

## Abstract

Sustainable flood management is defined as protecting people and property from floods, using resources economically and equitably, while taking into consideration the future and the environment. To do this, the goals, the objectives and principles of flood management should be established and determined through social agreement. In order to achieve the objectives, flood management is to be implemented with an effective framework. Among the criteria of flood management, risk is most critical and determined by considering flood's impacts on society, economics, environment and culture. In this study, in order to effectively implement flood management, a framework and strategies are presented based on flood risk management. Finally, it is revealed that this framework is necessary to efficiently implement flood management in the same context, sharing the information about flood.

## Introduction

(a) For sustainable flood management, measures are selected, reflecting several principles, and objectives are achieved using the best combination of strategies and site-specific measures.

(b) Competent flood management needs to consider the uncertainty factor, together with the changes in criteria and risks, from the changes of the socio-economic system and the value system.

(c) Appropriate measures are necessary to be selected and to be taken, while giving consideration to economic, social and cultural, lawful and institutional and eco-systematic and environmental aspects.

(d) A systematic framework for flood management is necessary to be developed, and measures are to be taken to obtain the goals and the objectives, referring to the framework. And the effects of activities can be maximized through sharing the framework and information related to flood management. And they are to be implemented with the same context at national, regional, and community levels.

(e) In this study, to achieve the goals and the objectives of flood management and to adhere to the principles, a framework and strategies are established.

## Flood risk management

(a) Risk management is a series of activities, namely: to identify the state of the systems, to analyze the risks, to assess measures, to select appropriate measures, to implement measures, and to monitor and review the results.

(b) In order to reduce flood damage, site-specific measures are identified and implemented according to appropriate criteria determined by the value system. Therefore, appropriate risks for flood management need to be determined with the participation of stakeholder, residents, and NGOs, reflecting the state of each system.

(c) Figure 1 illustrates the relationships of the mechanisms causing flood damage, the interaction of measures for reducing damage and the damage's impact on the social-economic system.

(d) Flood risk management is employed to develop a new system, to modify an existing system, and to develop new mitigation measures. Flood risk management can employ scenario analysis to select the appropriate alternative, comparing each alternative's risk.

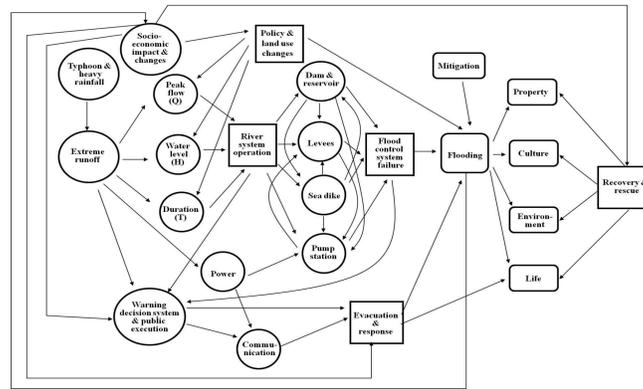


Figure 1. . Mechanisms of flood damage

## Framework for flood risk management

### (1) Necessity of framework

Since flooding affects all the sub-systems of a society and, specifically, damage to any sector affects all the others, disaster prevention activities are implemented from the all social perspectives. And flood management is dynamically implemented in a procedural format, taking appropriate measures during the pre-flooding, flooding and post-flooding periods. In this context, a flood risk management framework is developed to quantitatively reduce flood damage by decreasing flood risks from multiple perspectives.

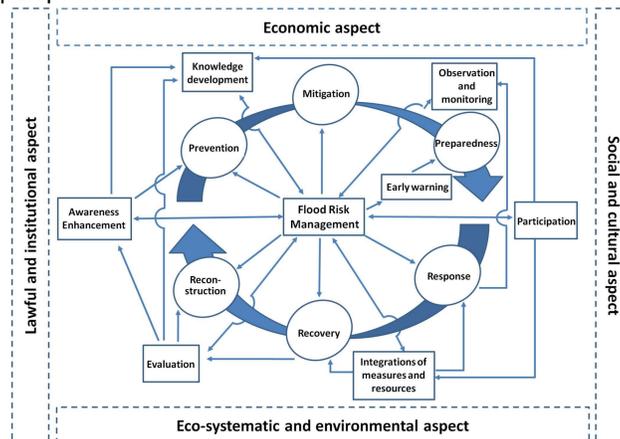


Figure 2. Flood risk management framework

### (2) Features of framework

(a) The process of flood management is divided into six stages, namely: prevention, mitigation, preparedness, response, recovery, and reconstruction.

(b) To carry out flood risk management, the risk of each alternative is estimated and compared at each stage, taking into account each alternative's damage magnitude and recovery time, which varies with the states of the socio-economic systems.

(c) A scenario analysis is employed to select the most appropriate alternative, comparing the risk of each one.

(d) Determining appropriate risks involves factors which are uncertain, such as the occurrence of extreme hydrological events due to climate change, the increase of flood discharges due to urbanization, and changes in socio-economic systems.

(e) Appropriate measures are considered from the economic, social and cultural, eco-systematic and environmental, and lawful and institutional aspects, and are then implemented. The balance among these aspects is considered to achieve the goals and the objectives of flood management.

(f) Awareness enhancement, knowledge development, observation and monitoring, early warning, stakeholder participation, integration of measures and resources, and evaluation are considered.

## Integrated strategies

To effectively implement the measures in real situations, strategies are integrated and applied to the framework proposed in this study.

### (1) Adaptation to changes of climate and related circumstances

From the economical view, it is not appropriate to apply all structural measures necessary for flood protection, which in turn negatively affects ecosystems. Therefore, flood management planning and its timeframe should be so flexible that they can be modified and adapted to the circumstances which change according to related factors.

### (2) Site-specific measures and optimal combinations

Measures are required to be reversible and flexible and coincide with the concept of sustainable flood management, and the balancing of structural and non-structural measures is to be taken into account.

### (3) Positive participation of stakeholders in flood management

Efficient flood management requires active participation of all stakeholders in implementing the measures. Also, institutions and committees should be established to promote active involvement of stakeholders and legally and institutionally guarantee their activities.

### (4) Integration of measures and maintenance of their consistencies through all flooding stages

The measures at all stages need to be implemented in an integrated manner, consistently considering the effects of potential measures planned for the following stages. In addition, the lessons from the flooding and flood-fighting activities are extracted during the post-flooding stage, well documented, and fed back into the entire flood management process.

### (5) Achievement of the goals and objectives and adherence to the principles

The goals and objectives should be adaptively evolved, reflecting the changes in the related systems. And the results of measures are reviewed by the authorities in governance from multi-perspectives.

### (6) Inter-sectoral and holistic approaches

It is necessary to accept the inter-sectoral approach within the context of IWRM, because flooding affects various sectors that have complex relationships. And a holistic approach is also necessary to collectively estimate the effects of flood damage, accurately predict the effects of measures, and finally achieve the objectives of the measures from multi-perspectives.

## Conclusions

The study shows that the utilization of the flood risk management framework, the participation of stakeholders and social learning about flood management are necessary to efficiently deal with problems related to flood management. Also it is revealed that in the light of the changes in climate and socio-economic system, social consensus is important, and, especially, measures should be considered from multi-perspectives and implemented consistently and strategically. In addition, it is thought that the framework and integrated strategies which are developed and discussed in this study can be utilized for sustainable flood management and provide useful guidelines in making systematic flood management plans, taking measures and adaptively implementing them.

## References

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