GeoHazard description for the Varna region in the frame of the Pangeo project

Описание на геоложките опасности за района Варна като част от проекта Пангео

Stanislav Stoykov, Kalin Ruskov, Miloslav Katsarov
Станислав Стойков, Калин Русков, Милослав Кацаров

University of Mining and Geology “St. Ivan Rilski”, 1700 Sofia, Bulgaria; E-mail: ststst@abv.bg

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Introduction

PanGeo was a 3-year EC FP7 R&D ‘Space’ project (1st Feb 2011–31st Jan 2014). The main objective of the project was to provide free, online information on geohazards for 52 of the largest towns in the EU (two in each country, except only one in Luxembourg and Cyprus). For Bulgaria, these two towns are Sofia and Varna (Ruskov et al., 2014). For each town were made a GIS Ground Stability Layer (GSL) and a ‘Geohazard Description document’ (Stoykov et al., 2013a, b). Users of the PanGeo service include local authorities, civil protection agencies, geological surveys, insurers and businesses providing environmental and land reporting services and of course the general public (Bateson, Glenfield, 2011; Jordan et al., 2011).

The area covered by the GSL of Varna includes the town of Varna and other surrounding boroughs, with a total population of about 304,000 inhabitants in 2011. Urban areas cover ~258 km² while the town of Varna covers ~153.6 km². Mountains and forest units cover approximately 28%, while agriculture and semi-natural cover around 60% of the area.

Methods

PanGeo offers a free and open access to geohazard information service in support of GMES (Global Monitoring for Environment and Security). PanGeo geohazard information is derived from integrations of (1) satellite radar Persistent Scatterer Interferometry (PSI) for ground instability measurement; (2) geological land use and other geospatial information available at the University of Mining and Geology, Sofia and (3) the land use and land-cover infor-
severely damage urban infrastructure and buildings (Bateson, Glenfield, 2011).

Geohazards can be described as either ‘potential’ or ‘observed’. A potential geohazard is possible in the case that the local geology makes it more probable for ground movement to occur even if movement has not been measured. At the other hand, observed geohazards are where ground movement has been measured (by whatever method). The PanGeo ground stability layers captures both potential and observed geohazards.

Within PanGeo project ground stability geohazards are grouped into common classification themes describing the wide range processes at work (Cigna et al., 2012): 1) Deep ground motions (earthquake seismic hazard; tectonic movements; salt tectonics; volcanic inflation/deflation); 2) Natural ground instability (landslide; soil creep; ground dissolution; collapsible ground; running sand/liquefaction); 3) Natural ground movement (shrink-swell clays; compressible ground); 4) Man-made ground instability (ground water management – shallow compaction; ground water management – peat oxidation; groundwater abstraction; mining; underground construction; made ground; oil and gas production); 5) Other.

The area covered by the GSL corresponds to the administrative area of Varna, Avren, Suvorovo, Balchik, Dobrich, Provadiya amd Devnya Municipalities (~1110 km²) and includes the city of Varna and other surrounding boroughs. The area falls in area of Varna and Dobrich regions.

It was identified 16 geohazard polygons over investigated area in 3 different categories (geological hazard, industrial area, mining sites), consisting of ~31 km² of observed and potential geohazards. Potential for natural ground movements is observed for the majority of the area. Geohazards observed

![Image](image_url)
through the PS data include both natural processes (compaction of the marine shore sediments) and anthropogenic instability due to water abstraction and recent engineering works.

Conclusions

PanGeo represent an online service that provides to all users open access to geohazard information across European towns down to a mapping scale of 1:10 000. Geohazards are natural and man-made phenomena that make the ground unstable and in a built environment can be both costly and dangerous. PanGeo’s geohazard products have been created to improve decision-making and reduce risk. PanGeo data can be viewed in Google Earth or via the integrated “portal”.

In the study there is one larger area to the west of Varna with subsidence rates >10 mm/year. Apart from this mainly local motion is observed, especially along the river and the coast. More than 3% of the identified data point falls in the range between −100 and −3.5 mm/year class. The data are available on http://www.europe-geology.eu/pangeo/.

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References


Table 1. ENVISAT ascending processing information

<table>
<thead>
<tr>
<th>Point motion statistics (mm/year classes)</th>
<th>Points in each mm/year class</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>−100.0 to −3.5</td>
<td>3409</td>
<td>3.3</td>
</tr>
<tr>
<td>−3.5 to −1.5</td>
<td>7617</td>
<td>7.4</td>
</tr>
<tr>
<td>−1.5 to 1.5</td>
<td>87 585</td>
<td>84.8</td>
</tr>
<tr>
<td>1.5 to 3.5</td>
<td>4555</td>
<td>4.4</td>
</tr>
<tr>
<td>3.5 to 100.0</td>
<td>163</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Analysis type: IPTA single reference stack
Master scene date: 2005/07/25
Number of PS identified: 103 329
Average annual motion rate of the entire processed area: −0.15 mm/year
Standard deviation of average annual motion rate: 1.77 mm/year