

# Geo-Hazard monitoring in northern Greece using InSAR techniques: the case study of Thessaloniki.

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## Abstract

Temporal monitoring of terrain movements and satellite observations are used here to monitor geophysical Natural Hazards in northern Greece for 1992-2010, applying Persistent Scatterer Interferometry and Small Baseline Subset techniques in an attempt to address their causes: anthropogenic or natural due to geological and geomorphological evolution. Our study highlights new areas that were previously unknown to be at risk and validates the remote sensing estimates using drill data, geomechanics and hydrogeology results. Site-specific results are presented for the broader urban area of Thessaloniki, Thessaloniki plain (Nea Malgara-Kimina, Chalastra) and the broader area of Katerini.

## 1. Data & Software

Data:

➤ESA:

- 46 Images ERS1 & 2
- 37 Images ENVISAT

➤Orbital data from:

- Department of Earth Observation and space systems (DEOS) of the Delft University of Technology
- ESA

➤The database of active faults of NOA faults

➤Drill data from K.E.D.E (of the Ministry of Reconstruction of Production, Environment & Energy)

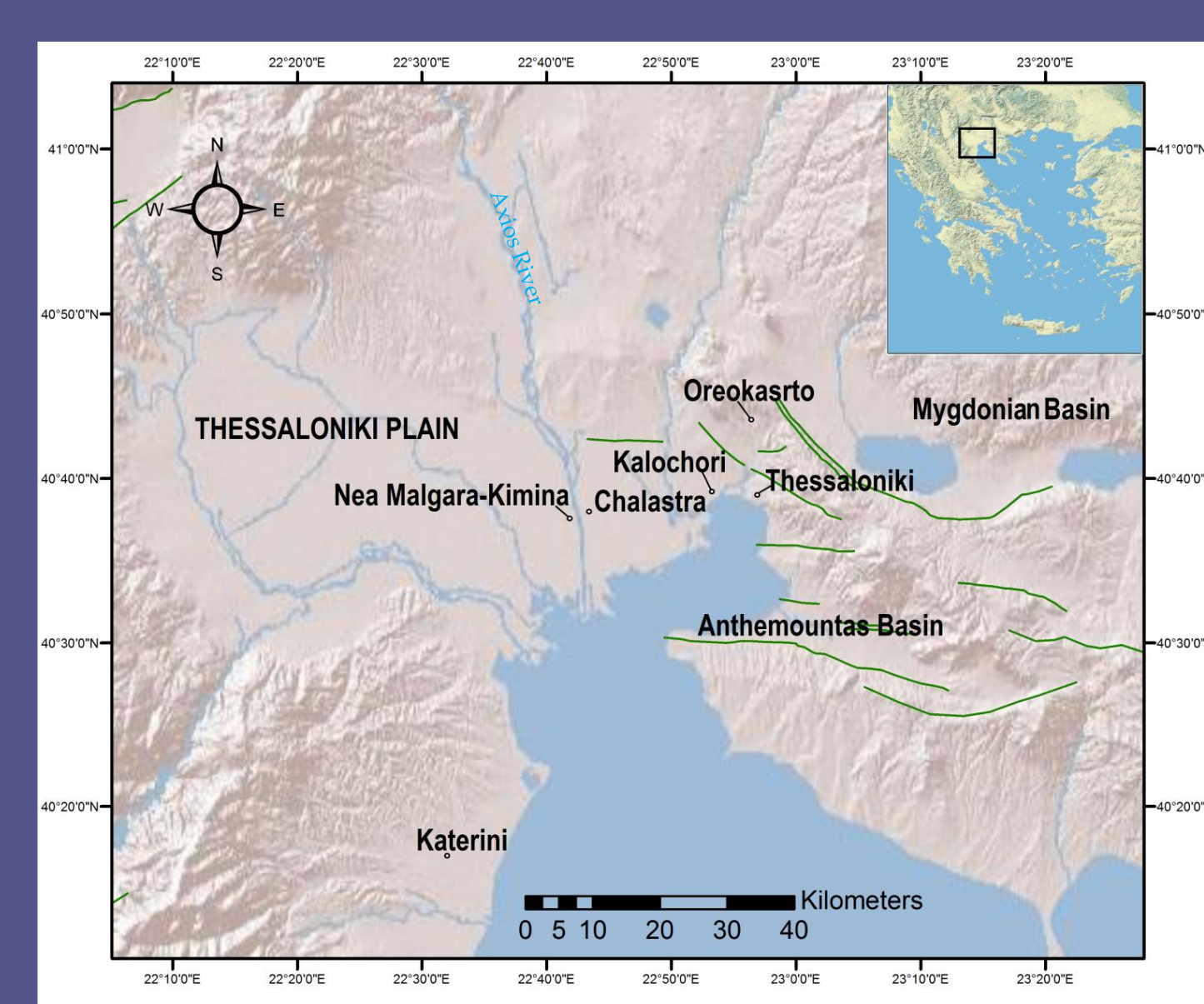
Software: SARscape, STAMPS, ROI\_PAC, DORIS

## 2. Motivation

The study aims to detect and distinguish small-scale movements, tectonic movements and subsidence triggered by the overexploitation of the aquifers or settlement from consolidation.

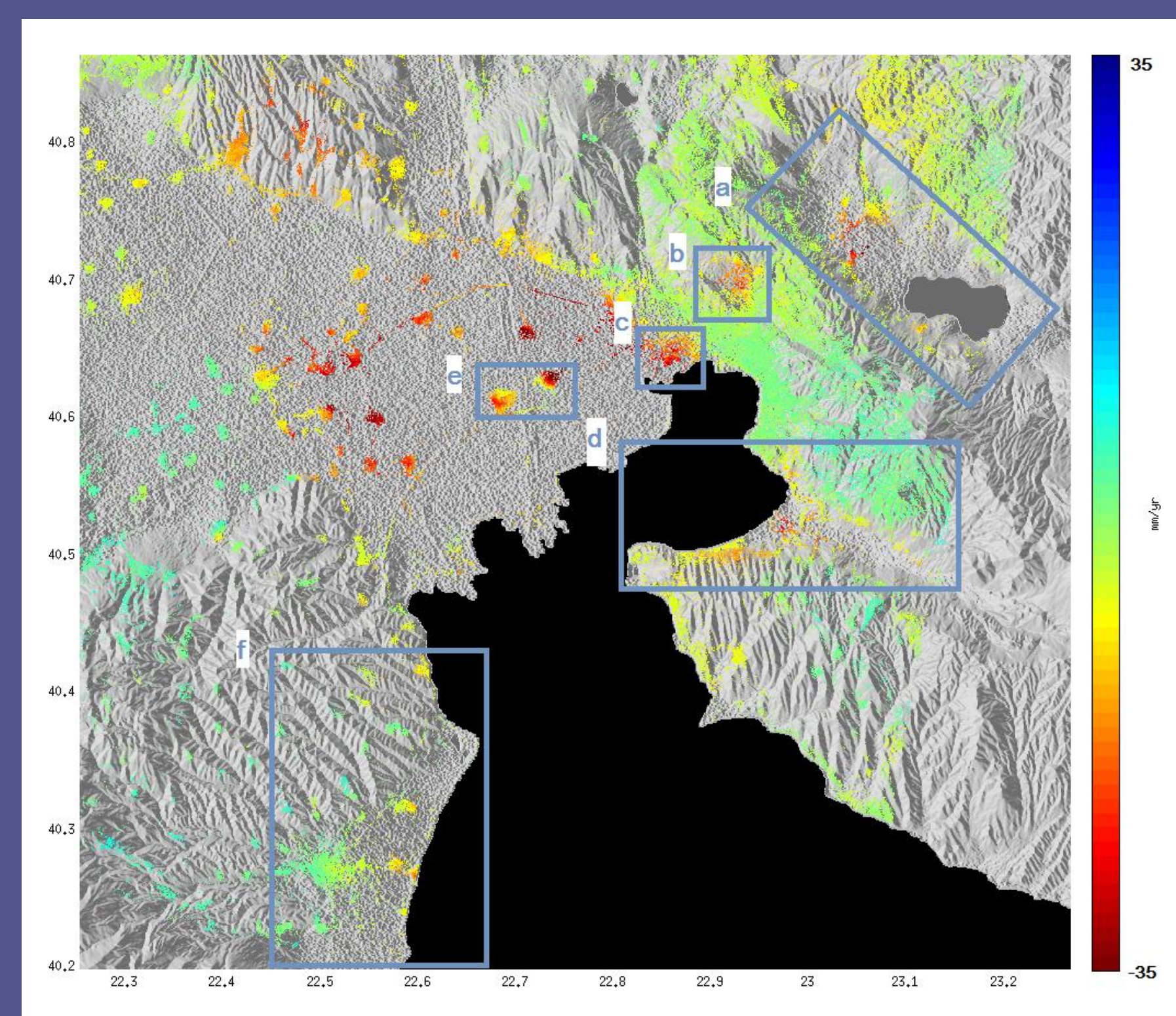
At the same time the products are contributing to the seamless monitoring of the region, which acts as a junction of the Balkans, especially important in the new Sentinel era where shorter revisit times provide systematic geodetic measurements over the area.

## 3. Area of study



General view of the area of study. Green lines are active faults. The Inset map showing Greece depicts, with the black rectangle, the area of study.

## 4. Results for 1992 - 2000



### a) Migdonian Graben

Tectonics, overpumping, geothermal activity

### b) The area south of Oreokastro

Tectonics (needs further investigation)

### c) Kalochoi

Overpumping

### d) Anthemoundas Basin

Tectonics, overpumping

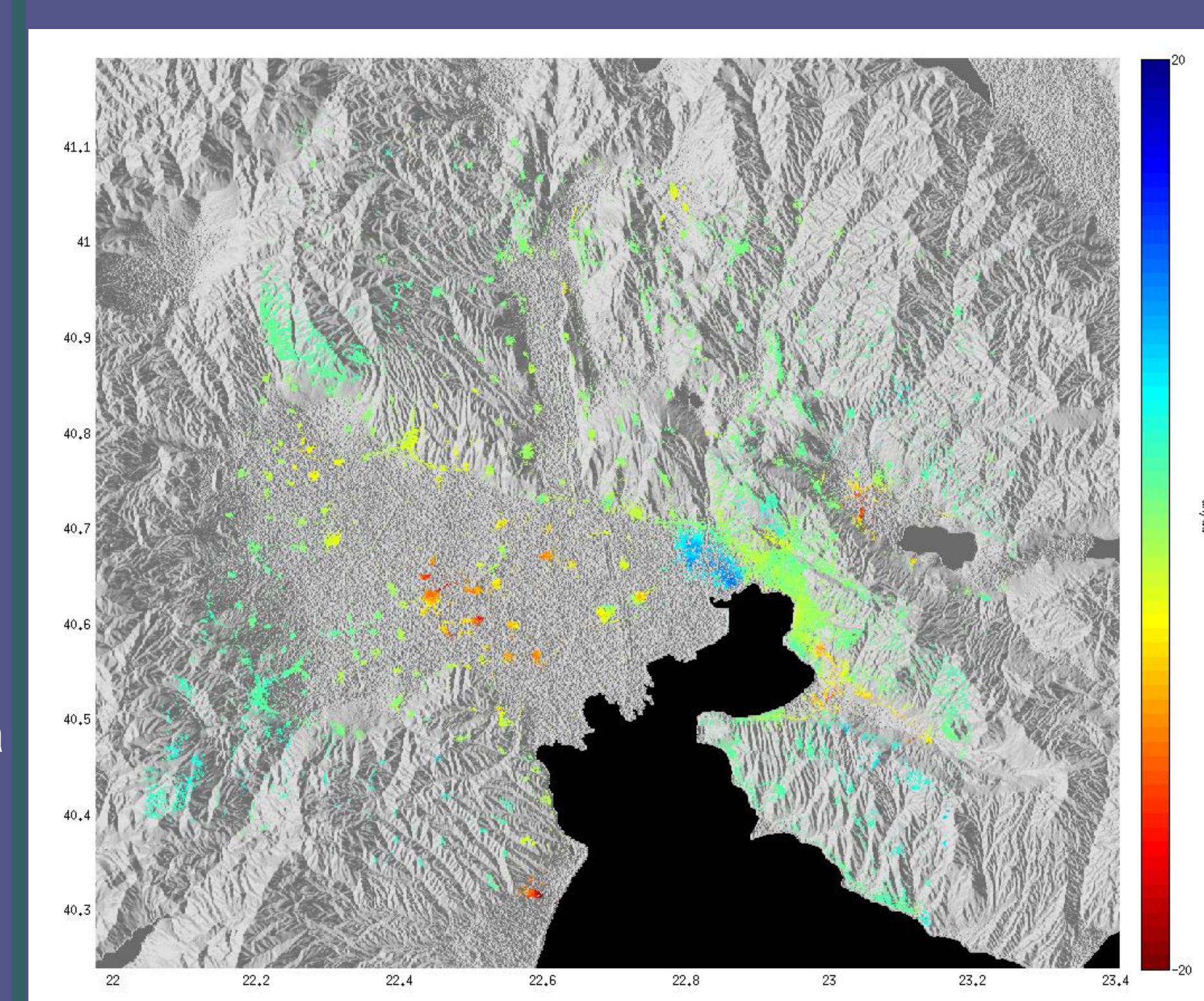
### e) Nea Malgara- Kimina and Chalastra

Settlement due to natural consolidation

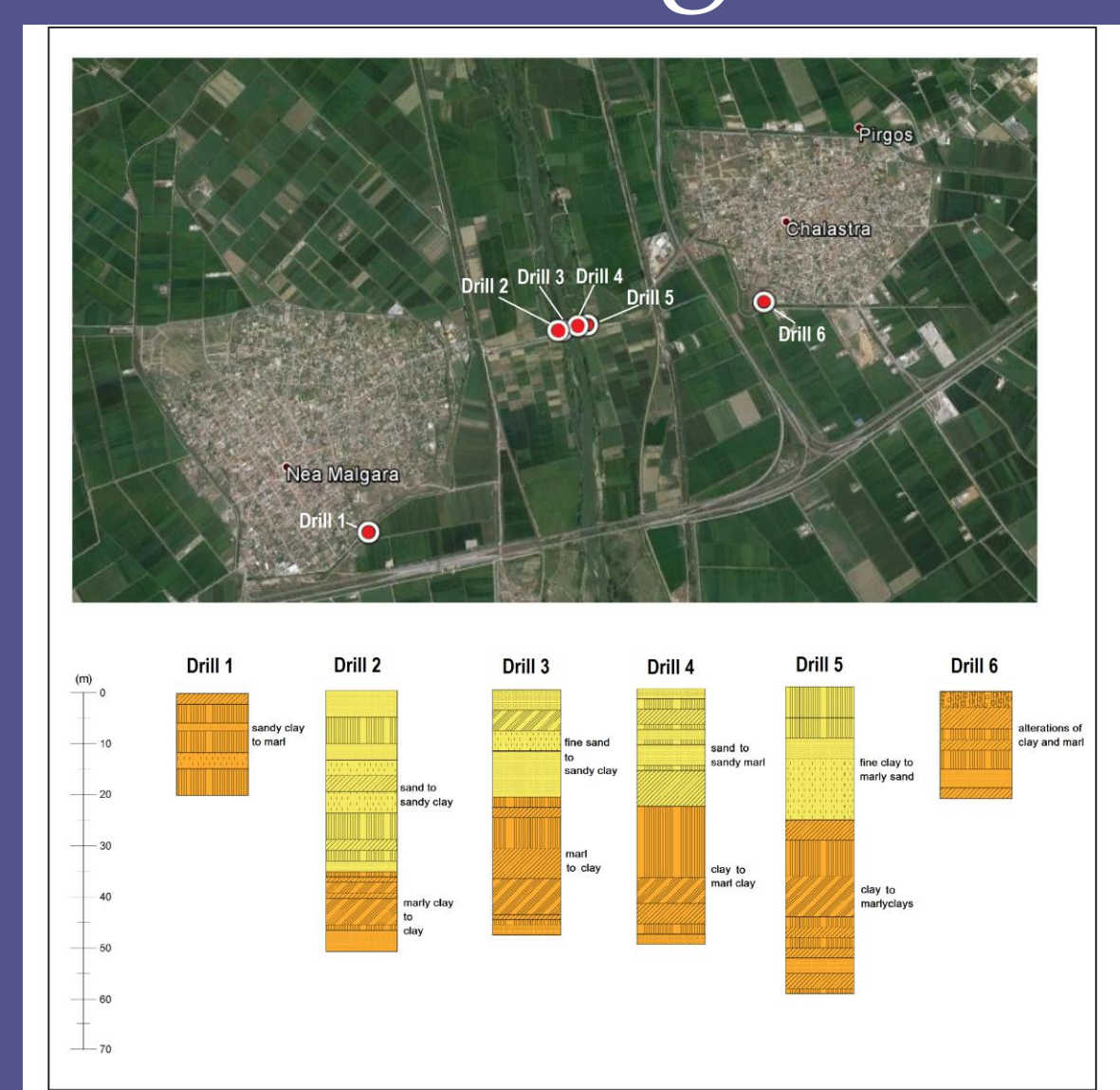
### f) Broader area of Katerini

overpumping

## 5. Results for 2002 - 2010



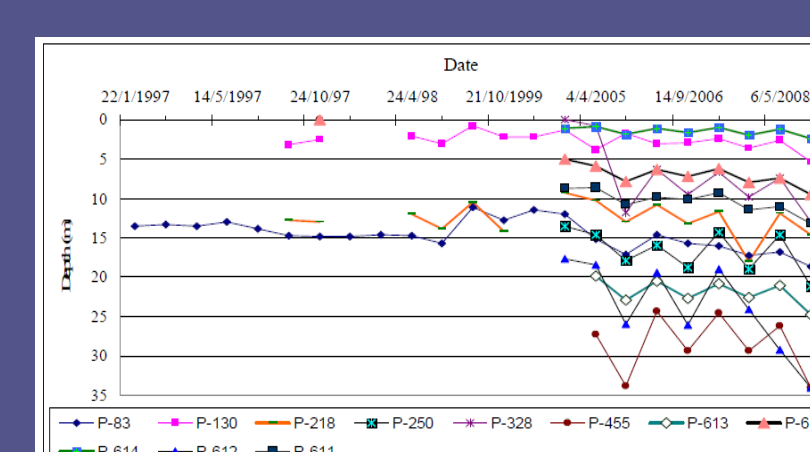
## 6. Nea Malgara-Kimina & Chalastra



➤The high compression index and the high void ratio of the clay layers justifies the manifestation of notable vertical displacements

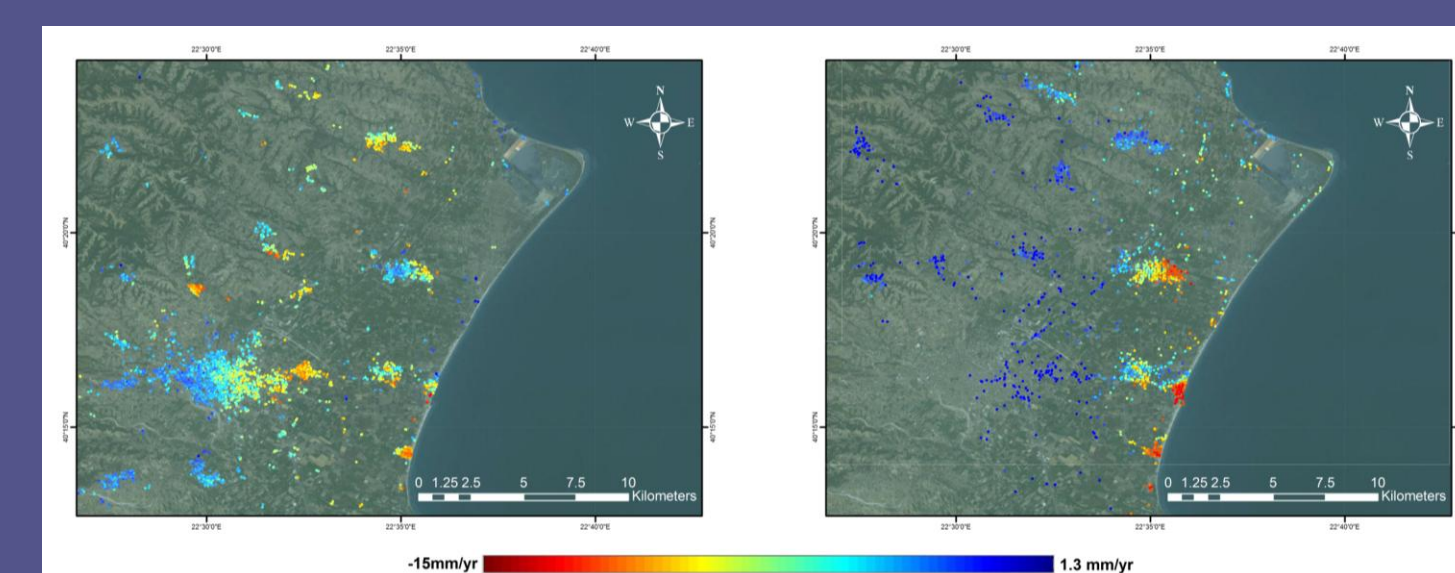
➤Vertical displacements due to the natural compaction of the material (settlement)

## 7. Katerini



(Veranis et al. 2014)

➤Subsidence: Pumping activities led to gradual decline of the underground water level



a) SBAS results 1992-2000 b) PS results 1992-2000

## Conclusions

The deformation between 1992 to 2010 is investigated in Northern Greece. The detected areas under hazard are: the Migdonian Graben, the area south of Oreokastro at the city of Thessaloniki, Kalochoi and Anthemountas basin to the west and east of Thessaloniki respectively. Previous researchers have studied the broader area of Thessaloniki or parts of it (Mouratidis & Constantini, 2012; Raucoules et al. 2008 ; Raspini et al. 2013, 2014). This study investigates the reasoning of deformation for areas previously unstudied. Next to the banks of Axios the towns Kimina, Nea Malgara and Chalastra are showing strong deformation signals. Based on Drill data we conclude that the reason of this deformation is found to be settlement from natural consolidation due to the fact that at this location there used to be the paleo-delta of Axios River. Another area showing negative vertical velocities is Katerini an area previously unknown to be deforming. The deformation is due to the pumping of the permanent groundwater reserves. The deformation of Nea Malgara, Kimina and Chalastra is a natural procedure and no governmental actions needs to be taken whereas at the case of the plain and coastal areas of the vicinity of Katerini, the detected deformation was caused by man intervention. We also present in Fig. 9 PS time series results using ENVISAT data for 2002-2010 from our on-going research. The deforming trend is mostly the same except the area of Kalochoi and the area at the south of Oreokastro. A validation of these results together with an interpretation is needed in a future work.

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