

## ASSESSING THE LANDSCAPE CONDITION IN THE MORAVA RIVER CATCHMENT AFTER FLOODS IN 1997

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**Abstract:** In the summer 1997, the Czech Republic was afflicted with a disastrous flood whose intensity was greater than that of the thousand year's water as indicated by experts. Riverbeds and flood plains were remodelled and the intensive rainfall induced slope processes with extensive slope displacements of which the most severe ones could be seen in the Vsetín and Zlín districts. Losses on property were estimated to 60 billion CZK, and 49 persons lost their lives. Other ecological losses can hardly be expressed in numbers and it will take time and effort to remove their consequences. The Brno Branch of the Institute of Geonics, CR Academy of Sciences gained a grant for 1999-2002 named "Floods, landscape and people in the Morava River catchment". The aim of this research grant is to monitor the consequences of the floods for the landscape and population and to analyse possibilities and trends of the further development in the flood-afflicted areas. The project is focused on the investigation of long-term or chronic consequences of the disaster and should contribute to the deeper knowledge of individual landscape functions.

**Key words:** floods, extreme climatic events, slope deformations, historical and geographical research, humane aspects of floods

### 1. INTRODUCTION

July and August in 1997 were the months with the so-called extreme climatic events. A destructive wave of floods afflicted the whole area of Central Europe and other countries over the world. For example, in Poland the floods took the toll of 4 persons, in Slovakia there were as many as 50 flood victims. On the Russian-Chinese border the water element destroyed about 2000 houses. The overflowing mighty stream of Jang-C' Tiang flooded the area of 210 000 km<sup>2</sup>. The storming water did the damage

for 20 billion US dollars. At this great water which was the worst in China since 1954 as many as 3004 persons were killed. Floods in Uttarpradesh, India where the Rapti and Ghagra Rivers overflowed their banks took the toll of nearly 1200 victims.

The worst floods in the last 10 years were also recorded in Bangladesh, the country regularly hit by floods. The water washed off the shelters of more than 30 million persons and took the toll of about 420 killed. Due to the great water, Bangladesh lost as much as 385 000 tons of cereals. Floods resulting from heavy rains afflicted also the western Africa. In Ethiopia more than 70 thousand of people had to leave their homes and water that left the Baro River bed flooded and destroyed the crop on over 3 thousand hectares of agricultural land.

Extreme temperatures are one of the extreme climatic phenomena recently worrying the world. The July of 1998 was one of the warmest months on the Earth since 1880 when the mean temperatures started to be monitored. The killing heat caught the south of the U.S.A. (129 dead), France, Italy, Spain, Canary Islands, Croatia and Greece where fires arising due to the high air temperatures destroyed thousand hectares of forests. Climatologists warn that the cumulation of episodic events such as thawing of glaciers in the Arctic Regions and Antarctic Continent could result in the rise of the world ocean water table and in the flooding of the densely populated coast areas.

## **2. THE FLOOD IN THE CZECH REPUBLIC**

At the beginning of July 1997, the territory of Moravia and eastern Bohemia recorded 3.109 m<sup>3</sup> of precipitation. The intensive rainfalls induced an extreme run-off at which the values of centenary water were substantially exceeded at many a place. The flood arrived very quickly, especially on the upper reach of the Morava River and its tributaries while the areas on the lower reach such as the town of Břeclav came under the threat of the flood wave only eight days after the rains had started.

The disastrous flood markedly remodelled river beds and flood plains situated on the upper reaches of watercourses. Extensive inundations appeared in the Hornomoravský and Dolnomoravský Grabens. The rainfalls induced intensive slope processes with extensive slope deformations mainly in the flysh uplands and hilly lands of the Outer Western Carpathians in the central and northern Moravia. Deformations in the Vsetín and Zlín districts were of a particularly destructive character. The district of Zlín so far registered 250 localities with the development of extensive large-scale slope movements in the cadastral areas of Mikulůvka, Růžďka, Malá Bystřice, Bystřička, Velká Lhota, partly also Vsetín and Valašské Meziříčí. It is well possible that the number of localities will be greater since not all of them have yet been included in the records. An example can be seen between the southern limits of Valašské Meziříčí and the confluence of the Vsetínská Bečva R. with the Bystřička R. where the engineering-geological mapping at a scale of 1:10 000 revealed a total of 120 landslides

of which 60% were newly activated. It is estimated that there are about 500 landslide areas registered in the territory of the Vsetín district. The slope movements - mainly landsliding in some localities disturbed the general infrastructure of the landscape and put into danger or even damaged houses (particularly in Mikulůvka and Růžďka), recreational facilities, roads, sources of drinking water, telephone and electric lines, forest areas, orchards, etc. The flow of waterlogged clay-loam soils in the lower accumulation portions of the slides had a similar destructive effect. Children summer camp and some recreational facilities were endangered by falling rocks.

The floods in Moravia and Silesia in 1997 launched discussions concerning the relation between the extreme climatic and hydrological situations and the landscape. What is the influence of the flood on the landscape management? What is the role of water works? Would it be realistic to leave the landscape to its own natural evolution with no larger technical interventions?

The direct consequences and losses were recorded, summarised and expressed in numbers. Official estimates speak of the losses amounting to 60 billion CZK. Afflicted were 538 towns and villages. 49 persons lost their lives, 2 151 flats were destroyed, 5 652 flats became uninhabitable for a long period of time and other 11 000 flats were partly damaged. About 10 000 people were left for a certain time with no shelter. Destroyed or severely damaged were 25 railway bridges, 13 railway stations, 945 km of railways, 51 road bridges and 592 km of roads with other 2 000 km of roads becoming non-passable. About 100 000 telephone stations were completely destroyed or temporarily put out of operation. About 100 000 hectares of agricultural land were flooded with the crop being completely wasted. 291 heads of beef cattle, 2 928 pigs, 20 horses, 200 thousand heads of poultry, 31 232 small domestic animals etc. perished in the flood.

Apart from the losses on lives and property, there were also huge ecological losses whose expression in figures would be hardly feasible. It can be assumed that the floods destroyed whole ecosystems and killed all insects and larger animals including game. Huge amounts of topsoil were washed off to give rise to enormously high mud deposits. A range of noxious substances were leached out from waste dumps, land fillings, factory stores and sewage plants and introduced into the agricultural landscape from where they are expected to gradually reach the food chains. Drinking water resources were damaged or impaired. The floods resulted in numerous landslides that destroyed or damaged houses and roads. Many damaged industrial facilities lost their buildings, machines, raw materials and final products in warehouses. Many of their employees lost their jobs.

Similarly as the ecological losses, psychological losses on people cannot be expressed in numbers either. The immediate fight for lives and property was later replaced by the shock, depression, apathy and despair. The people who were deprived of everything that they had been building for whole their lives in just a couple of moments lost any further sense of their future. They could not cope with the situation and the number of suicides rapidly grew. Psychologists advised that the most vitally important thing for the afflicted is to prevent their idleness so that the people evacuated from the flooded areas had no time to think about their misery.

Experts warn that one of causes of the extensive floods is the poor landscape management. The ecological balance of the landscape was seriously disturbed during the era of socialism and hence the hydrological situation. The landscape got unified in monocultures under the pressure of large-scale technologies and heavy mechanisation; balks, dispersed greenery (including riparian stands), wetlands and other non-agricultural vegetation formations were removed. In addition, extensive areas of agricultural land were ameliorated, small watercourses straightened and confined into concrete beds. Permanent grass stands were ploughed under the name of a so-called recompense recultivation at the even higher altitudes so that in the end, cereals were grown even in mountain and sub-mountain regions. In 1989, the total area of agricultural land consisted of 75,5% arable land of which 56,6% were jeopardised by erosion. Clear-cut areas arose in the mountain areas due to the disturbed forest stands, whose retention capacity is impaired thus increasing the risk of flood waves.

In 1992, the government passed a programme for the revitalization of river systems, which is to support and reinforce the landscape retention capacity, to increase the portion of sod resources, to slow down the surface and subsurface run-off, to hold water in lakes, wetlands and small reservoirs. The natural functions of watercourses should be gradually restored including the accompanying greenery and protection belts that stabilise riverbeds at floods as well as the self-purifying capacity of streams.

River channel reconstruction and stream recovery works were started in some localities as early as before the flood but the newly planted trees were far from being capable of fulfilling their function of riparian stands and anti-erosion barriers. There was no system of water works that could hold the water in the landscape as early as on the mountain torrents. Some new facilities built at the cost of much labour and money were washed off by the flood. The losses are enormous; yet it is important to continue in the existing set programme.

### **3. THE PROJECT OF "FLOODS, LANDSCAPE AND PEOPLE IN THE MORAVA RIVER CATCHMENT"**

The Brno Branch of the Institute of Geonics, Czech Academy of Sciences gained a grant for the period 1999-2002 with the name "Floods, landscape and people in the Morava River catchment". Its objective is to monitor consequences of the disastrous floods in 1997 for the landscape and population in the territory and to analyse possibilities and trends of the further development in the afflicted areas.

The project does not aim at the study of technical and water management problems associated with the floods. Its objective is to investigate the situation of the landscape, economy and society in the afflicted areas two to five years after the flood, it means the long-term or permanent consequences of the disaster. The research should contribute to the further knowledge of the landscape functions and to the role of seats and

technological works located in the landscape. A hypothesis should be verified, which originates from the research of other large-scale disasters and catastrophes (such as the nuclear power plant in Chernobyl) that the socio-psychic consequences have a much more serious long-term impact than the immediate material losses.

Very important is going to be the historical and geographical view. The 1997 floods were probably the most extensive floods of the historical time but they were far from being the only ones. The historical aspect was worked out for the Elbe River catchment but is still missing for the Morava River. The question of "What were the flood impacts at the time when the landscape conversion had not reached the today's development?" can be answered by a method of the historical and geographical research. We wish to demonstrate and document the historical sequence of floods in the past 400 to 500 years. Similar studies were made in some western European countries (Italy, Germany and Switzerland). The obtained results are then used in practice for flood-protection measures.

In the physical and geographical sphere, the research should be focused on the relation between the flood and the landscape as a whole. A partial task will be the processing of respective physical and geographical characteristics (particularly those of the relief and biota):

- ♦ the degree of damage on the floors of valley and flood plains;
- ♦ slope deformations.

The research will make a basis for the investigation of bindings between the respective phenomena:

- ♦ links in the system of the valley floor and the valley slope
- ♦ links between the dynamic effects of flood processes, relief and biota on new forms
- ♦ links between the physical and geographical sphere and the socio-geographical sphere of the landscape, affected by the floods.

An entirely unfathomed area is humane aspect of floods and of the post-flood situation. Again, the project does not aim at finding the direct consequences which have already been expressed in numbers (and sometimes cast doubts upon today). We want to study the situation today, two years after the flood in the most afflicted regions and seats.

Some surveys were made immediately after the event. However, a number of problems may appear only now when the floods are no more the number one event. The humane aspects in the afflicted areas can be divided into several groups:

- ♦ The course of life restoration in the afflicted communities:
  - Does the jeopardy and affliction result in the mutual cooperation and in the feel of appurtenance or rather in the defence of individual concerns?
  - What is the people's viewpoint of the local patriotism?
  - What is the behaviour of municipal council, unions and inhabitants themselves in extreme situations?
  - What are the stages of the restoration process?

- What are the future prospects?
- ◆ The course of housing resources restoration:
  - What are the chances of people with no shelter or with a heavily damaged house?
  - Are people motivated enough to build a new house?
  - Does the building take place in the same locality or the building sites are situated at a greater distance from the water?
  - Where to put the old people who lack the strength to restore their houses?
  - Was the damage a good impulse for the communities to start a better thought of construction methods?
- ◆ The course of restoration of infrastructure, production facilities and agricultural land resources:
  - Has the flood affected the rate of unemployment?
  - Are people motivated to refurbish the damaged facilities?
- ◆ The socio-psychic aspects:
  - How the floods reflect in people's attitudes?
  - Are people endangered by certain socio-pathological phenomena?
  - Do the experienced stress situations still show in the present behaviour of people?
  - What is the place of social impacts in the hierarchy of general flood losses?
  - What was the way in which people responded to the presence of mass media and "flood tourists"?
- ◆ The level of opinion as related to the future life in the afflicted localities:
  - Where do people see main reasons for the extensive flood losses?
  - Was the assistance of the government sufficient?
  - What measures would be preferred in the case of other floods?

The project will be focused on the comprehension of mechanisms occurring in the afflicted areas. For these purposes, the research team has chosen several model regions in the catchment of the Morava River that ranked with those most affected:

1. The upper reaches - between Hanušovice and Jindřichov;
2. The area of intensive slope deformations in the catchment of the Bečva River - cadastral areas of Růžďka, Mikulůvka;
3. The village of Troubky with the large-scale damage;
4. Large towns - Olomouc and Kroměříž;
5. The long-term flooded territory of Otrokovice.

The planned methods of research will be pursuant to the set goal and will include:

- ◆ field research (geomorphological and biogeographical mapping);
- ◆ observation;
- ◆ behavioural method - steered interview;
- ◆ public inquiry.

The research results will be complemented with the existing and processed information such as investment activities, unemployment, educational structure, health aspects, etc. provided by some state institutions, mainly district and municipal councils from the afflicted areas. One of important cooperation partners is going to be Povodí Moravy a.s. as an institution responsible for the whole catchment and respective flood-protection measures.

In terms of international cooperation, the research team would like to establish working contacts with the IGU Commission for Natural Hazard Studies (Chairman Prof. Rosenfeld from the University of Oregon) which launched the cooperation with some geographical workplaces in Central Europe several years ago.

The project results will be currently presented in technical magazines and conferences the main output being a publication of the monograph character summarising the flood consequences in the landscape and in the human society. The knowledge is to be applied in practice in the cooperation with the bodies of the state administration.

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## Resume

### Hodnocení stavu krajiny v povodí řeky Moravy po záplavách v roce 1997

V posledních letech přibývá stále více tzv. extrémních klimatických událostí. K nim můžeme zařadit ničivou vlnu povodní, která zasáhla v létě roku 1997 téměř celou střední Evropu. Mezi klimatické výkyvy patří i extrémní teploty. Červenec roku 1998 patřil mezi nejteplejší měsíce na Zemi od roku 1880, odkdy se průměrné teploty měří. Klimatologové před tímto nakupením epizodických událostí varují.

Ničivá povodeň, která v létě 1997 postihla Českou republiku, měla podle odborníků sílu větší než tisíciletá voda. Během šesti dnů spadlo na území Moravy a východních Čech 3.109 m<sup>3</sup> srážek. Velká voda výrazným způsobem přemodelovala koryta i údolní nivy v horních částech vodních toků. V moravských úvalech se vytvořily rozsáhlé rozlivy vody. Ve flyšových vrchovinách a hornatinách Vnějších Západních Karpat na střední a severní Moravě deště způsobily intenzivní svahové pochody se vznikem rozsáhlých svahových deformací.

Povodně 1997 rozpoutaly rozsáhlé diskuse na téma vztahu mezi extrémními klimatickými a hydrologickými situacemi a krajinou. Jaký vliv na povodeň má způsob hospodaření v krajině? Jakou roli sehraávají vytvořená technická díla na tocích? Je možné nechat krajinu vyvíjet se přirozeným způsobem bez větších technických zásahů?

Brněnská pobočka Ústavu Geoniky AV ČR získala na roky 1999 - 2002 grant s názvem "Povodně, krajina a lidé v povodí řeky Moravy", jehož cílem je monitorovat důsledky katastrofálních povodní v roce 1997 pro krajinu a obyvatelstvo tohoto území a analyzovat možnosti a trendy dalšího vývoje postižených oblastí.

Účelem projektu není zkoumat technické a vodohospodářské problémy spojené s povodněmi. Cílem je zaměřit se na stav krajiny, ekonomiky a společnosti v postižených oblastech dva až pět let po povodni - tedy na dlouhodobé, popřípadě trvalé následky katastrofy. Výzkum by měl přispět k hlubšímu poznání funkcí krajiny včetně sídel a technických děl zde umístěných. Snahou je i prověření hypotézy pocházející z výzkumu jiných plošně rozsáhlých havárií a katastrof (např. jaderné elektrárny Černobyl), že sociálně psychické následky jsou dlouhodobě závažnější než bezprostřední škody.

V oblasti fyzicko-geografické sféry se výzkum zaměří na vztah povodně a krajiny. Budou se zpracovávat jednotlivé fyzicko-geografické charakteristiky. Zcela neprobádanou oblastí jsou humánní aspekty povodní. Cílem projektu není opět zjišťovat přímé následky, které již byly vyčísleny. Chceme se zaměřit na to, jak vypadá situace dnes 2 roky po povodni.

Výsledky výzkumu budou doplněny už existujícími a zpracovanými informacemi některých státních institucí - především okresních a obecních úřadů postižených oblastí. Jedním z důležitých subjektů pro spolupráci bude podnik Povodí Moravy, a. s.,



který odpovídá za celé povodí a jednotlivá protipovodňová opatření. Hlavním výstupem bude publikace monografického charakteru, shrnující důsledky povodní v krajině a lidské společnosti. Také bychom chtěli spolupracovat s orgány státní zprávy a aplikovat zjištěné poznatky v praxi.