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AN ANALYSIS OF SELECTED TRANSPORT CATASTROPHES CAUSES PRESENTED AGAINST THE BACKGROUND OF THE OCCURRING GEOPHYSICAL CONDITIONS

Abstract:

The more and more frequently occurring disturbances in the continuity of the properly functioning transport in its full variety, make us undertake an attempt to deeply recognize them in order to minimize or avoid losses resulting from them. The paper aims at explaining the circumstances of the causes of some selected transportation catastrophes. The basis for the undertaking should be a thorough analysis of the available data concerning the occurring geophysical phenomena which might have had some impact on the discussed catastrophes. It is indispensable that the materials collected by the functioning satellite systems are studied and constitute the base for the analyses in focus.

Key words: disturbances, catastrophic geophysical phenomena, satellite teledetection.

INTRODUCTION

Geophysical service teams including synoptic specialists should be the key formations cooperating with the transport management authorities. Warnings concerning various extreme meteorological phenomena e.g. cyclones with highest pressure differences and maximum wind speed, should immediately be delivered to adequate services.

The dynamics of the phenomena and their outcomes which are, to a certain degree, possible to forecast, give a possibility of an immediate reaction and of undertaking preventive measures. Numerous weather forecasting services provide reliable information that should be used by the transportation managing officials. It must be understood that taking reasonable decisions by the people involved is conditioned by the knowledge of basic climatologic processes. Owing to the more and more frequently occurring geophysical catastrophes there is an urgent need to acquaint students of technological universities, especially of Transportation and Management Faculties, with the problems (Kapuściński, Zabielski 2009b; Kapuściński, Zabielski 2010).

The influence of the selected geophysical phenomena on the proper functioning of transport, both locally and globally, will be presented.

1. CYCLONES

Cyclones are a natural phenomenon which frequently occurs in the Polish climatic conditions. Their intensity depends first of all on thermal conditions of the clashing air masses

- the higher the difference, the more intensive the front phenomena, as well as torrential rains and hurricane winds are. The phenomena are specially dangerous for functioning of transport in all its varieties. That is why transport managers should be acquainted with the phenomena-steering processes and understand the prospective outcomes resulting from their turbulent courses (Kapuściński, Zabielski 2009a).

The development of the cyclone dating May 30, 2005 may serve as an example. The day was warm in Poland, the Czech Republic and Austria with the temperature higher than 30 degrees.

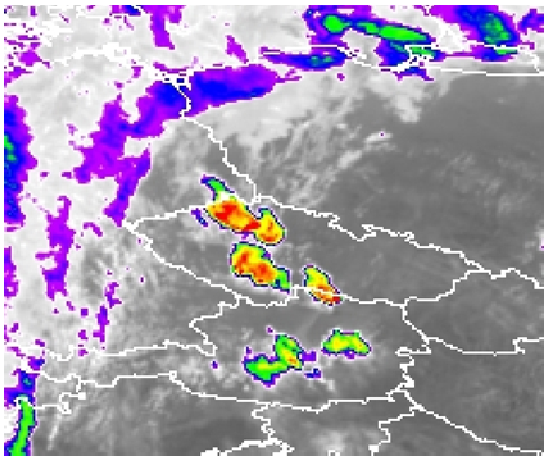

Fig. 1. Weather situation on May 30, 2005 12.15 p.m.(image Meteosat 8, channel 09)

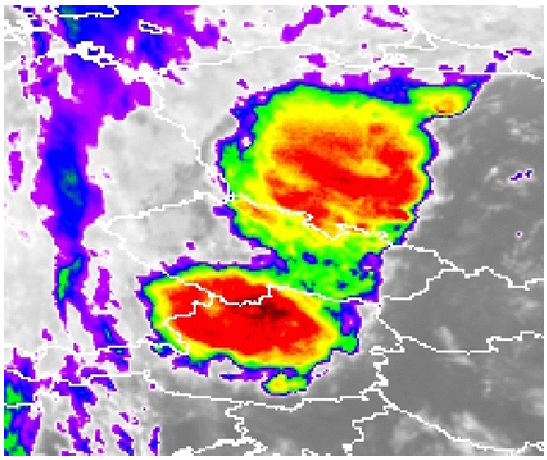

Fig. 2. Weather situation on May 30, 2005 17.15 p.m.(image Meteosat 8, channel 09)

Fig.1 presents the weather situation at 12.15p.m. A few storm areas can be observed over the Czech Republic - intensive red colour indicates high dynamics of the cyclogenesis phenomena. Figure 3 presents the growth of convection in Prague. Figure 2, on the other hand, presents the meteorological situation at 17.15. In five hours the rainstorm moved over to Poland and covered the prevailing part of the country. During the downpour the wind exceeded 100km/ h which resulted in numerous trees being broken and roofs damaged. A lot of electrical power grids were broken by strong wind blows (including four high voltage truss construction supports). In Wrocław many trams were left on rails due to broken electric traction lines and broken trees blocking the rails (Fig. 3.).

Fig. 3. Weather situation in Prague on May 30, 2005

Source: [8].

Railway traffic was also closed for many hours. The local fire brigade was called 450 times. Many streets were flooded and changed into brooks surprising drivers who would leave their cars and evacuate choosing some other ways. In the neighbourhood of Kraków three persons were killed by falling trees.

The next described cyclone developed over the Atlantic on January 5, 1993. During the storm the tank ship Braer, carrying 84thous. tons of crude oil to Canada, was pushed into the southern coast of the Shetlands. The difficult weather conditions (wind of 10-11 degrees, Beaufort scale) caused serious damage to the ship resulting in stopping the generator and next the main engine.

The tanker without drive was drifting towards the coast, finally grounded at Garth's Ness (Fig. 4). The damage to the tanker was so serious that the oil from the ship leaked out causing one of most serious ecological catastrophes in the history of sea navigation. The efficiently carried out rescue operation saved the crew.

Fig. 4. The tanker Braer sunk at the Shetlands coast-observable oil leak on the sea surface

Source: [9].

The storm that came a few days later i.e. between January 10 and 11 caused breaking of the tanker into two and finally its sinking.

The last of the presented cyclones developed in mid-January, 2007 over the Atlantic. The pressure gradient between its centre and edge equaled then approx. to 55hPa, which was decisive in high wind speed occurrence and thus bringing about vast scale damages (Fig. 5).

The cyclone was one of the strongest cyclones in recent years that had approached Europe. It totally paralysed the transport and all its means. The damage caused by the cyclone exceeded billions of euros (Kapuściński, Zabielski 2009). The Śnieżka Mt. experienced a record with wind speed exceeding 200km/ h; the anemometer scale was too small to measure the real speed.

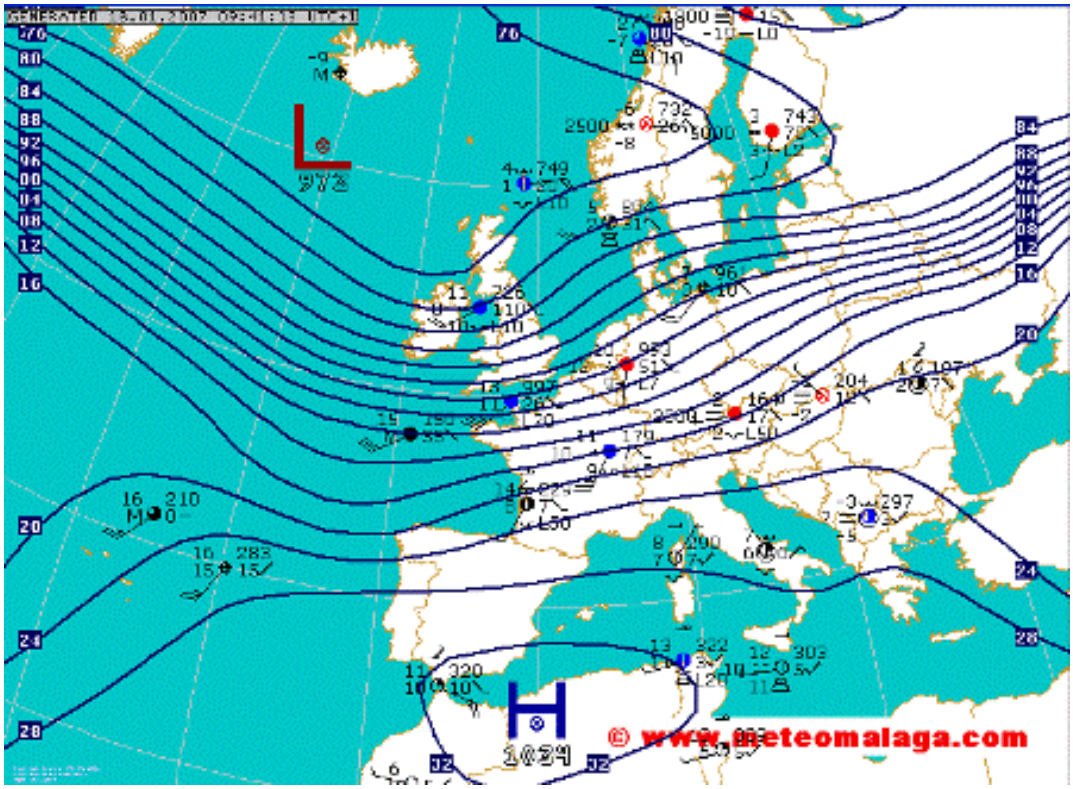

Fig. 5. Distribution of isobars of Kyrill cyclone

Source: [10].

2. FLOOD AND LANDSLIDES 2010

The flood last year was preceded by a relatively severe and snowy winter. The snow cover in the mountains stayed till April, and in their upper parts even longer. Water, after the snow had melted, had no time to leave the rock mass, and moreover, already in May and June heavy rainfalls came (such rains usually fall in July). The precipitation caused, alongside with the soaked heavy ground, the downward movement of the ground initiating landslides (Fig. 6.).

The floods of 1997 and 2010 exposed a c**o**mplete organisational helplessness in face of the phenomenon of denudation**.** The flood of 1997 was called 'the flood of the millenium', and it affected mainly the western part of Poland. On the other hand, the 2010 flood started with freshets of the Vistula and its tributaries. Below some precipitation data from June and July, 1997, as well as May and June, 2010, cited after the Institute of Meteorology and Water Management, are given.

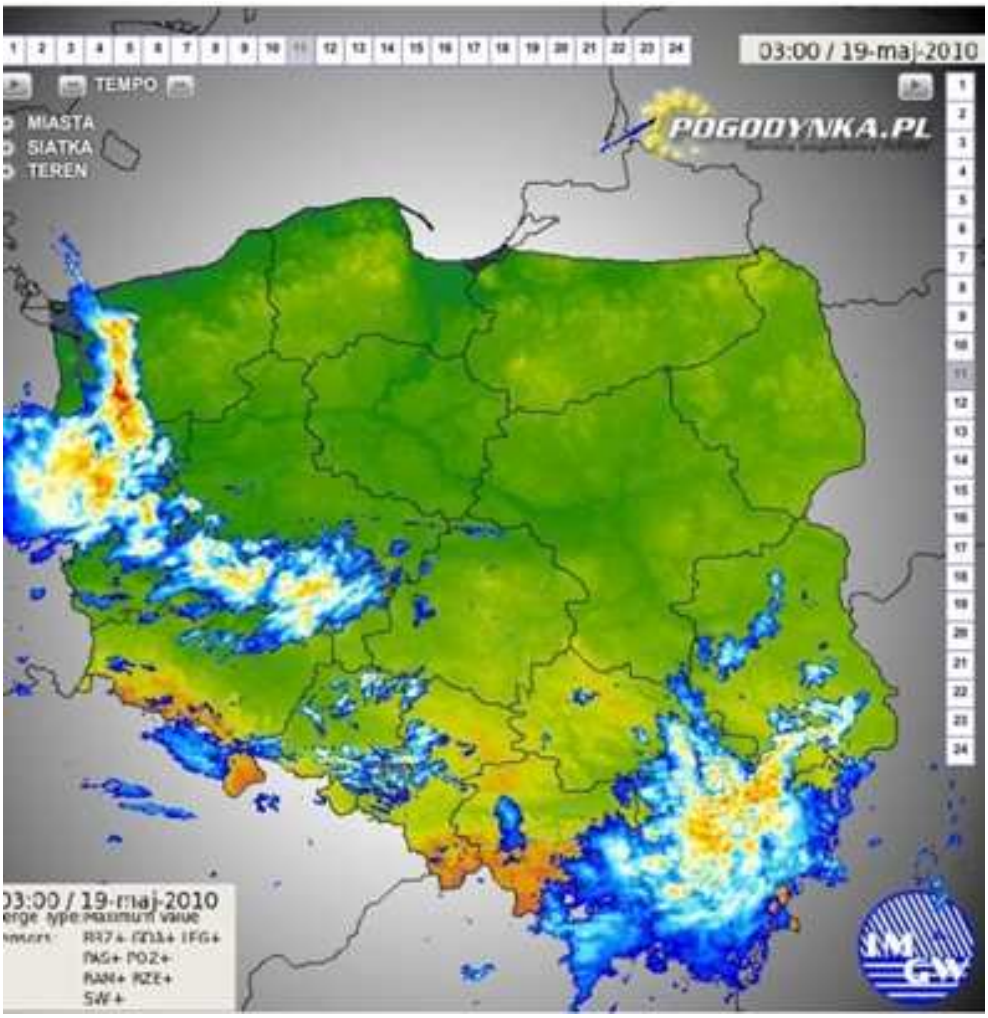

Fig. 6. Front clouds over Poland on May 19, 2010

Source: [11].

In 1997 flood in Wrocław respectively in June and July 32mm and 228mm were noted. In Poznań the values were 59mm and 217mm respectively. The Karkonosze Mts. experienced daily precipitation exceeding 100mm (details concerning the flood can be observed in the publication Kapuściński, Zabielski in the periodical Logistyka 4/ 2009).

Rainfalls in May and July, 2010 most heavily covered the south-eastern part of Poland. For instance in May, Cracow noted 299mm and 134mm in June, in Rzeszow in analogical months the values were 178mm and 127mm, while in Lublin 170mm and 64mm, respectively and finally in Warsaw the values reached 115mm and 87mm.

The phenomenon of denudation is usually accompanied by floods and in extremely difficult hydrological situations also by landslides. The very phenomena occurred in 2010. Denudation aims, via water and air erosion, landslides and flood run-off, at levelling the area it operates on. The south- eastern areas of Poland are especially endangered by denudation. The Carpathian flysch, which has been populated and deforested, creates favourable conditions for denudation to operate in this part of the country. Mountain slopes have been turned into arable fields and meadows, and urbanized (Fig. 7).

Fig. 7. A damaged road-landslides effect

Source: [12].

The changes have caused intensification of denudation; house-building on the slopes had the strongest impact. It needs to be noticed that the danger still exists and after another frosty winter we observe new freshets and alert levels.

In January-February 2011 alert levels were exceeded on the Bug and mid-stream Vistula. February this year brought a short-period thaw and as a result, ice-jamming floods were witnessed. They occurred in the area of the Dąbie lake in the lower part of the Oder where ice-breaking activities were carried out. The Vistula water reservoir in Włocławek was also protected by carrying out ice-breaking procedures. The river Noteć was particularly turbulent which was manifested by ice-jamming floods. The river is characterised by a very small slope and numerous hydrotechnical devices of different types impounding the ice-flow. The river partly damaged one of national roads overflowing its crown. Despite the losses the January thaw was favourable since it helped to free the rivers' estuaries from ice and prevented from spring cumulative flow.

Barometric low system from the south and south-western part of the continent brought the flood over the south-western part of Poland (Kapuściński, Zabielski, 2009). On the other hand, the flood of 2010 was initiated by intensive rainfalls, which appeared from the south-eastern part of Europe. The precipitation moved around the area of Poland from northern-south towards southern-east, especially watering the area of Małopolska, including Podkarpacie and the Carpathian Mts. Fig. 9 is a unique image of the Sandomierz environs from the flood of 2010 taken by NASA.

Fig. 8. Sandomierz- view from a NASA space station

Source: [13].

Satellite images, as well as GPS technology are able to warn geophysicists against the dangers of the type. Presently, the process of denudation should be observed on continual basis in order to define its activity early enough.

It is widely known that during the period of intensified denudation the most involved and devoted rescuers are professionally equipped formations of the army, forest workers and fire brigade teams. It is imperative to discontinue the procedure of irresponsible policy concerning issuing of permissions for constructing buildings in a given area without any formal consequences in case of unwise location. At lower levels, i.e. in communes, both planning and anti-flood policy should be conducted as a must. The policy should be defined already at the stage of working out the local spatial town-and-country planning study.

3. PLANE CRASHES

The review of the phenomena in focus would not be complete if we did not mention the circumstances which resulted from general atmospheric circulation and led to the air crash of Airbus A310 flight IY 2662 of the Yemen Airlines on June 30, 2009. It needs to be added here, on the margin of our discussion, that the same month (June 1, 2009) witnessed, at approx. the same distance from the equator, another crash, namely, of Airbus 330, from Rio de Janeiro to Paris.

The crash took place in the area of the main island of the Comoras archipelago (the Great Comora). The plane was approaching the airport landing in the conditions of strong wind and turbulence. The plane carried 147 passengers and 11 crew members.

The airbus A310 flight IY626 crash took place in the zone close to the equator (Fig. 9). In the zone on that very day, very strong thunderstorms, accompanied by powerful turbulence, occurred. The equatorial zone is very dangerous to air traffic because of trade winds ascending there. The winds end up their course in the place and return to the tropics. Ascending currents cause enormous turbulences in the area. It is caused by the highest density of the net radiation and the most intensive evapotranspiration met. It is due to the biggest

thickness of the troposphere reaching from 15 to 16km. The layer is a few kilometers thicker than it is in our latitude where it reaches up to 13km. The only person who survived the described crash was a 14-year old girl from Paris. The circumstances of the tragedy are not publicized by the Yemeneese airlines.

The crash on June 1st over the Atlantic confirms our suppositions. The crash happened at the similar latitude in the area of exceptionally unfavourable weather conditions with an accompanying strong turbulence.

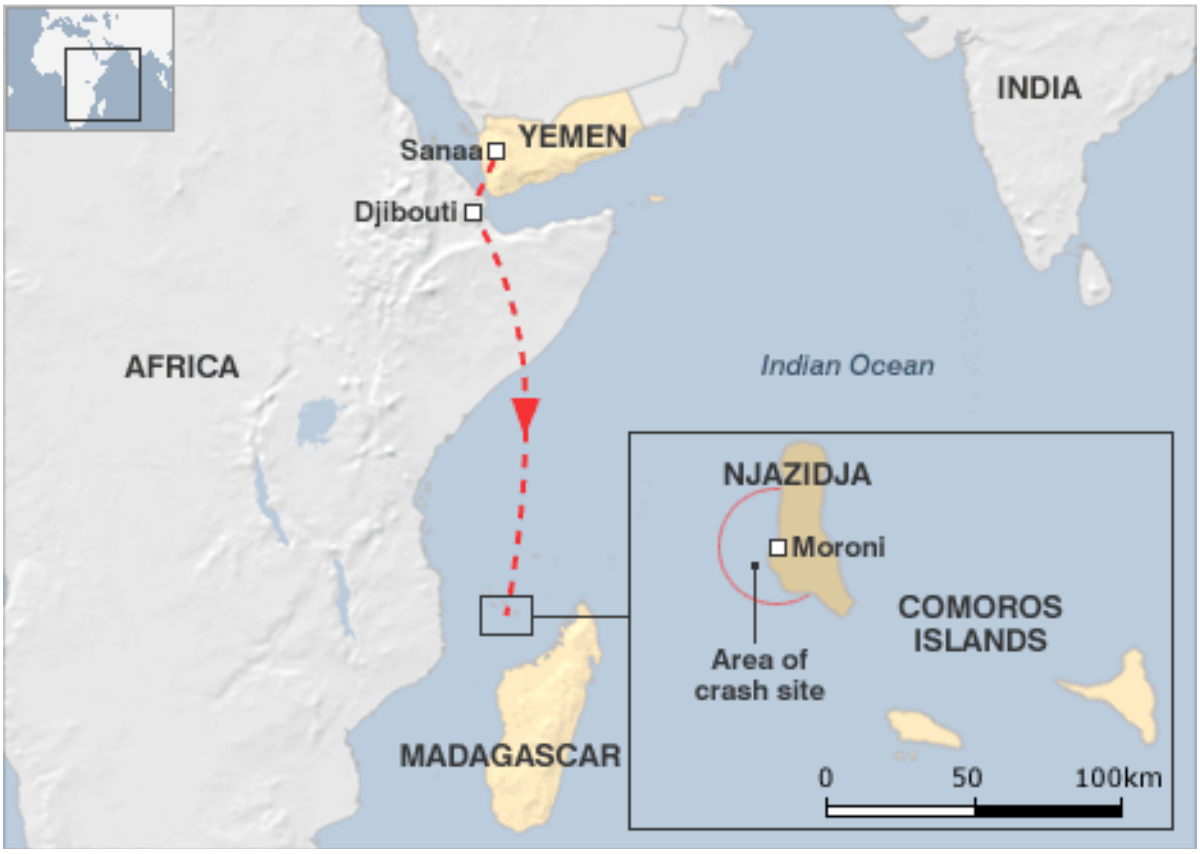

Fig. 9. The place of the crash of Airbus A310, flight IY626

Source: [14].

The plane crashes in the Polish army are a proof that the knowledge of geophysics is insufficiently utilized. The indispensable component of the knowledge should include satellite teledetection, on the basis of which the occurrence of flood, alongside with hurricanes, vortexes, fogs and other geophysical phenomena, could be forecast.

The Tupolew 154M, side number 101, crash was in a way provoked by the fact it had been sent in the morning to Smolensk where at this time the most intensive fogs in the region occur. Advection fogs are created when ground is still frozen and covered with snow, and on such a ground warmer and moist air masses come.

Morning is the most dangerous time of the day in the situation when the temperature is the lowest and fogs the thickest. It proves that the set of issues should be introduced especially to the team of decision-taking authorities of all levels. The knowledge is supposed to provide help in obtaining skills necessary nowadays. It is advisable to approach the geophysical dangers thoughtfully and substantially; the approach has to be supported by deep knowledge.

It is imperative that the current conditions and circumstances are taken into considerations.

4. TSUNAMI, JAPAN 2011

The earthquake of 9 degrees, Richter scale took place on February 11, 2011 in north-eastern Japan, east of Sendai. The occurrences from December, 2004 and current from March, 2011 have caused that the powerful tsunami waves evoked by the earthquakes taking place at the bottom of the ocean are perceived as the most dramatic symbols of the contemporary world catastrophic phenomena. Tragic effects of earthquakes and resulting from them tsunami wave make humanity revise the total of decisions taken as to the locations in the area of its activity.

Tsunami carries huge amounts of energy although it is hardly noticeable in the open ocean. Water speed at the bottom though reaches even 900km/h, so it can move long distances in a short time. The moment it reaches the continental shelf the speed decreases, which is related to a stronger friction power, and water masses thrust, placed deeper, create a wave which increases its height. The energy concentrated in the wave-front measures a dozen or so and even several dozen kilometers reaches the coast wreaking havoc and death.

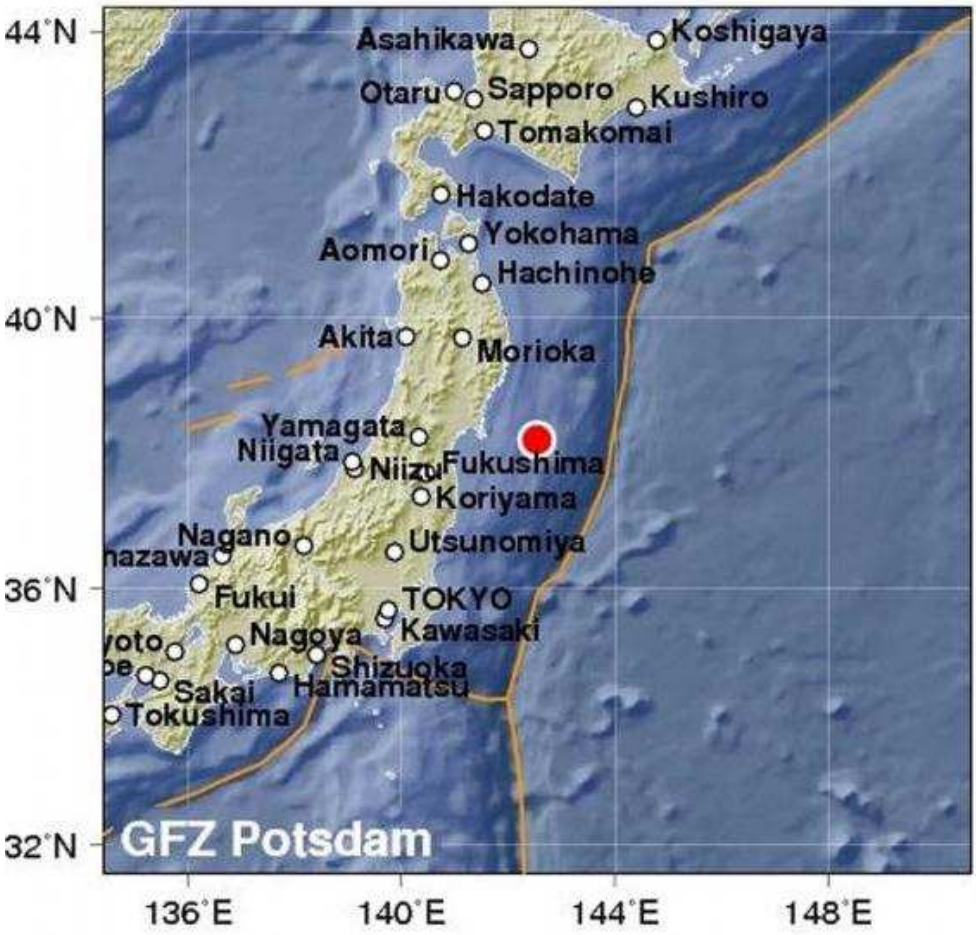

Fig. 10. The focus of the earthquake (red point) preceding the tsunami in Japan

Source: [15].

The tsunami wave which was observed in Japan on March11, 2011, was created as a result of the earthquake which had it epicenter below the Pacific Ocean bottom (Fig. 10), east of Sendai, situated close to the Fukushima 1 atomic power plant.

The wave caused the most devastating havoc in Sendai and seriously damaged the atomic plant. Ground waters and The Pacific water were contaminated by the leaked out radioactive substance. The present estimate of deaths and lost reaches 24thous (6).

Fig. 11. The tsunami wave

Source: [16].

The presently applied tsunami warning system functions basing, among others, on the meteorological satellite provided by EUMETSAT in 2005. The system having at its disposal information delivered and perceived each 15mins enables to take (by the authorities) fast decisions concerning evacuation of people, which can save numerous human lives. The system though needs a number of corrections to work at a satisfying and efficient level. Especially the floating buoys transmitting the signal to the satellite need to be modified since they are the weak, unreliable element of the system.

Japan has the best organised earthquake warning system in the world; it is then frightening to think of such high human losses as a result of the combination of earthquake-tsunami type. The wave would sweep to the Ocean whatever it met on its way- Fig. 11 shows swept and floating cars.

5. SUMMING UP

Cyclones, in their extreme shape, are one of the most dangerous geophysical phenomena which have been lately devastating Europe. Till now they have been frequently paralysing all kinds of transport and communication. The losses have reached billions euro.

Information obtained via artificial satellites must be widely applied in both management and organization of all types of transport. Synoptic services utilize the information to build weather forecasts which should be commonly used.

The present level of knowledge enables us to predict, to a high extent, catastrophic phenomena. The efficiency of the protection system functioning does not consist exclusively

in the fact of detecting, but also in the system of informing about a potential danger; the last one very often does not exist at all!

Cyclones, floods, landslides, turbulences or tsunami are natural phenomena, frequently in their extreme forms perceived as catastrophes. Having no influence on their occurrence, we should improve the systems of early detection of the phenomena. How important the knowledge is in the field of transport management is learnt only after another disaster has happened.

Early reaction would limit the high losses and negative effects resulting from the situation, especially eliminating death cases among humans. The high losses due to the phenomena and era of globalization impose on us introducing into the existing curricula, especially at technological universities and other technical tertiary level educational institutions, the issues connected with the catastrophic geophysical phenomena steering processes.

6. CONCLUSIONS

- Observations and analyses of synoptic information facilitate a better understanding of meteorological phenomena and improvement of reaction strategy i.e. counteracting the effects of catastrophic geophysical phenomena in order to increase transport safety.
- Appearance of a cyclone of more than 20hPa/ 24h pressure on a synoptic map, the so-called explosive cyclogenesis, especially approaching Poland should be a serious warning signal for the transport managing services
- Denudation, floods and landslides which result from the discussed phenomena present an obvious and strong impact on the road infrastructure and the transport
- The areas especially prone to strong turbulences should be monitored on continual basis, especially by air traffic controllers who should take responsible and safe decisions
- It appears indispensable to introduce, on selected faculties (civil engineering, architecture, transport, energetics and others) of technical universities, a subject concentrating on the catastrophic geophysical phenomena

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ANALIZA PRZYCZYN WYBRANYCH KATASTROF KOMUNIKACYJNYCH NA TLE ZAISTNIAŁYCH WARUNKÓW GEOFIZYCZNYCH

Streszczenie:

Coraz częściej występujące zaburzenia ciągłości właściwego funkcjonowania transportu we wszystkich jego rodzajach zmuszają do bardziej dogłębnego ich poznania, celem minimalizowania lub uniknięcia strat, które z tych zaburzeń wynikają. W niniejszej pracy podjęto próby wyjaśnienia okoliczności przyczyn wybranych katastrof komunikacyjnych. Podstawą tych działań winna być dokładna analiza dostępnych informacji o występujących zjawiskach geofizycznych, które mogły mieć wypływ na omawiane katastrofy komunikacyjne. Niezbędnie musi być podjęta próba przestudiowania materiałów zebranych przez systemy satelitarne, które winny stanowić podstawę tych analiz.

Słowa kluczowe: zakłócenia w transporcie, katastroficzne zjawiska geofizyczne, teledetekcja satelitarna.