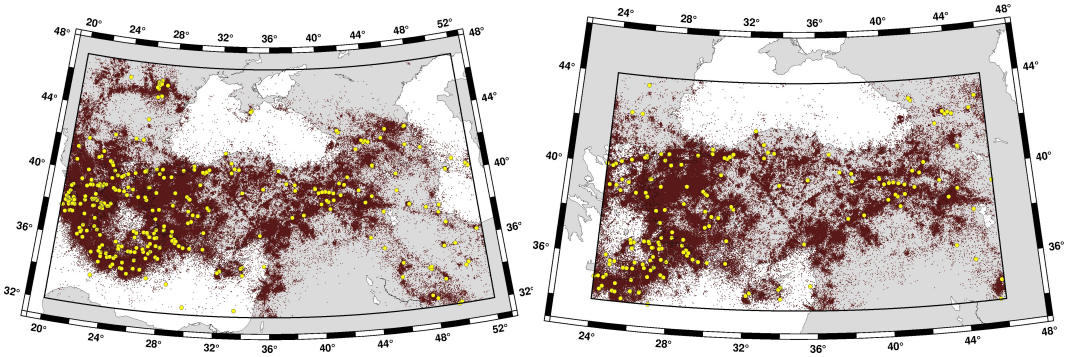
Response to the Referee #2
for
"A Homogeneous Earthquake Catalogue for Turkey ~~and Surrounding Region~~"
by Onur Tan

General

First, I want to thank to all referees for their vulnerable comments. I revised the database and manuscript (MS) according to their comments.

The main revisions:

- The title was changed: "A Homogeneous Earthquake Catalogue for Turkey"
- The catalogue area was reduced according to the common comments: 34°-44° N 24°-46° E



Previous area Revised area

- The events in the period of Jan-Oct 2018 were included because ISC updated the database.
- Mw* = 0.0 events were removed from the database.
- The database was reanalysed.
- All numerical outputs, tables, and figures were updated

Response to Referee #2

on the manuscript "A Homogeneous Earthquake Catalogue for Turkey and Surrounding Region" by Onur Tan, submitted for publication to "Natural Hazards and Earth System Sciences".

The manuscript is presenting a new earthquake catalog expanding over the period 1900-2017 and covering a very wide region bounded by the coordinates 32° - 47° N, 20° - 52° E.

The compilation of the catalog is based on records of already published earthquake bulletins of international seismological data providers as well as of regional national agencies of Turkey and surrounding countries. There is a special treatment by the author regarding the magnitudes issue in an effort to offer reliable values expressed in the moment magnitude scale. For this reason, five new converting relations are proposed, correlating magnitudes expressed in widely used scales with the moment magnitude scale.

Finally, the magnitude of completeness of the catalog is defined, as well as its variation in space and with time.

Accurate catalogs, with reliable focal parameters (epicenters, focal depths), homogenized regarding the magnitude, are valuable tools, especially for studies regarding seismic hazard assessment. Therefore, the

topic of the manuscript is of interest to the readers of the journal. However, in my opinion, there are serious handicaps, which I describe in the following sectors.

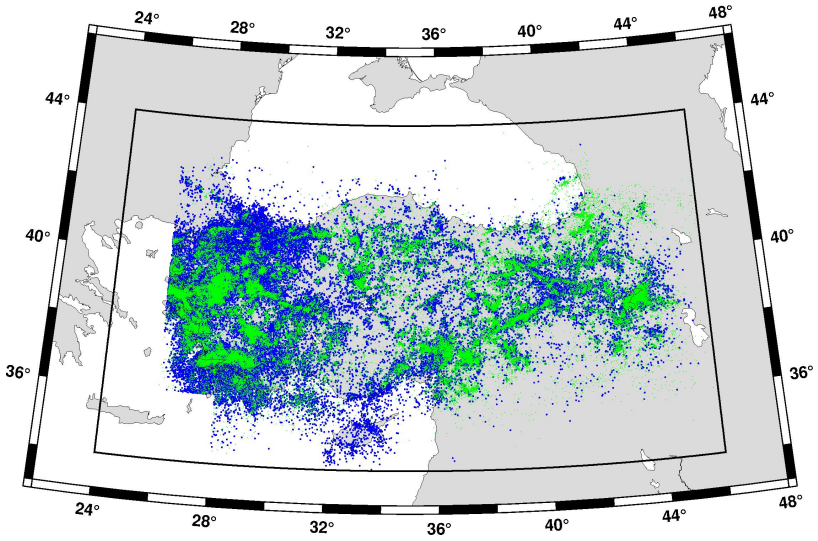
Thank you for your thoughts.

In general:

It is not clear which is the procedure followed by the author to adopt the epicenter coordinates and the focal depths for each event of the catalog. Why for earthquakes occurred far away from Turkey the solutions of Turkish seismological centers are considered as more reliable than solutions offered by regional centers operating close to the epicentral area?

A location procedure was not applied in this study. I used the revised ISC database in 2020. The sentences at the end of the first paragraph of Section 2 were rewritten and the location procedure reference was cited.

The Turkish seismology agencies (ISK and DDA) do not locate the events in far away from Turkey because the neighbouring countries are out of the networks. Rarely, moderate events in the neighbouring countries are reported by them. Out of the international agencies, e.g. the events in Greece and Bulgaria are reported by Obs. of Athens and Sofia National Institute of Geophysics, respectively. The selection algorithm used in this study (flowchart in Fig. 2) is checking the location (see the map below). If an event far away from the Turkish border is reported by ISK or DDA, the hypocentre parameters of both agencies are omitted and data of the local agencies is selected.



The events located by KOERI (blue) and DDA/AFAD (green) in the homogenised catalogue.

On the other hand, as mentioned in the General section above, the study area was restricted (34°-44° N 24°-46° E).

Furthermore, there is an extensive description regarding the magnitude homogenization procedure. However, this procedure is not quite clear. Is the finally adopted magnitude coming after a single magnitude conversion following the hierarchy described in the manuscript? Is it a mean value of all available converted magnitudes? Is it a weighted mean?

The averaged values are for the reported magnitudes. For example, if there are six reported ML values for an event, their arithmetic mean is calculated without weighting.

The sentences are re-written for clarity as below. The flowchart in Fig. 2 is also updated.

After determining the event origin parameters in the selected area, the magnitude data sub-block is analysed by the magnitude parser. The reported values of different magnitude scales given in Table 1 are collected. If there are two or more values for a magnitude scale, the arithmetic mean and median of all reported values are calculated. Selecting a magnitude value from a particular institute such as KOERI, Harvard, and EMSC is not preferred to overcome the problems such as unreported magnitude, the effect of network distribution, and calculation errors.

In addition, there are problems in the quality control of the catalog. Figures 7 and 8 are contradicting each other as in the first one the cut-off magnitude (completeness magnitude) is Mc=2.9 (it is not clear if it corresponds to the period 1964-2017 or 1900- 2017) while in the second one, and before ~1995, the Mc is clearly greater than 3.0.

The Mc in Fig 7 was calculated for the events in the large area from1964 to 2017. In the first version of the MS, I used the Mc=2.9 value as a cut-off value in the spatial distribution of the Mc. Therefore, minimum Mc in the map is about 3.

Thank you for this valuable comment.

In the revised version, I did not use a cut-off for the spatial distribution calculation.

After adding new events in Jan-Oct 2018, I re-calculated the b-value and Mc for the period of 1964-2018. Fig 7 and 8 were updated.

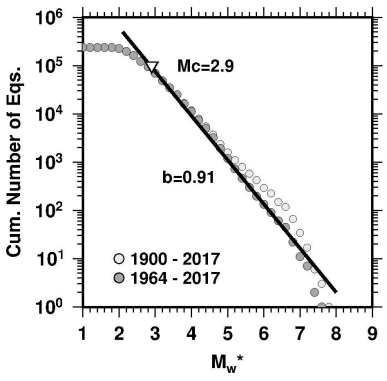


Fig 7 – previous

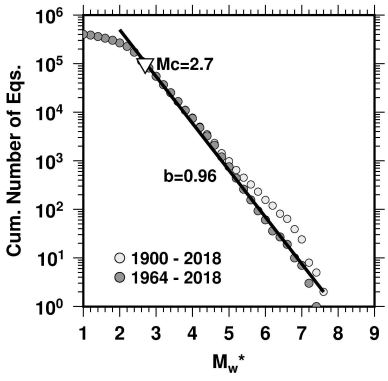


Fig 7 - updated

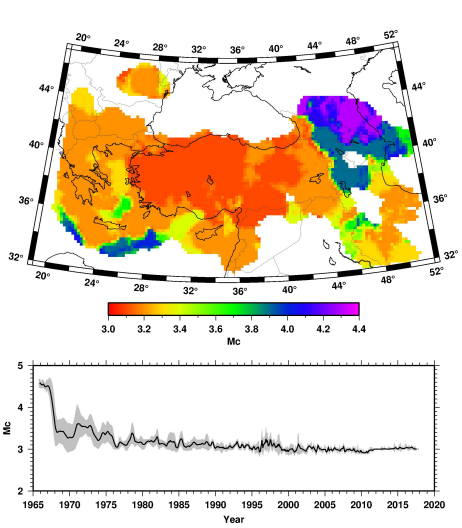


Fig 8 – previous

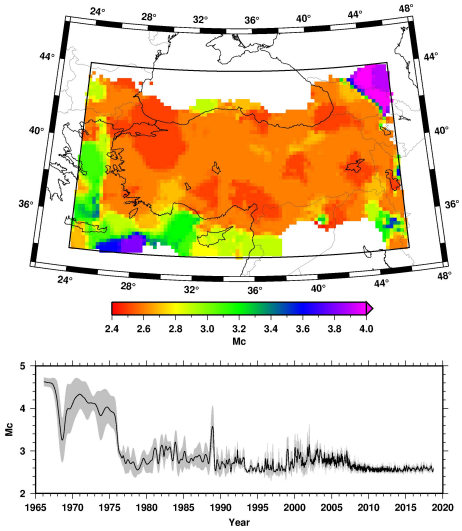


Fig 8 - updated

Finally, the on-line part of the catalog is not representative at all. There are not enough cases of recent earthquakes with more than one available magnitudes in order to test the effectiveness of the process followed by the author.

Because of the open system of the journal, I do not prefer the upload the full version of the catalogue.

In details:

1) Although English is not my mother tongue, I would say that English throughout the manuscript is quite poor. Bad English made it difficult (and in some cases impossible) for me to understand certain parts of the manuscript. I recommend the author to check and correct the manuscript in order to make it more understandable to the reviewers and/or to the readers.

The MS was checked for grammatical errors. The mistakes were corrected.

2) The region under study is so wide that is far away from been characterized as "Turkey and surrounding region".

The catalogue area was restricted and all outputs were updated.

3) In this wide region shallow as well as intermediate depth earthquakes occur. It is well known that their records differ significantly from each other, meaning that there is no way the same converting relations to be applicable for both. There is no mention in the manuscript of any particular procedure followed for intermediate depth events.

In the revised catalogue, the intermediate depths are mostly excluded from the catalogue by narrowing the study area. The high percentage of the events is in Turkey. Therefore, additional conversion equations for different depth intervals are not defined.

4) Line 32: What do you mean "then they are averaged"? There are several magnitude estimations reported for each event and expressed in different magnitude scales. How these values have been "averaged"?

This part was re-written as given above.

5) Is there any special treatment for events reported as "explosions" or "mining activities" or, in general, for artificial events?

No. The magnitudes of artificial seismic events are not larger than M_L 1.5-2.0 in Turkey. KOERI and DAD/AFAD identify explosions and do not include earthquake catalogue since 2005. However, the blasts in the earlier years are questionable. For example, KOERI reports blasts in a different catalogue. In this study, the events with an explosion flag in the ISC bulletin are not selected.

If there is a real blast that is not identified in the ISC Bulletin, it is eliminated before the regression because of the Mc-threshold.

I added the sentence below to Section 3.1.

"Using a threshold helps eliminate a possible blast (M < 2.0-2.5) before the regression."

6) Line 105: For such a wide area, the process of final selection of focal parameters for adoption is rather delicate and, in any case, is not sufficiently explained in the text. For example, why solutions from Turkish seismological centers should be preferred for earthquakes occurred in distant regions such as Adriatic, Romania etc. instead of solutions of Italian or Romanian institutes?

As I mentioned above the parameters of an event in the neighbouring country are obtained from the international (i.e. ISC, EMSC) or the local agencies (i.e Obs. of Athens).

7) Line 107: "The other institutes are used for the lfocal events around Turkey". This is contradicting with the previous reference.

The sentence was re-written.

8) Line 113 – Figure 2: I am confused. In the text, you mention, "if there are two or more values for each type, average with standard deviation and median are calculated". What do you mean? If there are more than one magnitude values reported in the same scale, what you have done? Have you calculated their mean value? If this is the case then, how do you know how these magnitude values correlate to each other?

For example, if there are 4 M_L values for an event, the average and median of them calculated. The sentence is re-written as follow:

> *After determining the event origin parameters in the selected area, the magnitude data sub-block is analysed by the magnitude parser. The reported values of different magnitude scales given in Table 1 are collected. If there are two or more values for a magnitude scale, the arithmetic mean and median of all reported values are calculated. Selecting a magnitude value from a particular institute such as KOERI, Harvard, and EMSC is not preferred to overcome the problems such as unreported magnitude, the effect of network distribution, and calculation errors.*

9) Line 132: It looks that ISC bulletins were used as the source of Mw values. However, ISC does not estimate moment magnitudes, instead, it includes in its bulletins moment magnitudes from other available sources, such as GCMT (former HRVD), NEIC etc. Have you checked their consistency to each other? There are also reports of seismic moment values in reliable catalogs (e.g. Pacheco and Sykes, 1992; Engdahl and Villasenor, 2002; etc.). Have you used them to enrich the available moment magnitudes in your catalog?

Yes, it is true that the ISC does not determine Mw for an event. The institutions' Mw estimations and their consistencies are not the scopes of this study. Whether two (or more) Mw (or other scales) values are consistency or not for an event, they are reported and are in the international databases. If the values are close, their standard deviations are small in the homogenised catalogue (column #40). The std.dev. show the consistency.

I do not prefer to use printed papers in this study. For a standard database and format, the ISC Bulletin is preferred.

10) I strongly disagree with including in the catalog earthquakes with no magnitudes. Usually such earthquakes are not strong enough to give reliable recordings that are necessary for a robust estimation of focus and/or magnitude. In such a case, their focal parameters could be questionable, contaminating the final product.

I agree with the referee.

The events with no magnitudes are excluded from the catalogue.

11) Figure 4: Searching the ISC data-base for the period 1900-2017 and for the region that you have used I found 22,970 mb values reported by ISC and a total of 33,607 reported by ISC & NEIC. The respective numbers of Ms values were 4,557 & 12,716. Even though these numbers do not agree with the respective ones in the histograms of figure 4, it is more likely that you have also used magnitudes other

than ISC. Have you checked their compatibility to each other (i.e. mbISC/mbNEIC and MsISC/MsNEIC) before considering them as a priori equivalent?

Of course, I used the all reported, e.g. mb values for an event. Not only ISC & NEIC but also EMSC and national observatories in the region. As I mentioned in the manuscript, I averaged all values for each scale. Here is an example:

```
Event  1768311 Turkey
   Date       Time        Err   RMS Latitude Longitude  Smaj  Smin  Az Depth   Err Ndef Nsta Gap  mdist  Mdist Qual   Author      OrigID
2000/11/07 21:13:58.49   0.70 1.461  39.4287   26.2702 4.007 3.863  32  10.0f        77   69  24   0.18  23.57 m i se ISC       4370817
 (#PRIME)

 Magnitude
 Err Nsta Author      OrigID
 Mb      3.6          NAO         3610951
 mb      4.0        3 NEIC        4036975
 MD      3.9          ISK         4036975
 ML      3.4          THE         4036975
 ML      4.0          ATH         4036975
 MD      3.8          ISK         3041816
 MD      4.0       12 ATH         4015830
 ML      4.0          ATH         4015830
 ML      3.7          THE         3860907
```

The average mb value comes from the reports of NOA and NEIC. The ML is from THE and ATH. There is no way to analyse multiple reports from an institution. Therefore, averaging is a good way to assign one mb and ML value to the event.

12) Line 162: What is the reason to check each magnitude scale's completeness in a catalog? The completeness check has a meaning if it is performed in a homogenized (with respect to magnitudes) earthquake catalog in an effort to reveal its quality characteristics.

I used Mc of each magnitude scale to obtain more reliable data set for conversion equations. It is also a good tool to exclude possible blasts.

13) Line163:What do you mean "averaged magnitudes"? How can there be averaged magnitudes for each scale (!) and for each earthquake? It is not comprehensive what exactly is that you have done. Please, clarify.

The average magnitude calculation is mentioned in Section 2.

For example, all M_L values and all Mw values of an event are averaged because there is no way to construct a reliable relation for individual values. To obtain a single M_L and Mw pair for each event, the average value is the best way according to my opinion.

14) Line 201: This difference is expected, since ML starts underestimating for magnitudes over ~6.0 and undergoes saturation for values over ~6.5 (e.g. Heaton et al., 1986). It has also been shown that Ms exhibits rather bilinear behavior becoming equivalent to Mw for Ms>6.0 (e.g. Heaton eat al., 1986; Scordilis, 2006). Such a behavior is also visible in the graph of figure 5. You should take it into account.

I try to give a single equation for each conversion for simplicity. The recent dataset in Fig5 show a linear relation between MS and Mw. On the other hand, bilinear behaviour is in the uncertainty interval.

15) Line 214: What do you mean by "priority saturation order"? Which was the procedure applied when there were more than one converted magnitude values available? Have you adopted the converted Mw value following the hierarchy of table 1? Have you used a mean value of all converted magnitudes? A weighted mean value? You must be clear about that.*

I need only a one conversion equation for Mw* calculation. Otherwise, different Mw* values can be calculated for an event. This is an ambiguity for the users. The best tool is the saturation of magnitude scales. The sentence below was added to Section 3.3 for clarity.

For example, if an event has only average Ms and ML values, Ms is selected for Mw calculation.*

Some one also calculate Mw* using other scales because the catalogue has all values. The catalogue gives a flexible usage.

16) Lines 228-229: Fig 5a and fig 5b must be renamed to Fig 6a and Fig 6b, respectively.

It is corrected.

17) Line250:What do you mean by the term "pre-instrumental period (1900-1964)"? The term is completely inappropriate. There were installed seismographs during this period in the study region. The same expression is also met in the caption of figure 7.

The terms are corrected.

"pre-instrumental period (1900-1964)" is changed to "*the period from 1900 to 1964*"

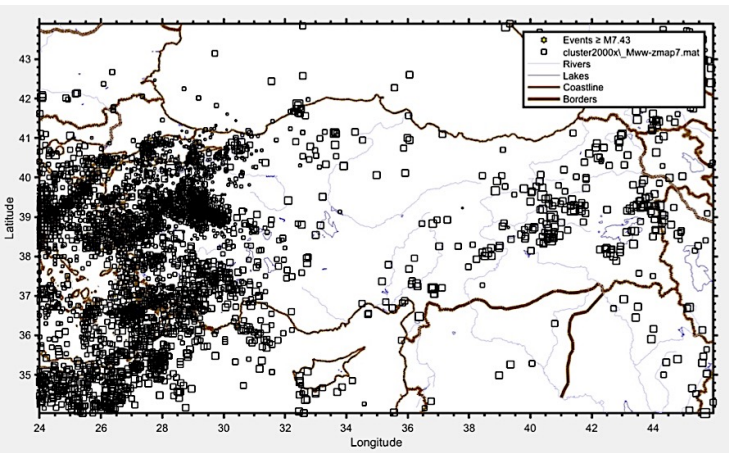
"*The modern instrumental period ...*" is used for the period since 1964.

18) In Figure8b it is obvious that the value Mc=2.9 for the magnitude of completeness does not hold for the whole period. I would say that it could be considered Mc=3.0 since 1995 or Mc=3.1 since 1978 and, maybe, Mc=3.4-3.5 since ~1968. So two maps should replace the map of figure 8: one for the period 1968-1978 and the second for 1978-2017. Relative adjustments are also needed for figure 7.

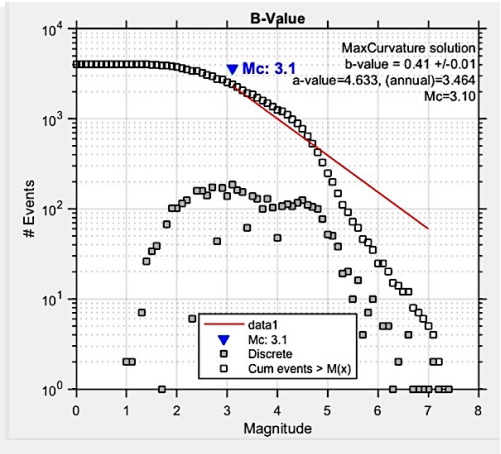
Because the study area is narrowed, all graphs are changed.

I think that the maps for different periods give similar information with Fig8b.

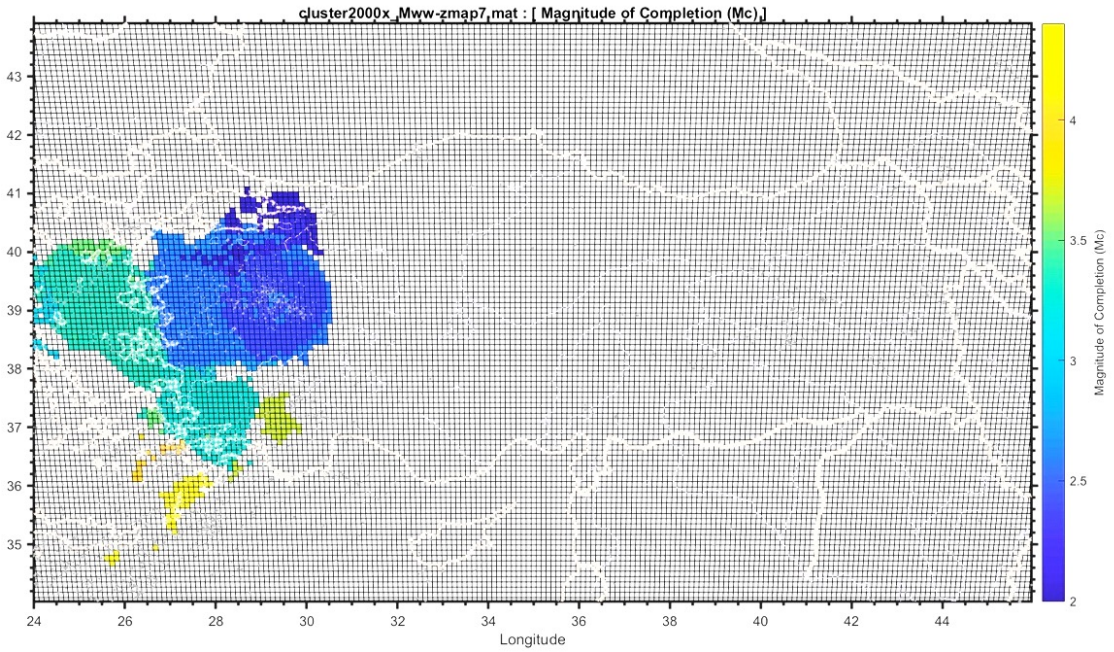
Mc distribution in the study area between 1964 and 1978 is given below. Because there are few located events in the area, Mc calculation at each grid is not accurate.



Earthquakes (1964-1978)



G-R plot



Mc map for the years 1964-1978. There is no enough data for b-value and Mc analyses.

19) I believe that the sample of 500 events with 480 events overlapping (moving step of 20 events) forms a very strong filter, which "hides" temporal changes of Mc values (Fig 8b).
20) Line277:The change in detect ability of networks after the 1999 Izmit earthquake is not visible, probably due to the strong filtering that has been applied in sampling.

Thank you for these comments (#19-20).

I changed the parameters. I used 200 events with 40-event-step. It is much more appropriate. Now it is clearly seen that the network improvement since 2007.

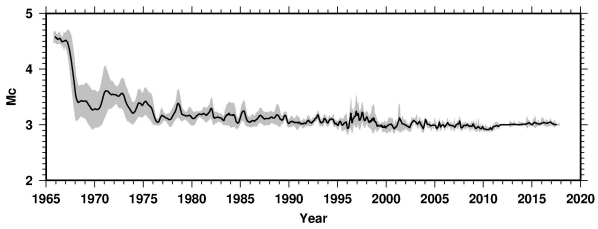


Fig 8b – previous

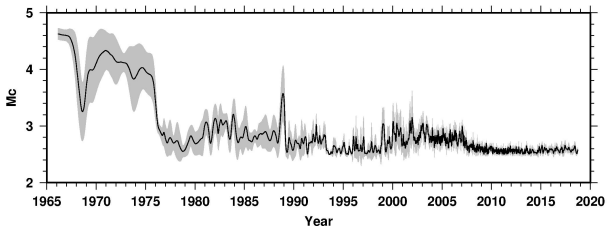


Fig 8b - updated

21) In my opinion, the first paragraph of "Discussion" is not needed at all. I suggest you delete it.

The first paragraph is introduction information for the later discussion. I think that it is better to hold the paragraph.

22) Line 325: "On the other hand, a truncated final earthquake list using a magnitude threshold is not useful for the researchers who not familiar details of earthquake catalogues and want to analyse or map whole instrumental period seismic activity in a region". I disagree. Researchers less familiar with data could be misled by using earthquake catalogs with non-complete data. In my opinion, completeness of

data must be considered as a prerequisite for a published catalog. However, incomplete data could be included in the catalog, provided they do not have zero magnitudes (equivalent to Mw).

The zero-magnitude events are excluded from the catalogue.

The catalogue is not only for seismic hazard studies. For example, a geologist wants to plot a seismicity map for a region in Turkey. He/she may want to see small events in the region. He/she can truncate the data to plot bigger events.

23) AppendixA: It looks that well-known published catalogs, global and regional, have not been considered (e.g. Papazachos and Papazachou, 1997, 2003; Pacheco and Sykes, 1992; Karnik, 1996; Engdahl and Villaseñor, 2002 etc.). They are not even mentioned in the manuscript.

Only the ISC bulletin is considered for a standard data procedure. The printed event lists are not suitable for the used process in this study.

24) Line 411: Correct reference Galton... 1896 to Galton... 1869.

It is corrected.

25) Appendix B: In column 2 replace "Mount" with "Month"

It is corrected.