# Building an Earthquake Catalog for The Middle East

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**SUMMARY:**
During centuries earthquakes have caused many disasters all around the world including the Middle East, so they can be considered among the most ruinous and terrifying natural hazards. Nowadays we know how much a comprehensive database of the past seismic events can help us to study the frequency of earthquakes during history and clarify some proposed patterns. Reliable catalogs of earthquakes are necessary, not only for the adequate assessment of seismic hazard but also for many other seismicity studies. To fulfill this need, some efforts have been done in many regions with high potential for seismicity, during the 20th century. We tried to make a comprehensive database for Middle East earthquakes with a unified magnitude (Mw). Using the accessible source of data for earthquakes records, an instrumental catalog is provided through the steps which are briefly explained in this study. Afterward applying the Gutenberg-Richter law for later time periods we tried to evaluate the capability of this law for different time periods.

*Keywords: Middle East, Earthquake Catalog, b-value*

## 1. INTRODUCTION

The Middle East region with high range of seismicity especially in the extensive band in which the Alps and the Himalayas meet, accounts as an important area of interest for seismologists. Preparing a comprehensive database for all the past events is an effortful study regardless of the location. Considering the lake of seismic research investment in some undeveloped countries, the Middle East criteria highly needs to be studied for gathering a collection of data in the format of earthquake catalog. There are some published Historical and Instrumental earthquake catalogs for Middle East which mostly go back to Prof. N. Ambraseys efforts in The books: “A History of Persian Earthquakes” (1982), ”The seismicity of Egypt, Arabia and the Red Sea” (2005) and “Earthquakes in the Mediterranean and Middle East” (2009). There also exist some other valuable catalogs by other authors that mainly prepared in the 1980’s.

In this study our initial goal was to collect all events from available and reliable sources for a criterion which is located in a window from $22^0$N to $44^0$N and from $25^0$E to $65^0$E. We obtained a Historical catalog for events before 1900 and also an Instrumental catalog for the events after 1900. In this paper we are going to explain the process of preparing this vast amount of data.

## 2. TECTONIC FRAMWORK AND GEOGRAPHICAL BOUNDRIES

As we know the junction of three major tectonic plates of African, Eurasian and Arabian plates is placed in east of the Middle East. On the other hand the Middle East is important as a part of long seismic belt of Himalayas-Alps that starting from east of Asia and going through Indonesia, Burma, north of India, Afghanistan, Pakistan, Iran and Turkey it continues to the Mediterranean sea and ends in south west of Europe.

The geographical boundaries are adjusted on the edges of the 34 Flinn-Engdahl seismic regions The Flinn-Engdahl regions are some standard divisions that in 1995 were determined to be 754 parties for earthquakes epicentre locating purposes (J.B. Young et al 1996). In our study 37 of these 34 regions are completely considered but 10 of them have been cut by the chosen geographical window which was mentioned in the introduction. These are numbers 337, 351, 356, 359, 360, 362, 363, 365, 370 and 555, Figure 1.

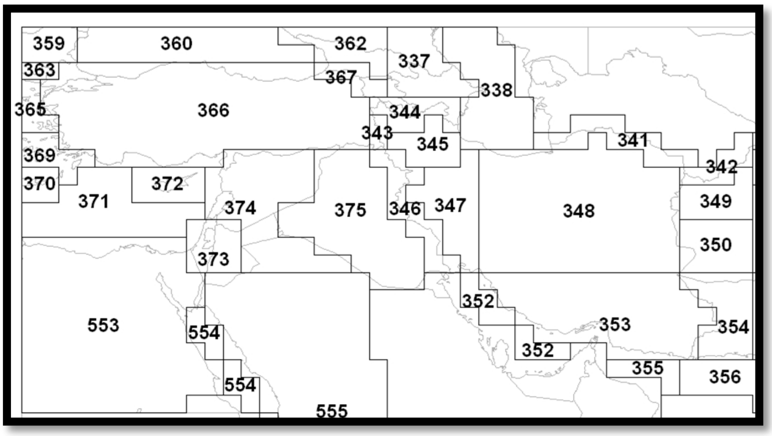


**Figure 1**. Flinn-Engdahl regions in the studied area

## 3. THE MAIN SOURCE OF DATA FOR CATALOG

The main sources in this effort include both international sources which were availible on internet, Figure 2, and regional sources.

### 3.1. International Sources

**NEIC:** We did an online search in March 2010, through rectangular area search and in two databases of USGS official website for the mentioned Middle East region. The selected databases were:

1. USGS/NEIC(PDE)(after 1973 AD)
2. Significant Worldwide Earthquake (2150 BC-1994 AD)

The result was about 50000 records for the period of time 2000 BC to March 2010 AD. There were some records without any registered magnitude or having magnitude with unknown scale. Others are given by PDE as the main source. In this catalog there also exists a column with the title “ofc” which means the official or preferred magnitude. The time scale is UTM and its reference is given using some symbols which are explained on the website.

**ISC:** First we put a condition on magnitude agency to be only ISC. This gave us more than 20000 records for the time period between 1964 and March 2008. Almost all of the records have the mb magnitude. Next time we removed the condition before start searching but after transferring the list of records into an excel file, we only selected those records whose magnitude and epicenter were given by HRVD agency. We defined the achieved list as the Harvard catalog for the Middle East. It contains about 300 records from August 1995 to August 2005 and the only magnitude scale in this catalog is Mw.

**EHB:** The result of searching on EHB bulletin which is available on the ISC website was above 6000 records from 1960 to 2007. Almost all the records after 1963 have the mb value.

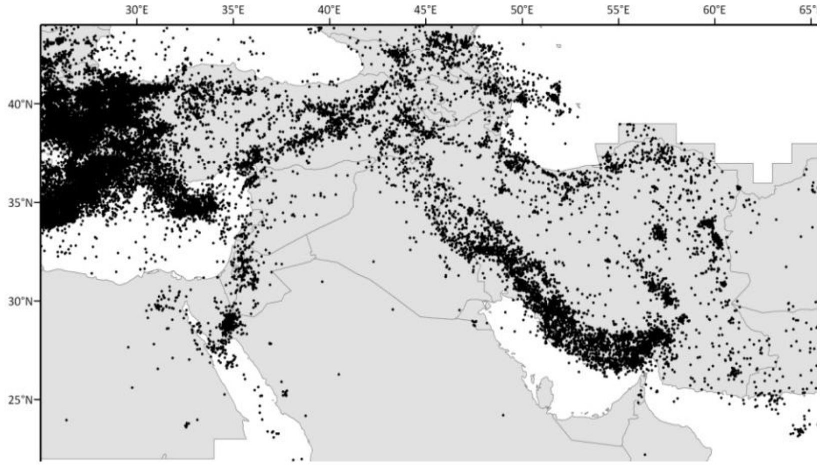


**Figure 2**. Distribution of data gathered from International Sources

### 3.2. Regional Sources (Alphabetically Presented)

**Armenia**: Armenia with a long list, including about 17400 rows which are representing events in this country and around its frontiers for a time period of March 1932 to 2008, helped the Middle East catalog. A Historical catalog of Armenia which covers the time period of 782 BC to 1931 AD and a pre-historical one from 19750 BC to 408 BC.

**Azerbaijan**: The gain information from this country is a catalog of about 600 records from 427 AD to 2009 AD. Regarding to their note they had used the data from new catalog of strong earthquake in USSR (NCUSSR) for the events up to 1975. The other source of the data is Russian Space System Cooperation (RSSC) catalog. Therefore we did not change the source name of these records in our final catalog. All the events have both Ml and Mw magnitude values.

**Georgia**: Georgia with more than 2200 records from 4 main sources and in the time period of 1250 BD and 2009 helped us. All records have both Mw and Ml. regarding to a note which was attached to the catalog file, after the determination or specification of the basic parameter of earthquakes, they presented a Historical catalog (pre-1900) and a refined Instrumental catalog (1900-2009).

**Iraq**: The only Iraqi’s data we achieved was a historical catalog with less than 100 records and it was handed by them. The source names have been kept as original in our final results.

**Iran**: Iran with 3 different sources of data improved the catalog within its area. The International Institute of Earthquake Engineering and Seismology (IIEES) by enhancing the Iranian National Seismic Network (INSN) developed a catalog for 21th century. The number of records that were obtained from IIEES online bulletin for this study was more than 7700 records from 2000 to the end of 2009.

The other organization who publish earthquake catalog for Iran is The Building and Housing Research of Iran (BHRC). This centre provide our study with both an instrumental (more than 4500 records) and historical (about 300 record) catalog of earthquakes in Iran. Iranian Seismological Center (IRSC) whose seismological network in Iran is the largest one had started to work in 1995 via Geophysical Institute of Tehran University. The online earthquake catalog of this center which has been included in our catalog has about 7500 records for the time period of 2007 to the end of 2009. For all tree mentioned catalog the name of the center is considered to be as the main source in our final result.

**Jordan**: This country has recently delivered a catalog with both historical and instrumental parts. It has totally 206 records from 31 AD to 2007 which 180 of them belongs to present time (after 1900) and the specified magnitude scale is Ms.

**Turkey**: The instrumental earthquake catalog of Turkey with about 9000 records from 1900 to 2009 has the magnitude values of mb and Mw for all and is the result of Dr. Dogan Kalafat's efforts in 2009 (A revised and extended earthquake catalog for Turkey since 1900 and with M ≥4.0). In addition to their instrumental catalog, our Turkish colleagues gave us a historical catalog of their country with about 1000 records from 2100 BC to 1899 AD. The main source of all Turkey's records is "ISK".

The table below has summarized the information about all sources of data we have collected up to 1 March 2011 for building our catalogs.

## 4. BUILDING THE CATALOG WITH ACHIVED DATA

### 4.1. Unifying the format of the list of data

The first step was to determine one specialized format for Instrumental catalog and one for Historical catalog. The second step was to merge all data (those that were not listed in two types of instrumental and historical catalogs) in one general format. This general format was a table with 33 columns to keep all types of information (magnitude types, references, symbols, accuracies and etc.) from different catalog we had.
After this step it became easy to eliminate the records which were out of the selected criteria. Therefore we could separate the historical records (before 1900) from the contemporary records (after 1900) and bring them into the unified historical format as above meanwhile we merged them with ready historical catalogs. After doing this process we had to filter data once again to be sure that all data we obtained were located inside the determined Middle East region. The result was a historical catalog for the time period of 19750 BC to 1899 It has to be noticed that about a quarter of this number are not representing any value as their magnitude or intensity and meanwhile there also exist some records with less information, we kept all in our historical catalog.
The remained part of the comprehensive list with the mentioned general format was a collection of all data for the last 110 years (from 1900). Then we had to prepare an acceptable unified instrumental catalog for the Middle East.

We determined the Flinn-Engdahl region of all records. This can help us with dividing the earthquakes in terms of their location and is useful for different purposes. Eliminating about 12,000 records with no reported magnitude value was the next step. Most of them were belong to the PDE reference and this reduced the number of records to about 127,000.

Determining the desirable range for the magnitude was done regarding to this point that we intended to prepare an earthquake catalog with the moment magnitude ≥ 4. Therefore before doing the magnitude conversion for calculating the moment magnitude for all records some low intensity earthquakes were eliminated. The cases below were eliminated from our list of data regarding to the discussions by Kanamori (1982) and Scordilis (2006) about the relations between different magnitude scales.

- All records with Ml < 4 and Mw < 4 if they have no other type of magnitude.
- All records with Ms < 2 if they have no other type of magnitude. (The surface wave magnitude around 2.7 is almost equal to the moment magnitude 4)
- All records with mb < 3.4 if they have no other type of magnitude.( Scordilis showed that the moment magnitude 4 is approximately equal with the mb= 3.5)

Then the number of records was dropped to about 86,000. Running the Remove Duplicate command by selecting the parameters; date, hour, minutes, latitude, longitude and Mw caused this number to fall just below 85,000. This was because of the fact that many sources usually report some earthquakes from a same reference with no change in the values. For example many of ISC records were reported by Iranian catalogs and also Turkish catalog.

At this level the magnitude conversions became essential for the next steps. Therefore we started to study the relation between different scales.

**4.2. Conversion relation between mb and Mw**

A relation was derived from those records that had both mb and Mw. Comparison with what was obtained by Scordilis in 2006 for the correlation of about 39,000 global records from NEIC and ISC (1965-2003) made us to believe in the correlation between mb and Mw in our catalog's records and use it for further conversions instead of any other formula from other authors. For mb > 6 we did not use this relation any more. This manner is mostly because of the fact that mb is calculating from the maximum amplitude in of short period records in first 5 seconds while for strong earthquakes this maximum amplitude happens after 5 seconds. Therefore we have to study the correlations between ML or Ms and Mw.

$$Mw = 0.874\, mb + 0.828 \qquad 3.5 \le mb \le 6.0 \qquad (1)$$

$$R^2 = 0.880 \qquad n = 16752$$

**4.3. Conversion relation between Ms and Mw**

For determining Mw from Ms a relation was derived from those records that had both Ms and Mw. Same as the decision we made for the case of relation between mb and Mw, due to the comparison we made with Scordilis results (2006) for the correlation of about 26,000 global records from NEIC and ISC with depth ≤ 70 Km (1978-2003) in this case we also used the formula that was obtained from the internal correlation between Ms and Mw. This correlation shows a dual behavior with the turning point on about Ms = 6.1, therefore we are facing with two formulas. (Note: in our case the depth of the events is not considered)

$$Mw = 0.663\, Ms + 2.118 \qquad 2.8 \le Ms \le 6.1 \qquad (2)$$

$$R^2 = 0.942 \qquad n = 4123$$

$$Mw = 0.931\, Ms + 0.449 \qquad 6.2 \le Ms \le 8.2 \qquad (3)$$

$$R^2 = 0.880 \qquad n = 129$$

**4.4. Conversion relation between Ml and Mw**

There were about 1600 records in Box7 with Ml value between 4 and 6.2. As we know many authors have studied the correlation between Ml and Mw but their ideas do not converge, partly due to the different effective magnification of Wood-Anderson Seismographs and distance corrections. As Scordilis (2006) says it is not possible to define unique global relations connecting Ml to Mw or to other magnitude scales. Therefore we could only trust the internal correlation which exists in about 2000 records with both Mw and Ml. The divergence or distribution of the points is minimum and the $R^2 = 0.98$ is also convincing to pick up this relation at this stage.

$$Mw = 1.014\, Ml - 0.050 \qquad 4.0 \le Ml \le 8.3 \qquad (4)$$

$$R^2 = 0.980 \qquad n = 2271$$

**5. THE GUTENBERG RICHTER DIAGRAM**

First we can take a look on the diagram which explains the number of earthquakes with magnitude Mw for each Mw and for last 110 years in the Middle East. Neglecting the deficiency and lake of data for some parts and non uniform distribution of real data and records, it shows a good correlation and with $R^2$=0.98. Figure 3 shows the number of events with magnitude of Mw.

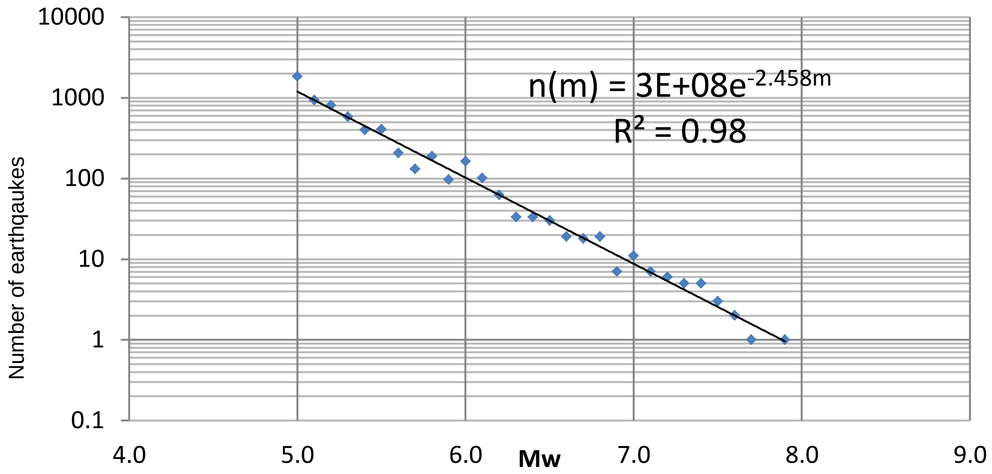


**Figure 3**. Correlation of Mw and the number of records with magnitude=Mw

The Gutenberg Richter relation for the achieved set of data was obtained as below:

$$Log(N(m)) = -1.19(m) + 9.84 \quad (5)$$

Where N(m) is the number of records with magnitude ≥ m. This relation is shown in Figure 4.

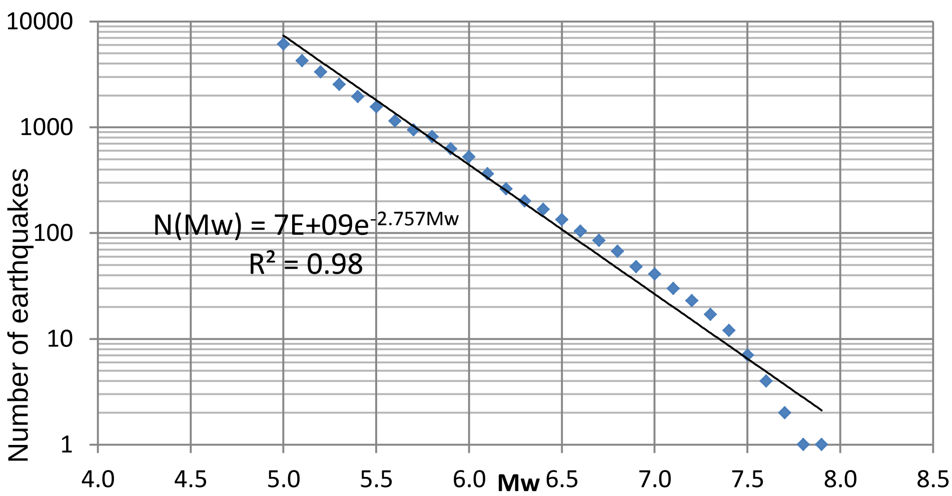


**Figure 4**. Correlation of Mw and the number of records with magnitude ≥Mw

We have also tried to study the Gutenberg Richter relation for smaller scale in time to have a better understanding of the quality of data distribution in the obtained catalog. Table 1 shows the number of instrumental data in 10 years time periods to clarify the time distribution of records. The primer conclusion was made by looking at the number of earthquake with magnitude 5 which was doubled in 1970s in comparison with 1960s and remained around 400 until 2000s and that was; the distribution of data from 70s has been improved. Therefore we re-count the number of records for smaller time windows of five year and from 1970 which has been shown in table 2.

**Table 1**. Time distribution of Instrumental records through 10 years periods

| **1900-1959 (60 years)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mw | Number of M=Mw | Number of M≥Mw | Mw | Number of M=Mw | Number of M≥Mw | Mw | Number of M=Mw | Number of M≥Mw |
| 5 | 49 | **1133** | 6 | 57 | **210** | 7 | 6 | **19** |
| 5.1 | 65 | 1084 | 6.1 | 31 | 153 | 7.1 | 2 | 13 |
| 5.2 | 155 | 1019 | 6.2 | 29 | 122 | 7.2 | 3 | 11 |
| 5.3 | 179 | 864 | 6.3 | 15 | 93 | 7.3 | 3 | 8 |
| 5.4 | 110 | 685 | 6.4 | 12 | 78 | 7.4 | 1 | 5 |
| 5.5 | 121 | 575 | 6.5 | 18 | 66 | 7.5 | 1 | 4 |
| 5.6 | 78 | 454 | 6.6 | 6 | 48 | 7.6 | 1 | 3 |
| 5.7 | 35 | 376 | 6.7 | 10 | 42 | 7.7 | 1 | 2 |
| 5.8 | 101 | 341 | 6.8 | 11 | 32 | 7.8 | | 1 |
| 5.9 | 30 | 240 | 6.9 | 2 | 21 | 7.9 | 1 | 1 |
| Total | 923 | | Total | 191 | | Total | 19 | |
| **1960-1969 (10 years)** | | | | | | | | |
| 5 | 223 | **829** | 6 | 28 | **68** | 7 | | **3** |
| 5.1 | 149 | 606 | 6.1 | 12 | 40 | 7.1 | 2 | 3 |
| 5.2 | 122 | 457 | 6.2 | 9 | 28 | 7.2 | | 1 |
| 5.3 | 81 | 335 | 6.3 | | 19 | 7.3 | | 1 |
| 5.4 | 52 | 254 | 6.4 | 2 | 19 | 7.4 | | 1 |
| 5.5 | 57 | 202 | 6.5 | 3 | 17 | 7.5 | 1 | 1 |
| 5.6 | 20 | 145 | 6.6 | 4 | 14 | 7.6 | | |
| 5.7 | 19 | 125 | 6.7 | 2 | 10 | 7.7 | | |
| 5.8 | 23 | 106 | 6.8 | 4 | 8 | 7.8 | | |
| 5.9 | 15 | 83 | 6.9 | 1 | 4 | 7.9 | | |
| Total | 761 | | Total | 65 | | Total | 3 | |
| **1970-1979 (10 years)** | | | | | | | | |
| 5 | 412 | **1076** | 6 | 14 | **43** | 7 | 2 | **4** |
| 5.1 | 177 | 664 | 6.1 | 15 | 29 | 7.1 | 1 | 2 |
| 5.2 | 158 | 487 | 6.2 | 2 | 14 | 7.2 | | 1 |
| 5.3 | 101 | 329 | 6.3 | 4 | 12 | 7.3 | | 1 |
| 5.4 | 63 | 228 | 6.4 | 2 | 8 | 7.4 | 1 | 1 |
| 5.5 | 63 | 165 | 6.5 | | 6 | 7.5 | | |
| 5.6 | 20 | 102 | 6.6 | | 6 | 7.6 | | |
| 5.7 | 17 | 82 | 6.7 | 2 | 6 | 7.7 | | |
| 5.8 | 10 | 65 | 6.8 | | 4 | 7.8 | | |
| 5.9 | 12 | 55 | 6.9 | | 4 | 7.9 | | |
| Total | 1033 | | Total | 39 | | Total | 4 | |
| **1980-1989 (10 years)** | | | | | | | | |
| 5 | 385 | **983** | 6 | 12 | **46** | 7 | 1 | **5** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5.1 | 174 | 598 | 6.1 | 12 | 34 | 7.1 | 1 | 4 |
| 5.2 | 126 | 424 | 6.2 | 6 | 22 | 7.2 | | 3 |
| 5.3 | 76 | 298 | 6.3 | 1 | 16 | 7.3 | 1 | 3 |
| 5.4 | 51 | 222 | 6.4 | 3 | 15 | 7.4 | 2 | 2 |
| 5.5 | 58 | 171 | 6.5 | 2 | 12 | 7.5 | | |
| 5.6 | 28 | 113 | 6.6 | 2 | 10 | 7.6 | | |
| 5.7 | 18 | 85 | 6.7 | | 8 | 7.7 | | |
| 5.8 | 14 | 67 | 6.8 | 1 | 8 | 7.8 | | |
| 5.9 | 7 | 53 | 6.9 | 2 | 7 | 7.9 | | |
| Total | 937 | | Total | 41 | | Total | 5 | |
| **1990-1999 (10 years)** | | | | | | | | |
| 5 | 376 | **1036** | 6 | 17 | **77** | 7 | 2 | **8** |
| 5.1 | 178 | 660 | 6.1 | 18 | 60 | 7.1 | 1 | 6 |
| 5.2 | 119 | 482 | 6.2 | 6 | 42 | 7.2 | 3 | 5 |
| 5.3 | 68 | 363 | 6.3 | 8 | 36 | 7.3 | | 2 |
| 5.4 | 65 | 295 | 6.4 | 8 | 28 | 7.4 | 1 | 2 |
| 5.5 | 62 | 230 | 6.5 | 2 | 20 | 7.5 | 1 | 1 |
| 5.6 | 30 | 168 | 6.6 | 4 | 18 | 7.6 | | |
| 5.7 | 20 | 138 | 6.7 | 2 | 14 | 7.7 | | |
| 5.8 | 19 | 118 | 6.8 | 2 | 12 | 7.8 | | |
| 5.9 | 22 | 99 | 6.9 | 2 | 10 | 7.9 | | |
| Total | 959 | | Total | 69 | | Total | 8 | |
| **2000-2010 (11 years)** | | | | | | | | |
| 5 | 391 | **1045** | 6 | 35 | **82** | 7 | | **2** |
| 5.1 | 186 | 654 | 6.1 | 13 | 47 | 7.1 | | 2 |
| 5.2 | 127 | 468 | 6.2 | 10 | 34 | 7.2 | | 2 |
| 5.3 | 74 | 341 | 6.3 | 5 | 24 | 7.3 | 1 | 2 |
| 5.4 | 58 | 267 | 6.4 | 6 | 19 | 7.4 | | 1 |
| 5.5 | 43 | 209 | 6.5 | 5 | 13 | 7.5 | | 1 |
| 5.6 | 29 | 166 | 6.6 | 3 | 8 | 7.6 | 1 | 1 |
| 5.7 | 22 | 137 | 6.7 | 2 | 5 | 7.7 | | |
| 5.8 | 22 | 115 | 6.8 | 1 | 3 | 7.8 | | |
| 5.9 | 11 | 93 | 6.9 | | 2 | 7.9 | | |
| Total | 963 | | Total | 80 | | Total | 2 | |

**Table 2**. Time distribution of Instrumental records from 1970 and through 5 years periods

| Mw | 1970 - 1974 | # | 1975 - 1979 | # | 1980 - 1984 | # | 1985 - 1989 | # | 1990 - 1994 | # | 1995 - 1999 | # | 2000 - 2004 | # | 2005 - 2009 | # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.0 | 178 | 473 | 234 | 603 | 191 | 496 | 194 | 487 | 224 | 591 | 152 | 445 | 142 | 396 | 242 | 622 |
| 5.1 | 65 | 295 | 112 | 369 | 88 | 305 | 86 | 293 | 102 | 367 | 76 | 293 | 54 | 254 | 125 | 380 |
| 5.2 | 81 | 230 | 77 | 257 | 60 | 217 | 66 | 207 | 68 | 265 | 51 | 217 | 54 | 200 | 70 | 255 |
| 5.3 | 58 | 149 | 43 | 180 | 37 | 157 | 39 | 141 | 37 | 197 | 31 | 166 | 24 | 146 | 45 | 185 |
| 5.4 | 26 | 91 | 37 | 137 | 29 | 120 | 22 | 102 | 30 | 160 | 35 | 135 | 26 | 122 | 30 | 140 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.5 | 33 | 65 | 30 | 100 | 34 | 91 | 24 | 80 | 37 | 130 | 25 | 100 | 21 | 96 | 22 | 110 |
| 5.6 | 7 | 32 | 13 | 70 | 13 | 57 | 15 | 56 | 18 | 93 | 12 | 75 | 15 | 75 | 13 | 88 |
| 5.7 | 7 | 25 | 10 | 57 | 7 | 44 | 11 | 41 | 8 | 75 | 12 | 63 | 9 | 60 | 12 | 75 |
| 5.8 | 2 | 18 | 8 | 47 | 8 | 37 | 6 | 30 | 12 | 67 | 7 | 51 | 7 | 51 | 15 | 63 |
| 5.9 | 5 | 16 | 7 | 39 | 3 | 29 | 4 | 24 | 9 | 55 | 13 | 44 | 3 | 44 | 8 | 48 |
| 6.0 | 3 | 11 | 11 | 32 | 6 | 26 | 6 | 20 | 11 | 46 | 6 | 31 | 18 | 41 | 17 | 40 |
| 6.1 | 4 | 8 | 11 | 21 | 6 | 20 | 6 | 14 | 15 | 35 | 3 | 25 | 4 | 23 | 8 | 23 |
| 6.2 | | 4 | 2 | 10 | 3 | 14 | 3 | 8 | 2 | 20 | 4 | 22 | 6 | 19 | 4 | 15 |
| 6.3 | 2 | 4 | 2 | 8 | 1 | 11 | | 5 | 6 | 18 | 2 | 18 | 4 | 13 | 1 | 11 |
| 6.4 | 1 | 2 | 1 | 6 | 2 | 10 | 1 | 5 | 2 | 12 | 6 | 16 | 1 | 9 | 5 | 10 |
| 6.5 | | 1 | | 5 | 1 | 8 | 1 | 4 | | 10 | 2 | 10 | 4 | 8 | 1 | 5 |
| 6.6 | | 1 | | 5 | 2 | 7 | | 3 | 2 | 10 | 2 | 8 | 1 | 4 | 2 | 4 |
| 6.7 | | 1 | 2 | 5 | | 5 | | 3 | 2 | 8 | | 6 | 1 | 3 | 1 | 2 |
| 6.8 | | 1 | | 3 | | 5 | 1 | 3 | 1 | 6 | 1 | 6 | 1 | 2 | | 1 |
| 6.9 | | 1 | | 3 | 2 | 5 | | 2 | 2 | 5 | | 5 | | 1 | | 1 |
| 7.0 | 1 | 1 | 1 | 3 | | 3 | 1 | 2 | 2 | 3 | | 5 | | 1 | | 1 |
| 7.1 | | | 1 | 2 | 1 | 3 | | 1 | | 1 | 1 | 5 | | 1 | | 1 |
| 7.2 | | | | 1 | | 2 | | 1 | | 1 | 3 | 4 | | 1 | | 1 |
| 7.3 | | | | 1 | 1 | 2 | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| 7.4 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | | 1 |
| 7.5 | | | | | | | | | | | 1 | 1 | | | | 1 |
| 7.6 | | | | | | | | | | | | | | | 1 | 1 |
| 7.7 | | | | | | | | | | | | | | | | |
| 7.8 | | | | | | | | | | | | | | | | |
| 7.9 | | | | | | | | | | | | | | | | |

Considering the mentioned time periods we calculated the b-Values using Gutenberg Richter low and the result was obtained as below. The Gutenberg Richter relation for the period between 1975 and 2010 (which due to the Figure 5 seems more proper for further studies on earthquake parameter for the Middle East) was obtained with $R^2$=0.984.

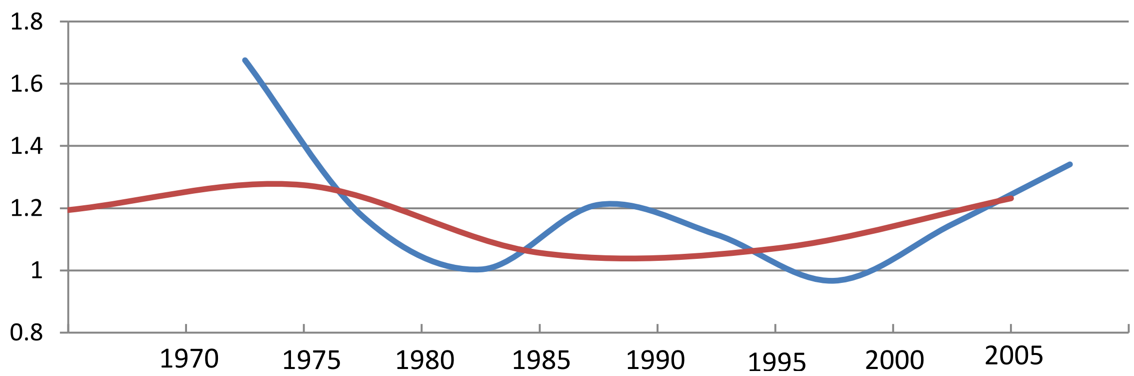


**Figure 5**. b-Value change, the curve started from 1965 belongs to the 10 years periods calculation and the other one belongs to the five years periods study.

$$N(m) = 2(10^9)e^{-2.713\,(m)} \quad (6)$$

$$LogN(m) = 9.3 - 1.17\,m \quad (7)$$

As an example and base on above relation the return period of the earthquakes with magnitude between 6 and 6.1 will be 1.36 which means one earthquake each year and 3 month in the Middle East. But in table 2 we can see than in 35 years we had 128 earthquakes with magnitude between 6 and 6.1. The main reason for this difference is that the Middle East consists of variety of tectonic conditions and seismic behaviour. For example the Arabia peninsula is not an active seismic area in comparison with the Anatolian region in Turkey. This makes us to understand we need to study the seismic parameter of the Middle East not also in shorter time scale but in smaller location scale.

## 5. CONCLUSION

Preparing an earthquake catalog for the Middle East beside all difficulties specially in collecting too many records in one unified list of data has been reached to an acceptable point for being practical in further works and researches on statistical behavior of earthquakes. Now we have developed an Instrumental catalog including all accessible events with $M_w \geq 4$ and a Historical catalog which can be more completed and more developed in the future. After bringing all data together and be up to date the study of the earthquake happening pattern will be easier if we have a good view of their distribution in possession


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