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ADAPTIVE MANAGEMENT OF THE CLIMATE CHANGE PROBLEM: BRIDGING THE GAP BETWEEN RESEARCH AND PUBLIC POLICY

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Key words: weather disasters, natural hazard, human vulnerability, extreme events, statistics and impact, management of event forecast, regional risk assessment, post disaster management.

Abstract: There are important differences between adaptation to normal climate and adaptation to climate change. One scientific community is organized to address extreme probabilities in current distributions, and their disaster potential. Another scientific community addresses the longer-term changes in the climate system. There are important differences between natural hazard (extreme and unpredictable events) and disaster as natural hazard with disastrous economic and social consequences as a matter of enormous concern. Finally, disaster management means a forecast for the real disaster events and after these disasters occurred, a post disaster attitude is necessary to ameliorate the situation and to take measures for rapid recovery. In this paper the author tries to address the description, understanding and prediction of extreme events in the weather system and their impact across a range of natural and socio-economic phenomena. Other goals of the paper are to present the weather and climate characteristics, the statistics of extreme events and to evaluate their impact on economy. Thus one major task of the work is to address the management of natural disasters caused by weather: the management of event forecast, risk assessment for various regions, and disaster management after the event occur. At the intersection between Economics, Management and Science of Weather Processes, this interdisciplinary study will provide the reader with insight and tools to address contemporary climate and weather hazard management problems.

1. INTRODUCTION

Over the last few decades, there is an increase in the number of disasters, and the number of people affected. Today, the world is facing disasters on an unprecedented scale: more than 250 million people were affected by natural disasters globally each year, on average, between 1994 and 2005, with a range of 68 million to 618 million. During the same period, these disasters claimed an average of 58,000 lives annually, with a range of 10,000 to 123,000. In the years 2004 - 2007, one in 25 people worldwide was affected by natural disasters. During the last decade disasters caused damage of an estimated US$67 billion per year on average, with a maximum of US$230 billion and a minimum of US$28 billion. The economic cost associated with natural disasters has increased 14-fold since the 1950s [1-3]. Scientific predictions and evidence indicate that global climate change will likely increase the number of extreme events, creating more frequent and intensified natural hazards such as floods, draughts and windstorms. Population growth, urbanization and the inability of poor populations to escape from the vicious cycle of poverty makes it all the more likely that there will be an increase in the number of people who are vulnerable to natural hazards, with a resulting increase of natural disasters and emergencies. Natural disasters of all kinds were responsible for killing 16,517 people worldwide in 2007, fewer than the 21,342 people killed by similar events in 2006. However, the number of people hit in general by natural disasters grew from 135 million in 2006 to 200 million in 2007, according to the most recent *UN-report: Natural disasters,* (2008), the majority being affected by flooding, and half of those suffered from inundations. Globally, the ten deadliest disasters were all climatic, except for the earthquake in August in Peru, with a death toll of 519. Overwhelmingly the region most touched by climatic disasters was Asia subjected to eight of the world's ten worst catastrophes last year, and overall, the United States experienced the greatest number of natural disasters (22), ahead of China (20) and India (18).

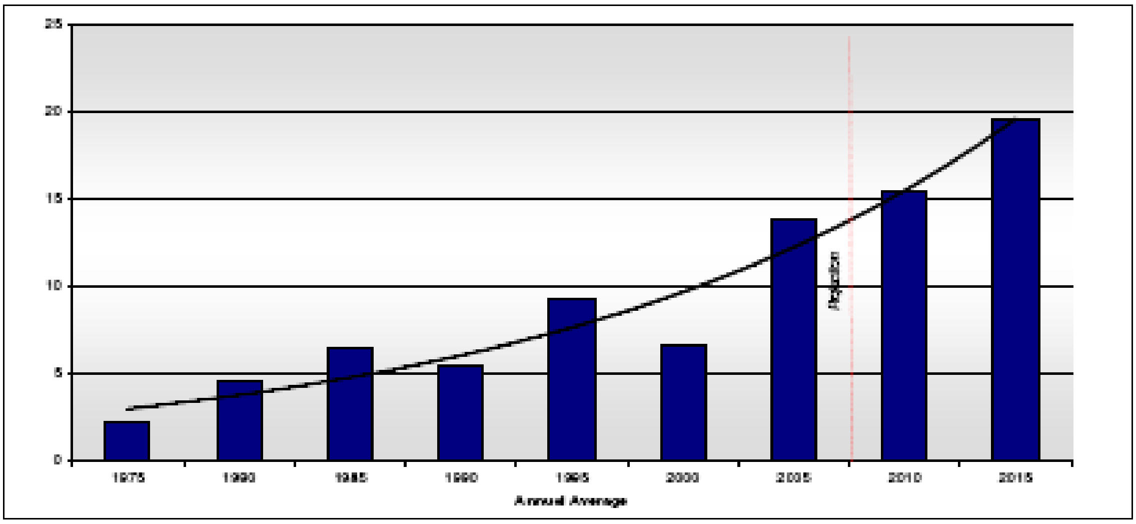


Fig.1. South Asia Regional Analysis–annual frequency of floods (forecast 2010- 2015)
Source: EM - DAT: The OFDA / CRED, International Disaster Database, www.em-dat.net

From the impact point of view, future tendencies of floods as the most important natural disaster will be the same or even more frequently occurred in the areas of South Asia. During the period 1990–2050, the scientific research will assume a climate change to a level of +4^{0}C and a slight increase in precipitation, that will increase net annual increment under current climatic conditions. Three main tendencies are detailed through linear-interpolated smoothed lines: an amazing increasing in the number of natural disasters and in the number of people affected reported, and a profound decreasing in the number of people reported killed by natural disasters. For the last trend there could be some interesting explanations: the modern management of event forecast and mitigation due to international and national institutions and to their disaster database, and the new management of the global climate problem.

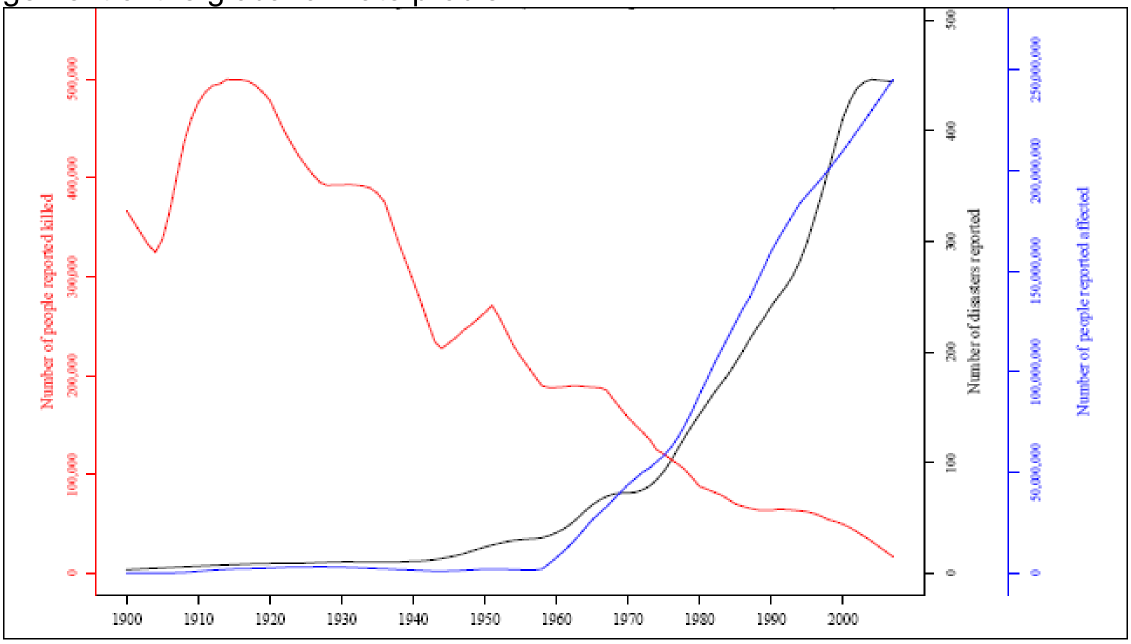


Fig.2. Natural disasters summary between 1900 and 2007
Source: EM - DAT: The OFDA / CRED, International Disaster Database, www.em-dat.net

Disaster preparedness, mitigation and prevention for vulnerable populations are gaining a high priority and it is expected to reduce the damage caused by natural hazards in a permanently increasing trend. Over the last 50 years, there has been a growing body of evidence pointing to the effect of human behaviour on the global natural environment and on the possibility that certain types of natural disasters, such as floods, may be increasing as a direct consequence of human activity. Weather can have great variability from hour-to-hour, day-to-day, and season-to-season, and modern society requires continuous monitoring and forecast as part of daily activities. Climate change can be described as a complex hazard being multifaceted (from drought to flood) and multidimensional (from local to global) hazard that has short-, medium- and long-term aspects and unknown outcomes. What it is known is the fact that climate change is intensifying the hazards that affect human livelihoods, settlements and infrastructure. It is also weakening the resilience of livelihood systems in the face of increasing uncertainty and frequent disasters [4].

Currently, the weather services relay on complex global observations systems, computer modelling, and forecast information broadcasting. Thus World Meteorological Organization (WMO), national and regional weather centres have created a network of communication that optimizes the data collection, transmission, processing and forecast dissemination and facilitate the mission of disaster management.

2. ECONOMICS AND MANAGEMENT OF VULNERABILITY TO CLIMATE CHANGE

Major weather and climate natural disasters can have severe negative short-run economic impacts. Disasters also appear to have adverse longer-term consequences for economic growth, development, and poverty reduction. On average each year, natural disasters around the world leave 4 million people homeless, injure another 900,000 people and kill 128,000 people. There were about 500 reported natural disaster events worldwide in the fifth year of the new millennium (2005), of which 50 were major, requiring international assistance. It has been estimated that since 1992 the world economy lost more money (US$ 62 billion) from natural disasters in the less developed countries than it spent on development aid (US$ 60 billion). In Bangladesh, for example, more than 5 per cent of gross domestic product (GDP) is lost annually to recurrent natural disasters. In 1970 and 1991, from 300,000 to 138,000 lives, respectively, were lost in Bangladesh only due to cyclones. In industrialized countries, even major disasters rarely cost more than 0.1 per cent of gross national product; however, it can be 20-30 times more in less developed countries. The relatively small size and specialized nature of the economies of many developing nations make them more vulnerable to the effects of natural hazards than the larger economies of industrialized countries. Also, in many developing countries, disasters recur regularly, principally because of a lack of funds to introduce sustainable disaster-management solutions. The more notable social and economic consequences of natural disasters include the following:

(a) Loss of human lives;
(b) Panic; social disruption (e.g. no sense of community, security or control);
(c) Increase in the likelihood of social unrest or violent conflict;
(d) Damage to the natural resource base and to the environment;
(e) Loss of housing; temporary and/or permanent migration;
(f) Loss of industrial/agricultural production (hence employment, income and tax revenue);
(g) Damage to infrastructure (including transportation and communication systems);
(h) Disordered markets and distribution; loss of commerce;
(i) Immediate downgrading of living conditions owing to the deferral or cancellation of other development plans that deal with real social needs;
(j) Short-term reduction in GDP and per capita income;
(k) Imbalances in the fiscal budget as a result of emergency reallocations of expenditure;
(l) Immediate and medium-term inflationary pressure due to market disorders and externally financed reconstruction expenditure.

Approximately 25 per cent of the world's population lives in regions that are at risk of natural disaster. However, the impact of disasters and their secondary effects (e.g. loss of life, property damage and social and economic disruption) are invariably the greatest where poverty-stricken people are concentrated. Asia has been the continent most affected by major disasters, accounting for over 60 per cent of the 45 million disaster-related deaths, and 85 per cent of the 3.7 billion victims of natural disasters, since 1900. Of all those disasters, drought and floods have been responsible for the largest number of deaths (over 53 per cent).

The social and economic costs of natural disasters are increasing worldwide. This tendency is attributed in part to increasing vulnerability in less developed countries, where people are often left more vulnerable to subsequent hazards after experiencing one disaster. Many factors contribute to increasing vulnerability. These include increasing population and rural-urban migration and urbanization pressures, increasing insecurity of food and water supplies, increasing numbers of poverty and illiteracy, increasing global interdependence of economies, increasing global climate changes, degradation of natural resources, inadequacy of disaster management measures and forecasting techniques, inadequate training, inadequate participation of local community in disaster management, inadequate communications and transport infrastructure, inadequate market mechanisms to help buffer against disasters and spread risks, lack of strict environmental control measures, weak institutional capacity for confronting disasters, etc.

While some societal factors tend to increase vulnerability to disasters, there are several technological and managerial trends that serve to decrease it. Examples of such positive trends are increased understanding of hazardous processes and phenomena, improved analytical methods, which permit the development and use of complex models, and management solutions, enhanced communications, which permit applications resulting from this new understanding to be communicated in a timely manner improving disaster management, advanced engineering practices, which have given an improved understanding of the susceptibility of materials and structures together with the development of new approaches to management, engineering and design, etc. Technology must always balanced against the negative aspect and contribute to these positive trends. Given their significant social and economic costs, it is evident that sustainable development could be considerably enhanced by reducing the impacts of natural disasters. Vulnerability to natural hazards is determined by a complex, dynamic set of influences that include the country's economic structure, stage of development, and prevailing economic and policy conditions. The reduction of vulnerability should, as part of an overall disaster management strategy, be a routine objective of development activities and be integrated in investment decisions. But the increase of vulnerability in population remains dramatic in the last few decades, with concurrent economic growth and in absence of significant effort to manage natural disasters, the toll can be increasing. The major solution is to solve the problem of disaster management using technology and research results and implement information systems that can prevent or minimize loss [5-6]. That means a new management of the global climate problem, able to bridge the gap between climate research and climate policy. New disaster management involves a series of information-intensive phases: pre-disaster planning, disaster preparedness and forecasting, emergency/disaster response, recovery and reconstruction. Space technology can play a role in furnishing the information required in each of these phases.

Disaster management must describe not only how the weather works, the main atmospheric circulation characteristics, but even some important climatology, and its treatment becomes such that engineers and economists can benefit, and references to more technical know–how to solve the problem must be given too. The main scope is detailing the weather versus climate, the main governing principles, the methods used to produce weather forecasts and climate characterizations and the modern techniques used to the observation system, data management and dissemination, role of the World Meteorological Organization (WMO), regional and national weather centres, methods used in weather research (numerical deterministic models and statistical methods), etc. Disaster management underlines the role of climatology (or the normal climate for a region), and contrast this with weather events, which can vary considerably from the average climate and address the problem of weather extremes, how they form and why they produce the largest damage to environment, society and economy. Disaster Management describes also the background for other various specific weather related disasters: deadly cyclones, floods, landslides, draughts, heatwaves, wildfires, and winter extreme weather, and provides a basis for the topic of economic and general management too.

3. METHODS OF DISASTER MANAGEMENT

Disaster management response cycle means mitigation (activities to prevent or reduce impacts of a catastrophic event prior to its occurrence, such as land use planning, retrofitting, building codes and public education), preparedness (activities to improve the effectiveness of response and recovery, such as establishing warning systems, developing hazard plans and storing emergency supplies), response (activities during the acute phase of the disaster designed to minimise loss of life and restore basic services, such as rescue efforts, and provision of food, shelter and medical aid) and recovery (restoration and reconstruction of the community through emergency repairs, gradual restoration of structures and infrastructure, and replacement of capital stock).

The weather disaster management involves many disciplines and institutions and focus on the main activities that take place, some on a regular basis as part of the weather forecast service, and some triggered by extreme events. These activities are: 1) weather and hydrological forecast; 2) assessment of weather disaster risk for specific zones and warning; 3) evacuation and other measures taken to diminish damage; 4) further intervention and rescue missions, help in case of weather disaster; 5) steps to restore normality and resume economic activities; 6) complex evaluation of the situation and implementation of plans that will adapt communities for future possible severe weather disaster [7-8]. *Environmental monitoring* as a spatial analysis of environmental data linked to natural hazards is getting popular to monitor the environment and delineate risk areas. These areas can be affected by natural processes including extreme meteorological events, floods, landslides, etc. Advances in spatial modelling and statistics allow not only to identify and delineate such risk areas but also to assess the uncertainties associated to these risk maps.

Societal decisions and economic aspects for reducing natural hazards risk underline the role, influence, and value of scientific information in societal (collective) choices, decisions, and outcomes. Scientific information and the potential actions taken by decision makers are expected to improve policy and management outcomes for society. However, analysis of community vulnerability to natural and man-made hazards and risks depend on more than just the natural science input for policy implementation. Decisions depend, in large part, on human preferences and behaviour. Reducing societal risks depends on many economic, psychological, and social factors.

Human impacts, vulnerability assessments and multidisciplinary approaches in natural hazards and risk assessments are the essential parts within natural risk analysis. Commonly, these assessments generally relate to the stability of buildings or to chances that people will be affected, and in particular to natural and engineering science approaches. The role of vulnerability assessment within risk analysis is of particular importance for its conceptual ideas and new methods on the analysis of vulnerability.

The importance of techonology in the management of natural disasters is prooved by diagnosis, modelling and forecasting of meteorological and hydrological hazards produced by extreme weather and climate change. Current research of disaster management focused to the understanding of their occurrence to an estimation of their (regional) risk or return periods, to the ability of models to reproduce them and methods to forecast them or produce warnings at different lead times from nowcasting to future climate change. Thus this paper is an interdisciplinary outlook of research approaches and results, involving meteorology, economics and management too. Advances in radar, satellite and hydrological modelling methods for flash flood forecasting and droughts are relevant for the interdisciplinary approach of disaster management. Recent developments in radar and satellite remote sensing technologies as well as advancements in rainfall-runoff models open new possibilities for obtaining detailed spatially distributed information about precipitation and soil/vegetation status parameters and use them as input/verification for quantitative precipitation forecast (QPF) and hydrological model in international disaster management.

Remote sensing and geophysical surveying represent two indirect investigative techniques that are potentially complementary and offer a possibility to arrange a suitable combination of applications, tailored to specific ground and environmental logistic conditions, in order to effectively infer and correlate surface/subsurface information. The progress in digital photogrammetry and cartography, in GPS surveying, in multi-temporal Synthetic Aperture Radar differential interferometry analysis (DInSAR), the recent deployments of new, more sophisticated satellite systems (e.g. IKONOS, QUICKBIRD, ENVISAT), as well as upcoming launches (e.g. ALOS, RADARSAT 2, SkyMed/COSMO), hold the premise for ever increasing use of remote sensing and Earth Observation (EO) data in landslide investigations.

Quantifying fluxes of water among hydrologic reservoirs, and understanding the causes of global water and energy cycle variability are key aspects of improving global climate change predictions and atmospheric warming effects. Precipitation is probably the most important component of a complex mixture of hydrologic cycle parameters (precipitation, evapo-transpiration, soil and canopy wetness, snow, etc.) Most strategies for both preparedness and emergency management in case of disaster mitigation are related to *urban planning or urban disaster management*. While natural, engineering, economics and other social sciences contribute to the evaluation of the impact of earthquakes and their secondary events (including tsunamis, earthquake triggered landslides, or fire), floods, landslides, high winds, and volcanic eruptions on urban areas, there are the instruments of urban planning which are to be employed for both visualisation as well as development and implementation of strategy concepts for pre- and post disaster intervention regarding following aspects are especially welcome:

- assessment and mapping techniques of the impact of natural hazards on urban areas;
- visualisation and communication techniques of the assessed impact of natural hazards on urban areas, especially case studies of 'impact assessment, including GIS and internet;
- strategies for reduction of natural hazards' impact on urban areas;
- suitable instruments of urban planning for the development of disaster mitigation strategies in case of occurrence of various natural hazards;
- partnerships models for actors of the decision making process for disaster mitigation;
- case studies of master plans including protection from natural hazards impact

But the main aspect of disaster management remains natural catastrophe risk modelling: recent development in loss modelling technology and application to insurance, *risk managers and local governments.* Natural catastrophe risk can represent overall social and economic impacts of natural hazard on humans and the built environment. Such impacts include: loss of life, injury, damage and loss to properties, business interruption and loss of profit. This integration of natural phenomena and their consequences is mathematically specified as exposure: Risk = Hazard x Vulnerability x Value. Evaluating the social and economic impacts of natural catastrophes involves a number of different disciplines ranging from earth and weather sciences, to management, economics, mathematics, statistics, physics, engineering, demography, etc. Natural catastrophe risk models may also be used by local government for risk mitigation, post-disaster reaction, recovery planning and public awareness programs relating to: computer modelling of natural risks, natural catastrophe risk modelling methodologies, the use of GIS in natural catastrophe risk modelling, uncertainty and sensitivity of computer risk models, availability, reliability and quality of data used in natural catastrophe risk models, regional vs. local risk models, modelling the social and humanitarian impacts of natural disasters, natural catastrophe risk modelling of urban areas and its application to urban planning, post-disaster planning and risk mitigation, building and social vulnerability of developing countries to natural disasters, practical applications of natural catastrophe risk models in the business environment, etc.

4. A CASE STUDY – THE FLOODS MANAGEMENT IN ROMANIA (2005-2006)

Using this case study as an example of good management, especially by the efforts of EU and Romanian specialized agencies and government (central and local) is an interesting exercise of underlining the importance of cooperation in disaster management. Selecting floods as a natural disaster is based on the idea that floods were exceptionally severe and even advanced countries like Germany had major problems during last few years (e.g. Elba floods). Flooding may be caused by excessive precipitation over a given period, exceeding the maximum capacity of the drainage network or, mainly in coastal areas, by sudden increases of the sea level for shorter or longer times induced by either atmospheric or tectonic activity. Recent studies have shown that the causes and the effects of flooding may be monitored quickly by application of satellite remote sensing technology in various ways. Natural disasters create an opportunity for government intervention Community coordination involves complex interaction among multiple government agencies, non-profit organisations, private business, and individual citizens.

Global distribution of flood risk is rather an expression of variability marked by:

a) Mortality *b) Total economic loss*

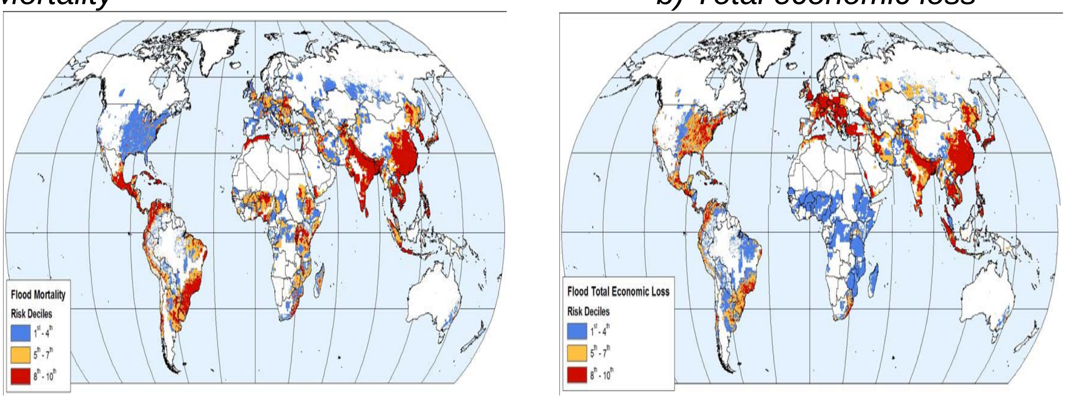
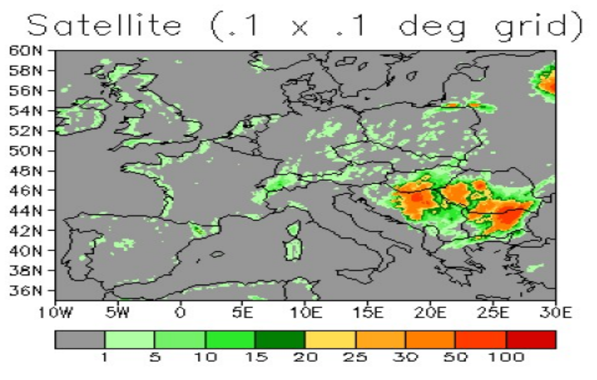


Fig.3. Floods Hotspots: 2007 (minimum flood risk in blue and maximum in red)

Source: *Natural Disaster Hotspots: A Global Risk Analysis—Synthesis Report*, www.em-dat.net

The significance of high mortality and economic loss risks for socioeconomic development indicated in this analysis extends well beyond the initial direct losses to the population and economy during disasters. Covariate losses accompanying mortality, for example, include partial or total loss of household assets, lost income, and lost productivity. Widespread disaster-related mortality can affect households and communities for years, decades, and even generations. An enormous effort has taken place to obtain better information for an efficient management of disaster. To understand the evolution of precipitation and flood situation in Romania during 2005 – 2006 we use data and analysis from several agencies: European Space Agency (ESA), German Aerospace Center (DLR), National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), and National Centers for Environmental Prediction (NCEP). In addition, reports of the National Institute for Meteorology and Hydrology (NIMH) and the Romanian government publications are used in evaluation the floods and economic impact in detail. Meteorological and hydrological data: hourly, daily and monthly data for each station, for various regions and for all European continent can provide a dynamic picture of precipitation and flood evolution. In addition, satellite imagery, in a wide range of scales and spectral capabilities allow a detailed investigation of these cases.

Heavy rain in April and May 2005 caused the worst floods since 50 years in Romania, affecting thousands of people and destroying hundreds of houses. The Romanian government responded on 19 May by launching an appeal for European civil protection assistance, triggering a rapid response from the Monitoring and Information Centre (MIC) of the European Commission. As a result EU Member States offered their assistance and in this context the MIC triggered the International Charter 'Space and Major Disasters' to provide a synoptically overview of the affected areas. In close cooperation with the European Commission, the German Aerospace Centre (DLR) took over the project management and the analysis of all available satellite imagery including ENVISAT ASAR and SPOT 5. From these data, flood maps and damage statistics were derived to support European relief. A series of measures were initiated by authorities to monitor precipitation, floods, manage help efforts, and conduct works designed to prevent or diminish flood effects. Since both 2005 and 2006 had unusually high precipitation and floods over large areas or Romania, we illustrate several datasets useful for a hydro-meteorological characterization. In addition, each station of interest can be monitored for the accumulated precipitation and comparison with the normal value.



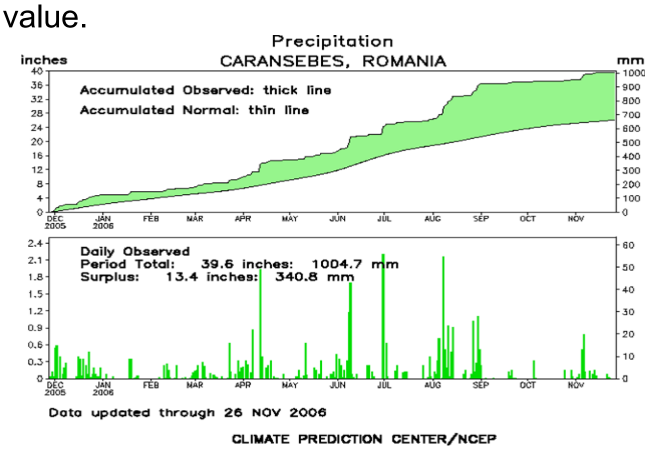


Fig.4. Precipitation distribution over Europe 2005
Source: Climate prediction center/NCEP

Fig.5. Anomaly of precipitation Caransebes 2005
Source: Climate prediction center/NCEP

Daily maps of precipitation distribution over Europe are useful in assessing the day by day evolution of accumulated rainfall, illustrating typical pattern for very rainy day in West and South of Romania. An example for Caransebes is shown in the above figure, indicating large positive anomaly of precipitation. But not only government is a significant player. There are other international key players like Hazard Management Unit (HMU), formerly called the Disaster Management Facility, established by the World Bank in 1998, US Agency for International Development (USAID) - Office of Foreign Disaster Assistance (OFDA), ProVention Consortium, United Nations International Strategy for Disaster Reduction (ISDR), European Community Humanitarian Office (ECHO). ECHO's Disaster Prevention, Mitigation and Preparedness Programme (DIPECHO) was launched in 1996 to help prepare populations in areas at risk from natural catastrophes and to support practical measures to reduce such risks. A major problem European Union is the fragmented jurisdiction over the different types of disasters. Floods, windstorms or wildfires are managed by different authorities such as the Ministry of the Interior, the Ministry of Water and Forests or the Ministry of Public Works. Disasters are also often handled at provincial level, such as Landes authorities in Germany or Departments in France. Information is not always centralized at a national level similar to the Federal Emergency Management Authority in the US, which monitors all major disasters in the country even if the Federal authorities are not directly involved. Flood risk awareness as component in a disaster management comprises several components like

a) awareness of living in an at-risk area;
b) awareness of flood warning systems, codes and methods of dissemination;
c) awareness of appropriate action to take in the event of a flood or flood warning.

The summary of the effects caused by floods and storms in Romania during year 2005 is detailed in the next table:

Table no 1. Summary of the effects caused by floods and storms

COUNTY (DISTRICT)	TOTAL VALUE OF DAMAGES (TH RON)	AFFECTED LOCALITIES	KILLED PEOPLE	FLOODED OR AFFECTED DWELLINGS	AFFECTED ROADS (KM)	AFFECTED RAILWAY (KM)	DAMAGED BRIDGES	CONTAMINATED WELLS	DEVASTATED ELECTRIC / GAS	DEVASTATED AGRICULTUR
ROMANIA	**5975201.5**	**1734**	**76**	**93976**	**10420.4**	**23.8**	**9113**	**90394**	**yes=19 no=23**	**656392**

In 2005, floods and storms in Romania, killed 76 people, caused at least 1.66 billion Euro in damage (975,201.5 thousands RON). This represents 2.1% from Romanian GNP. Flooding has also affected about 656,392 ha from agricultural land, 10,420.4 km of roads, 23.8 km of railway, 9,113 bridges and foot bridges and contaminated 90,394 wells [6-8]. In 2006, the extreme floods between April and August were among the most devastating natural disasters from recent Romanian climate history. Although there were no human victims, the extent of the damage and the number of evacuated people surpassed by far the floods of 1970, the worst floods that hit Romania. Romanian officials ordered the controlled flooding of thousands of hectares of unused agricultural spaces to prevent further damage in cities across Romania. Estimations show that during April – May interval, 12 counties were affected, and the total economic damage is over 1% from Romanian GNP. The number of affected localities is 160; the estimated number of affected homes is 10,000. About 600 km of roads and 300 bridges ware damaged, and the total farmland affected was 21,000 ha [9 -11].

5. CONCLUSIONS

In the last decades, the damage caused by weather related disasters increased exponentially, mainly due to population and economic wealth growth, combined with alteration of land use. For instance floods represent a major threat to European countries and the floods in Romania during 2005 and 2006 caused significant loss of life and economic damage. There are two basic management approaches for reducing the impacts of natural disasters: mitigation and response. Mitigation includes all those actions that are taken before, during, and after the occurrence of flood that minimize its impacts. Response includes those actions that are taken during and immediately after the event to reduce suffering and help recovery of affected population. Both elements are important in dealing with flood, but response has predominated in the past practice.

This short analysis of such an important disaster management as floods are, in Romania, indicates the need to research, develop and implement methods to improve weather disaster management. Such measures are:1) improve meteorological/hydrological forecast, observation systems, computing infrastructure, and communication; 2) improve the plans and infrastructure for communications and intervention in case of emergency, and develop information systems for supporting disaster management; 3) determine areas of vulnerability and conduct risk assessment (for example, given a specific community or region, determine the risk to floods, determine scenarios of damage, and loss); 4) prepare economic assessments for risk reduction (implement long term plans to build dams, irrigation systems, robust infrastructure); 5) reassess the process and progress and continue long term research, collaborations to improve disaster management and make recommendations for risk reduction measures.

Demographers, atmospheric scientists, engineers, and most of all disaster managers must try a new vision and a new public project of a new policy in the emergency or disaster management. Institutions must be “the voice” for warning information, because if the warning comes from an official source, the public is more likely to respond to the warning message, if they are younger, if the warning messages are delivered over multiple channels etc. [12].The disaster response should distinguish clearly between the intention to evacuate and the capacity to do so. Evacuation increases with proximity to a possible threat, official instructions, structural damage and loss of utilities. The central factors which determine evacuation decisions in disaster management are: 1) direct perception of threat, 2) exposure to the evacuation advice, 3) factors relating to family, 4) community preparedness, and 5) demographic characteristics.

Studies of emergency and disaster management must underline the necessity for laws of mitigation and evacuation.

6.REFERENCES

[1] Masika, R.,(2002), *Gender, Development and Climate Change,* Oxford

[2] Guha-Sapir D., Hargitt D., Hoyois P., (2004), *Thirty Years o Natural Disasters 1974-2003: The Numbers,* Centre for Research on the Epidemiology of Disasters, Presses universitaires de Louvain-la-Neuve, Belgium

[3] Tschoegl L., Below R.,Guha-Sapir D., (2006), *An Analytical Review of Selected Data Sets on Natural Disasters and Impacts,* UNDP/CRED Workshop on Improving Compilation of Reliable Data on Disaster Occurrence and Impact, April 2-2006, Bangkok – Thailand, below@esp.ucl.ac.be

[4] Grothmann,T.,Reusswig, F.,(2006), *People at Risk of Flooding: Why Some Residents Take Precautionary Action While Others do not, Natural Hazards* 38: 101–120, DOI 10.1007/s11069-005-8604-6.

[5] Holz, K-P, Hildebrandt, G., Weber, L(2006), *Concept for a Web-based Information System for Flood Management*, Nat. Hazards 38, pp.121–140.

[6] Iwan, W.D, (1998), *Mitigation Emerges as Major Strategy for Reducing Losses Caused by Natural Disasters,* Science Vol 284, pp. 1947 – 1963.

[7] FEMA (Federal Emergency Management Agency) (2001),*Information Technology Architecture, The road to e-FEMA* (Vol.1),Washington, http://www.fema.gov/pdf/library/it_vol1.pdf.

[8] EM-DAT (2006): The OFDA/CRED, International Disaster Database, www.em-dat.net, Université Catholique de Louvain, Brussels – Belgium)

[9] Ministry of Administration and Interior (2005-2007), *Buletine informative*, http://www.mai.gov.ro/engleza

[10] Ministerul Mediului şi Gospodăririi Apelor–Raport privind efectele inundațiilor şi fenomenelor meteorologice produse în anul 2005-ianuarie 2006–www.mmediu.ro/ape/gestionarea_inundatiilor/

[11] Nota de fundamentare -H.G.nr. 1171/06-09-2006 la H.G.nr. 1171/2006 privind aprobarea proiectului WATMAN-Sistem informațional pentru managementul integrat al apelor M.Of. nr. 773/12-09-2006.

[12] Trebilcock, M.J. Daniels R.J.,(2006) *Rationales and Instruments for Government* Intervention in Natural Disasters. In R.J. Daniels, D.F. Kettl and H. Kunreuther (eds.) *On Risk and Disaster: Lessons from Hurricane Katrina.* University of Pennsylvania Press, Philadelphia, PA. pp. 89–107.