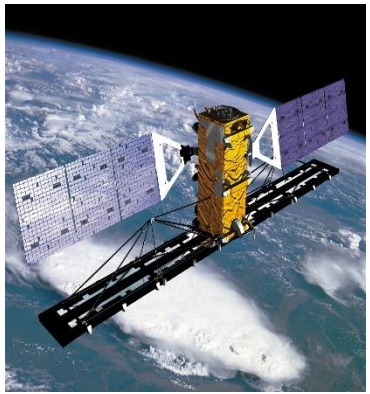
- Changes in glacier surface
- Changes in lake water levels
- Ground subsidence due to drought or groundwater depletion
- Changes in sea ice bottom and extent

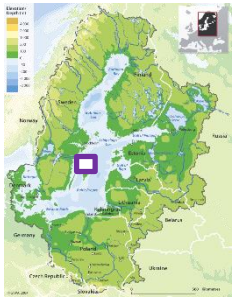


InSAR- Advantages

Interferometric Synthetic Aperture Radar (InSAR) studies the change in the radar pulse signal to explain changes in ground and water surfaces…

- that are not easy to detect with equipment or observation
- at larger spatial scales
- at locations with difficult access
- inexpensive
- fast/avoids cumbersome data requests

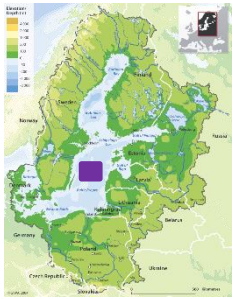


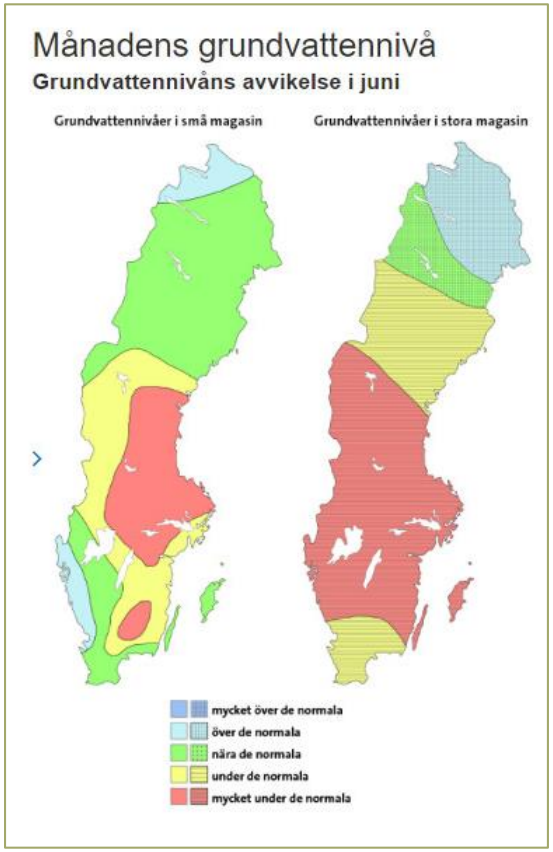


Research questions

- Can variations in groundwater level ground level be detected by InSAR?
- Is there a relationship between groundwater level and ground deformation in Southern Sweden?
- Are there different signals from climate/seasonal variability and groundwater withdrawal?

Groundwater changes





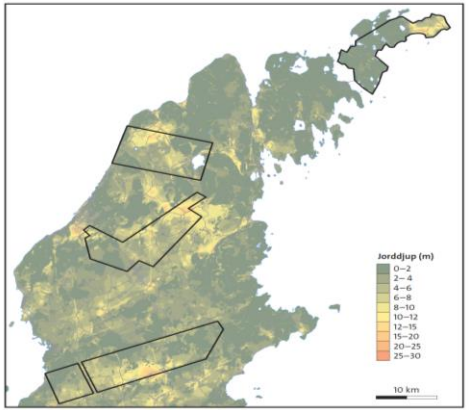
Groundwater levels in June 2017. SGU

Stockholm University

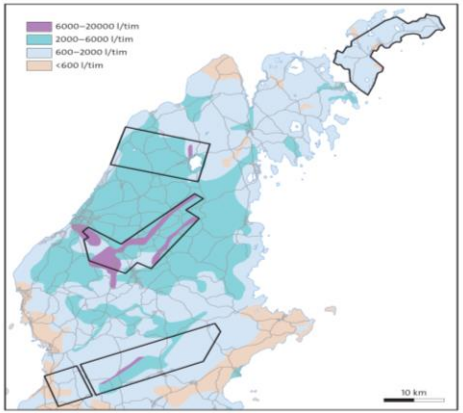
Hydrogeological background data

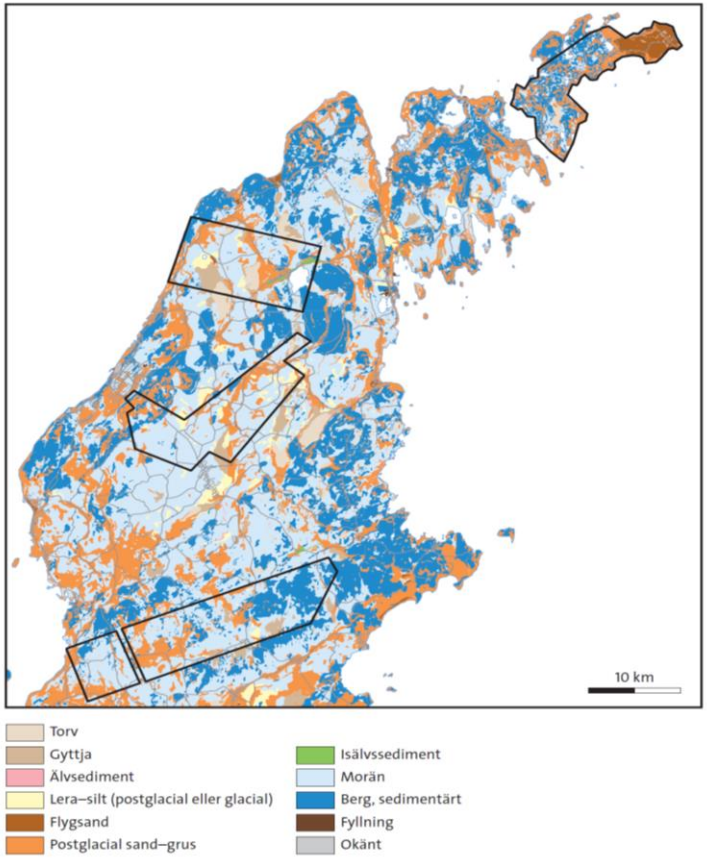
Stockholm University

Soil depth



Extraction potential

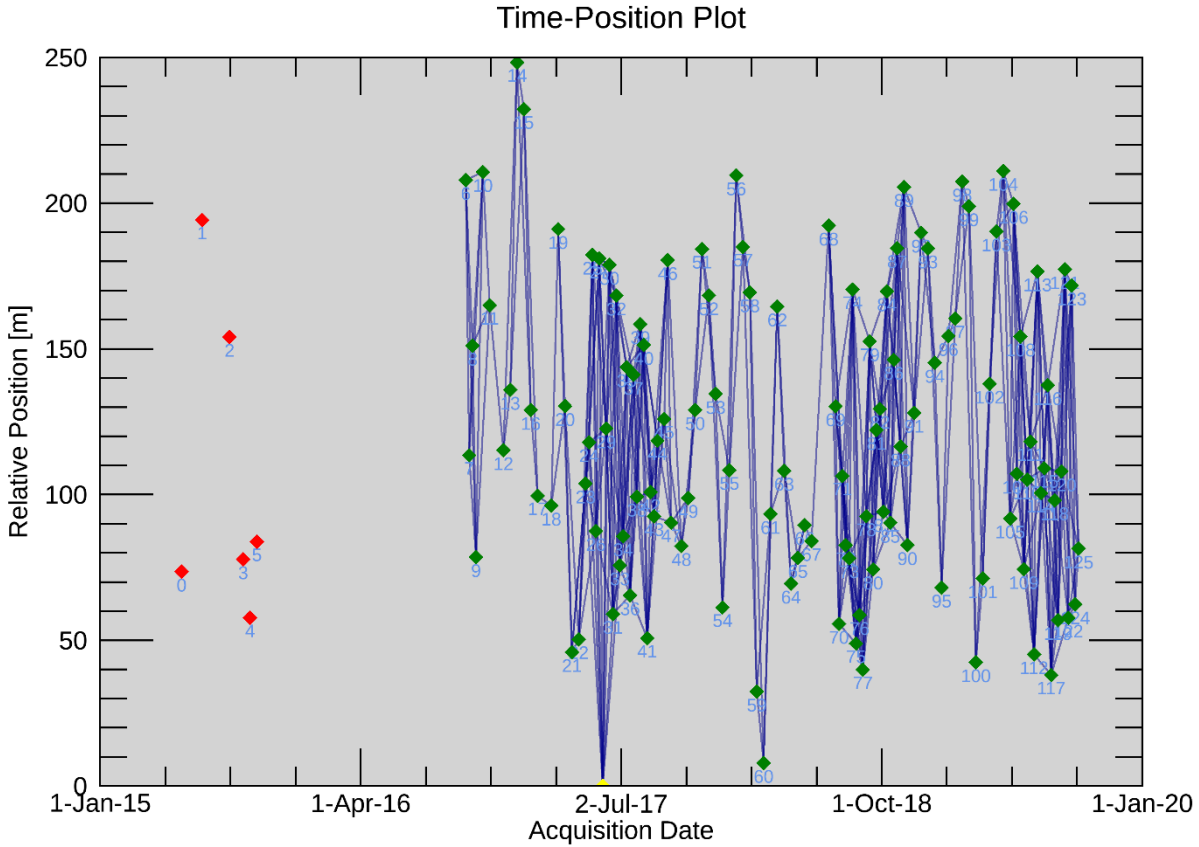


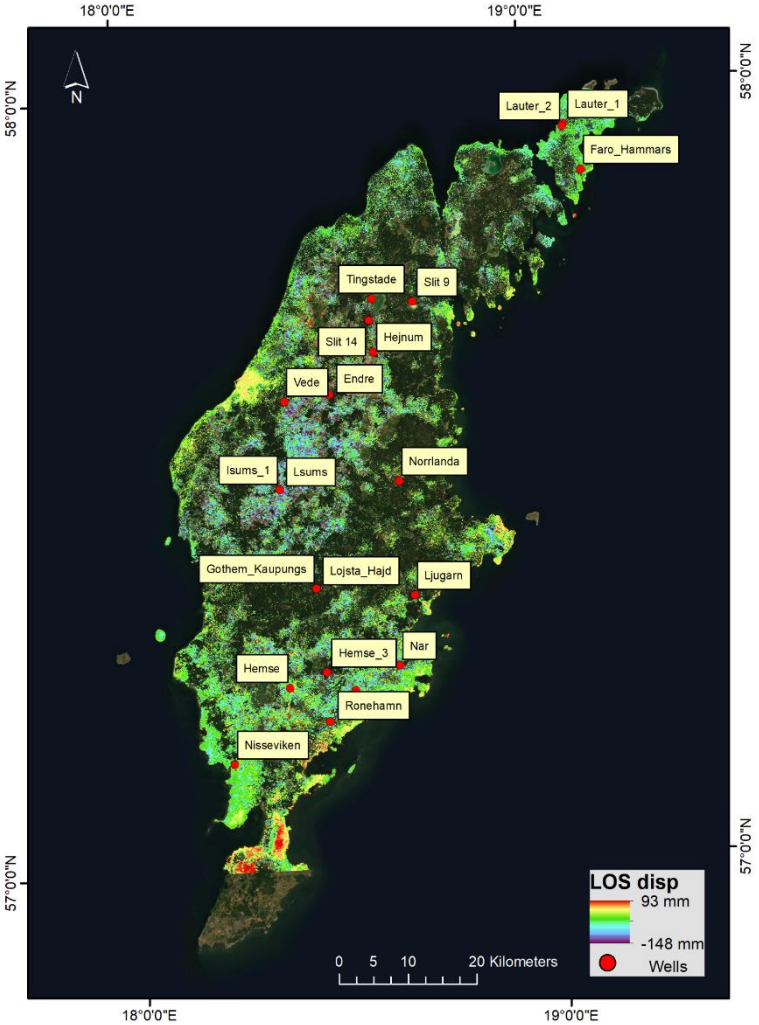


Geological map

Erlström et al. 2009

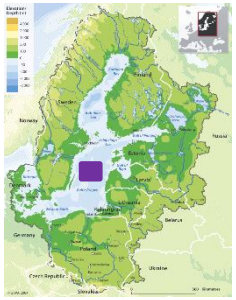
120 Sentinel-1 (S1) data



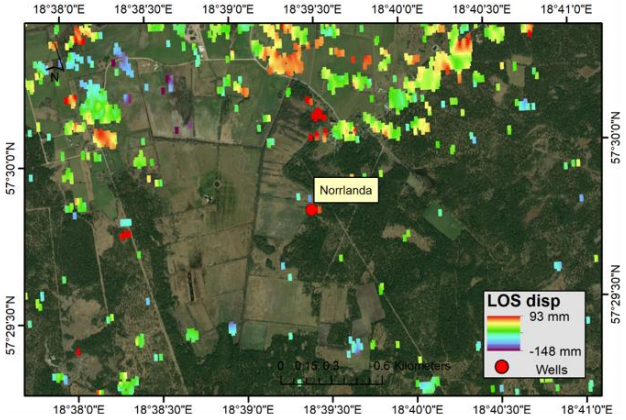


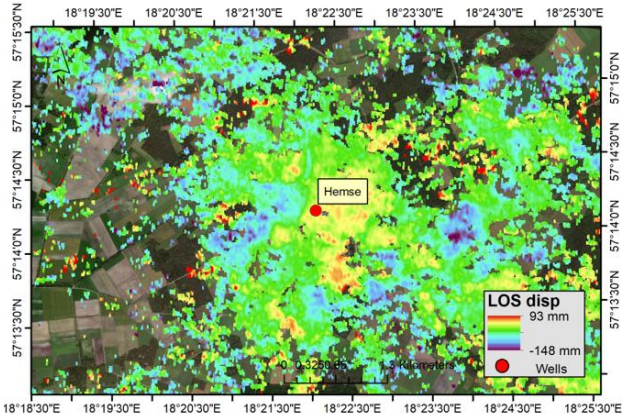
- Groundwater level monitoring stations by SGU in Gotland
- Ground deformation map

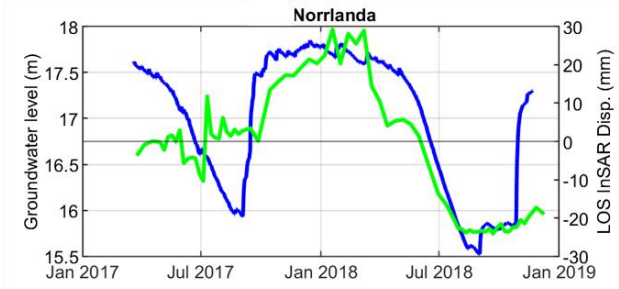
Ground deformation

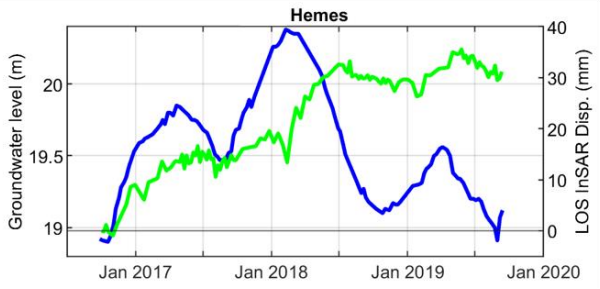


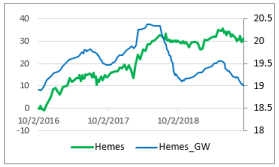
Focus groundwater stations

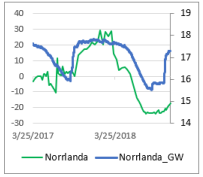


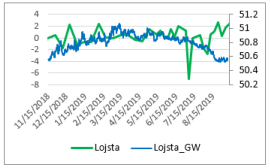


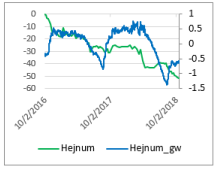


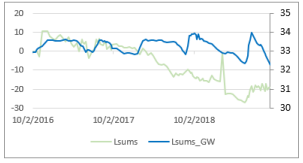


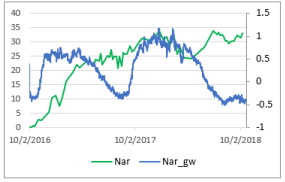

Hemes
Hemes_GW

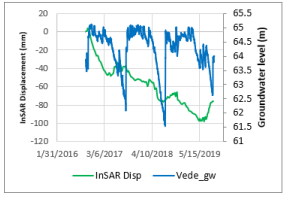

Norrlanda
Norrlanda_GW

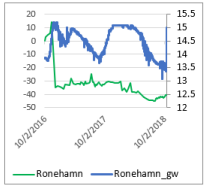

Lojsta
Lojsta_GW

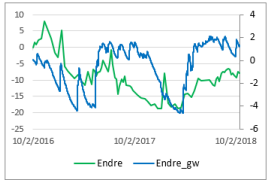

Hejnum
Hejnum_gw

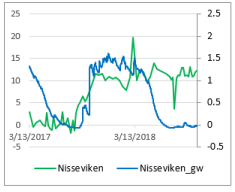

Lsums
Lsums_GW

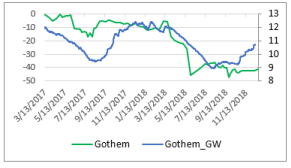

Nar
Nar_gw

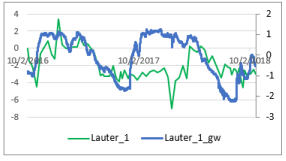

InSAR Displacement (mm)
Groundwater level (m)
InSAR Disp
Vede_gw

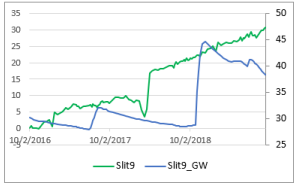

Ronehamn
Ronehamn_gw

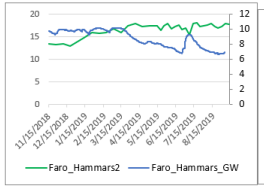

Endre
Endre_gw

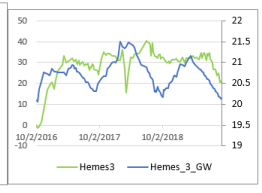

Nisseviken
Nisseviken_gw

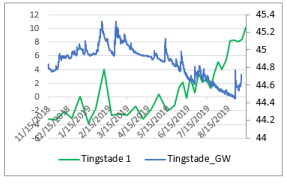

Gothem
Gothem_GW

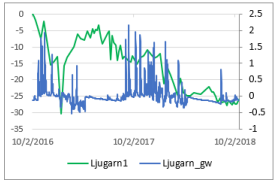

Lauter_1
Lauter_1_gw

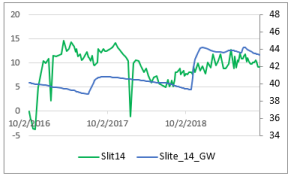

Slit9
Slit9_GW


Faro_Hammars2
Faro_Hammars_GW


Hemes3
Hemes_3_GW

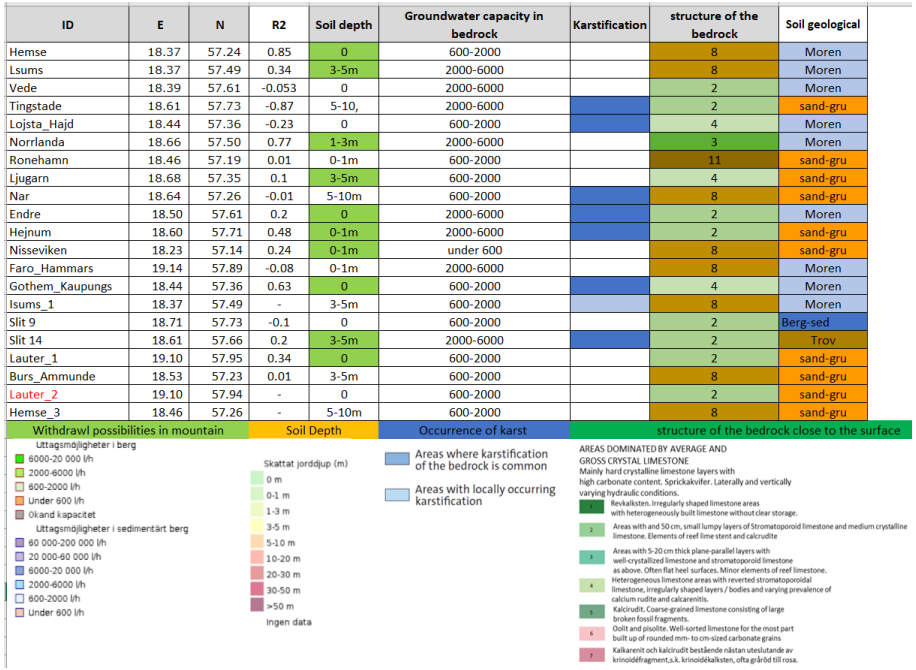

Tingstade 1
Tingstade_GW


Ljugarn1
Ljugarn_gw


Slit14
Slite_14_GW

Patterns and relationships of deformation /ground water levels

ID	E	N	R2	Soil depth	Groundwater capacity in bedrock	Karstification	structure of the bedrock	Soil geological
Hemse	18.37	57.24	0.85	0	600-2000		8	Moren
Lsums	18.37	57.49	0.34	3-5m	2000-6000		8	Moren
Vede	18.39	57.61	-0.053	0	2000-6000		2	Moren
Tingstade	18.61	57.73	-0.87	5-10,	2000-6000		2	sand-gru
Lojsta_Hajd	18.44	57.36	-0.23	0	600-2000		4	Moren
Norrlanda	18.66	57.50	0.77	1-3m	2000-6000		3	Moren
Ronehamn	18.46	57.19	0.01	0-1m	600-2000		11	sand-gru
Ljugarn	18.68	57.35	0.1	3-5m	600-2000		4	sand-gru
Nar	18.64	57.26	-0.01	5-10m	600-2000		8	sand-gru
Endre	18.50	57.61	0.2	0	2000-6000		2	Moren
Hejnum	18.60	57.71	0.48	0-1m	2000-6000		2	sand-gru
Nisseviken	18.23	57.14	0.24	0-1m	under 600		8	sand-gru
Faro_Hammars	19.14	57.89	-0.08	0-1m	2000-6000		8	Moren
Gothem_Kaupungs	18.44	57.36	0.63	0	600-2000		4	Moren
Isums_1	18.37	57.49	-	3-5m	600-2000		8	Moren
Slit 9	18.71	57.73	-0.1	0	600-2000		2	Berg-sed
Slit 14	18.61	57.66	0.2	3-5m	2000-6000		2	Trov
Lauter_1	19.10	57.95	0.34	0	600-2000		2	sand-gru
Burs_Ammunde	18.53	57.23	0.01	3-5m	600-2000		8	sand-gru
Lauter_2	19.10	57.94	-	0	600-2000		2	sand-gru
Hemse_3	18.46	57.26	-	5-10m	600-2000		8	sand-gru



Conclusions

- Potential of using InSAR to understand changes to groundwater resources in Sweden
- Elastic hydrogeological relationships
- InSAR, a tool to study water resources in the Baltic Sea Basin
- Combination with other hydrogeodetical tools +++