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Józef Edward Mojski

FORECASTS OF THE MORPHOGENETIC PROCESSES' EVOLUTION IN POLAND

Abstract: According to the global climate change forecastss the quantitative evaluations of climate change for Poland in next 100 years are presented. Their impact on the evolution of the Vistula River valley is estimated, separately for upper, middle and lower river course. In the upper course more debris will be transported from the Carpathians to their foreland zone. In the middle course there will be growing tendency of the anastomosing river beds development and the earthslides might become more frequent, while in the lower course the uplift of the erosion base will probably occur.

Key words: climate change, morphogenetic processes, the Vistula River, Poland, the Baltic Sea.

Preparing the forecasts of epigeosphere's evolution will be soon one of the most important tasks of the contemporary geomorphology (Mojski 1997). The present paper is focused on selected issues of this problem. Forecasts of the morphogenetic processes are still very little developed, as generally the predicting itself is often considered to be of minor importance for science. There are no sufficient methods or appropriate research procedures as far as the investigation of morphogenesis of the Poland's territory is concerned. The forecast demands too many assumptions, rather poorly defined, while at the same time there are many problems which need to be investigated with well known and tested methods. However, the forecast of morphogenetic processes satisfies at least three conditions, which makes it worth trying. The conditions are as follows:

1. Understanding of the Poland's relief evolution and the factors influencing it in the nearest geological past.
2. Recognition of present geomorphological processes presented quantitatively in relation to the time of their duration.

3. The forecast should be based on the trend of the factor decisive for morphogenetic processes, which is climate change. The forecasts of climate evolution in the nearest future are very advanced and regardless many uncertainties the obtained results might be taken as a basis for the forecast of morphogenetic processes' evolution.

The most outstanding study concerning the forecasts of climate change is the report of IPCC (Intergovernmental Panel for Climate Change) (Houghton et al. 1990). It states that humans will be confronted in the nearest future with climate changes without parallel in our history. In next 100 years those changes may cause damages of the dimension not known so far, which may endanger social and economical development of some regions (Schönwiese 1992). Such statements are explicit and their importance was marked with the publication in the documents of the United Nations. The report mentioned above provides unequivocal forecast, with numerical values, but in variant formulation. It reconciles two seemingly contradictory conditions demanded at present from all forecasts: quantitative presentation of predicted changes and the uncertainty linked with basic data and many unpredictable future circumstances.

The report takes into account four scenarios (A, B, C and D) of the average global temperature increase near the ground. Scenario A predicts the increase of 0.3°C in every 10-year period, scenario B – about 0.2°C, scenario C – a little bit more than 0.1°C and scenario D – about 0.1°C. The error interval is 0.2-0.5°C per 10 years, which means that in case of scenario A the temperature increase might be from 0.1 to 0.8°C in every 10-year period, which makes from 1.0 to 8.0°C during next 100 years. The possibility of error is obvious due to many shortcomings in the models used for forecast. Scenarios B, C and D assume that the mitigating actions protecting us from the anthropogenic increase of greenhouse gases' emissions will be progressively realised. Depending on many factors the temperature increase will take place more or less stepwise. It will impede the regional and especially local forecasts. Nevertheless, we already know the first quantitative evaluations of climate change for Poland in next 100 years. Poland's territory should be considered against the background of the whole European moderate climatic zone and the following changes might be expected:

1. Land will warm more quickly than the Baltic Sea.
2. North-eastern territory of Poland will warm more quickly in winter than the land globally.
3. The Mediterranean area will warm more than the land globally and the sum of summer precipitation will decrease. That will cause the intensification of Mediterranean climatic influences in south-eastern Poland.
4. The mean sea level will increase about 20 cm by 2030 and about 65 cm before the end of the next century. It will be caused by the water temperature increase, which will lead to water's larger volume and melting of the ice-sheets.
5. Mean annual air temperature in Europe will increase by 4°C during forthcoming century.
6. The annual sum of precipitation will increase by 3-10%, but the interior of Europe will be much more drier in summer.

7. Surface runoff will increase due to higher soil moisture at the end of winter.
8. Icelandic Low will shift its center eastward in winter and in summer the Azores High will be weaker.
9. There will be more very hot days, accompanied by the decrease of cold periods.
10. Extreme processes will be intensified. Such processes are responsible for many morphogenetic events and processes to much more extent than it was suspected so far, even though their results are known for thousands of years (storms at seashore, floods, huge earthslides).

From all the forecasts mentioned above the increase of the Baltic Sea level and intensification of extreme processes should be considered the most important ones for the exact evaluation of the morphogenetic processes' evolution. Moreover, some of them will cause a combine effect expressed in changes of surface runoff volume.

The increase of the Baltic Sea level proceeds due to warming of the water, melting of the ice-sheets, glaciers and permafrost. In the most reasonable and most careful forecasts the increase is estimated to reach from 30 to 110 cm (mean value: 63 cm). However, there are forecasts estimating the increase of the sea level to amount up to a few meters and even though those calculations are sometimes controversial they should not be neglected. The most significant changes will be observed in the rivers' deltas and in the depressions, but the consequences of the Baltic Sea level increase will affect many domains of both inanimate nature and marine economy which was proved in the works of Rotnicki, Borówka (1989) and Zeidler (1992).

Some changes of morphogenetic processes might also occur in river valleys, especially in the bottoms of large river valleys. Vistula River valley is a very representative example as it is the largest Polish river's valley, with tributaries placed in different physical-geographical regions, from the Carpathians to the northern part of Polish Lowlands. A special series of publications, edited by L. Starkel (1982-1996), is a great advantage facilitating the predicting, as it presents the results of many years' investigation on the history of the Vistula River valley in the last 15,000 years.

The Vistula River valley evolution trends should be divided into two groups: 1. Changes due to construction of dams and water reservoirs, similar to those already occurring in Włocławek; 2. Changes with no dams and reservoirs being constructed. New dams and reservoirs on Vistula River are constructed so inefficiently that most probably happily none of them will be completed by the end of the next century. Moreover, the need of their construction is often questioned as most of the river valleys' regulations in Poland have had rather negative impact on natural environment. Therefore, being convinced that there will be no new dams constructed in the nearest future, I present only the forecast of changes based on this assumption.

The Vistula river bed and its valley's bottom might be divided into a few parts. First of them is in the Carpathians. If the mean annual sum of precipitation and the storm frequency increase, it will be followed by the increase of surface runoff, the amount of debris including the fine-grained material in the Carpathian rivers' beds and valley bottoms and more debris will be transported from the Carpathians to their foreland zone. The higher frequency of extreme phenomena, including those due to deforestation, will be the decisive factor. Every river's bed regulation will increase

the probability of flood, also the extreme so-called 100 years ones. There will be growing tendency of the anastomosing river beds development in the river valley bottoms. Such tendencies are out of accordance with the contemporary drainage of the Carpathian river valley bottoms. The drainage seems to enhance the downcutting. However, it is very limited or disappears in many places as the river beds reach bedrock. It resists the river's downcutting and permits the river bed to widen and create new secondary river beds, which enables the anastomosing river formation.

The volume of accumulated material transported by Vistula River and its tributaries will increase in the Carpathian Foreland, in Sandomierz Basin, especially in its northern part above the Vistula's gap in Central Poland Highlands. That is how it has been in a few last thousands years when the Holocene sediments covered not only the river valley bottom but also the surface of older mantle rock.

Below the river gap the Vistula River valley bottom will maintain its present state which is the tendency to drainage and preservation of the present river beds. The forecasted increase of precipitation sums will have no effect as the evapotranspiration will be higher. That will be accompanied by the lowering of the underground water table. Those phenomena might be intensified in narrow parts of the valley, where the valley bottom is also narrow. Below the Bug River junction with Vistula, down to Włocławek, the earthslides might become more frequent at the right, steep river bank. This part of the river's bed has been moving slightly in north-eastern direction during last one thousand years, which is linked with the uplift of Kujawy-Pomerania Anticlinorium. The process will be invisible in a secular scale but it is important to mention that the present tendency will be continued.

The Vistula River lower course and the delta will experience processes resulting from the Baltic Sea level increase. As far as the river is concerned, a slight but distinguished uplift of the erosion base will occur, followed by the increase of accumulation in the river bed together with its uplifting. Other changes in the delta are described in the works of Rotnicki and Borówka (1989) and Zeidler (1992).

The changes presented briefly for the Vistula River will be reflected to different extent in river valley bottoms of its tributaries in Polish Lowlands. The negative effects of anthropopression will intensify in many places, for example in Biebrza River valley. The forecast presented here should be completed with the evolution of the lowland basins with no runoff, lakes, slopes, eolian sediments and dunes, industrial areas and again the sea shore zone.

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Józef Edward Mojski
Institute of Oceanography
University of Gdańsk
Gdańsk
Poland