# On a potential relationship between climate change and seismic activity of Earth, explained by a general model

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**Abstract**. The scope of this paper is to investigate a potential relationship between the melting of icecap caused by the global warming and the seismic activity of Earth. The first step is the analysis of seismic activity data of the last decades, in order to establish if there is an ascending trend in the frequency or magnitude of the earthquakes, or to see whether this data exhibits certain features which could indicate a certain change in the pattern of the seismic activity of Earth. If there is an ascending trend in the seismic activity, the correlation with the amount of the melted icecap (expressed in both: square kilometers and tons) is to be further analyzed. If however, there is no such ascending trend but still, the data shows certain changes in its pattern, these changes will be analyzed and explained using the model proposed and presented in this paper. This general basic model describes and explains how reduction of pressure exerted by the melted icecap leads to a redistribution of gravity pressing forces on the earth's crust and releases additional movement forces of the tectonic plates, thus causing an increased seismic activity.

**Keywords**. Climate change, seismic activity, earthquakes, earth's crust, gravity pressing forces

## 1. Introduction

There are numerous implications of the climate change and respectively of global warming caused by the economic activity of man. Some of these consequences as in [1], are already well known and they refer to extreme weather conditions, increase of the radiation on the Earth's surface where icecap has been melted thus causing increased further melting of ice, rising of the level of oceans, viruses and pathogens frozen in the icecap released and becoming active, etc.

This paper is presenting another potential additional consequence of the climate change, by investigating the relationshipbetween the seismic activity and the global warming causing melting of the polar icecaps.

According to a previous paper of the author, many of these so called "natural" disaster are actually "manmade" disasters, as it is presented in paper [2]. The present paper investigating the relationship between the climate change and the seismic activity of Earth, also accounts a great portion of the seismic activity to those aforementioned "manmade" disasters.

## 2. Methodology

The first step is the analysis of seismic activity data of the last decades, in order to establish if there is an ascending trend in the frequency or magnitude of the earthquakes, or to see whether this data

exhibits certain features which could indicate a certain change in the pattern of the seismic activity of Earth. If there is an ascending trend in the seismic activity, the correlation with the amount of the melted icecap (expressed in both: square kilometers and tons) is to be further analyzed. If however, there is no such ascending trend but still, the data shows certain changes in its pattern, these changes will be analyzed and explained using the model proposed and presented in this paper. This general basic model describes and explains how reduction of pressure exerted by the melted icecap leads to a redistribution of gravity pressing forces on the earth's crust and releases additional movement forces of the tectonic plates, thus causing an increased seismic activity.

*2.1 Analysis of seismic activity data*

This section regards the quantitative analysis of the seismic activity data, namely frequency and magnitude of deadliest earthquakes by year in the last decades, according to [3],in order to establish if there is an ascending trend in the frequency or magnitude of the earthquakes, or to see whether this data exhibits certain features which could indicate a certain change in the pattern of the seismic activity of Earth. If there is an ascending trend in the seismic activity, the correlation with the amount of the melted icecap (expressed in both: square kilometers and tons) is to be further analyzed.

The tables below present this seismic activity data, per each decade between 1950 and 2020, as follows: Table 1 contains the number of earthquakes of magnitude greater than 7, Table 2 presents the number of major earthquakes per each decade, Table 3 presents the cumulated or aggregated magnitude of earthquakes per each decade and Table 4 contains the number of earthquakes of magnitude greater than 8.

**Table 1.** Number of earthquakes of magnitude greater than 7

| Decade | Number of earthquakes of magnitude greater than 7 |
|---|---|
| 1951/1960 | 4 |
| 1961/1970 | 5 |
| 1971/1980 | 7 |
| 1981/1990 | 4 |
| 1991/2000 | 4 |
| 2001/2010 | 8 |
| 2011/2020 | 7 |

**Table 2.** Number of major earthquakes per decade

| Decade | Number of major earthquakes per decade |
|---|---|
| 1951/1960 | 10 |
| 1961/1970 | 10 |

| | |
|---|---|
| 1971/1980 | 10 |
| 1981/1990 | 10 |
| 1991/2000 | 10 |
| 2001/2010 | 10 |
| 2011/2020 | 10 |

**Table 3.** Cumulated or aggregated magnitude of earthquakes per each decade

| Decade | Cumulated or aggregated magnitude of earthquakes per each decade |
|---|---|
| 1951/1960 | 69.80 |
| 1961/1970 | 70.90 |
| 1971/1980 | 72.90 |
| 1981/1990 | 73.10 |
| 1991/2000 | 70.60 |
| 2001/2010 | 81.15 |
| 2011/2020 | 73.20 |

**Table 4.**Number of earthquakes of magnitude greater than 8

| Decade | Number of earthquakes of magnitude greater than 8 |
|---|---|
| 1951/1960 | 1 |
| 1961/1970 | 1 |
| 1971/1980 | 10 |
| 1981/1990 | 1 |
| 1991/2000 | 1* |
| 2001/2010 | 3 |
| 2011/2020 | 1 |

(* 7.9 magnitude earthquake in Indonesia in 2000 also considered)

It is obvious that the data presented in the previous tables does not show any clear ascending trend of the seismic activity of Earth, however still there are some important considerations to be made regarding this data presented.

Although the earthquake data does not show, at a first glance, an increase of the seismic activity in the last past 70 years, Table 1 Number of earthquakes of magnitude greater than 7, Table 3 Cumulated or aggregated magnitude of earthquakes per each decade and Table 4 Number of earthquakes of magnitude greater than 8, exhibit the very same feature, namely they suggest, at a closer look, two important things: an increased seismic activity around 1980's followed by a decrease of this activity and an increased seismic activityin the last 20 years, at a higher level than the previous one.

One possible logical explanation, explanation which will be completed with the model in the next section, is that the balance of forces corresponding to the tectonic plates has been altered and afterwards, following to the movement of the tectonic plates on other positions has been restored for a further period of time.

One can observe that although there is no clear trend in the data presented, especially the data processed in the Table 4, show that there are actually some rather significant changes in the evolution of the seismic activity. According to this table, there is an increased incurred seismic activity in the 80's and 90's, caused by additional movement of the tectonic plates, followed by its decrease, potentially caused by the repositioning of the tectonic plates in other positions of equilibrium.

In the decade 2001/2010 there is recorded a maximal aggregated magnitude of 81.15, and moreover, two consecutive earthquakes of magnitude 8, have also been for the first time recorded. The very same repositioning of the tectonic plates and the subsequent de-tensioning of the tectonic forces has been taken place in the next decade at a higher level than the previous ones, namely at an aggregated level of 73.2 magnitude. As one can see in the Table 3, this cumulated magnitude of 73.2 is higher than any previous aggregated magnitude recorded in the period 1951/2000.

These changes and this periodic oscillation of the seismic activity are to be explained by the model of redistribution of gravity pressing forces on the earth's crust, as presented in the next section of this paper.

### *2.2 The general basic model of icecap melting to explain the increased seismic activity*

The earthquake data was analyzed based on the recordings of the deadliest earthquakes by year in [3] and following this analysisthere is no clear ascending trend.Still, this data shows changes in its patternas previously commented and presented in the tables above. These changes will be additionally analyzed and explained now, using the model proposed and presented in this section.

This general basic model describes and explains how reduction of pressure exerted by the melted icecap leads to a redistribution of gravity pressing forces on the earth's crust and releases additional movement forces of the tectonic plates, thus causing an increased seismic activity. This model is only meant to generate an image of the consequences of the climate change.

#### *2.2.1 Assumptions used in the general basic model of icecap melting*

The assumptions this general basic model is based upon in order to explain the increased seismic activity, are the following:

1. Almost uniform and symmetric distribution of the icecap around the Earth's poles
2. Approximate amounts of the yearly decrease of the icecap in tons
3. Approximate amounts of yearly decrease of the icecap in square kilometers
4. Actual position of the tectonic plates is not taken into consideration
5. The redistribution of weights due to the transformation of the ice from the icecap in ocean water is not to be considered
6. The centrifugal force of due to Earth rotation is not taken into consideration
7. Additional forces and other influences (such as activity of the magma or Earth core, etc.) are also not considered in this general model.

This model is only meant to present the general idea, on which a more complete and complex model could be built.

### *2.2.2 Assumptions to be used in the complex model of icecap melting*

This more complex model should take into consideration as much data as possible, data which can contribute to a much better accuracy of the model generated.

Much of the data necessary to generate this complex model is either not published online or it has not been made available, since it is generated by sophisticated and costly instruments and equipment, as, for example, in the case of [4] and [5], and hence cannot be freely made available on internet. A great deal of this data which is actually not available on Internet, because of the higher costs related to this data, being either costs incurred due to the value of equipment involved in the gathering of this data, or costs with the scientists and researchers using this latest equipment and pieces of technology, could be used, if available, to generate this complex model presented**.** The assumptions this complex model is based upon,to explain the increased seismic activity, are the following:

1. The exact curvature (radius) of Earth is to be taken into consideration
2. The exact detailed distribution of the amounts of ice in the polar icecaps are to be considered in terms of both, surface and thickness
3. The exact amounts, in terms of quantity and position, of the yearly decrease of the icecaps in tons, are to be considered
4. The exact amounts, in terms of surface and position, of the yearly decrease of the polar icecaps in square kilometers, are to be considered
5. The precise positions of the tectonic plates and their inherent movement and movement forces are to be taken into consideration
6. The centrifugal force due to Earth's rotation is to be considered
7. The redistribution of weights and of their corresponding gravity pressing forces on earth's crust, due to the transformation of the ice from the icecap in ocean water, is to be considered
8. As much as possible all the other forces and influences, such as activity of the magma or Earth core, etc., are to be considered

### *2.2.3 The general basic model of icecap melting explained*

Let us now consider two different moments in time, noted in this general model with (1) and (2). The weights, surfaces and thicknesses of the polar icecap, corresponding to those moments are G1, G2, S1, S2, respectively h1 and h2.

Taking into account the assumptions of the general basic model, presented above, the gravity pressing force exerted on the earth's crust at the moment (1) is p1=G1/S1, whereas at the moment (2) is p2=G2/S2. One can easily understand that the pressing forces at the moment (2) have seriously decreased.

On one hand, at the moment (2), on the surface previously occupied with ice which was freed by the ice melted, the pressure exerted on the earth's crust is now zero, whereas, on the surface which is still occupied with ice, the pressure exerted on the earth's crust has also diminished (p2 < p1), due to the decrease of the thickness of ice from h1 to h2 and hence due to the decrease of the weight exerted on square km, as well.

In order to understand the magnitude of this phenomenon, one can see the data presented by NASA in its websites: [6], [7], [8], [9] and [10].

It is also to be mentionedthat, only in 2022 alone, the surface freed from ice melted was of about 400.000 square kilometers, surface which is almost double as compared to Romania's surface.

This basic simplified model presented before is only meant to generate a general idea about the serious implications of the global warming. Taking into account that both, frequency and intensity of earthquakes, have not significantly increased until now, this fact is only due to the periodical repositioning of the tectonic plates and the subsequent de-tensioning and readjustment of the tectonic forces, forces periodically increasing and decreasing by redistribution of the gravity pressing forces, as explained before, by this model.

## 3. Results and discussion

Although there is no clear ascending trend in the seismic data recorded in the last decades, still this data indicates that there is highly likely that the actual pattern of the recorded seismic data may actually prove both, the model and the main hypothesis of this paper, namely that there is a relationship between the climate change and the seismic activity of Earth.

Both, the statistical analysis and the general model presented, as well, have no claim to be exhaustive. A complete analysis of the seismic activity should also consider the number of earthquakes' replicas and their magnitude too, and the complex model based on the general one presented in the paper should also consider much more factors to be taken into consideration.

The movement of tectonic plates corresponding to the model presented in this paper could also represent an explanation for the occurrence of earthquakes in areas where seismic activity has not been long time recorded before, such as the area of Oltenia in Romania, where recently significant seismic activity has been recorded.

However, since both of this data, corresponding to the seismic activity and the additional data for generating the complex model are not freely available on Internet, at this stage, one cannot go much deeper into the analysis presented in this paper.

Furthermore, two different hypotheses related to the model presented in this paper are possible. The first one is assuming that the seismic activity will continue as presented before and corresponding to data recorded so far, that is to say, there will be permanent periodical oscillations in the seismic activity caused by the redistribution of forces and the readjustment of the tectonic plates.Still, according to this first hypothesis, the average or aggregated magnitudes will permanently slightly increase in time, meaning that the balance point of the seismic activity will take place at increasingly higher magnitudes, that is to say at greater seismic activity levels.

The second hypothesis regards a muchgloomier and more pessimistic scenario and is assuming that there will be a tipping point in future, due to the redistribution of gravity pressing forces on the earth's crust because of the great amount of ice melted, and assumes that after this tipping point, the seismic activity will exponentially increase, thus causing disastrous cataclysmic seismic events.

## 4. Conclusions

According to the research and findings in this paper, it is very likely that there is a potential relationship between climate change and an increased seismic activity of Earth.

Hence the conclusion is that the model used in this paper to describe and explain how the reduction of pressure due to the melting of polar icecap causes additional forces due to the redistribution of pressing gravity forces, thus moving the tectonic plates and causing increased seismic activity may be a valid one.

However, at this moment, the model presented in this paper can neither be definitely approved nor categorically disproved by the seismic data recorded so far. Unfortunately enough, this model may only be proven using the remaining data until 2040. In 2040, when according to actual predictions it is supposed that almost all polar icecap will melt, if the theory in this paper will be confirmed, perhaps it may be too late for actions with regard to both, the consequences of the climate change and the outcomes predicted by this paper, corresponding to either of the two main effect hypotheses of this model.

**Acknowledgement**

Many thanks to Constanta Maritime University for the financial support offered, by paying the fee for the publication of this paper, out of the research funds of the institution.

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