The use of radar DINSAR technique for the assessment of mass movements in Austria

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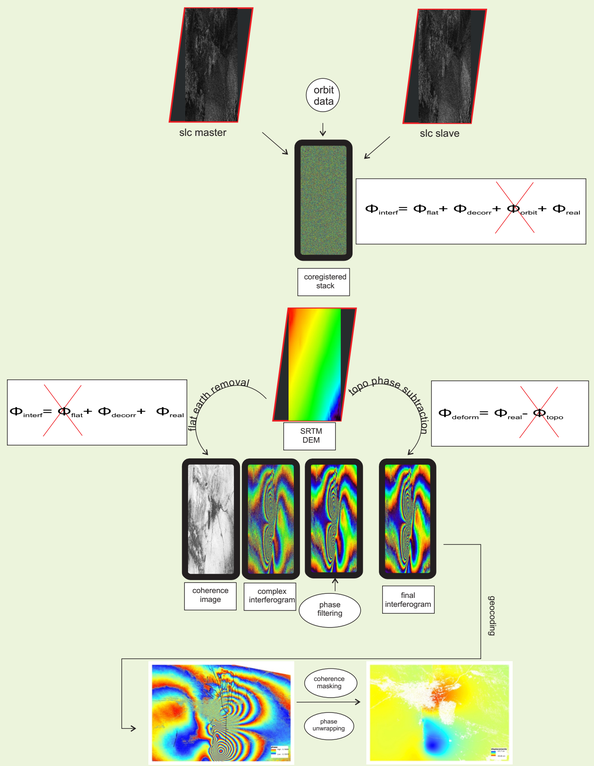
1.Introduction

Considering that in the past the Differential Interferometry SAR was a technique used only by a restricted scientific community nowadays the number of opportunity for governmental organisations to acquire and process SAR images in house is largely augmented. In fact it´s now possible to use open source software which enable a competent user to visualise, process and analyse available ESA ERS and ENVISAT data.
The GBA is involved in a EU project called PanGeo aimed at detecting and mapping, through the analysis of state of the art PSI (persistent scattering interferometry), geo-hazards related to terrain motion in two of the biggest city of Austria (Salzburg and Vienna).
The department of engineering geology by applying for an EarthNet ESA project is preparing a cost effective strategy for data processing of SAR images in the aim of assessing the Austrian landslide cadastre.



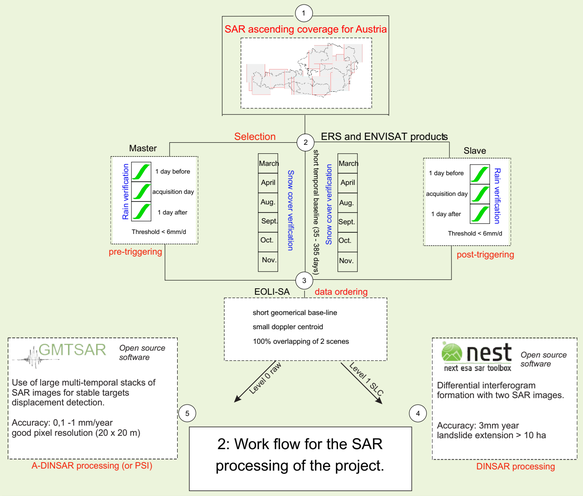
1: Work flow for the creation of an unwrapped differential interferogram.

2.Theory and software

New functionalities of open source software like EOLI-SA (ordering software), NEST (DINSAR software) and GMTSAR **(1)** (advanced DINSAR or PSI software) by processing well known examples of pre-seismic and post seismic events were tested. The available data of a recent earthquake (2004 Bam, Iran) represents the basis for the investigation on the applicability of the open software's. The results of the wrapped interferogram were compared with the literature successfully. In (1) the term Φ_{decorr} or noise on the equation can be solved by selecting images in certain conditions; for esample by acquiring images in spring and fall season or in arid zones and by avoiding spatial decorrelation by mean of very short baselines. Bam is in a desertic area of Iran and the baseline is only 21m.The first wrapped interferogram was obtained processing pre-seismic and post seismic ENVISAT images in LINUX with NEST open source software. Then with the SNAPHU software it was possible to unwrap the phase which shows a differential movement of the reactivated fault and the amount of displacement in centimetres.

3.Strategy

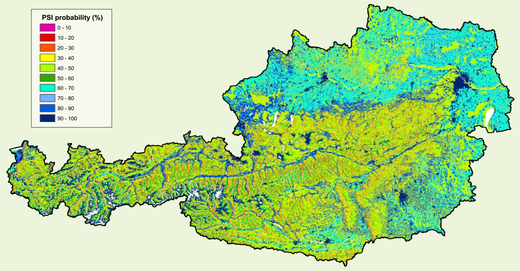
In order to accomplish the project "Austrian landslide catalogue assessment through the use of radar interferometry application" the GBA will adopt a method (2) which takes into account pre-triggering and post triggering related landslide events in Austria (landslides, extreme rainfall, extreme snowfalls, flooding) and compare the DINSAR results with the GEORIOS cadastre.



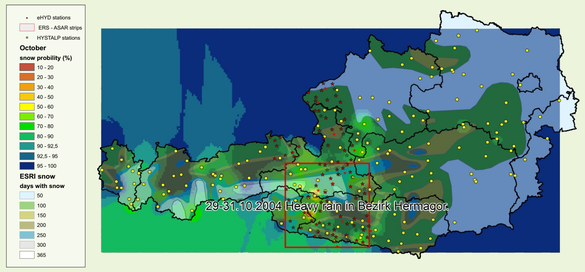
2: Work flow for the SAR processing of the project.

4.Modelling

The first part of the analysis for the nationwide project was addressed to the creation of the PSI predictability model **(2)** based on slopes, aspects and land use and use it as a reference for forecast the higher probability to detect potential very slow mass movements catalogued on the GEORIOS **(3)** cadastre. More than 500 features with extent > 10 hectares are susceptible to be detected in motion by using classic two pass DINSAR method.



3: PSI predictability model for ascending orbits (night acquisitions) describing the probability to find persistent scatters overall Austria.

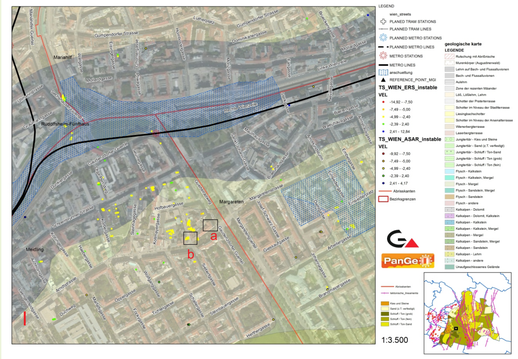


4: Wheater stations eHYD **(4)** for one of the 50 Km by 50 Km site and HISTALP **(5)** snow probability compared to the ESRI snow layer.

5.Vienna preliminary results - PanGeo examples

The main product of PanGeo consists on the creation for each city of a ground stability layer. This layer, coupled with a hypertext reporting the interpretation of the phenomena, contain the areal extensions of the geo-hazards. Furthermore PanGeo portal will publish those results on a web GIS application **(6)**.
By comparing urban geo atlas of Vienna **(7)** and the distribution of made ground deposits with PSI data it was possible to validate two buidings instabilities on the ground floor. In 5a and 5b the subsidence is due to the presence of loess on the ground.

5a, 5b: cracks evidences on buildings, Meidling (Vienna).

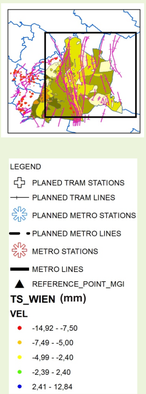


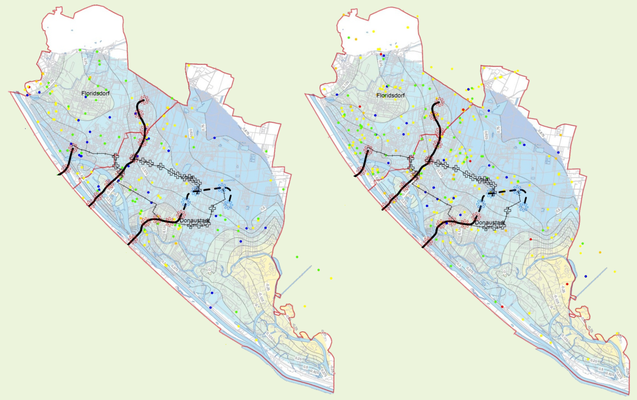
5: location map of the hot spot of subsidence present in Margareten and part of Meilding

In two Bezirks of Vienna (Florisdorf and Donaustadt) in 2004 the project HydroModul **(8)** was carried out. One of the result was to illustrate the variation of the ground water table level before and after the construction of a Freudenau dam on the Danube.

Since PSI ERS data (1995 -2000) correspond to the time frame of the geo-hydrological investigation it´s possible to see in 6a an overall well response of the satellite to water table fluctuation.

In 6b on the other hand the ground works oparated on the U2 line of Vienna from Donau Marina station until Aspern station can be spotted with a corresponding relative aggravation of the subsidence. At the same time on the planned tram and metro lines further negative motion are present.

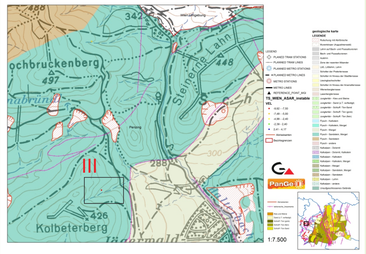




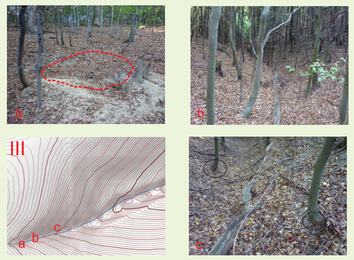
6a: ERS data 1995 -2000 (mm), groudwater difference 1995 -2000 (m)

6b: ENVISAT data 2001- 2010 (mm), groudwater difference 1995 -2000 (m)

The versatility of PSI data can be proved in non urban environment as well as it happend in couple of cases in Salzburg **(9)**. The presence of few scatters in Wienerwald on Flysh persuade us to made a verification on the field. At the northern part of Kolbeterberg hill a particularly active channel created by under cutting a deep graben.
On 7a it´s possible to see in fact the extreme action of the erosion (the fall of an old tree) in 7b the deep graben itself and in 7c the bending of young trees.



7: location map of the graben investigated in Winerwald.



7a, 7b, 7c: locations enlargements.

6.Conclusions

The comparison of boreholes and piezometers measurements with the PSI time series of affected subsidence areas allowed the understanding of the hydro-geological process taking place.
This tecnique showed sporadic good results in non urban areas as well.

The use of the archieved ESA SAR images will allow the GBA, through the application of DINSAR and A-DINSAR methods, to study how in mountainous areas major triggering events can cause over aggravation phenomena on instable slopes **(10)**.

7.Bibliography

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