Guideline For Reservoir Operation in Relation To Flood Forecasting

December 2008

UNITED NATIONS
Economic and Social
Commission for Asia and
the Pacific

World
Meteorological
Organization
Weather • Climate • Water

UNITED NATIONS
Economic and Social
Commission for Asia and
the Pacific

World
Meteorological
Organization

ESCAP/WMO
Typhoon Committee

Typhoon Committee

Guideline for Reservoir Operation in relation to Flood Forecasting

By K-water, Republic of Korea
December 2008, 36 pages

WMO/TD-No. 1471

Chairperson, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box No. 2300
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0) 22 730 84 03
Fax: +41 (0) 22 730 80 40
E-mail: publications@wmo.int

TABLE OF CONTENTS

PREFACE

UN-ESCAP needs "the guideline for reservoir operation in relation to flood forecasting" to consider the benefit of dam to the public. The production of this General and Technical guideline was undertaken within the framework of the Thirty Eighth Session of Typhoon Committee Workshop (2003) in Beijing, China. Among the principal issues of Hydrologic Working Group, Theme 3 : Enhanced beneficial Typhoon-related effects for the betterment of quality of life is related to the positive effect of reservoir operation.

In accordance to the terms of reference agreed with the Secretariat of the UN/ESCAP, it is the purpose of this document to provide guidelines on general and technical aspects for reservoir operation to the public, NGO, Federal or State government, and Reservoir Engineers for the formulation of integrated flood control policies and for their implementation.

There are several reasons advocating for more community-based strategies for reservoir operation and management such as the complex of social needs for reservoir operation or flood control, the difficulties encountered while the flood control is implementing.

The involvement of the general public in water-related decision-making processes, especially with view to implementing integrated reservoir operation, no longer is a new concept, and is being practiced today in many Asian countries, especially South Korea, Japan, China, Thailand, and The Philippines. Yet, the difficult and complex involvement of stakeholders in decision-making processes addressing to flood control policies and planning, especially at local level, has not be fully appreciated everywhere by water experts, state officers, and the public.

What are the consequences of such community-based reservoir operation in terms of social, political, and technical aspects? In other words, to what extent can there social tools dedicated to public involvement in decision-making processes be applied to reservoir operation and flood control?

Since flood control policies by reservoir operation cannot be separated from more general, integrated, water management and planning, this document with a presentation of guidelines in public participation in reservoir operation will open. Such achievements indeed form a critical basis for any water-related expert, practitioner, decision maker, researcher, or representative of the civil society, considering to involve the general public and stakeholders in decision-making processes related to flood control by reservoir operation.

This document seeks to: a) present the reasons for advocating a stronger involvement of the general public in flood-related decision-making processes, b) discuss the conditions making such an involvement feasible in practice, and c) illustrate with technical strategy for flood control by reservoir operation and management.

The draft manuscript was made by Cha Kee-Uk and reviewed by Mr. Oh Kwang-Jin, Mr. Ahn Chang-Jin, Mr. Moon Tae-Wan, Mr. Hwang phyll-Sun, Mr. Shin Yong-Lo, and Mr. Chong Kooyol of the Water Resources Division of Korea Water Resources Corporation (K-water). I appreciate very much all the comments and amendments that were suggested. I also wish to thank all persons, Dr. Ti, Mr. Miyake, and organizations, within the United Nations systems and elsewhere, contacted during the preparation of this report for having provided much valuable information and sound advice.

GENERAL INTRODUCTION

The implementation of flood-disaster mitigation strategies by reservoir operation is a complex task for dam owners or governmental authorities because they have to cope with a high diversity of stakeholders such as up- and down-stream residents, non-governmental organizations (NGO), different purpose-prone dam owners, national and local agencies, and land users or the public. These stakeholders indeed show different perceptions, relationships, responsibility to flood control, and reflect different socio-economic and socio-psychological backgrounds.

Public participation is a unique opportunity for dam owners or reservoir operators to assess the social feasibility of a strategy for water-related disaster mitigation and management. Preparing the communities as a whole to implement water-related participatory processes, shall therefore help identify more clearly responsibilities regarding disasters, and increase the efficiency of flood control and response strategies and actions. Building up a consensus of communities on flood mitigation measures, requires a new behavior from all stakeholders, including mutual understanding and recognition, as well as a strong capacity of dialogue, and the management of decision-making and action-taking powers and processes (B. Affeltranger, 2001).
For these public participations on reservoir operation in relation to flood forecasting, there are various considerations as follows:

Who are the stakeholders to be taken into account when building strategies for flood control by reservoir?
What conditions must be set up to achieve public participation to the strategies of flood control due to reservoir operation?
What are the knowledge and skills needed to implement public participation? What technical guideline for reservoir operation is needed for various countries? These are some questions to which this report will attempt to propose elements of answers, which answers may also be different in developed and in developing countries.

Sections of this report will also focus on developed and developing countries, as well as up- and down-stream areas of the dams and any other stakeholders in relation to reservoir operation. In other words, we assume that public participation and participatory processes may not be implemented the same way in different socio-economic and socio-cultural contexts, thus requesting different strategies and implementation modalities.

This report produces general guideline on participatory processes in flood control by reservoir operation and technical guideline for reservoir operation during flood season in particular. First, there are several categories of professional and non-professional participants likely to be involved in water management and in the mitigation of water-related disasters:

a) Reservoir operating professionals who are charge of reservoir operation and management,
b) National or local governmental workers who occasionally take part in the various phases of water management,
c) Policy-makers and decision-makers,
d) Agencies whose responsibility includes water resources management in addition to other purposes such as hydro-power or agricultural water use,
e) Non-professionals involved in the implementation and operation of water resources projects, including NGOs,
f) Representatives occasionally taking part to the decisions, and representing the users of the water resources, communities affected by water-related disasters and projects, and other interest groups and stakeholders,
g) Public and private companies, and the media, with assets or interests in flood-prone areas.

Second, public participation is an essential added-value to the decision-making process of flood control operation issues because it enables reservoir operators to analyze the flood control related problems and civic environment, and thus community-based mitigation strategies. Such bottom-up approach also appears as a guarantee for official flood-related decisions and activities to be better appropriated by the community, and benefit from increased public support for implementation.

Successful public participation in flood control issues should actually combine (often differing) valuable judgments from stakeholders and technical information in a structured framework involving workable decision tasks. The objective of

groups representing community members, NGOs or the civil society, should then be to provide better informed recommendations to decision-makers in charge of flood control by reservoir operation. Authorities with reservoir responsible for monitoring of participatory processes should therefore seek that non-expert community members should be provided with reliable, quality information on issues related to flood control.

This report shall be divided into three main parts as follows:

Part 1. What is public participation in flood control?

Part 2. General guideline including public participation in flood control, and

Part 3. Technical guideline for reservoir operation during flood season.

PART 1 - WHAT IS PUBLIC PARTICIPATION IN FLOOD CONTROL?

1.1 Public participation

In the last decades, and in particular in democratic "western" countries, authorities have in the past been indeed increasingly confronted with NIMBY ("not-in-my-backyard") syndrome situations. Such local protest is likely to take place when inhabitants neighboring a project challenge or reject the change that it causes, arguing that it would induce negative consequences, for instance regarding their quality of life and living conditions (B. Affeltranger, 2001). Such conflicts, occurring at local level because of competing expectations on a same space or resource, were still often likely to produce impacts at national level in terms of public opinion and to have country-wide political costs. These conflicts also usually dealt with environmental issues and often involved active and/or legal response from environmental non-governmental organizations (NGOs) and similar citizen-based networks. Such reactions, at both local and national levels, to public projects that had been designed, approved and implemented by elected and/or appointed authorities, confronted governments with a concept increasingly shared by the public. This concept dealt with the limits of centralized decision-making in democratic countries. In other words, authorities in charge of the country/region/city may design public programs, projects and products that would eventually fail to meet the actual social expectations. Along with these reactions, authorities need to take into account in several public decision-making processes considering public participation. Similarly, dam owners or reservoir operators gradually need to assess the social feasibility of a strategy for water-related disaster mitigation and management. Preparing the communities as a whole to implement water-related participatory processes for reservoir operation, shall therefore help identify more clearly responsibilities regarding disasters, and increase the efficiency of flood control and response strategies and actions. Building up a consensus of communities on flood mitigation measures, requires a new behavior from all stakeholders, including mutual understanding and recognition, as well as a strong capacity of dialogue, and the management of decision-making and action-taking powers and processes.

Public participation is a generic term identifying an ethical and democratic value, and on the other hand, a series of technical procedures, also called participatory processes. The definition of public participation was discussed at the Fourth Ministerial Conference in Aarhus, Denmark, in 1998.

In the Conference "The public" means one or more natural or legal persons, and, in accordance with national legislation or practice their associations, organizations or groups; "The public concerned" means the public affected or likely to be affected

Table 1. Processes of public participation for flood control

Flood control elements	Public participation	Participatory processes	Regulation or Guidelines
-Reduce flood damage -Up- and down-stream conditions -Local government requirement -Joint operation with dam owners	-Government • National, local -Dam owners -NGO -Residents • up and down -Fishery -institutions	-General process • communicate with the public and agency -Technical process	-General regulation • responsibility • public opinions • flood control • notification -Technical regulation • flood forecast • reservoir operation

by, or having an interest in, the environmental decision-making process and output. Public participation for flood control by reservoir operation follows these procedures:

1.2 Participatory processes in flood control

Principal challenges face today's water managements. The first is the technical challenge of finding solutions to increasingly complicated flood control problems. The second is to communicate effectively with the water-related participants like up- and down-stream residents, dam owner and non-governmental organizations for environmental impacts, dam owners with different purpose-prone, national and local agencies, decision support between flood control center and reservoir operation center, land users, environmental agency etc.

No serious objections to widely fluctuating reservoir storages for flood control until mid of 1900's. Also water would be released by Government or dam owners and water levels and release could fluctuate largely by them. As the society grows quickly, public participation in flood control by reservoir operation emerges as an energetic power for their purposes. NGO, up- and down-stream residents, local land owner, and local government become more important in governing reservoir regulation to diminish flood damage in each party. And also each party demands the establishment of reservoir operation guidelines for flood control. Along with these requirements, public participation is essential element for flood control. But the criteria for choosing flood control by reservoir operation policy differ from a country to another. Reasons for these differences are not always rational, but also include, like any human decision, feelings, beliefs, prejudices, irrational and ill-grounded practices. In this context, one of the goals of water-related authorities setting up participatory processes would be to get a clear picture of what characterizes this qualitative and complex frame of decision-making for individuals and communities. In other words, there exist different approaches to the same water-related issues.

Eventually, several agreements and conventions have, more or less recently, advocated for the participation of the public in both environmental matters and to water-related issues as well.

1.3. Implementation of participatory processes

There are several flood control issues inside and outside of the country as follows:

- Water-related international agreements including treaties on transboundary rivers for flood control(Ti, 2000);
- Water-related conflicts and tensions for reservoir operation in the country;
  - Up- and down-stream residents
  - Dam owner and Non-governmental organizations for environmental impacts
  - Dam owners with different purpose-prone
  - National and local agencies
  - Decision support between government and reservoir operation center
  - land users, environmental agency etc.

Along with these issues, several specialists related to solve the water-related problems insisted on the limitations of traditional technical response to the complex issue of the management of the flood control community expectations and behaviors, and the limitations of the current technocratic policy models in Table 2. Therefore public-driven decision making model might be an alternative to address the policy intent of involving the community, decision-making process and comparative participations are proposed such as technocratic-driven and social-driven policy model. According to these requirements, collaborative water management is

Table 2. Comparative policy

Social policy	Technocratic policy
• Community is integral to decision-making process • Power and control with citizens • Enables, empower and educates • Increases complexity • - sophistication • Driven by community needs • Multidisciplinary process • Optimal solution through community partnerships	• Community is an appendix to decision-making process • Power and control with government • Uses technical expertise • Decreases complexity - simplification • Driven by legislative requirements and professional biases • Single discipline experts • Optimal solution is technical

identified and agreed upon by the water-related organizations.

According to the above table, collaborative flood control has benefits such as the participatory processes contribute to consensus building, and consensus is the strongest decision; decisions based on consensus are more widely known and accepted by the community; consensus may help mobilize human and community resources for action; collaborative working helps identifying all dimensions of a problem or decision; participatory processes contribute to the socio-economic cohesion of a community; participatory decisions support integrated, preventive, solutions.

1.4. Level of public participation

An important task for water-related organizations to implement participatory processes in flood control is to design appropriate participation activities and actions at appropriate participation levels. In other words, the decision-making process is a continuum, in which several "intermediate decisions" are often made, and the concept of "public participation" may thus have different meanings, according to the time and place where it occurs. B.Affeltranger in 2001 proposes four simple levels of participation contributing to the design of adapted and efficient participatory processes cited by Creighton in Table

Table 3. Levels of participation

Level	Public information	Public involvement	Consensus-seeking	Dispute resolution/ negotiation
Goal	inform of the decision	Hear before the decision	Influence the decision	Agree to the decision

Table 4. Extents of public participation in decision-making

Fully internal administrative decision	Information giving public	Information gathering opinion surveys	Discussion, negotiation	Advice-giving	Public control
Level of participation					

3 and Scales (1997) in Table 4.

Several perceived benefits of participatory processes have been identified and widely reproduced in the literature: Participation is used to improve policy and service outcomes by providing a forum for better informed decision making; Participation is used to provide a forum for discussion and negotiation to set priorities and deal with competing and sectional interests; Participation is a political strategy to persuade, to advance a proposal, or to be innovative; Participation is used to seek to maintain a commitment to social justice (equity, access, participation and rights); Participation is used to build citizenship, i.e. to enable people to have a say over decisions that impact on their lives - people can come together as citizens and deliberate about their common affairs.

1.5. Methods for effective participatory processes

It is essential that participatory processes be designed according to the specificity of each governance level considered in a given context. The objective of participatory processes is to reach a concerted consensus involving all possible relevant stakeholders; yet, this involvement may appear at different stages of the decision-making process, so that the added-value of discussion participants may be optimized and do not interfere with other decision levels.

Participatory processes for flood control are indeed meant to provide for "a solution based on technical and socio-economic facts, as well as on national and international agreements".

Water-related participants and policy makers designing methods and tools for a water-related participatory process should make sure that appropriate representative bodies will speak for the different stakeholders. Designing participatory processes is also strongly connected to the analysis of the policy cycle (Glas & Leentvaar, 2000) in Table 5. According to these authors, the objectives of the policy cycle are in short : i) to clarify and rationalize policy management solutions in objective terms, ii) to gather and present information to all interest groups involved in the project and those affected by the consequences, and iii) to prepare for a final

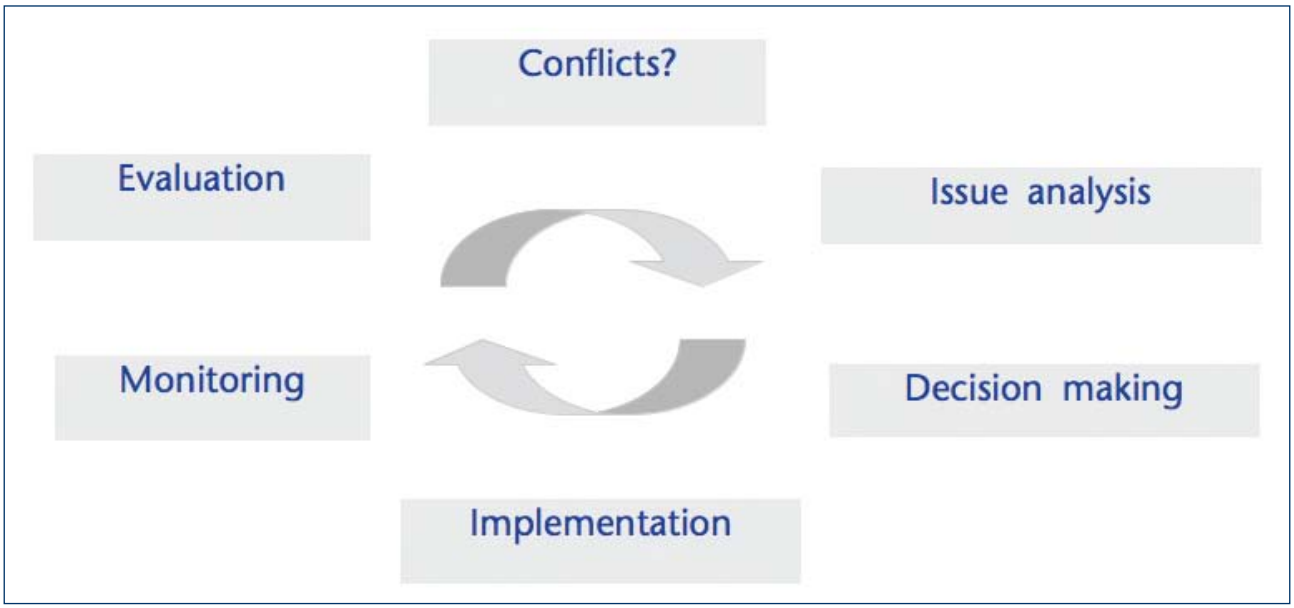


Figure 1. Policy Cycle

decision.

The objective is here to obtain valuable information, creative suggestions, as well as an insight on the implementation modalities of the water-related decision at stake. Yet, the public alone should not be in charge of the final decision, the responsibility of which regards the flood control authority or the dam owner or reservoir organization in charge of the management of the participatory process.

Creighton (1999) is an early designer and practitioner of participatory processes; he insists that an effective analysis of the decision making process may help avoid several difficulties in the implementation of public participation. Creighton also clearly depicts the stages of public participation planning as follows:

1) Decision analysis
- clarifying the decision being made
- specifying the planning/decision-making steps and schedule
- deciding whether public involvement is needed, and for what purpose

2) Public participation planning
- specifying what is needed to involve the public at each step of the planning/decision-making process
- identifying the stakeholders, internal and external
- identifying techniques to be used at each step of the process, taking into account the needs of different population subgroups and stakeholders
- linking the techniques in an integrated plan

3) Implementation planning
- develop a workshop agenda
- decide where meetings will be held
- decide who will make the presentations
- decide feedback activities and communication options for presentation of results

1.6. Mutual agreement of public participation

The success of a public participation initiative may depend on the water authorities' capability to merge two different approaches : 1) on the one hand, technical and scientific water modeling systems, including for instance computer-based decision support systems, and 2) on the other hand, more sophisticated, non-linear, anticipation and forecasting models likely to take into account the interplay between water stakeholders.

Creighton (2000) stresses that it is important to select public participation techniques according to the type of public and stakeholders that the decision process is involving; for example, Table 5 provides an overview of possible techniques in accordance with six generic types of stakeholders.

Public participation for flood control, and especially in water-related disaster mitigation, belongs indeed to the series of non-structural measures, even though participatory processes may be also used by authorities to communicate on flood-control structural measures, such as major civil works for example dams and levees, conducted in their vicinity. Public participation may indeed be relied upon as a side-measure in order to improve the integration of flood control measures in human settlements. Structural and non-structural flood control measures have been widely commented upon in the literature.

Communities in flood-prone areas need water professionals to design (structural and non-structural) flood control strategies, methods and tools. Yet, these initiatives are most likely to interfere with pre-existing socio-cultural, socio-economic and socio-political conditions. In other words, pure technical "top-down" approaches to water problems may be unable to seize all the dimensions of a flood problem, or of its consequences, possibly leading to a failure in the implementation of the flood control measures. For example, flood control strategies (land-use planning, retrofitting instructions, floodplain design) may turn out to be rejected by the public, including in "NIMBY Syndrome" situations.

Table 5. Mutual agreement of public participation

Type of community	Possible techniques
-representatives of national and local agencies for flood control -public participants -technical reviewer -NGO participants -reservoir operators -environmental agency	-negotiation session -workshop or advisory committee -review panel -public meeting -information bulletin -news releases

PART 2 - GENERAL GUIDELINE INCLUDING PUBLIC PARTICIPATION IN FLOOD CONTROL

2.1. Purpose of general guideline

General guideline is to guide between water-related participants and water resources professionals in reservoir operation and flood control. A participatory process needs "interaction between water resources professionals and the public". Therefore this section illustrates general items likely scope, issue analysis, coordination processes, announcement for flood control by reservoir operation.

2.2. Interaction process

Priscoli (1989) suggests that "interaction between water resource professionals and the public refers to a continuum of activities, programs, and techniques. The continuum ranges from public involvement (e.g. public information, advisory groups, workshops) at one end of the spectrum, to conflict management (e.g. mediation, collaborative problem-solving, negotiation, and arbitration) at the other end". Furthermore, public interaction is explicitly intended to be an iterative, two-way process within which concerns, ideas, and information flow freely between water resource professionals and the individuals and organizations representing various public interests.

The implementation process of the "interaction with the public" scheme is presented by Walesh (1989, 1993) in eight steps and was developed according to works of Costello (1974), McPherson (1977), and Sheaffer et al. (1982). Key to success in the process of interaction with the public is that there be jointly developed both high-quality technical work and effective communication, including repeated interacting with all the elements of the public (Astrack et al., 1984).

Step I: Establish objectives and standards

The objectives are the targets and priorities of the water management plan; the standards are used to measure the degree of success in reaching these targets. Targets and standards must be designed in common by authorities and by the public. Participatory problem-solving starts with participatory problem-setting. Resolution of concerns stated by the public should be reflected in objectives and standards;

Step 2: Conduct inventory

Water planning deals with large amounts of information. Data collected during the inventory (prior to formulating alternative solutions) may be organized within three categories: i) completed or on-going studies, ii) natural resource data and information, and iii) infrastructure data and information. Interaction with government officials and the public will help to optimize this phase;

Step 3: Analyze data and prepare forecasts

The two purposes of this step are a) to understand the present social, economic, and environmental conditions prevailing in the flood-prone area, and b) to formulate hypothetical future conditions and scenarios (prospective). Typically, public interaction is minimal during this phase.

Step 4: Formulate alternatives

This step consists in a creative and systematic effort to conceptualise, screen and, if appropriate, further develop alternatives. To survive, an alternative should be conceptually, technically, economically, environmentally, financially, legally, administratively, and politically feasible. An alternative should also be socially sustainable. Previous and concurrent public interaction can be very useful in applying the listed feasibility criteria to each alternative.

Step 5: Compare alternatives and select the recommended Plan

The essential characteristics of each surviving alternative should be captured in summary form (and presented in such a way that options and consequences can be understood by non-specialists) for consideration by members of the expert team preparing the plan, and eventually by other decision maker and by the public. Within the public arena, the alternatives should be evaluated on the basis of their ability to achieve the objectives and standards established in Step 1.

Step 6: Prepare p/an implementation program

The effort must now turn towards answering questions such as when the various elements of the plan are to be implemented, who has the responsibility for implementing each element, and how the implementation is to be achieved (including financial resources). Lessons learned from previous and concurrent interaction with the public, particularly various governmental units, is crucial to the prepa-

ration of a viable plan implementation process.

Step 7: Implement the plan

This step is the most unpredictable. Plan implementation will also be influenced by the persistence or occurrence of water-related problems, and assistance on plan implementation should be provided to local authorities by the government units or agencies that prepared the plan. Such units or agencies should be in a position to interpret the plan to interested individuals and groups, and to update the plan as needed.

Step 8: Operation

As the implementation of an urban water plan begins, there will be an increased need for effective operation of water management facilities. Though referring to Grigg (1986) according to which the issue of personnel management should be addressed in water planning, the author does not explicitly mention interaction with the public at this step of the process.

2.3. Issue analysis

The participants related to a flood control strategy carry out as to guarantee that the flood control strategy was not only oriented towards properties and lives of residents, and dam safety but also guarded the environmental and ecological value. However, according to the economic growth and social development, reservoir operation professionals or dam owners are faced with various stakeholders who are all trying to defend or strengthen their specific interests for flood control. A vital question is how to communicate with these stakeholders in the different stages of the flood control process. What communication strategy applies to what situation? And equally important, if a communication strategy is developed, how should it be instrumented? What will the message be, how are the target groups identified and addresses? And, more important, what kind of public participation is required to enable cooperation and avoid opposition to reservoir operation for flood control?

In general, communication strategies in each group for reservoir operation during the flood season can be required as Table 6. These strategies in each item apply to different situations, following the cultural and historic context in the areas or countries, and the established relationship between reservoir operation professionals and the public or other participants.

Reservoir operation professionals or dam owners might develop the communication strategies in various flood control issues.

2.4. Communication for communities' needs

The communication events are presented in order

Table 6. Issue analysis

Items	Federal agency	Local agency	Reservoir operator	Residents	NGO	Env. agency
Flood control	O	O	O			
Channel capacity		O	O	O	O	O
.....		.		.		

to assist water resource professionals for practical implementation of the interaction. These following events are expected to meet the public interaction needs of the flood control by reservoir operation. (Walesh, 1993)

1 - Advisory committees
Members, who should represent various public interests, might include reservoir professionals; elected and appointed government officials; experts from the private sector; regional, state and federal officials; university professors; representatives of environmental and recreation groups; and representatives of the public like up- and down-stream residents should be involved.

Examples of committee functions are providing data and information, raising issues and concerns, establishing goals, conducting public meetings, reviewing draft reports or report chapters and helping to interpret the planning process and the plan recommendations to committee members' associates and constituencies;

2 - Public meetings
One or more intermediate public meetings can then focus on status reports and on the presentation of alternatives that are under consideration. Draft recommendations of the flood control can be presented during a final public meeting. To the extent feasible, these meetings should be conducted within affected areas such as flood prone area. Schools, religious places, business centers and other buildings should be available in lieu of government facilities. Participation of citizens should be encouraged and documentation should be prepared.

3 - Contacts with up- and down-stream land users and other societies
The principal element for flood control from these stakeholders was solicited through meetings and direct contacts. Because of their experience and influence, such groups can provide valuable insight, useful data and information and offer support during flood control implementation.

4 - Presentations to community subgroups
Knowledgeable and influential community leaders are typically members of one or more civic organizations such as service clubs, environmental groups, and professional associations. Because of the .frequency of their meetings - sometimes two or more times per month - these groups are often receptive to suggestions for speakers and programs. Such presentations can help to expand public knowledge of and support to an flood control by reservoir operation.

5 - Field survey and contacts
One or more members of the expert team should perform a field survey of the planning area by vehicle and by walking during which they may make notes, obtain measurements, and take

Table 7. Public interaction

Item	Advisory committee	Public meeting	Contacts with each group	Presentations	Field survey
Interaction					
Item	Guided tour	Briefing	Workshops	Negotiation	
Interaction					

photographs. This reconnaissance also provides opportunities for informal, one-to-one interaction with inquisitive or interested community members, if any.

6 - Guided and self-guided tours
Interested community members and groups can be provided with guided tours of the watershed or planning unit. Guided and self-guided tours (if a written tour guide is available) enhance understanding of water issues, including flooding, as well as remedial and preventive measures. This is an example of what practical communication on water management can be.

7 - Briefings for (newly) appointed or elected public officials
By being introduced to local water-related issues, and by being provided with basic information on on-going or completed water management efforts, new public officials are more likely to be supportive of future water management activities (e.g. flood control). Tactics include inviting them to join advisory committees or to attend public meetings.

8 - Workshops
Water professionals preparing a flood control by reservoir operation should conduct workshops involving interested citizens. These events indeed provide an opportunity for in-depth exploration of substantive water-related topics such as issues to be addressed, methodology, findings, alternatives, and recommendations.

9 - Negotiated conflict resolution among contending interests
Contending interests which might include environmentalists, citizens, land developers, and water-related professionals can be provided with an opportunity to negotiate an acceptable solution (dispute resolution), provided that it satisfies applicable rules and regulations (Priscoli, 1988).

2.5. Devices of the interaction with the public

A set of programs and events in order to encourage effective interaction between water professionals and the public has various supporting devices. These are tools and techniques intended to enhance the success of the interaction events in following five items.
I. Newsletters, brochures, fact sheets and other special publications
Special brochures, informing on the flood control effort, fact sheets, and other information pieces can be prepared and mailed to citizens, with utility bills or in response to requests. Comic books, posters, and cartoon characters may be used to gain attention of children or the public. Besides using the mail service, all forms of written material can be distributed or provided at public meetings, during presentations to various groups, or during guided tours, and can be made available in public places.

2. Press releases and the media
Public interaction programs can be announced via press releases sent to newspapers and to radio and television stations. Public interviews of reservoir operation authorities may also be appropriate.

3. Audio-visual materials
They can be prepared for repeated use at various programs and events. Visual material can be supplemented with written explanations or guides for use by speakers or for self or small-group study.

Table 8. Interaction devices

Item	Publication	Media	Audio-visual materials	Graphics	Physical model
Event					

4. Graphics
Most tables, figures, maps and other illustrations that appear in flood control reports are often too complex for use by people other than water experts, or at least appear to be so. Special graphics should be prepared to support public interaction programs and events. These graphics should diminish the preceding obstacles and focus on concepts, problem definition and feasible alternatives.

5. Physical models
Although typically expensive, physical models may be justified as a means of explaining complicated three-dimensional phenomena or complex solutions to flood control problems. Such models can be displayed in public places or taken to public meetings, workshops, and other places where water professionals are interacting with the public.

2.6. Conclusion

Successful public participation in flood-related issues should combine value judgment (from stakeholders) and technical information in a structured framework involving workable decision tasks. The objective of groups representing community members, NGOs or the civil society should be then to provide better informed recommendations to local authorities. Appointed or elected local decision-makers in charge of the design and monitoring of participatory processes should therefore seek that non-specialist participants to flood-related and reservoir operation-related public debates are provided with reliable, quality information on issues related to flood mitigation and control.

Though the issue of assessing the quality of participatory processes in flood control would deserve a specific attention in itself, four criteria may here be proposed in order to assess for the success of flood-related public participation initiatives:

a) The achievement of a consensus agreement,
The political objective of participatory processes is not to resolve a dispute (or seldom), but rather to provide decision-makers with an insight on the decision's potential impact on affected communities, and to identify the expectations of these communities;

b) The way the steps of the process were addressed.
These ways should be understandable to all participants and involved stakeholders, and addressing their key factual questions. Decision quality requests both an appropriate decision framework, as well as appropriate information provided to the right people and groups. The selection of the decision framework therefore is the first critical step;

c) In the nature of the alternative recommended by the process.
This alternative should be highly effective in meeting most of all the objectives initially or progressively established for the decision.

d) There should be conducted an assessment of the participation campaign tangible and intangible "costs and benefits". This assessment should be made public.

Reservoir operation for flood control occurs often a communication gap between the reservoir operation professionals and the social activity and the public. This guideline aims to fill this gap by providing suggestions for flood control strategies, and this technical report intends to serve this objective. Regarding the flood control of water-related disasters, WGH of UN/ESCAP represent an opportunity for the promotion of a convergence between water sciences on the one hand, and human, social and political science on the other. The water-related professionals of developed or developing countries in Asia in the implementation of comprehensive flood disaster prevention measures may involve suitably methodological and operational guidance on the implementation of participatory processes in flood mitigation and control in each country.

CASE REVIEW

Public Participation in Flood Control of Dam

1. Purpose
The basic purpose of this public participation plan is to provide for a meaningful process through which reservoir operation professionals, public officials such as flood control center or environmental agency, non-government organization, up- and down-stream residents of dam and stakeholder groups may effectively participate in developing

flood control plan by reservoir operation. This public participation plan recognizes every participant's right to participate in the process of making reservoir operation professional's decisions. Significant financial, time, and energy investments will be needed to complete this planning effort.

2. Objectives of the public participation plan

Recognizing that there are many levels of public participation, to provide for an effective mix of participation opportunities that include public information, public education, public input, public interaction, and public partnership.

Recognizing that not everyone participates in the same way or at the same time, to include a mix of participation strategies that provides for a broad and diverse set of participation opportunities that considers the diversity of the participants.

3. Public participation steps for flood control

No	Flood control steps	Public participation steps
1	Conduct data analysis and draft plan goals and objectives for flood control by reservoir operation	- Conduct data analysis with the assistance of the reservoir operation committee (a public partnership group) and use analysis to define and prioritize draft goals and objectives - Build public awareness and education for reservoir operation and flood control - Solicit public input for flood control - Utilize reservoir operation committee to refine findings, goals, and objectives
2	Revise plan goals and objectives and draft preliminary flood control plan	- Hold quadrant (regional) public listening sessions to refine and validate the draft data findings and plan goals and objectives - Determine who are the key stakeholders needing to review the preliminary draft - Use reservoir operation committee and other resource people to begin draft of preliminary flood control plan
3	Revise and finalize flood control plan	- To develop key questions reviewers of the preliminary draft flood control plan should assess - Send out the preliminary draft plan to reviewers for comment and post draft plan on Web site for comment - Enforce meeting or workshop for key stakeholders of flood control to provide insightful review of the preliminary draft plan - Hold public hearings if necessary
4	Plan adoption and begin implementation	- Send final report through required committees and to reservoir operation professionals - Build public awareness of the finalized and adopted plan through the use of meeting, mass media, newsletters, presentations, web-site to participant s groups.
5	Evaluate plan and process	

Recognizing the back ground of dam construction and reservoir operation difficulty to the public participants within past and current flood control. Reservoir operation professionals will continue to provide the public with opportunities to review, clarify, and update previously generated information, as well as generate new policies, goals, objectives, and information for weather forecasting, hydrological analysis, and reservoir operation.

To build public support for, and ultimately ownership of flood control plan by reservoir operation during the flood season.

4. Issue analysis

Climate effects due to global warming prove to be a strong motivation for looking differently at issues of water management by reservoir. For decades, the only answer to hazardous situations (e.g. flooding by increased river discharges or by incoming storm water) was to strengthens levees and dams.

A vital question is how to communicate with these stakeholders in the different stages of the flood control process. What communication strategy applies to what situation? And equally important, if a communication strategy is developed, how should it be instrumented? What will the message be, how are the target groups identified and addresses? And, more important, what kind of public participation is required to enable cooperation and avoid opposition to reservoir operation for flood control?

The aim of the plan is to provide justified and affordable flood control that will reduce the risk of flooding, taking into account future changes in the natural and cultural environment. The other principal objective is to ensure that consensus for issues is technically feasible, economically viable, environmentally appropriate and socially acceptable.

The communication strategy in each group for

Table 9. Issue analysis

Items	National agency	Local agency	Dam owners	Residents	NGO	Env. agency
Flood control	O	O	O			
Water supply		O	O	O	O	O
Channel capacity		O		O		
Land use		O		O		
Flood damage	O	O	O	O		
Non-damage flow	O	O	O	O	O	
Water quality		O	O		O	O
Max. outflow guide	O		O			
Operating guide curve	O		O			
recreation					O	O

reservoir operation in this case review is shown in Table 6.
As the table6, participants with each interest might develop the communication strategies in various flood control issues.

5. Communication with participants

The communication process can be divided into three main stages.

Communication with the reservoir operation professionals and other participants

Due to consensus for flood protection, the participants strive for an integrated concept of flood protection and prevention of damage by flooding.

Representatives of participants discuss how to control flood, which priority need for the flood event, and so on.

Extensive discussion about the planning with all target groups

Flood control by reservoir operation is presented to the general public and in particular to land users in up- or down-stream of dam, environmental agencies, and non-governmental organizations. The communication representatives stand open to all their comments and suggestions and conduct an intensive dialog with the participants. The problems and concerns of participants have to be worked out clearly, making use of experts opinions.

Participation of the public in relation to the legal procedures

The administrative procedures request approval from the general public. The communication strategy bears specific efforts for creating awareness / drawing attention to the project and its purpose. There is a strong desire for / willingness to treat target groups in a fair and correct way. There is a strong focus on 'the hard interests', such as economical and ecological interests, and lifesaving.

6. Evaluation and enhancement guidelines

To meet the changing needs of your community, a communication strategy should be evaluated and amended periodically. Changes in land use, development, environmental policy variation, and non-governmental organization requirements can affect a variety of flood control by reservoir operation. Because so many factors will affect the success of flood control efforts, a planned evaluation of the communication strategy is essential. Evaluation gives an opportunity to better incorporate effective flood control.

- Identify procedures for periodic review of the communication strategy. Indicate how a coordinated reservoir operation professionals, federal or local governmental agencies, environmental agencies, land users, non-governmental organization review will be conducted and include a review schedule.]

- Identify procedures to ensure that a broad group of participant's representatives participate in the review and revision of the flood control strategy.

- Identify procedures for exercising the components of the flood control plan among each group.

PART 3 - TECHNICAL GUIDELINE FOR RESERVOIR OPERATION

Reservoir Operation Guidelines in Flood Forecasting

CHAPTER 1 GENERAL RULES

Article 1 (The Rule) General rules are the following:

1. The flood operation rule refers to the activities required for coping with the flood inflow in the reservoir for securing dam safety and mitigating flood damage to the downstream area along the river.
2. General rules mean comprehensive features of reservoir operation for flood season

Article 2 (Purposes of Dam) The purposes of the dam involve effective water utilization by the following concerned parties:

1. Flood control
2. Water supply and Irrigation
3. Power generation
4. Recreation

Article 3 (Purposes of Flood Operation) The flood operation aims to attain:

1. Prevention of flood damage to the dam and appurtenant structures
2. Prevention of damage to the public in the downstream areas along the river from the dam to the target area at the time of commencing the discharge of the stored water through the spillway of the dam
3. Regulation of outflow from the dam so as not to exceed the flood inflow
4. Filling the Reservoir with flood inflow by the end of the flood operation
5. Mitigation of flood damage to the target area by means of flow regulation by the dam using a part of the reservoir capacity and early flood warning to the public in the target area.

Article 4 (Responsibility) Responsibility for flood operation follows:

1. The reservoir operation professional shall be assigned to undertake and supervise all the activities concerning the flood operation

2. The reservoir operation professional shall be tasked with making necessary decision on flood operation in compliance with the rule.
3. The reservoir operation professional shall execute the flood operation according to the rule of the dam

Article 5 (Features of Dam and Reservoir) The principal features of the dam and the reservoir for the flood operation shall be as following:

(1) Dam Design Flow

a. Design flood flow	OOO/s
b. Discharge of the spillway at the design flood water level EL.OOO m	OOO/s
c. Allowable discharge for the prerelease	OOO/s

(2) Dam Features

a. Dam crest elevation	EL.OOO m
b. Top elevation of the spillway gate	EL.OOO m
c. Crest elevation of overflow weir of the spillway	EL.OOO m
d. Number of spillway gates	OO m
e. Height of a spillway gate	OO m
f. Width of a spillway gate	OO m

(3) Reservoir Features

a. Drainage area	OOO
b. Reservoir surface area at HWL	OOO
c. Flood water level (FWL)	EL.OOO m
d. Surcharge water level (SWL)	EL.OOO m
e. High water level (HWL)	EL.OOO
f. Restricted water level (RWL)	

for flood season EL.OOO m
g. Low water level (LWL) EL.OOO m
h. Tail water level (TWL) EL.OOO m

Article 6 (Features of Flood Forecasting and Warning System) The principal features of the flood forecasting and warning system shall be as specified as following:

(1) Principal Features of the Flood Forecasting System

a. Rainfall gauging station OO points
b. Water level gauging station OO points

(2) Principal Features of the Flood Warning System

a. Warning Station OO points
b. Warning Post OO points
c. Warning Vehicles
OO units

(3) Principal Features of the downstream Stream or River

a. Tolerable flow in specified point OOO/s
b. Bankfull flow in specified point OOO/s
c. Water level at Telemetering Station
(i) Allowable high water level in 50% of bankfull flow EL.OOO m
(ii) Flood alert water level in 75% of bankfull flow EL.OOO m
(iii) Bankfull water level EL.OOO m
d. Distance from the Dam to control points such as the stations, and facilities
e. Approximate propagation time of the dam discharge from the Dam to control points

CHAPTER 2 DEFINITION

(1) Flood Water level (FWL)
Water level that would be reached when the design flood flows into the Reservoir while operating spillway. Design flood water level is EL.OOOm.

(2) High Water level (HWL)
Highest elevation that water is normally stored or that elevation which the reservoir should be operated for conservation purposes. Except when the flood inflow is regulated by the Dam under flow regulation during flood period or discharge during post flood period the reservoir water level shall not be raised above the normal high water level throughout the year. High water level is EL.OOOm.

(3) Surcharge Water level (SWL)
The highest acceptable water level which considered water surface wave affecting the dam. When the reservoir water level rises to the surcharge water level, all the spillway gates shall be kept fully opened until the inflow decreases to be equal with the dam discharge. Surcharge water level is EL.OOOm.

(4) Low Water Level (LWL)
Lowest water level above which it is planned to normally use the reservoir capacity. Low water level of the Reservoir is EL.OOOm.

(5) Restricted Water Level (RWL)
Except when the flood inflow is regulated in accordance with the provisions during flood period and except when the reservoir water level is lowered in accordance with the provision during the post flood period, the reservoir water level shall not be raised above high water level of the flood season. Restriced water level is EL.OOOm.

(9) Tail Water Level (TWL)
Water level in downstream site of the dam installed power generation facility. Tail water level is EL.OOOm.

(10) Surcharge Capacity
Surcharge capacity is reservoir capacity provided for use in passing the inflow design flood through the reservoir. It is the reservoir capacity between the surcharge water level and flood water level.

(11) Flood Control Capacity
Flood control capacity is reservoir capacity between the flood water level and restricted water level during the flood season.

(12) Flood Season
Flood season for the Dam is defined as the periods from OOO to OOO (ex, June 20th to September 20th) while the remaining period from OOO to OOO (ex, September 21st to June 19th) is defined as the non-flood season.

(13) Control Point
The principal site that designates along the river or stream for flood control due to the dam.

(14) Reservoir Operation Professional
Water related operating specialist in charge of flood control by reservoir operation and flood forecasting during flood season.

(15) Flood Control Center
Authority that take the responsibility for flood disaster prevention through prerelease or flood control. Reservoir operation professional notifies hydrological analysis and reservoir operation information to flood control center.

(16) Public Participants in relation to flood control
Water related agencies or organizations, which are an essential added-value to the decision-making process of flood mitigation-related issues because they enable authorities to analyze the local and environmental problem, and thus community-based flood mitigation strategies.

CHAPTER 3 PRINCIPLE AND CRITERIA

Article 11 (Principle of reservoir operation)

1. Reservoir operation during flood season shall have the priority of flood control. The legitimate right of reservoir operation agency shall be guaranteed in the provision.
2. Reservoir operation during flood season shall consider weather and hydrological condition in dam basin, dam storage, inflow and outflow condition, stream flow situation in control points.
3. Reservoir operation professional shall operate rainfall-runoff system as a rule. But in case of the emergency situation for reservoir operation, Reservoir operation professional comes to agreement with flood control authority.

Article 12 (Reservoir operation during flood season) The term flood operation refers to the activities required for coping with the flood inflow in the reservoir for securing dam safety and mitigating flood damage to the downstream area along the River. The flood operation shall consist of the following activities:

1. Flood forecasting
2. Announcement/release of the flood periods
3. Flood vigilance during the flood periods
4. Prerelease of stored water in the Reservoir through the spillway upon instruction from flood control operation center
5. Operation of the spillway gates
6. Issuance and dissemination of the dam discharge warning to the public in the target area
7. Dissemination of the flood warning to the public in the target area
8. Notices on the flood operation of the Dam to the related agencies
9. Inspection and maintenance of equipment and facilities required for the flood operation
10. Hydrological observation and study
11. Preparation and custody of the flood operation records
12. Other activities required for securing dam safety from floods and for flood mitigation

Article 13 (Flood Control Criteria) The flood operation due to dam refers to the activities required for coping with the flood inflow in the reservoir for securing dam safety and mitigating flood damage to the downstream area along the river.

Article 14 (Dam Discharges) It is permitted to discharge the stored water in the reservoir through the spillway only when the situation corresponds to one of the conditions prescribed hereunder:

1. When the reservoir water level rises above the restricted water level during the flood season
2. When the reservoir water level rises above high water level during the non-flood season
3. When the reservoir water level is lowered to the restricted water level during the transition time from the non-flood season to the flood season
4. When the prerelease is carried out in accordance to flood control procedure
5. When the flow regulation is needed for flood control during flood period
6. When the reservoir water level is lowered during the post flood period
7. When it s required and decided to make the discharge through the spillway for water supply/irrigation or maintaining the river flow on the downstream reaches
8. When it is required and decided to make the discharge through the spillway for lower-

ing the reservoir water level for inspection and maintenance of the spillway gates, equipment, facilities, structures, etc. in the Reservoir

9. When it is urgently required and decided to make the discharge through the spillway due to any other unavoidable reasons.

Article 15 (Principle of Dam Discharging)
(1) Increasing rate of dam discharge
The discharging from the dam shall be made within the allowable increasing rate in order to avoid rapid rise of the river water level on the downstream reaches. It is, however, allowed to increase the dam discharge at a rate exceeding the allowable increasing rate when the inflow increases rapidly and such increase in the dam discharge is considered requisite and unavoidable to secure dam safety.
(2) Maximum use of water
Whenever the dam discharge through the spillway is required or expected, the reservoir operation professional shall discharge through the spillway.

(3) Dam discharge warning
Whenever the dam discharge through the spillway is commenced or increased in such high rate as would cause some damages to the downstream reaches, the dam discharge warning shall be made in accordance with the provisions.

Article 16 (Priority for Flood Control) The priority for flood control capacity is following:

1. Surcharge capacity
2. Flood control capacity
3. Effective storage capacity

CHAPTER 4 RESERVOIR OPERATION

Article 17 (Flood Periods) Flood periods separate the following stages:
(1) Flood Caution Stage
Flood caution stage is defined as the period that corresponds to one of the following conditions:

a. It is forecasted by the Meteorological Administration Agency that a tropical cyclone would pass across the for areas wholly or partly covering the drainage area of the Reservoir
b. The reservoir water level is higher than the Restricted water level
c. Tropical cyclone enters into the influential area in a O days
d. Accumulated amount of rainfall within the latest OO hours exceeds OOO mm

(2) Flood Stage
Flood stage is defined as the period that corresponds to one of the following conditions:

a. The reservoir water level is higher than the restricted water level.
b. The inflow exceeds allowable flow in the Dam

(3) Post Flood Stage
Post flood stage is defined as the period that corresponds to both of the following conditions:

a. Reservoir water level is between the restricted water level and flood water level in case of the flood season, or between the high water level and flood water level in case of the non-flood season.
b. The inflow is less than the allowable flow in the Dam

Article 18 (Measures to be taken during flood caution period) The reservoir operation professional shall take the following measures during the flood caution period.

1. To collect weather information from the meteorological agency
2. To collect hydrological data such as rainfall, water level, inflow, outflow
3. To carry out the prerelease in accordance with the preparation of the prerelease plan
4. To notice and disseminate the flood warning in accordance with the provisions
5. To control communication on the radio telephone system
6. To release or announce the flood period and to notify to the flood related organizations
7. To record the flood operation
8. To require other activities for effective flood operation

Article 19 (Measures to be taken during flood period) The reservoir operation professional shall take the following measures during the flood period.

1. To collect weather information from the meteorological agency

2. To collect hydrological data such as rainfall, water level, inflow, outflow
3. To carry out the flow regulation in accordance with the provisions
4. To notice and disseminate the flood warning in accordance with the provisions
5. To control communication on the radio telephone system
6. To release or announce the flood period and to notify to the flood related organizations
7. To record the flood operation
8. To require other activities for effective flood operation

Article 20 (Measures to be taken during post flood period) The reservoir operation professional shall take the following measures during the post flood period.

1. To collect weather information from the meteorological agency
2. To collect hydrological data such as rainfall, water level, inflow, outflow
3. To lower the reservoir water level to the restricted water level for flood season
4. To control communication on the radio telephone system
5. To record the flood operation
6. To require other activities for effective flood operation

Article 21 (Inspection and Maintenance)
(1) The reservoir operation professional shall be tasked with the inspection and maintenance of the equipment and facilities enumerated hereunder in accordance with the maintenance manual by instructing the staff whenever the flood caution period is declared in addition to the periodical inspection and maintenance:

1. Main and Regulation dam
2. Spillway gates
3. Hoisting equipment and control equipment necessary for the spillway gates operation
4. Observation stations and facilities
5. Power supply system
6. Flood warning system
7. Flood forecasting system
8. Other equipment and facilities required for effective flood operation

(2) The reservoir operation professional shall undergo tests of spillway gates and the auxiliary power supply system by instructing the staff to keep these in good working condition once a year preceding the flood season.

Article 22 (Rate of dam discharge) Whenever it is required to make any of the dam discharges prescribed in the provisions of dam discharge, the reservoir operation professional shall determine the time and rate of the discharge to be made through the spillway within the allowable maximum rates of the respective dam discharges.

Article 23 (Operation of Spillway Gate)
(1) Gates
The spillway gates shall be referred to herein as Gate No. 1, Gate No. 2 and Gate No. 3 from the nearest left bank towards the right bank.

(2) Prompt maximum operation
Any of the spillway gates shall not be operated continuously for more than OOO m at first operation. If the operation of more than OOO m is required, then the gate shall be operated in two (2) or more operations with a time interval of more than five seconds between each stop and restart of the gate. However, if it is considered requisite and unavoidable to operate the spillway gates exceeding this limit under such a critical situation as rapid increase in the inflow, the spillway gates may be operated regardless of this provision.

(3) Maximum difference among gate openings
The spillway gates shall be operated so that the differences in gate openings among the three (3) spillway gates are within OOO m.

(4) Gate operation sequence
When the discharge through the spillway is commenced, Gate No. 2 shall be opened first to the required opening within the maximum opening of OOO m, followed by Gate No. 3 and Gate No, 1 for more discharges. While in the closing operation, the spillway gates shall be operated in the reverse sequence.

(5) Minimum operation time interval
When it is required to operate simultaneously two (2) or three (3) spillway gates, said gates shall be operated one after the other with a time interval of more than five seconds.

Article 24 (Flood Forecasting)
(1) Weather observation
The reservoir operation professional shall undertake necessary measures for obtaining information on tropical cyclones, rainfall and other weather conditions from the meteorological agency

(2) Flood forecast
The reservoir operation professional shall forecast the expected flood volume, its peak flow and its starting time based on the relation between these and the location and moving speed of the tropical cyclones in order to be prepared for the expected flood operation.

(3) Simulation of flood operation
The reservoir operation professional shall carry out the simulation of the flood operation of the dam for the forecasted flood inflow hydrograph using rainfall-runoff model.

Article 25 (Principle of Prerelease)
(1) Decision
The reservoir operation professional will decide whether or not to make the prerelease, which requires dam discharge through the spillway, preceding the expected flood.

1. Expected time and date to commence the prerelease
2. Total volume of the prerelease to be made including the water through the main power and auxiliary powerhouse
3. Expected time and date to complete the discharge
4. Flow regulation starting water level (FRSWL) to be adopted

(2) Prerelease
1. Preparation of the prerelease plan
Reservoir operation professional shall prepare a plan of the prerelease including the dam discharge warning.
2. Prerelease
After the preparation of the prerelease plan, the reservoir operation professional shall notify the prerelease to the related agencies, issue and disseminate the dam discharge warning and carry out the prerelease.

Article 26 (Preparation of Prerelease Plan)
(1) Preparation of Prerelease Plan
The reservoir operation professional shall prepare the prerelease plan incorporating into the following:

1. Instruction on the prerelease received from the Flood Control Organization
2. Data on tropical cyclones and other weather conditions
3. Forecasted flood
4. Reservoir water level
5. Discharging plan for the prerelease
6. Dam discharge warning plan for the prerelease

(2) Discharging Plan for Prerelease
The discharging plan for the prerelease shall be prepared in compliance with the following discharge rule for the prerelease:

1. The discharge through the spillway for the prerelease shall be made after the power output of the main power plant reaches its maximum
2. The discharge shall be increased gradually within the allowable increasing rate of dam discharge
3. At the end of the prerelease, the discharge shall be gradually reduced until it becomes equal with the inflow.

(3) Dam discharge warning plan for prerelease
A plan of the dam discharge warning for the prerelease shall be prepared in accordance with the provisions.

Article 27 (Prerelease)
(1) Notice on Prerelease
Preceding the commencement of the prerelease, a notice on the prerelease shall be given to the relat-

ed agencies

(2) Dam Discharge Warning
The dam discharge warning for the prerelease shall be disseminated in accordance with the provision.
(3) Commencement of Prerelease
The prerelease shall be commenced and carried out in accordance with the discharging plan for the prerelease.

(4) Check of downstream Flow condition
Throughout the period when the prerelease is being made, the reservoir operation professional shall monitor the water level in order to check the rising speed of the river water level in the down stream target area.

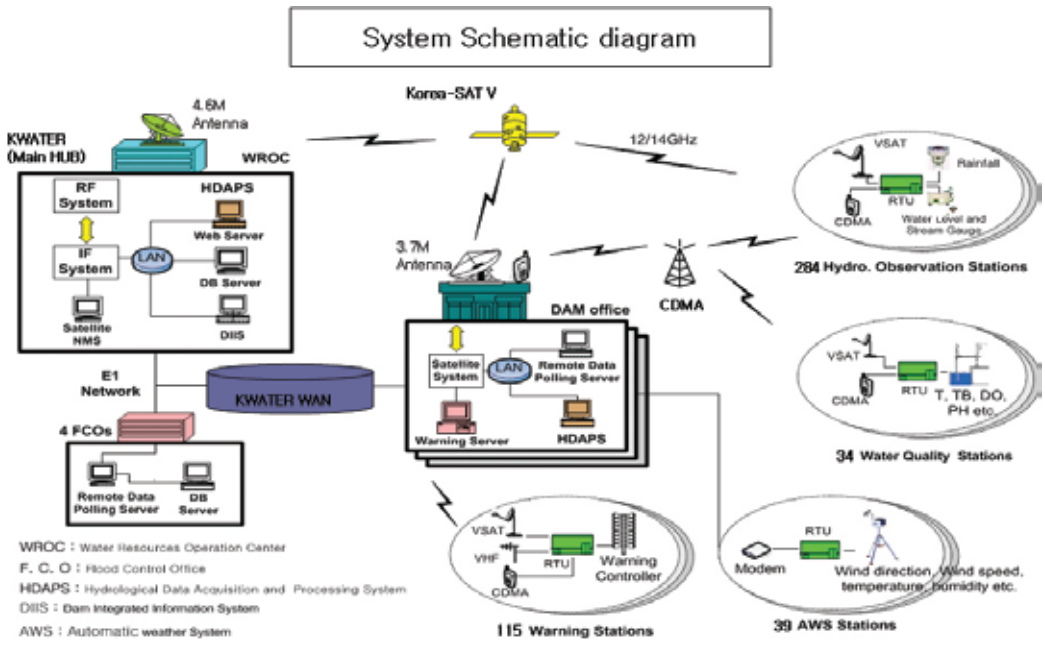
(5) Adjustment of Discharge
When it is considered necessary during the prerelease to stop or decrease the discharge due to the damage to the downstream reaches or other unavoidable reasons, the reservoir operation professional may adjust the discharging.

Article 28 (Flow Regulation during Flood Period)
The flow regulation by the dam shall be made during the flood period in accordance with the rules:

(1) Flow Regulation below Surcharge Water level
(a) Until rainfall peak

After announcing the flood period and until it is considered that in view of the rainfall and location of tropical cyclones that the rainfall peak has passed, the flow regulation shall be made in accordance with the reservoir operation rule..
(b) After rainfall peak
After it is considered that the rainfall peak has passed, then the discharge shall be kept until the inflow decreases to correspond to the discharge.
When it is considered based on the simulation results of the flood operation that the reservoir could not be filled to the allowed water level by the end of the flood operation, it is then allowed to gradually reduce the discharge in order to store the water up to the flood season high water level in case of the non-flood season.
(c) Flood recession period
After the inflow decreases to correspond to the discharge, the discharge shall be made in accordance with target water level which is determined by reservoir operation professional.

(2) Transition Operation above Transition Water level
If the reservoir water level rises to the flood water level in the course of the flow regulation and if it is considered based on the simulation results of the flood operation that the reservoir water level would rise beyond the surcharge water level, the flow regulation shall be made in accordance with the flood control rule.



(3) No Flow Regulation above Surcharge Water level
When the reservoir water level continues to rise above the surcharge water level, all the spillway gates shall be kept fully opened and no flow regulation using the gates shall be made.

Article 29 (Discharging during Post Flood Period) After the inflow decreases, the constant discharge shall be regulated until the reservoir water level lowers to the flood season high water level in case of the flood season.

Article 30 (Non-functioning of Reservoir water level observation) In the event of non-functioning of the Reservoir water level observation, the reservoir operation professional shall take necessary countermeasures in accordance with the provisions. If the reservoir water level detector installed in the flood control center does not work, then the reservoir water level shall be read on the staff gauge by a gauge reader and reported to the flood control center on the local telephone system or on the portable telephone set.

Article 31 (Non-functioning of Flood Warning System) If no good sign comes back or if the sound from the loudspeaker of any of the warning stations could not be monitored when the dam discharge warning or the flood warning is disseminated through Warning Stations, the required warning shall be disseminated by dispatching the warning vehicles to the areas.

Article 32 (Emergency Spillway Gate Operation) In case the spillway gate operator could not receive instructions during floods on the spillway gate opening due to some reasons, the spillway gate operator shall operate the specified gates in accordance with the emergency spillway gate operation procedure.

CHAPTER 5 NOTICES AND WARNINGS

Article 33 (Notices)
(1) Notice on Flood
Whenever any of the flood periods is announced or released in accordance with dam discharge provisions, the reservoir operation professional shall notify promptly to the flood control organizations and related agencies.
(2) Notice on Prerelease
When it is instructed to carry out the prerelease, the reservoir operation professional shall notify promptly to the flood control organizations and related agencies.

Article 34 (Dam Discharge Warning) The warning to the public in the target area on commencement and rapid increase in the dam discharges shall be issued and disseminated whenever any of the dam discharges through the spillway is commenced and whenever such possibility is recognized in the course of the dam discharging as any damage would occur to the downstream target area in relation to the rapid increase in the dam discharge.

Article 35 (Dissemination of Dam Discharge Warning to the Public) Dissemination of the dam discharge warning shall be made to the public and water-related agencies or organizations in the target area along the downstream of the dam.

Article 36 (Dam Discharge Information) The reservoir operation professional may issue and disseminate information on the dam discharges as follows:

1. Dam release size and timing
2. Spillway gate opening
3. Flood control operation

CHAPTER 6 REPORT AND APPRAISAL

Article 37 (Records of Flood Operation) Whenever the spillway gates of the dam are operated regardless of whether there is actual discharge of water through the spillway or none, the reservoir operation professional shall record and keep the following items:

1. Reason for the gate operation
2. Name of the gate operated, starting time and closing time of each gate operation, and gate opening at the closing time of each gate operation
3. Reservoir water level at starting time of each gate operation, inflow, discharge through the spillway, and discharge for power generation
4. Time and new discharge through the spillway at the peak of the dam discharge
5. Time and new discharge when the power plant starts, stops or changes its output
6. Time and contents of notice and dissemination of the dam discharge warning, and time and route of the warning vehicles for the dissemination of the dam discharge warning
7. Time and contents of dissemination of the flood warning, and time and route of the warning vehicles for dissemination of the flood warning.

Article 38 (Report on Flood Operation) The reservoir operation professional shall review this report on the flood operation and exchange the following items to the flood control organization:

1. Weather information on rainfall characteristics
2. Hydrograph characteristics
3. Inflow, outflow, and reservoir water level variation characteristics
4. Comments and recommendations on the flood model, flood forecasting, flood warning, rule, etc.

Article 39 (Hydrological Observation and Study)
(1) Observation of rainfall and water level is made automatically by the telemetering system normally in every minute everyday.
(2) The reservoir operation professional shall perform the run-off measurement at the main control site to improve and update the run-off rating curve.
(3) The reservoir operation professional shall review the following parameters of the flood-forecasting model after each flood operation:

1. Parameters to obtain mean rainfall over each sub-basin
2. Parameters of initial loss and retention loss rate of rainfall
3. Lag time and peak height of hydrograph
4. Parameters of rising curve of hydrograph
5. Parameters of recession curve of hydrograph
6. Parameters to calculate the inflow based on the reservoir water level

Article 40 (Flood Control Manual) The reservoir operation professional shall prepare the flood control manual showing the detailed procedure and forms for the effective flood operation in accordance with the rule.

BIBLIOGRAPHY

- Creighton, J.L., "Tools and techniques for effective public participation in water resources decision, (I), 1999, 20 p.
- Henry R. Renteria, Completed in compliance with the Flood Emergency
- Action Team (FEAT): Initiative Number 1, "Guidelines for coordinating flood emergency operations", 8p, Nov. 1997
- M.Rijnveld, M.Duijn, and P.van Rooy, ERSA-Conference 2005, Amsterdam, 23-27 August, "Public participation in flood control areas: approaches to 'sustainable' communication strategies", 22p
- Walesh, S.G., "Interaction with the public and government officials in urban water planning", (7) 1993,13 p.
- Alberta Environment, "Reservoir lands guidelines", 6p, Nov. 2005
- Australian national committee on large dams inc., "Guidelines on selection of acceptable flood capacity for dams", 37p, Mar. 2000
- Economic and social commission for Asia and the Pacific, United Nations, New york, "Guidelines on strategic planning and management of water resources", 94p, 2004
- Federal emergency management agency, "Federal guidelines for dam safety: emergency action planning for dam owners", 40p, Oct. 1998
- Department of economic and social affairs, United Nations, New York, "Guidelines for reducing flood losses", 79p, 2001
- Technical Documents in Hydrology) No. 48, UNESCO, Paris, "Public participation in the design of local strategies for flood mitigation and control", 82p, 2001
- Water O&M Branch, Division of O&M, Technical service, USBR, Denver, Colorado, "Training for dam operators-a manual for instructors", 81p, sep. 1981

For more information, please contact:

Chairperson, Publications Board
Tel.: +41 (0) 22 730 84 03
Fax: +41 (0) 22 730 80 40
E-mail: publications@wmo.int

7 bis, avenue de la Paix - P.O. Box 2300
CH 1211 Geneva 2 – Switzerland

www.wmo.int

WMO/TD-No. 1471