PanGeo project and the future exploitation of the ESA Radar SAR archive in Austria

Filippo Vecchiotti, Arben Kociu, Nils Tilch, Edmund Winkler

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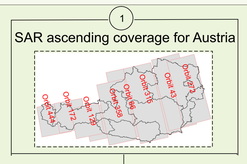
1.What is PanGeo?

PanGeo is a collaborative project of the EC's Seventh Framework Program aimed at mapping and cataloguing in a web GIS portal natural and anthropogenic geo-hazard in Europe. The involvement of European geological surveys , ESA qualified PSI (Persistent Scatterers Interferometry) providers, together with the makers of the GMES Land Core Service "Urban Atlas"**(1)**, insures state of the art contribution on hazard and mapping detection in urban and semi-natural environments. Salzburg (fig. 1) and Vienna are only two out of 52 cities investigated in PANGEO. The Persistent scattering Interferometry technique enables to detect terrain motion and the correlation with geological information and ancillary data is very important since it enable analysts to investigate and map specific geo-hazards. PSI (1992-1999 and 2003-2009) is one of the gathered information needed for the realisation of the ground stability layer. By combining such a layer with a hypertext, it will be possible to visualise natural and anthropogenic instabilities on the GIS PanGeo portal **(2)**. This portal is meant to be a main reference for local authorities who deal with risk management and assessment.

Fig.1: PanGeo project area

2. The use of the ESA radar archive in Austria

The "Austrian landslide catalogue assessment through the use of radar interferometry application" it´s the title of the project proposed by the GBA which has been approved by the ESA in April 2012.
The aim of the project is to improve the GEORIOS landslide cadaster of certain regions of Austria using Differential InSAR technique processing ERS and Envisat images provided free of charge from the ESA.
The cost effective strategy to exploit the ESA Radar SAR archive in Austria is based on the fact that in mountainous areas major triggering events could cause over-aggravation phenomena on instable slopes **(3)**. The DINSAR technique could prove if catastrophies activates new or re-activates previous mass movements.



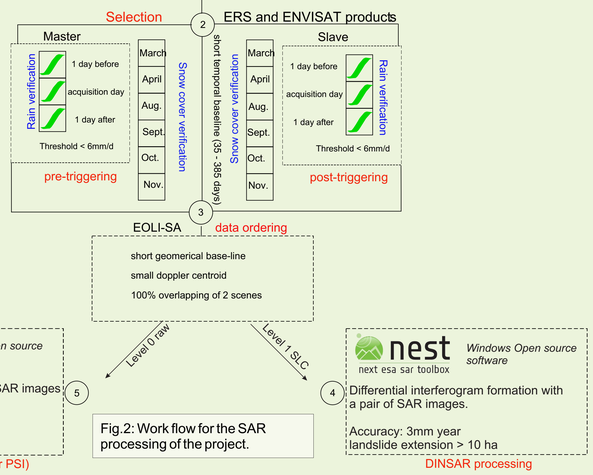


Fig.2: Work flow for the SAR processing of the project.

3. Methods overview

By reviewing historical rain, snow, flood and landslide events it's possible to apply a kind of pre-seismic and post-seismic approach the so called "pre-triggering and post-triggering" method (fig.2).

HISTALP snow data combined with the ESRI snow cover layer allows for the discrimination of the probability to find snow free areas in specific months of the year.

More than 1200 local weather rain stations allows for the right choice in terms of date of image acquisition; being the humidity a factor which introduces a high atmospheric noise on the radar signal **(4)**.

A predictability PSI layer for ascending and descending orbits by using CORINE data and DEM derived slope and aspect map was created and compared to the GEORIOS landslide cadaster of Austria.

4. Data availability

The data available (fig.3) for PanGeo were :
-Two series (1993-1999 and 2001-2009) PSI point data for Salzburg processed by Altamira;
- various geological maps (1:50.000 and 1: 200.000 scale);
- GEORIOS cadaster;
- various digital elevation models (ASTER DEM and laserscan derived DEM);
- the Urban Atlas (landcover map for cities > 100.000 inhabitants).
Being the „Austrian landslide catalogue assessment through the use of radar interferometry application" on a national scale will bring together geological maps at various scales, the GEORIOS landslide cadaster **(5)**, the CORINE land use map, the ESRI snow cover map, the HISTALP **(6)** snow cover and precipitation historical data, "eHYD" data warehouse **(7)** for cumulated daily rain weather stations, the ASTER DEM digital elevation model. Those layers of information (fig. 4) will be compared with DINSAR and advanced DINSAR products obtained by processing a series of radar SAR images.

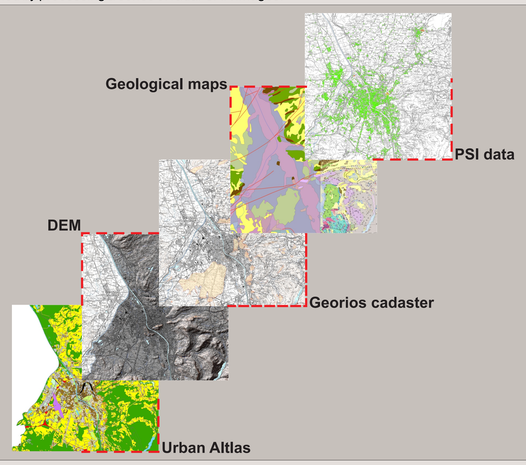


Fig.3: Data availability in PanGeo for Salzburg urban area.

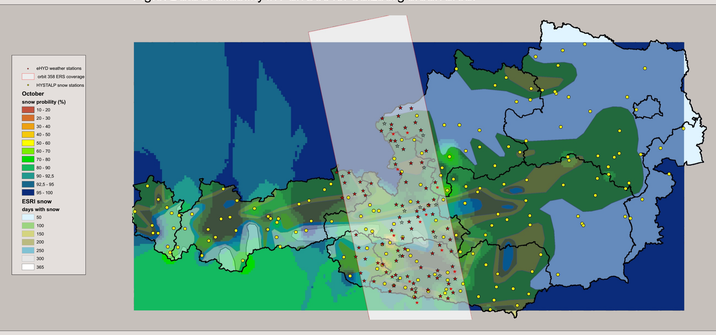


Fig.4: Wheater stations (eHYD) for orbit 358 and HISTALP snow probability compared to the ESRI snow layer.

5. Software processing

The PSI predictability model (fig.5) **(8)** was tested successfully on the PSI data delivered for PANGEO. The ascending orbit give the higher probability to find mass movements mapped as very slow on GEORIOS. Around 500 features with extent > 10 hectares are susceptible to be detected in motion by using classic two pass DINSAR method.Through EOLI-SA software the first couple of images for the orbit 86 was ordered via ftp and analysed with NEST software. Since the interferogram covers alpine areas the date chosen were in August and the time between two acquisitions was 2 years (97-99). The first interferogram is unwrapped but showed good coherence over montaineous areas **(9)**. The phase unwrapping it´s going to be tested with SNAPHU and MATLAB alghoritms. The future step in the analysis is to use GMTSAR **(10)** to perform the A-DINSAR focused on 2 sample sites.

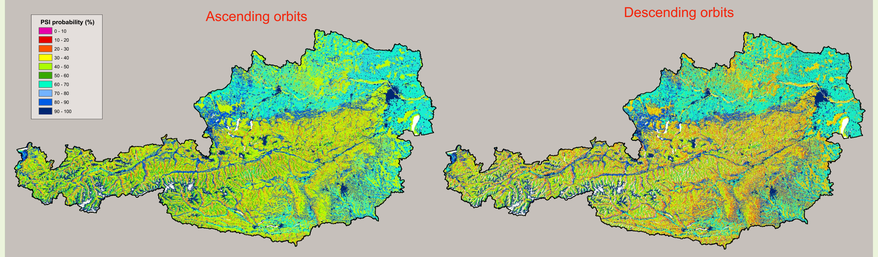


Fig.5: PSI predictability model describing the probability to find persistent scatters overall Austria.

6. Preliminary results and their validation

After having visualised PSI data, geo-hazard data and ancillary data together the main attention was draw where maximum rate of subsidence (in mm/year) in both series of descending orbit data were found (red and orange points).
Two main areas affected by a pattern of subsidence driven displacement and two characterised by punctual evidences were examined. The latter are positioned very close to landslides mapped in the 1:50.000 scale geological map and in GEORIOS. The former areas, at the first sight, showed any geological evidences supporting instability apart for the case of *Seekirchen am Wallersee* (fig. 9) where there is a well-documented history of subsidence causing failure of a series of buildings **(11)**. The validation work on the field was undertaken the 22nd of May 2012 in Salzburg urban area and surroundings. The survey revealed for the punctual areas good feedback since on *Mülltal* evidence on the field of three creep mass movement were mapped on „Eisrand Terrasse"formation (fig.7c). Whereas on the *Heuberg hill* the satellite was able to spot a minor movement of a retention wall; here it was possible to map a rotational landslide imposed on „Rhenodanubian Flysch"(fig.8). In Langwied, a central area of Salzburg, instead three buildings showed cracks (fig. 6c). Further exams by combining boreholes and levelling data will be attempted in order to clearly define the motion occurred in urban areas.

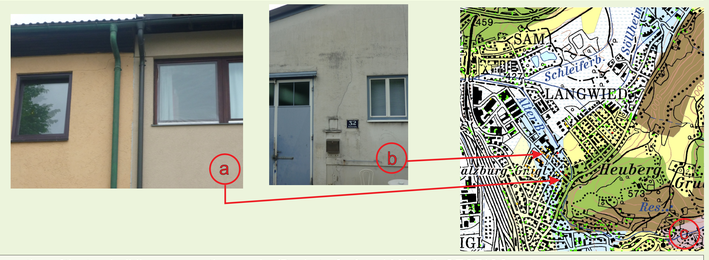


Fig.6a, 6b, 6c: Location of the two buildings presenting cracks (Bachstraße 9 and 32); both GEORIOS and geological map categorised the site as alluvial fan.

Fig.7a, 7b, 7c: Location of two out of three creep mass mapped on Mülltal on würmian „Eisrand Terrasse".

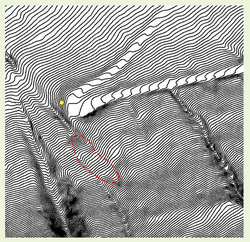


Fig.8:Mapped rotational landslide sliding northwestward, the lithoghy is Flysh; movement of retention wall indicated by the yellow point (-4 mm/y).

Fig.9: Underlined measurements (geoland web application) indicated similar subsidence rate than (10-12 mm/y) those obtained from the ers PSI.

7.Conclusions

The PSI data available for Salzburg were very useful for the detection of subsidence and gravitative phenomena. This technique allows for the discovery of new terrain motions and for the monitoring of known ones, furthermore it´s been used for the classification of mass movement based on their activity. The validation on the field showed a very good reliability of the data since on the main hot spots visited, with movement > -4 mm/y, it was possible to detect some indication of ground or building instability. Being the method robust and reliable it supposed to be more intensively adopted by municipalities which are concerned for infrastructures planning. The use of the ESA radar archive in Austria it´s an ongoing project which is supposed to achieve similar results.

8. Literature

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Geologische Bundesanstalt Österreich -
Neulinggasse 38, A-1030 Wien

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Tel: +43-1-7125674-0 Fax: +43-1-7125674-56 393
Filippo.Vecchiotti@geologie.ac.at www.geologie.ac.at