ANA
AGÊNCIA NACIONAL DE ÁGUAS

# CONTRIBUTIONS TO GUIDELINES FOR A PUBLIC POLICY FOR FLOOD RISK MANAGEMENT

REPORT FOR THE CONSOLIDATION OF THE MAIN RESULTS OF THE WORKSHOP ON FLOOD RISK MANAGEMENT, HELD FROM MARCH 23 TO 27 2015, AT THE NATIONAL WATER AGENCY, BRASILIA, DF

OPERATIONS AND CRITICAL EVENTS SUPERINTENDENCE

APRIL, 2015

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## Abstract

The National Water Agency ("Agência Nacional de Águas" - ANA) is the Federal Entity for the implementation of the National Policy for Water Resources and it has, among its legal attributions given by article 4º of the Law Number 9.984, of July 17 2000, the competency to plan and promote actions to prevent or minimize the effects of floods, in support to States and Municipalities. However, the management of risks and responses to natural disasters in Brazil is an activity performed by different institutions, acting in different governmental areas and levels and some of these actions are performed in integrated ways. Among the main institutions are: Basin Committees and Agencies; Water resources management organs of the States; the Ministry of National Integration ("Ministério da Integração Nacional" - MI); the Ministry of the Cities ("Ministério das Cidades" - MCid); the Ministry of Defense ("Ministério da Defesa"); The National Operator of the Electric System ("Operador Nacional do Sistema Elétrico" - ONS); the National Center for Management of Risks and Disasters ("Centro Nacional de Gerenciamento de Riscos e Desastres" - CENAD/SEDEC/MI); the National Center for Natural Disasters Monitoring and Alert ("Centro Nacional de Monitoramento e Alertas de Desastres Naturais" - CEMADEN/SEPED/MCTI); the Geological Service of Brazil ("Serviço Geológico do Brasil" - CPRM).

In order to improve the performance of the duties, specifically the ones related to the prevention of impacts of critical hydrological events, the supervision of reservoirs, the coordination of the National Hydro-meteorological Network, and the regulation of water use, the ANA established, in 2013, a partnership with the United States Army Corps of Engineers (USACE), an institution internationally renowned by their expertise, size and credibility in the area of Water Resources. Under this partnership, the Workshop on Flood Risk Management was held from March 23 to 27, with the presence of specialists from the USACE and institutions directly or indirectly involved in flood risk management and control.

The present document represents the consolidation of the main results of this workshop, especially those discussed and considered relevant for the improvement of flood risk management in Brazil by the multi-institutional, multidisciplinary group. Besides the description of what was presented and discussed in the lectures on the experiences in Brazil and the US, the result of group activities is also presented. These were performed in order to take advantage of the professional experience of participants, in order to collect suggestions and recommendations for a public policy for the management of flood risks considering fundamentals, guidelines, objectives, instruments and institutional attributions.

## 1 Introduction

The National Policy for Water Resources ("Política Nacional de Recursos Hídricos") has three objectives (article 1, of Law nr. 9,433, from January 8, 1997): I – to ensure the present and future generations the necessary availability of water in adequate quality standards to the respective uses; II – the rational and integrated use of water resources, including transportation in waterways, aiming at the sustainable development; and III – the prevention and defense against critical hydrological events of natural origin or resulting from the inadequate use of natural resources.

The National Water Agency ("Agência Nacional de Águas" - ANA) is the Federal Entity for the implementation of the National Policy for Water Resources and it has, among its legal attributions given by article 4 of the Law Number 9,984, of July 17 2000, the competency to plan and promote actions to prevent or minimize the effects of floods, in support to States and Municipalities.

Thus, the ANA has stimulated the development of Risk Management Plans for Hydro-meteorological Critical Events, which are important support instruments to natural disasters risk management. The identification of critical events, the characterization of the their potential impacts and the assessment of urban environment vulnerability work as support to States and Municipalities in the mapping of the most susceptible to natural disasters and in the development of integrated structural and non-structural actions for mitigation of their effects. An example of this action is the support provided by the ANA to the Committee for the Integration of the Paraíba do Sul River Basin ("Comitê de Integração da Bacia Hidrográfica do Rio Paraíba do Sul" - CEIVAP) in the execution of auxiliary studies for flood risk management, culminating in the System for the Prediction of Critical Events in the Paraíba do Sul River Basin ("Sistema de Previsão de Eventos Críticos na Bacia do Rio Paraíba do Sul" - SISPREC) and in the System of Structural Interventions for the Mitigation of the Effects of Floods in the Muriaé and Pomba River Basins - SIEMEC), concluded in 2012.

On the other hand, the management of risks and responses to natural disasters in Brazil is an activity performed by different institutions, acing in different governmental areas and levels, some of these being performed in integrated ways. For example, the group formed by ANA, the National Center for Natural Disasters Monitoring and Alert ("Centro Nacional de Monitoramento e Alertas de Desastres Naturais" - CEMADEN), the National Center for the Management of Risks and Disasters ("Centro Nacional de Gerenciamento de Riscos e Desastres" - CENAD) and by the Geological Service of Brazil ("Serviço Geológico do Brasil" - CPRM) has an important role in the monitoring of gradual floods. In this same action, the ANA also acts in support to the States and the Federal District in the modernization of the monitoring network and development of their own alert systems.

In the prevention action, the ANA has partnerships with the Ministry of National Integration ("Ministério da Integração Nacional") in developing the National Plan for Water Safety ("Plano Nacional de Segurança Hídrica" - PNSH), which is in elaboration. The aim of the plan is to define the main structural and strategic water resource interventions for the whole country, such as dams, water mains systems, channels and integration hubs necessary to ensure the offer of water for human supply and for the use in productive activities. Another focus of the plan will be to reduce the risks associated to critical events (droughts and floods).

However, several actions taken by other institutions are related to flood risk management: structural works conducted by the Ministry of National Integration ("Ministério da Integração Nacional"); the national housing project "Programa Minha

Casa, Minha Vida", managed by the Ministry of Cities ("Ministério das Cidades"), which has supported the reconstruction of houses affected and in areas under the risk of floods; the Annual Plans of Flood Prevention ("Planos Anuais de Prevenção de Cheias") developed by the National Operator of the Electric System ("Operador Nacional do Sistema Elétrico" - ONS); the structural and emergency works developed by the Engineer and Construction Department ("Departamento de Engenharia e Construção") of the Ministry of Defense; among others.

With the aim to improve the performance of its duties, specifically the ones related to the prevention of impacts of hydrological critical events, the supervision of reservoir operation, the coordination of the National Hydrometeorological Network and the regulation of water use, the ANA established, in 2013, a partnership with the United States Army Corps of Engineers (USACE), an institution internationally renowned by their expertise, size and credibility in the area of Water Resources..

Under this partnership, the Workshop on Flood Risk Management was held from March 23 to 27, with the presence of three specialists from the USACE, with the participation of several institutions directly or indirectly involved in flood risk management and control.

During the first three days of the event, lectures were made on Brazilian and American practical experiences related to the theme as well as discussions among participants, and in the last three days, participants were organized into groups to discuss more directly, mostly based on individual experiences, on suggestions and recommendations for a public policy for flood risk management, considering fundamentals, guidelines, objectives, instruments and institutional attributions.

The present document represents the consolidation of the main results of this workshop, especially those discussed and considered relevant for the improvement of flood risk management in Brazil by the multi-institutional, multidisciplinary group. Some themes that were approached repeatedly during the Workshop, especially during the plenary discussions, were grouped with the aim of keeping text continuity and flow.

We hope this document may serve as a guideline for federal and state governments in their actions, contributing to the improvement of flood risk management in the country.

## 2 Opening Session

The opening session of the event started with a lecture by the Director of Regulation of the ANA, Mr. João Gilberto Lotufo Conejo. In his lecture, the Director commented on the occurrence of large magnitude floods in Brazil, highlighting the record floods of the Madeira river in 2014 and 2015 and in the state of Acre in 2015. He drew a parallel with the occurrence of drought in the southeastern region of Brazil, the magnitude of which surprises even hydrologists working in the area. He also pointed out that, to meet these events, an improvement of the performance of the institutions involved is needed. In this sense, the partnership was established with the USACE, which possesses broad experience in water resources. Mr. Lotufo spoke of the action of the ANA in the design of studies for the management of flood risks in the Paraíba do Sul river basin and the Atlas of Vulnerability to Floods, which had the intense participation of the States. Lastly, he pointed out the importance of the event to collect information to subsidize a policy for flood risk management in the country.

Then, Mr. Wade Ross showed an institutional video of the USACE, highlighting the importance of the action of the USACE in different areas related to water resources and how this affects the economy, the environment, and the population. Mr. Wade also commented that, despite the many differences between the two countries, Brazil and the United States face similar challenges, mainly related to ensuring safety to the people. Lastly, he said that the USACE does not have solutions to all problems, but they are very good in brainstorming to discuss how to overcome their challenges, making themselves available to use the knowledge acquired by USACE in the discussion of alternatives for the challenges Brazil faces.

The other American lecturers, Mr. Nicholas Applegate and Mr. William Veatch commented the themes of their lectures in the workshop and highlighted that they work in large American projects to decrease the risks of floods, considering climate change and sea level elevation.

Closing the ceremony, it was the turn of the Director of the Water resources Department of the Water Resources and Urban Environment Secretariat of the Ministry of the Environment (“Departamento de Recursos Hídricos da Secretaria de Recursos Hídricos e Ambiente Urbano do Ministério do Meio Ambiente - SRHU/MMA”), Mr. Marcelo Jorge Medeiros, who commented on the floods of 2010 and 2011, that affected several regions of the country. According to him, it was from these events that the ANA identified the need to improve its action in flood risk management and started to establish the first contacts and partnerships with institutions with recognized experience in the area, such as the USACE. He also commented on the challenges of risk management and response to natural disasters at the federal level, whose legal role frequently requires joint action with states and municipalities, reinforcing the need of integrated action of institutions at all levels of government.

## 3 The Series of Lectures

During the first three days of the event, there were lectures on Brazilian and American experiences and practices relating to the theme, as well as discussions among participants. General comments on the lectures and the main points debated are presented below.

### 3.1 Brazilian legal and institutional framework on flood risk management

ANA specialist in Water resources, Ms. Alessandra Daibert Couri, made a lecture on “Brazilian legal and institutional provisions on flood risk management”.

The main federal laws that approach flood management are:

- The Federal Constitution of 1988: establishes that it is the duty of the Union to plan and promote permanent defense against public calamities, especially droughts and floods;
- The National System of Civil Defense (“Sistema Nacional de Defesa Civil”): It was initially structured in 1988 (Decree nr. 97.274/1988) and has suffered several amendments (Law nr. 12.340/1988 and Law nr. 12.608/2012); and
- The National Policy for Water Resources (“Política Nacional de Recursos Hídricos”, Law nr. 9.433/1997): establishes as one of the objectives “the prevention and the defense against critical hydrological events from a natural origin or resulting from the inadequate use of natural resources”.

Between 2003 and 2015, around 4 thousand municipalities were affected by floods in Brazil (of a total of 5,564 municipalities). Since 2011, with the occurrence of landslides and floods in the mountainous region of the State of Rio de Janeiro, considered as the largest natural disaster in Brazilian history, there was a change in the conduction of risk management of natural disasters by the Federal Government. Since then, the National Center for Natural Disasters Monitoring and Alert (“Centro Nacional de Monitoramento e Alertas de Desastres Naturais” - CEMADEN) was created in July 2011; the new Federal Law was on the National Policy of Protection and Civil Defense ("Política Nacional de Proteção e Defesa Civil" – Law nr. 12.608/ 2012); and, in August 2012, the National Plan for Risk Management and Response to Natural Disasters was issued and the new home of the National Center for the Management of Risks and Disasters (“Centro Nacional de Gerenciamento de Riscos e Desastres” - CENAD) was inaugurated.

The National Center for the Management of Risks and Disasters (CENAD) has four dimensions: prevention, including structural works; mapping, with focus on areas with high risks of landslides and floods; monitoring and alert, aiming at enhancing the network of observation; and response, for the increase in help and rescue, assistance and reconstruction capacities. As an example, the actions under the responsibility of the ANA, in the mapping dimension, refer to the development of the Atlas of Vulnerability to Floods and, in the dimension of monitoring and alert, the support to the States in the implementation of the Situation Rooms. The need of articulation of the institutions that act at different levels of the government is one of the main challenges for the implementation of the Plan.

In 2014 (Law nr. 12.983/2014), another step forward was recorded, when prevention actions were included in the system of obligatory transfers and prevention works were included in the financing lines of the National Fund for Public Calamities,

Civil Defense and Protection ("Fundo Nacional para Calamidades Públicas, Proteção e Defesa Civil" - FUNCAP).

After the context of the advances, the institutional relations in the management of floods and reservoirs in the Federal, State and Municipal Governments were presented. The large number of agents involved and the institutional and federative complexity for articulated action were highlighted.

Then, a systemic approach to flood management was presented, following the lines of action predicted in the National Policy of Civil Defense and Protection:

- Prevention: action previous to the disaster that includes the design of National, Regional and State plans of territorial ordainment, definition of areas of permanent preservation, water resource plans, monitoring of risk areas, vulnerability mapping and inspection of dam safety;
- Mitigation: action previous to the disaster that includes the construction of reservoirs, dams and diversion channels, as well as works on urban drainage, reservoir operation;
- Preparation: action previous to the disaster that includes weather and climate forecasts, operation of Situation Rooms, emission and diffusion of warnings and alerts, planning of relocation of populations in risk areas, design of contingency plans, and training and capacity building of professionals;
- Response: includes actions of help and assistance to victim populations, rehabilitation of the disaster scenario (re-establishing normality) and construction and management of shelters to affected populations;
- Recovery: action post disaster that includes evaluation report of damages and of efficacy of alerts, building of an information system on disasters and activities to recover the infrastructure and re-establish public services, the economy of the region, the social morale and the well-being of the population.

In the conclusion of the lecture, the main changes in the management of flood risk in the country, since 2011, were summarized: political prioritization of the actions of risk management with monitoring of the execution of the National Plan for Risk Management and Response to Natural Disasters by the Civil Office of the Presidency of the Republic; inclusion of a specific program for risk management and response to disasters in the Multi-Year Plan ("Plano Plurianual" - PPA) 2012-2015 of the Union, which will continue in the next cycle 2016-2019, increased focus on prevention; better federative articulation and institutional capacity; advances in the mapping of risk areas; improvement of the forecast and alert systems; integration of the Situation Rooms and the network of financing.

### *3.1.1 Considerations by the USACE*

After the lecture by the ANA, the representative of the USACE, Mr. William Veatch, made his lecture comparing Brazilian institutions with those of the United States, in a way to find similarities and differences and propose suggestions to Brazilian legal and institutional framework for the management of flood risk. Besides, the specialist pondered that the study of the Brazilian experience represented an opportunity to reflect upon their own action in the U.S.

In the comparison between areas of action, five Brazilian functions were listed (prevention, mitigation, preparation, response and recovery) corresponding to the ones

adopted in the U.S., which are: prevention, protection, mitigation, response and recovery. Besides pointing out several similarities, he concluded, among other things, that the actions of preparation in Brazil are related to protection actions in the U.S., which are those related to hydrological forecasts.

In institutional terms, the U.S.A. do not have a national agency for water or a National Operator for the Electric System, and several actions are conducted in different ways in different regions of the U.S. Besides, the activities performed by the Civil Defense in Brazil correspond, in great part, to the ones of the U.S. Federal Emergency Management Agency (FEMA). Similarly, actions performed by the CENAD and CEMADEN in Brazil are performed by the National Weather Service (NWS) in the U.S.

Concerning the management model, it was highlighted that the USACE is distributed in 7 divisions and several districts in the U.S. territory, these being for the local activities of this institution. Differently, the ANA has a central office and acts in articulation with the States, which may represent one more complexity factor to make actions effective, as it depends on the institutional capacity of the States.

From the perspective of action planning, the USACE pointed out the economic assessment made for the choice of projects to be executed by the institution. According to him, apparently, in Brazil studies of economic assessment are not considered in the technical viability, so the reduction of damage resulting from a given project is not quantified.

Finally, the following recommendations were made:

- To improve damage reports, also considering how the management was performed (actions that worked well or did not), transforming it into a post-event report. This information is very useful in future decision processes and also for the retention of knowledge in the institution. He commented that the ANA, having a small technical body, is more subject to the loss of knowledge due to the exit of one staff member;
- To improve periodic inspections in the dams to evaluate the need for a safety program of dikes, even if the number of dikes is not very expressive in Brazil;
- To improve Civil Defense, as there is a small number of workers with the responsibility of alerting the population and taking response measures. He mentioned that, in the U.S., districts give support to each other and that in Brazil the legal and institutional possibility of one State giving assistance to another in moments of crises could be verified which would increase the action capacity without increasing costs very much. Besides, it would aggregate more experience to the process;
- To keep the understanding of the risk associated to the implementation of structural measures, considering that after the works, there is still the residual risk and it must be avoided that the work induces the exposition to flood risk;
- Keep the integrated operation of the hydro-meteorological network;
- Keep the “social capital” and resilience. Mr. Veatch observed that, after a disaster, Brazilians show great solidarity with donations.

### 3.2 The U.S. National Flood Insurance Program

The USACE representative, Mr. William Veatch, made a lecture on the “U.S. National Flood Insurance Program (NFIP)”. The lecture provided a general view of the

advantages, disadvantages, and challenges related to the program, since Brazil does not have a similar experience. This way, the lesson from the U.S. experience may bring subsidies to the discussions of economic instruments for flood risk management in Brazil.

The NFIP, which is administrated by the U.S. Federal Emergency Management Agency (FEMA), was instituted by law in 1968, and allows owners in participating communities to buy insurance as a protection against the losses caused by the flood, both for the property and for the goods inside it. For this, partnerships are made between the federal government, local communities and private insurance companies.

When the NFIP was created, there was recognition that the price of the insurance would not be affordable without subsidy from the Federal Government. Since insurance is voluntary, the Government also noticed that few communities were joining the system. Then, in 1973, another law forbade Federal Agencies to provide financial assistance for the purchase of real estate and certain assistance where there was a probability of flood superior to 1% (a figure adopted arbitrarily), if the community did not participate in the insurance program. Additionally, a voluntary incentive program was created (Community Rating System - CRS) to encourage the communities participating in the NFIP to take measures of risk reduction. Through this incentive program, the community receives points of credit for the measures adopted, which allows for a discount of up to 45% in the premium value.

The basic components of the NFIP are: identification and mapping of flood prone areas; adoption and fulfillment, by the community, of norms for the management of the flood plain; and the supply of the flood insurance.

Maps are central elements of the NFIP, as they allow for the identification and assessment of the present and future risk, besides being good instruments for the communication of the risk and encouraging the wise occupation of the floodplain.

About the values of the insurance premium, due to the subsidy they are quite affordable, being even more attractive to people in areas of high risk of floods. However, the NFIP recorded debits of over 20 billion U.S. dollars after the Katrina and Sandy hurricanes. After this, there was an attempt to update insurance values to more realistic plateaus, however, there was a popular reaction against the measure.

It is possible that program only transfers the relative risk of financial loss to the insurance company and the government, as the value paid by the beneficiary does not reflect the risk to which people are submitted. Also, it is possible that the insurance might be encouraging people to accept more peacefully the risk they are subjected to.

The program has suffered many critics in recent years and, in order to remain relevant and useful for the management of flood risks, it is necessary that it continue under adaptation.

### 3.3 Studies for flood risk management in the Paraíba do Sul river basin

ANA specialist in water resources, Mr. Othon Fialho, presented the lecture "Auxiliary studies for Flood Risk Management in the Paraíba do Sul river basin". He started his lecture with a general view of the Paraíba do Sul river basin, its importance and vulnerabilities, following by a brief history and description of the studies undertaken.

The risk management studies were performed by request of the CEIVAP - the Committee for the Integration of the Paraíba do Sul River Basin and motivated by the great flood of 2008 in the Muriaé River. The main objective of the studies was to provide the basin with instruments for flood risk management as part of a future

contingency plan, including structural measures (SISPREC) and non-structural measures (SIEMEC), to be developed by the committee. The execution of the studies started in 2011 and finished in 2013.

The Paraíba do Sul river basin has a drainage area of 55,000km², within the states of São Paulo (13,900 km²), Rio de Janeiro (20,900 km²) and Minas Gerais (20,700 km²).

Being responsible for circa 12% of the national GIP, the basin faces frequent floods, especially in the municipalities located in the sub-basins of the Muriaé and Pomba rivers. The floods that happened in 2008 are noteworthy, for the levels of the Pomba and Muriaé rivers increased circa 10 and 8 meters, respectively. The cities most affected then were Cataguases, Carangola and Cardoso Moreira. Other municipalities in which people had to leave their houses were Natividade, Itaocara, Aperibé, Italva, Porciúncula, Campos dos Goytacazes and Cambuci.

According to the "Flood Vulnerability Map", developed by the ANA, there are a smaller number of critical sections in the portion of the basin located in the state of São Paulo, partly due to the presence of reservoirs that act in the control of floods. In the lower part of the basin, on the other hand, frequent floods are observed due both to the absence of hydraulic control and to the strangulation of the river by the advance of urbanization.

Another factor of concern is the existence of a significant number of tailing dams in the basin. Important events involving dam breaches have occurred in recent years. In 2003, a dam belonging to the companies Cataguases de Papel and Cataguases Florestal breached, leading to the spill of 1.2 billion liters of toxic residues in the Pomba and Paraíba do Sul rivers. In 2006 there was a new breach in the region that lasted for three days. In this occasion, 400 million liters of bauxite treatment - clay and water - reached a stream in the region and arrived to Rio de Janeiro. Inhabitants of Laje do Muriaé had their water supply suspended preventively, due to the possibility of contamination. In 2012 there was the breach of a dike in the locality of Três Vendas (Campos dos Goytacazes) which left many families without shelter.

It is, then, evident the great impact of the occurrence of accidents and the launching of pollutants in the Paraíba do Sul river basin, which may reflect on the transposition of waters from the Paraíba do Sul river to the Guandu river, with potential impact on the supply to the Rio de Janeiro metropolitan region.

The process of elaboration of the studies of SISPREC and SIEMEC was performed in stages, of which three main phases are highlighted:

- Phase 1: Data acquisition (hydrology, water quality, topography, local interferences and dams). In this phase we observed the existence of ongoing works and others planned;
- Phase 2: modeling of processes (floods, dam breaches and water quality) and spatial studies with GIS; and
- Phase 3: development of the systems SISPREC (simulation and forecast of floods, propagation of pollutants, and dam breaches) and SIEMEC (structural measurements divided in 3 subsystems – storage, channel improvement and structural interventions, including diversion channels).

Hydrological and hydraulic models were used in the studies. Rainfall-runoff hydrological models represent physical processes that occur in nature as interception, infiltration and runoff, sub-surface and underground. Hydraulic models, in turn, represent the spread of flow in sections of the river through the translation and damping of the hydrograph, and are also used when one wants to represent and assess the downstream effects (tide) and reservoir on the runoff.

From these models, maps were produced for the risk of flood, flood depth and alert levels (the combination of depth and flow speed), considering 2, 5, 10, 50, 100 and 500 years of return period.

SISPREC seeks to anticipate the consequences or possible effects of a certain event, being central to integrate a future contingency plan in order to drive response mechanisms in a timely manner. It has 3 subsystems:

- Flood forecast in the Paraíba do Sul river basin, which supplies flood hydrographs and maps of flooded areas;
- Dam breaches, with assessment and provision of breach scenarios (by structural failure - *piping* - or overtopping, with or without cascade effect) of the main reservoirs of the basin and some tilling dams.
- Water quality, in which a tool was developed to assess the spread of pollutants in the rivers Paraibuna, Pomba, Muriaé and Paraíba do Sul for different flow scenarios and from different launch places (for instance, crossings of roads and railroads with sections of the river) and vulnerable points (for instance, catchments for water supply systems).

In turn, the SIEMEC was organized in 3 subsystems:

- Dams for storage of flood detention, which aim to locally reduce the peak flow, reducing the flood wave in the downstream sections;
- Improvement of river troughs, increasing the capacity of river runners crossing the cities directly benefited by the SIEMEC;
- Partial diversion of flood flows in some cities, resulting that, ate the end of the studies, no diversion works were proposed, since the activities of subsystems 1 and 2 proved sufficient to mitigate the effects of floods, to the risk considered.

We highlight that, for the design of the SIEMEC, 12 critical municipalities were visited, with the aim of identifying the population potentially affected by floods and to survey critical points that interfere in runoff flows. In the assessment of the alternatives, dam performance was considered separately and in conjunction, and the hydraulic improvements required for each combination of dams. It is noteworthy that as it was a feasibility study of the works, costs were estimated by parametric curves.

Among the challenges pointed for the implementation of the actions predicted in the studies is the need to improve articulation among the states, as structural works performed in the state of Minas Gerais, although bringing benefits to the municipalities of the state, are also considered strategic for the state of Rio de Janeiro, located downstream. Identification of the parties responsible for financing, implementation, operation and maintenance of the project is not defined to date and must be discussed, preferably with the Basin Committee.

One last aspect highlighted in the lecture is the need to enhance the viability analysis of the projects for the next studies, considering cumulative failures probability along the years (not only the yearly probability) and the economic assessment of the decrease of potential damages for each scenario considered in the study. In this sense, the possibility was raised for the ANA to establish criteria covering these elements for the concession of grants for water use or for water sustainability certification of projects.

### *3.3.1 Considerations by the USACE*

After the lecture by the ANA, the USACE representative, Mr. William Veatch, made a lecture on the review of the studies, seeking to point out good practices and to propose recommendations for future studies. He noted that both ANA and USACE must seek improvement of their studies, aiming to reach excellence level.

The strategic management of the project that integrated the studies of hydrological forecast and structural intervention, avoiding the duplication of efforts to treat common issues to both studies was considered a good practice. However, despite the reduction in costs, it is possible that some of the studies will advance less than it would if it was conducted individually by an independent team.

For the production of the Atlas of flood risk maps, the choice was made to previously simulate several scenarios of flood risk and to generate a set of risk maps to, then, associate the predicted flow to the closest scenario. This measure may reduce the time spent during the disaster. This approach has recently started to be used by USACE for the forecast of river floods; the experience of the U.S. institution in this type of method is more associated to the simulation of hurricanes due to the great complexity involved in modeling these.

The approach on dikes in the study of structural interventions was considered realistic. Dikes may induce an underestimation of flood risk creating a sense complacence in the population. However, they may cause sudden floods when there is breach or overtopping. The USACE understands that the proper functioning of a system of dikes depends on a forecast that allows for the evacuation of the population in case of overtopping.

Concerning recommendations for future studies:

- The need to describe uncertainty on data and results, so as to allow for decision-making with an adequate degree of uncertainty;
- Concern to specify the data collected in studies, especially transformations between different coordinate systems (DATUM). It was noted that the USACE has had problems in relation to elevation data in previous projects, which were not properly converted in the cartographic base used in the studies;
- Although flood maps are a useful tool in communication of the risk, it is recommended that the forecast system consider assessment of the impact associated to different river levels. Future studies may determine flood levels or elevations that impact certain areas or some important facility, such as hospitals;
- The need to consider climate change scenarios in order to assess the performance of the infrastructures predicted in the project (for instance, channels and dams);
- Consider maintenance costs in the economic assessment in the viability study. Although the costs of civil works are normally the most representative elements in cost assessment, it is possible that a cheaper project may have a maintenance cost that makes it more expensive in its life cycle. For example, significant sedimentation processes were reported in stretches of the Paraíba do Sul river which would elevate operation and maintenance costs due to the need of dredging;
- It is important to work with acceptable levels of risk, considering the probability of a flood, the loss of lives and the tolerable limit of losses to be admitted in the project; and

- It is important to involve local partners and players in the initial phase of the project. This process may, for example, contribute so that environmental requirements are considered in the design of the project, previous to the application for the environmental license of the works.

### 3.4 Decision tree used by the USACE for flood risk management, including non-structural alternatives and effects of climate change

The USACE representative, Mr. Nicholas Applegate, presented the lecture called "Decision tree used by the USACE for flood risk management, including non-structural alternatives and effects of climate change". The aim of the lecture was to supply a general view of how planning is done at USACE and to present the U.S. experiences on non-structural measures and on considering the effects of climate change in the plans.

**Decision tree**

USACE projects are defined in the budget, must have an economic justification and must be in accordance with the policies of the U.S. Army. USACE projects include navigation, flood risk management, ecosystem restoration, projects of multiple uses (hydroelectric, recreation and water supply).

Flood risk management includes flood damage reduction and hurricane damage reduction, besides having environmental restoration and the multiple uses of water as one of the objectives.

The USACE planning process includes 6 steps:

1. Specification of problems and opportunities: for example, the problem is not the flood, but the risk it brings to lives and property;
2. To survey and predict conditions: check the present situation, identifying what is in risk (hospitals, houses, etc); to predict the future without the project, that is, what happens if nothing is done, like, for instance, if there will be sedimentation that will worsen present condition or if geotechnical problems are predicted in the dams along time;
3. To elaborate alternative plans: develop measures, which are small actions to solve parts of problems and, together, create alternatives; discussion of possible alternatives with the several players;
4. To evaluate the effects of the alternatives: using tools for the analysis of alternatives (for example, HEC-FDA), considering data uncertainty to assess expected damages;
5. To compare plans: compare all results and check which plan maximizes the benefit for the nation (reduces damages more);
6. Select the recommended plan: the recommended plan is usually the one with the best net benefit.

In order to make the planning process more efficient, the "Smart Feasibility Study Process" has been applied. This consists in five points of decision (milestones) along the planning process, placing teams of the three hierarchical levels of the USACE to review the planning (in-progress review) with the aim of concluding the studies in, at most, three years. The USACE observed that, in a study performed in the traditional way, a lot of data were surveyed in the beginning, which not always proved very relevant to the process, and that, through the smart process, data are gathered as they are actually necessary, reducing development costs. Besides, the review of the plan during

design reduces the chance of having to make great changes in advanced phases of development. It was noted that, in all projects, players and the local populations are consulted.

**Climate change**

Climate change undermines the basic premise that has facilitated the management of water resources and risks, in which it is assumed that the statistical properties of hydrological variables in the future will be similar to the past (hydrological stationarity).

The USACE policy recognizes the existence of climate change and requires that adaptation to its effects be integrated in their missions, programs and projects. The change in sea level change is the first, the largest and the simplest effect of climate change, as it is assessed through the analysis of multiple scenarios. Other changes include hydrological non-stationarity and extreme climates.

The USACE climate change policy determines the use of the best information on climate change available in long-term planning. The USACE recommends the analysis of multiple scenarios in which three possibilities are considered for the elevation of sea level. The most adequate situation is used to formulate the plan, however, the remaining scenarios are used to check project performance so as to ensure the plan may be adaptable to change.

Besides, the USACE seeks to design their projects so that they are adaptable in the future, permitting enhancement due to the uncertainties relative to the effects of climate change.

**Non-structural measures**

Non-structural measures are those that do not alter the course of the flood. Measures considered by the USACE are: local protection against floods; elevation of houses; relocation; flood alert and evacuation; regulation of the floodplain (generates mid to long term effects). It was noted that the USACE projects, which are economically justified by the cost-benefit analysis, must consider non-structural measures.

## 3.5 USACE Best practices on flood control plans, including international experience and lessons learned by the USACE on flood risk management

USACE representative, Mr. Nicholas Applegate, presented the lecture “USACE Best practices on flood control plans, including international experience and lessons learned by the USACE on flood risk management”.

When there are no adverse consequences, the risk of flood is always low. To the study of risk, it is important to be clear on the concepts of danger, performance, exposure, vulnerability and consequence. Danger may be quantified in terms of frequency, intensity and extension of the event. Performance is the quantification of the response of the system to the event. Fragility and robustness of the system are parameters that define system performance. The exposure is a description of the elements subject to damage due to the flood. According to the exposure, the risk may be higher or lower. Vulnerability is the sensitivity to the loss of human lives, property and

damages to the environment. The concepts of vulnerability and exposure cannot be confounded. The consequence is simply the result of the event.

The mission of the USACE in flood risk management is to reduce the risk of loss of lives and long-term damages to the economy, besides improving the natural environment, promoting the dialog among all levels of government, involving other key interests, aiming to develop a national view on flood risk management.

There was a paradigm shift from "Flood control" to "Flood risk management". In the past, the former approach was used, which did not prove very feasible for trying to control nature with the focus on structural measures (change in water flow); in the latter approach, other aspects are considered more comprehensively, besides structural measures, such as non-structural measures (without change in water flow), soil use planning, evacuation plans, emergency operations, identification of synergy opportunity to restore ecosystems, decision-making based on risk information and in the responsibility for the cost.

In this sense, planning is still going through a modernization process: the implementation of the six steps is being modernized (smart planning) in order to seek the more rational use of resources (time and money). In this context, the excessive detailing of solutions is avoided and the focus lies on faster search and definition of alternative solutions that are "good enough". This way, studies can be deepened gradually and detail is reached along the process.

The program of dam safety and the program of dike safety were presented. The aim of the first is to assess dam safety, classifying them according to breach probability and its consequences, considering the acceptable risk limit. Relative to the program of dike safety, created after the Katrina hurricane, assessment criteria are similar to those of the program for dam safety. In USACE projects, after the construction phase of the dam or dike, safety becomes priority, with the aim of reducing risks to life and property. Structures are inspected and assessed periodically to ensure that local agents are providing proper maintenance and operation of the system, with recommendations on mitigating measures to local agents.

In the analysis of flood risk management plans, the USACE considers four counts: NED represents the "national economic development" and aims to assess the advantages in terms of damage reduction, the justification of the project being based on benefit/cost; RED represents the "Regional Economic Development", and takes into account some effects that do not impact the national perspective, such as local benefits or losses generated; the OSE represents "Other Social Effects", being the most important factor to the safety of live; and EQ represents "Environmental Quality", in which transparency about positive and negative environmental impacts is sought.

It is part of the USACE mission to establish and keep relations with other international organizations aiming to exchange experiences, cooperation and collaboration to improve the technical approach used in the reduction of flood risk. The project of technical support "Building Resilient Asian Cities" was presented, as well as the case of Vietnam, that has problems with the elevation of sea level and with the increase in the severity of extreme events, where support has been given to the development of a model to support decision-making.

In the context of lessons learned, the following points were highlighted:

- During the process of planning, getting to the perfect solution costs a lot of time and money. Then, we must seek tools to help in the decision process. For this, it is recommended to evaluate the future situation without the project; vertically integrate the team (district, division and headquarters); to elaborate consistent and quality maps and charts to help the process of

communication of the impacts and risks to the parties involved in the process; to have a technical review of the plan, especially in the simplifications made in controversial points, avoiding the discussion of critical points in advanced phases of the project. Still, during the studies, the technical memory of the reasons for certain decisions must be elaborated; multiple uses must be considered in the planning; non-structural solutions must be included, such as territorial ordainment.

- The technical approach chosen to deal with the problem depends on its nature, for example, if there are shallow floods and deep floods, proper models for each case must be sought. Besides, uncertainty must be considered in risk analysis. In the U.S.A., there a transition in progress between the deterministic to the stochastic approach, that is, it is not enough to identify the expected performance of the project, but uncertainties and the residual risk must be considered, the safety of life being a critical factor. Uncertainty in the process must be identified and communicated to the players.
- Consider in a systemic way the contribution of measures for the reduction of flood risk from upstream to downstream. It must be assessed what happens when one of the elements fails and if this may take to catastrophic consequences. The project must consider the 4 Rs - Resilience, Reliability, Robustness (how the system responds to different types of floods) and Redundancy. The contribution of ecosystems to the reduction of flood risks must be considered.
- Emergence, Preparation, Operation and Response: clear communication of the risk and the understanding of the inhabitants of the flood plain must be promoted. It is necessary to update and communicate on the actions predicted in evacuation plans. Besides, volunteer programs contribute to a prompter recovery of the area hit by flood. The management of debris and cleaning programs must be considered. Reconstruction strategies must be designed. The use of standardized models in quasi-real time may improve decisions. The emission of false alerts and evacuation operations may have adverse effects in the future, it is necessary to be careful about over alerting the people; for example, after the Katrina hurricane, the alert about the Rita hurricane generated mobilization and evacuation, but this hurricane was not so intense and, later there was another hurricane, but the alert was less heeded and fewer people evacuated the city, resulting in larger impacts.

Figure 1, from the USACE presentation, exemplifies sequential actions to reduce the risks of floods, from measures of adequate soil use performed by the local authority to structural actions by the local, state and federal authorities, but keeping the residual level of risk.

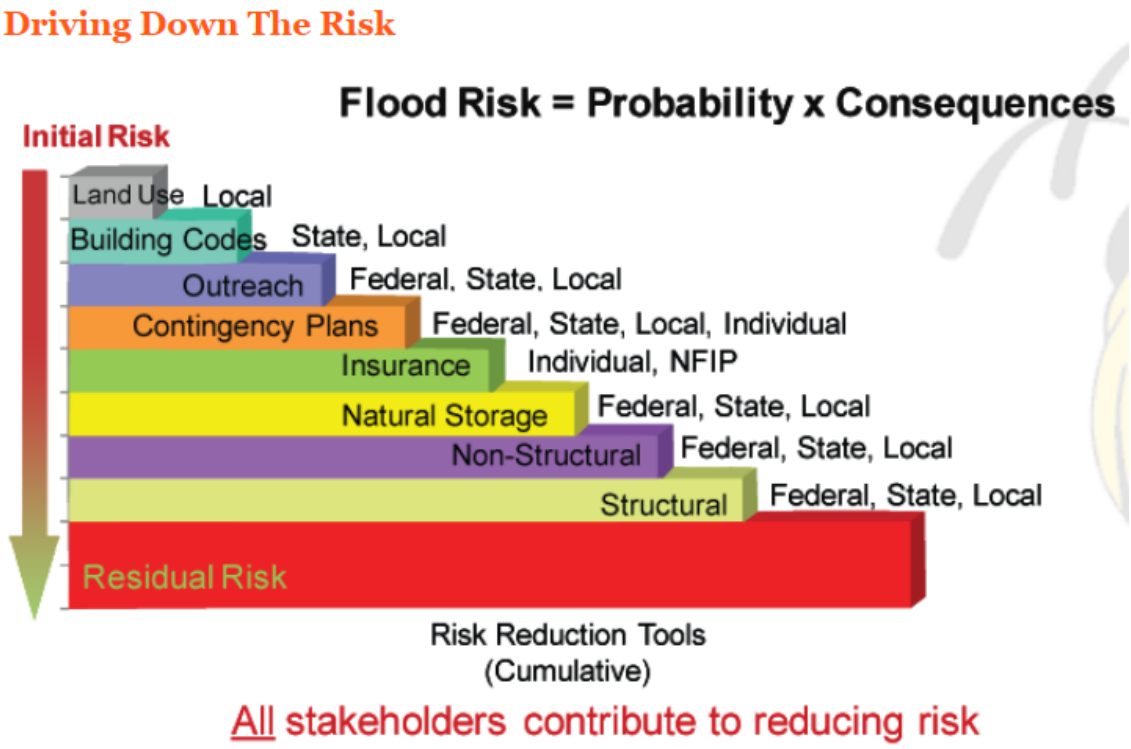


Figure 1 - Sequence of actions to reduce flood risk.

### 3.6 Basic aspects to be considered in the formulation of a public policy for flood risk management

ANA water resources specialist, Mr. Othon Fialho, made the lecture entitled "Basic aspects to be considered in the formulation of a public policy for flood risk management".

Public policy may be considered as a set of strategies pointing to diverse ends or, from a more operational point of view, as a system of public decisions that aims at preventive or corrective actions or inactions in order to maintain or change a reality.

Then, some steps of the process of a public policy were indicated:

- Definition of an agenda: indication of the issues or problems recognized by the Government;
- Policy design: corresponds to the generation of plausible options to solve the problem, considering governmental and non-governmental players involved and the instruments, which are "how to do it" (means, device, tools);
- Decision making: it is the phase of selection (or not) of a course of action from the options;
- Policy implementation: it is the translation of the public policy into actions;
- Policy assessment: it is the checking of the performance of the public policy, to improve it;

Common elements to the diverse public policies in Brazil were emphasized: fundamentals; principles; guidelines; objectives; instruments; competency sharing.

The following were mentioned as problems associated to public policies:

- Ineffective but popular public policies, call attention of policy makers while many policies that are necessary, but unpopular, find great resistance;

- The creation of public policies is pushed by crises in which policy makers must act as firefighters, while policies to avoid crises in the first place are undervalued;
- Failure of public policies lead to changes in the political leadership, but the main causes of the failures remain inadequately approached;
- The effects of public policies defended by particular a government organ may be undermined by strategies used by another organ, deliberately or not;
- Public policies are formulated to ensure the support of politically powerful groups at the expense of long-term public interests which are under-represented in the political system;
- Disagreement among the different levels of government lead to contradictory public policies, which are mutually destructive;
- The risk of political subversion by the executor, which may deviate considerably from what was predicted in the phase of formulation;
- Despite their importance, the assessment of public policies is rarely used for most decisions and, when it is performed, it is motivated by process requirements or narrow political considerations;

As an example, the National Policy for Water Resources was presented with emphasis on the fundamentals, objectives, instruments and institutional competencies.

Lastly, based on what was presented, themes were proposed for discussion in each block of group activities:

1. Definition of the agenda: aims to identify the problems and opportunities recognized by the Government related to Flood Risk Management;
2. Objectives: from the definition of the agenda, to establish the possible objectives of the Public Policy for Flood Risk Management;
3. Fundamentals, principles and guidelines: intend to identify the pillars that must be included in a Public Policy for Flood Risk Management and the course of action that must guide its implementation;
4. Instruments: Considering the fundamentals, principles and guidelines, they seek to identify what tools the Public Policy may consider to reach its objectives;
5. Competencies: refers to the sharing of attributions or instruments of the Public Policy at the different federative levels, including the Hydrographic Basin.

The lecturer emphasized that the aim of the group activity is not necessarily to discuss the formulation of a Public Policy, but to make a reflexion on the elements considered necessary to the improvement of the Flood Risk Management, from the Public Policy point of view. It was even remarked that some of the elements identified and deemed necessary already exist.

## 3.7 Main points of the plenary discussions

### *3.7.1 Deconcentration and decentralization*

Questions were raised about the difficulties of the ANA to make its actions effective, since it acts from a central office (concentration). As an argument in favor of the present situation, the fact that the ANA acts for strengthen the capacity of state managing organs (decentralization). In this sense, an example of ANA action is the support to the implementation of Situation Rooms and the improvement of the monitoring network. In the near future, it is expected that all Situation Rooms will be integrated with the Situation Rooms of the ANA and the CEMADEM. Another ANA action is through the "Programa Pró-gestão" (Pro-management Program), which aims to pay the states for fulfilling the goals associated to the management of water resources.

However, there is much discrepancy in the action capacity of the States. While some operate their alert systems satisfactorily, others have not even finished the implementation of the alert network. That is, effectiveness depends on the capacity of the States, which has been an observed point of fragility. It was argued that the existence of local offices (deconcentration) could direct the regional action of the ANA more objectively, besides aggregating local knowledge of the problem and streamlining the action when necessary. Still on this line, according to the USACE specialists, having local offices does not exclude the need to dialog with the States (deconcentration does not conflict with decentralization).

The cooperation of the USACE districts with the States is quite variable, since state laws vary due to the influence of the Spanish, Mexican, French, English and Russian heritages. Besides, the USACE depends on the local stakeholder to develop any viability study for flood risk management, as a way to ensure that the project is relevant for the region. Project costs are shared between the USACE and the stakeholder. Then, the USACE designs the project, organizes how the operation of the system must be performed and passes the operation and the maintenance onto the local agent.

As a relevant difference between the Brazilian and the U.S. system, it is noteworthy that, in the U.S.A. there is no federal and state dominion of water resources, water resources are associated to property. Water is a "commodity" and when there are controversies between the States, the Union intervenes, being that the resolution of problems through lawsuits is very common.

### *3.7.2 Institutional and federative cooperation*

On the limitation of State resources to face a crisis situation, the possibility to establish partnerships among the States was suggested. This cooperation may be made viable through the Situation Rooms. This way, places without emergency demand could assign their professionals to work in other States.

It was remarked that States have sought their own arrangements of articulation. The experience of Acre in flood management came from an articulation with federal institutions (CPRM, INPE and SIPAM). The importance of federal organs providing the necessary support to the fulfillment of the requirements for the release of resources for recovery actions was also noted.

About institutional articulation, it was informed that the inclusion of the CPRM and the CEMADEN in the cooperation agreements that the ANA maintains with the States for the installation and operation Situation Rooms is under discussion.

The USACE specialists commented on the “Silver Jackets” cooperation program among U.S. agencies both at the federal and state levels, aiming to help communities in response and recovery actions. The “Silver Jackets” also make presentations at schools in risk areas, giving orientation about flood risk and the role of institutions.

### *3.7.3 Education and risk communication*

The risk includes the combination between the probability and the consequences of floods, usually being measured in terms of occurrence probability. However, the risk may also be assessed in terms of cumulative probability over a certain period, in terms of monetary damages or the loss of lives. The USACE representative noted that risk communication to the population is still evolving in the U.S.A. and that there is much difficulty in transmitting information in clear ways to the population.

In the U.S.A. there is a program of the National Weather Service (NWS) in schools for education on flood risk, in which, every year, in the period before the floods, the institution opens its doors to inform and prepare people about flood risk. In these events, activities for children are also performed. There is also an advanced program of management education in flood risk areas that includes classes and exams.

However, the USACE specialists see that improvements are still necessary, such as in telling the population whether a certain property is located in the risk zone and if it is necessary to get flood insurance. Besides, many people ignore flood warnings and, even in the U.S.A., people usually only worry about floods when they are being affected or when they buy a house and have to pay insurance. Looking for new ways to promote communication and awareness, about two years ago, the NWS launched a creative advertisement with good repercussion which asked the population if they were prepared for a zombie invasion and, then, made the association to the occurrence of floods.

On the responsibility for alert emission in the U.S.A., it was explained that the local offices of the U.S. National Weather Service have the competency to emit alerts based on the forecast provided by the River Forecast Centers of the National Weather Service (RFC/NWS). The forecast is then made available on the internet, informed about on TV and radio programs or even sent by telephone. It was also informed that metrics are used to measure the error of the models used in the forecasts and that the emission of alert with much uncertainty in the data depends on the mission and on what is expected: an alert for population evacuation must be emitted with much caution because an excessive alert for an event that does not happen may lead to a loss of credibility.

In Brazil, the need was noted to standardize terms and concepts related to flood risk management, from the dialog among federal and state institutions. For this, it was recommended to use documents that exist, like the “Glossário da Defesa Civil” (Civil Defense Glossary) and the “Manual de operação da Sala de Situação da ANA e para apoio aos Estados” (Operation manual of the ANA's Situation Room and for support to the States).

The importance of informing the population of the benefits generated by the operation of reservoirs was also noted, as hydrographic basins that do not operate reservoirs are less protected from critical hydrological events. Besides, it was remarked that an effective way to present the operational situation of a reservoir to the population is through toll flags in the energy bills.

### *3.7.4 Responsibility for planning, designing, construction, operations and maintenance of dams and dikes for flood control*

A point that generated much discussion was the responsibility over the operation of dikes and dams. In Brazil, the Dam Safety Law ("Lei de Segurança de Barragens - Law nr. 12.334/2010) applies to dams with certain features of height, capacity, potential damage and the presence of dangerous wastes. On the other hand, the legal gap on the responsibility for dike maintenance has not been filled.

The present legislation makes the owner responsible for the safety of dams. About the dams in the basins of the Muriaé and Pomba rivers, affluents of the Paraíba do Sul river, located in the State of Minas Gerais and which will bring great benefits to the State of Rio de Janeiro, located downstream, there is still no definition of which institution will be responsible for their construction, operation and maintenance. In this sense, the importance of seeking a federative solution as to the operation of these dams and that the process of environmental licensing be conducted by IBAMA was highlighted, that is due to regional impacts although the present legislation indicates that such enterprises be licensed by state environmental organs.

On the functioning of the reservoirs in the riverhead of the Paraíba do Sul river, which were originally conceived to generate energy, it was remarked that these took other responsibilities and minimum and maximum flow restrictions were imposed for droughts and flood situations, respectively. Due to the present drought situation, new operative rules are being proposed in order to maintain water stocks. However, it was informed that the new rules may produce side effects such as the possibility of reservoirs being full at the end of the drought period, being ineffective in generating energy, or even lead to larger operational risks on flood control, especially those reservoirs without spillage control systems. It was commented that it is necessary to plan considering not only the present crisis the region is going through.

In the U.S.A., whenever a project is authorized, the party responsible for its maintenance and operation is defined. This way, federal and local agencies execute works and are responsible for the operation and maintenance of both dikes and dams. Among the U.S. institutions that act in the operation of reservoirs, the Bureau of Reclamation, that operates to help develop the region economically, and the Tennessee Valley Authority, that acts in some states in a similar fashion to the CODEVASF were mentioned. It was also highlighted that in USACE projects, the responsibility for the operation and maintenance is passed onto the local agent after the construction, but that the USACE is involved in the operation for flood control.

### *3.7.5 Flood insurance*

The insurance was conceived to create awareness of flood risk and generate responsibility for the cost of damages, however, however, low insurance prices due to government subsidy associated to the increase in the number of disasters may encourage the population to take more risks.

In the U.S.A., the value of the insurance depends, among other things, on the flood area and the type of construction. If there are protection dikes certified according to the criteria of the norm relative to the mapping of areas protected by a dike system, the area is considered of moderate risk and there is no requirement for insurance. Moreover, there is no distinction for the value of the insurance in poor communities.

However, in these places, the value of the premium tends to be lower, due to economic evaluation of the property and of the goods it contains.

About other economic instruments, the USACE specialist explained that the government may expropriate an area, but this is usually not done because it is a quite unpopular measure. Alternatively, it may establish parks for environmental reasons, which contribute to avoid the occupation of flood areas; right-of-way areas for the flow ("flowage easements"), in which the right to occasionally flood some private property and the type of occupation that can be applied to the terrain is restricted. In this last case the population tends to accept it better, as there is no need to give up a property, however, the cost of the measure has proven high in the cost-benefit analysis.

It seems unfeasible to replicate the U.S. flood insurance policy in Brazil, especially due to the significant portion of low-income communities that occupy floodplains, frequently in an irregular fashion. Irregular occupation and breaking the law are not seen by the USACE specialists as a problem in the U.S.A.

After the latest disasters in the U.S.A. and, especially, the one caused by the Katrina hurricane, the insurance program accumulated great debt and is being reviewed. Caution was recommended about the adoption of insurance programs, for they do not affect the probability of floods and may also cause the adverse effect of stimulating the occupation of the flood area and generate dependence on government subsidies. On the other hand, it is important that flood risk management plans consider and evaluate the possibility of implementing economic instruments and right-of-way areas, for the Plan must consider all options and seek for synergies among the several programs existing programs.

### *3.7.6 Conservation practices*

It was discussed if Brazil would be going in the opposite direction in relation to the U.S.A., seeking to implement structural measures while the U.S.A. seeks to restore water bodies. USACE representatives gave the example of a project in which dams were removed to recover the original ecosystem and the rapids that existed originally, but they said this type of measure is not a general trend in their projects, although this type of analysis is becoming more frequent as they seek to integrate projects of flood risk management and ecosystem recovery. Moreover, it was pondered that the U.S. have implemented many infrastructural facilities, while Brazil still has demand for new reservoirs.

The importance of prioritizing non-structural actions and to value Brazil's environmental potential was emphasized. The importance of considering, in studies, the assessment of the contribution of environmental services in river dynamics such as the benefits generated by the protection and recovery of the basin cover and the vegetation on the riverbanks to flood risk management was emphasized. As good practices, the Water Producer Program ("Programa Produtor de Água") developed by the ANA, and the environmental ICMS (a state tax) that is practiced in some states.

### *3.7.7 Adaptation to climate change*

The existence of climate change cannot be checked from the analysis of a small data series and it is recommended to research indicators of large magnitude events through other means, like the observation of geological change caused by great floods.

Besides, it must be considered if the increase in flood impact is due to climatic non-stationarity or to bad soil use.

An important concept related to adaptation to climate change is resilience, which reflects the recovery capacity of a system after a catastrophe. In the Third World Conference on Disaster Risk Reduction, held in Sendai (Japan), there was emphasis to the need for governments to propose resilience and plan structural measures to integrate solutions to floods and droughts.

In the U.S.A., the USACE considers possible impacts of climate change in the development of their projects. For example, in relation to sea-level elevation, three scenarios are evaluated - high, medium and low elevation rates. Besides, they seek to elaborate plans that allow for future adaptations facing a possible change in climate.

In Brazil, the National Adaptation Plan ("Plano Nacional de Adaptação" - PNA) is under development in the Ministry of the Environment, with the contribution of several institutions and of the society. Its results, even though in the form of guidelines and strategies, must be appropriated by the institutions involved in flood risk management. Besides, at the ANA, there are actions under development involving questions of adaptation to effects of climate change, the main ones being: the study in the basins of the Piranhas and Jaguaribe rivers; The study in the basin of the São Francisco river; the contributions to the development of the PNA; and the discussion on how to include climate change in water resources plans.

### *3.7.8 Soil use and occupation*

In the U.S.A., most land use is determined by the local authority, following what is determined in the master plan developed for the next 10 or 20 years. So, the decision about the construction of critical infrastructures in flood risk areas is made by the City Hall, according to the area division. However, master plans must follow the legislation, such as the rule by FEMA on the occupation in areas with flood risk over 1% and the federal executive order that requires the construction of public buildings away from the areas of largest flood risk. Besides, when vulnerable areas subject to frequent floods are identified, the USACE, in articulation with the local community, propose actions to reduce the risks.

In Brazil, soil use and occupation has been a great challenge, considering the occupations of irregular areas due to the disrespect to norms and laws. Besides, several problems of irregular occupation of lowlands that have occurred downstream from the reservoir as an adverse effect of the flow controls performed by the operation of the dam. These factors have elevated the exposure to flood risk by the population and compromised the effectiveness of some actions (it is impossible to apply the zoning, it compromises the effectiveness of structural measures like the construction of reservoirs, etc.).

About the reconstruction of houses affected by floods, it was mentioned that the state or municipality starts receiving resources and assistance from the Federal Government after the survey phase and that, presently, an inter-ministerial ordinance of the Ministry of National Integration and the Ministry of Cities established that new facilities to be reconstructed must be out of the risk area. This measure, besides avoiding bad investment of public money also contributes to better use and occupation of soil.

### *3.7.9 Development of Plans*

A fundamental question when discussing planning is the approach used. In the U.S.A., the concept of "flood control" evolved to "flood risk reduction" and then to "flood risk management". The basic differences between these approaches are: "flood control" carries the idea of structural interventions and denotes the attempt of man to control nature; "flood risk reduction" changed the focus to the reduction of impact; and "flood risk management" is the present term that has a more comprehensive character, aggregating, for example, actions like the evacuation of high flood risk areas.

In the U.S.A., the process of development of a plan counts with participation of a local entity and other agencies involved with the theme from the beginning. Moreover, the USACE advocates transparency in the process of plan design and clarity in the occasional communication of its lack of feasibility, using previously known criteria; when the criteria considered in the elaboration of the plan are clear, the possibility of political interference in plan implementation and in the execution of the works is reduced. The USACE selects the viable plan that brings the most economic benefits. However, it is possible that the plan preferred by the local agent be implemented, as long as the additional cost is covered by the local agents.

As a complement, the proper level of information necessary for the formulation of the plan must be sought, because experience says that it is not possible to make an adequate decision without enough information or even with bad quality information that may lead to bad decisions. On the other hand, through the practice of engineering, one always seeks more data, but there are never enough resources and thus it is necessary match the quality and quantity of data to be surveyed with the use intended for them. In this sense, a sensibility analysis is recommended to check the influence of the data on model results. Moreover, in order to reduce the uncertainty in the data obtained in the field and the one generated by the models, the USACE seeks to standardize their assessments according to several existing manuals, which are available on the internet.

In Brazil, institutions have tried to rationalize the process of identification of the most relevant works. In this sense, the National Water Safety Plan ("Plano Nacional de Segurança Hídrica"), resulting from a partnership between the ANA and the Ministry of National Integration and aiming at choosing priority works to fight droughts and floods is highlighted. On the other hand, in the set of alternatives, non-structural alternatives and environmental projects still have not been included. Besides, it is recommended that studies in Brazil consider the assessment of damage reduction promoted by the actions proposed and consider the uncertainty of the data utilized.

### *3.7.10 Post-disaster actions*

A disaster may represent an opportunity to review and change the way institutions act. For this, it is necessary to have a good management of knowledge, which allows for a construction of a learning process on disaster management, to create an institutional memory and to replicate good practices. One way to stimulate this is through the formulation of post-disaster reports, containing the record of the event and the critical analysis of the actions performed, especially indicating the failures that occurred in the process.

In the U.S.A., USACE post-disaster reports are public. They provide useful information such as flood patches and the heights reached by the water. From these reports, it is possible to plan actions and even change existing policies. For examples,

after the Katrina Hurricane there was a change in the way to analyze the performance of structural interventions, incorporating aspects as climate change and sea level elevation.

In the U.S.A., the responsible for the post-disaster report depends on the magnitude of the flood and its impacts. In some cases, a preliminary simplified report is elaborated, while deeper studies are conducted. When more parties are involved, the process usually takes longer.

### *3.7.11 Dilemmas about large or small reservoirs*

The question was raised if it would not be the moment to objectively deepen the discussion about the great reservoirs, which, in Brazil, has been object of great resistance due to environmental questions. But, at the same time, they could solve problems related to droughts and floods and increase the resilience of communities. They are capable to respond to demands of energy generation, human consumption, irrigation and industries, besides controlling floods. In relation to energy issues, it is noteworthy that, in Brazil, the reliance on hydraulic energy may be above 70%, while this source corresponds to 6% of the U.S. energy matrix.

In the U.S.A., reservoirs are usually for multiple uses. Conditions and operation rules are clearly established in the control manual of the reservoirs, being that the preparation of the manual is done with the participation of several players. Besides, in the U.S.A. there is similar discussion about environmental balance and the need for storage.

In a system without regulation, it is not possible to perform flood controls, the alert system being restricted to the warning about the occurrence of the event. On the other hand, in a system with regulation, from a flood alert it is possible to operate the reservoir in a way to reduce he impacts downstream. So, it is more efficient in the reduction of risks and loss of human lives.

## 4 Group activities

The aim of the group activities is to use the professional experience of participants to identify and discuss ideas about the main aspects considered for the formulation of a Public Policy for Flood Risk Management, taking into account what was presented and discussed in previous days about the Brazilian and U.S. experiences and without bond to the present arrangement of actions, so as to encourage new ideas to be presented and discussed.

As mentioned in section 3.6, the themes of each activity block were: definition of the agenda, objectives, fundamentals, principles and guidelines, instruments, and competencies.

The basic methodology used in each bloc for the group activities is described below. Occasionally. The basic methodology was adapted by the facilitator in order to conduct the group session more productively.

1. Each participant silently writes her/his thoughts and ideas on the theme of the block (up to 10 minutes);
2. Each participant reads his/her individual contributions to his group. Meanwhile, other participants check if they also have similar ideas (up to 30 minutes).
3. The group facilitator and the rapporteur consolidate the points raised and count how many times each item was mentioned (5 minutes);
4. Group discussion (10 minutes);
5. Preparation of presentation on the main points of the group to the plenary session (5 minutes).

The groups were defined to distribute institutional and state representations heterogeneously, promoting a more comprehensive discussion of different points of view. Representatives of the same organ or organizational unit were placed in different groups, and the work of the group was monitored by a USACE member. The distribution of participants in the groups is presented in the following tables:

Table 1 - Participants in group I.

| **GROUP I (USACE: Nicholas Applegate)** | |
|---|---|
| **NAME** | **INSTITUTION** |
| Alice Silva de Castilho | CPRM |
| Álvaro Alves da Silva Júnior | SIH/DOH/MI |
| Bráulio Eduardo da Silva Maia | SEDEC/MI |
| Bruna Craveiro de Sá e Mendonça (relator) | ANA |
| Clarice Fernandes Marinho | SPI/MPOG |
| Flávio Hadler Tröger (facilitador) | ANA |
| Francisco Alberto de Assis Teixeira | COGERH/CE |
| João Augusto de Pessôa | ANA |
| Josimar Alves de Oliveira | ANA |
| Márcia Regina Silva Cerqueira Coimbra | ANA |
| Paulo Roberto Roballo Ungaretti | ANA |
| Sérgio Luis da Silva Cotrim | SNSA/MCid |
| Vera Reis | SEMA/AC |

Table 2 - Participants in group II.

| GROUP II (USACE: William Veatch) | |
|---|---|
| **NAME** | **INSTITUTION** |
| Adalberto Meller | ANA |
| Alan Vaz Lopes (relator) | ANA |
| Alessandra Daibert Couri (facilitador) | ANA |
| Antônio Calazans Reis Miranda | SRHU/MMA |
| Antônio Cardoso Neto | ANA |
| Eduardo Mario Mendiondo | CEMADEN/SEPED/MCTI |
| Luiza Pinheiro Rezende Ribas | IGAM/MG |
| Márcio Tavares Nóbrega | ANA |
| Paulo Henrique Siqueira Isobe | SPI/MPOG |
| Reginaldo Pereira de Souza | ONS |
| Ricardo Brasil | ANA |
| Sandra Fernandes da Silva | CPRM |
| Taynara Rodrigues de Oliveira Montalvão | SEDEC/MI |
| Valéria Rezende de Oliveira | SAM/Casa Civil |

Table 3 - Participants in group III.

| GRUPO III (USACE: Wade A. Ross) | |
|---|---|
| **NAME** | **INSTITUTION** |
| Conrado de Moraes Rudorff | CEMADEN/SEPED/MCTI |
| Daniel Martinelli Duarte | SRHU/MMA |
| Janaína Rios Dias | SNSA/MCid |
| José Edson Falcão de Farias Júnior | INEA/RJ |
| José Luiz Gomes Zoby | ANA |
| Lígia Maria Nascimento de Araújo | ANA |
| Mariane Moreira Ravanello | ANA |
| Marcelo Pires da Costa | ANA |
| Michele Maris de Sousa Ferreira | SIH/DOH/MI |
| Othon Fialho de Oliveira (facilitador) | ANA |
| Paulo Diniz de Oliveira | ONS |
| Rubens Maciel Wanderley | ANA |
| Simone Vendruscolo (relator) | ANA |

In the next topics, the main results of the group activities are presented. The results of each block were grouped in “central ideas” or “categories”, to simplify and facilitate analysis.

It is highlighted that there are several ways to aggregate the results of group activities in central ideas, and there are even elements that could be under more than one central idea. It is recommended that this exercise be done individually by each institution that has access to this report, in order to facilitate the extraction of the information deemed more relevant.

## 4.1 Definition of the agenda

As indicated previously, the definition of the agenda aims at indicating problems and opportunities recognized by the Government and related to Flood Risk Management. The central ideas identified to aggregate the results of the group activities were:

- Not following the laws/norms/rules/criteria;
- Inadequacy of laws/norms/rules/criteria;
- Imbalance of the federative pact, institutional fragility, lack of institutional articulation and lack of clarity in the definition of roles;
- Local and sectorial approach;
- Deficient planning;
- Lack of prevention;
- Deficient communication and education;
- Inadequate or insufficient data;
- Lack of adaptation to climate change or variability;

Although the agenda was focused on problems, opportunities can be indicated from them, such as: improve laws/norms/rules/criteria; promote prevention; invest in monitoring and in data quality; consider climate change and variability in planning; etc.

About this activity, USACE representatives commented that it is possible that underlying fundamental questions which are not being treated might be responsible for several problems. For example, the reason for not following the laws must be investigated, if it is due to lack of knowledge or something like that.

## 4.2 Objectives

Form the definition of the agenda, it is made to establish possible objectives of the Public Policy for Flood Risk Management. The central ideas identified to aggregate the results of the group activities were:

- To define and implement the strategy for Flood Risk Management;
- To promote prevention;
- To regulate the use and occupation of the soil;
- To define and implement a strategy for the management of data and information;
- To promote the adaptation to climate change and variability;
- To strengthen institutions;
- To stimulate inter-institutional cooperation;
- To improve reservoir management;
- To promote the education and the participation of the population;

On this activity, USACE representatives commented on the need to specify goals and establish measurable criteria.

## 4.3 Fundamentals, principles and guidelines

As mentioned, fundamentals and principles are the pillars that must be considered in a public policy for flood risk management and the guidelines represent the line of action that must guide its implementation. The distinction of fundamentals,

principles and guidelines can be done in different ways, depending on the team that is analyzing the material, however, it is important that the main ideas be manifested.

The following is a list of fundamentals identified:

- The population must be protected from floods;
- Every citizen has the right to decent and safe housing conditions;
- It is the duty of every citizen and institution to respect and zeal for the legal principles of flood risk management (being subject to sanctions)
- Environmental preservations and recovery of degraded areas;
- The river basin is the unit of planning and action;

Principles were grouped according to the central ideas identified, listed as follows:

- Prioritization of non-structural measures;
- Adaptability and resilience;
- Responsibility of the public power;
- Systemic approach, public policy integration, articulated federative action and institutional cooperation;
- Transparency and public participation;
- Economic, social and environmental sustainability of plans;
- Measurable goals, based on updated reliable goals;
- Non transfer of responsibility and costs;
- Public education and awareness;

The remaining results of the group activities could be considered as general guidelines.

On this group activity, the USACE representatives commented:

- The conception of public policies is different in Brazil and in the U.S.A. and a difficulty is perceived in distinguishing between fundamentals, principles and guidelines. However, it is basic to consider the safety of life in public policies. In this aspect, Brazil must define an acceptable level of the loss of lives and, in the process, the conclusion may be that there is no acceptable level, however, this has to be discussed and people must be aware of it;
- It is necessary to establish priorities in the projects, but it must be considered that all structures must be inspected and the population must be communicated of the risk. It is important to educate the population on flood risk;
- It is important to consider non-structural measures and public communication as a guideline of any plan;
- Several principles and guidelines, it is possible to consider what in included in the National Policy of Protection and Civil Defense as a basis to guide flood risk management.

### 4.4 Instruments

As mentioned, instruments are tools the Public Policy may consider to reach its objectives. The following categories of instruments were identified:

- Economic and legal: funds, tax incentives, rights of ways, flood insurance, fee for occupying risk areas, compensation to municipalities, fines, environmental incentive programs and rules for reservoir operation;

- Plans and studies: strategic plans, contingency plans, master plans, dam and dike safety plans, risk area studies and economic and social-environmental assessments, post-disaster report and monitoring bulleting, and revitalization of risk areas;
- Zoning: zoning an mapping of risk areas;
- Information System: information systems on flood risk, infrastructure database for risk areas, monitoring and remote sensing;
- Communication, alert and alarm: situation rooms, alert systems, alarm;
- Education and research: actions for research, education and capacity promotions on flood risk;
- Cooperation: volunteer teams, task-forces, joint action protocols, consortia and committees;

Comments of this group activity by the USACE specialists:

- A good way to identify instruments is to discuss how flood risk management could be better if it were implemented today. Besides, if we keep doing the same thing, reality will hardly change, then, it is important to think beyond the present limits and then check what can be achieved;
- Sometimes, due to the difficulty in implementing some actions with very broad focus, we can divide the action in smaller pieces, which will be easier to manage. On the other hand, many actions may complicate management and it may be the case to seek to identify fundamental issues underlying several problems (the common origin of problems);
- It was highlighted that in some cases it is not necessary to "reinvent the wheel", for some groups indicated that the laws that already exist are sufficient to resolve the problems, it being necessary to find better ways to enforce them;
- Some examples of actions mentioned: volunteer work, which is a way to engage the population and create awareness of the risk; signs on the streets, to guide the population in moments of crisis; using the media; hydrological rights of ways ("flowage easements") seem a good option, but the feasibility of implementation must be checked.

## 4.5 Competencies

The discussion of competencies followed the grouping of the instruments considered, as shown below:

- Economic and legal: the three federative levels were included, with some opinions for having the Union in the role of coordination, articulation and guideline design. The possibility of the hydrographic basin organization implementing them was also noted;
- Plans and studies: studies and plans were predicted at the three levels of the federation and at the level of the hydrographic basin, more integration being necessary among the levels and the participation of institutions;
- Zoning: municipal responsibility, however, counting on State or Federal guidelines and coordination and, on occasion, with the participation of the basin organ;
- Information System: the Union is nominated as responsible for the coordination, articulation and standardization. On the other hand, the

feeding of information by Municipalities, States and occasionally, basin organizations is recommended;

- Communication, alert and alarm: results indicate that the three federative levels would have competency in this item and that, eventually, the basin organization could also perform this function, all in their respective scales of assessment. On the other hand, monitoring activity was more associated to the Union and the States, while the alarm (siren) was linked to the actions of the Municipal Civil Defense;
- Education and research: It was pointed out that educational activities to the communities would be performed by the Municipalities and States, and that there may be programs coordinated by the Union or, still, by the basin organizations. Research would be developed by State and Federal institutes;
- Cooperation: predicted among all federative levels and the basin organization to promote joint action. Besides, special articulations are considered relevant to treat specific issues such as dam safety, (Union and States) and international affairs (Union and neighboring countries);

About this activity, the USACE representatives commented:

- It is possible that the activity overlaps observed are caused by legal flaws or even by bad interpretations of the law, which may be clarified in some cases, by consultation to the legal department. If it happens by legal flaws, although the decision to alter it will take place in other bodies, institutions may point and signal where there are gaps or shades areas;
- It is important not to be limited to the present institutional and legal arrangements, but focus on the solution of the problem to for the population. Changes happen in many ways, clearly or not. In general, we seek instantaneous solutions to the problems, but change takes time and we must try to change what is possible.