OVEREXPLOITATION OF ECOSYSTEM RESOURCES VS. THE COSTS OF STORMS AND FLOODING RISK MANAGEMENT

B.R. Gurjar[1,*], I.M. Ciumasu[2,Ψ], N. Costica[2], A. Kumar[1], C.S.P. Ojha[1],

[1]Indian Institute of Technology Roorkee, Civil Engineering Department, Roorkee – 247667, Uttaranchal, India

[2]Alexandru Ioan Cuza University, Faculty of Biology, Centre of Expertise for Sustainable Exploitation of Ecosystems – CEXDUREC, Iasi, Romania.

Introduction

Historically, human settlements followed land terraces and banks close to watercourses, but avoided main riverbeds because of flood risks. Especially during recent decades, enlarging human settlements like cities broke this habit and extended themselves within riverbeds, with the help of grand works of river regularization. In the same period, intense local and regional deforestation changed the flow regimes of large river basins, in the sense that rivers increased basic and flood volumes of waters. By the time human settlements and agglomerations already went a long way in incorporating riverbeds, changes in hydrological regimes determined that river systems found their old natural course and flooded the primary river beds (Plate, 2002).

A highly typical way of overexploitation of natural resources that leads to high water-related risks is deforestation. Forests regulate directly the surface water circuits through their physiological and ecologic functions. In addition, forests have indirect influences on natural water circulation as their biomass traps moisture and atmospheric carbon dioxide – the gas most responsible for the "greenhouse effect", thus acting as sinks. On the other hand, new findings (e.g. Keppler et al., 2006) state that methane (an important greenhouse gas) is readily formed in situ in terrestrial plants under "oxic conditions" by a hitherto unrecognized process, thus acting as a source. Nevertheless, the extensive loss of Earth's forests may contribute to increasing global warming (e.g. Arrow et al., 2000; Andreassian, 2004; The Economist, 2005), and eventually contributing to changes in weather and climate.

Dealing with climate-driven and weather-related risks requires fair understanding of three fundamental aspects. First, climatic changes (in temperatures and precipitations) are not equally distributed across the Earth. Second, socio-economic and techno-infrastructural capacity to deal with environmental hazards is also not equally distributed among regions and countries. Third, detailed mechanisms of interactions and influences of human and natural factors are rarely clear, and need highly complex analysis, because of a) co-variation of anthropogenic and natural gradients in the landscape, b) scale dependence of mechanisms, c) nonlinear behaviour of natural systems, and d) complex history of natural influences and land-uses (e.g. Doorkamp, 1998; Simonovic, 2000; Allan, 2004). Given these limitations, we make an attempt in this background paper to address the following two questions in context of the overexploitation of ecosystem resources versus the costs of storms and flooding risk management:

Question 1: What factors account for the dramatically increasing costs of weather-related disasters (specifically, floods and storms) in recent decades?

Question 2: What are the implications of these understandings, for both research and policy?

A brief analysis of factors (e.g. overexploitation of ecosystem resources) accounting for increasing costs of climatic/weather-related disasters, their implications, and insights followed by a summary is presented hereinafter.

[*] Corresponding author (India): B.R. Gurjar (brgurjar@yahoo.com)

[Ψ] Corresponding author (Romania): I.M. Ciumasu (ciumioan@yahoo.com)

Contributing Factors

The weather-related disaster losses have increased dramatically in recent decades, as shown in a figure (http://www.grida.no/climate/ipcc_tar/wg2/fig8-1.htm) published in 2001 by the IPCC (Pielke, Jr., 2005). Moreover, the magnitude, frequency and impacts of storms and floods appear to have increased in the last decade apparently as a consequence of global climatic changes – but also because of higher human pressures over environment viz. deforestation, urbanization and river regularization (e.g. Kundzewicz and Kaczmarek, 2000; Muzik, 2002; WWDR1, 2003). In 2002, for example, approximately 47 percent of the Brazilian Amazon was under some type of human pressure including deforested areas, urban zones, agrarian reform settlements, areas allocated for mining and mining exploration as well as areas under pressure as indicated by incidence of fire in Fig. 1 (Barreto et al., 2006).

The mechanism through which forests control the surface water circuits is complex and not completely understood, but the basic processes are mainly related to mechanical reception of precipitations, respiration and biomass production, variation of soil hydrological and hydro-chemical properties (e.g. Naef et al., 2002). The runoff of meteoric water on surface slopes is dependent of the hydraulic properties of soils, notably soil infiltration capacity, the later being influenced by changes and memory effects associated with land-uses (Naef et al., 2002; Zimmermann et al., 2006). Agricultural expansion against forest cover can lead to constant degradation of land, albeit without significant increase in agricultural yields, especially in steep slope areas, for example like in Central Himalaya, India, during the 1967-1997 period (Wakeel et al., 2005).

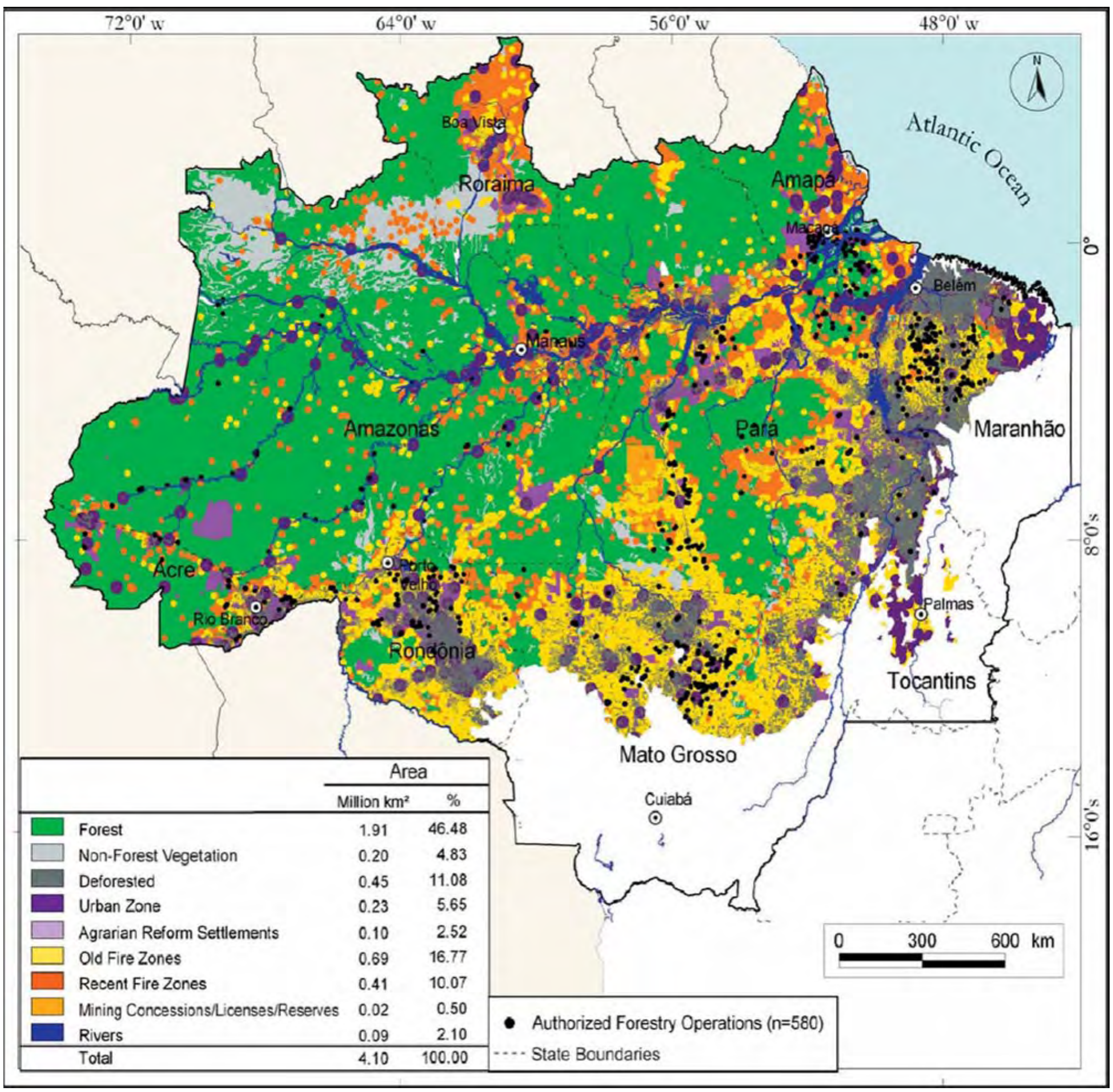

Fig.1: Human Pressure in the Brazilian Amazon - All Indicators (Source: Barreto et al., 2006).

It has been observed that the timber harvest and forest cover reduction usually results in increases of the stream flow. Just to give a short example, studies from southern Appalachian catchments showed that commercial clear-cutting resulted in 28% increase of the stream flow; water discharges diminished in the subsequent years as the wood vegetation started to recover (Swank et al., 2001). The extent of forest reduction needed to result in observable changes in water yield varies with geographical and biological properties of the river catchments (e.g. Stednick, 1996; Sun et al., 2005). Forest composition in a river collection basin directly influences how much effects forest have on low flows and peak flows in rivers (Robinson et al., 2003). Moreover, rapid urbanization of forested watersheds may cause higher peak flows and lower low flows, especially in areas with frequent heavy rains and steep slopes, one such representative example being Taiwan (e.g. Cheng et al., 2002).

Extreme storms and floods in the last decades happened mostly in Asia, but also in America and Europe. At present, about 40% of human population live in areas vulnerable to floods and rising sea levels, among nations most at risk being Bangladesh, China, India, Netherlands, Pakistan, Philippines, USA, and small island developing countries (Doornkamp, 1998; WWDR2, 2006). Tropical countries with monsoon climates (e.g. Bangladesh and India) are more prone to floods. Nevertheless, floods in the relatively small Red river in Canada and the USA in April-May 1997 have shown that developed temperate zone countries are not immune from them (Singh, 1997). In wealthy countries, however, while the number of fatalities from storms and floods go down, the material loses and economic risks keep rising, due to a increasing economic vulnerability in the general context of present policies (e.g., Kundzewicz and Kaczmarek, 2000; Hall et al., 2005). For example, costly ice storms in the US have been increasing strongly in recent years – as shown in Fig.2 (Changnon, 2003).

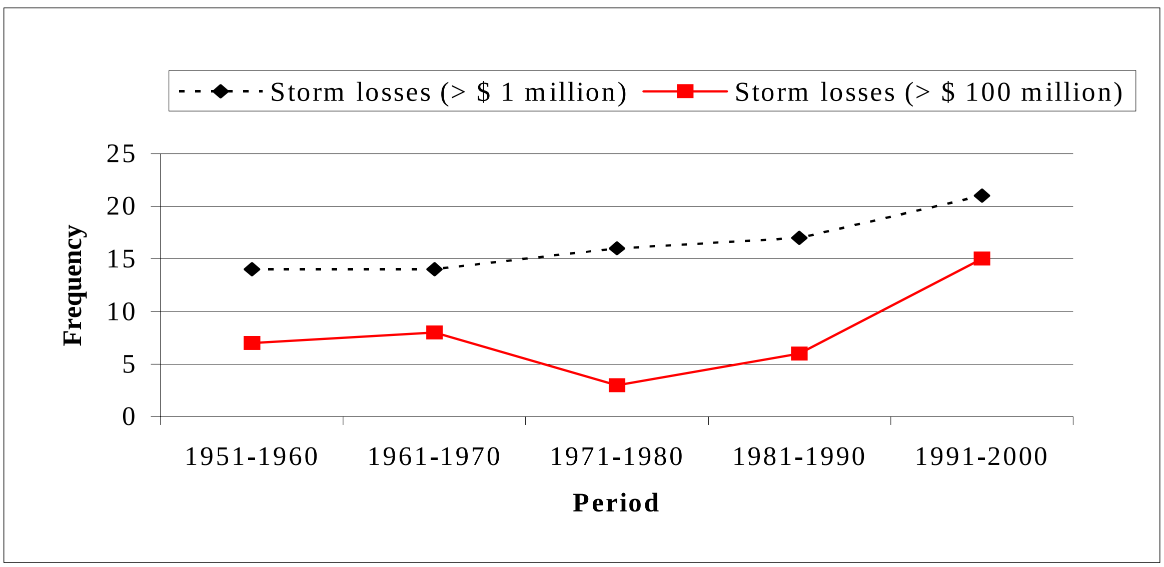

Fig. 2: The frequency of damaging ice storms during 1951-2000 in the US (as defined at two levels of losses – 1998 US $) (Data source: Changnon, S.A., 2003)

There are evidences that engineering measures such as storage, marginal embankments, improvement of waterways, etc. can and do reduce flood intensity and flood damage (Ojha and Singh, 2004). In contrast, Kundzewicz and Kaczmarek (2000) argue that higher cost of flood events is not only a policy issue, but a result of present practices e.g. over-reliance on engineering solutions such as dikes. The fact is that failure of physical solutions like dykes is usually, and inadvertently, considered as highly improbable. As a result, no significant preparation is carried out for such a possibility. One such example is the flooding of the New Orleans city in 2005, following dike failures during the level 5 hurricane Katrina. But this is not an isolated case. As a rule in the coastal areas, engineering works removed the danger from most (and low intensity) floods, so that what remain are only two situations: no flood or catastrophic floods (Doornkamp, 1998). Also, it is not uncommon that floods repeatedly visit the same country/area in short intervals, like it occurred in the Rhine River area in Germany during 1993 and 1995 and in South Korea in 1995 and 1996. In both cases, the later floods were less costly than the earlier ones, showing that some lessons were learned and appropriate actions were taken in time (Kundzevicz and Kaczmarek, 2000).

Case Study

Recently, Romania was the European country most hit by water related events, i.e. heavy storms and floods. In 2005, the yearly amount of rainfall in Romania was with 34% higher than the normal average (866.5 mm, instead of 647.0 mm), and with monthly distribution more uneven than usually, with several local highest recordings ever for rainfalls and river flows. The mean annual temperature was with 0.1°C lower than the reference period 1961-1990, with monthly average also with significant variations from the normal. Storms with heavy precipitations were concentrated in certain months, including winter snow covers. In almost every month it occurred that the flood defence levels were exceeded on rivers across the country, and a series of large floods affected the whole country mainly between April and September. The 2005 floods affected all 41 counties, and resulted in 76 human casualties and ca 2.0 billions US dollars (ca 1.7 billions Euros) (REIFMP2005, 2005). The extensive damages, notably on agriculture and infrastructures is thought to have strongly impacted on the national GDP annual growth, which dropped to ca. 4.3 in 2005, from 8.3 in 2004.

The recognized cause for such events and damages are: melting of snow (locally over 1 m thick) and heavy rainfalls (locally over 200 litres/m^2) or the two combined; deforestation; dikes failures due to higher, repeated and longer periods of high flow (up to 20 days); insufficient maintenance of flow-control system of reservoirs and channels; unauthorized and/or inappropriate constructions in high risk areas; under-equipped and inefficient institutions responsible for prevention and mitigation of disaster effects.

Putting aside the unusually extreme climate events and the unavoidable limits of any physical river regularization and the financial means, the big floods during 2003-2005 in Romania were most disastrous in areas that have undergone extensive deforestations following legal changes from state to private ownerships (law 400/2002), particularly on the slopes of the Carpathians Mountains. After flooding, new rules have being adopted in 2005, stipulating that, irrespective of ownership type, reforestation is compulsory within two years after deforestation. In case of reforestation failure with private owner, reforestation will automatically be realized by the National Forest Administration – RNP, at the cost of the owner. As reforestation is not very cheap, owners are expected to tend to avoid clear-cutting in the first place.

In addition, a detailed national map of flood risk is currently being worked by Romanian and German specialists, and due to be finished by 2008. Such measures are part of the National Strategy for Climatic Changes (SNSC) in Romania, developed by the National Commission on Climate Changes, within the authority of the Romanian Ministry for Environment and Waters, and in collaboration with other ministries, in order to comply with the United Nation Convention on Climatic Changes (law 24/1994) and the Kyoto Protocol (law 3/2001), and with the environment requirements of the European Union (SNSC, 2005), as well as the National Strategy for the Flood Risk Management (SNMRI, 2005), which also includes special first version of manuals like the Prefect's Manual for the Management of Flood Emergencies (MprefMSUCI, 2005) and the Mayor's Manual for the Management of Flood Emergencies (MprimMSUCI, 2005). Moreover, as a consequence of the floods in the spring of 2006 in all countries along Danube River, talks have began for building a joint international systems of early flood warning and associated management in the Danube's catchment. All such initiatives and management practices currently have a purely national character.

So far it seems that, with the support of the European Union to which it is planned to adhere most probably in 2007, Romania did learn the right lessons. However, now experts look at how efficiently applied these plans are: a matter of governance effectiveness. This was a point on which experts insisted during the negotiation of the treaty of EU – Romania association, namely Chapter 22 – Environment. New large floods are expected during 2006 and the next years, but casualties and material losses are due to decrease. A cost analysis of this evolution will be highly instructive for future measures of reduction in the costs caused by storms and floods.

Implications

In the past, once countries attained a certain level of economic development, they could deal better with issues of environmental protection and management. However, in the present era, developing countries appear to be stuck in a vicious cycle of poverty and deficient nature management. For example, economic development in lower income economies is accompanied by extensive overuse and/or natural resource conversion (Barbier, 2005).

In the context of a country's national strategy for sustainable development, holistic actions are a prerequisite to address climate and water-related crises in a cost-effective manner (Duda and El-Ashry, 2000). However, adoption and implementation of such action plans are a most difficult problem in developing countries in Asia, South America, Africa and Central-Eastern Europe, due to lack of financial and institutional resources (Loucks, 2000) and also due to the conflict in interests of different stakeholders. For example, a highly ambitious and massive water project that would integrate most of India's major waterways primarily aimed to mitigate problems of floods and droughts in different regions of the country has become a topic of intense debate in the scientific and policy-making communities (Gurjar, 2003).

The costs of facing natural hazards like storms and floods reflect the fact that prevention of and recovery from such extreme events is positively correlated with how sustainable society use natural resources. The rising costs of facing and recovering from storms and floods indicate *unsustainable* patterns of development, meaning human-caused climate and sea level changes, urban land claiming into flood plains and other wetlands, poor land use management like undiscerning deforestation, and short-sighted governance based on destroying the self-regenerating capacity of the natural life-support systems.

According to recommendations adopted by International Union for the Conservation of Nature (IUCN) in 2004, the *Precautionary Principle* should prevail in environmental decision-making and management. This appeal was followed by a resolution titled *Protecting the Earth's waters for public and ecological benefit*, and stating that the ecosystem approach to water resources management need to be central in any water governance policy (IUCN Congress Bulletin, 2004). The sustainable management of water resources involve anticipation and acceptance of change (as opposed to inflexibility in the face of new information and new objectives), clear goals, and adaptability in finding multi-objective tradeoffs in a multi-participatory decision making process involving all stakeholders (e.g., Peterson et al., 1994; Loucks, 2000; Simonovic, 2000; Plate, 2002).

In short, both investors and local authorities and populations must become fully aware that forests help catch and retain meteoric water where it falls (source control), with many advantages, most notably conservation of water resources (including recharges of groundwaters), and buffering natural systems and ecosystem resources from possible climate change impacts on local investments and economic and social activities. For example, even in currently highly centralized countries like China local people were recently involved in extensive works of reforestations aiming at mitigating destructive effect of floods (Wan, 2003). This might be due to the fact that in this country that pioneered grand work of engineering to regularize the streams of rivers, water containment by dikes proved to be inappropriate for the present days, and reduction of water runoffs are to be preferred (Plate, 2002).

Consequently, if they want to have a long-term perspective, investors should assist responsible institutions in updating knowledge and mechanisms of integrated local environmental management in areas with high risk of storms and flooding. Particularly developing countries should demand investors proceed to long term planning, and they should develop incentives for investors to make such long-term investments. One such solution is forest plantations for commercial logging, as alternatives to natural forest cutting; but also, such plantations should be knowledge-based, e.g. located in areas with best-suited topography and hydrology.

Insights

As nature recognizes no political border and the World is now acknowledging the benefits and the challenges brought by globalization, the considerate part of the human society is in process of merging economic, social and ecological perspectives into one paradigm: *sustainable development* (WCED, 1987; Giddings et al., 2002). This concept and theory developed around the idea of mitigating long-term risks in human activities, i.e. present developments should not compromise future developments.

In a narrow sense, flood risk management is the process of managing an existing flood risk situation, by being prepared for the storm and/or flood, and to mitigate the disaster. This includes performing (and continuously updating) risk and vulnerability analysis (which includes maps produced with the help of Geographical Information Systems – GIS) as a basis for long-term management decisions. In a wider sense, it includes planning of a disaster protection system (Todini, 1999; Plate, 2002).

An important aspect of flood risk management is that the flood-insurance when subsidized by governments may encourage settlements of hazardous areas, and increase material losses due to flooding. Without such incentives, settlers may consider leaving – permanent evacuation from high-risk areas should actually be encouraged, as it is safer and cheaper. Absolute safety against water-related risks is impossible. However, a disaster-conscious society should combine prevention of, preparedness to, and mitigation of disaster effects (e.g. Kundzevicz and Kaczmarek, 2000; Plate, 2002; Priest et al., 2005.). However, sharing risk management between insurers and the state might be an option for sustainable development in high-risk areas (e.g. Dahlstrom et al., 2003). In addition, investors might find incentives and mechanisms to contribute flood recoveries, especially in poor countries, which do not afford paying for protection prior to disasters (Kunreuther and Linnerooth-Bayer, 2003).

The above viewpoints indicate that risk management plans at national levels are essential but not sufficient – involvement of local people is needed. Particularly in countries with a history of centralized administration (e.g. in the former Soviet Union and its satellite countries), people tend to look for help from government rather than to help themselves (e.g. Nunes Correia et al., 1998; McDaniels, 1999; Vari, A., 2002). It is to be expected that integration of these countries into the European Union, will help improve local attitudes in governance, via the implementation of the "subsidiarity principle" of the EU, which states that what the lesser entity can do adequately should not be done by the greater entity unless it can do it better. In short, this means that any measure that can be taken locally should be taken locally (Duda and El-Ashry, 2000). The contrary would only impede upon operability, efficiency and costs of the storm and flood risk management.

Valuable toolkits, such as revealed-preference (RP) techniques, stated-preference (SP) techniques, and conjoint analysis (CJ), required for estimating individual and group preferences and options in valuations of complex (multi-attribute) natural resources (including in watersheds), and between alternatives of environmental management, are being already developed by economists. But they need further refinement, especially towards applicability to real-world management (e.g. Farber and Griner, 2000). Several researchers (e.g. Duda and El-Ashry, 2000; Allan, 2004; Reynolds and Hessburg, 2005) have a viewpoint that although it is hard to ascribe precise limits to most certain landscapes, management decisions (evaluation, restoration, and so on) should follow an integrated landscape perspective at the most natural landscape unit which is the river collection basin. As an illustration, instead of extending into riverbeds, the development of human settlements should be planned by giving priority consideration to river's natural course of flow. And further, regularization work all along river streams should be more relaxed, i.e. allowing more space for rivers; river flows should be regularized at the collection basin level by measures of adapted land uses (scenarios) and ecosystem management (Niehoff et al., 2002). As a result of such policy measures, with the floods along Danube River in Romania, in the spring of 2006, many previous agricultural fields have undergone controlled flooding, and some of them are planed to be left and restored as flood wet lands.

Forestry practices influence water yield and quality. Locally, forest management must integrate several basic water goals, at the level of each river catchment basin: quantitative and qualitative stream flow regularization in the target river basin, including limiting peak flows (Twery and Hornbeck, 2001). In this respect, management should be based on paired-catchment studies: similar river basins, one untreated (acting as reference) and one treated (deforestation of reforestation) (e.g. Watson et al., 2001). Lack of uncoordinated exploitation of forest and water resources can only result in reciprocally excluding measures and investments in forestry and hydrology, hence higher costs for the local community, including the costs of living with natural risks. This requires that the cost-benefits analyses of natural resources management must include details on the best type of forest (and other vegetation) cover (Sahin and Hall, 1996) for given local needs. For example, if the flood risk is high, the goal of diminishing the costs of environmental changes associated with floods should be aimed at by favouring forest types that insure low water yields and low peak flows. Agricultural and urbanization plans must take into account the effect of changing land uses implied by urban expansions within peri-urban ecosystems, in the context of current climate changes (e.g. Hartig et al., 1996; Nunes Correia et al. 1999; Niehoff et al., 2002; Naef et al., 2002; Pivot et al., 2002). Scientific research should support such planning, by investigating the climatic and ecological mechanisms that influence the water circuits and the weather-related risks. For example, the few studies on the effect of reforestation (most studies deal with deforestation) upon stream flows lead sometime to contradictory results (Andreassian, 2004). More knowledge is needed upon how ecosystems can regulate water circuits at river basin landscape. Long-term studies (with permanent stations) on both deforestation and reforestation are largely missing and should be promoted and supported.

During the 2003-2005, while the wood demand was basically stabilized, the demand for environmental services of forests, related to the protective roles of forests has soared (Leslie 2005; FAO, 2006). Thus, the relationships between the economic concept of value and the bio-physical dimensions of forests (especially uplands) need be further tackled by extensive research (e.g. Kramer et al., 1997). Similarly, flood (alluvial) plains have various functions which are not taken into consideration when river regularizations are planned, but which need economic valuation (e.g. Gren et al., 1995). In addition, combined natural risk effects must be studied and managed. For example, the Shanghai area is strongly exposed to and affected by typhoons. Beside wind-caused damages, storm-induced floods sometimes combine with high spring tides to produce highly destructive floods (Zhong and Chen, 1999). Similar effects are also well accounted in Europe, in the North Sea area; the situation can be further complicated, for example by coastal subsidence following gas extractions (e.g. Doornkamp, 1998).

In island and coastal countries, such as in the Pacific area that is particularly hit by cyclones, or in countries hit by monsoon and El Niño storms and floods, it is important not only to try to mitigate but also adapt to climate changes. Starting with the Pacific Islands Climate Change Assistance Programme and the Pacific Islands Framework for Action on Climate Change, Climate Variability and Sea Level Rise (2000), the region has seen a renewed interest in climate change adaptation over the past few years (Bettencourt et al., 2006). The broad solution at hand appears to be the promotion of research and global policy for carbon trapping (mainly by forests) to diminish the concentration of carbon dioxide in the atmosphere. But adaptations to climate change and risk management of natural hazards have emerged as core development issues particularly for Pacific Island countries. In this area the protective role of coastal forests (mangrove) is required to be further studied and employed in measures of risk attenuation and in general sustainable costal development. Among the most important properties of mangrove forests are: reduction of severity of storms and coastal flooding, high regeneration capacity and productivity, key roles in the stability and productivity of coastal marine ecosystems – including for the regeneration of the fish populations (e.g., Arrow et al. 2000; Benfield et al., 2005). The 2004 Indian Ocean tsunami showed the importance of maintaining natural wave breakers, by managing coral reefs, mangroves, and sand banks (Bettencourt et al., 2006).

In addition to the necessity of appropriate economic incentives and mitigation/adaptation related efforts, the general fundamental insight pertaining to risk costs and risk management is that nothing can be done on long term (i.e. in a sustainable fashion) without the involvement of the local people in a fair and inclusive manner. The concept of sustainable management of natural resources is (unfortunately) only recent, and it challenges most old cultural habits. It is, therefore, clear that no sustainable management can be carried out successfully without first achieving basic ecological education through all age groups, education levels, and professions. Otherwise, management efforts not including the local people (including owners, beneficiaries, etc) in a proper manner would simply be ineffective.

In this respect, particular international actions worth mentioning, like the conference "Education and public awareness for sustainable development", held in November 1995, in Pruhonice, Czeck Repunblic, and the European "Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters", from 25 June, 1998, Aarhus, Denmark (http://europa.eu.int/comm/environment/aarhus/). Also, in order to raise efforts in the field of environmental education and public awareness pertaining to environmental issues, the United Nations declared the period 2005-2014 the Decade of Education for Sustainable Development. Further information about educational and public awareness actions taken by United Nations, including those towards disaster reduction, are available at http://portal.unesco.org/education/en/ev.php-URL_ID=27234&URL_DO=DO_TOPIC&URL_SECTION=201.html.

To put it differently, old habits die hard. As a consequence, costs of water-related risks will probably go lower only on medium and long-term, and only on the condition that environmental education (including education for sustainable development) will be properly resourced and planned. Thus, economic agents have an interest in financing such education, desirably in a coordinated fashion with state authorities, because ecological education is the first step for any national environmental policy. Further, eco-efficiency of economic activities (e.g. Pickett et al., 2001; Huppes and Ishikawa, 2005 Wall-Markowski et al., 2005) should be a central issue in ecological education at levels of specialists in industrial planning and production.

Summary

Increasing environmental stresses associated with global climate change and less employment opportunities in rural areas force people to migrate towards burgeoning cities (Gurjar and Lelieveld, 2005) leading to significant changes in the regional landscape and anthropogenic emissions. A recent research report states that land-use conversion in the Brazilian Amazon is triggering forest loss and degradation and rapidly changing the regional landscape. According to the Food and Agriculture Organization (FAO) of the United Nations, Brazil accounted for approximately 42 percent of global net forest loss from 2000 to 2005; most of this deforestation occurred in the Brazilian Amazon (Barreto et al., 2006). The global water cycle is influenced by both global climate changes and Earth's ecosystems, and both undergo transformations caused by anthropogenic activities, e.g. release of greenhouse gases into the atmosphere and landscape modifications. As reported by the Intergovernmental Panel on Climate Change (IPCC), the average Global temperature increased by 0.6 ± 0.2 °C during the 20th century, and it has been estimated to rise further with 1.4 – 5.8 °C until 2100. This may lead to changes in frequency, intensity, and duration of extreme events, e.g. more hot days, heat waves and heavy precipitation events. It is argued that many of these projected changes would cause increased risks of floods and droughts in many regions, and predominantly adverse impacts on ecological systems and socio-economic sectors (IPCC, 2001).

Ecosystems and the functions they render to individuals and society (such as – providing food, fiber, medicines and energy; processing carbon and other nutrients; and purifying and regulating water resources) are sensitive to variation and change in climate (Brenkert and Malone, 2005). As natural systems are subject to considerable stochastic variations, sensitivity analysis is needed to investigate the uncertainty associated key parameters (e.g. storms intensity, rainfall amounts) and thus estimate floods risks and necessary management strategies and actions (Kramer et al., 1997; Doornkamp, 1998; Arrow et al., 2000). Insights from such analyses might help policy makers and managers identify appropriate trade-offs between the costs and the benefits of protecting forests in sensitive river catchments. From an economic and financial perspective, the idea is that ecosystems (notably forests) must actually be counted as water infrastructure, and valued using cost-benefits balance (Emerton and Bos, 2004). Also, because the price of timber usually does not include the removal of other forest benefits, the price of timber is naturally underestimated, particularly with clear-cutting. Correct estimation should not only include the costs of wood extraction and transport, but also the costs of removing the other functions of the forest (especially the protective effects), for example the costs of reconstruction after floods that are expected thereafter. In economic terms, this would mean bringing the so-called "shadow prices" (which account for all values that a product has to society) into the light (Freeman, 1993; Gardiner et al., 1995; Farber and Griner, 2000).

Economic welfare of human societies across the Earth depends on capital flows, but investments are very sensitive to perceived as well as actual risks. Therefore, natural events like climate-born phenomena qualify as most serious, long-term menaces to local, national and global economies. In this context, all socio-economic actors are deemed to corroborate efforts for achieving coherent action and effective risk management. The real-life success of any risk management program is key-conditioned by finding case-by-case answers to a pervasive problem – *the conflict of usages of natural resources*. Such unsolved conflicts can only result in the destruction of natural resources, due to overexploitation, and subsequent price escalations. For example, according to FAO of the United Nations, Indonesia is losing each year almost two millions hectares of forest (i.e. about the size of Wales), while South America loosed between 2000-2005 ca 4.3 hectares per year.

Since the world's rainforests, a global asset, are owned by the mainly poor and developing countries, cutting them down for profit or livelihood is a tempting source of income for their owners. On the other hand, the forests are sinks for atmospheric CO2 and hence help in mitigating the problem of man-made global warming and climate change. They are also rich storehouses of biodiversity – another global resource. In such situations, in order to stop illegal exploitations of forests in developing countries, economic incentives and use of advanced science and technology for controlled and sustainable logging are a promising solution – provided a good governance equipped with efficient socio-political institutions and effective policy instruments are there in place to ensure constructive co-operation between local community, government, industry and environmentalists. Fortunately, today science and technology is developed enough to help conserve the forests. For example, there could be a possibility that genetically engineered trees are used to make plantations faster growing and more viable, and consequently lessen the pressure to hack down wilderness forest (The Economist, Mar 23rd, 2006). Hence, with an aim to make markets work for the welfare of forest based communities, imparting education and giving control to the local people (including property rights) could probably result in the cost-effective and sustainable ways to avoiding overexploitation of ecosystem resources and reducing costs involved in storms and flooding risk management.

References

Allan, J.D., 2004. Landscapes and riverscapes: the influence of land use on stream ecosystems. Annual Review of Ecology and Systematics 35: 257-284.

Andreassian, V., 2004. Waters and forests: from historical controversy to scientific debate. Journal of Hydrology 291: 1-27.

Arrow, K., Daily, G., Dasgupta, P., Levin, S., Maler, K.-G., Maskin, E., Starrett, D., Sterner, T., Tietenberg, T., 2000. Managing ecosystem resources. Environmental Science and Technology 34: 1401-1046.

Barbier, E.B., 2005. Natural Resources and Economic Development. Cambridge University Press. 410 pp.

Barreto, P., C. Souza Jr., R. Noguerón, A. Anderson and R. Salomao (in collaboration with J. Wiles), 2006. Research Report: Human Pressure on the Brazilian Amazon Forests. World Resources Institute, Washington, DC. ISBN: 1-56973-605-7. URL: http://pubs.wri.org/pubs_description.cfm?PubID=3869

Benfield, S.L., Guzman, H.M., Mair, J.M., 2005. Temporal mangrove dynamics in relation to coastal development in Pacific Panama. Journal of Environmental Management 76: 263-276.

Bettencourt, S., Croad, R., Freeman, P., Hay, J., Jones, R., King, P., Lal, P., Mearns, A., Miller, G., Pswarayi-Riddihough, I., Simpson, A., Teuatabo, N., Trotz, U., Van Aalst, M., 2006. Not if but when – Adapting to natural hazards in the Pacific Islands Region: A policy note. East Asia and Pacific Region, Pacific Islands Country Management Unit; The World Bank, Washington D.C.

Brenkert, A.L. and E.L. Malone, 2005. Modeling vulnerability and resilience to climate change: a case study of India and Indian states. Climatic Change 72: 57–102

Changnon, S.A., 2003. Shifting economic impacts from weather extremes in the United States: a result of societal changes, not global warming. Natural Hazards 29: 273–290.

Dahlstrom, K., Skea, J., Stahel, W.R., 2003. Innovation, insurability and sustainable development: sharing risk management between insurers and the state. The Geneva Papers 28(3): 394-412.

Doornkamp, J.C., 1998. Coastal flooding, global warming and environmental management. Journal of Environmental Management 52: 327-333.

Duda, A.M., El-Ashry, M.T., 2000. Addressing the global water and environmental crisis through integrated approaches to the management of land, water and ecological resources. Water International 25(1), 115-126.

Ehrlich, PR, and AH Ehrlich. 1981. Extinction: The Causes and Consequences of the Disappearance of Species. Random House, New York.

Emerton, L., Bos, E., 2004. Value. Counting ecosystems as an economic part of water infrastructure. IUCN, Gland, Switzerland and Cambridge, UK. 88 pp.

FAO, 2006. Global Forest Resources Assessment 2005. Progress towards sustainable forest management. FAO Forestry Paper 147, Rome.

Freeman, A.M., 1993. The measurement of environmental and resource values: theory and methods; Resources for the future: Washington DC.

Gardiner, J., 1995. Developing flood defence as a sustainable hazard alleviation measure. In Gardiner, J., et al. (Eds), Defence from floods and floodplain management. Kluwer, Dordrecht, The Netherlands, 13-40. Cited by Kundzewicz, Z.W., Kaczmarek, Z., 2000. Coping with hydrological extremes. Water International 25: 66-75.

Giddings, B., Hopwood, B., O'Brian, G., 2002. Environment, economy and society: fitting them together into sustainable development. Sustainable Development 10: 187-196.

Gren, I.-M., Groth, K.-H., Sylven, M., 1995. Economic values of Danube floodplains. Journal of Environmental Management 45: 333-345.

Gurjar, B.R., 2003. Interlinking of rivers: A climatic viewpoint. Current Science 84 (11), 1381 -1382.

Gurjar, B.R. and J. Lelieveld. Megacities and global change. New Directions / Atmospheric Environment 39 (2005) 391–393.

Hall, J., Sayers, P., Dawson, R., 2005. National-scale assessment of current and future flood risk in England and Wales. Natural Hazards 36(1-2): 147-164.

Hartig, K.E., Grozev, O., Rosenzweig, C., 1996. Climate change, agriculture and wetlands in Eastern Europe: vulnerability, adaptation and policy. Climatic Change 36 (1-2): 107-121.

Huppes, G., Ishikawa, M., 2005. A framework for quantified eco-efficiency analysis. Journal of Industrial Ecology 9(4), 25-41.

IUCN Congress Bulletin, 2004. A daily report of the 3rd IUCN World Conservation Congress, volume 39 (15), 28 November, published by the International Institute for Sustainable Development.

IPCC, 2001. Climate Change 2001: Synthesis Report. Summary for Policymakers. An Assessment of the Intergovernmental Panel on Climate Change (IPCC).

Keppler, Frank, John T. G. Hamilton, Marc Brass and Thomas Röckmann, 2006. Methane emissions from terrestrial plants under aerobic conditions. Nature 439, 187-191 (12 January 2006). Doi:10.1038/nature04420.

Kramer, R.A., Richter, D.D., Pattanayak, S., Sharma, N.P., 1997. Ecological and economic analysis of watershed protection in Eastern Madagascar. Journal of Environmental Protection 49: 277-295.

Kundzewicz, Z.W., Kaczmarek, Z., 2000. Coping with hydrological extremes. Water International 25: 66-75. International Water Resources Association – IWRA.

Kunreuther, H.C., Linnerooth-Bayer, J., 2003. The financial management of catastrophic flood risks in emerging-economy countries. Risk Analysis 23(3): 627-639.

Leslie, A, 2005. What will we want from the forests? International Tropical Timber Organization (ITTO), Tropical Forest Update 15(1): 14-16.

Loucks, D.P., 2000. Sustainable water resources management. Water International 25: 3-10. International Water Resources Association – IWRA.

McDaniels, T.L., Gregory, R.S., Fields, D., 1999. Democratizing risk management: successful public involvement in local water management decisions. Risk Analysis 19(3): 497-510.

MprefMSUCI, 2005. Manualul prefectului pentru managementul situatiilor de urgenta in caz de inundatii. The Romanian Ministry for Environment and Waters, http://www.mmediu.ro/home/home/Ape/Manual%20Prefect.pdf.

MprimPMSUCI, 2005. Manualul pprimarului pentru managementul situatiilor de urgenta in caz de inundatii. The Romanian Ministry for Environment and Waters, http://www.mmediu.ro/home/home/Ape/Manual%20Primar.pdf.

Muzik, I., 2002. A first-order analysis of the climate change effect on flood frequencies in a subalpine watershed by means of a hydrological rainfall-runoff model. Journal of Hydrology 267: 65-73.

Naef, F., Scherrer, S., Weiler, M., 2002. A process based assessment of the potential to reduce flood runoff by land use change. Journal of Hydrology 267: 74-79.

Niehoff, D., Fritsch, U., Brostert, A., 2002. Land-use impacts on storm-runoff generation: scenarios of land-use change and simulation of hydrological response in a meso-scale catchment in SW-Germany. Journal of Hydrology 267: 80-93.

Nunes Correia, F., Da Graça Saraiva, M., Da Silva F.N., Ramos, I., 1999. Floodplain management in urban developing areas. Part I. Urban growth scenarios and land use controls. Water Resources Management 13(1): 1-21.

Nunes Correia, F., Fordham, M., Da Graça Saraiva, M., Bernardo, F., 1998. Flood hazard assessment and management: interface with the public. Water Resources Management 12(3): 209-227.

Ojha, C.S.P. and V.P. Singh, 2004. Introduction. In: V.P. Singh, N. Sharma and C.S.P. Ojha (eds.). The Brahmaputra Basin Water Resources. Kluwer Academic Publishers, The Netherlands. ISBN: 1-4020-1737-5.

Peterson, D.L., Silsbee, D.G., Schmoldt, D.L., 1994. A case study of resources management planning with multiple objectives and projects. Environ. Management 18(5): 729-742.

Pickett, S.T.A., Cadenasso, M.L., Grove, J.M., Nilon, C.H., Pouyat, R.V., Zipperer, W.C., Canstanza, R., 2001. Urban ecological systems: liking terrestrial, ecological, physical, and socioeconomic components of metropolitan areas. Annual Review of Ecology and Systematics 32, 127-157.

Plate, E.J., 2002. Flood risk and flood management. Journal of Hydrology 267: 2-11.

Pielke, Jr., R.A., 2005. Making Sense of Trends in Disaster Losses, Bridges-OST's Publication on Science & Technology Policy, Vol. 7.

Pivot, J.-M., Josien, E., Martin, P., 2002. Farms adaptation to changes in flood risk: a management approach. Journal of Hydrology 267: 12-25.

Priest, S.J., Clark., M.J., Treby, E.J., 2005. Flood insurance: the challenge of the uninsured. Area 37: 295-302.

REIFMP2005, 2005. Raport privind efectele inundatiilor si fenomenelor meteorologice periculoase produse in anul 2005.

Reynolds, K.M., Hessburg, P.F., 2005. Decision support for integrated landscape evaluation and restoration planning. Forest Ecology and Management 207: 263-278.

Robinson, M., Cognard-Plancq, A.-L., Cosandey, C., David, J., Durand, P., Führer, H.-W. et al., 2003. Studies of the impact of forests on peak flows and base flows: a European perspective. Forest Ecology and Management 186 (1–3), 85–97

Sahin, V., Hall, M.J., 1996. The effects of afforestation and deforestation on water yields. Journal of Hydrology 178: 293-309.

Singh, B., 1997. Water resource development in India – a perspective. In: Singhal, D.C., N.K. Goyal, D.K. Srivastava, R. Singh, H. Joshi and B.S. Mathur (eds.). Proc. Int. Symp. On “Emerging trends in hydrology”, Sept. 25-27, 1997, University of Roorkee, India, pp. 1-17.

Simonovic, S.P., Tools for water management. One view of the future. Water International 25: 76-88.

SNSC, 2005. Strategia Nationala Privind Schimbarile Climatice pentru Romania. 2nd version, 17 February 2005. Ministerul Mediului si Gospodaririi Apelor, Romania.

SNMRI, 2005. Hotararea Guvernului nr 1.854/22 decembrie 2005 pentru aprobarea Strategiei nationale de management al riscului la inundatii. Bucuresti, 22 decmbrie 2005.

Sun, G., McNulty, S.G., Lu, J., Amatya, D.M., Liang, Y., Kolka, R.K., 2005. Regional annual water yield from forest lands and its response to potential deforestation across the southeastern United States. Journal of Hydrology 308: 258-268.

Swank, W.T., Vose, J.M., Elliott, K.J., 2001. Long-term hydrological and water quality responses following commercial clearcutting of mixed hardwoods on a southern Appalachian catchment. Forest Ecology and Management 143: 163-178.

The Economist, 2005. Backgrounders – Forests, May 11th 2005.

Todini, E., 1999. An operational decision support system for flood risk mapping, forecasting and management. Urban Water 1(2): 131-143.

Twery, M.J., Hornbeck, J.W., 2001. Incorporating water goals into forest management decisions at a local level. Forest Ecology and Management 143: 87-93.

Vari, A., 2002. Public involvement in flood risk management in Hungary. Journal of Risk Research 5(3): 211-224.

Wakeel, A., Rao, K.S., Maikhuri, R.K., Saxena, K.G., 2005. Forest management and land use/cover changes in a typical micro watershed in the mid elevation zone of Central Himalaya. Forest Ecology and Management 213: 229-242.

Wall-Markowski, C.A., Kicherer, A., Wittlinger, R., 2005. Eco-efficiency: inside BASF and beyond. Management of Environmental Quality: An International Journal 16(2), 153-159.

Wan, Hongtao, 2003. Policies and Measures on Flood Mitigation in China since 1998. The International Conference on Total Disaster Risk Management, 2-4 December 2003, pp. 31-38.

WCED (World Comission on Environment and Development), 1987. Our Common future. ("The Brundtland Report") Report of the World Commission on Environment and Development, to the General Assembly of the United Nations (04.08.1987).

Whatson, F., Vertessy, R., McMahon, T., Rhodes, B., Watson, I., 2001. Improved methods to assess water yield changes from paired-catchment studies: application to the Maroondah catchments. Forest Ecology and Management 143: 189-204.

WWDR1, 2003. The 1st United Nations World Water Development Report "Water for People, Water for Life, March 22, 2003, The 3rd World Water Forum, Kyoto, Japan.

WWDR2, 2006. The 2nd United Nations World Water Development Report "Water, a shared responsibility", March 22, 2006, The 4th World Water Forum, Mexico City, Mexico.

Zhong, Y., Chen, X., 1999. Typhoon hazards in the Shanghai area. Disasters 23: 66-88.

Zimmermann, B., Elsenbeer, H., De Moraes, J.M., 2006. The influence of land-use changes on soil hydraulic properties: Implications for runoff regeneration. Forest Ecology and Management 222: 29-38.