

# Catastrophic geophysical phenomena in 2012

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## Abstract

The presented paper focuses on selected geophysical catastrophes at the scope of both Poland and the world. The review shows the causes and effects of the course of the phenomena that man cannot prevent. It is proved that, employing the satellite monitoring, can be a vital element to minimize the possible losses. It is the belief of the authors that the basis of a proper attitude towards the issue is a thorough and adequate education especially at technological universities (faculties).

**Keywords:** catastrophic geophysical phenomena, cyclones, denudation, satellite monitoring, education

## 1. Introduction

Geophysic is the field of science that combines geology, meteorology, climatology, as well as hydrology. It utilizes the newest achievements in informatics facilitating in this manner the explanation of geophysical processes and phenomena. Satellite teledetection, being a tool of geophysics, is the basis of the modern synoptic meteorology which, on the other hand, relies on artificial satellite observations. The information contained in various ranges of electromagnetic radiation, collected at high frequency and recurrence, has been supplementing the limited

stationary point measurements for many years now. It also makes it possible to explain the dynamic phenomena of the atmosphere. It is unimaginable today not to apply satellite data in any contemporary meteorological system (Ciołkosz, Kęsik 1989, Ciołkosz, Jakomulska 2004). The catastrophic phenomena in focus have become a permanent component of our everyday life. People are informed about new events on daily basis and mass media deliver information about various current happenings, bringing about disturbances in regular human activities in different parts of the world. It also corresponds to Poland which faces the problems more and more frequently.

Last year is a good example supporting the statement. In Poland the following areas were affected by cyclones: Bisztynek, a town situated in the area of the Masurian Lakes District on July 7<sup>th</sup>, 2012, the Tuchola Primeval Forests on July 14<sup>th</sup>, 2012, the same phenomenon in Prusim, situated in the area of the Międzychód Lakes District on August 5<sup>th</sup>, 2012, and the Ropczycko-Sędziszowski District on August 24<sup>th</sup>, 2012. The same happened in numerous other locations in the country. Last year was also the 10<sup>th</sup> anniversary of the disaster in Pisz (2002) and the 5<sup>th</sup> one of the so-called white squall in the area of the Masurian Lakes District (2007).

As far as the European continent is concerned the Austrian and Italian Alps

slopes denudation should be mentioned which was intensified by the Genoa Depression on July 7<sup>th</sup>, 2012.

Cyclone Isaac in the USA in August, 2012 should be brought to mind here, as well as the strong earthquake in Indonesia reaching nearly 8 degrees in Richter's scale (September 31<sup>st</sup>, 2012), and causing a weak tsunami wave, and typhoon in South Korea, and last but not least earthquakes in China.

## 2. Tornadoes in Poland

Poland faced numerous tornadoes which were formed over Poland in 2012. The phenomenon occurred also owing to the precipitations which appeared in May, June and July. By the end of August more than 100% of annual mean precipitation sum had fallen down in the region of Wielkopolska.

In Poznań, the capital city of Wielkopolska, 529.6 mm precipitation was observed in the period till August (annual 40 years mean=507 mm), and in Gorzów, another city of the region, over 563.8 mm were noted which was definitely more than the annual mean. Table 1 presents the distribution of precipitation in Wielkopolska. Lower precipitation sums were observed only in March and April.

Month	Poznań	Gorzów	Wrocław	Lublin	Lienz	Beijing
I	78	80.2	47.4	43.2	27.4	0
II	47.4	36.5	38	19.2	12.2	0
III	16.9	15	11.4	25.7	9.3	8.2
IV	20.6	27.3	32	30.2	94.8	55.2
V	63.4	72.2	24	34.4	39.5	31.5
VI	107.3	50.2	73.4	68.1	83.8	104.3
VII	149.3	177.6	107	57.7	247.8	288.1
VIII	53.7	104.8	63.5	44.4	108.3	54.3
Average (2001-2010)	577.1	623.5	625.5	656.7	892.5	487.2
Sum (I-VIII)	536.6	563.8	396.7	322.9	623.1	541.6

Tab. 1: Characteristics of precipitation of selected cities (wetteronline.de).

Different situation was observed in the south and east of Poland (Tab. 1). South-west of Poland, namely the city of Wrocław, observed 396.7 mm precipitation. Absence of driving rains in May, July and August is clearly observed in the table, in case of the Lublin station, where in the period January-August less water than in Wrocław was observed (322.9 mm)

It is worth mentioning here that the region of Poland, and especially the city of Poznań, is the area of the lowest precipitation noted in the country. Its multi-year annual mean reaches the level of only 507 mm; 2012 was an exception.

Numerous and frequent rainfalls, keeping air and soil humidity at a high level, support both instability of the atmosphere and convection. Turbulent convection is a combination of high temperature and intense evaporation. It results in a dynamic development of cumulonimbus type clouds (storm clouds), which always accompany the extreme phenomenon of typhoons.

Warm coniferous forests are the ecosystems which are especially susceptible to the development of typhoons; wet deciduous forests do not create good conditions to form convection (its intensity diminishes owing to the cooler air over the ecosystem). Both wet areas and water reservoirs do not provide favourable conditions for convection development in the period of spring. A good example here is the Kierskie Lake situated within the borders of the city of Poznań. On the eastern side of the lake there is a small town called Suchy Las (Dry Forest). Precisely in the town, the process of convection decreasing by the water surface is observed; it leads to an observable weakening of the convective currents and brings about reduced precipitation on this side of the lake; in Suchy Las.

On July 7<sup>th</sup>, 2012 in the afternoon, a strong driving rain, accompanied by hail

fall with hen-egg size stones, visited the mid-part of the Masovia and Warmia Lake District. A powerful storm rolled by 3 districts: Lidzbarski, Kętrzyński and Braniewski, causing high material losses. Over 300 buildings were damaged (roofs and tiles blown off, fig.1); transportation means were damaged, too (by falling down trees). Broken power lines created numerous problems to the inhabitants. According to various estimations about 15-18 thou. people in the area in focus had no electricity supply; fortunately no victims were reported.



Fig. 1: Buildings in Bisztynek, Poland, destroyed by the driving rain on July 5th, 2012, accompanied by hen-egg size hailstones (photo Piotr Wittman/ PAP).

The above introduction aimed at obtaining a better understanding of the forecasts concerning the appearing tornados and typhoons especially over the forest areas (mainly coniferous ones). The above statement is supported by the facts i.e. the places of the phenomena occurrence in Poland. The areas are situated within deciduous forests or are the forests themselves: Czarnków, Piła, the Tuchola Primaeval Forests and finally the Notecka Primaeval Forests (Prusim case, fig. 2).

The presented comparison of the precipitation values (Tab.1) also explains the reasons of low water level states of the Vistula River catchment area (August and beginning of September 2012). The observed precipitation both in eastern and

south-eastern Poland was noted to be meaningfully below the multi-year means.

Both hydrologists and navigation workers complain of the low Vistula water level. On September 11th, 2012 the operational activity in the port of Sandomierz was suspended owing to the 50cm water level in the Vistula. At the same time the navigation on the Danube, at the final section in Bulgaria, was also dramatic with approx. 40 ships run aground.



Fig. 2: A fragment of a forest stand in Prusim, Poland after the typhoon of September 5th, 2012 (photo Ryszard Kaczmarek).

### 3. Denudation in Alps

The diving rains in the Austrian Alps were again brought by the depression from the area of the Genoa Bay. Some of the valleys faced precipitation of 250 mm in July 2012 itself (Tab. 1) bringing about denudation catastrophe.

Moreover, taking into consideration the snow covering the glaciers, the occurring water flow was higher than it might follow from the precipitation itself; the recorded flood wave was the highest observed in the last 30-year period.

The flow was accompanied by mud slides and avalanches, cumulating at the valley bottoms and reaching the height of 5-6 m. Such an avalanche, moving at the speed reaching 80 km/ h, possesses a giant destructive power.

In such conditions mud masses take down everything they meet on their way. Simultaneously, they increase their weight

and multiply their destructive power. It results in damaging roads, blocking motorways, flooding households and tunnels, as well as destroying bridges (figs. 3 and 4).



Fig. 3: Destruction observed in Austria after a mud avalanche (© APA).

One of torrential rains reached its peak on August 21st, 2012. It brought daily precipitation at the level of 30 mm, which stayed in some regions for two days (in Styria and Tyrol it reached approx. 60 mm). Tens of houses were under mud avalanches, transportation means were destroyed, as well as the accompanying them infrastructure. Losses in cultivation were estimated at over 20 mln euro. The rescue action was carried out by approx. 1200 firemen and numerous formations of the army; many inhabitants were evacuated.



Fig. 4: Bird's eye view of the Austrian catastrophe (© BH LIEZEN (APA)).

Despite a very efficient rescue action there was one victim and one wounded person. In Lienz (Table 1) 247. 8 mm precipitation was reported in July 2012. The precipitation was announced one of

the most abundant in the history of the Austrian Alps.

The Mediterranean Sea which is warmed up at the time of the year, as well as the wet and hot air climbing up the Alps slopes, should be mentioned here while commenting the origin of the phenomenon. Air is subject to transformation;; first dry-adiabatic, and higher up, after water vapour condensation, wet-adiabatic. Owing to this process, the temperature drops, at the beginning, by 1 degree Celsius per 100m of the slope, and after condensation only by 0.5 degree Celsius per 100m (owing to loss of heat earlier absorbed during evaporation). The northern side of the Alps witnesses an increase of 1 degree Celsius per 100 m of foehn wind fall.

#### 4. Cyclones Isaac and tornadoes in the USA

The area of the USA has been frequently suffering from tornados in recent years. An explanation of the phenomenon is the fact that the north of the continent has no mountain shelterbelt. If the Cordilleras range was spread from the south to the east, the arctic air from the north, moving to the south, would meet an obstacle, overcoming which would subject it to adiabatic transformations.

As a result it would be warmed and in its further trip the effects of the clash of arctic and tropical air masses would be weaker. The transformation would weaken the tornados and their dramatic impact especially in southern states. Unfortunately, the situation is different- high thermal differences condition the sizes and dramatic outcomes.



Fig. 5: Bird's Satellite image of Isaac reaching Louisiana, USA (NASA Goddard MODIS Rapid Response Team).

## 5. Earthquakes in Indonesia

The Philippines Archipelago is one of these places in the world which are most endangered by earthquakes. The last year earthquake's intensity was 7,6 Richter's scale and the authorities forwarded an announcement warning against the danger of the tsunami wave. Fig. 6 presents the epicenter of the earthquake, approx. 66 miles from the islands shore.

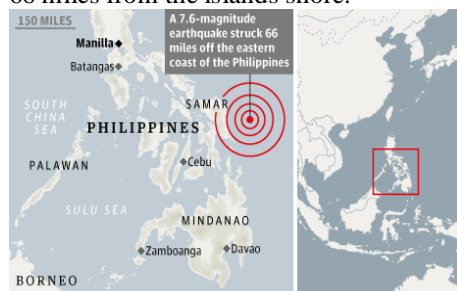


Fig. 6: Earthquake epicenter.

There was a tsunami, but fortunately not a serious one; the wave rose up to only 50-60 cm, for comparison, the Aceh, Sumatra tsunami wave (2004) was more than 10 m high (Kapuściński, Zabielski 2008). It is worth mentioning here that tsunami wave is evoked by subduction. Numerous losses occurred due to the earthquake. Fig. 7 shows deep road cracks.



Fig. 7: Damaged road.

## 6. Typhoons in South and North Korea

Cyclone Bolaven approached South and North Korea on August 29th, 2012. It came from the Pacific over the Korean Peninsula. Summer period is the rainy season in the monsoon climate of this part of the world.

The situation at the sea at the time of the typhoon activity is presented in fig. 8. The phenomenon brought about dramatic effects- in South Korea 15 people were killed, whereas in North Korea 48 victims were reported. North Korea suffered particularly painful losses with many agricultural crops damaged and numerous buildings destroyed.



Fig. 8: Turbulent sea during Bolaven Typhoon (REUTERS TV/Reuters).

## 7. July 2012 floods in China

Last year monsoon rain season brought exceptionally serious and far-reaching consequences for the inhabitants of Pe-



king. During the most abundant in 60-year period storm about 37 people were lost and many streets flooded, isolating people from their households; apart from that vehicle, train and air communication was paralysed. From time to time the disaster is compared to the one caused by the tropical Katrina cyclone, that destroyed a significant part of New Orleans. Saturday the 21st of July 2012 was the day when the more than 24-hour storm, bringing torrential rains, started. The falls moved heavy mud avalanches, blocking main roads and motorways, and damaging bridges (fig. 9). The intensity of the monsoon rains, lasting for approx. half a year (April-September), is dependent upon the Pacific temperature: the higher the temperature, the higher the water surface evaporation, and rainfalls resulting from it. China is visited by monsoon rains from two directions: The Pacific and The Indian Ocean.

Floods also visited the south-west of China where monsoon rains, climbing up the slopes of the Karakorum and Hindu Kush, bring about exceptionally heavy precipitation. Rivers having their springs in the mountains cause floods on the southern and northern side (China).



Fig. 9: Flood 2012, China, Beijing.

The highest rainfalls are recorded at the Himalayas foot in Cherrapunji, India; the annual average is approx. 12 m (slightly higher than 0.5 m in Wielkopolska, Poland!). It must be mentioned here that denudation is highest in this part of the

world. It is interesting to add here that owing to the above mentioned problems Bangladesh belongs to one of the countries where houses are built on floating rafts. The discussed high precipitations result from the fact that the monsoon rain front effect and orographic factor overlap with each other (the highest mountains in the world). The precipitation having no barrier of the Himalayas would water the whole Chinese area. In the existing situation the southern slopes face it while, on the other hand Tibet, is almost totally deprived of it.

## 8. Summing

2012 was the year which was worldwide abundant in geophysical phenomena. The great number of typhoons in Poland was disturbing. Despite the lower intensity (and thus lower losses compared to American tornados, floods in other parts of the world, earthquakes and tsunami) of the phenomena in Poland, the subject gains more and more importance in the country (3, 4, 5, 6, 7, 8, 9).

People who face the problems of geophysical catastrophic phenomena (in their full variety) in their vocational activities, should be aware of their occurrence and possess, at the same time, principles of fast-reacting capabilities.

The group of people includes controllers and traffic managers who are responsible for both for safety and frequently for human life.

The present level of knowledge makes it possible (to a high degree) to forecast catastrophic phenomena. Moreover, the modern informatics tools provide for its development and improvement.

The problem of appreciation of the discussed set of issues in the process of education of young generations of engineers, especially in the era of globalization and open labour world market, is a key task of higher education institutions, especially

technological ones. Lack of the knowledge of decision makers may turn out to be a crucial gap to take up proper decisions in critical situations.

In Poland the beginning of the process is already observed. The module called Catastrophic Geophysical Phenomena is introduced at higher educational institutions: Technological University of Częstochowa; major of Logistics, and State Higher Vocational School, Kalisz, Poland; major of Interior Security; Higher Police School in Szczytno in Poland is at its initial stage of introducing the subject.

Commenting the current weather phenomena the authors wish to point to the presently occurring situation. It is believed that the intensity of the catastrophic phenomena is first of all connected with the sun activity(3, 4). Presently the sun is terminating its exceptional activity entering the stage of subsidence and in our opinion the phenomenon of global warming will enter history. Recent European winters (especially 2012/2013) can be a proof supporting the thesis of the changes..

Snow cover in Poland stayed in the east of the country (in Suwałki) for over 120 days; it is a record of the last 60 years! It stayed more than 40 days longer than is observed in the recorded mean value which equals to 70-80 days. The spring this year appeared on the area of the Polish Lowland after April the 12th, 2013; three weeks later than the calendar spring. On the other hand, the earthquake endangerment, and resulting from it tsunami wave occurrence, can be explained by the theory of the earth globe expansion, and tectonic plates collision and subduction. Earthquakes in the depth of the Asiatic continent are explained by the theory of expansion (the earth radius is increased; as a result the crust of the earth cracks, magma forces its way into the fissures directly bringing about local earthquakes on the continent).

## 9. Conclusions

- 1) Systematic monitoring and teledetection along with synoptic information make it possible to improve understanding of catastrophic geophysical phenomena and counteract their effects.
- 2) There is an unquestioned necessity to observe and analyse all the geophysical threats, in order to define the intensity, duration time, directions of movement and expected effects of their occurrence.
- 3) Minimalization of the dangers and early reaction to the phenomena in focus should be an output of close cooperation of teams consisting of anti-crisis teams and geophysicists.
- 4) It seems indispensable to introduce the subject discussing the catastrophic geophysical phenomena at selected technological universities faculties (Management, Civil Engineering, Architecture, Transport, Energetics).

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