Operational network improvements and increased reporting in the NOA (Greece) seismicity catalog

Chouliaras, G., Melis, N., Drakatos, G. and K., Makropoulos

Institute of Geodynamics - National Observatory of Athens, P.O. Box 20048, Athens, 11810 , Greece

European Geosciences Union
General Assembly 2013
Vienna | Austria | 07 – 12 April 2013

EPOS
EUROPEANPLATEOBSERVINGSYSTEM

ABSTRACT

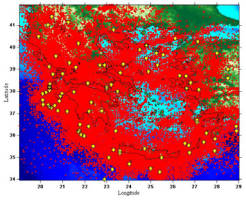
Geophysical Research Abstracts
Vol. 15, EGU2013-12634-6, 2013
EGU General Assembly 2013

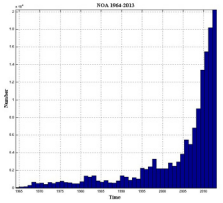
Operational network improvements and increased reporting in the NOA (Greece) seismicity catalog.

Gerasimos Chouliaras, Nikolaos Melis, Georgios Drakatos, and Konstantinos Makropoulos
Institute of Geodynamics, National Observatory of Athens, Greece (g.chou@noa.gr)

Earthquake catalogues are the basic product of seismology and of extreme importance for the assessment of seismic hazard. These data sets contain both, natural and man-made, changes. For example, seismological networks may improve their detection ability by the addition of more stations, by changing station locations for a better signal to noise condition and by improving the signal processing and analysis of seismic events. These man-made artifacts are apparent changes of the seismicity rate in earthquake catalogues and they mask the determination of real tectonic seismicity patterns.
The earthquake catalog of the Institute of Geodynamics of the National Observatory of Athens (NOA) is the most detailed data set available for the Greek area containing more than 150,000 events since 1964. During this 49 year period, many changes occurred in the processing, analysis and reporting procedures, as well as changes in the configuration and infrastructure of the seismological network, however the method of the magnitude determination remained undisturbed. In February 2011 major improvements were implemented in the standard procedure for analysis and reporting at NOA and most important was the change in the method and procedure for the earthquake magnitude determination.
In this investigation we will demonstrate the artificial seismicity increase in the earthquake catalog of NOA due to the recent improvements in the analysis and reporting. The results indicate a significant change in the magnitude of completeness of the earthquake catalog from a value of Mc~3 prior to 2011, to a value of Mc~2 after February 1st, 2011, mainly attributed to the registration of significantly larger number of events of smaller magnitudes. In order to maintain the homogeneity of the magnitudes reported throughout the NOA catalog, synthetic frequency-magnitude distributions are employed to determine the required conversion constants.

INTRODUCTION





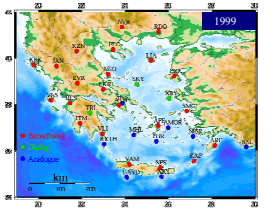
The Institute of Geodynamics of the National Observatory of Athens, Greece (**NOA**) coordinates the operation of the National seismological network.The 24/7 observatory practice and procedures, produce regular seismological bulletins and an instrumental seismicity catalog for Greece, with more than 160000 events since 1964.

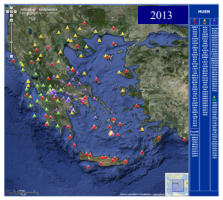
http://www.gein.noa.gr

After the destructive Athens Earthquake the seismological network has progressively increased the number of seismological stations from 18 in 1999 to more than 150 in operation today.

In addition to this, recent improvements in the seismological analysis procedures and magnitude reporting have allowed for the detection and reporting of events of smaller magnitudes.

Hellenic Unified Seismological Network



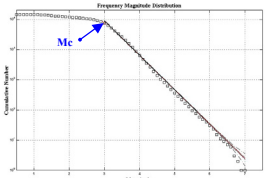


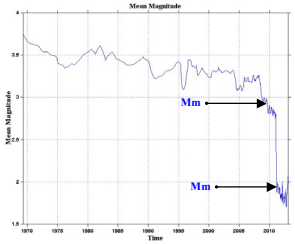
DATA ANALYSIS AND RESULTS

➢**Analysis** is performed in this study by the **ZMAP** software package.

➢The **b-value** of the frequency-magnitude distribution (FMD) determines the value of the **Magnitude of completeness** (**Mc**) for the entire seismicity catalog.

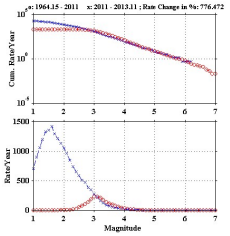
➢Temporal variations of the **Mean magnitude** (**Mm**) are observed as a result of the network improvement periods.



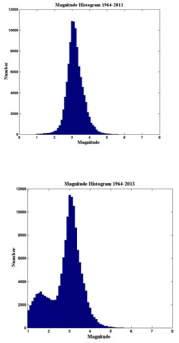


b-value (WLS) = 1.14 +/- 0.03
b-value (MLE) = 0.97 +/- 0.003

Comparison of the seismicity rates for the two periods. **Before and after 2011**.



➢In 2011, the sudden **decrease of the Mm** indicates that the improvements in the analysis and magnitude, result in the reporting of a larger number of events of **smaller magnitudes**. This is demonstrated by the results concerning the **seismicity rate increase** and also by the **shift in the FMD and the magnitude histogram.**

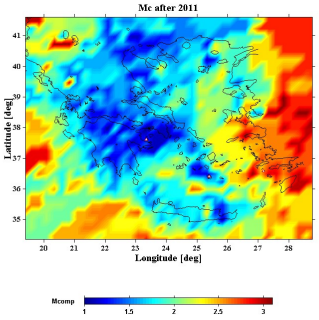


Mc map of Greece

➢**Mc** for the NOA earthquake catalog for the **recent period** (after 2011).

➢**Significant improvement in the detection** of smaller magnitude events is indicated when comparing the Mc value of the mean FMD distribution (Mc=3) before 2011, to the Mc map that shows lower values (**Mc<3**), **after 2011**.

➢The spatial configuration of the seismological network determines the variation of the Mc map. **Spatial variations of the Mc depend on the station density** of the seismological network.



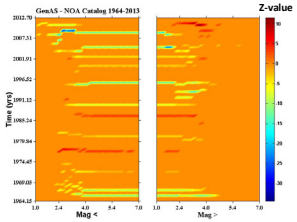
Data Analysis and Results

GENAS algorithm

➢Determines the **periods of rate increases/decreases** by comparing the mean rates between two different time periods repeatedly for the entire catalog.

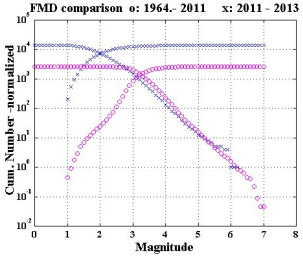
➢The resulting **z-value** indicate the **times** and the **magnitude range** of the respective rate increases (in blue) and rate decreases (in red).

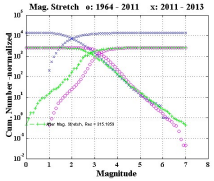
➢ The **significant 2011 rate increase** for small magnitudes (**M < 3**) is clearly demonstrated.

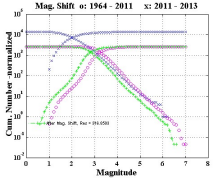


FMD Fitting Method

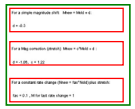
Synthetic FMD' s (green curves) **determine correction constants** for **Magnitude Shift/Stretch** and **Seismicity Rate Changes** by **comparing the foreground** (cross) **to the background** (circle), periods.







Results of the FMD fitting method. Correction constants are determined from the foreground and the background periods



CONCLUSIONS

✓**Temporal variations** of the **Mean magnitude** (**Mm**) indicate that in 2011 the sudden **decrease of the Mm** is mainly due to the **increased reporting** of a larger number of events of **smaller magnitudes**.

✓ **GENAS** determines a **significant rate increase in 2011** for small magnitudes (**M < 3**). Also demonstrated by the seismicity rate increase and the **magnitude shift** in the **FMD** and the magnitude histogram results.

✓ Mc mapping exhibits that **Mc** is **inversely proportional** to the **station density**. The **b-value** remains **unchanged**.

✓Results of the **FMD fitting method**. Determine **correction constants** for the foreground and the background periods. Artifacts and man made inhomogeneities may be identified and removed from earthquake catalogs. Importance in **earthquake hazard assessment research**.

Geophysical Research Abstracts
Vol. 15, EGU2013-12634-6, 2013
EGU General Assembly 2013

Operational network improvements and increased reporting in the NOA (Greece) seismicity catalog.

Gerasimos Chouliaras, Nikolaos Melis, Georgios Drakatos, and Konstantinos Makropoulos
Institute of Geodynamics, National Observatory of Athens, Greece (g.choul@noa.gr)

Earthquake catalogues are the basic product of seismology and of extreme importance for the assessment of seismic hazard. These data sets contain both, natural and man-made, changes. For example, seismological networks may improve their detection ability by the addition of more stations, by changing station locations for a better signal to noise condition and by improving the signal processing and analysis of seismic events. These man-made artifacts are apparent changes of the seismicity rate in earthquake catalogues and they mask the determination of real tectonic seismicity patterns.
The earthquake catalog of the Institute of Geodynamics of the National Observatory of Athens (NOA) is the most detailed data set available for the Greek area containing more than 150,000 events since 1964. During this 49 year period, many changes occurred in the processing, analysis and reporting procedures, as well as changes in the configuration and infrastructure of the seismological network, however the method of the magnitude determination remained undisturbed. In February 2011 major improvements were implemented in the standard procedure for analysis and reporting at NOA and most important was the change in the method and procedure for the earthquake magnitude determination.
In this investigation we will demonstrate the artificial seismicity increase in the earthquake catalog of NOA due to the recent improvements in the analysis and reporting. The results indicate a significant change in the magnitude of completeness of the earthquake catalog from a value of Mc$\sim$3 prior to 2011, to a value of Mc$\sim$2 after February 1st, 2011, mainly attributed to the registration of significantly larger number of events of smaller magnitudes. In order to maintain the homogeneity of the magnitudes reported throughout the NOA catalog, synthetic frequency-magnitude distributions are employed to determine the required conversion constants.