

## RECOVERY OF FLOODED AREAS

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### Abstract

*The article is focused on the problems with the flooded area renewal. Floods are not the only reason for investments in buildings, homes and infrastructure repairs without taking into consideration other significant aspects. The authors discuss the issue of population protection in long-term prospective. They analyze facts and consequences of flood disasters in the past and point to new aspects of redevelopment for the future – destroyed human dwellings, communication and infrastructure are the reasons for anti-flood measures, relevant laws and new attitudes of the authorities. The article argues against a traditional solution: "Get resources, invest, build, repair, and the subsequent floods will destroy again." Instead avoid unnecessary spending on structures that the flood can damage again. Support the efforts to invest in recovery and in preventive measures at the same time.*

### Keywords

*Redevelopment, recurring floods, security threats, area renewal, anti-flood measures, regulating constructions in flooding areas.*

## INTRODUCTION

The occurrence and course of extraordinary events caused by natural forces have been rising recently. Since 1997 when the Czech Republic was affected by the most disastrous flood since its establishment, we have been talking about more intense prevention against floods. However, in fact we just mitigate, recover and remove the consequences of floods. We recover affected territories and try to bring the buildings and communication routes to "the conditions before floods". For these activities we use a large amount of financial sources from the state budget, insurance companies and affected citizens as well.

### 1 Floods as a recurring phenomenon

Regarding floods, the year of 1997 is breakthrough. From the contemporary point of view, not more than 100 years ago, we were affected by the largest and most dramatic floods ([18], [20]). During them 50 people died and

material damage was enormous ( 2151 houses were destroyed, 26 bridges were pulled down, the damage amounted to 63 billion of crowns. But let us ask two questions. Has it really been the most disastrous floods in the history and what does the nature try to say to us? It is obvious that the memory of the public is very short. Floods have been affecting our territory regularly and they are very well described already since 13<sup>th</sup> July 1257 when the heavy flood on the river Svitava had affected the town Brno. After having studied historical sources we found out that since then large floods have been occurring in different size several times each century. In case of large floods, the largest and disastrous ones occur from June to August except ice floods from spring melting.

According to notes in chronicles and preserved records the extreme floods occurred in Bohemia and Moravia in 1118, 1180, 1257, 1272, 1342, 1359, 1481, 1501, 1784, 1845, 1872, 1890, 1897, 1905, 1907, 1997, 1998, 2002, 2006 and 2010 and of intensity which is presented in fig. 1 [7]. The 20<sup>th</sup> century was without floods (larger flood occurred only in 1903 in Silesia). However, larger human interventions into the countryside carried out, the areas which were due to recurring disasters for the centuries uninhabited began to be overbuilt, the rivers were regulated and the forests which keep water back from the vicinity of rivers disappeared.

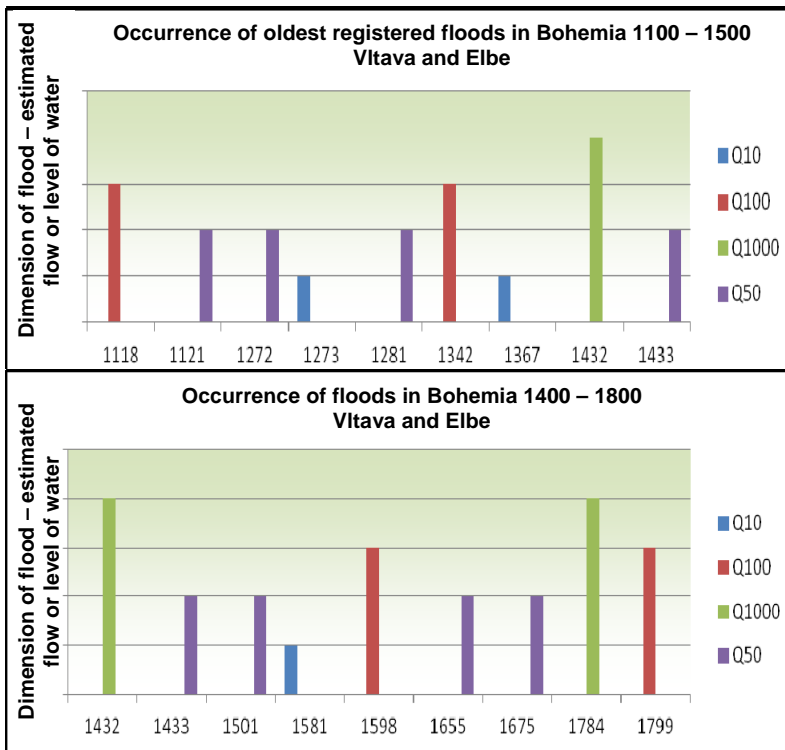
In 1997, after decades of calmness, the citizens of a large area were scared by floods caused by heavy precipitations. High water destroyed first of all the river-basin of the Morava and Dyje rivers. Only a few years later the destructive element came to Bohemia. Continuous precipitations at the beginning of August 2002 raised the water level in the Vltava river-basin, water system managers could not master the Vltava cascade full of water from previous rainfalls so the high water flooded the capital city and a significant part of Central Bohemia. The flood wave partly disappeared behind the confluence with the river Elbe and part of it flooded fields around the Elbe. Besides the river Vltava, the situation was critical also around the rivers Berounka and Dyje. ([3], [17])

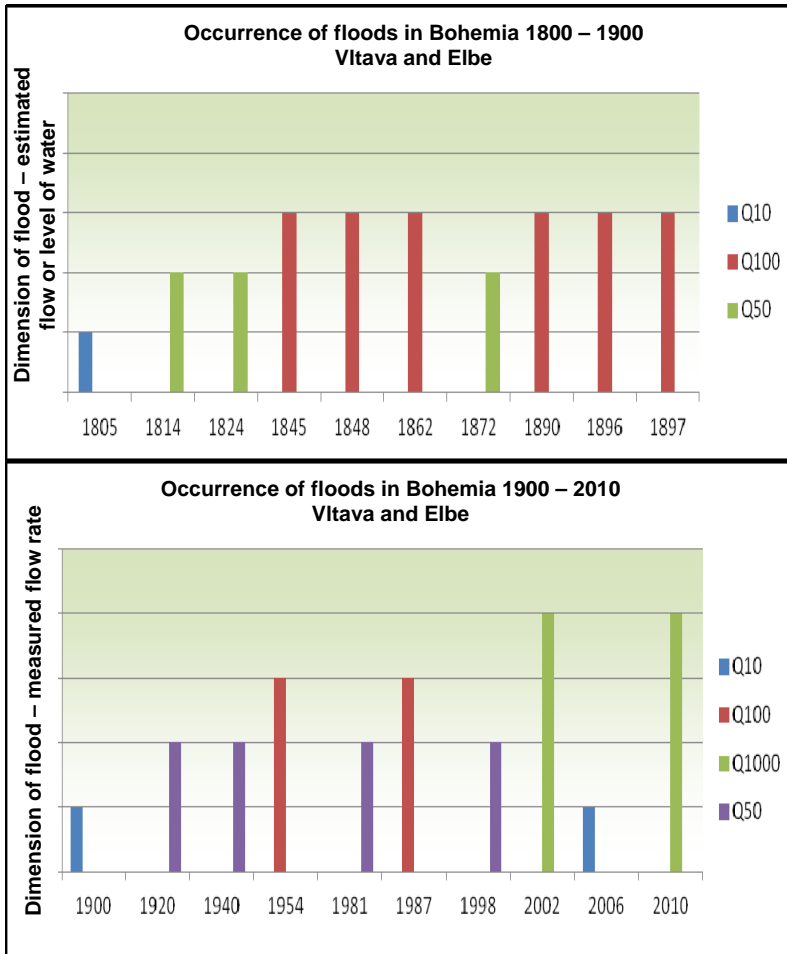
From the historical point of view, lessons learned are from the flood of 1897 which occurred on July 27 till August 3 as it is recorded very well. It was then exactly 100 years before the flood in 1997 and after 113 years (2010) it came back to our territory (Liberec region) where it caused heavy damage. This flood was specific for several reasons. At that time in Nova Louka in the middle of Jizerske mountains  $345 \text{ mm/m}^2$  in 24 hours poured which has been so far the precipitation record . ([1], [12]). This flood was a turning point in the frequency of the occurrence of another, recurring flood of July 1903, i.e. already 6 years after. Here we can see a certain continuity of the flood frequency in years 1997 (Morava river) and 2002 (Vltava and Elbe rivers + 5 years), 2006 (spring flood on Dyje, Morava, Elbe, Luznice rivers + 4 years), 2010 (summer flash flood on the rivers Luzicka Nisa and Smeda in Liberec region + 4 years). ([17], [18], [20])

People have always been confronted with floods. From the sources we deem that according to the speed and amount of water and first of all from their course they were floods which we now call floods caused by torrential rainfalls. In principle the dwellings were not built in places where the floods occurred either

based on the own experience or due to preserved records. [16]. As long as the dwellings were built, they were built outside the main stream of flood wave as it was recorded by witnesses, historians or artists in preserved papers in order that the damage was the least. Destroyed facilities used to be – water mills, sailing constructions, ports, water forging shops - iron mills, facilities for drapery production – wash boards and hemp-kilns, buildings for maceration of flax, water saw-mills, bridges and banks as well as other water system constructions – fire tanks and wells. The most precious property was the human life, life of livestock, food and clothes. As a result of catastrophic floods of 1897 the extensive regulation of rivers was initiated for the first time together with other protective activities against high water which have not had an analogy in the history of Czech countries. [21]

Year 1903 was a breaking year due to the initiation of large regulation of rivers on the national territory. Vast adjustments of river-beds and construction of dams (the Vltava river cascade) started as a basic element of holding-back systems, the construction of flood-gates, weirs, and reinforcement of banks in order to protect citizens and property. With regard to these basic changes in the countryside and the capabilities of man to regulate and hold back coming water, the situation gradually calms down and the floods cease to have such material consequences.





*Fig. 1  
Occurrence of largest floods in Bohemia since the first records*

The situation begins to change radically after the Second World War. The generation that decides on foundation of new buildings in inundation areas applies the experience from previous 50 years (1900-1950). Unfortunately not the information from previous centuries. Construction boom starts also in inundation areas which has been persisting up to now with the belief that man stopped the regulated element. This contributes to the fact that floods since 1997 have been causing such material damage even though in its scope they could be smaller than floods in the past. The lessons which the natural forces learnt us after a 100 of years, therefore after years for which we dimension anti-flooding measures of towns and villages (for 100-year water  $Q_{100}$ ), is the fact that through human

activities the situation in the bottom lands of rivers in the CR changed the way that whatever large flood will cause huge material damage. These lessons learned mean that we have to change the concept of the recovery and development of dwellings in the vicinity of rivers in the way which will result in losses much lower, not higher in the following a 100 of years.

## **2 Recovery of areas affected by floods**

The aim of recovery is to bring the territory back to the previous state as it was before the flood. The effect is dual, first to renew the functionality of a region, secondly help the citizens to overcome the situation psychically and materially. [26]. Here the heaviest financial burden is up to the state together with insurance companies and afflicted citizens. Now the fundamental problem rises, whether the financial means are purposefully used. The question is, whether 100 % of this way determined means is to be used for the recovery or whether it would be wiser to spend them e.g. 90 % on the recovery and 10 % on the prevention against another, future flood? The aim of each municipality, town or region is to bring the things back to the previous state. However, what is the previous state? Mostly we think that it is the state before the flood. And this is one of the biggest mistakes. Because this state resulted in the flood and subsequent damage. It is the state before the flood in a remote time horizon? No, it is not. The time after floods is zero. In this time, just after the flood, it is absolutely indispensable to solve together both the recovery and the cause why the flood had destructive consequences. Why was the damage so high? The answer is the target for expert teams which are supposed to identify the tasks for the territory recovery in the way which would exclude the possibility of new damage in case of another flood and at the same time the recovery would be satisfactory.

The issue of floods has always been an inter-branch matter (from hydrology, civil engineering to math modeling). The practice proves that the generation of quality expert teams is not the task for municipalities or districts. This team of experts should be governed by the ministry. From this point of view, Population Protection Institute as an independent body composed of experts for floods and constructions is an appropriate institution. Another type could be an independent coordination or consultation company having sufficient experience in the issue with independent and temporarily hired professional services. The independence on a region or area is necessary because developed projects of recovery will influence the municipalities, towns, regions and the influence of them on an expert team would only result in preservation of a current state.

## **3 August flood in Liberec region in 2010 in the context of the floods of 1897**

On 6<sup>th</sup> – 7<sup>th</sup> August 2010 the territory of Luzické and Jizerské mountains was afflicted by uninterrupted torrential rainfalls which reached 150 mm/m<sup>2</sup> in 24

hours, in some places the total values were  $255\text{mm/m}^2$  in 48 hours. The flow down of these rainfalls from the hill-sides resulted in a steep rise of water levels which rapidly reached the 3<sup>rd</sup> flood level. The Liberec, Podjstedi and Frydlant territory can be divided into three areas. The first area is around the river Jizera which takes the water from southern hill-sides down to the south to the confluence of the river Elbe next to town Celakovice. Here much damage was not caused despite the 3<sup>rd</sup> flood level. The second area is around the river Smeda which caused flash flood with a huge dynamic effect on constructions in Hejnice, Raspenava and Frydlant districts and moreover caused damage along the valley of its flow to the north up to Czech- Polish border (Visnova-Predlance, Cernousy-Boleslav). The third area is around the river Jerice up to its confluence with the river Luzicka Nisa which has a shallow rocky bottom without the possibility of deepening. Here the constructions and pieces of land in municipalities Nova Ves, Chrastava, Bily Kostel, Chotyne, Hradek nad Nisou were affected. It was a recurring kind of summer flood with a hydrometeorological situation Vb (5b) for which it is typical that after the arrival over our territory it stops for several hours and days and causes the fall of very intense torrential rainfalls. This time the rainfalls and induced floods returned to the place next to the place where 100 years ago (1897 in Krkonose mountains) caused probably the highest material damage in our territory and certainly had the most casualties (at that time 150 people died). ([14], [19], [22])

A detailed historical citation about the flood in 1897:

*In<sup>1</sup> 1997 one hundred years had passed since the biggest natural disaster which has ever afflicted the Krkonose mountains. The flood of 1897 took place in the territory of almost two thirds of Bohemia, part of Moravia and Silesia, and brought to the Krkonose mountains the pictures of an apocalyptic destruction. As if at the very end of the 19<sup>th</sup> century all previous threats culminated and current destructive cloud-bursts and high water which have always troubled the Krkonose people, as if they were just the prologue to the tragedies which occurred in this fatal year. Yet the consequences of large floods of 1858 and 1882 did not disappeared of the mind of the highlanders when after long-term rainfalls the Krkonose mountains experienced on 28<sup>th</sup> till 30<sup>iet</sup>h of July the cloud-burst. Above the highest Czech mountains a terrifying stormy night came. It was similar to a Biblic flood; but, unlike that one, it came to the life of thousands of people absolutely unexpectedly and without any warning. Especially both main rivers, the Elbe and Upa changed into huge water flows pulling down, destroying and taking everything ahead of them. The destructive force of high water damaged all Krkonose villages, on the Czech side of mountains it did away with 120 people and in its action it continued also in lower flows of the rivers.*

This can be completed by another record:

*„30. July of 1897<sup>2</sup> the Jelenohorska hollow basin was affected by the largest and due to its consequences by the most tragic flood in the history. At night of 29<sup>th</sup> to 30<sup>th</sup> July 1897 the cloud-burst came and the water in the river Jedlice soon overcame the state which is declared as the state of emergency. The rain poured through the streams, it was sticky and hot and during the next 10 hours approximately 200 liters of water per one square meter fell down. Unaware*

*citizens of the town were sleeping calmly, only those living next to a river heard growing murmur of water multiplied by the hits of stones rolling through a river-basin and hitting the stone walls fixing the banks. Only in the morning a delayed alert was declared, deafened by the element. The havoc was seen already at crack of dawn. Many houses were flushed away by the flash, the element took everything which was ahead: wood buildings, doors, windows, furniture and other house equipment. Many inhabitants were not able to leave their dwellings because they were surrounded from all sides by a strong flow of water. 14 apartment buildings and 15 other buildings were completely destroyed, 10 apartment buildings and 5 other constructions were widely damaged. Water also flushed away 12 public and 9 private bridges, destroyed 3 km of public and 11 km of private roads and ways.* We can compare both situations within 100 years, the former and the current one. This way we can evaluate whether our intervention in the countryside in the form of construction of buildings, bridges, roads and networks were cautious.

#### **4 It is possible to fight the floods?**

Two flash floods in one year (2010) which afflicted first Moravia and then the north of Bohemia prove that something is wrong. “Thousand-year water” has come in a last decade every 2<sup>nd</sup> – 4<sup>th</sup> year. The question is whether we can prevent the damage and which of potential preventive measures we should carry out and at what price? [25]

A significant number of experts think that increased occurrence of floods is connected with the climate change which manifests itself in the increase of precipitation extremes. This differs from the tradition periods by more frequent e.g. waves of heat, violent storms or heavy freeze. The most significant consequence is in the area of hydrometeorology: a period of extreme drought is changed by a wave of heavy or long-term precipitations.

These phenomena are obviously connected with global warming of our planet which manifests itself in surface layers of the earth crust, oceans and adjacent parts of the atmosphere. Simply said, in the troposphere more and more thermal energy has been gathered which subsequently results in the escalation of the phenomena aiming to balance energy surplus. The connection with the floods is however induced only thanks to long-term observations and therefore it has exclusively a statistic character. [10]

However, as long as it begins to occur casualties, damage to dwellings and property, people have to react to this extreme weather. We differentiate adaptation and mitigating measures. Adaptation measures are e.g. these which are focused on timely warning and preparation of population for an extreme situation: weather forecast, monitoring of water flows, lakes and dams and provision of publicly available information on the flood level, protective measures in the countryside in agriculture, forestry and water system, as well as construction of retaining, regulation and retention enhancing systems such as levees, half-permeable blocks,

drainages, mobile block devices, deepened and cleaned water basins and capacitive dry polders or river polders.

Very important are technical actions, for example building norms, revitalization of water flows or regulation of the territory development or organization measures of state administration e.g. (not) granting building approvals due to the cooperation between insurance companies, water-law authorities and construction administration elaborate long-term plans of the territory with the updating of flood maps and plans. Adaptation measures are effective only in specific limits. In order to know how to set specific norms and carry out adaptation measures we have to be familiar with these limits, i.e. we have to be aware of the development of current weather situation as well as the global climate system and especially of the development of prospective extraordinary events in the location of planned building activities.

## **5 Guiding, regulating and cooperating activities**

Since the destructive flood in 1997 the Czech Republic has worked on anti-flood measures, on larger cooperation of rescue forces and all institutions and works which might be affected by high water. The regulation of water flow has improved e.g. by “preventive” shedding of dams and synchronized emitting of dams cascades which are then able to retain more water and at the same time keep the operation of recreation, irrigation and transport functions as in times without floods. ([26], [28])

Despite this fact it proves that floods are at preset more destructive than they used to be in the past, especially as far as the calculation of property damage is concerned. Previously the floods were more expected and according to common sense our predecessors built farther from the water. Houses in old Prague were e.g. built with double doors on opposite sides alongside the bank and in case of floods the water could flow freely. The most visible is then the respect for floods on the railways, because rails have always been built on the railway embankments in the height where the water, according to experience, did not reach.

In the 20<sup>th</sup> century the built-up area along rivers spread in a mass scale. In places where in the past used to be the fields, the villages are built (the village Troubky is on the confluence of the river Morava and Becva) and people have been scared and surprised during each flood, already several times in the last ten years. The river basins are costly made of concrete and prospective high water cannot either soak or leak and flows therefore to lower inhabited areas where it causes the damage.

## **6 Flood protection and updated legislation**

The amendment of Water Act came into force 1<sup>st</sup> August 2010. The most substantial changes in Water Act are related to a new process of planning regarding



rivers, its evaluation, simplification of some administration acts etc. The amendment reflects the regulation of the European Parliament and Council 2007/60/ES on the evaluation and management of flood risks. At present the amendment of a wide range of relevant promulgations including the public notice on determination of flood territories and the notice on planning. This way the Czech Republic fulfilled its commitment in the issue of crisis management toward the European Union and this amendment submitted. [28]. After the experience from floods in 2006-2010 also the Guideline for warning and forecast flood duty was adjusted. Also gradual implementation of Flood regulation on the evaluation and management of flood risks is being discussed which comes into force together with the amendment of Water Act (2010-08-01). ([27], [28]) For the specification of areas with a significant flood risk we already have the guidelines. They order to define the areas with a significant flood risk till 2011-12-31 and consequently to elaborate the maps of danger and flood risk for these locations (till 2013-12-22). Two years later (2015) the plans for mastering flood risks are to be ready. This means that within 5 years the Czech Republic is supposed to submit measures to decrease potential risks of relevant territories. ([2], [6], [9], [13], [26])

Last but not least it will be necessary to interconnect better the territorial planning and systemic and effective proposals for anti-flood measures for integrated river basins. Just the implementation of Flood Guideline is now an important task of the Ministry of the Environment as a central flood authority. Water Act among others mentions a flooding territory and its active zone. Formerly the owner was not allowed to repair the building if it was in the active zone. Now the amendment of Water Act counts with the fact that real estates may be repaired but the repairs must not worsen flow conditions of a river. For example the building should not be extended cross the valley. The question remains if the pressure to limit this way repaired buildings should not be intensified the following ways

- a) to raise the insurance for real estate,
- b) to warn the owner that the municipality does not recommend that the building should be built in this place and in case of future damage the owner will not be provided the turnaround compensation,
- c) not to permit new construction on repeatedly flooded land,
- d) proposal for and implementation of anti-flood measures in the territory administered by municipalities and towns as a part of state policy to prevent future damage.

As long as a person has a real estate in a flooding zone, nobody is allowed to take out it from this place. The problem is that people are used to living in the place when it takes for years. Therefore it is necessary to consider whether to take out the building from a risk territory or to choose local protection – to build a levee or a mobile wall, “to open” a house to the possibility of its flow capacity, make downpipes, septic tanks, wells etc., to build raised foot-walls under the building with respective modern insulation, to install press fillings of sink, ground-floor windows and insulation of ground-floor enclosure walls and complete flood protection of cellars. ([8], [23], [24])

The situation in some localities is necessary to solve within the integrated river basins and look for localities where it is possible to retain precipitations, e.g. lowered pouring areas - polders, drain and spillway leakage paths, sewerage systems and through-pushes. It is therefore important to consider whether it would not be cheaper to give the owner the money for building a house outside the risk territory. The speciality in Liberec region has been since 2010 the offer of available plots within the residential area of a municipality for free for building a house outside the river inundation with the commitment of an owner e.g. to reside in a municipality for a determined minimal number of years. Everything is focused on the operability of an integrated system of electronic recording of inundation areas in which the regions and districts would be engaged i.e. the authorities which determine the flooding areas.

## **7 The influence of agriculture activities on the course of a flood situation**

In connection with the 2010 floods it proves again clearly that besides costly technical measures the rise and course of floods are essentially influenced by the activities of farmers in the countryside and their way of farming. The floods in Liberec and Usti region proved again that in the areas with prevailing grass and beef and sheep raising the impacts of floods are much lower than in the countryside which is extensively used by farmers. The fixed grass turf prevents from not only the erosion and washing away of the arable land but also a rapid outflow from the country and after excessive precipitations it works as a porous sponge which still, for weeks after torrential precipitations, retains the water.

A negative example are the municipalities with intensive ploughing as e.g. Bily Kostel nad Nisou which were repeatedly flooded from the surrounding fields even during a weak rain. Arable land especially from fields with corn which is grown here for bio-gas stations gradually substitutes the beef-raising. The arable land of these fields ends up, based on negative experience after torrential rainfalls, down in the village in a three-meter layer of mud. Fields with corn gradually "go" to villages and valleys and besides the arable land outflow significantly worsen the retention of a country with regard to torrential waters. The corn is however grown also on slopes with the bent which is not for it suitable. In spite of the fact that these cases repeat, there is at present no obligatory procedure how to make the farmers prevent such situations or make them participate in the substitution of the damage for the affected people.

As an effective prevention against maximal flood damage proves the combination of beef and sheep raising on slope and hilly pastures with ecology agriculture. The capability of grass surface to retain water is here even exponentiated by ecology farming which provides better protection against floods than the soil farmed in a current intensive way. The land with high content of humus and biology activity is two times more capable to infiltrate and retain the water.

The floods cannot be avoided. However, their impacts can be minimized and it proves that it really depends on the farmers whether the damage after floods will reach 60-70 billion (1997, 2002, 2010), or “only” 4 billion (Usti region 2010). It proves that the approach to agriculture whose aim is a short-term maximization of profits regardless the country and population results in high costs. And the adjustment of these excesses is fully in hands of the state. Since nobody can predict where the precipitations and floods will strike again, the most effective tools in this regard are integrated solutions motivating farmers to change the way of cultivation. The Association of Marginal Areas match independently farming peasants from mountain, under mountain and border areas of the CR involved mostly in animal husbandry. The members of this association or its member organizations are more than 950 agricultural farms.

## **8 In flood areas it is being built and repaired as if the floods do not threaten any longer**

The example is the village Troubky where heavy flash floods have stricken several times and the situation repeats all the time. The water has not fallen off yet and the debates already occur that in flooding areas we should not either build or reconstruct.

Nevertheless, soon after the water disappears, people again reconstruct and build and so the stories of flooded people and destroyed buildings repeat again. The problem is in the activity of water-legal offices which express their opinions on the construction in flooding areas, and building offices of towns and regions which elaborate and follow the land-use plans. These authorities mostly prohibit nothing though, and therefore we all as the society lose huge amounts, billions of funds for useless reconstruction and building which will run to waste. The applicants for construction in such locality address the river-basin office where they learn about the requirements which must be followed. The owners are obliged to found the building on their own expenses in the way which ensures that prospective higher river level does not threaten it, this is the requirement.

And in a similar way the things go on in Troubky which have been affected several times and definitely not for the last time. Also there people go on building though. The authority e.g. determines that the ground floor of a house must be above the border of a hundred-water, nevertheless again we witness flooded cellars, damaged communications and foundation backfill under the houses and this fundamentally affects the statics or damage water pipes, cables, gas-pipes which must be revised then. Better than leave the technical floor to be flooded is the Austrian way of anti-flood protection. There the houses in flooding areas are built on piles - e.g. on iron-concrete pillars. When the high water comes nothing serious happens, people just deal with their cars where to park them.

2010 floods in Liberec region carried away four casualties. Still more frequent flooding occurs due to shortening – straightening of river flows and removal of river bottom lands, balks and hedge-rows which retained the water or slowed it down.

## 9 Land-use plan - the way to prevent damage caused by recovery without a concept

New development in areas threatened by floods brings also a higher number of threatened inhabitants and expressive accumulation of potential damage to economic and cultural values. Since it pays that the best way of protection against floods is to stay farther from them, it is necessary to specify these areas in details as **flooding areas**, determine their **active zones** and reasonably regulate their utilization.

In these areas it is necessary to analyze the character of the flood course and determine the range and borders for potentially threatened territory. On these bases it is then possible to identify the level of a risk and the potential of possible damage, make decisions on the **utilization** of individual parts of a threatened territory and carry out **risk analyses**, which are indispensable for reliable elaboration of flood plans and the acceptance of short-term and long-term measures in the area of protection against floods.

Flooding areas (within the Water Act) are areas whose size and borders must be determined on the suggestion of the administrator of a water flow – most frequently River – basin Office, Water – legal Office. These are obliged also to demarcate, in build – up areas of municipalities and areas determined for the development according to land-use plans on the suggestion of the administrator of a water flow, the active zone of flooding area due to the dangerousness of flood flow rates. **Active zone** is the area in build-up parts of villages and in the territory designed for the development according to land-use plans which during the flood **drains away a crucial part of a total outflow**, and this way imminently threatens the life, health and property of people. [29]

At present when setting the size of flooding territory we use mostly the **flooding curve for  $Q_5$ ,  $Q_{20}$  a  $Q_{100}$** .

This way we obtain the course of water surfaces in the total area of a territory of interest together with the direction and the velocity of water flowing which has a considerable influence on the extent of damage and jeopardy to inhabitants lives. These data then enable to quantify much better the range of **risk for different types of buildings and determine more precisely potential economic damage**.

In order to facilitate and accelerate the elaboration of flooding areas it is suitable to use the possibilities of geographic information systems (GIS) and store the data in the form of coordinate vectors. They enable the data analysis and their subsequent presentation both for the expert and laic public. The results in an electronic form can be easily updated. They can be also interconnected with other information sources (e.g. the real-estate register, registry office) and applied actively in case of flood. Construction administration should supervise during their current activities especially in flooding territories the illegal construction of fences, shelters, green-houses and other minor constructions. As long as the construction of such building in a flooding area is announced, it can be approved only if it cannot influence the course of the flood, e.g. by decreasing spillway conditions and submit this construction to proper building proceedings, i.e. not allow the construction only on the notification.

## **10 Plan for mastering flood risks – guidelines for prevention of damage from prospective floods**

Flood plans and plans for mastering flood risks are elaborated in three phases which are:

- a) Preparatory work which contains preliminary evaluation of flood risks and demarcating of areas with a substantial flood risk which must be published and available for the public for the remarks at least 4 years before the beginning of a period for which the plans for mastering flood risks are made. Further it is a schedule and a program of activities for the elaboration of plans for river basins which must be published and available for water users and the public for remarks at least 3 years before the beginning of a period for which the river basins plans are made.

Then it is the analysis of general and water system characteristics of a river basin, the evaluation of the impacts of human activities on the condition of surface and ground water, maps of flood danger and maps of flood risks for the areas demarcated according to the point a), economic analysis of water utilization and then elaborated preliminary list of significant problems with water management in a water basin including specification of artificial water formations, specification of strongly influenced water formations and its reasoning and suggestions of special goals for water protection which must be published and made available for water users and the public for remarks at least 2 years before the beginning of a period for which the river basin plans and plans for mastering of flood risks are made.

- b) Elaboration of suggestions of river basin plans and suggestions of plans for mastering flood risks which must be elaborated according to the results of preparatory activities and contain programs of measures for the achievement of goals and published and made available for water users and the public for remarks at least 1 year before the beginning of a period for which the river basin plans and plans for mastering flood risks are made.
- c) Elaboration of river basin plans and plans for mastering of flood risks adapted according to the evaluation of consultations with water users and the public.

River basin plans and plans for mastering of flood risks are reviewed and updated every 6 years from the date of their approval. The range of measures for the protection against the floods is determined by the position of a building and the threatening by the flood, by the level of a flood threat and the progress of a flood situation. It is a vested right of each owner of a threaten real property and first of all a municipality to consider the extent of this protection. The municipalities can decide then that they will take specific technical measures for the protection against floods – e.g. increase of spillway capacity of a river basin, construction of stabile flood walls or use mobile barriers, etc. and this way, under specific financial costs on this construction and operation they enhance the protection against floods. However they are not able to completely exclude the danger of floods. On the contrary, they can decide that for the protection against floods they will not take or take only minimal technical measures. They save the money but they risk that

during the flood the damage to real properties will occur. Therefore it is the exclusive decision making of municipalities within self-administration.

## CONCLUSION

People in flooding areas repeatedly suffer from floods. Many a time they do not know what to do first, if to save a house, fill out the applications for the subsidy in emergency or to repair their house. A number of them want to take the matters into their own hands. This is also the case of volunteers from village Troubky who with bare hands built several hundred meters long levee which protected the village from the flood sufficiently. The issue “How to carry out the recovery” is wide:

How to protect against raising water level? How to get ready for the flood?

To repair damaged houses or move elsewhere?

It is possible to build a high water resistant house?

How to distribute grants and investments among the repair costs, prevention costs, insurance costs?

Why the house was affected by the flood? Was it possible to prevent from it?

How to protect districts and human dwellings against flash floods?

The investments only into repairs is not a way out for the future and it depends only on the moment when the state “after the flood” changes into the state “before the flood”. That is to say, a more-year flood can come again. Above mentioned facts regarding repeated floods in Czech countries and the ways out for the recovery of affected territories result in these logical directions how to decrease the future damage:

- a) generation of a panel of on local administration independent experts from the meteorology branch, hydrology, crisis management, building industry, ecology, insurance, ministries of the environment and local development and agriculture and other areas. The panel should address among others the legislation and the change of the countryside in order to be able to retain water and expressively better prevent from harmful effects of recurring flash floods or floods caused by region rainfalls;
- b) introduction of strict coordination and regulation measures of future construction in flooding areas and adoption of legislation steps to accomplish the reconstruction of existing but repeatedly damaged buildings;
- c) suggestions and accomplishment of preventive measures in the countryside which would prevent from catastrophic impacts of floods on human dwellings and routes.

It is a very purposeful activity with regard to the reality that prevention is always cheaper than therapy. The second point is how to motivate people to make the decision on the change of their domiciles and looking for the place to live that is not repeatedly affected by floods. A good example is the allocation of land in the town residential areas. Great responsibility rests on territorial self-administration and its willingness and courage to use all available tools, especially

a land-use plan. Further on the courage of construction administration not to permit any building in flooding areas. Self-administration is to mark areas in its land-use plan about which it is known that are in flooding areas and mark them as impossible for the building-up. In this connection it is worth considering to coordinate and determine the conditions for the construction in flooding areas. Nevertheless the floods of August 2010 were caused by sudden torrential rainfalls during which the rivers which were not dangerous in terms of floods, got flooded. That of course does not witness to anything which would prove when a similar event occur again, if the next year or in a hundred of years.

### Résumé

*Recovery of areas affected by floods is the process of renewing the functionality of the area concerned, and often very expensive repairs, covered by the state funds, are carried out. The article shows that the flood is not just a one-off disaster, but it is a recurring phenomenon. This natural phenomenon should not be underestimated and we should try, when it is not possible to fight it equally - at least not to succumb to it by authorizing the construction of new buildings in risk zones. For this purpose the state must use the tools of territorial planning, flood maps, flood plans, and last but not least the risk assessment and insurance tools. Allocation of funds for renewal and recovery must not be spent totally only on the recovery, but based on the independent expert participation and decision making. The part of these funds must be set apart for the investment into effective flood measures coming under the population protection of a region.*

### NOTES:

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<sup>1</sup> The excerpt from the publication "The biggest flood in Krkonose mountains 1897" published by the Administration of Krkonose National Park and Krkonose Museum in Vrchlabi with the text by Miroslav Bartos to remind 100<sup>th</sup> anniversary of the biggest Krkonose natural disaster, 1997.

<sup>2</sup> Magazine Krkonose – Jizerske hory August 2007. Taken from the publication "High water in Bohemia from July 29<sup>th</sup> – 31<sup>st</sup> 1897", published in Prague by Alois Hynek - a bookseller.

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