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Terrafirma project - monitoring of subsidence of the Upper Silesian Coal Basin

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TerraFirma is the international project to establish “a pan-European ground motion hazard information service in support of policies protecting the citizen”. Ground motion hazards include subsidence in all its forms, landslides, tectonic activity, effects of seismicity, mining activity etc. During the past two years, new ways of processing satellite radar images have been invented, that allow ground movements to be mapped and monitored with an accuracy better than 1 mm per year. This method is called Permanent Scatterer Synthetic Aperture Radar Interferometry (PSInSAR). The TerraFirma project is split into the following three stages (2, 3, 5 years). The first stage, which commenced in early 2003, was focused on formulation of the overall strategy and analysis of the various supply, demand and system requirements. With the initial direction to urban subsidence, 186 European towns representing 26% of the total population have been chosen for PSInSAR processing. Up to now so far 18 have been completed, including Sosnowiec and the surrounding area in Poland. Beginning of the Stage 2 of the project (3 years) has started in autumn 2005. Among the 168 remaining urban agglomerations another 2 localities were chosen in Poland, one in Upper Silesian Coal Basin (Southern Part) and the second in Legnica-Glogow Copper Region (LGOM) The Polish Geological Institute obtained PSInSAR processing results for the Sosnowiec area in mid-March 2004. Processing has covered 54 scenes both ERS-1 and ERS-2, registered between 1992 and 2003. Presently, the results of Sosnowiec PSInSAR are the subject of interpretation. However, it is already possible to make preliminary remarks on these data. They are as follows: The indicated subsidence values in the period from1992 to 2003 vary between -39.63 mm to +25.12 mm. These values seem improbable, because greater changes (even up to few meters) were indicated by precise leveling. These values show rather the tendencies of the slow ground

motion with a very high accuracy. There is a distinct difference between the northern (relatively stable) and southern (unstable) areas. This is probably related to the mining activity in the Upper Silesia. Mining activity in the northern area, including Sosnowiec city, practically ceased. In the southern area, the coal is still being mined. There are clearly visible linear anomalies oriented WNW-ESE formed by changing values of the ground motions. These linear anomalies correspond to structural features (faults, geological boundaries, etc.) which are parallel to the productive Carboniferous sediments forming the coal basin. Therefore, the linear anomalies could be interpreted as the surface expression of the active faults and other tectonic features. There is an evident correlation between linear negative anomalies and induced seismicity, mainly in the vicinity of the Klodnica fault. There are many punctual negative anomalies indicating subsidence, mainly in the southern part of the scene. They should be a subject of further, detailed studies and correlation. The Sosnowiec case study and examples from other 18 European cities have indicated, that the geological application of PSInSAR is a very useful tool for monitoring subsidence in relation to mining and tunneling, climate change-driven shrink-swell ground conditions, landslides, volcanic and tectonic motions, as well as for assessing localized flood risk.