



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

Fernando Jaramillo, Saeid Aminjafari,
Mohammad Nia, Mehdi Darvishi, Veronika Lund

Department of Physical Geography

Baltic Sea centre

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 /

www.thelocal.se

▶ Swedish drought to bring worst harvest in 25 years

4:58 min [My playlist](#) [Share](#)

Published måndag 23 juli 2018 kl 09:00

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

The Local
news@thelocal.se
[@thelocalsweden](https://www.thelocal.se)

25 April 2019
07:54 CEST+02:00

water shortage

drought

weather

summer

Share this article



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

www.thelocal.se

Risk assessment framework, dependent on data availability

Hazard (fara)

Exposure (exponering)

Vulnerability (sårbarhet)

Flooding

Droughts

Storms

Fires

High temperatures

Increase in pests and pathogens

Release of fertilizers & pesticides

Salt intrusion

Coastal erosion

Urban development

Health

Energy supply

Industry

Agriculture

Forestry

Fishery?

Supply of water for population

Safe drinking water

Ground- and surface- water availability

Agricultural water use (green & blue)

Industrial water use

Energy supply

Expected vulnerability in 2050 due to:

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

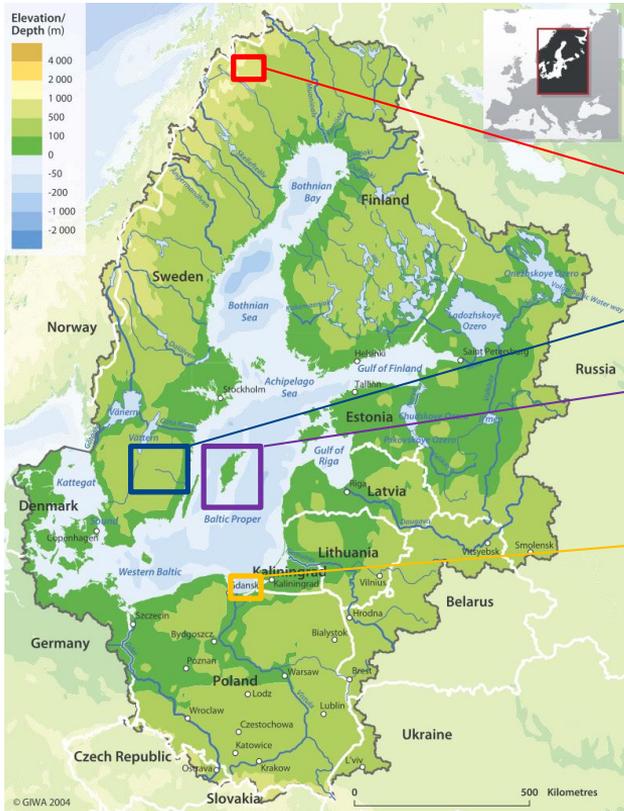
Motivation

- 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.

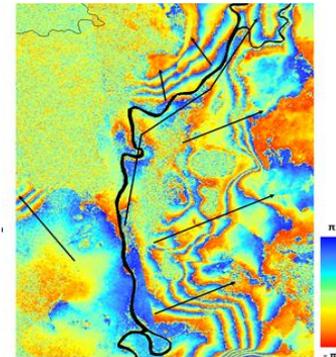
- Global Navigation Satellite System (GNSS)
- LIDAR
- Satellite gravimetry (GRACE)
- Interferometric Synthetic Aperture Radar (InSAR)

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

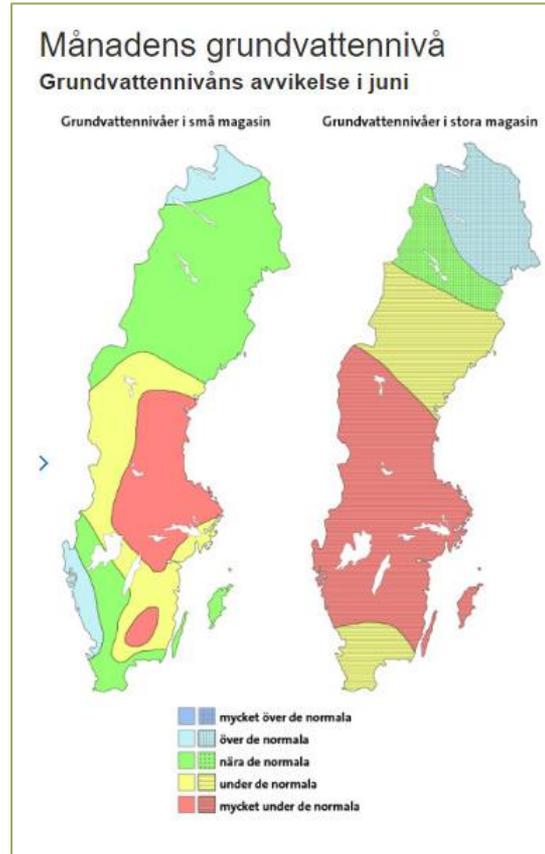




Research questions

- 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?

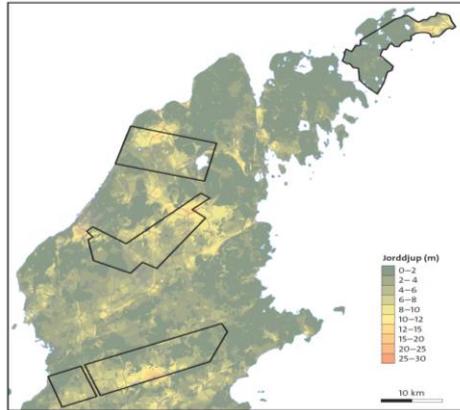
Groundwater changes



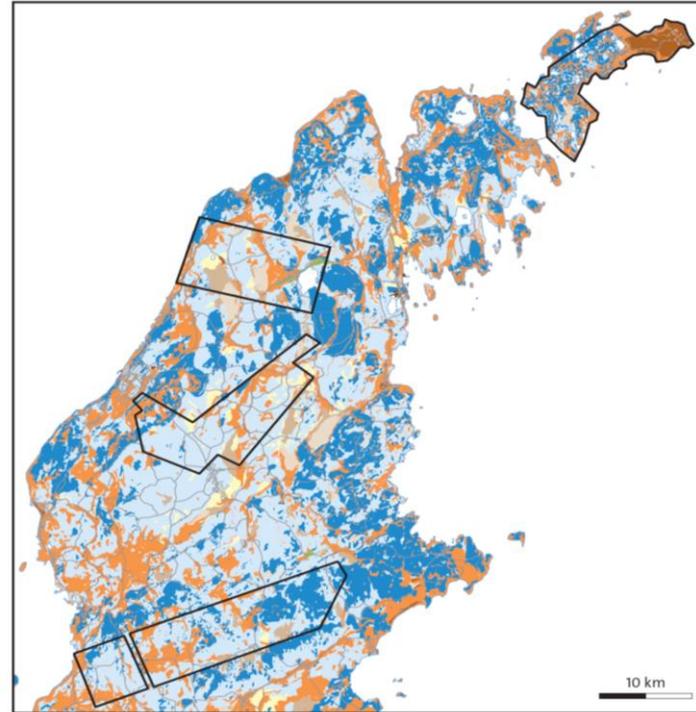
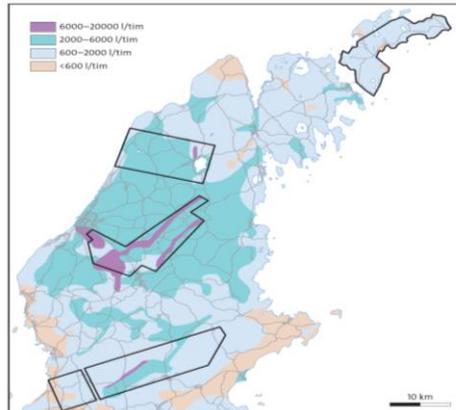
Groundwater levels in June 2017. SGU

Hydrogeological background data

Soil depth



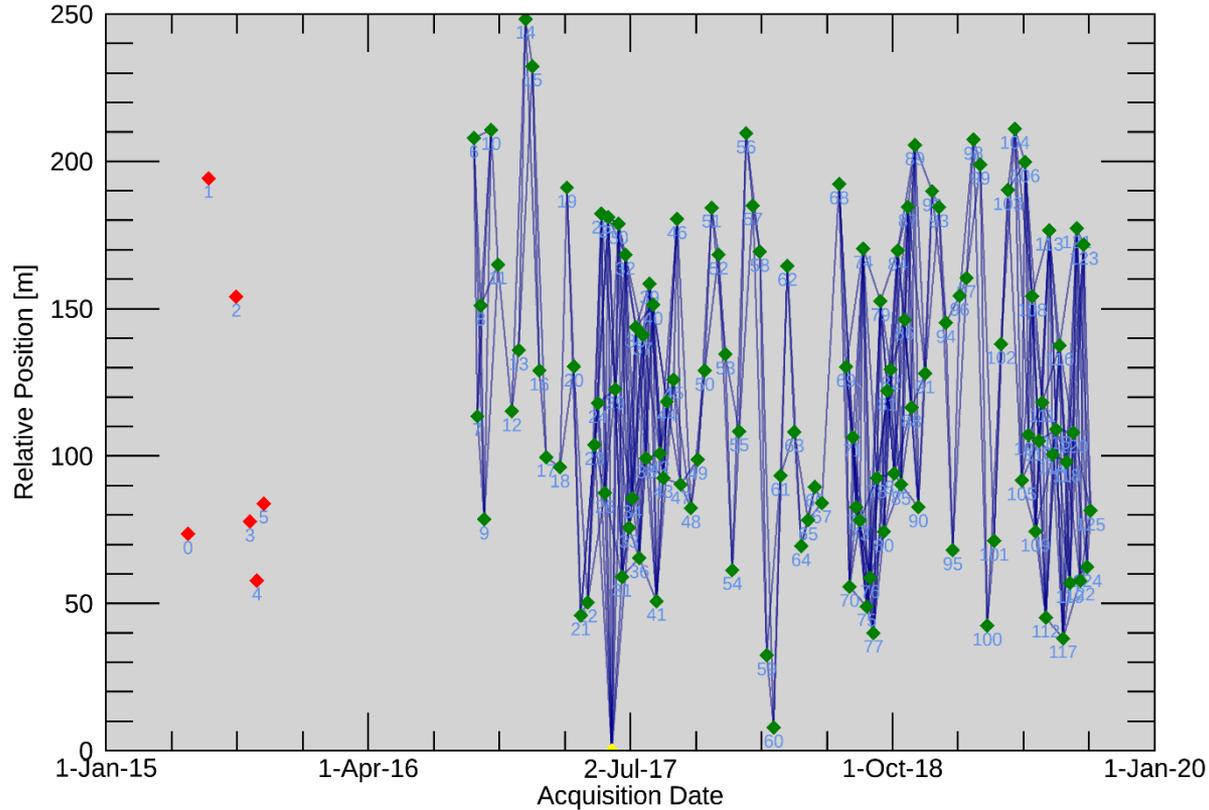
Extraction potential

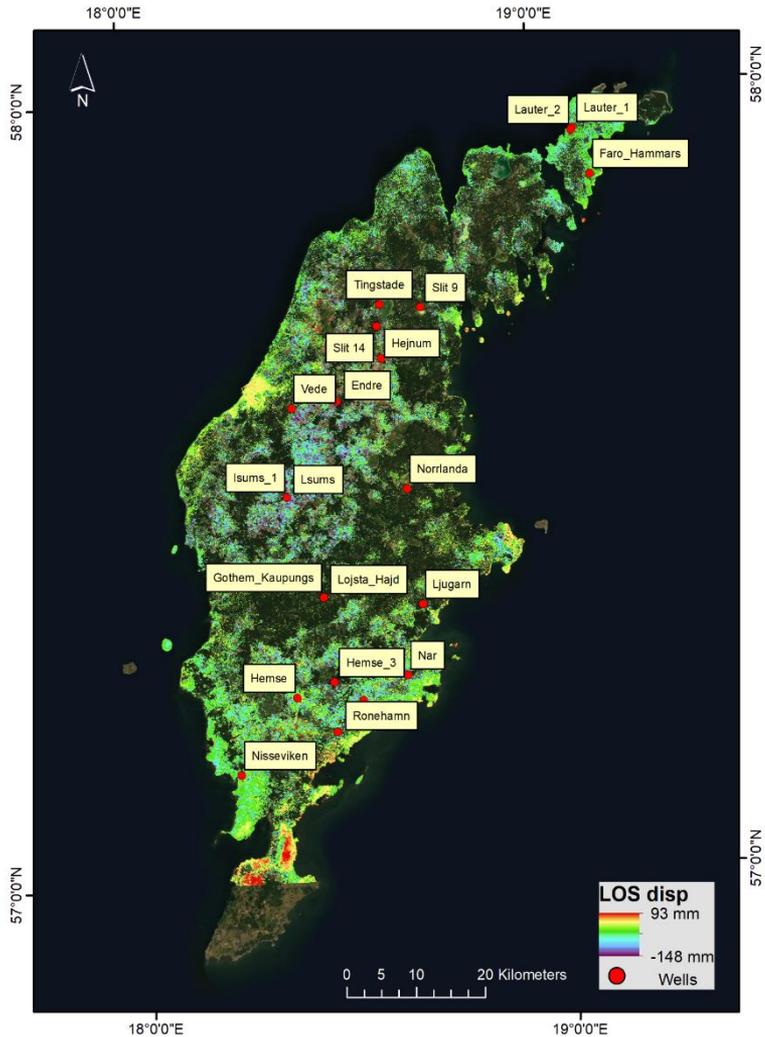


Geological
map

120 Sentinel-1 (S1) data

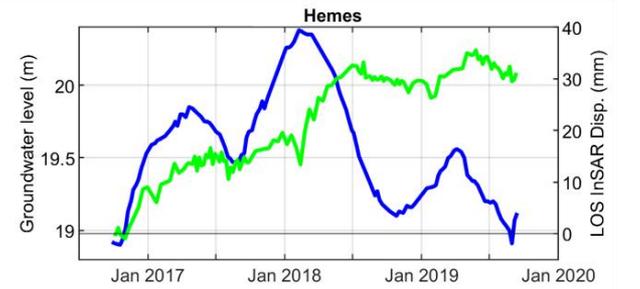
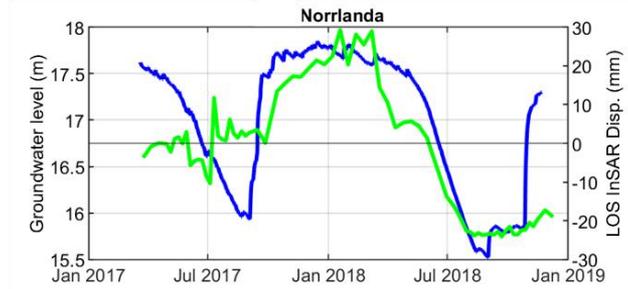
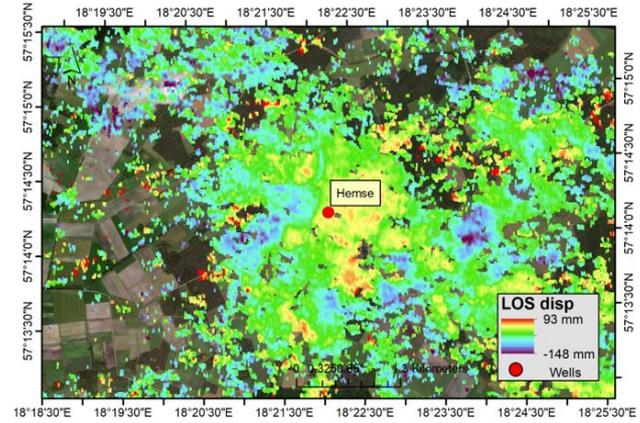
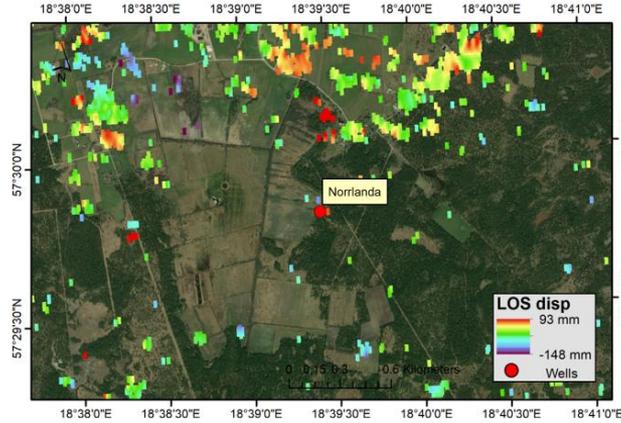
Time-Position Plot

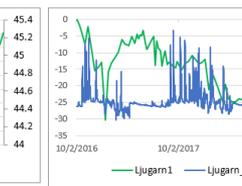
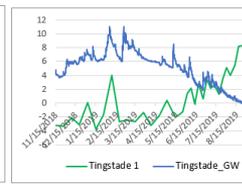
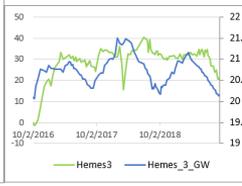
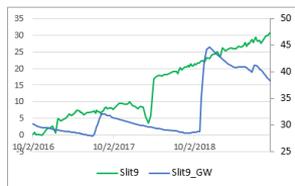
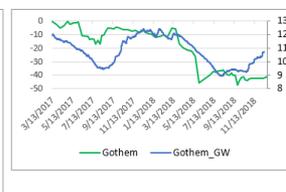
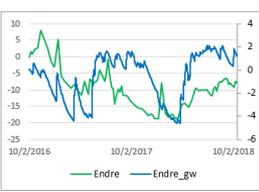
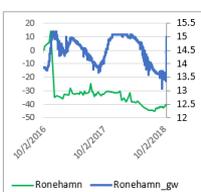
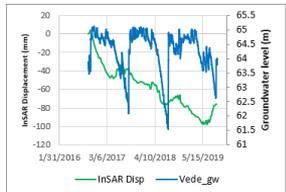
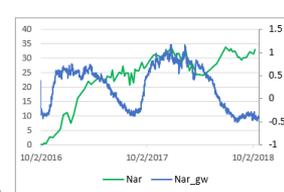
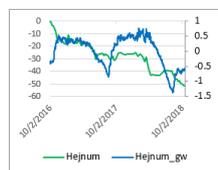
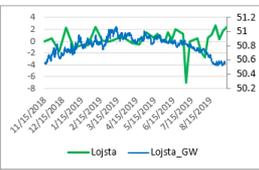
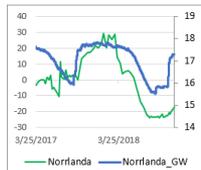
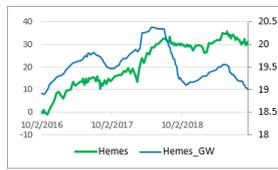




- Groundwater level monitoring stations by SGU in Gotland
- Ground deformation map

Focus groundwater stations





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		
Withdrawal possibilities in mountain				Soil Depth	Occurrence of karst	structure of the bedrock close to the surface				
Uttagsmöjligheter i berg				Skattat jorddjup (m)	Areas where karstification of the bedrock is common	AREAS DOMINATED BY AVERAGE AND GROSS CRYSTALLINE LIMESTONE				
6000-20 000 lh	2000-6000 lh	600-2000 lh	Under 600 lh	Oskand i lagacet	Uttagsmöjligheter i sedimentärt berg	Mainly hard crystalline limestone layers with high carbonate content. Sprickackarier. Laterally and vertically varying hydraulic conditions.				
60 000-200 000 lh	20 000-60 000 lh	6000-20 000 lh	2000-6000 lh	600-2000 lh	Under 600 lh	Areas with locally occurring karstification	Revkalksten. Irregularly shaped limestone areas with heterogeneously built limestone without clear storage.			
0 m	0-1 m	1-3 m	3-5 m	5-10 m	10-20 m	20-30 m	30-50 m	50 m	Ingen data	Areas with and 50 cm, small lumpy layers of Stromatoporioid limestone and medium crystalline limestone. Elements of reef lime stent and calcrudite
										Areas with 5-20 cm thick plane-parallel layers with well-crystallized limestone and stromatoporioid limestone as above. Often flat heel surfaces. Minor elements of reef limestone.
										Heterogeneous limestone areas with reverted stromatoporioid limestone, irregularly shaped layers / bodies and varying prevalence of calcium rutite and calcarenitis.
										Calcudite. Coarse grained limestone consisting of large broken fossil fragments.
										Dull and prismatic. Well-sorted limestone for the most part built up of rounded mm- to cm-sized carbonate grains
										Kalkarenit och kalkrudit bestående nästan uteslutande av krossöfverlagret, s.k. krossöfverlagret, ofta grå-öd till rosa.

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 +++