Phase 3- 2016

Task	Partner involved	Final data	Expected Results
Task3.1. Development of Lithosphere-Atmosphere-Ionosphere Model for seismic hazard assessment of Vrancea tectonic active zone	**CO, P1, P3**	**23.12.2016**	**Study - Lithosphere-Atmosphere-Ionosphere Model for Vrancea zone. -Satellite and in-situ data base. -Scientific report**
Task 3.2. Development of Plate Kinematic Model for Vrancea tectonic active zone	**CO, P2, P3**	**23.12.2016**	**Study – Plate Kinematic Model for Vrancea-Crustal deformation report as support for plate Kinematic model. Geospatial, in-situ and geodetic data base for Vrancea zone.**

Results Phase 3

Phase III of VRAGEO Project targeted two distinct tasks:

a) Development of Lithosphere-Atmosphere-Ionosphere Model based on geospatial and in-situ precursors monitoring for Vrancea tectonic active zone.

b) Development of Plate Kinematic Model for Vrancea tectonic active zone.

The Carpathian bend zone and Vrancea region provides a key natural laboratory for the development of a new generation of models and concepts for ongoing orogeny and its effect on continental landscape evolution for seismic hazard assessment in Europe.
In this phase of the project was adapted and developed a coupled atmosphere-ionosphere lithosphere- model with direct application for the seismic hazard zoning in the active geotectonic Vrancea and Romania.

The development of lithosphere-atmosphere-ionosphere model was achieved by the following successive steps :a) development of new algorithms, sequential models and methods for integrated analysis of seismic, geophysical, geodynamic, geodetic, parameters as seismic precursors; b) model development and quantifying of the lithosphere-atmosphere interaction and quantifying lithosphere-atmosphere-ionosphere interaction for seismic precursors surveillance in Vrancea active geotectonic zone; c) the analysis of the applicability of the model in Vrancea seismic hazard zoning and Romania; d) monitoring and detection of preseismic crustal deformations from time-series satellite, meteorological, geodesy and in-

situ data and complement existing databases. During this phase was implemented a set of models and instruments for production explicit scenarios of spatial, geophysical / seismic / spectral / climatic changes and seismic precursors analysis followed by their subsequent integration.

The model developed in this phase of Poisson 1-D and Gauss multidimensional type of geophysical and geodynamic processes responsible for seismic Vrancea zone is a multidisciplinary complex approach designed to elucidate the nature of the the short term (days - weeks) precursors detected in the atmosphere, atmospheric electricity, ionosphere and magnetosphere in relation to major earthquakes. This model is based on the known tectonics fundamental principles according to earthquakes are the end result of the relative motion of the tectonic plates and blocks of different sizes. This model facilitates highlighting the mechanism of interaction of electromagnetic phenomena - geophysical - seismic - atmospheric - ionospheric through monitoring of seismic precursors for hazard assessment using geospatial specific techniques, validated and integrated at the same time with geophysical/geochemical and in - situ monitoring data to improve knowledge of seismic hazard and advancement knowledge on seismic precursors in relation to their geodynamic processes.

Monitoring geophysical parameters anomalies having precursory character in Vrancea area Time-series geospatial and in-situ monitoring data have been used for : a) preseismic crustal deformation with millimeters-centimeters precision order through GPS, LEVELLING network and radar satellite interferometry (TerraSAR-X,ALOS, Sentinel 1); b)geomagnetic and Ionospheric anomalies, short term or immediate seismic precursors over strong earthquakes areal expressed through Total Electron Content TEC provided by GPS permanent network stations or from real-time IPS - WDC for Solar-Terrestrial Science data; c)possible thermal surface anomalies inferred through surface latent heat flux (SLHF) and Land Surface Temperature (LST) changes from time-series satellite data in IR regions (NOAA-AVHRR, Terra/Aqua-MODIS, Landsat TM/ETM, ENVISAT, Sentinel). Was quantified long-, medium-, short- and immediate- term of geophysical parameters and radon concentration variations, sensitive to seismic events. Information derived from time-series satellite data was used in synergy with in-situ monitoring data provided by geophysical, geodetic, geodynamic, electromagnetic, solar, seismic, meteorological monitoring networks of Romania.

Another achievement in frame of this phase was the development of Plate Kinematic Model for Vrancea tectonic active zone in order to explain the physical mechanisms of seismic activity and its validation through precursor geophysical parameters derived from geospatial and in – situ data. Crustal preseismic deformation detection from GPS networks data, leveling and in-situ data was accomplished by successive steps which were: a) making observations with geodetic GNSS technology; observation sessions at least 24 hours / GNSS station receptors (2 working frequencies); c) making observations leveling with electronic and classical instruments (accuracy better than 0.7mm / Km); b) the acquisition of new GPS data, processing after each campaign measurement and estimation quality raw data and results, c) detecting crustal deformations from networks GPS data and d) ionospheric geospatial observations in Vrancea area as support model of plates kinematic.

This project is focused on relevant connexions findings between different geophysical, geochemical (radon gas), geodynamical, geomagnetic, ionospheric, atmospheric, seismic parameters and different natural hazard indicators based on time-series satellite , GPS and in-situ monitoring data as well as data provided by national seismic and geodynamic networks aiming at development of lithosphere-atmosphere-ionosphere and plates kinematic model for the detection in near-real time of seismic short term precursors associated with seismic activity assessment in Vrancea area.

Through geospatial and in-situ monitoring data aquired in frame of field data in the area of geodynamic line Tg.Secuiesc-Tulcea and GNSS/leveling observations in the area of geodynamic polygon Tulnici-Valea Sării-Vrâncioaia, as well as at seismological observatories Vrâncioaia (VRI), Ploştina (PLOR) in Vrancea area, Cheia – Muntele Roşu (MLR) and Bucharest (BUC) placed at different distances of Vrancea source was possible to be cross-validated the developed models.

Have been established the steps and procedures for geodata base update for multiparametric monitoring, surveillance and awareness from geospatial and in-situ data of seismic hazard in Vrancea area and its neibourghood.

In frame of III phase VRAGEO‘s project web page was permanently updated : http://vrageo.inoe.ro.

Have been published 9 scientific papers (2 ISI and 11 in ISI web base) and was confirmed publication of 1 ISI new paper. Was sent for ISI publication another new paper, which is under review. Have been published more 2 papers in other data bases. Have been presentd 29 papers at International and national Conferences.