

NATURAL HAZARDS IN BULGARIA AND MALDIVES

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Abstract: *A comparative study of the natural hazards in Bulgaria and Maldives is performed. Both countries are located in a completely different geodynamic environment and show completely different threats due to the natural disasters. The target of such investigations is to create a common methodology to be used in such cases of huge differences of the origin and sources of hazards and their use to decrease and mitigate the negative consequences of the disasters in different environment to the society.*

ПРИРОДНИ ОПАСНОСТИ В БЪЛГАРИЯ И НА МАЛДИВИТЕ

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Резюме: *Извършено е сравнително изследване на природните бедствия в България и Малдивите. И двете страни се намират в напълно различна геодинамична среда и показват напълно различни заплахи поради природните бедствия. Целта на такива изследвания е да се създаде обща методология, която да се използва в такива случаи на огромни различия в произхода и източниците на опасности и тяхното използване за намаляване и смекчаване на негативните последици от бедствията в различна среда за полза на обществото.*

Introduction

A very complicated situation about the natural hazards acting on the territories of Bulgaria and Maldives is dominated by the typology, origin and negative consequences expected by the disasters.

The Maldives is a country located in Indian Ocean and Bulgaria is a country located in average latitudes in the northern hemisphere. Both countries are threaten by natural hazards but they have completely different typology, origin and produced different negative effects on the territories, creating negative effects to the societies of both countries. Using the comparative analysis a new methodology can be created, performed and to lead to new and non-expected results. Such results can be useful for the mitigation and preventive measures. If such a methodology could be transformed to the universal tool for such investigations it could be very useful and performed to different cases and completely different environment.

This study was triggered by a project called CABARET targeted to the high school education in the tsunami prone countries in Indian Ocean. The cooperation between Bulgaria and Maldives was very fruitful and produced education tools for master level of education in the Mining and Geology University, Sofia, BULGARIA and Maldives National University, Male, MALDIVES [1].

Geography positions

The geography positions of the both countries (Bulgaria and Maldives) are completely different.

The Maldives – equatorial islandic country with lowest average land above the sea level (about 2.4 meters) consists of more than 1200 coral atolls located in two parallel and extended to 1200 kilometers with a width of about 50–60km separated by a shallow water inner sea between them. The climate is equatorial to tropical with two main seasons. The origin of Maldives was discovered by B Ranguelov and F Shadiya [6] as a sealed before 5–20 My mid-oceanic rift with relatively simple geology – basaltic basement and coral reefs above it with steep slopes to the Indian ocean and a shallower sea filled with coral sediments with low oil potential [1]. The greatest world negative gravity anomaly is located there. The Maldives are famous as a touristic heaven.

Bulgaria is an Eastern European country with a lot of mountains, valleys, rivers and about 300 km seashore. The climate is demonstrated by 4 seasons – soft winter, hot summer and rainy spring and autumn. The country is famous with its more than 60 natural hazards (familiar in most disastrous prone countries) lacking only constant ice, desertification and active volcanoes. It is rich of underground and surface waters and a lot of mineral springs (over 500) with various hydrothermal waters. The geology is very complicated containing rocks from the Precambrian up to the present day deposits. Bulgaria is also a touristic country.

Natural Hazards

a) Maldives

Very famous fact is that the Maldives is one of the most seismically calm country. This fact provoked the interest of the origin of Maldives [6]. There are not active faults except some cases of listric ones generated by the weight of the coral sediments to the periphery of the atolls. Almost all natural hazards are “imported”. Most dangerous are transoceanic tsunamis (demonstrated during the 2004 Great Indian Ocean tsunami) with a lot of destructions and victims. Other dangerous tsunami sources are these ones in the Arab (BENGAL) bay. The serious hazard is expected sea level rise due to the climate change. The location of both sides of equator (known as “no hurricane ring”) protects Maldives from hurricanes and tornadoes, but sea storms are an important hazard. Local sea event known as “udha” (sea waves, which are known as gravity waves caused by high tides and strong winds) is another dangerous phenomena.

The protection of people is by National geodetic service responsible for the early warnings to the population in case of tsunami, sea storms, etc.

According to Ministry of Environment and Energy [8], three major types of swells exist in the Maldives, they are 1) “Udha” waves, which are known as gravity waves caused by high tides and strong winds; 2) swell waves, which are known as tidal waves and 3) Tsunami waves, which are low frequency high impact waves caused by earthquakes and other bottom phenomena. Wave swells can cause significant flooding that can damage key infrastructures such as homes, harbors, schools, mosques, and jetties in the islands. Other hazards such as monsoon strong winds can cause high tides, which can increase coastal flooding events. In 2008, strong surface winds, combined with heavy rainfall, caused significant damage to roofs and the uprooting of trees in many islands of the Maldives. Hazardous weather events which regularly affect Maldives include tropical cyclones and sever local storms. Tropical cyclones are considered destructive if they are associated with strong winds exceeding 150 km per hour with rain fall above 30 to 40 centimeters within a 24-hour period and storm tides exceed four to five meters. Northern atolls have a greater risk of cyclonic winds and storm surges compared to the southern atolls however, the cyclones that affect northern islands of the country are weak cyclones that are formed in the southern part of the Bay of Bengal and the Arabian Sea [14]. Islands located within close proximity to the equator, are largely free from storms. The northern region of the Maldives is more prone to wind hazards from cyclones compared to southern region of the Maldives. Strong winds can damage vegetation, houses, communication systems, roads, while heavy rainfall can cause flooding and cyclonic winds sometimes can cause sudden rise in the sea-level along the coast leading to storm surges [7].

b) Bulgaria

As it was previously mentioned Bulgaria is threaten by more than 60 natural hazard of different origin [3] – geological gravitational processes, earthquakes, tsunamis, floods, forest fires, subsidence of loess, etc. etc. In a geology context Bulgaria is located on a part of the Moesian platform (to the North) and a part of Alpo-Himalaya orogeny (to the South) [4].

The southern part has a much more diverse structures, more complexly configured tectonic units (blocks and the boundaries between them) and correspondingly more complex geodynamics, which is also expressed in more intense GPS anomalies (horizontal and vertical displacements), increased seismic activity (as the clearest demonstration of active geodynamics) and a much more

complex geomorphology (a clear characteristic of orogenic zones). An attempt to explain this geodynamic behavior is made in [2], where the deeper horizons below the earth's crust are investigated - the complex "crust-asthenosphere" – which shows intensive depth differences in the asthenosphere layers and serious variations in the thickness of the crustal-mantle block structures. This explains the formed block structure of the crust and the presence of deep faults, as boundaries between the earth's blocks. These are the main characteristics of the geodynamics which define the active recent vertical and horizontal movements – the fundament of the sources of inner natural hazards. Meteorological factors is another reason for the surface hazards – such as floods, erosion, abrasion, subsidence, etc. [5].

Similarities and Differences

The summary table of the differences and similarities of the natural hazards of Bulgaria and Maldives is constructed including the geodynamic conditions, main natural hazards and similarities and differences of all aspects of the investigated topics.

Countries/Parameters	Bulgaria	Maldives	Differences	Similarities
Geodynamic conditions	Moesian microplate and orogeny zone	Indian Ocean plate. Ancient sealed rift zone	High	Low
Geomorphology	Mountains land with a sea shore in mid latitudes (BG)	Long double chain of islands (atolls) on both sides of the equator (MAL).	Very high	Very low
Earthquakes	Intensive local seismicity. High effects from outside sources	Lack of local seismicity. Low effects of outside sources	Very high	No
Tsunamis	Rare Black Sea tsunamis	High danger from transoceanic tsunamis	Low	High
Landslides	High danger especially on the Black Sea and Danube coasts	No data	Very high	No
Floods	Flash floods. Melting snow floods.	Floods due to heavy rains in wet season	Low	High
Sea storms	Frequent from Black Sea	Frequent from Indian Ocean	Low	High
Wind storms	Intensive	Intensive	Low	High
High waves	Rare due to sea storms	Frequent due to sea storms and gravitational waves	Low	High
Tides	Low tides	High tides	High	Low
Forest fires	Very frequent	No data	Low	No
Sea level change	Low changes	Increased attention due to the sea level rise	High	Low
Icing	Very frequent during winter time	No possibility for icing	Very high	No

In general the analysis of the table show the following peculiarities:

Due to the different geography position, the geomorphology and the geodynamics of Bulgaria and Maldives the conditions for natural hazards triggering are rather different.

There are some similarities about the natural disasters in both countries (like floods, tsunamis, storms, etc.) which needs the development of measures for mitigation and soft long lasted preventive measures to decrease negative effects of such natural hazards.

The perspectives for more detailed studies need larger use of GNSS technology *especially for Maldives) to establish the horizontal and vertical displacements of the islandic country. The international observing system about the ocean and sea level change and tides, the temperatures water increase and other global anomalies will bring more information about the climate change and the consequences for Maldives and Bulgaria.

Conclusions

A comparative study about natural hazards in Bulgaria and Maldives is done following the available data.

Detailed investigation about similarities and differences and their origin is performed revealing the sources of the hazards and possible universal and/or specific measures to avoid the heavy consequences from the disasters.

Such approach can be very useful for development of a common methodology for application in such cases of countries located in a different geodynamic conditions and the use in case of occurring disasters.

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References:

1. Rangelov, B., F. Shadiya. 2018. Fractals, Natural Disasters and Ecological Problems of Maldives., J. Ecological Eng. and Env. Protection.
2. Yosifov, D., B. Rangelov, E. Oynakov, 2018. Deep low velocity layers inferred by the MSS – indicators of the asthenosphere structure in Bulgaria. Proc. IX National Geophysical Conference, 30th November 2018.
3. Rangelov, B., 2020. A new edition of a book of the natural hazards, their prevention and protection. J. Aerospace Research in Bulgaria. Vol. 32., pp. 241–242. <https://doi.org/10.3897/arb.v32.e19>
4. Brouchev, I., et al., 1994. Geological Hazards in Bulgaria, BAS edition, Sofia (with a Map – scale 1 : 500 000)
5. Rangelov, B., 2011. Natural Hazards – nonlinearities and assessment., Acad. Publ. House (BAS),
6. Rangelov, B., F. Shadiya. 2020. The Genesis of the Maldives: A New Hypotheses., Chapter 3 in “Contemporary Studies in Sciences”, (Eds: Recep Efe and Isa Cürebal). Cambridge Scholars Publ. <https://www.cambridgescholars.com/contemporary-studies-in-sciences>
7. United Nation Development Programme.2017. Detailed island risk assessment in Maldives: Natural Hazards and physical vulnerability assessment report (2008). Retrieved on 18th Sept. 2017 from www.housing.gov.mv/v1/daaownload/1
8. Ministry of Environment and Energy. Second National Communication of Maldives to the United Nation Framework Convention on Climate Change. Ministry of Environment and Energy. Male’, Republic of Maldives, 2016.