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The Economic impact of floods and their importance in different Regions of the World with Emphasis on Europe

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Abstract

The paper deals with the positive and negative impacts of floods the world economy. The paper analysis economic of flooding damage in different parts of the world, especially Europe and Slovakia. The objective of this paper is to economical analyze flood damage in various regions of the world. The paper was developed based on data from secondary sources from the European Environment Agency and the Ministry of Environment of the Slovak republic. One single event may produce both benefits and losses to different parts of the riverine ecosystem and the impact on the economy of the State. These impacts are extremely difficult to quantify or monetize e.g. by quantifying ecosystem services before and after an event or accounting for the number of fish killed or trees damaged. If more people are to dwell in vulnerable areas and more and more businesses settle down in these areas the more intensive effect a flood event will have upon society and the world economy. Society is becoming more aware that floods can be controlled to a limited extent, and that absolute safety against floods is a myth with which is necessary to fight for the improvement of the world economy.

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1. Introduction

For centuries and even millennia, people have been settling near rivers in order to till fertile soils, profit from flat

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terrain, have easy access to the water needed to sustain life, and use the river for transport. In days gone by, dwellings were typically constructed on higher land, while lower ground was used for farming. Riparian peoples benefited from the floods which have enriched the soil (irrigation and nutrient supply) and helped agriculture. In short, people lived in harmony with floods (Kundzewicz, 2004).

The frequency and consequences of extreme flood events have increased rapidly worldwide in recent decades (e.g. Bouwer et al. 2007; Kron 2009 in Zevenbergen, 2013).
The key drivers for these increases are the world's population growth and the increase in socioeconomic activities in flood-prone areas and significant climate change, which occurred in almost all countries of the world.

2. Material and Methods

The cause of floods are most frequently extremely heavy rains or sudden melting snow combined with significantly reduced ability, even inability of an area to retain rainwater (due to damage to the country – e.g. dried swamps or drained of agricultural land).

Flood risk may have increased due to a range of changes in the use of land, which induce changes of hydrological systems. Deforestation, urbanization, and reduction of wetlands cause a decrease in accumulation of water in the basin and increase the runoff. Urbanization has a negative impact on the risk of flooding by increasing impervious surfaces (roofs, roads, sidewalks, parking lots, etc.) (Kundzewicz, 2004). Extensive asphalted or concrete surfaces contribute to the rapid runoff of rainwater and the drying the soil under these built-up areas, including reduction of groundwater reserves and climate change in cities. These factors cause changes in drainage conditions and increase the risk of local flooding. According to EEA (2001) on average every 10 years a loss of 2% of agricultural land in Europe occurs.

The dried soil without anti-erosion measures (e.g. fields with an area of tens of hectares without any vegetation) behaves as an impermeable film. In such an affected land a flood wave can easily arise, which rises up to 3 or 4 meters within a few tens of minutes respectively hours, even at a creek which the water level of is typically 20 or 30 cm.

The countries face a wide variety of flood problems and have differing capacities to deal with these problems. Some countries are situated in temperate and monsoon-like climates, or have mountainous or flat floodplain-like features. Bangladesh has extensive floods every year, covering up to 30–60% of the country, whereas the Netherlands experienced real devastating floods for the last time in 1926 (rivers) and 1953 (storm surge).

Several sources of floods were identified: *(a)* floods that occur regularly in relation to yearly monsoon rainfall (Bangladesh, China, Vietnam), or *(b)* as sudden flash floods after torrential rains in mountainous areas (Argentina, Bangladesh, China, Croatia, Flanders, Indonesia, Japan, USA, UK, Vietnam). In addition, floods may occur *(c)* as rare events due to unusual combinations of rainfall and soil conditions (prolonged rainfall in combination with frozen or saturated soils, poor drainage or drainage congestion due to high river or sea levels, e.g. during typhoons or hurricanes (Croatia, Japan, USA) or floods may occur *(d)* due to embankment failure, e.g. due to poor maintenance (Croatia), inadequate construction or poor design (failures can occur everywhere) or riverbank erosion (Bangladesh).

Flood damage is most pronounced in urban areas, where high densities of people, assets and vulnerable infrastructure occur (Buenos Aires, Dhaka, Jakarta, Japanese cities, Croatian and Chinese floodplains). Extremely dangerous are low-lying polders behind embanked rivers, where flood levels may be 5–10 meters above ground level. This situation occurs in the river deltas of the Netherlands, China, Japan, USA and Bangladesh (Van Alphen, Lodder, 2006).

3. Results and Discussion

Since the early 20th century to the present day, there is a significant increase to the extent of damage caused by natural disasters. Only for the period since World War II the total average amount of damage per decade increased almost tenfold (Munich Re 2005 in Langhammer, 2007A). The most characteristic feature for the current disasters is the growing extent of the damage made in a single event while at the same time a greater population and greater expanse of territory are affected (Axco 2005, Munich Re 2005 in Langhammer, 2007A). While in the 1980s annually 147 million inhabitants have been affected by natural disasters, it was already 211 million inhabitants in the

1990s (UNEP 2005 in Langhammer, 2007A). Social and economic impacts of natural disasters vary considerably. There is a continuously decreasing total number of victims of natural disasters, while direct and induced economic losses are growing rapidly (UNEP 2005 in Langhammer, 2007A).

According to data from Swiss Re an event is considered a disaster where there are at least 20 victims, 2 000 people homeless and over 335 million USD insurance claims (Čamrová, Jílková, 2006). Floods are the most common natural disasters and represent 40% of all natural disasters between the years 1985-2009 (Cunado and Ferreira, 2011 in Soukopová, Furová, 2012).

During the last few decades, however, increased attention has been paid to the consequences of floods and measures that could be developed to reduce the effects of a flood. This has been triggered by the observation that economic and insured losses due to "extreme" floods have drastically increased during the last two decades (Munich RE, 2005) even though flood protection investments have also increased.

The main explanation for this trend can be found in socioeconomic development and spatial planning policies, as it appears that wealth and exposure have increased in flood-prone areas (Munich RE, 2005; EEA et al., 2008). Even in areas where the overall population growth is slowing down (for example, along the Rhine river), population growth in cities along rivers tends to be increasing (LDS NRW, 2008 in De Moel et al., 2009). Flood-prone areas remain attractive for socioeconomic activities and it is therefore likely that the damage potential (that is the amount of assets in flood-prone areas) will continue to increase in the future.

Using data compiled according to the Red Cross for the period 1971-1995 we find that the floods have killed annually on average more than 12,700 people worldwide, affected 60 million others and caused 3,2 million people to became homeless (Kundzewicz, 2004). Since 1990, there have been over 30 floods, in each of which either the material losses exceeded one billion USD, or the number of fatalities was greater than 1000, or both. The highest material flood losses, of the order of 30 billion USD, were recorded in China in the summer of 1998, while a storm surge in Bangladesh in April 1991 caused the highest number of fatalities (about 140 000). Flood damage in Europe in the period 1991-1995 reached the level of 99 billion EUR (EEA, 2001).

Countries such as Bangladesh and China have suffered at least 2,5 million victims in the last 100 years in major floods. In Europe, the loss of life has been a matter of thousands in the past century. In the last decade, in terms of casualties, major riverine flooding has occurred in Vietnam in 1997 (3000), Bangladesh in 1998 (1100) and China in 1998 (1320). In economic terms, major floods of the past decade were along the Mississippi (1993, 21 billion USD), Jang – c' (1998, 30 billion USD) and in Central Europe (2002, about 20 billion USD). In terms of loss of GNP, the most devastating floods occur in developing countries: the 1998 and 2004 floods in Bangladesh caused damage of 2,8 and 2,2 billion USD, i.e. about 7% of their GNP. In China flood damage accounts for 1–3% of its GNP every year, whereas in Japan it accounts for about 0.1%. The wealth of a country determines the amount of funds that can be spent on flood protection and can be expressed through the annual income per capita. In the countries concerned, this varies from less than 2000 USD in Bangladesh to about 40000 USD in the USA (Van Alphen, Lodder, 2006).

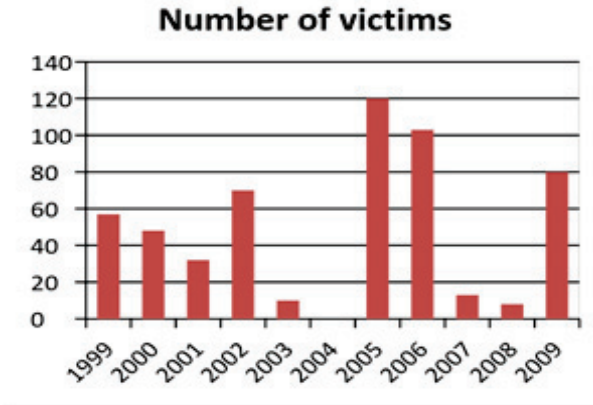
Although most dramatic extreme floods occur outside Europe (especially in South Asia), Europe is not immune. There have been several flood events with material damage in excess of 1 billion EUR and the growing flood damage has intensified concern among European nations. After the flood-rich decade of the 1990s, with many disastrous flood events in Europe, the 21st century has already witnessed several destructive floods. Among the destructive floods in Europe in the 1990s were flooding in the basins of the River Rhine and its tributaries (1993, 1995), in the Mediterranean region (1994) and in Central Europe (1997). The flood on the Rhine in December 1993 caused inundation of parts of the cities of Koblenz, Bonn and Cologne and then in January and February 1995 another large flood hit Germany, northern France and The Netherlands. Dramatic floods devastated large areas in the Czech Republic, Poland and the Oder basin in Germany in July 1997. Major floods occurred in the UK, Italy, France and Switzerland in the year 2000. The absolute record of annual flood loss in Europe was observed in August 2002, when the material damage exceeded 20 billion EUR in nominal value (Table 2). This flood damaged the historical cities of Prague and Dresden. Major large floods also occurred in Europe in 2005, 2007 and 2010 (Kundzewicz, Pińskwar and Brakenridge, 2013). After a heavy rainfall there has also been a dramatic increase in the levels of European rivers in 2013, as for example in Germany and the Czech Republic which also brought casualties and the declaration of the highest level of flood activity.

Table 1: Floods in Europe with significant consequences

Year	Month	Area	Number of victims	Economic losses (mil. EUR)
				805
1999	May	Germany (Bavaria), Switzerland, Liechtenstein and Austria	**5**	(370 Germ.
	June	Romania	**19**	+ 435 Switz.)
	November	France	**33**	**570**
	April			
2000	Oct.-	Romania, Hungary, Serbia, Ukraine	**9**	**400** (Rom.)
	Novem.	England and Wales	**10**	**1400**
	October	Italy, French, Swiss and Italian Alps	**29**	**11700**
2001	June	Romania	**7**	**220**
	July	Poland	**25**	**810**
				20900
				(13700 Germ.
				+ 3500 Czech Rep.
2002	August	Germany, Czech Republic, Austria		+ 3700 Austria)
	September	France	**47**	**1500**
	Nov.-Dec.	Italy	**23**	**440**
2003	January	Italy		**150**
	February	Greece		**650**
	August	Italy	**3**	**510**
	December	France	**7**	**1600**
2004	August	England		**700**
				565
	April-May			**335**
	May -			**1200**
2005	August	Romania and Serbia		**2810**
	July -	Bulgaria	**24**	(190 Germ.
	August	Romania	**85**	+ 620 Austria
	August	Switzerland, Austria, Germany	**11**	+ 2000 Switz.)
	March			
	March -			**410**
2006	May	Greece		**800**
	June	Hungary, Slovakia, Serbia, Czech Republic, Austria and Germany	**12**	(590 Hungary
	Oct.-	Romania	**44**	+ 210 Czech Rep.)
	Novem.	Turkey	**47**	**265**
2007	May	Spain		**310**
	June	England		**270**
	June	Northern England and Wales		**1900**
	July	England		**1900**
	August	Switzerland	**6**	**290**
	September	Slovenia	**7**	**245**
2008	July	Romania	**5**	**440**
	December	Italy	**3**	**290**
				450
2009	June	Czech Republic and Poland		(200 Czech Rep.
	September	Turkey	**14**	+ 250 Poland)
	October	Italy	**31**	**100**
	November	England and southern Scotland	**35**	**230**

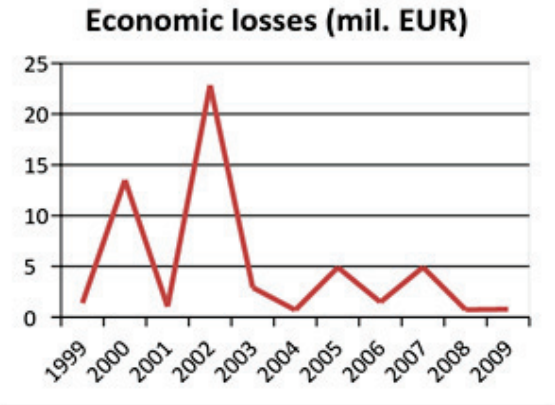
Source: EEA. 2010

The direct economic losses from the major events between 1999 and 2009 were about 55 billion EUR. The most destructive events in terms of economic losses were: the floods in the Elbe basin in 2002 that produced losses of over 20 billion EUR; floods in Italy, France and the Swiss Alps in 2000 causing around 12 billion EUR and a series of flood events in the United Kingdom during summer 2007 accumulating in losses of more than 4 billion EUR Several areas were affected several times in a relatively short period of time. This is the case of England (Worcestershire and Gloucestershire) where two major events were reported in 2007. Also north-east Romania and Bulgaria experienced repeated flooding. Two particularly large floods hit both countries within just a few weeks of each other during the summer of 2005 (EEA, 2010).



Source: Prepared on the basis of data from EEA. 2010

Fig. 1. Numbers of victims



Source: Prepared on the basis of data from EEA. 2010

Fig. 2. Economic losses

The countries registering the highest economic losses were Germany (14,26 billion EUR), Italy (13,1 billion EUR), United Kingdom (6,4 billion EUR), Austria (4,32 billion EUR), Czech Republic (3,91 billion EUR), France (3,67 billion EUR), Romania (over 2,82 billion EUR) and Switzerland (over 2,72 billion EUR).

Flood events resulted (in the reporting period) in around 541 human fatalities. The most fatal events occurred in Romania with 85 people killed in 2005, in Turkey with 47 and in Romania 44 killed in 2006 and in Italy with 35 killed in 2009. It seems that there is no evident trend over time in respect of the number of fatalities. This is because the number of deaths is very much dependent on single events. Furthermore, in the past few years early warning systems and prevention measures have improved evacuation procedures in the areas exposed to floods (EEA, 2010).

Flooding, along with wind related storms, is the most important natural hazard in Europe in terms of economic loss (CRED 2009 in EEA, 2010). In central Europe, floods have been recently recognized as a major hazard, in particular after the 1997 Odra/Oder flood, the 2001 Vistula flood, and the most destructive 2002 flood on the Elbe, the Danube, and their tributaries. It is estimated that the material flood damage recorded across the continent of Europe in 2002 was higher than in any single previous year. According to Munich Re (2003), the floods in August of 2002 alone caused damage at a level exceeding 15 billion EUR (9,2 billion EUR in Germany, after 3 billion EUR each in Austria and in the Czech Republic). Further, during severe storms and floods on 8-9 September 2002, 23 people were killed in southern France (Rhone valley), while the total losses went up to 1,2 billion USD. Destructive flood events occurred in many other parts of the world in 2002. In July and August, floods and landslides in northeastern and eastern India, Nepal and Bangladesh killed 1200 people. A flood in central and western China in June caused 3,1 billion USD losses and killed 500 people, while another in central and southern China, caused 1,7 billion USD damage and killed 250 people (EEA, 2010).

Floods in 2013, which affected parts of Europe, Asia, Canada and Australia have caused about 47% of total global losses and 45% of insured losses (Munich Re, 2013). The most deadly disaster of the 460 recorded "natural hazard events" worldwide in 2013 was the series of flash floods in June in northern India and Nepal, which killed more than 1,000 people after extremely heavy monsoon rains. By far the costliest natural disaster were river floods that hit the southern and eastern Germany and neighbouring countries in May and June 2013 and caused damage

worth more than 16 billion USD (mostly in Germany). In some places the rainfall was up to 400 liters per square meter within a period of a few days, which led to rapid increase in river systems of the Danube and Elbe (Munich Re, 2013).

In 2013 Slovakia faced a record-high level of the Danube. Flood wave came from Germany and then from Austria. According to estimates it was historically the third largest flood in Bratislava (in terms of maximum flow), more water has not passed the river bed in the last 113 years. The water level peaked in the Capital at up to 1034 cm at a maximum flow rate of 10 641 m3 / s. The Danube basin faced a hundred-year water level and Slovakia passed this test. Without the flood protection (the project was worth 32,5 million EUR, of which Slovakia co-financed about 4,8 million EUR) the water level would reach, in theory, a level of 1,25 m at the Courthouse ("Justičný palác"), 2,5 m at the well-known shopping center on Vajnorska street and even 4 m at the Ružinovská polyclinic. Reported damage to public and private property, that is, for example, municipalities, autonomous regions, local offices or individuals after the flood on the Danube in 2002 reached 5,079 million EUR. Damages in 2013 represented less than 2% of this amount or vice versa, damages in Bratislava in 2013 were about 98% lower than in 2002 (MŽP SR, 2013).

4. Conclusion

Floods in the past brought humanity many positive effects as floods in the Nile, which helped ensure the livelihood of the population in ancient Egypt. Only when the floods began to threaten the lives, health and property of the population and economic activities of society, they became a serious problem for the mankind. Not the nature can be held responsible for the fact that the floods are harmful to society, but the people because they take natural space from water and put themselves in her way (MŽP SR, 2010). On the other hand, building of settlements in the watercourses was necessary because rivers provided enough water to cater for the necessities of life and the most fertile land due to floods is in riverside floodplains. Society is becoming more aware that floods can be controlled to a limited extent, and that absolute safety against floods is a myth.

The flood as a natural hazard has effect on the stability of society. If more people are to dwell in vulnerable areas and more and more businesses settle down in these areas the more intensive effect a flood event will have upon society (Seifert, 2012). It will be necessary to evacuate more buildings, provide emergency accommodation for more people, more workers will not be able to make money, because they will have to rescue and look after their property. More and more companies will have to suddenly cease production, services will no longer be provided, unexpected shortfalls in tax receipts shall bring the municipal budgets out of balance and public services will no longer be funded. The infrastructure to repair after a flood event will also be more extensive.

One single event may produce both benefits and losses to different parts of the riverine ecosystem. These impacts are extremely difficult to quantify or monetize e.g. by quantifying ecosystem services before and after an event or accounting for the number of fish killed or trees damaged. Regular annual floods provide water resources for domestic supply, irrigation or industrial use. Some of the most important benefits of floods are linked to the maintenance of biological diversity in the flood plain ecology (Smith and Ward, 1998). Furthermore, many rivers carry minerals and nutrients which support agricultural production on the flood plains. Another aspect that makes it difficult to quantify the ecological consequences of floods is that some of the benefits from floods tend to become evident months or years after the event, or are often not apparent at all (e.g. recharging of groundwater stocks). This suggests that any immediate ecological accounting is prone to error (NRC, 1999). Flooding in river ecosystems should be regarded as a natural process and not as a disturbance.

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