UNITED NATIONS
Economic and Social Commission for Asia and the Pacific

World Meteorological Organization
Weather • Climate • Water

Final Report on Flood Hazard Mapping Project

December 2009

Typhoon Committee

Final Report on Flood Hazard Mapping Project

By Infrastructure Development Institute (IDI) Japan
Mr. Ryosuke KIKUCHI (former)
Mr. Kazuo UMEDA (former)
Mr. Kazuhisa ITO (former)
Mr. Hirotada MATSUKI
Mr. Masahiko NAGAI

December 2009, 42 pages

WMO/TD-No. 1519

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

NOTE

TABLE OF CONTENTS

FOREWORD

Typhoon Committee area is the region with the most severe natural disasters in the world, and floods are probably the most recurring, widespread, disastrous and frequent natural hazards in the region. Flood Hazard Mapping (FHM) is a vital component for appropriate land use planning in flood-prone areas and emergency response in real-time flood events. It creates easily-read, rapidly-accessible charts and maps which facilitates the decision-makers, planners and dwellers in communities to identify areas of risk and prioritize their mitigation/ response efforts. Therefore, as one of major non-structural measures for Flood control, FHMs play very important roles in reduction of flood-related disasters.

The FHMs project, led by Japan, is one of the most successful projects of TC Working Group on Hydrology (WGH). It is in line with 4 of 7 TC Key Results Areas (KRAs) of Strategy plan, namely: 1) reduced loss of life from typhoon-related disasters; 2) minimized typhoon-related social and economic impacts; 3) improved typhoon-related disaster risk management in various sectors; 4) strengthened resilience of communities to typhoon-related disaster.

FHMs project was kicked off in 2001. By that time, the TC had directed its assiduous efforts toward reducing disasters due to meteorological anomalies, notably typhoons. The Hydrological Component of the Committee, in cooperation with the Meteorological and Disaster Prevention and Preparedness Components, had pursued the upgrading of flood forecasting and warning systems, improvement of the statistics compilation system for natural disaster damage. etc. In the meantime, the socioeconomic conditions of most of the Committee Members had developed rapidly with the rapid growth of their populations, industries, and assets in urban areas. These socio-economic changes had led to important changes in the disaster patterns and its socioeconomic impacts. With the foregoing circumstances taken into account, the Typhoon Committee at its 33rd session in 2000 decided to undertake a comprehensive review of its activities in the Hydrological and Disaster Prevention and Preparedness Components, including a regional survey and an expert review mission to the Members to discuss the framework for these related activities. Based on the results of the regional survey compiled responses to the questionnaires and subsequent discussion at the Hydrology Workshop held in Bangkok in August 2001, a plan for priority action including 11 cooperation projects was submitted to TC at its 34th Session and approved by TC. The Government of Japan committed to take the lead of two of them: “Pilot project on the preparation of Inundation and Water-related Hazard Maps” and “Pilot project on the establishment on flash-flood warning system including debris flow and landslides”.

During its implementation in the past 8 years, the project of FHMs has been spreading the technique of Flood Hazard Mapping among TC Members. There are 11 of 14 TC Members taking part in this project, namely: Cambodia; China; Hong Kong, China; Japan; Lao People’s Democratic Republic; Malaysia; Philippines; Republic of Korea; Singapore; Thailand and Viet Nam. The 76 trainees in total had studied how to build up and apply a flood hazard map at JICA/ ICHARM Flood Hazard Mapping Training Course in 2004-2008. The trainees can be an engine to promote FHM in each country. The “Flood Hazard Map Manual for Technology Transfer” has been adopted widely in TC area.

The implementation of the project has been of great importance for the decision-makers in the TC Members to pay more attention to Flood Hazard Mapping. Through this project, the most TC Members recognized further the importance of FHMs and strengthened the producing this type of mapping. Some TC Members even developed new methods of flood hazard mapping compiling their own experiences based on this project. Nowadays, a lot of flood hazard maps were produced in almost all TC Members, and FHMs have been starting to be applied as effective measures to reduce damage related to floods.

The implementation of the project provided a good example of cooperation in TC. Japan government provided the strongest support of both technique and fund through the Ministry of Land, Infrastructure Transport and Tourism

of Japan (MLIT) together with the Infrastructure Development Institute (IDI) to aid TC Members. Also, TC participating members shared their experience and lessons so that to help Japan to improve the methodology of FHM.

As the decision made at the 41st session of the Typhoon Committee (TC) held in Chiang Mai, Thailand from 19 to 24 January 2009, FHMs project is going to be finalized in 2009. This final report aims to review and summarize the progress and the achievement of the project of FHMs in the past years.

I am confident that the project has achieved the expected goals and its success will have a great impact in relation to the flood-related disaster prevention, preparedness and mitigation not only for the Typhoon Committee but also for the Members of the Panel on Tropical Cyclones, Hurricane Committee and other WMO Members. Also I believe that this final report does not mean the end of FHMs cooperation in TC area. I would like to express thanks to all experts of MLIT and IDI of Japan and all related hydrologists of TC Members for their kind cooperation and great contribution to the project of FHMs during the past 8 years.

Olavo Rasquinho
Typhoon Committee Secretary
10 September, 2009

EXECUTIVE SUMMARY

Most countries in Asian monsoon region have a history of national development based on rice production in alluvial plains that are blessed with water resources, but vulnerable to water-related disasters. Standing on this historical background, major urbanized areas have been developing in the flood-prone area. Therefore the administration for disaster prevention against floods, tidal waves, tsunami and others must be a main task of each government.

In recent decades, Asian countries have been achieving remarkable growth in global economic system, while making rapid progress in urbanization. In many cases it means that national properties are concentrating into limited flood-prone areas and the country is at increased social/economic risk of tremendous damage.
Under such conditions of the natural/historical status, Asian countries have to consider further impacts of climate changes. The impacts are projected to affect flood-prone areas as both frequency and scale of water-related disasters increase. It is suggested that the "adaptation" to climate change impacts is almost as important as the "mitigation" of global warming.

In order to guarantee social security and lead to future development in Asian monsoon region, a strategic policy on flood disaster prevention is imperative. And the policy must be framed by both structural measures and non-structural measures.

Structural measures, such as construction of runoff control facilities and riverbank protection structures, have to be promoted essentially to reduce potential damage of flooding. The river administrator with the best effort conducts these public works, however it takes a huge amount of budget and period of time.

As for the reason, to reduce substantial damage during flood in a few years, efforts of local community will have further importance. For example, flood fighting activities can empower river management facilities and adequate evacuation can approach zero fatality target. The key factor of local community is awareness of possible damages and ability to respond to flooding.

With regards to these factors, the members of Working Group on Hydrology (WGH) have participated in and implemented the Flood Hazard Mapping (FHM) project for 8 years, which is expected to be quite effective for flood disaster management.

The first trial related to FHM in Japan was flood record disclosure in 1980 for new comers to flood-prone areas who had no past experience around their houses. In 1991 necessity for disclosure of flood risk map was discussed and reported in the River Council Recommendation. And the Flood Fighting Act was partly amended in 2001, based on understanding of the need for active preparedness and disclosure of flood hazard maps.

After these experiences, the FHM project was proposed by Japan and accepted as one of 5-year Regional Cooperation Programme Implementation Plan (RCPIP) of Typhoon Committee from 2002. Following the progress of the members, the period of the FHM project was extended 3 years up to 2009, to decrease disparities in progress among the members and to carry away some deadlocks due to lack of data, analyzing system, human resources, budget, etc.

During the 8 years of the FHM project, Cambodia, China, Hong Kong, Japan, Lao People's Democratic Republic, Malaysia, Philippines, Republic of Korea, Singapore, Thailand and Viet Nam continued to challenge intensely in each project area and held sincere discussion at the WGH workshops. Besides, the 76 trainees in total had studied how to build up and apply a flood hazard map at JICA/ICHARM Flood Hazard Mapping Training Course in 2004-08. The trainees can be an engine to promote FHM in each country.

At the end of the FHM project, all members became to hold sufficient capacity to create suitable flood hazard maps for target cities in flood-prone areas. The members are expected to popularize flood hazard map to reduce flooding damage in Asia monsoon region, taking the following factors into a greater consideration:

- Effectiveness of FHM,
- Role of the central government, and
- Action in local community.

As supplementary tools of this final report, achievements of the 8-year discussion are able be downloaded through the internet.

IFNet homepage is providing following contents (PDF) at
http://www.internationalfloodnetwork.org/index.html

- Report

Final Report on Flood Hazard Mapping Project
Extra Report on FHM project discussions in WGs
- Appendix

1. Flood Hazard Map Manual (Japan 2005)
2. Manual for Making Flood Hazard Map Ubiquitous (Japan 2006)
3. FHM Impact on Land Price in Japan

ICHARM homepage also is open for everyone who needs technical support, at
http://icharm.pwri.go.jp

- Flood Hazard Map Help Desk

1. OUTLINE AND BACKGROUND

1.1 Typhoon Committee

Effective response to typhoon calls for regional cooperation among the affected countries. A key element in such a response is an efficient typhoon warning system which involves the rapid and frequent exchange of information between countries and areas based on extensive observations and close monitoring of storm's development and movement. Obviously such activities can not be effectively performed on ad hoc informal thus, a regional collaboration mechanism is necessary.

The Typhoon Committee(TC) is an inter-governmental body organized under the joint auspices of the Economic and Social Commission for Asia and the Pacific(ESCAP) and the World Meteorological Organization(WMO) in 1968 to promote and coordinate the planning and implementation of measures required for minimizing the loss of life and material damage caused by typhoons in Asia and the Pacific. The founding members of the committee were China; Hong Kong, China; Japan; Republic of Korea; Lao People's Democratic Republic; Philippines; and Thailand. More recent members include, Cambodia since 1972, Malaysia since 1976, Viet Nam since 1979, Macao, China since 1993, People's Democratic Republic of Korea since 1993; Singapore since 1997, and the USA since 1998 raising TC membership to fourteen.

The TC aims to reduce the damage caused by tropical cyclones and floods in the region by:

(i) receiving regularly the progress made in the various fields of typhoon damage prevention;
(ii) recommending to the participating governments concerned plans and measures for the improvement of meteorological and hydrological facilities needed for typhoon damages prevention;
(iii) recommending to the participating governments concerned plans and measures for the improvement of community preparedness and disaster prevention;
(iv) promoting the establishment of programs and facilities for training personnel from countries in the region in typhoon forecasting and warning, hydrology and flood control within the region and arrange for training outside the region, as necessary;
(v) promoting, preparing and submitting to participating governments and other interested organization plans for coordination of research programs and activities concerning typhoons;
(vi) considering, upon request, possible sources of financial and
technical support for such plans and programs;
(vii) preparing and submitting, at the request and on behalf of participating governments requests for technical, financial and other assistance offered under the United nations Development Program(UNDP) and by other organizations and contributors.

In carrying out these functions, the TC maintains and implements action programs under three components such as meteorology, hydrology, disaster prevention and preparedness with supported by Advisory Working Group (AWG) and Training and Research Coordination Group (TRCG), and Resources Mobilization Group (RMG) and also with contributions by its members and their cooperation and assistance provided by the UNDP, ESCAP, WMO, and other agencies. In general, the members are responsible for implementing those parts of the program within their national jurisdiction with assistance, if necessary, from the TC staff or consultants.

1.1.1 Vision

The vision of the typhoon Committee is to be the world's best intergovernmental, regional organization for improving the life quality of the populations in country of members through integrated cooperation to mitigate impacts and risks of typhoon-related disasters and to enhance beneficial typhoon-related disasters and to enhance beneficial typhoon-related effects.

1.1.2 Mission

The typhoon committee's vision is to integrate and enhance regional activities in the areas of meteorology, hydrology and disaster prevention and preparedness of members within international frameworks to reduce the loss of lives and minimize the social, economical, and

environmental damages by typhoon-related disasters and to enhance beneficial typhoon-related effects.

1.1.3 Key Results Areas and Strategic Goals

The key results areas are defined as the critical, overarching, priority areas of special interest for the Typhoon Committee. The committee must complete the strategic goals associated with these key results area for it to achieve its vision and mission through regional, integrated actions. The committee has identified seven key results areas for special emphasis in the next five years. It should be noted that the TC along with its working groups can make major contributions key areas, but there are many other factors and influences which are not under the direct control of the TC and the committee sources. Table 1 shows the key results areas and strategic goals of the TC. A chronology of the Typhoon Committee is given in Appendix I.

Table 1. The Key results area and strategic goals of the Typhoon Committee

Key Results Areas	Strategic Goals
Reducte loss of life from typhoon-related disasters	To reduce the number of deaths by typhoon-related disasters by half using the decade 1990-1999 as the base line to compare with the decade 2006-2015 in the TC region
Minimized Typhoon-related Social and Economic Impacts.	To reduce the socio-economic impacts of typhoon-related disasters per GDP per capita by 20% using the decade 1990-1999 as the base line to compare with the decade 2006-2015 in the TC region
Enhanced Beneficial Typhoon-related Effects for the Betterment of Quality of life	To improve the beneficial use of typhoon-related effects of typhoons by 10% in water management by selected members using the decade 1990-1999 as the base line to compare with the decade 2006-2015 To promote increasing use of the typhoon-related beneficial effects among the Members in many different sectors
Improved Typhoon-related Disaster Risk Management in Various Sectors	To provide reliable typhoon-related disaster information for effective policy making in risk management in various sectors To strengthen capacity of the members in typhoon-related disaster risk management in various sectors To enhance international and regional cooperation and assistance in the field of disaster risk reduction
Strengthened Resilience of Communities to Typhoon-related Disasters	To promote and enhance culture of community-based disaster risk management among the members To promote education, training and public awareness of typhoon-related disasters among members
Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats	To strengthen RSMC capacity to respond to the needs of the members in forecasting and capacity building To improve capacity of members to provide timely and accurate user-oriented and friendly TC products and information To enhance capacity of members' typhoon-related observation and monitoring
Enhanced Typhoon Committee's Effectiveness and International Collaboration	To strengthen the capacity for resources mobilization for the implementation of the strategic goals To strengthen the capacity of the TC effectively discharge its responsibilities and functions

1.2 Working Group on Hydrology

1.2.1 Terms of Reference of WGH

In order to coordinate efforts on the implementation of various activities under the Hydrological Component with the aim to better support the socio-economic development process in the Typhoon Committee Area and to help accomplish the hydrological related goals and objectives in the Strategic Plan, the Typhoon Committee has established the Working Group on Hydrology (WGH) with the following Terms of Reference and operational modalities.

The 14 member countries are: Cambodia; China; Democratic People's Republic of Korea; Hong Kong, China; Japan; Lao PDR; Macao; Malaysia; Philippines; Republic of Korea; Singapore; Thailand; USA Guam and Viet Nam.

The Working Group of Hydrology of the Typhoon Committee promotes cooperation among the Members in the implementation of activities under the Hydrological Component of the Committee's Strategic Plan with the aim to support the socio-economic development process and enhance cooperation among the Members in all three components. Towards this end, the WGH is expected to advise and assist the Typhoon Committee in:

- Identifying priority issues and areas of cooperation in the Hydrological Component;
- Facilitating the exchange of experiences and knowledge on latest developments and techniques related to the above issues and areas;
- Undertaking priority activities and programmes of the Committee aiming at strengthening capacity of the Members in hydrology and water resources;
- Mobilizing resources to carry out priority activities of the Committee related to the Hydrological Component;
- Reporting overall progress in the implementation of the hydrological component of the Strategic Plan; and recommending to the Committee priority areas, programmes and activities for cooperation in research by related experts of the Members.

1.2.2 Activities of WGH

The main Projects on Course of the Working Group Hydrology, as of 2009, are:

1. Flood Hazard Mapping
2. Debris Flow and Landslides Warning System
3. On-the-job Training on Flood Forecasting between TC members
4. Urban Flood Risk Management in TC region
5. Assessment System of Socio-economic Impacts of Water-related Disasters for Infrastructure
6. Hazard Mapping for Sediment-related disasters
7. Establishment of Flood Disaster Preparedness Indices

1.3 RCPIP (Regional Cooperation Programme Implementation Plan)

To review past WGH activities and to discuss the coming program of WGH, a questionnaire survey and dispatch of missions to members were decided in the 33rd Session of the Typhoon Committee in Nov. 2000.

Necessities of following projects were pointed out based on the result of the questionnaire survey and discussions at the workshop in 2001.

- Knowing the present situation of hydrological and disaster prevention and requests
- Sharing the data among members to improve accuracy of flood forecast
- Development of guideline for dam operation
- Implementation of OJT on flood forecast
- Increase the number of rivers with flood forecast system
- Implementation of flood and water-related disaster hazard map project
- Implementation of project for estimation and improvement of practical flood forecast model
- Implementation of community-based flood forecast system
- Implementation of pilot project for flash flood warning system including debris flow and landslide

- Improvement of user-oriented hydrological information
- Implementation of project for estimation and improvement of hydrological equipment and TV communication system

Review mission teams which were dispatched to the Philippines, China, Republic of Korea, Vietnam, Cambodia, Las P.D.R. and Thailand reported as follows:

- need of collaboration between WGH and DPP
- improvement of gathering system of disaster information
- collaboration of community-based education and NGO
- exchange information through TC Web Page
- participation to the third World Water Forum (3WWF)

Each member agreed to implement the 11 projects which were proposed in the workshop.

The decisions in the 34th Session of Typhoon Committee in 2001 were followings.

- Regional Cooperation Programme Implementation Plan (RCPIP), which consisted of activity plans of Typhoon Committee, was decided and "Flood Hazard Mapping project" was included.
- Budget for "Integrated risk analysis and management workshop on water-related disaster" in Philippines in July or Aug. 2002 was approved.
- Establishment of working groups to implement the proposed projects

Each project was required decision of the leading country and management of the projects.

Government of Japan committed to take the lead of "Pilot project on the preparation of Inundation and Water-related Hazard Maps" and "Pilot project on the establishment on flash-flood warning system including debris flow and landslides".
The 5-year Regional Cooperation Programme Implementation Plan (RCPIP) included following projects and was implemented from 2002.

- Pilot project on the preparation of Inundation and Water-related Hazard Maps (Japan)
- Pilot project on the establishment on flash-flood warning system including debris flow and landslides (Japan)
- Development of guidelines for the dam operation in relation flood forecasting (Korea)
- Evaluation and improvement of operational flood forecasting system
- focusing on model performance (Korea)
- Extension of flood forecasting systems to selected river basins (China)
- Project on the evaluation and improvement of hydrological instruments and telecommunication equipment (China)
- On-the-Job Training on Flood Forecasting between TC members (Malaysia)
- Pilot project on the establishment of community-based flood forecasting system (Philippines)
- Improvement of hydrological products in response to user needs (Philippines)

1.4 FHM project

The Typhoon Committee members have been called on to make efforts to reduce damage, particularly harm to humans, from flood disasters inflicted by typhoons. To do this, it is essential that flood forecasts and warnings and evacuation advisories and directives be made functional and effective.

Therefore, improving the accuracy of the dissemination of flood forecasts and warnings is of extreme importance, as is the creation of flood hazard maps providing knowledge of flood risks and when evacuation would be needed.

It is expected that the synergetic effect of these efforts will lead to voluntary and rapid evacuation when necessary.

11 countries in the WHG gathered and informed their efforts each other. The representing agencies were:

- (Cambodia) Department of Meteorology, Ministry of Water Resources & Meteorology;
- (China) Bureau of Hydrology, Ministry of Water Resources
- (Hong Kong) The Hong Kong Observatory
- (Japan) Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
- (Lao PDR) Department of Meteorology and Hydrology, Water Resource and Environment Administration
- (Malaysia) Hydrology and Water Resources Division, Department of Irrigation & Drainage
- (Philippines) Weather & Flood Forecasting Center (WFFC), Philippine Atmospheric, Geophysical and Astronomical Services Administration
- (Republic of Korea) Korea Institute of Construction Technology
- (Singapore) Meteorological Services Division, The National Environment Agency
- (Thailand) Office of Hydrology and Water Management, The Royal Irrigation Department
- (Viet Nam) National Center for Hydro-Meteorological Forecasting

The discussions were continued intermittently and aggressively at: Manila, Philippines in 2002; Beijing, China in 2003; Seoul, Republic of Korea in 2004; Kuala Lumpur, Malaysia in 2005; Macau, China in 2006; Bangkok, Thailand in 2007; Beijing, China in 2008 and Cebu, Philippines in 2009.

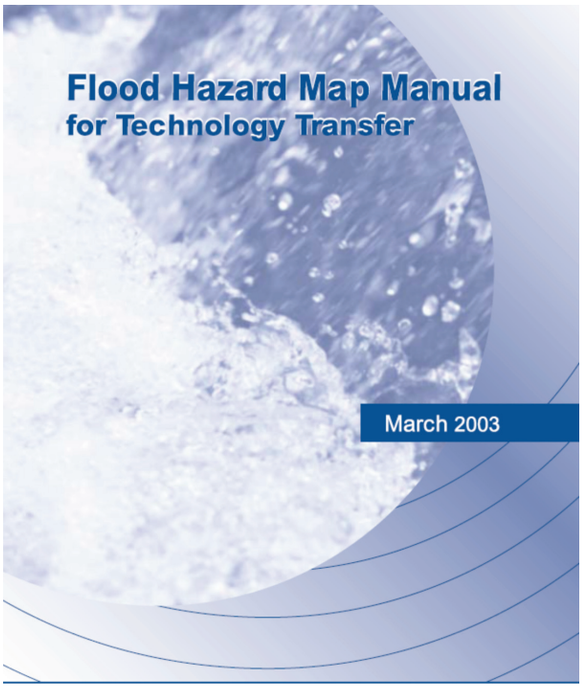
2. COOPERATIVE ACTIVITIES

2.1 Flood Hazard Map Manual

This manual describes in brief the background, purpose, production and distribution of Flood Hazard maps, as well as their verified effectiveness and current usage in Japan. Realistic questions on the evacuation of local residents in the event of flood are clarified, and the practical and effective usage thereafter of Flood hazard Maps is reviewed in turn.

The features and characteristics of rivers, flooding mechanisms, social framework, viewpoints on flood protection, collaboration of river management and residents, and the background and circumstances of Flood Hazard maps of Japan might be different from those of other countries.

The experience gained from use of Flood Hazard Maps in Japan would be of significant use to other countries as well, provided the maps are used according to the specific circumstances of the respective countries.



Ministry of Land,
Infrastructure and Transport,Japan
Infrastructure Development Institute-Japan

This document (PDF) is always available from IFNet homepage.
(http://www.internationalfloodnetwork.org/index.html)

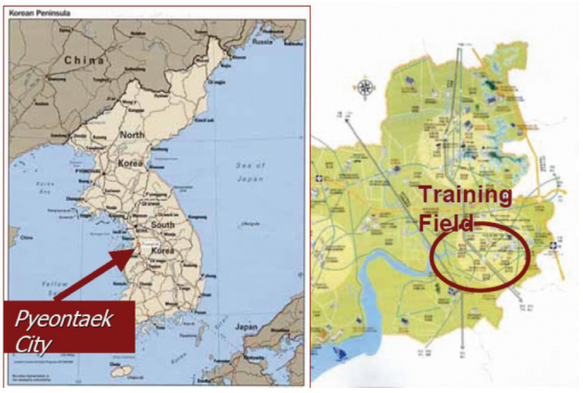
2.2 Flood Hazard Mapping Training

July 2004 Seoul, Korea
- On-site trainer's training at the Anseong River in Pyongtaek City

• Background
- Disparity in the progress of FHM in each participating country,
- The median, 3rd, year of 5-year program,
- Necessity for trainer's training.

• Objectives

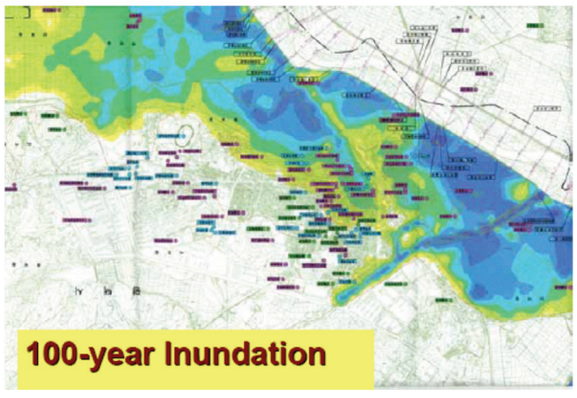
To deepen the understanding on the followings:
- Effectiveness, knowledge and skill of FHM
- The importance of the participatory process



Date: 22 Sep. 2004
AM: Field Survey PM: Mapping and Presentation

• River and Place
- The Anseong River in Pyeontaek City (70km south of Seoul)
- Right bank protected area

• Inundation Map: KOWACO, Korea
• Manual: IDI's FHM Manual



• Lecturer

Prof. Ogawa, Fuji Tokoha University

• Training Method

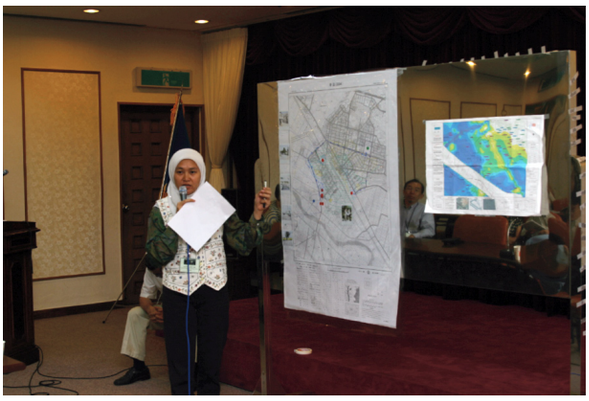
ADRC (Asian Disaster Reduction Center's) Town Watching (Group Training)

- Field check and taking photos (inundation area and depth, evacuation routes, shelters, dangerous spots, etc.), interview with local residents, and so on.
- Mapping and presentation

Field Survey in Pyongtaek City

Group Mapping Exercise

Comment by Prof. Ogawa



Presentation by each Group

Summary of Field Training

• Outputs

- Different 4 maps were created.
- Safer route or shorter route ?

• Obtained information from the interview with local residents was:

- past inundation area and depth
- information transmission system in communities
- idea of evacuation route

• Participatory process

- the process of field survey and mapping deepens the understandings

2.3 "Flood Hazard Mapping" Training Course in JICA/ICHARM

Collaboration between TC-WGH and JICA/PWRI-ICHARM Training

Background:

• Disparity in progress among members
• Lack of budget, staff, data, etc.
• Different social and administrative system from Japan's

Objectives:

• to fill the members' progress gap.

Way to collaborate by:

• Info exchange between WGH participants and FHM trainees,
• Sending FHM training GI by email cc to TC WGH members,

- Trainees' participation in WGH workshop if possible,
- Others.

The "Flood Hazard Mapping" training course in ICHARM has been implemented as a five-year program from FY2004 in cooperation with JICA. The target countries are Cambodia, China, Indonesia, Laos, Malaysia, Philippines, Thailand and Vietnam. As of November 2008, this ongoing training course has 10 participants from 7 countries. Further 9 students of the master course (Water-related Risk Management Course of Disaster Management Policy Program) have been sharing the curriculum with this training course.

The curriculum of the course consists of getting the knowledge and technique of (1) making flood hazard maps through lectures and exercises, and (2) utilization and dissemination of flood hazard maps through exercises and discussion. It also includes field survey and observation called "Town Watching" which is helpful for getting idea of inundation situation and how to secure safe evacuation.

In addition, ICHARM and the Office of State Flood Control and Drought Relief Headquarter, China (SFDH) co-hosted the "East & Southeast Asia Regional Seminar on Flood Hazard Mapping, 2008" in cooperation with JICA. This second regional seminar was held in Guangdong, China, from January 30 to February 1st. The annual seminar is part of the follow-up program. A part of former participants of the 1st-4th training courses were invited from several different countries (China, Vietnam, Cambodia, Malaysia, the Philippines, Indonesia, Laos, Thailand). After the presentations and discussions, the participants commonly voiced that it is necessary to develop flood hazard mapping guidelines for their countries in addition to database development and acquisition of advanced mapping techniques.

Total number of trainees in this 5-years training course is 76 from 8 countries. They had learned technical mapping process and studied how to build up and apply a flood hazard map. They must be a key person of FHM project not only in each home country but also the neighboring countries. It is hoped that they will retain a friendly network each other and promote FHM project in the region of TC member countries. ICHARM plans to provide continuous support for them and their countries.

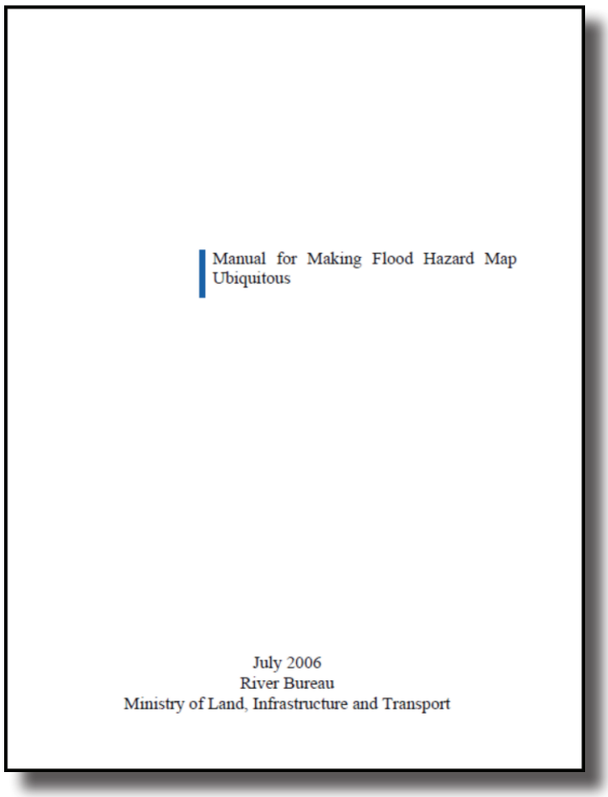
	Cambodia	China	Indonesia	Laos	Malaysia	Philippines	Thailand	Vietnam	total
2004	2	2	2	3	2	2	2	1	16
2005	2	2	2	2	2	3	1	2	16
2006	2	2	2	2	2	2	2	2	16
2007	2	2	3	2	3	2	2	2	18
2008	1	2	0	2	2	1	1	1	10
total	9	10	9	11	11	10	8	8	76

2.4 Manual for Making Flood Hazard Map Ubiquitous

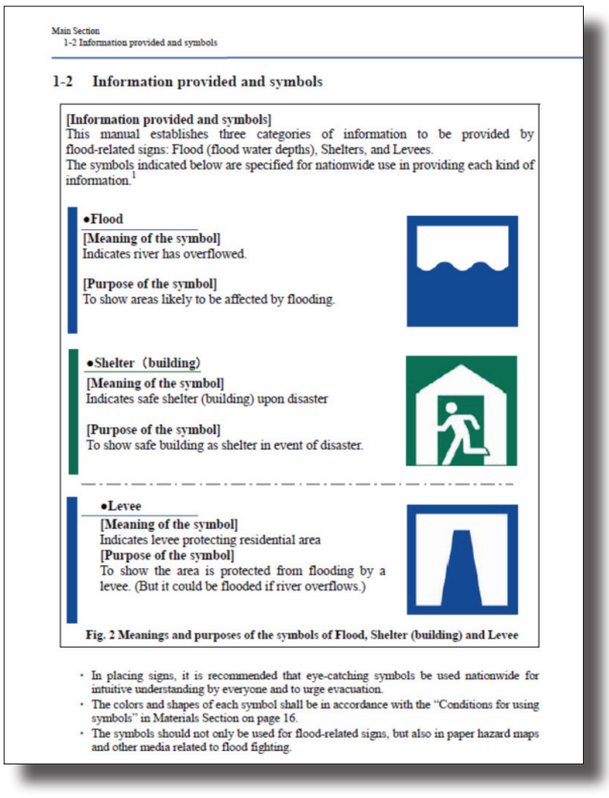
In many parts of Japan, efforts to pass on regional memories of floods to later generations have included building steles, setting up stakes as water-level gauges and preserving other markings that recall people's experience with floods.

On the other hand, changes in local communities in recent years have led to a decrease in the numbers of residents that have experienced flood disasters. Most community residents lack information on major regional flood damage in the past and lack knowledge of projected flood water depths in the area in which they live and other facts pertaining to flood risk.

The aims of this manual are to promote the further dissemination of flood hazard maps, to create a heightened sense of risks, and better awareness of shelters in case of floods in each community. To enable residents to appreciate the real risk of floods in their areas, this manual provides guidelines for the creation of Ubiquitous Flood Hazard Maps and signs providing flood-fighting information that can be displayed in communities.


Manual for Making Flood Hazard Map Ubiquitous

July 2006
River Bureau
Ministry of Land, Infrastructure and Transport


Main Section
1-2 Information provided and symbols

1-2 Information provided and symbols

[Information provided and symbols]
This manual establishes three categories of information to be provided by flood-related signs: Flood (flood water depths), Shelters, and Levees.
The symbols indicated below are specified for nationwide use in providing each kind of information.[1]

●Flood
[Meaning of the symbol]
Indicates river has overflowed.
[Purpose of the symbol]
To show areas likely to be affected by flooding.

●Shelter (building)
[Meaning of the symbol]
Indicates safe shelter (building) upon disaster
[Purpose of the symbol]
To show safe building as shelter in event of disaster.

●Levee
[Meaning of the symbol]
Indicates levee protecting residential area
[Purpose of the symbol]
To show the area is protected from flooding by a levee. (But it could be flooded if river overflows.)

Fig. 2 Meanings and purposes of the symbols of Flood, Shelter (building) and Levee

- In placing signs, it is recommended that eye-catching symbols be used nationwide for intuitive understanding by everyone and to urge evacuation.
- The colors and shapes of each symbol shall be in accordance with the "Conditions for using symbols" in Materials Section on page 16.
- The symbols should not only be used for flood-related signs, but also in paper hazard maps and other media related to flood fighting.

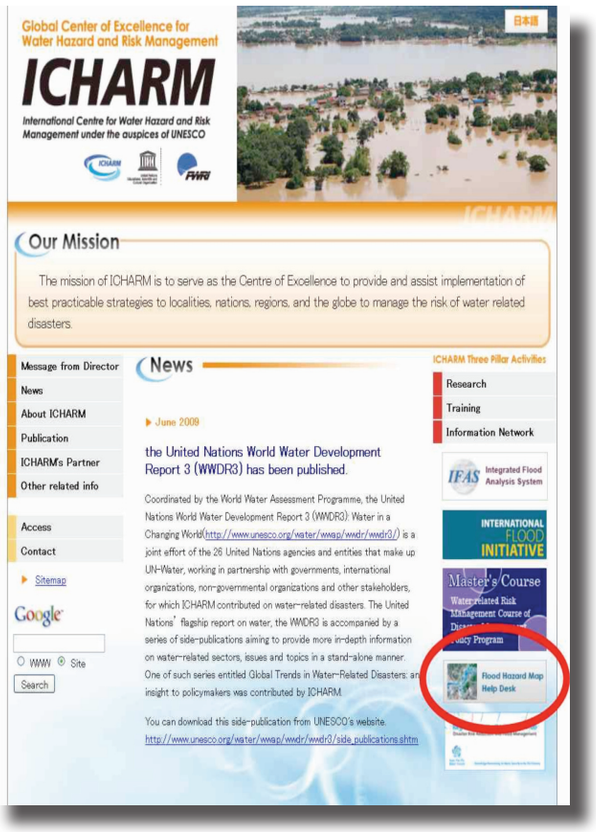
This manual was published to bring about greater public awareness of flood hazard maps, along with the amendment to the Flood Fighting Law in 2005. This document (PDF) is always available from IFNet homepage.
(http://www.internationalfloodnetwork.org/index.html)

2.5 Flood Hazard Map Help Desk (FHM-HD)

Aiming to support practitioners, who are looking for technical supports regarding the development and implementation of Flood Hazard Map especially in developing countries, ICHARM has established a "Flood Hazard Map Help Desk (FHM-HD)" since July 2007. It can be accessed via ICHARM Homepage (http://icharm.pwri.go.jp/). On the same website, Frequently Asked Questions (FAQ) and related answers will be updated in a regular basis.

It is requested to read FAQ to get possible answers. If it is required to ask additional or new questions, link for the Online Inquiry Form is provided on the same site.

ICHARM will try to reply individual inquiry in time and will also update the same information on FAQ column for future reference. It is hoped that the FHM-HD can provide best platform for practitioners especially from developing countries to get best answers to their technical questions in the right time and in the right manner.



3. MEMBER'S ACTIVITIES AND FHM SAMPLES

3.1 Cambodia

On implementation of the meteorological filed in Cambodia, Department of Meteorology (DOM) under the Ministry of Water Resources and Meteorology (MOWRM) has full responsibility and the most major basis are as follows:

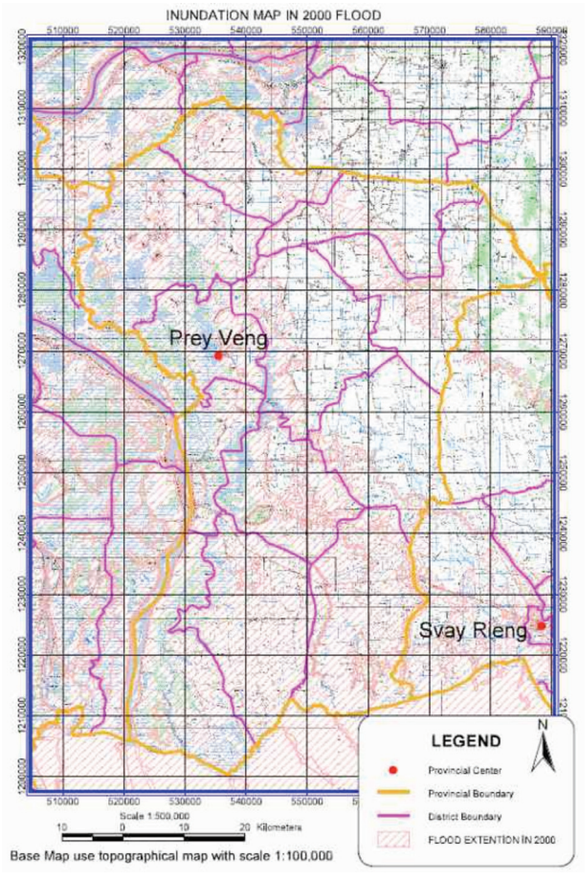
- To collect and compile meteorological data observed.
- Forecasting and warning of hazardous meteorological phenomena to the general public which will be happened eventually.

It's remarkable that for many years before the climatic condition has been varied heavy. The occurrence of the natural disasters such as heavy rain, flooding, drought, etc has suffered from serious damages to people and properties and come social-infrastructure. In such case people must know what is the meteorological situation?

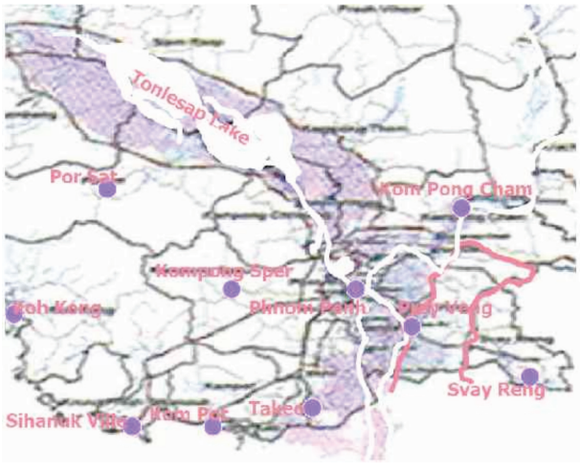
Thus the DOM makes more efforts to be successfully in avoiding any difficulties and will activity contribute to development of providing safety and socio-economic welfare for Royal government and people of Cambodia, through

- Observing weather,
- Performing weather network, forecasting and dissemination of meteorological phenomena, and
- Transmitting and receiving meteorological data through national and international GTS.

As an effort, DOM showed the inundation map in 2000 flood at the TC Workshop in Bangkok in 2007. DOM has a plan to provide a flood hazard map for the Pray Veng Province.



Inundation map around Pray Veng in 2000 flood



Flood map at the Prey Veng province in 2000
(TC Bangkok WS in 2007)

The flood hazard project management is not at the Prey Veng Province, but MOWRAM also activities making for everywhere all the provinces of Cambodia. MOWRM manages not only the strategy of irrigation against flooding and drought, but also the broadcast public weather forecasting.

Cambodia will provide flood hazard for divided three areas:

1- Flat area (area agriculture)
2- Coastal area (sea)
3- Plateau area (mountain)

Although the flood hazards mapping is still new for Cambodia. Flood hazard map is very important not only for evacuate people but also for making development plan and crop calendar.

3.2 China

Flood Hazard Mapping Project in China is has been getting well-planed and definite progress.

In 2003, China's Ministry of Water Resources (MWR) declared that a successful shift form flood control to flood management should be realized in the coming future. FHM is one of the effective technical supports to mitigate flood hazard.

Nowadays, FHM has become one of the most important and urgent tasks in China. The China's State Flood Control and Drought Relief Office (SFCDRO) made out a guidance (The Guidance for Flood Hazard Mapping) in 2004 and assigned 36 pilot trials in the seven major river basins in 2005, and the project of 1st phase national flood hazard mapping commences in the beginning of 2008.

Name		River	City	Reservoir	Detention Basin
Song and Liao Conservancy Commission	Commission	—	—	Chaersen	—
	Helongjiang	Nenjiang Lahai Dike	Harbin	—	Pangtoupao
Haihe Conservancy Commission	Commission	—	—	Yuecheng	—
	Hebei	Zhanghe North Dike	Baoding	—	Wenanwa
Yellow River Conservancy Commission	Commission	Flood prone area in the lower Yellow River	—	—	—
	Shangdong	Yellow River Dike (from LaowangMiao to Huojialiu)	Jinan	—	Dongpinghu
Huaihe Conservancy Commission	Commission	Yihe Dike Along Left Bank (Upper Pengdaokou)	—	—	Chengdonghu
	Jiangsu	New Yihe Dike	Lianyun Gang	Shilianghe	Huangdunhu
Yangtze River Conservancy Commission	Commission	—	Chengdu	—	Jingjiang
	Hunan	—	Yiyang	Guanshan	Lianyuan
	Hubei	—	—	Danjiangkou	—
Taihu Conservancy Commission	Commission	Taipuzha	—	—	—
	Zhejiang	Dongtiaoxi	Wenzhou	Qingshan	Gaohu
Pear River Conservancy Commission	Commission	Hejiang River	—	—	—
	Guangdong	Beijiang Dike	Guangzhou, Foshan	Feilaixia	Pajiang
	Guangxi	—	Wuzhou	—	—

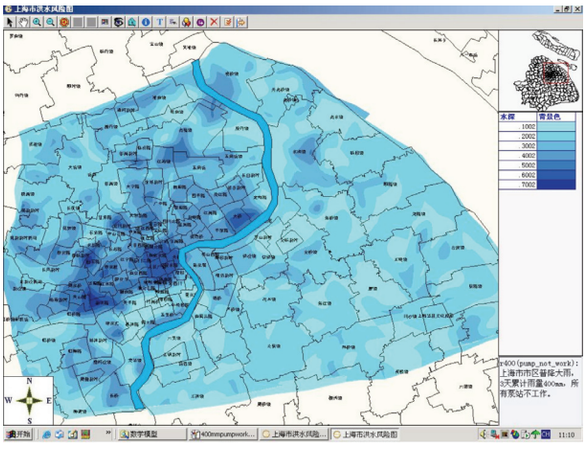
Efforts of China can be summarized as following remarks.

1) Making a standard technical specification plays an important role for FHM and management. In China, preliminary specifications have been making based on the Guidance for Flood Hazard Mapping, which regulates the general common bases.

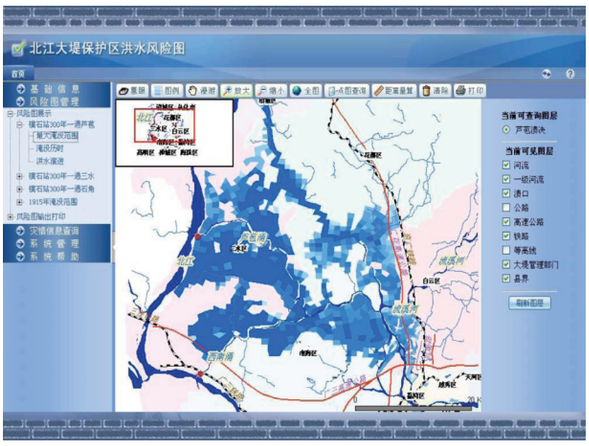
2) Different level softwares are remarkably necessary to analyze flood hazard, integrate various results of flood hazard analysis, and serve various requirements for flood hazard map.

3) Social needs are the powerful driving force for FHMs. FHMs are used in the fields of flood management, landuse planning, flood insurance and flood risk public awareness and education. This is the powerful driving force for promoting FHM.

4) China is making great efforts to practice FHM. Roughly estimated, about 13 municipalities in China have produced FHM, including Shanghai, Guangzhou, Chengdu, Harbin, Jinan, Kunming, Baoding, Lianyungang, Foshan, Yueyang, Wenzhou, Jiamusi and Wuzhou. However, FHMs are currently only used by the department of flood control, and no FHM has disseminated by printing or internet to the public in any municipalities. China is striving for more potential of FHMs for her social and economic development and hope to learn from and share experience of FHM with other countries.



Flood simulation map in Shanghai (TC Bangkok IWS in 2007)



Flood Hazard Map for (TC Beijing IWS in 2008)

3.3 Hong Kong, China

In Hong Kong, structural and non-structural efforts have come to fruition. Since 1997, major river-training and flood-control projects have been completed in the New Territories (NT) over the northern part of Hong Kong. As a result, the flooding situation in NT improved significantly.

To alleviate flooding in low-lying villages, the Hong Kong Special Administrative Region Government (HKSARG) had already completed 27 village flood pumping schemes to protect 35 villages where river-training works could not be effectively undertaken due to local topography.

For the rural areas, the construction of 26km of drainage channels and 15km of stormwater drains were in progress.

For the urban area in West Kowloon, 44 km of stormwater drains and 1.5km drainage tunnel were completed.

For other urban areas, the construction of 32 km of stormwater drains and 11km drainage tunnel were underway/

Data from raingauges operated by the Drainage Service Department (DSD) and Geotechnical Engineering Office of the HKSARG are relayed to Hong Kong Observatory (HKO) to support operation of the Rainstorm Warning System, the Special Announcement on Flooding in

the northern NT and the Landslide Warning System.

In these circumstances, Hong Kong authority made maps of flood hazard for internal use only, not disclose it to public.

3.4 Japan

3.4.1 Development and Popularization of Flood Hazard Maps in Japan

1. Introduction

Japan's vulnerability to floods comes from severe natural conditions such as topography and weather and the fact that about 50% of its population and about 75% of its assets are concentrated in probable flood areas in alluvial plains which account for only 10% of the national land area. In recent years, the spread of nuclear families and population growth in urban areas has meant an increase in new residents in areas prone to flooding who have never experienced inundation. Even residents who have experienced flood damage tend to forget over time and awareness of potential flood damage weakens.

Therefore, in a worst case, a dike break in the event of severe flooding could bring about the loss of many lives and assets, and heighten the threat of huge socioeconomic disruption beyond all imagination. In recent years, characteristics of urban flood damage were revealed in subsurface inundation in Fukuoka City on the occasion of heavy rain in a Baiu front in 1999 and in subsurface inundation and paralysis of lifeline services on the occasion of the Tokai Heavy Rain in 2000. In 2004, damage occurred in many other areas due to such phenomena as the Niigata-Fukushima Heavy Rain, Fukui Heavy Rain, and Typhoon No. 23.

Structural measures such as developing flood control facilities, including embankments, are needed to mitigate this type of flood damage, and non-structural measures needed to convey disaster information and evacuation guidance should be promoted.

As part of the non-structural measures, the Ministry of Land, Infrastructure, Transport and Tourism has guided and assisted municipalities in developing and promulgating flood hazard maps since 1994. In 2001, the Ministry worked to have the Flood Fighting Act amended, and it published "Flood-Prone Areas," which is based on the amendment, to help develop flood hazard maps distributed by municipalities.

The Flood Fighting Act, as again amended in 2005, set "Special-Warning Water Levels" for major small- and medium-size rivers (rivers with water level information) for river areas other than those with flood forecasts. Special-Warning Water Levels are set for small- and medium-size rivers with small basin areas and limited time for flood forecasts, and they are provided with information on high-water levels reached. The Act also provides that flood-prone areas shall be designated, not only for rivers with flood forecasts, but also for major small- and medium-size rivers (rivers with water level information). Municipalities with flood-prone areas are obligated to develop hazard maps showing shelters, the flood-prone areas and expected flood depths.

2. History of Flood Hazard Maps

(1) Publication of Maps Showing Where Inundation Occurred

Maps showing where actual inundation in past floods has occurred simply indicate the danger of flooding. They are technically easy to create and understand. Despite this, the inundation-record maps were only recently created in conjunction with flood control measures. In a project related to comprehensive flood control measures implemented since 1980, actual inundation data has been released to promote proper land use, as an aid to emergency flood-fighting, and for use when evacuation is needed. Such maps were published for six rivers in 1981, and maps for the country's major rivers have been published since 1985.

(2) Announcement of the Results of Flood Simulation

Inundation-record maps do not reflect the development or improvement of flood control facilities in many rivers since the occurrence of floods. Urbanization of river basins is another problem because it can lead to flooding that is more severe than in other areas with rainfall of the same scale. Therefore, it was desirable to use simulation to show areas that could be flooded under current conditions. Hydraulic accounting was used to simulate possible flood situations under current flood control conditions at particular sites. Flood simulation technology was developed to do this. After technical review, the results of the flood simulation were published for use in maps of areas where inundation could be expected along specific rivers covered by comprehensive flood control measures undertaken since 1987.

Further, in 1991, responding to the question of "desirable river improvements in the future," the River Council recommended non-structural measures such as educational programs to help the public learn about floods, storm surges, tsunami, debris flows and volcanic eruptions in order to minimize damage in the event of a crisis. As part of this effort, flood-danger area maps created on the basis of flood simulation were published for Japan's major rivers between 1993 and 1994.

(3) Development and Announcement of Flood Hazard Maps

Now that inundation-record maps, expected-inundation area maps and flood-danger area maps are published and specific risks of floods in major rivers in Japan are shown, it is natural for many people to ask how to avoid the dangers indicated in the maps. The River Improvement and Management Division, River Bureau issued pamphlets such as "Promoting the Development of Flood Hazard Maps" and "Manual for Development of Flood Hazard Maps" to stimulate organized development of flood hazard maps. This effort helped bring about standardization of the contents.

(4) Partial Amendment of the Flood Fighting Act

(i) Amendment in 2001

In 1998, the effectiveness of the hazard maps was confirmed in the heavy rain that hit the Tohoku Region. In 2000, a heavy rain in Tokai Region brought about urban flood damage, including inundation of underground malls. In its recommendations issued under these circumstances, the Flood Prevention Committee, River Council, pointed out the effectiveness of flood hazard maps.

Reflecting this, the Flood Fighting Act was partially amended in June 2001 to create the flood-prone area map system. Under this system, the national government and prefectures shall designate and announce flood-prone areas for rivers subject to flood forecasts. Also, mayors of municipalities shall be notified, and municipalities that include flood-prone areas shall fully inform residents about shelters, methods of communication established in municipal disaster-prevention plans and provide other information needed to ensure smooth, swift evacuation when floods occur. A notice issued by the Director-General of the River Bureau upon enforcement of the Act to Partially Amend the Flood Fighting Act stated that it was desirable to prepare and distribute flood hazard maps or other visual means when fully informing the residents of the requirements for smooth and swift evacuation in the event of a flood.

(ii) Amendment in 2005

The Act to Partially Amend the Flood Fighting Act

1. Expansion of rivers subject to flood forecasts (Article 10-2)
1) In addition to the Minister of Land, Infrastructure, Transport and Tourism, Prefectural Governors may designate rivers as rivers subject to flood forecasts, when considerable flood damage is likely.
2) When the threat of flood exists, in cooperation with the Director-General of the Meteorological Agency, Prefectural Governors shall, notify the flood-fighting administrators of the water level and flow rate situations and fully inform the general public. Cooperation from the media

shall be obtained as necessary.

2. Announcement of flood-prone areas (Article 10-4)
1) To secure smooth and swift evacuation in the event of a flood, the Minister of Land, Infrastructure, Transport and Tourism or a Prefectural Governor shall, along rivers subject to flood forecasts, designate as flood-prone areas those areas where inundation is expected (under design rainfall established in river improvement plans).
2) The Minister of Land, Infrastructure, Transport and Tourism and others shall notify related municipalities of the designated areas of flood-prone areas and the water depths expected in the event of inundation.

3. Measures to secure smooth and swift evacuation (Article 10-5)
1) Municipal disaster-prevention conferences held in accordance with the Disaster Countermeasures Basic Act shall, when flood-prone area maps are designated, prescribe the information to be included in the maps on shelters, on the means of communicating flood forecasts, and on other matters required for smooth and swift evacuation.
2) When underground facilities such as underground malls used by significant numbers of people exist in a flood-prone area, the means of communication of flood forecasts shall be prescribed to secure smooth and swift evacuation of such facilities.
3) Municipal mayors shall fully inform residents of the means of communication of flood forecasts, shelter information, and so on as prescribed in the municipal disaster-prevention plan.
4) If a council is established by the municipal disaster-prevention conferences, the council shall prescribe the means of communication of flood forecasts and shelter information for each flood-prone area covered in the inter-municipal disaster-prevention plans.

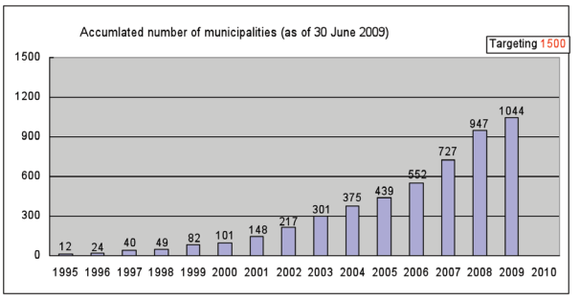
History Leading to Flood Hazard Maps

Month/year	Events
1977	River Council launches "Intermediate Recommendation on Promotion of Comprehensive Flood Control Measures." Ministry of Construction establishes council for comprehensive flood control measures.
1979-1980	Ministry of Construction creates comprehensive flood control system for rapidly urbanizing river basins (Notices from Vice-Minister and Director-General of River Bureau). Publication of inundation-record maps begins.
1979-	River basin comprehensive flood control councils created for following rivers: 1979, 9 rivers: Tsurumi, Shingashi, Ina, Hikiji, Sakai (Kanagawa), Tomoe, Mama, Shin, Fushiko 1980, 1 river: Naka/Ayase 1981, 2 rivers: Zanbori, Mekujiri 1982, 2 rivers: Northern Yamato, Sakai (Aichi) 1988, 1 river: Sakai (Gifu)
Oct 1979	Typhoon No. 20
-1981	Inundation-record maps published for 6 rivers including Tama, Naka/Ayase.
Jul 1982	Heavy rain of July 1982
Aug 1982	Typhoon No. 10
Jul 1983	Heavy rain of July 1983
1985	Publication of inundation-record maps begins for Japan's major rivers.
1987	Results of flood simulations released in maps of expected inundation areas for specific rivers covered by comprehensive flood control measures.
1988	The Kanda and Neya rivers included among major river basins with urban areas.
1991	The River Council decides to recommend "non-structural measures such as educational programs to impart knowledge of flood, storm surge, tsunami, debris flow and volcanic eruption in order to minimize damage during a crisis."

Month/year	Events
Sept 1991	Typhoon No. 19
1993-1994	Publication of flood-danger area maps based on results of flood simulation for major rivers across Japan.
Jul-Aug 1993	Heavy rain of August 1993
1994	Notices: "Promotion of Development of Flood Hazard Maps," River Bureau, Ministry of Land, Infrastructure and Transport "Instructions for Developing Flood Hazard Maps," River Bureau, Ministry of Land, Infrastructure and Transport These notices spurred organizations to develop flood hazard maps and greatly contributed to standardization of the contents.
1998	Effectiveness of flood hazard maps confirmed when torrential rain hits Tohoku Region
Jun 1999	Fukuoka Flood
Sept 2000	Tokai Heavy Rain
Nov. 2000	Emergency recommendation on urban flood countermeasures Effectiveness of flood hazard maps pointed out for urban floods involving underground spaces.
Dec 2000	Effectiveness of flood hazard maps pointed out in Recommendation of the River Council "Desirable Flood Prevention in the Future"
Mar 2001	Cabinet decision on Bill to Partially Amend the Flood Fighting Act (submitted to the 151st session of the Diet)
Jun 2001	Promulgation of Act to Partially Amend the Flood Fighting Act (Act No. 46, 2001) Promulgation of Ordinance for Enforcement of the Flood Fighting Act (Ministry of Construction Ordinance No. 44, 1990)
Jul 2001	Enforcement of Act to Partially Amend Flood Fighting Act (Provisions for efforts to develop flood hazard maps)
Jul 2004	"Niigata/Fukushima Heavy Rain" "Fukui Heavy Rain"
Oct 2004	Heavy rain from Typhoon No. 23
Dec. 2004	"Heavy Rain Damage Countermeasures General Policy Committee" of the River subcommittee of the Council for Social Infrastructure develops "Emergency Recommendation for Comprehensive Heavy Rain Damage Countermeasures"
Apr. 2005	"Heavy Rain Damage Countermeasures General Policy Committee" of the River subcommittee of the Council for Social Infrastructure finally develops "Promotion of Comprehensive Heavy Rain Damage Countermeasures"
Feb. 2005	Cabinet decision on Bill to Partially Amend Flood Fighting Act and Act on Promotion of Sediment Damage Countermeasures in Sediment Damage Vigilance Areas (submitted to 162nd session of Diet)
May 2005	Promulgation of Act to Partially Amend Flood Fighting Act and Act on Promotion of Sediment Damage Countermeasures in Sediment Damage Vigilance Areas (Act No. 37, 2005)
Jun 2005	Promulgation of Ordinance for Enforcement of Flood Fighting Act and Act on Promotion of Sediment Damage Countermeasures in Sediment Damage Vigilance Areas (MLIT Ordinance No. 62, 2005)
Jul 2005	Enforcement of Act to Partially Amend Flood Fighting Act and Act on Promotion of Sediment Damage Countermeasures in Sediment Damage Vigilance Areas (Compulsory development and distribution of flood hazard maps).

3.4.2 Result of flood hazard map production

Until June 2009, the number of FHM completed was 1,300. Among them, 1,044 maps are disseminated to local communities by printing, and 1,014 are by internet.



3.4.3 Future activities

(1) Increase of the number of designated river with flood forecast (1st priority river) and designated river which is needed to inform water stage information (second priority river)

- Designation of large rivers, main rivers (about 2,000) by the end of 2013 fiscal year.

(2) Implementation of production of Flood hazard map

- Production in more than 1,500 municipalities by the end of 2010 fiscal year

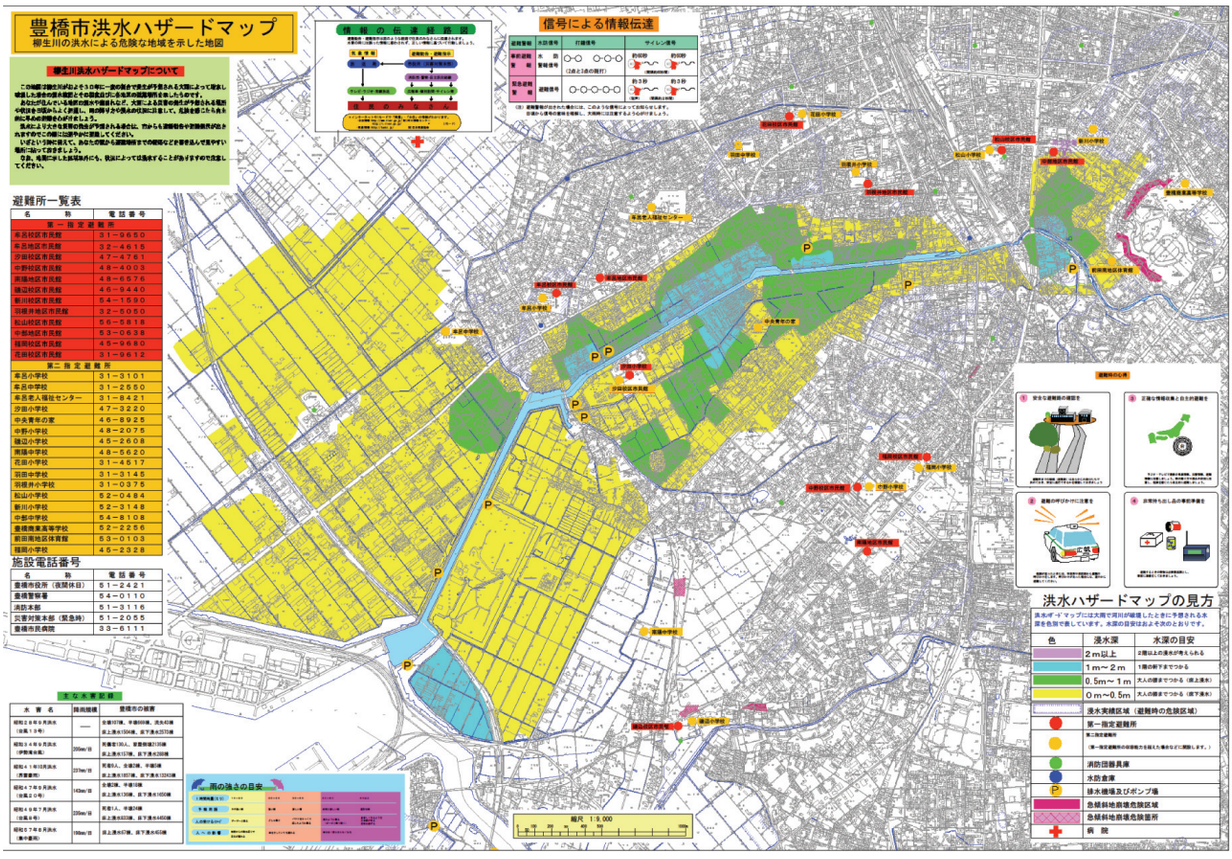
These 1,500 municipalities almost covered the affected populations in inundation area.

(3) Publish the guideline for evacuation order etc

- Preparation of the guideline in specific municipalities and expand itthroughout of Japan

(4) Integration of various hazard map such as flood, tsunami, volcano, debris flow etc

- browse and retrieve various hazard maps



Flood Hazard Map in Toyohashi city, Aichi prefecture

3.5 Republic of Korea

In the past, Korea's floods occurred between June and September accompanied by a monsoon or typhoon. However, due to climate change, floods occur at random with a torrential rain. Moreover, the damage is exacerbated due to industrialization, increase of land use, and the ensued land development. Hydraulic structures such as levees, dams, and retention ponds can prevent floods and reduce the damage. However, they have limits against floods that exceed the standard incorporated into the construction design. Therefore, comprehensive flood control requires both structural and non-structural measures. The flood inundation map is the basis for the non-structural measure, providing data for various countermeasures.

Flood inundation map offers information on submerged zones, flooded depth, flood concentration time, flooded duration, and flood speed that is utilized in developing plans to prevent natural disasters. Data on submerged zones facilitate the process of designating the assembly point after evacuation, and evacuation route. The map also provides topographical information and analysis model for the efficient estimation of flood damage in the downstream upon the collapse of a dam or reservoir. It helps the development of an emergency measure to minimize the loss.

The development process for the flood inundation map is largely divided into the collection of topographical data, coming up with a flood scenario, inundated analysis, drawing of map, and setting-up of a database.

- Collection of topographical data

Topographical data required in making the flood inundation map can be categorized into data on river and protected lowland topography. It is pivotal for the objectiveness of a flood inundation map. The results of profile, transverse profile, plane leveling upon various projects on the rivers are used as river topography data. numerical map(1/1,000, 1/5,000), digital elevation data, LiDAR survey result are used for protected lowland topography data .

- Development of flood scenario

A flood scenario shows the conditions to which a flood would occur. It is divided into the watershed conditions scenario that shows the land use conditions in the basins, flood magnitude scenario that indicates the size and amount of flood, and flood inundation scenario that shows the process of which a flood would occur.

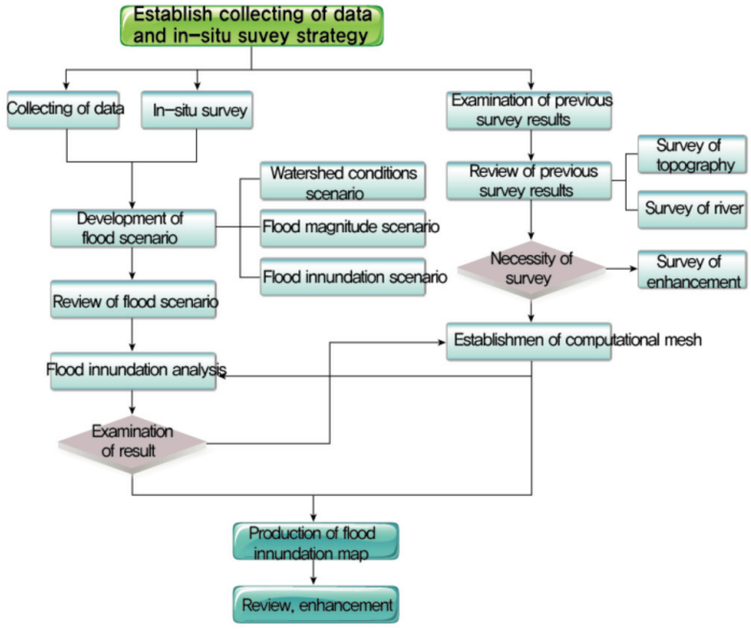
- Flood inundation analysis

Korea's flood inundation analysis is based on the 1D-steady · unsteady analysis, and 2D- unsteady analysis. Especially, the 2D- unsteady analysis is utilized to analyze the expected , movement of a flood inundation flow in the urban areas with high population and diverse industries. For the internal inundation risk, runoff analysis through the review of urban rainwater network and water pump facilities, and the ensued internal inundation analysis are used.

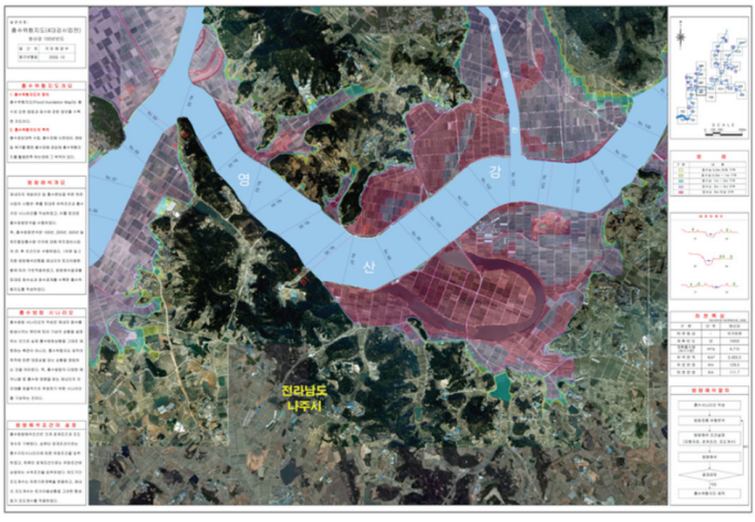
- Flood inundation map and system development

Zones expected to be submerged through the flood inundation analysis are indicated on the flood inundation map, and all information on the map are incorporated into a database.

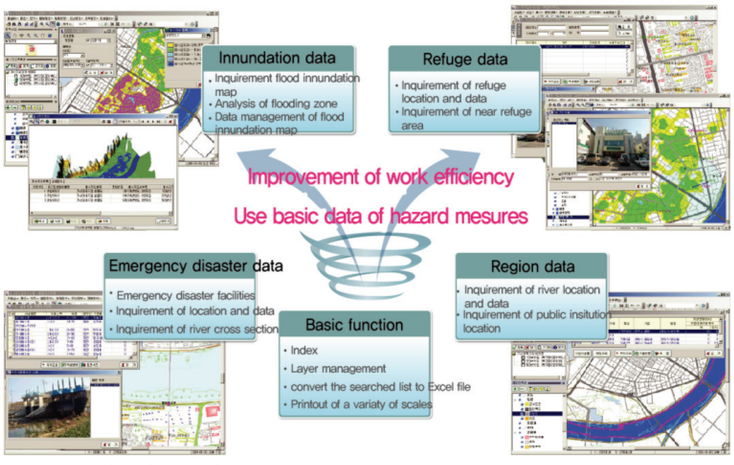
Flood-prone zones designated under the flood inundation analysis will be indicated in an easy-to-read map. Base maps for reference are numerical map and orthoimage map. Until mid-2000, flood-prone zones were noted on the numerical map, but are now shown on the orthoimage map instead. In addition, the introduction and manufacturing conditions of the flood inundation map are mentioned when drawing a map to help the understanding of users. A system map based on the database on flood inundation map is also drawn to provide GUI based on graphics, raising the usability of the flood inundation map.



Picture 1. Development process for the flood inundation map



Picture 2. Flood inundation map (Based on orthoimage map)



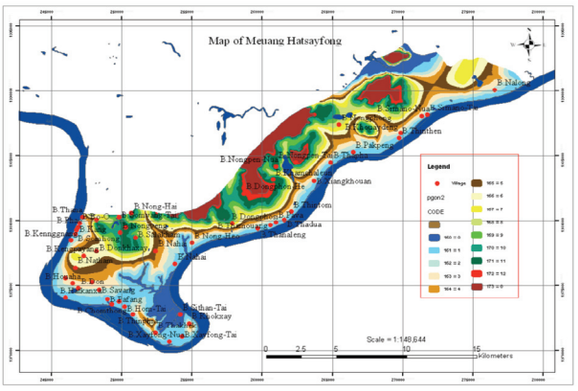
Picture 3. Flood inundation map system

3.6 Lao P.D.R.

In Lao PDR, the Flood Hazard Map (FHM) is a new approach for last few years. Then in 2007, Department of Meteorology and Hydrology (DMH), Water Resources and Environment Administration had started a practical study using GIS for some selected areas in Vientiane Capital City and central part of the country, where flooding occurred every year.

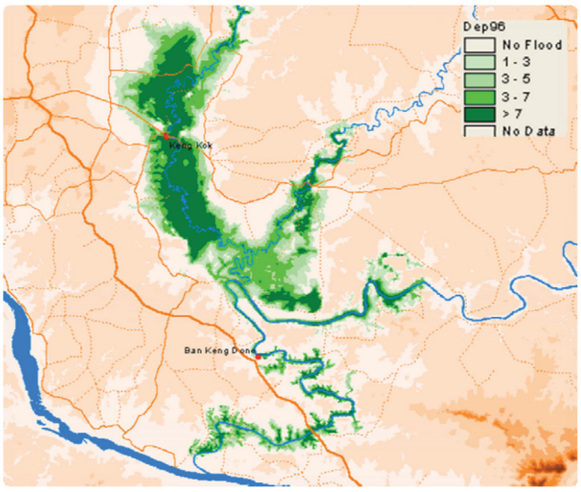
Input geographic data from National Topographic Department to Arcview 3.2 is;
-Elevation data,
-DEM map,
-Merge to selected area and
-Draw polygon by using observed water level at different magnitude.

As a result, it has been able to illustrate a digital image that shows flooding water depth in each village.

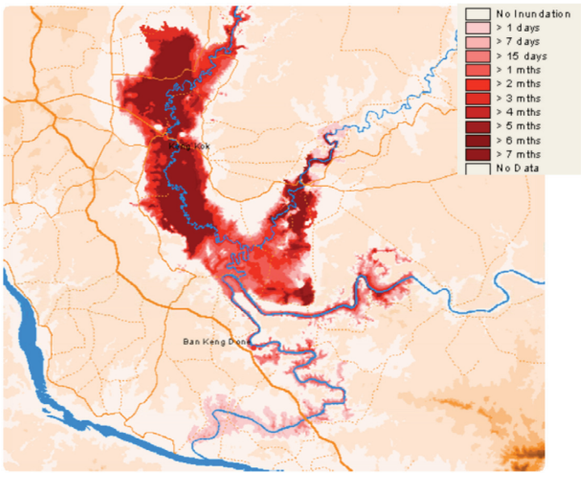


Flood Hazard Map of Meuang Hatsayfong, Vientiane

Another approach was taken for Sebanghieng Floodplain using Decision Support Framework (DSF), which input necessary knowledge data into hydrological, basin simulation and hydrodynamic model.



Flood depth in Sebanghieng Floodplain



Flood duration in Sebanghieng Floodplain

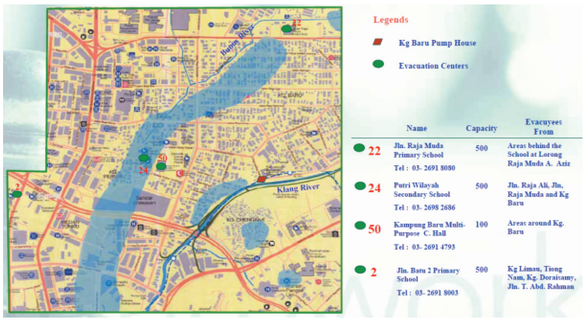
Through this trial DMH had learned that data are not so accurate but good enough for planning purpose. Lao will use this FHM to evaluate three scenarios on Climate Change, Hydropower development and Interbasin diversion.

3.7 Malaysia

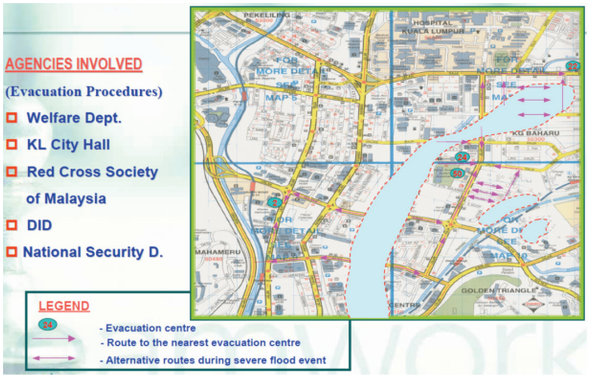
FHM activities in Malaysia was started in 2004 by selecting three target areas.

- Initial Effort during 2004 - 2007

State	River Basin	Target Area	Remark
Kuala Lumpur (2004)	Klang Valley Catchments	Kampong Baru (URBAN)	Initial effort – manual mapping on local based map observation
Kuala Lumpur (2005-2006)	Klang Catchments	Kuala Lumpur City Centre	Initial effort -methodology establishment – Hydrology-hydraulic model-based
Johor (2006/2007)	Johor Catchments	Kota Tinggi & Muar Town	Initial effort – ICHARM methodology

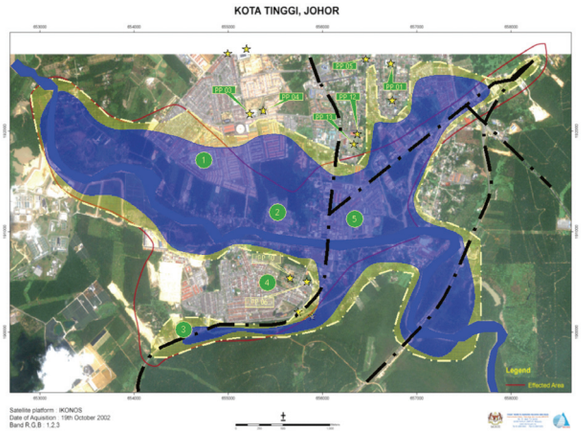


Flood Hazard Map in Kampong Baru, Kuala Lumpur (Evacuation center)



Flood Hazard Map in Kampong Baru, Kuala Lumpur (Evacuation route)

In response to severe floods occurred in Johor State in Dec. 2006 and Jan. 2007, HTC Kuala Lumpur and ICHARM agreed to collaborate on a research involving flood hazard assessment in Johor Malaysia. This research is aiming to carry out flood risk assessment through multi-disciplinary approach, to develop basic risk map and flood hazard maps of the area for flood preparedness and emergency response.



Flood Hazard Map in Kota Tinggi, Johor (Draft)

FHM project is an on-going project of the Humid Tropics Centre (HTC) Kuala Lumpur and local governments in Malaysia. The project is making progress on the action/future plan on FHM as following;

Year 2006

- Deliver a presentation of FHM to department
- Formed the committee members of FHM
- Suggest to the department to send the right officer to attend the FHM course
- Check the viability and update topographic map at Department of Survey and Mapping
- Having some meeting and understanding of FHM between the related organizations
- Get an opinion and idea from the local residents' perspective of FHM
- Carry out pilot project using existing FHM in terms of flood modelling, flood stimulation (review and enhance the exist FHM)

Year 2007

1. Promote the idea of FHM to the local government
2. Educating people and enhancing

their awareness due to flood disaster preparedness
- Start planning and doing some ground works of FHM for rural and urban area

Year 2008
- Carry out survey to study effectiveness
- Model construction (consists Topographic Modeling, Flood Modeling and flood stimulation)

Year 2009
- Model construction (consists Topographic Modeling, Flood Modeling and flood stimulation) (cont …)

Year 2010
- To disseminate the completed FHM to the target group
- Educating people and enhancing their awareness due to flood disaster preparedness
- Carry out survey to study effectiveness
- To conduct survey via questionnaire to the target groups with the view to improve the usefulness of the FHM

3.8 Philippines

The Philippines have been conducting flood and storm surge mapping in the past. As a matter of fact, the Comprehensive Land Use Plan (CLUP) of every province and city/municipality contain these maps which were prepared by the local government units or by government and private institutions. Most often these maps have different scale and made use of the old base maps produced by the National Mapping and Resource Information Authority (NAMRIA). In the aftermath of the flashflood in Quezon and Aurora provinces in 2004, government agencies conducting hazard mapping convened and harmonized their efforts in mapping both geological and hydrometeorological hazards. These agencies include the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) for flood (1:10K scale) and storm surge mapping (1:50K scale). The Mines and Geoscience Bureau (MGB) uses a 1:50K scale base map to map flood and rainfall-induced landslides while the Philippine Institute of Volcanology and Seismology (PHIVOLCS) is responsible for mapping geological hazards.

The harmonized set-up which involved the PHIVOLCS, PAGASA and MGB and the Office of Civil Defense (OCD) was introduced during the implementation of the REINA (REal, Infanta, General NAkar – areas affected by the 2004 flashflood) project funded by the United Nations Development Programme (UNDP) in 2005. The components of the REINA project included multi hazard mapping and establishment of early warning system for floods and tsunami. The success of the REINA project paved for a bigger project i.e. the UNDP Ready Project (Hazard Mapping and Assessment for Effective Community Based Disaster Risk Management) in 2006 (Phase 1). The Phase 2 of the Ready project commenced in 2007, this time with the inclusion of NAMRIA. Similar with the REINA project, the components of the Ready project include multi hazard mapping, early warning systems in twenty seven (27) provinces prioritizing those located along the eastern seaboard of the Philippines. One of the important features of the Ready project is the mainstreaming of disaster risk reduction into the local contingency plans. In addition, the NAMRIA provided updated base maps to be used in the Ready project. Considering the limitation in the budget, the project also welcomes the participation of other stakeholders i.e. the non-government organizations (NGOs) and even the LGUs. The project is targeted fro completion in 2011.

For floods and storm surges, apart from being located along the eastern seaboard, the project sites are also selected in terms of vulnerability and economic considerations and the availability of updated base maps.

The methodology employed by PAGASA in conducting flood hazard mapping includes: table top analysis, field mapping and verification, GIS processing, technical peer review for quality control and layout and printing.

The activities in the field are concentrated mostly on mapping the areas by traverse using GPS

and compass, taking notes of key geomorphic elements on the field. Accordingly, actual interviews with the residents are conducted to get the flooding history such as frequency, depth, flow characteristics and duration for verification purposes. The data gathered are incorporated in the GIS processing using Manifold software and the initial map is produced for peer review and analysis by the Technical Review Committee. Some minor comments and suggestions are noted and incorporated in the editing and correction procedures. The peer reviewed flood hazard map will be printed by NAMRIA to come up with a preliminary flood hazard map. Likewise, a technical report will also be produced by the team.

The preliminary hazard maps are presented to the concerned local government officials to check the political boundaries and comment on the said maps. During the presentation of the hazard maps, the local officials are trained to read the maps and be familiar with the symbols used including the hazards affecting their locality. Any corrections will be integrated by NAMRIA for the final version of the maps which will be distributed to the LGUs. Each map bears the logos of all the government agencies involved in the Ready project and now considered as the standard hazard map in the Philippines.

The flood hazard maps provided to the LGUs will serve as tools in updating their CLUPs. The hazard maps are also used by the Disaster Action groups as guide or reference in flood forecasting and warning or in designing the hydrological network of a basin or watershed for the establishment of community based flood early warning system. The hazard maps are utilized in identifying the safe areas where to locate the evacuation area or where to construct the evacuation building.

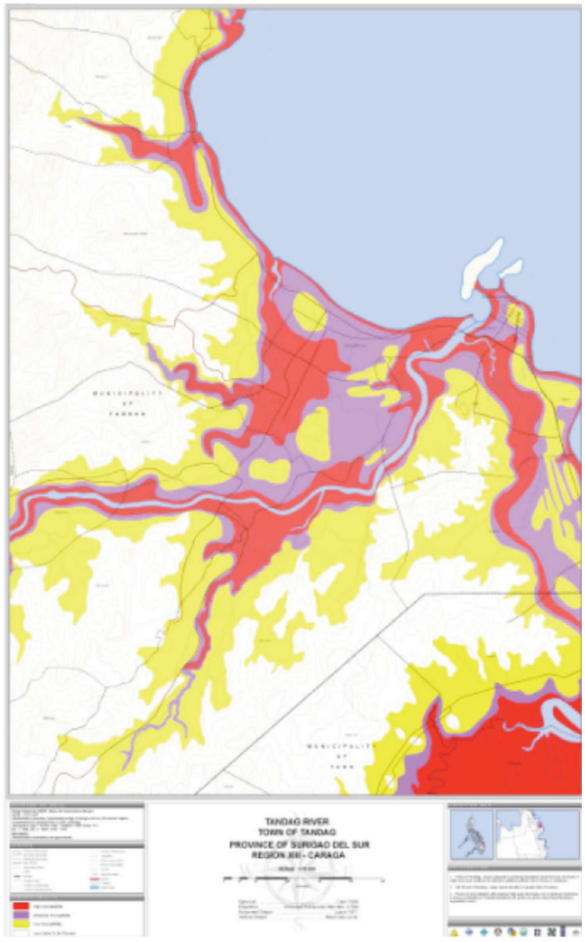
Under the Ready Project, the following flood hazard maps have been completed:

- CY 2006 – Surigao del Sur Province (Tago and Tandag)
  Surigao del Norte Province (San Francisco and Mainit)

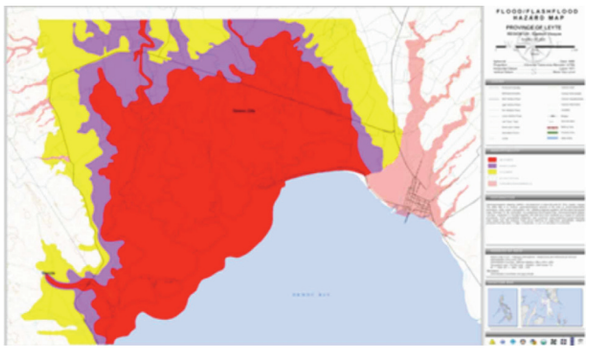
- CY 2007 – Leyte Province (Ormoc City)

- CY 2008 - Cavite Province (Bacoor, Kawit, Noveleta, Rosario, Tanza, General Trias and Imus)
  Pampanga Province (Angeles City)
  Laguna Province (Calamba City)
  Ilocos Sur (Vigan City)

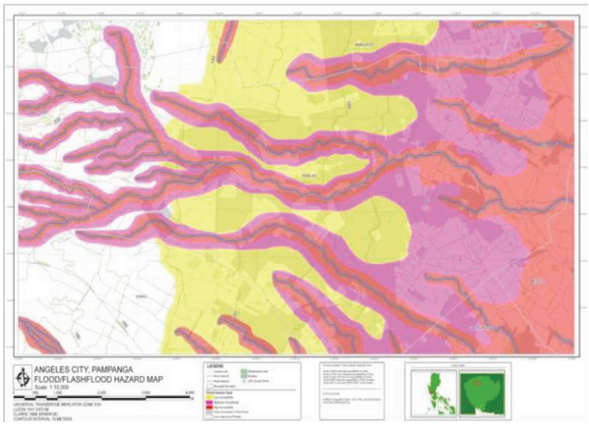
Some of these maps (preliminary and final) are shown in below;



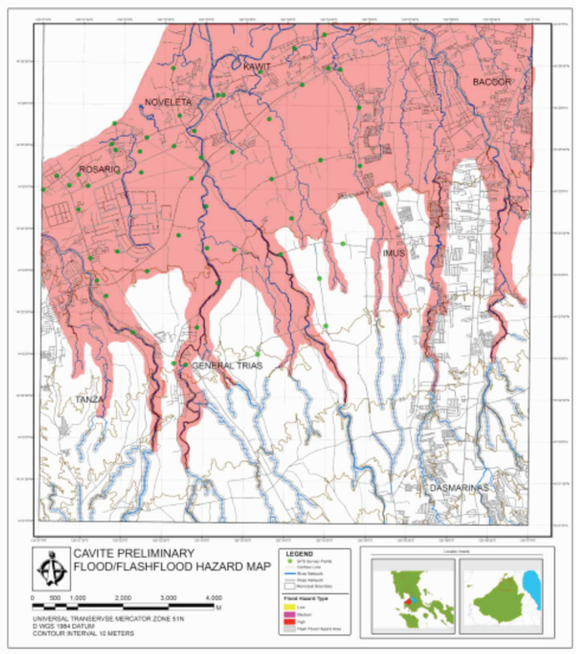
Flood hazard map of Tandag, Surigao del Sur



Flood Hazard Map of Ormoc City, Leyte



Preliminary Flood Hazard Map of Angeles City, Pampanga



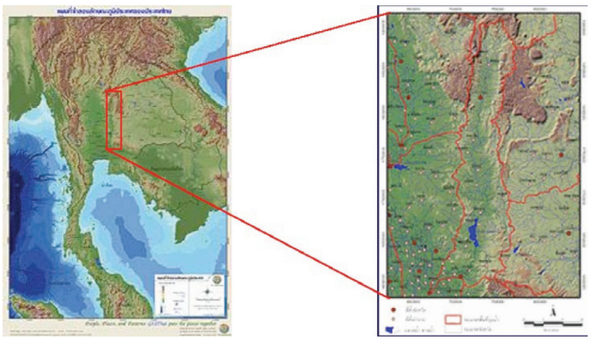
Preliminary Flood Hazard Map of Cavite (7 municipalities)

3.9 Thailand

In Thailand there are no laws which indicate and assign for any organization to take responsibility in making Flood Hazard Mapping. Whereas the knowledges and technologies are enough for making FHM. Hydrological and topographical data is available and accurate enough for making FHM. Many organizations, e.g. the Royal Irrigation Department, the Water Resources Department, and the Electricity Generating Authority of Thailand have recorded the hydrological data in every river basins of Thailand. The Land Development Department already developed the digital elevation model (DEM) throughout Thailand. This DEM can be used for inundation analysis. However, the land leveling may be performed for the better accuracy of FHM.

Many FHM-related projects were developed in Thailand. The examples of good FHM-related projects are;

1. Development of River Basin Flood Management System by Optimal Reservoir Operation and Real Time Flood Forecasting and Warning: A Case Study of Pasak River Basin. This project is the joint study of the National Research Council of Thailand, the Asian Institute of Technology, and the Irrigation Development Institute. The project developed the real time flood forecasting and warning system including the real time FHM for the area in Pasak River Basin. The system can forecast and provide flood warning 3-4 days prior the flood event.



Pasak River Basin

2. Flood hazard mapping of Lampang municipality. This project was conducted by the Regional Irrigation Office 2, Royal Irrigation Department

under the approval of the National Research Council of Thailand. The objective of the project is to prepare the FHM of Lampang municipality to be used as the tool for flood warning in this municipality. The inundation analysis of this project was successfully completed and ready to be used for flood warning

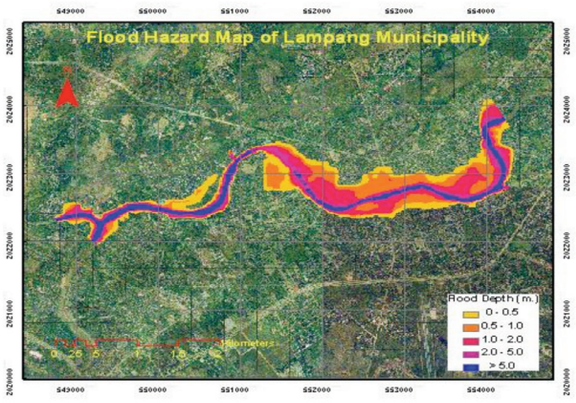


Figure 2 Flood Hazard Map of Lampang Municipality

3. Flood hazard mapping in Nan province of Thailand under the Nan river basin. This project was conducted by the Regional Irrigation Office 2, Royal Irrigation Department and the Asian Institute of Technology under the sponsor of the Japan Aerospace Exploration Agency (JAXA), Japan. The objective of this project is to prepare the FHM of Nan province for 10-year, 20-year, and 50-year flood event. The study area covers the area of Nan municipality and Phupiang municipality in Nan province. The project will finish on February 13, 2009. This FHM will be used for improving flood warning system in Nan province.

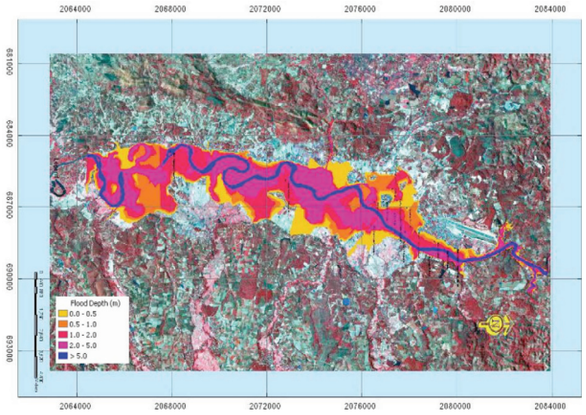


Figure 3 Flood Hazard Map of Nan Municipality

The use of FHM as a tool for the officials who issue flood warning and evacuation is the most suitable way of using FHM for the officials to provide clear flood information such as flood extent and flood depth to the people so that they are able to evacuate on time. The FHM project is extending the future plan in other flood risk and inundation areas.

3.10 Vietnam

Vietnam is a flood-prone country. Flood and typhoon disasters are occurred throughout the country from June to Dec, incl. river flood, flash flood and sea flood (storm surge).

The Govt. of Vietnam has National flood control policies as followings;

Objectives:

- Social: to reduce the loss of life, injury, properties and other disturbance;
- Economic: to increase the benefit of flooding areas;
- Environmental: to improve the environment.

Main tasks

- Forecast and Warning Systems at national and provincial levels;
- Preparedness and Mitigation: dike, water storage, reforestation, integrated river basin (coastal zone) management, etc;
- Emergency relief.

To conduct the policies, some authorities in

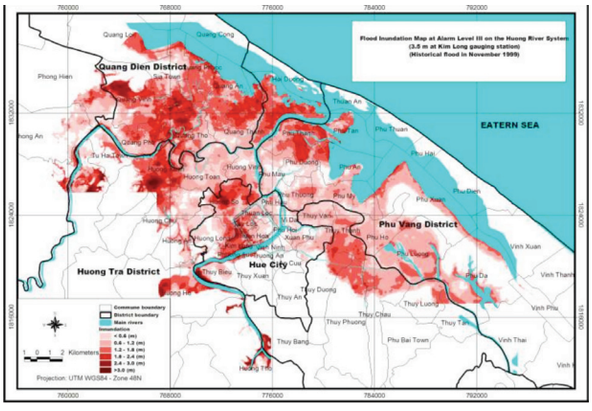
Vietnam are playing a role of each section;
+ National level

- Central Committee for Flood and Storm Control (CCFSC)
- Natural Disaster Mitigation Partnership incl. representatives of CCFSC, MARD, UNDP, other donors and NGOs to deal with flood control and mitigation in highly disaster prone and also poorest areas.

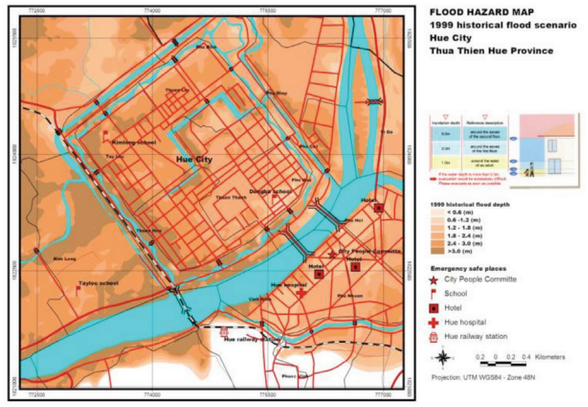
+ Provincial and Local level

- Provincial Committee for Flood and Storm Control.
- The Operating Center for inundating prevention of Ho Chi Minh city was established On 14 March 2008.

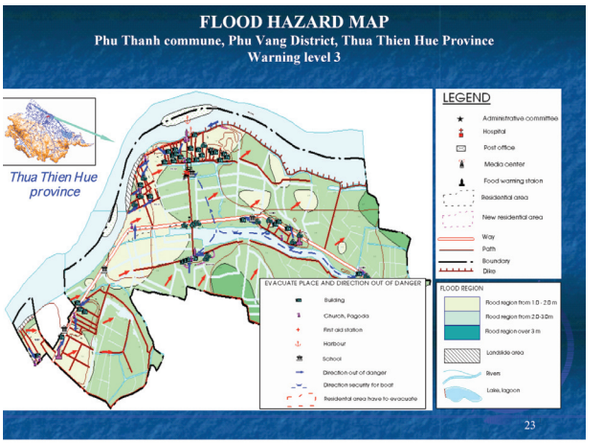
Although Vietnam had simulated already FHM for Hue City located in central of the nation, it is not yet practical and useful to deliver to local communities. Then further development is required: river flood, storm surge… As structural measure to prevent flood in Huong River system is not applicable, local community has always to be prepared during flooding season.



Flood inundation map at alarm level III on the Huong River system



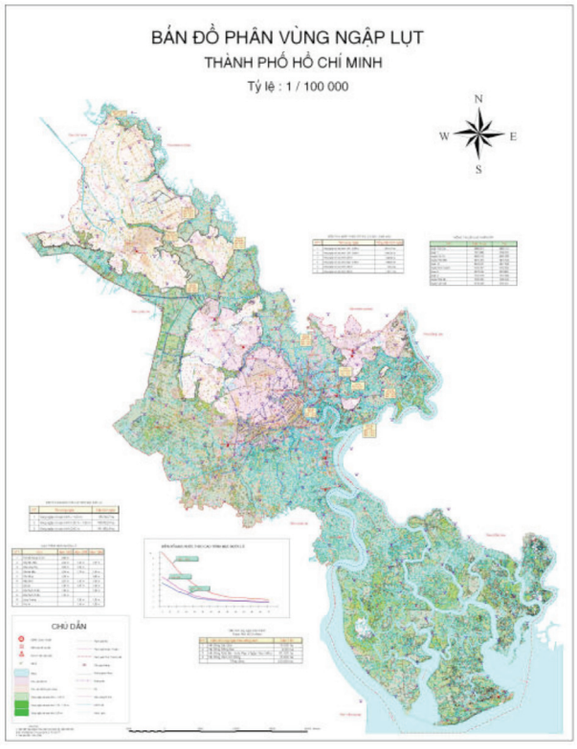
Flood hazard map of Hue City



Flood Hazard Map of District level

The inundation map of Ho Chi Minh city is disseminated on internet. (www:/ phongchonglutbaotphcm.gov.vn)

Clear flood hazard map is of great importance! Vietnam has to produce many FHM for many areas and cities. And FHM training is necessary for local people, involving line agencies at provincial/national level.



Flood inundation map of Ho Chi Minh city (on Website)

4. CONCLUSION

4.1 Achievements

Through our FHM project, many flood hazard maps were produced in almost all member countries. It was confirmed that every member country has obtained capacity to build up an effective map for each local community located in flood-prone areas, and FHM project in each country is now on the next stage, to apply the map into actual actions to reduce flood damages.

As an achievement of the FHM project, the number of municipalities, that have a flood hazard map, has been increasing in each country. For example in Japan, in total 1,300 municipalities prepared flood hazard maps, and 1,044 of them disseminated it by printed materials and 1,014 municipalities present it on their web-sites until June 2009. In the case of China, no flood hazard map has disseminated by printing or internet, however 13 flood hazard maps are produced and utilized for flood control actions in 2008. Also in other countries, flood hazard mapping has become popular in disaster prevention service and some regulations or guidelines are arranged for each meteorological/geographical conditions.

Thus, every agency who is in charge of disaster management is able to contact the counterpart in other countries to exchange information. Trial and comparison of flood hazard mappings under different conditions will bring us a lot of suggestions to brush up the FHM project.

4.2 Findings in FHM project

In China, FHM is one of the effective technical supports to shift from flood control to flood management. The State Flood Control and Drought Relief Office (SFCDRO) made the Guidance for Flood Hazard Mapping in 2004 and assigned 36 trial pilot projects in seven major river basins. The project of 1st phase national flood hazard mapping commenced in the beginning of 2008.

In Japan, FHM is an obligation of the local government and the river administrator, prescribed in the amendment of Flood Fighting Act in 2001 and 2005. The act mandates that:

- River administrator will designate, as flood-prone areas, those areas that may be inundated in the event of flooding;
- River administrator will announce publicly the expected water depth in the event of inundation and notify the city/town/village concerned;
- City/town/village, on the basis of the flood-prone area map, will prepare and disseminate the flood hazard map to residents to facilitate their rapid/smooth evacuation while enhancing their awareness on flood disaster; and
- City/town/village, included in the flood-prone areas where the river administrator announces official flood forecasts, is to prepare flood hazard maps and distribute their content for thorough understanding of the general public in the form of printed materials.

In Korea, maps for the purpose of controlling floods are flood inundation map (to indicates zones that could be submerged under a potential flood), flood hazard map (to helps the minimization of damage from natural disasters and evacuation of residents) and flood insurance management map (to indicates the insurance premium by insurance purpose through flood risk analysis). Among them, production of the flood inundation map was suggested in 1999 in Korea, and currently, the map is gaining popularity, and its usage is being settled down. The Ministry of Land, Transport and Maritime Affairs is planning to complete drawing of a flood inundation map for required 2,332 km of national rivers by 2012.

In Thailand, Royal Irrigation Department (RID) is leading FHM for some provinces. The previous efforts were conducted under collaboration with JICA, the Asian Disaster Preparedness Center (ADPC), the Asian Institute of Technology (AIT), Japan Exploration Agency (JAXA). And flood risk maps and inundation area maps were made individually.

In Vietnam, the Operating Center for inundation prevention of Ho Chi Minh city was established on March 14, 2008. And the Ho Chi Minh city's act on preparedness and adapting to the inundation situation caused by heavy rain and tide on Ho

Chi Minh city was promulgated on March 12, 2009.

4.3 Lesson-learned

For the next stage of FHM application, it is important for members to recognize some lessons that had been learned through the FHM project in 2002-09.

The lessons can be classified into three parts:

I. Effectiveness of FHM
II. Role of the central government
III. Action in local community

I. Effectiveness of FHM

1) FHM is an essential countermeasure to reduce flood damage at national/ local/individual level.
2) FHM can be effective within shorter-period of time, while structural measures such as embankment or dams need a longtime to be constructed.
3) The most suitable FHM for a certain area can be built-up, combining topographic map, past flood investigation, inundation analysis and required data.

II. Role of the central government

1) To reduce human/economic losses, FHM should acquire a primary position in national disaster prevention policy.
2) Through the FHM project, a right perception on supposed disaster and facilities' capacity shall be recognized in local society.
3) For popularization of FHM, the central government is expected to set up a legal regulation, immediate target and technical domestic support system.

III. Action in local community

1) Local government/NGO shall connect flood fighting services and residents by FHM, and brush it up by referring to many activities in other regions.
2) Residential collaborative action of information/experience sharing is a key factor of FHM to ensure the local livelihood sustainability.
3) FHM work may become a culture to live in flood-prone area through identification of area-specific dangers, resources and warning messages.

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. 1519