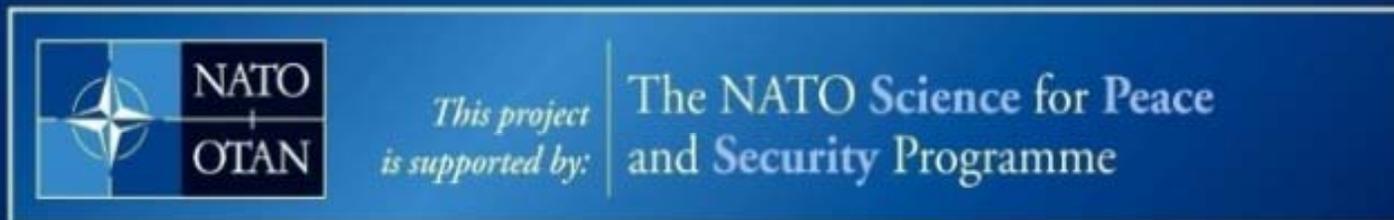


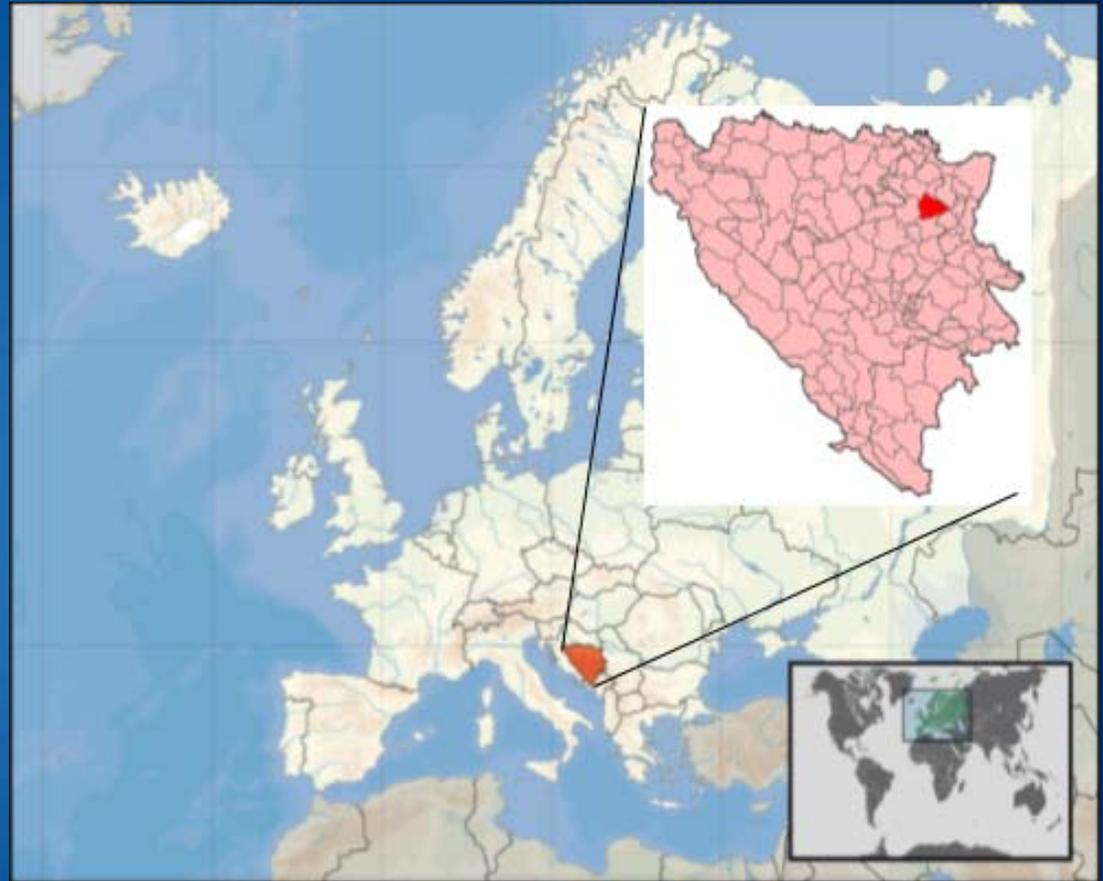
# Development of a Monitoring System to Counter-manage the Risks of Subsidence Deformation on the Population of Tuzla (Bosnia)

Project number: PDD(TC)-(ESP.EAP.SFP 983305)



# TUZLA

- Tuzla is located at  $44^{\circ}32'17''\text{N}$ ,  $18^{\circ}40'34''\text{E}$ , in the northeastern part of Bosnia
- Population: 175.000 inhabitants
- One of major urban areas in Bosnia and Herzegovina,



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# CONSEQUENCES

- Demolition of about 2700 edifices during the last 60 years
- About 15.000 people had to move



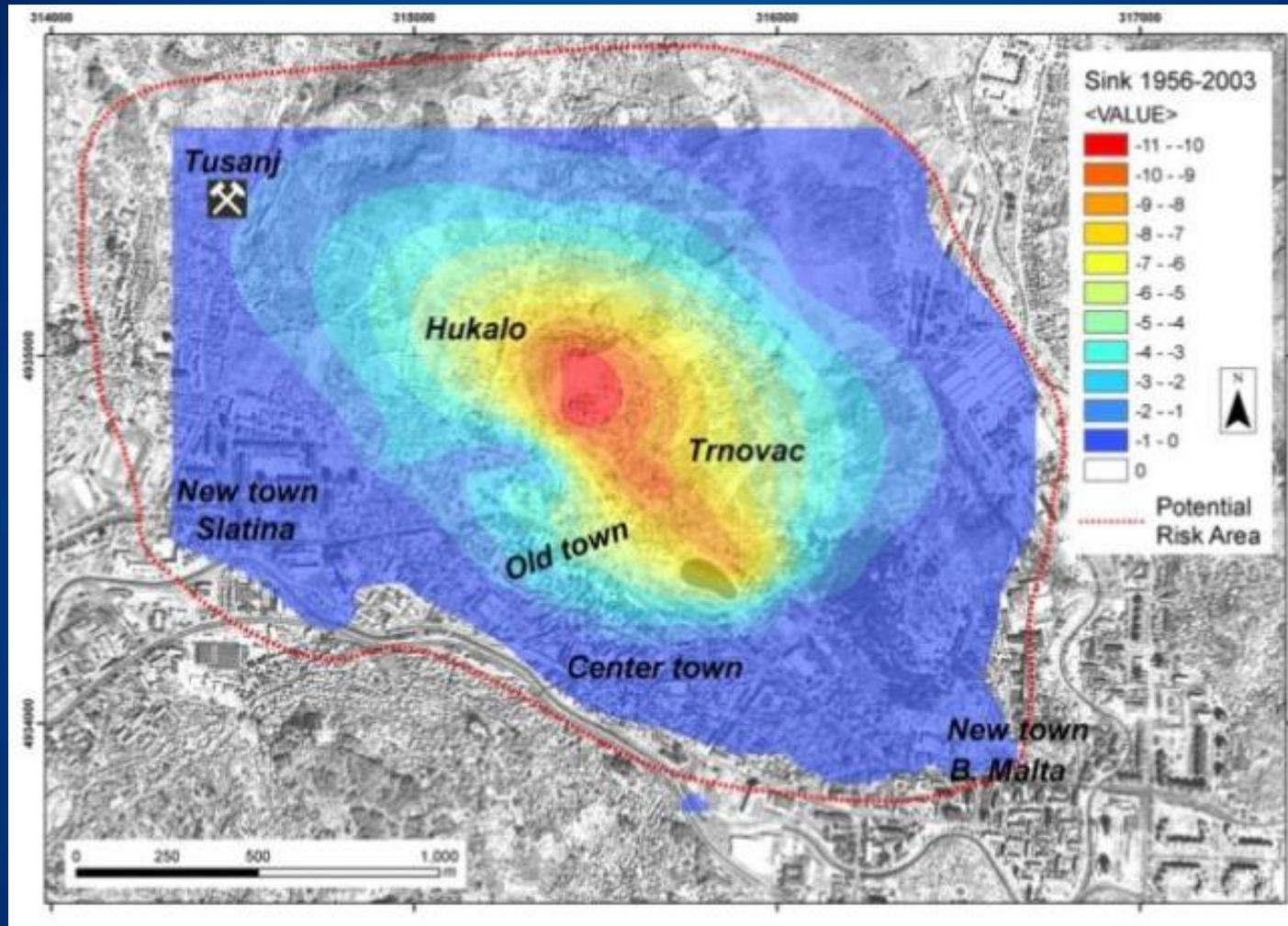
Destroyed objects  
(1956-2002)



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# AFFECTED URBAN AREA



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# PROJECT GOALS

- Knowledge and modern technologies for remediation, urbanization and urban development in destructed populated areas
- Status of investigated area,
- Compare results with historical records of previous measurements,
- Risks map,
- Basis for future measurements,
- Exchange professional experience,
- Acquire equipment and software,
- Form and train the Bosnian team,
- Define scenarios to estimate future subsidence



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# INSTITUTES AND CONTRIBUTION

- **University of Bologna**: integrating nets and more productive approaches, level of subsidence, guidelines
- **CIRSA**: GIS & WebGIS; geologic and hydro geological setting; urban, structural and tectonic deformation analysis; geochemical analysis; topographic and geodetic investigations.
- **Politecnico di Bari**: remote sensing and topographic-geodetic investigation;
- **University of Tuzla**: measurements; verification of sinkholes; control of consolidation; methods to backfill; GIS database; education.
- **Tuzla Canton**: application of (IT) instruments and models (GIS, WEBGIS, etc), urban planning and environmental survey.
- **Municipality of Tuzla**: Urban planning.



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# CHANGES IN INSTITUTION/COUNTRY

- Equipping and education for environmental research related to intensive geo-risks in urban areas.
- Scenario for solution of major environmental problem in highly populated area and urban policy development

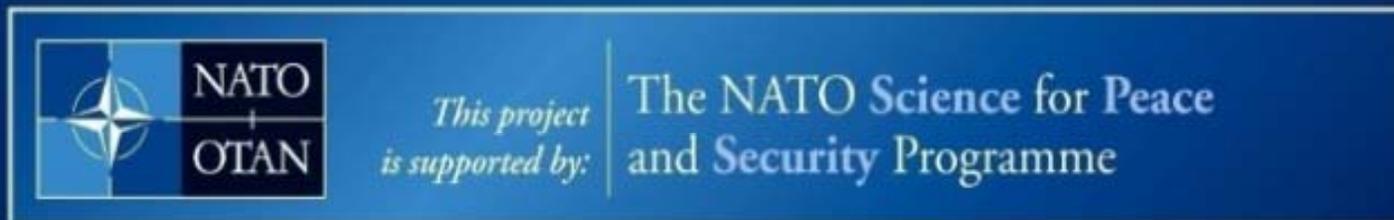


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# END-USERS AND CONTRIBUTION

- University of Tuzla: measurements, training, continuous research
- Tuzla Municipality: urban policy development and planning
- Tuzla Canton: support to urban policy development and managing of geoenvironmental risks



# SCIENTIFIC ACTIVITIES

- Analysing of the available data and GIS development, GIS modelling, GPS and DGPS
- Geophysical (radar, Seismic , electrical, tomography) Geodetic and Topographic survey
- Hydro geological measurements, monitoring and modelling
- Geochemical analyses, fluid tracing and water cycle budget analysis
- Remote sensing (Aster, Quickbird and/or Ikonos numeric images analysis)
- Determination of size, distribution and relationship between brine filled areas and permeable areas
- 2-3d Geological modelling of the surface & subsurface
- Geo environmental risk assessment and urban planning



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# DELIVERABLES

- Detailed meso and micro scale geological map and model,
- Hydro geological maps and model,
- Hazards, Risk and vulnerability maps,
- Model for identification, monitoring, recording and analyses of risk indicators,
- Spatial data and preconditions for EUREF connected GPS network,
- Recommendations for remediation, monitoring, territorial and environmental management strategy,
- Reports on international conferences and other publications,
- Books and urban policy guidelines



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# WHAT HAS BEEN DONE...

- DEMOS Project, officially started on the occasion of kick-off held in Tuzla on march 9th 2009 ([http://www.demos.ba/kickoff\\_en.htm](http://www.demos.ba/kickoff_en.htm)).
- During the first six months activities have been mainly focused on compilation and processing of existing data from Municipality of Tuzla, Canton Government, Salt Mine Company “Rudnik Soli D.D. Tuzla” and from published papers and technical reports.
- Available topographic, geologic, hydrogeologic and geotechnical data have been preliminary compared, analysed and catalogued in a preliminary GIS database, defining digital terrain models, objects and infrastructures, geological structures, borehole, ground and surface water mapping.
- Started web site dedicated to the Project ([www.demos.ba](http://www.demos.ba))



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# WHAT HAS BEEN DONE...

- **Geographic Information System (GIS) training:** 25 - 29 May 2009 held at the University of Tuzla. The whole training was accomplished in 5 days as in the approved version of the Project Plan (teacher: *Dr. Luigi Cantelli*, University of Bologna, Dept. of Earth Science, CIRSA)



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# WHAT HAS BEEN DONE...

- **Remote sensing training:** a three days long training course on Satellite Remote Sensing was carried out within the period 7-9 sept. 2009 followed by further field training and GPS survey of the ground deformation in the city of Tuzla (teacher: *Dr. Francesco Mancini*, Politecnico di Bari, Italy)



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# WHAT HAS BEEN DONE...

- **Tracer tests for aquifer management: applications and modeling: 16 – 20 November 2009**, held at the University of Tuzla. The whole training was accomplished in 5 days as in the approved version of the Project Plan (teachers: *Dr. Micol Mastrocicco and Dr. Nicolo Colombani*, Ferrara University, Italy).



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# MILESTONES for the next six months

2010



Processing of new GPS data acquired during September campaign

Processing of new elevation data available from the mining company

Geological model will be developed after the completion of geological survey

The purchasing of equipment, software and hardware will be completed as soon as possible

Geophysics surveys, ground and surface water tracing and chemical and physical boreholes water analysis will be carried out as soon as climatic conditions will be favorable

# CONTRIBUTION TO STABILITY, SECURITY, PEACE

- Environmental and territorial protection as factor of security, economical and political stability
- Specific geopolitical position and large scale of anthropogenic geo-environmental hazards in Tuzla
- Precise geological underground model using novel methods
- Complex analysis for urban development policy
- Remediation and risk management



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