MITIGATING OF WATER RELATED NATURAL DISASTERS IN DEVELOPING COUNTRIES

Prof. Carlos E. M. Tucci
Institute of Hydraulic Research – University of Rio Grande do Sul – Rua Lavradio, 150 Porto Alegre, 90690-370 RS Brazil (E-mail: tucci@iph.ufrgs.br)

Abstract – Natural disasters had an important increase in last decades in different parts of the world, with more impact on pooper population. In this paper is presented an overview of the main impacts, the source of uncertainties related to the risk areas. The institutional international scenario is described with some overview related to South America.
The water management framework for preventing the natural disasters related to the source of uncertainties was discussed as measures in order deal with these risks.

Keywords: risk/management/water

NATURAL DISASTERS IMPACTS

From 1992 to 2001, developing countries accounted for 20% of the total number of disasters, and over 50% of all disaster fatalities (WWAP, 2005). There were of about 15 people killed/millions of inhabitants and 25 thousands/millions of inhabitants by disasters (based on data of 1994-2003, ISDR, 2005). The economics losses were about US$ 66 billions dollars yearly on the period 1994-2003 (ISDR, 2005). On the top 25 countries affected (inhabitants killed or affected) are developing or least developed countries in Africa, Asia and Latin America. Developing and least developed countries are those which have higher risk of disasters in terms of lives, injured inhabitants and economic losses. Between 1985 and 1999 the Least Developed Countries lost 13.4 % of their GDP to disasters and developed countries over 4%.

The increasing trend on natural disasters are related mainly to the *population grow* and occupation of risk areas (flood plains and coastal); *economical development grow* as consequence the pressure on the environment and the urbanization; *climate variability and change* which includes another dimension of the risk. In recent years 90% of natural disasters have been related to weather of climate conditions. These factors are interrelated and this trend on natural and water related risk is one of the main challenges for reduction of poverty together with the danger on the major sustainability conditions.

WATER HAZARD CONCEPTS

Definitions

Disaster is the "situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering". (ISDR 2005).

Hazard has been defined as "a threatening event, or the probability of occurrence of a potential damaging phenomenon within a given time period and area" (DHA,1992). It can be seen that Hazard and Disaster has similar definitions. In that perspective *Water Related Natural Disaster* is the event in which water is the cause or consequence, when impacts is on the water, of the disaster.

Vulnerability "are the degree of loss (in % of total) resulting from a potential damaging phenomenon" (DHA,1992) and *Risk* are the losses in lives, persons injured, damaged and economic activities disrupted, due a hazard event. *Risk* is estimated as the following (DHA,1992):

$$\text{Risk (R)} = \text{ Hazard (H) x Vulnerability (V)} \quad (1)$$

The above definition of vulnerability did not take into account the environment vulnerability to human development. Natural events are related to the impact on the population.

These above concepts are related to the effect of the event and there are other concepts which are related to human or environment to cope with the hazard event. *Resilience* is the ability to return to a previous state of the event. *Capacity* is "a combination of all strengths and resources available within a community or organization that can reduce the level of risk, or the effect of a disaster " (ISDR,2005).The equation 2.1 was updated to take into account the capacity (C) in the risk assessment (ISDR,2005)

$$\text{Risk} = \frac{\text{Hazard x Vunerability}}{\text{Capacity}} \quad (2)$$

Equations 1 and 2 may be used in different perspective. The former is used to evaluate the impact and the second the impact together with the capacity of the system to recover from the event.

Risk management in water natural disasters is the development of actions through prevention and mitigation measures in order to reduce the risk of the disaster. ISDR (2005) mentioned that disaster risk management comprises "the systematic process, administrative, decisions, organization, operational skills and abilities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters".

Risk reduction can be planned through structural or non-structural measures. Structural measures are planned to protect the population from the event avoiding impacts. Non-structural measures do not change the event level of occurrence for the population but reduce the vulnerability through some of the following measures: early warning, insurance, disaster relief, institutional measures.

Water related risk impacts

Water related risk impacts are mainly due to the effects on the population and environment of the natural and anthropogenic process developed in the water systems. In terms of environment and human development they could be classified based on the system or source such as:

- Urban development: supply & sanitation, urban drainage and solids;
- Energy: demand and production (hydropower);
- Transport: navigation;
- Rural development: supply, agriculture environment;
- *Water relater natural disasters*: floods, droughts, health, landslide & avalanche, famine;
- Environment: system sustainability such as wetlands; water quality, forest burn, etc.

This is a very broad classification of impacted areas of water resource management. It is a combination of socioeconomic areas and natural environment systems. There are strongly

overlapping on these groups such as: During a flood urban development, energy, transport, agriculture and environment could be affected in the same way as during other natural disasters. Urban development could also increase the chances of disasters such as landslide, urban drainage floods, environment impacts on water and deforestation, among others.

Natural related disaster has been classified in broad groups as OEA (1990): (a) *Atmospheric*: hailstorms, Hurricanes, lightning, tornadoes, tropical storms; (b) *Hydrologic*: coastal flooding, desertification, salinization, drought, erosion and sedimentation, river flooding, storm surges; (c) *Seismic* : fault ruptures, ground shaking, lateral spreading, liquefaction, Tsunamis, Seiches; (d) *Volcanic*: Tephra (ash, cinders, lapilli), gases, lava flows, mudflows, projectiles and lateral blasts, Pyroclastic flows; (e) *other geologic/hydrologic*: debris avalanches, expansive soils, landslides, rock falls, submarine slides, subsidence; (f) *wildfires:* brush, forest, grass, savannah.

ISDL (2005) organized the data of **natural disasters** into 3 specific groups:

- **Hydro-meteorological disasters:** including floods and wave surges, storms, droughts and related disasters (extreme temperatures and forest/scrub fires), and landslides & avalanches;
- **Geophysical disasters:** divided into earthquakes & tsunamis and volcanic eruptions;
- **Biological disasters:** covering epidemics and insect infestations.

WWAP (2005) presented the water related natural disasters as: Floods, droughts, landslide and avalanche, famine and water related epidemic. It shows that 50% of the events between 1990 and 2001 were due floods and in Americas and Africa occurred 49% of 2,200 water related disasters events in the period. Some statistics on flood impacts are WWAP (2005):

- Floods account for 15% of all deaths related to natural disasters;
- Approximately 66 million people suffered flood damage from 1973 to 1997;
- Between 1987 and 1997, 44% of all flood disasters affected Asia, claiming 228,000 lives (roughly 93% of all flood-related deaths worldwide). Economic losses for the region totaled US$136 billions.

ISDR (2005) presented the impacts due to Floods, surges and storms as a proportion of other natural disasters for a country classification in **Table 1**. It can be seen that floods has an important impact on the developing and least developing countries in all aspects and it is the main vulnerability to these countries as well to the others. It represents almost all economic losses for least developing countries (97%). **Figure 1** shows the hydro-meteorological evolution of events by decade since along twenty century. It shows high slope of increase in the curve after the 80's. It has to take into account that the population increase which increases the number of people vulnerable to hydro-meteorological events.

Table 1 Proportion (%) of impacts due to Floods, Waves surges and storm compared to the total natural disasters in the period of 1994-2003 (ISDR, 2005).

Type of countries[1]	Killed	Affected	Economic losses
OECD	10	50	38
CEE+CIS	17	51	79
Developing countries	56	70	73
Least developing countries	21	50	97

1- OECD – Organization for Economic Cooperation and Development State members: CEE + CIS: Central and Eastern European Countries + Commonwealth of independent Sates;

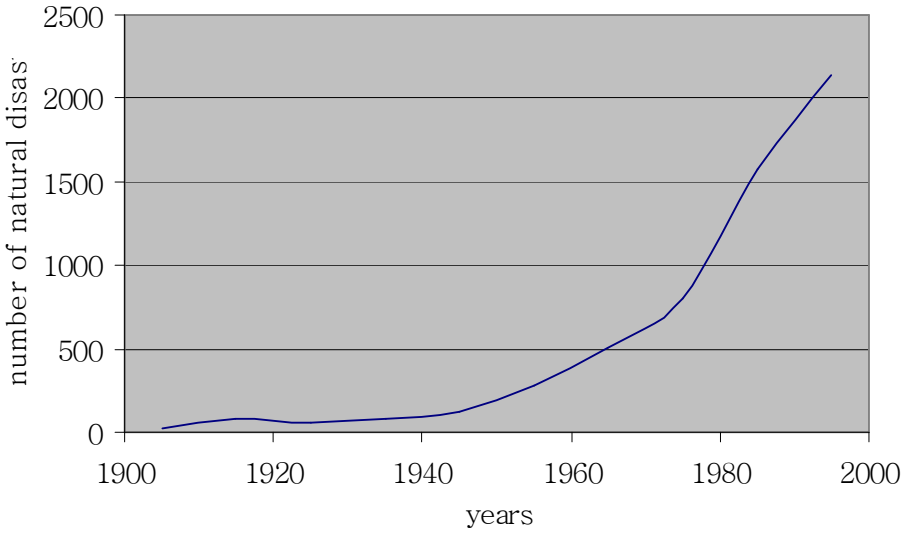

Figure 1 Increase of the number of hydro-meteorological events along twenty century by decade data (ISDR,2005).

SOURCE OF THE UNCERTAINTIES

The source of risk are related mainly to the pressure society exerts on the environment, impacts of the climate variation on the society and social and economics vulnerabilities.

The pressure that society exerts on the environment

This is the scenario where the water and environment are in danger and impact is on the resource. In some way the impact will reflect on the man, since damaging the natural system through pollution, its physical conditions such as river channel, basin characteristics, among other, will affect the human quality of life and potential use of the resources.

Development tends to exert pressure on natural resources particularly when

- The control of human activities is ineffective; and
- The complex impacts of the development.

The first of these occurs most often in poor and developing countries, where the need for growth and improvement in the quality of life takes precedence over environmental considerations. In the long term also the quality of live is impacted but the decision is made on the short term issues. The second is much more a problem of more advanced societies, where a great range of products (especially chemical) continues to emerge without sufficient understanding of their complex interactions with the environment and with their potential to threaten the improved quality of life resulting from the development.

The impacts of climate variation on society

As the demands for water resources of an increasingly sophisticated society increase, together with its requirement that such resources be sustainable, climatic fluctuations can bring about conditions which prejudice this sustainability in the medium term.

In South America, where all countries can be regarded as being in the course of development,

the principal challenges are:

- How to develop and acquire the quality of life desired by the population without damaging the available natural resources?; and
- How variations in climate might affect the environment, which, in turn, will impact upon the planning for growth?

The uncertainties related the unknown impact of long term trends of climate variability and climate change due to greenhouse effect. Climate variability has been a major factor on long term human sustainability on the earth. It is well known in history the population movement due to lack of water or agriculture sustainability (Diamond, 1997). For instance:

- In Brazil the energy production is 93% of hydropowers. In the last 30 years Paraná River mean flow (of about 60% of Brazilian energy production) increased of about 30%, creating a new level of available firm energy (Tucci and Clarke, 1998). Since this increase could be mainly due to climate variability and could decrease for other level, the system vulnerability is high. The key question without answer is: Is it permanent or will come back to previous flow level?
- A sequence of bad water years for agriculture without irrigation could be enough to create an important economic stress in a country, which has been the scenario in many countries in Africa after the 70's;
- According to the IPCC (2001), it is likely that extreme weather events will increase the frequency and severity during the 21st century as result of the climate variability. Population vulnerability varies with climate conditions. For instance, humid tropics and tropics has more intense rainfall used in urban drainage which requires more investment for the same level of risk protection of climate outside of the tropics (Tucci, 2001). Since the developed countries are in temperate or cold climates and some of the developing countries are in tropical climates, the lack of funds and prevention in developing and least develop countries increases the inhabitant's vulnerability;

Social and Economics Vulnerabilities: Urban Development

The social and economics vulnerabilities are based in the economic, political and institutional development of the societies. Developed countries usually have more funds and sound institutions to deal with hazard events developing prevention and decreasing the population vulnerability to disasters. The vulnerability increases with poverty and lack of funds, policies, institutions which could minimize the population vulnerabilities.

Rees (2002) mentioned four reasons that water risk management has to be developed beyond a good physical science and technology:

- "Risk, in human terms, exists only when humans have a stake in outcomes" Jarger et al (2001). The society is always in risk, the measure of the risk and the social and economics investment to decrease the risk is always a decision based on public perception and capacity of investment;
- the physical events alone are not the cause of the disasters, but human activity in moving to risk areas, increase the water demand or the pollution of water used for human are the source of the problems;
- Physical and hydrologic are only one group of the uncertainties related to risk management;
- Relying on the technical solutions for protection on high frequency events may increase the vulnerability for low frequency events.

The main vulnerability related to social and economic aspects are:

- *Poverty* is related to the lack of economic sustainability at daily basis, aggravated by: occupation of risk areas such hill slopes and flood plains; lack of access to clean water and adequate disposal of human waste;
- *Weak Institutional arrangements*: most of the developing and least developing countries have weak institutions and decision results in: corruption, bad investments, and lack of prevention and mitigation of the disasters events;
- *Lack of integrated risk water management*, which takes into account all the components and uncertainties together with the public perceptions of the risk. Lack of integration can be seen (Rees, 2002) in: cost shifting which is the transference of impact in space and time; inequities in risk allocations investments. Very often the poor receives less protection than the others; segmented management usually lead to an specific solution which may be in conflict with others;
- *Political decision making*: Usually the cost of prevention is highly small compare to disaster scenarios, but there are many decisions taking at short term bases, assuming that low frequency event would not occur in his the decision maker term;
- *Public x professional perception of the risk* (Margolis, 1996): Very often it can be seen that the perception of risk between professional and public are in conflict which create a difficult process of decision on the water risk management;
- *Social, Economical and financial evaluation and decision*: Reduction of natural disaster risk usually has high cost, that individual in the population can not afford. Usually it is a public investment and decision is based in social and economic variables taking into account the structural (high cost) and non-structural (lower cost) measures. Public participation should be included in the consultation process of decision making.

The social and economics vulnerability is strongly related to *urban development.* Most developed countries have its urban population above 75%. In developing countries the urbanization is smaller (exception of South America which is above 75%) but is moving for high urbanization.

Urban development in developing countries creates a dense population in small areas, poor public transport, lack of some water facilities, and polluted air and water with large vulnerabilities to disasters. Such poor environmental conditions are the main concern for the quality of life in these areas. A major part of this urban population lives in squatter settlements (*favelas* in Brazil or *barrios* in Venezuela). Caracas has over 50% of its population in this type of settlement. These slums are built out of cardboard and scrap material in areas which can be flooded or are located on steep hillsides. After a few years, this kind of construction improves and better materials are used, but the settlements are labyrinths of small streets without any planning for water supply, waste disposal and drainage.

There are many uncertainties related to climate, human demand, and environment together with complex interactions among these aspects. Some of the main uncertainties are related to these aspects are:

- Climate trends have been detected in a number of flow series around the world, and the possible effects of climate change of hydrologic regimes have also been identified (IPCC, 2001);
- Soil use has been one of the main concerns on the environment change with consequence on the water systems such as: deforestation, urbanization (flow increase and occupation of flood plains), change in agriculture practices, among others;
- Water demand and pollution: increasing population, irrigation and degradation of water quality due to diffuse and point pollution sources and decreasing the available

clean water for human, animal and industrial use, together with the supply for agriculture, conditions for energy production and navigation;

- Urban developments are increasing the impervious surfaces, occupation on flood plains and coast areas which increasing and amplification of the disasters risks.

The increasing social, economics and environment impacts from disasters requires the development of knowledge and actions for prevention and mitigation in order to recover the design risk and decrease the impact of low frequency events, improving the population quality of live and environment conservation. Water Hazard is a main international issue for the population and environment sustainability. Management water related risks has great impact on the capacity of countries to achieve the Millenium Development Goals (MDGs) (WWF,2005).

INTERNATIONAL AGENDA

Environment concern and investments grew strongly from 1970 onwards in the developed countries. With the 1980s marked by the accident at Chernobyl, society came to see that climate and the factors which influence it must be considered at large, even global, scales. The result was worldwide concern about climate and the effects of human activities on it. The 1990s were marked by the search for sustainable development, and in this decade and new millennium which are now entering. There is a widespread concern about water, its uses, and the consequences of the way it is used. United Nation Millenium Goals has been declared after many international meeting. One of the main goals is the reduction of poverty which is strongly related to the population vulnerability to disasters. In the Plan of Implementation of the World Summit on Sustainable Development (WSSD), held in Johanesburg in 2002, the proceedings highlights the need to "… mitigate the effects of drought and floods through such measures as improved use of climate and weather information and forecasts, early warning systems, land and natural resource management, agricultural practices and ecosystem conservation in order to reverse current trends and minimize degradation of land and water resources.."

In Kyoto during III^{o} World Water Conference there were many sessions where flood impacts and risk management was discussed and the one of the main subject of the Mexico IV^{o} WWC (March of 2006) is Risk Management.

United Nations General Assembly of 22 December 1989 proclaimed the International Decade of Natural Disasters Reduction (IDNDR) followed by the establishment of High Level Council. Scientific Technical Committee and the secretariat presented the objective as to "reduce through concerted international action, especially in developing countries, the loss of life, property damage, and social and economic disruption caused by natural disasters, such as earthquakes, windstorms, tsunamis, floods, landslides, volcanic eruptions, wildfires, grasshopper and locust infestations, drought and desertification and other calamities of natural origin." (Askew, 1994).

In 1994 the Yokohama World Conference on Natural Disaster Reduction held in Yokohama marked the middle of the decade and stress some important concepts related to risk assessment, disaster prevention, early warning, vulnerability reduction and mitigation.

Through its resolution A/RES/58/214, the United Nations General Assembly convened a World Conference on Disaster Reduction, to be held in Kobe, Hyogo, Japan, from 18 to 22 January 2005. The Conference was to take stock of progress in disaster risk reduction accomplished since the Yokohama Conference of 1994 and to make plans for the next ten years. The Hyogo framework of actions was an important tangible output of the Conference for future actions and development of the natural disasters mitigation. The gaps and challenges identified on the event were: *governance*: organizational, legal, and policy frameworks; *risk identification*, assessment, monitoring and early warning; *knowledge managing and education*; reducing underlying risk factors; *preparedness for*

effective response and recovery. In this conference declarations was stressed the relation of disaster reduction to sustainable development, the need for society reduction vulnerability, states responsibility for protection of the society, build resilience and stakeholder participation (UN, 2005).

At global levels the main needs are related to:

How to come from global goals to actions? There are some initiatives since 90's on risk management at global levels such as ISDR which has assessed the global impacts and its trends. IPPC is also developing assessing the impact due climate change. International Conference on WSSD developed the global goals and other conferences have developed the connections of goals and process what should develop at International level for the risk management on natural disasters (see above). The main need is how to implement the main actions at regional and local levels. WSSD proposed the development of Water Plans for at country level in order to implement Integrated Water Resource Management to achieve the millennium development goals (MDG). Water Plans still have a broad definition and has been understood as a set of principles on water that the country should develop in order to meet the MDG. Water Plans could be developed taking into account the four E's: Engineering, Economics, Environment and Efficiency.

In this perspective it is important that in developing the Water Plans the water management risk should be inside of these Plans. One of the main target would be to develop procedures in order to implement risk management on the Water Resource Management Plans

How to develop knowledge and capacity building? It is important that some international institutions develop knowledge and capacity building in order to cope with the aspects of risk management. The key is how to do that? The UN system rely on donor's from developed countries which usually has some part of its budget for support international agenda of developing and least developed countries. However, the way the international cooperation has been done does not improve the solutions of the problems. The activities are concentrated on international and donor's countries professionals which usually does not have good knowledge of local realities. In this procedure there are not much benefit in outputs or knowledge transference and capacity building for the receiving countries. In natural resource each reality has its complexity and requires ingenuity to solve the problem at local level. The basic knowledge and how to develop the skill to solve its own problems can be learned outside but the solution has to be found and developed at local level with local well known capacity. The main action could be in developing skill on the local professionals to learn and develop its own solutions for local realities.

REGIONAL AND LOCAL: SOUTH AMERICA

In South America the perception and management of risk has been strongly related to vulnerability to natural events. Some of the main distributions of risks related to natural disaster in the regions are:

- Along the Pacific Coast and Andes the main natural disasters are related to earthquakes, storm surge, snow avalanche, mud flood, land slide and flash flood;
- Floods along most of the rivers with important impacts on La Plata River: Paraná, Uruguay and Paraguay due to large flood plains and its population and soil use;
- Drought in major areas of regions such as Northeast of Brazil, east of Paraná and Paraguay River and some coast areas of Pacific.
- Urban drainage floods in most of the cites as consequence of lack urban planning and governance;

Some of main issues at regional levels are related to the following:

- Lack of governance: in most countries there is not policies related to risk management for natural disasters and the institutions are very weak in capacity building structure, funds, among others. Some of policies and strategies are developed just after a major or a sequence of important events and the capability to deal with disasters decreases along the time. In this scenario most of the policies has been effective for high frequency and less efficient for rare events.
- Risk identification: there is a very poor monitoring of natural variables and early warning. It varies from country to country and of the type of natural disasters.
- Knowledge and capacity: Since the governance is very weak, lack of information and lack of prevention, there is not incentive to develop knowledge or capacity to deal with this type of event.
- Preparedness and resilience: The majority of the population on risk areas is poor with high vulnerability and without resilience. After each events these population rely on public non-refund funds to improve its capacity of recovery. There is a bad incentive for this process, since the National or States govern supports the local areas with some non-refund funds during events, but do not invest on prevention.

The main needs at regional and local levels are to improve:

Governance: develop a policy for natural disasters inside of the Water Plans; strong institutions, capacity building and research;

Assessment, Monitoring and early warning: identification of risk areas, increases the monitoring of natural variables, develop indicators, and prepare a early warning system.

Prevention and resilience: Develop plans for vulnerability reduction and prevention of events.

WATER RESOURCE RISK MANAGEMENT FRAMEWORK

The technological developments of recent decades have resulted in a significant increase in the quality of life for one part of the world's population. Most of the remainder have yet to benefit from these developments and the thrust of international assistance is to bring this about. Some of the main challenges to society arising from the evolution of technology are discussed in the following sections.

The Framework of water risk management is described in the figure 2 is based on the *source or cause of risk*: Climate change and variability, Social and economics vulnerabilities; *actions do reduce vulnerability*: Governance, risk identification, knowledge and capacity building, improve prevention and resilience; and the *main overall goals*: reduction on losses and vulnerability; improve population safety and quality of live, environment conservation, reduce uncertainty on economic sectors: agriculture, energy and transport such as navigation.

OUTLOOK ON WATER RESOURCE RISK MANAGEMENT

The main challenges WRRM was described were described above and the main line of actions are described below.

Environment sustainability

The pressure that society exerts on the environment is strongly related to environment

movement which has been sufficient covered by many institutions at international and regional level. Usually the component which is not taken into account is the associate risk of natural disasters on the environment. The main opportunities on this risk management of environment sustainability assessed are:

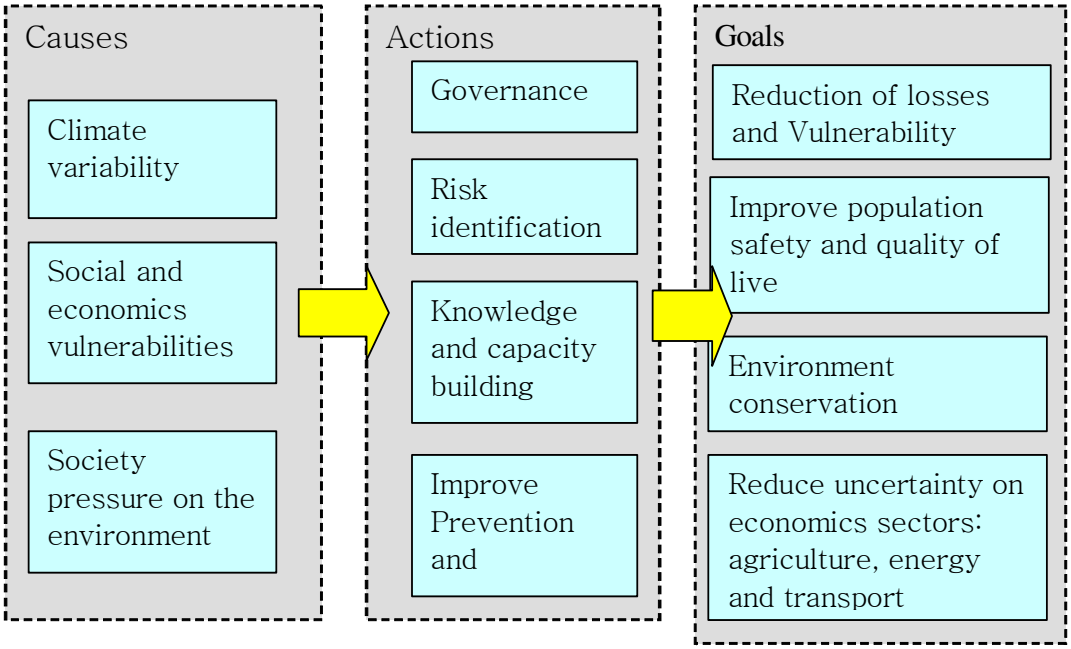

Figure 2 Water risk management Framework

- Synergic or integrated environment impact of water resource development in a basin and its coastal environment: changing in flora, fauna and population due to combination of water uses and works.
- Strategic environment risk management on Basin Plans: Strategic environment development is the actual development decision making process developed at govern levels in order to develop sustainable economical development compatible com environment conservation and mitigation;

Climate variability and sustainability of water resource systems

Climate variability has been detected in many flow series around the word and climate change (IPCC, 2001) the flow series usually are not stationary in long term as used in these water uses. The main impact in using non-stationary series in water resource engineering is the increase of the uncertainty of the water investments. River flow forecasting can be used to decrease the uncertainty and the risk of the water resources uses and conservation.

Climate variability and the sustainability of water resources systems usually has been studied mainly inside of climate change agenda, which is significant for future scenarios, about 50-100 years in the future and it is likely to be in development in short term. However, it can be seen that independent of the long term climate change or variability scenario, median and short term are very important in designing and management of water systems related such as agriculture planting, hydroelectric energy and river navigation. Energy and agriculture products already have hedging in Chicago market based on median term variability of temperature.

In the last 30 years large part of Africa had rainfall below the mean which created a lack of

human economic sustainability in the continent. In the other way, in La Plata Basin in South America there was an increase in the flow and energy and agriculture production. This inter-decadal variability is essential for human sustainability in the space. All the engineering design was based in stationary historical records which increases the risk of water resources systems deliver its planned outputs. How to design on this scenario? There is a need for development of non-stationary methods on design of water resources systems.

How the flow forecasting can help in reduction of risk assessment? Is it possible to integrate weather, hydrologic, optimization and economic models to reduce uncertainties in managing systems? This is an important field of development for water resources where *prediction scenario* is a future conditions without a defined date (for instance, climate change) and *forecast scenario* is a future condition with defined date at short term (few hours to about 14 days) and long term (of about 1 to 9 months in the future) (Georgakakos and Krysztofowicz, 2001). Usually short-term flow forecast is always linked mainly to flood forecast and management but there are many other uses which require a forecast such as: navigation in rivers where the load transported is dependent of the flow depth in unregulated rivers; irrigation and water supply and; integrated water uses such as floods and hydropower.

Long – term flow forecasting has been used to describe the methods used to forecast flow in seasonal systems (Villanueva et al, 1987; Druce, 2001), but after the use of climate models (Tucci et al 2002) or empirical and probabilistic relationship among climate variables and flow (Anderson et al, 2001) this forecast has been improved. Long-term forecasting can decrease the uncertainty of the economical evaluation of some commodities related to water resources such as: planning energy price in the system where hydropower has an important share of the production such as in countries as Brazil (~ 91%), Uruguay, Canada, and Norway among others; agriculture production for non-irrigated areas and; management of water conflicts.

The framework of development knowledge on this component is presented in figure 3. The main opportunities assessed on climate change and variability related to risk management is the following:

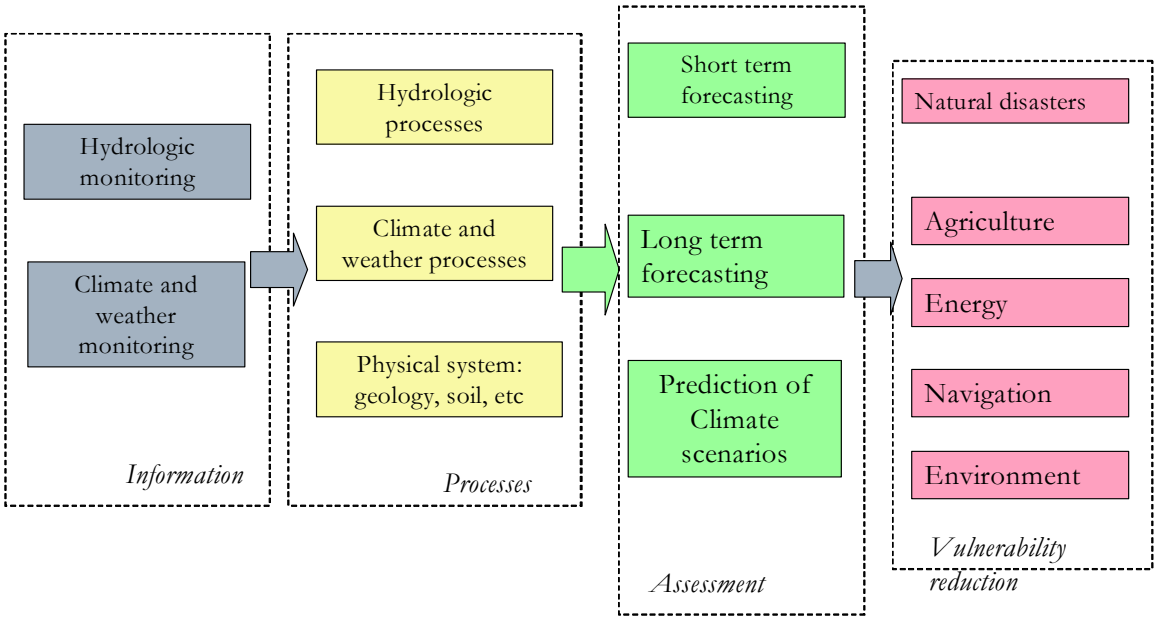

Figure 3: Framework for risk management related to climate change and variability

- Inter-decadal variability and sustainability of agriculture and energy of some regions;

- Effect of Climate change on the variability on extreme events (floods and draughts) in urban developments;
- Short-term forecast for warning on extreme events, security of population and works, operation of dams and hydraulics systems and navigation;
- Long term forecast for commodities markets such as energy or agriculture and long term planning
- Planning and design of water resources development and management based on non-stationary hydrologic series.

Social and Economics Vulnerabilities

Social and economic vulnerabilities are mainly in urban development aggravated in coastal cities. Urban population is increasing and scenarios of developing countries such as in South America (urban population above 75% in all countries) is happing in Central America and other regions in which the urbanization is moving above 50% of the total population. Lack of urban planning, governance and technical updating on urban drainage (floods), high water demand and pollution (water & sanitation stress and droughts), environment impact on water sources has been the main cause of the increase vulnerability.

The development of a sound risk management requires the Integrated Urban Water management which is the integration of Urban Development Plan Integrated with the urban water infra-structure taking into account the risk management. The opportunities on risk management assessed are:

- Indicators of extreme events such as flood and droughts which taking into account the social, economical and climate vulnerability related to the event for the potential conditions of an area. This type of indicators allow the decision makers assesses comparative conditions and take decisions for investments;
- Integration of indicators of urban development and vulnerability to floods, regulation and governance.
- Development of regional and globally assessment on risk aversion or public perception of risk in water management. It has been one main aspect on decision support process in different levels.

Water Plans, Integrated Water Resource Management and Risk Management

The main trends and water resource management on this scenario has as international goals the MDG for poverty. Reduction of poverty is related to supply of secure water and sanitation and reducing poor population vulnerability. The international community has discussed the Water Plans as instrument for in achieving these goals. The Water Plans has as main combination of tool the Integrated Water Resource Management, discussed in many papers in GWP series (GWP, 2000; GWP,2003; Rees, 2002; Jonch-Clausen,2004). The main discussion is how to move from general principles to objective action with specific goals in each country or region.

Usually there are the following stages of water resource development in the countries, as described in table 2. In the first stage of governance water resource is development by sectors without a national integrated legislation on water resource. In this scenario water related disasters are not managed, there are only funds ore helps for relief when it happens. It occurs because it is not water sectors which have revenues. In the second scenario, when exists a national legislation water resource management has mainly instruments for water use and distribution. In the third stage, when there is a decentralization of water resource management natural disasters such as floods and

draughts starts to have support due to public participation and assessment of the population needs at local levels.

Table 2 Governance in water Resource management

Stage	Characteristics
Previous	• Without integrated water legislation; • Water resource developed by economic sectors such: urban water and sanitation, energy, agriculture, transport, environment conservation
Transition	• National integrated water resource legislation is approved • Regulation of the national legislation • Implementation of national institutions: agencies and Councils
Decentralization	• Basin committee as space decentralization • Regulation of sectors: water & sanitation; energy, agriculture; taking into account the integrated legislation in water and environment
Development of Plans and actions	• Long term Economic Sustainability of the system • Plans: National, regional and basin plans • Implementation

The main opportunities of development on this component are:

- Develop studies in order to suggest risk management aspects on the integrated national legislation an regulation;
- Develop knowledge in order to support risk management aspects in the development water resource Plans: National, regional a basin.

CONCLUSIONS AND RECOMMENDATIONS

Human development in the last decades is getting more sophisticated due to the increase of population pressuring the natural systems, increase of the international economical and resource interdependence, new technologies and needs. This scenario increased the population vulnerabilities to natural and anthropogenic disasters. In the past a flood or drought would have space limited impact, but nowadays this events may create vulnerabilities which could spread to other regions such as the production reduction and price increase in agriculture commodities, energy (electric and oil), economic impacts reflecting in the markets, among others.

The main sources of the risks and vulnerability are the climate change and variability of the natural systems, social and economic development of the regions. The interactions of these conditions are the challenge in the modern society in order to decrease the risk and develop sustainability of the population and environment.

Risk is part of the human live, the sophistication of the impacts and interrelation of the modern society shows that the risk is increasing and the perception and knowledge of the integrated impacts are small.

REFERENCES

ASKEW, A.J. (1997). Water in the International Decade for Natural Disaster Reduction. In: Leavesley, G.; Lins, H.F.; Nobilis, F.; Parker, Randolph S.; Schneider, V.; van de Ven, F.H.M. (eds) Desctrictive Water: Water Caused Natural Disasters, their Abatement and Control. IAHS Publication n. 239 3-11p.

BOGARDI, J. (2002). Hazard, Risk and Vulnerability: a New look on the Flood Plains. International workshop on Water Hazard and Risk Management. January 20-22, 2004. Tsukuba, Japan.

DHA (1992) International Agreed Glossary of Basic Terms Related to Disasters Management. United Nations Department of Humanitarian Affairs, Geneva.

DHA (1994) Disasters Around the World – a Global and Regional View. Information pap n.4 World Conference on Natural Disasters Reduction. Yokohama May 1994.

DRUCE, D.J., 2001. Insights from a history of seasonal inflow forescating with a conceptual hydrologic model. *Journal of Hydrology* Volume 249 p102-112.

GWP,2000. Integrated Water Resource Management TAC Background paper n.4 Global Water Partnership.

GWP,2003. Poverty reduction and IWRM. TAC background paper n.6. Global Water Partnership.

ISDR,2005 _ Introduction – International Strategy of Disaster Reduction http://www.unisdr.org/disaster-statistics/introduction.htm

IPCC (2001) Climate Change 2001: Impacts, Adaptation and Vulnerability. A Report of Working Group II of Intergovernmental Panel on Climate Change.

JARGER, C. C. et al (2001). Risk, Uncertainty, and Rational Action London, Earthscan Publications.

JONCH-CLAUSEN, TORKIL (2004). Integrated Water Resource Management and Water Efficient Plans by 2005. TEC Background Water Management n. 10 GWP Global Water Partnership. Estocolmo.

MARGOLIS, H. (1996) Dealing with Risk. The University of Chicago Press. Chicago 227p.

OEA, (1990). *Disasters, Planning, and Development: Managing Natural Hazards to Reduce Loss*. Department of Regional Development and Environment Executive Secretariat for Economic and Social Affairs Organization of American States. Washington 80p.

REES, J.A. (2002) *Risk and Integrated Water Management*. TEC Background Water Management n. 6 GWP Global Water Partnership. Estocolmo 48p.

TUCCI, C.E.M. (2002). *Variabilidade climática e uso do solo na bacia do rio da Prata*. ANA Agência Nacional de Águas Pluviais. 160p.

TUCCI, C.E.M.; CLARKE, R.T. (1998). Environmental Issues in the La Plata Basin. Water Resources Development Vo. 14 N.2 p 157-173.

TUCCI,2005 Programa de Drenagem Sustentável: Apoio ao Desenvolvimento do Manejo de Águas Pluviais. Ministério das Cidades do Brasil.

UN,2005. Proceeding of World Conference on Disaster Reduction. ISDR Kobe January 2005. 146p.

WWAP (2005) – Managing Risks - World Water Assessment Programme www.unesco.org/**water**/wwap/facts_figures/managing_risks.shtml. access September