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Detection and Analysis of Anomalous Permanent Scatterers in TerraSAR-X Data

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ABSTRACT

Permanent Scatterer Interferometry (PSInSAR) leads to the formation of networks of targets with a stable behavior in time, used to overcome decorrelation phenomena induced by long revisiting periods of the same area. This technique has been mainly used for the computation of deformation time series in the form of displacement maps. However, the results depend on the quality of the permanent scatterers (PS) extraction methods and on each individual data set.

We select the PS candidates from a set of co-registered SLC products using the spectral behavior of stable points, that significantly differs from the one exhibited by distributed targets. We perform a classification of the parameters used for the extraction process, such as the number of acquisitions and decision thresholds (window sizes, SNR threshold etc.). Apart from analyzing the implication of traditional error sources, such as APS and baseline values, PS with anomalous behavior will be identified, isolated and monitored for the duration of the different time series. Causes for the apparition of false detected targets will be studied, based on the amplitude analysis and an in-depth study of each individual scenery.

In order to ensure scenario diversity for the validation of the results, three data sets are being analyzed. The data consist of TerraSAR-X StripMap images taken over urban regions from Bucharest (32 images), Valencia (8 images) and San Francisco (7 images) in the frame of MTH1628, MTH0302 and MTH1118 proposals.

STUDY AREA AND DATA

The analyzed areas consist of three urban scenarios:

	Area 1	Area 2	Area 3
Region	Bucharest	Valencia	San Francisco
Number of images	32	8	7
Imaging mode	StripMap	StripMap	High Resolution SpotLight
Orbit	descending	descending	descending
Polarization Mode	HH	VV	HH
Time span	July 2011 – December 2012	May 2009 – May 2010	December 2007 – October 2010

METHOD

The PS networks are computed using two different approaches, dependant on the number of available images from each data set. Both methods receive as input a set of previously co-registered SLC products.

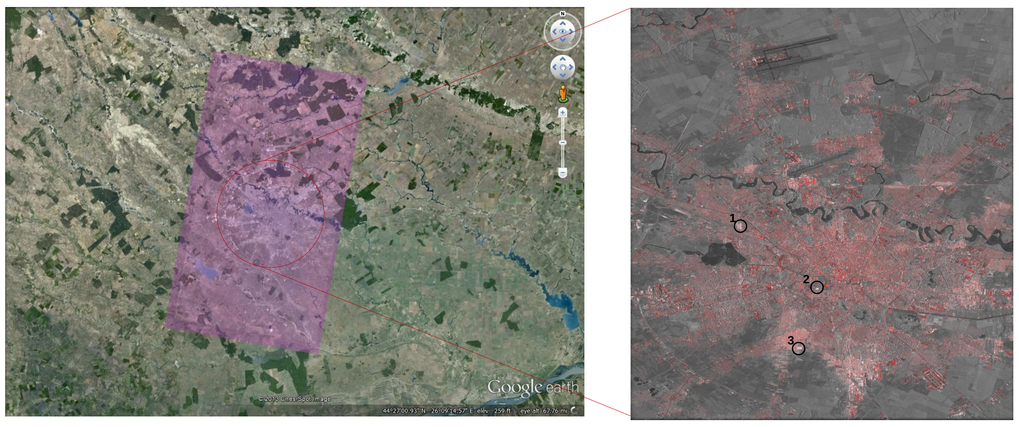
The first method exploits the spectral behavior of stable points and selects stable targets based on the differences exhibited to other distributed targets. This method has been employed for all scenarios.

The second method selects potential candidates that exhibit a low intensity variation, which is characteristic to the response of a single dominant scatterer in the resolution cell. Due to the size of the data stack necessary for reliable results in this case (> 25 images), this method has only been applied for the Bucharest test site.

In order to see how the parameters affect the resulting network, several parameters have been taken into account (number of SLCs in the data stack, baseline values – in the original dataset and independent subsets, thresholds – SNR, coherence, window sizes).

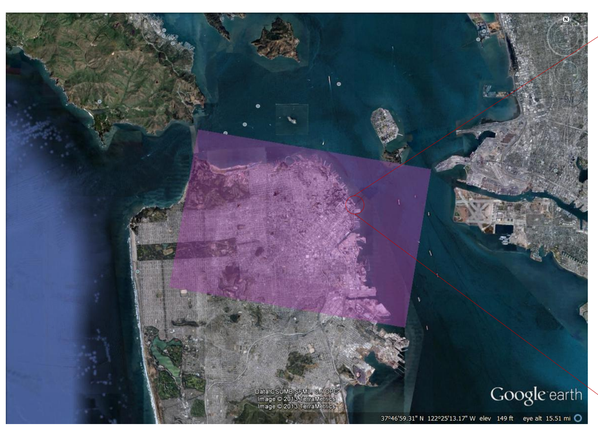
To ensure a more accurate assessment of the parameters' influence, three urban scenarios have been selected (Bucharest, Valencia, San Francisco) acquired with different imaging modes and polarization and with maximum temporal baselines ranging from 1 to 3 years.

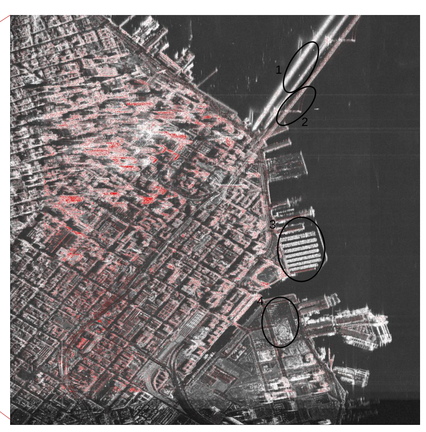
RESULTS

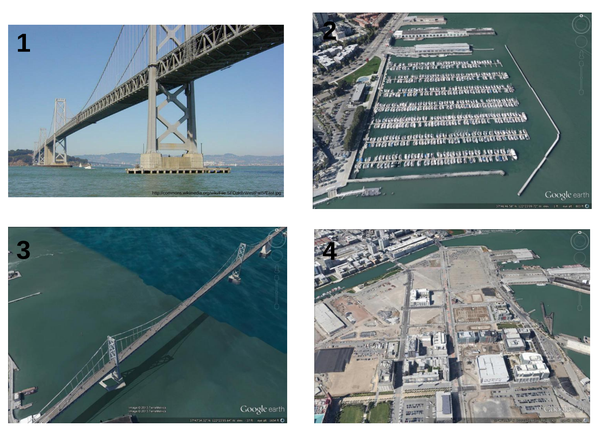


Extracted patches for the Bucharest site:
1 – Railroad yard
2 – Construction site (Mantuirii Neamului Cathedral)
3 – Outdoor market & parking lots

Persistent scatterers were extracted based on the spectral behavior of stable points and selecting candidates that exhibit low intensity variation. Due to the size of the dataset, the second approach offers an increase of 84% with respect of the total number of PS found in the analyzed region, 86% of which are common for both methods.



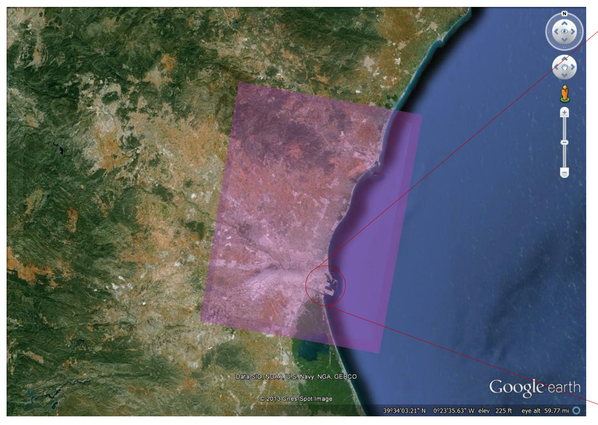


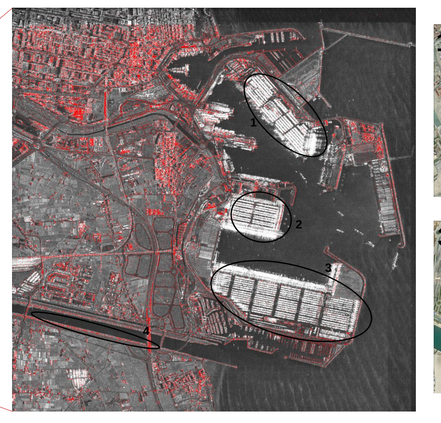


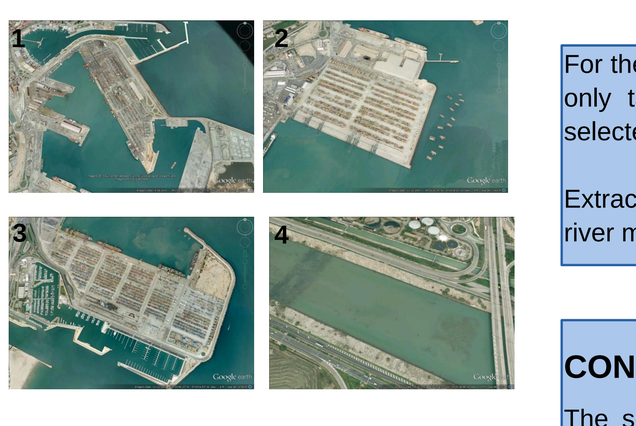
Considering the small number of images, PS were extracted by analyzing the spectral behavior of the stable points in the data. The characteristics of the scene (downtown San Francisco, Financial District) strongly influence the quality of the results, leading to a density of the PS of approximately 88000PS/km^2.

False negatives include areas such as (1), where the reflection of the bridge on the water leads to the detection of unreliable PS on the water surface.

The reliability of the PS on the bridge's cables (3) is currently under assessment using sub-aperture decomposition.





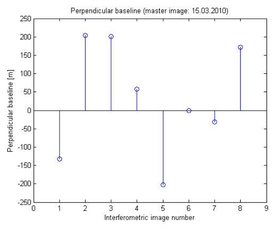


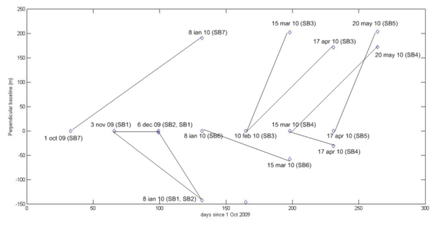
For the Valencia data site, a threshold for the coherence of 0.75 was used, and only targets exhibiting low values for the dispersion index (< 0.25) were selected as PS candidates.

Extracted areas include crate storage areas (1, 2), parking areas (3) and rocky river margins (4).

CONCLUSIONS

The selection of a valid PS map is strongly dependent on the scene. The selection of different parameters (baseline values, number of SLCs in the stack, thresholds) has a direct impact on the quality of the results.





Using the SBAS constraint lead to an increase of 30% in the total number of detected PS

When performing an analysis over an extended time interval, the number of persistent scatters is reduced. In order to minimize the influence of the decorrelation phenomena, PS networks can be obtained by extracting valid candidates from Small BAseline Subsets (SBAS).

An assessment of this approach was validated using the Valencia test site. The baselines for the original and SBAS data sets can be observed:

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Acknowledgements

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