Titolo della tesi
Seismological and geodetic tools synergy
for the understanding and prediction of earthquake
(specificare se sperimentale, progettuale o compilativa)
Sperimentale

Tipo di Laurea (triennale, magistrale con indirizzo)
Magistrale con indirizzo “Tutela dell’Ambiente”

Sessione di Laurea
Marzo anno accademico 2017-2018

Nome Candidato Sara Forte
Matricola 1513080

Relatore
Mattia Giovanni Crespi

Correlatore
Augusto Mazzoni

Riassunto della tesi (max 2 pagine)

Il riassunto della tesi non deve superare le due pagine e non devono essere inserite figure

This thesis work focuses on the prediction and understanding of earthquakes through the synergy of geodetic and seismological tools. The earthquake is generated by tectonic nature forces that act constantly within the Earth's crust. Italy is located in a particular geodynamic situation, at the margin of convergence between two large plates, the African one and the Eurasian one. The Italian territory is therefore frequently subject to earthquakes, giving it the primacy in Europe for these phenomena. Our attention focused especially on the Emilia earthquakes of 20th and 29th May, 2012 and the Amatrice earthquake of August 24th, 2016. Both areas, characterized by the presence of several fault segments with high structural complexity, are located in seismogenic areas close to the Apennine areas. The earthquake of Emilia in 2012 was a seismic event consisting of a series of shocks located in the Emilia Po Valley, while the area of the seismic event of Amatrice involved the whole of Central Italy. Earthquakes cannot be predicted with precision, but algorithms exist for intermediate-term middle range prediction of main shocks above a pre-assigned threshold, based on seismicity patterns. We present a further development of integration of seismological and geodetic information, based on the retrospective analysis of GPS data prior to the earthquake of 2012 in Emilia and the seismic crisis in Central Italy, which began on August 2016 with the Amatrice earthquake. Raw GPS data, associated to several GPS permanent stations, are routinely processed at INGV, which provides daily coordinates solutions and velocities estimation for each

station. In this thesis an algorithm was developed and a source code was implemented in the Python programming language, called G4UPE (Geodesy for the Understanding and Prediction of Earthquakes), which allows to analyse SINEX files (Solution INdependent EXchange) from the Analysis Center RING, managed by INGV. Differently from the much more common approach, here GPS data are not used to estimate the standard 2D velocity and strain field in the area, but to reconstruct the velocity and strain pattern along transects, which are properly oriented according to the a priori information about the known tectonic setting. It is therefore possible to make a useful monitoring of surface movements, giving the possibility to understand and to improve significantly spatial and temporal resolutions of Earth's crust deformation in the analyzed Italian area. The transects are defined within the alarmed areas, where the strongest earthquakes occurred, which in our case are precisely the area of Po Valley and Central Italy. A series of information defining the transects are inserted in the algorithm: origin (GPS station coordinates), direction (Azimuth value), length and width of the main transect. The analyses are performed considering two directions: one main and one orthogonal to this. Eventually it is possible to consider also additional transects parallel to the previous one, inserting the distance from the origin along the axis orthogonal to the main transept direction. The information is also temporally filtered, considering a minimum data processing interval of 3 years. The code is used to obtain the velocities and positions of the GPS stations within the transect reference system. The output files are: text files with information about the coordinates, velocity and standard deviation of the velocity of the GPS stations; graphs with velocity projected along the transect on the ordinate and with coordinate along the main direction of the transect on the abscissae; positions of the stations shown on the Google Earth platform. The transects through Central Italy and the transects from the Apennines to the Po Valley show, respectively: the overall tectonic extension through the central Apennines and the overall tectonic shortening that moves northwards from the Apennines to the Po Valley. For example, on the Amatrice transect graph there is an obvious variation of velocity, with an increasing trend from the Tyrrhenian coast to the Adriatic coast: we go from the minimum value of 0.0260 m/y, near Rieti, to the maximum value of 0.0305 m/y, East of Amatrice. The results obtained so far show the feasibility of earthquake forecasting based on the analysis of seismicity patterns at the intermediate-term middle-range scale.