

People Centered Approach in Flood and Land Management in the Mekong Basin

25 February 2011, Luang Prabang-Lao PDR

Flood Vulnerability Indices in the Lower Mekong Basin

ADB-TA 7276

Ali Chavoshian

ali55@pwri.go.jp



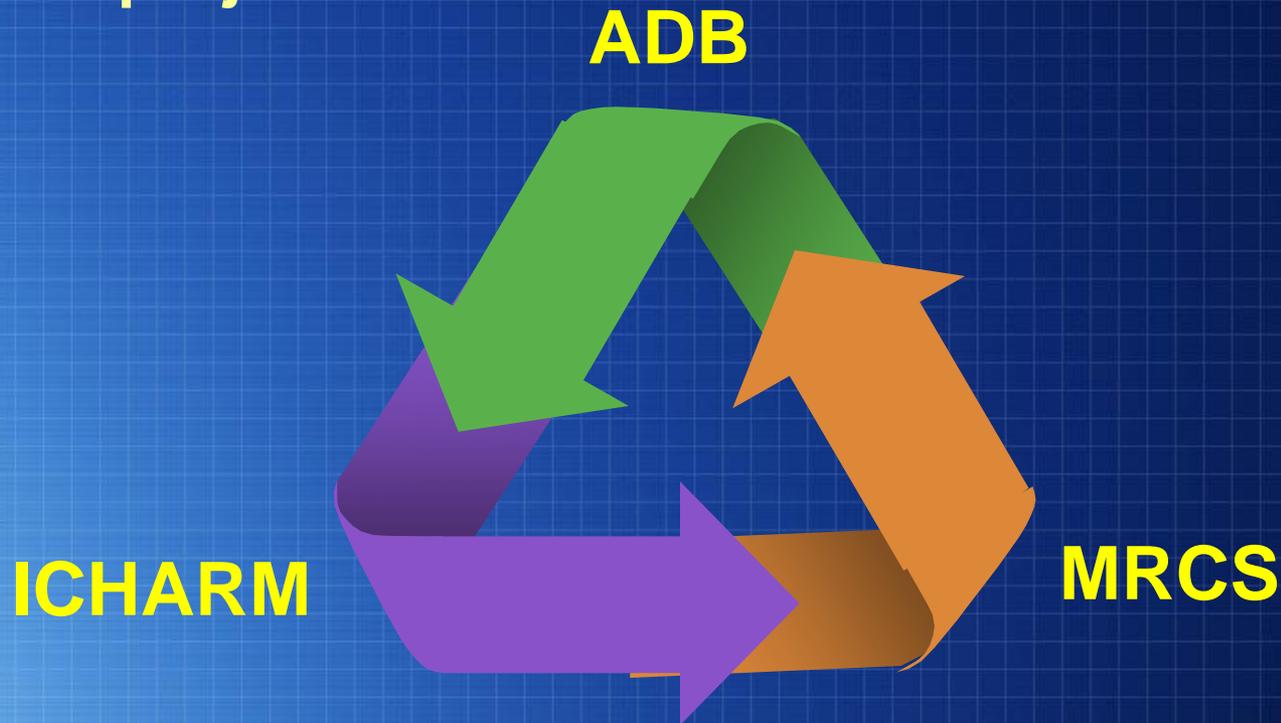
United Nations
Educational, Scientific and
Cultural Organization

International Centre for Water Hazards and Risk Management
under the auspices of UNESCO
Public Works Research Institute



Objective and Scope

The TA is expected to support the Mekong River Commission Secretariat in developing flood and drought vulnerability indices for the lower Mekong basin, which have been identified as a priority requirement for preparing investment projects.





The Letter of Agreement

August, 6 2010



Mekong River Commission

Office of the Secretariat in Phnom Penh (OSP)
576 National Road, # 2, Chak Angre Krom,
P.O. Box 623, Phnom Penh, Cambodia
Tel. (855-23) 425 353. Fax (855-23) 425 363

Office of the Secretariat in Vientiane (OSV),
Office of the Chief Executive Officer
184 Fa Ngoum Road, P.O. Box 6101, Vientiane, Lao PDR
Tel: (856-21) 263 263. Fax: (856-21) 263 264

No. L-OSP 009/10

6th August 2010

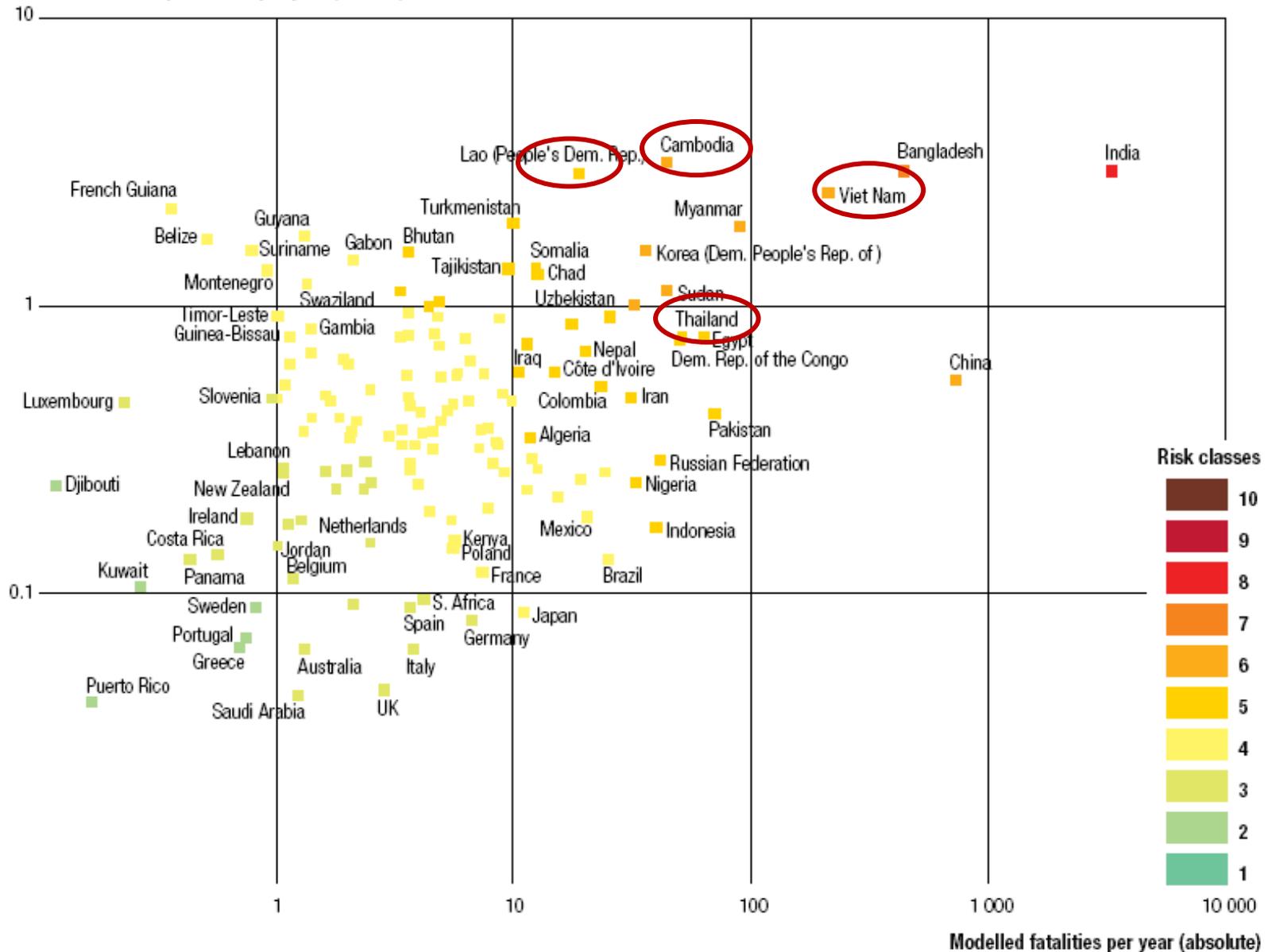
Letter of Agreement

Subject: Support to the Mekong River Commission to develop flood vulnerability indices (FVIs) in the Lower Mekong Basin under the ADB RETA-7276 by the ICHARM

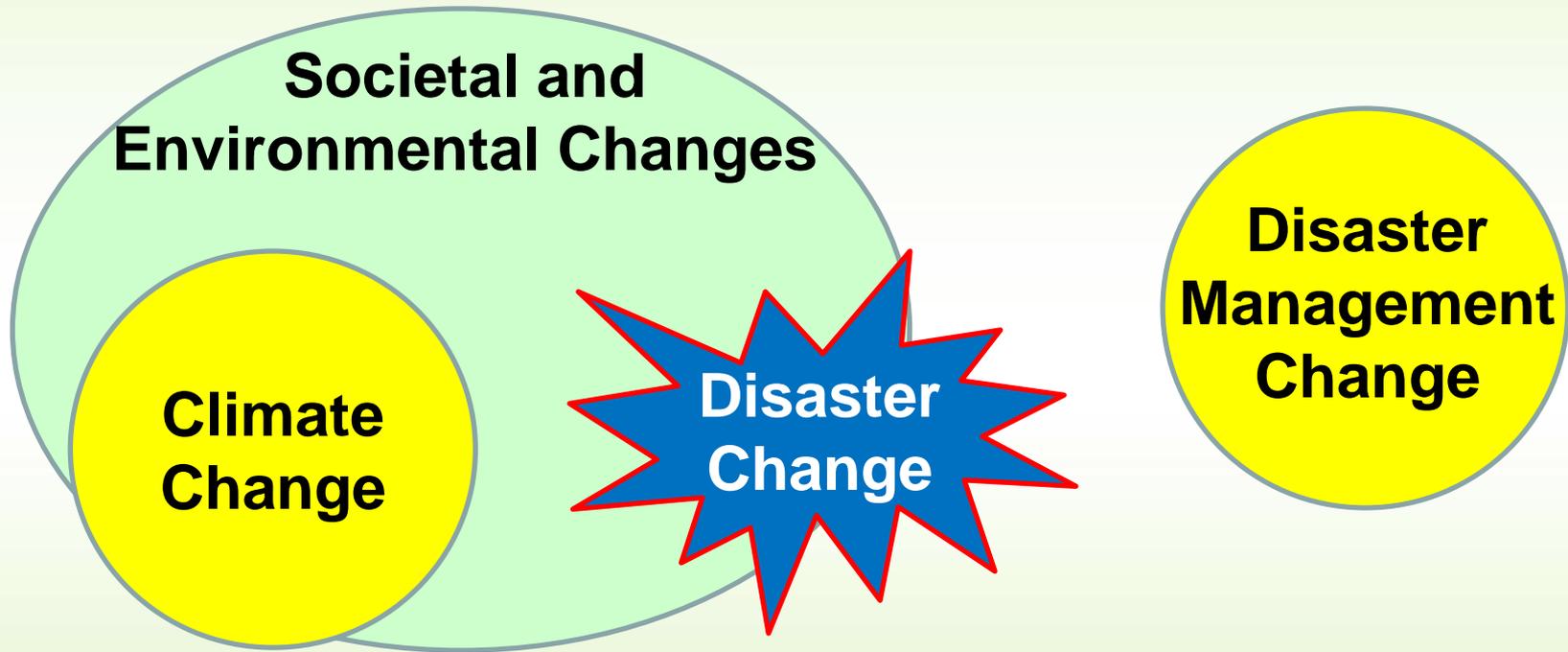
Dear Mr. Kuniyoshi Takeuchi,

1. The Flood Management and Mitigation Program (FMMP) of the Mekong River Commission (MRC) is being implemented since December 2004 and is expected to be completed by November 2010. The FMMP consists of five inter-related components designed to enable the MRC to assist the countries of the lower Mekong basin to reduce the damage to infrastructure, economic losses and loss of lives and livelihoods as a result of extreme floods. ADB co-funded FMMP's Component 2 "*Structural Measures and Flood Proofing*" from 2004 onwards.

Modelled fatalities per million per year (relative)



Policy response to future uncertain global change



Climate Change

Societal Change

Disaster Change

Disaster Management Change

Intensifying

- Torrential rains
- Cyclones
- Storm surges
- Droughts

Urbanization & Urban concentration & Rural depopulation

Limited resources, poverty, poor governance

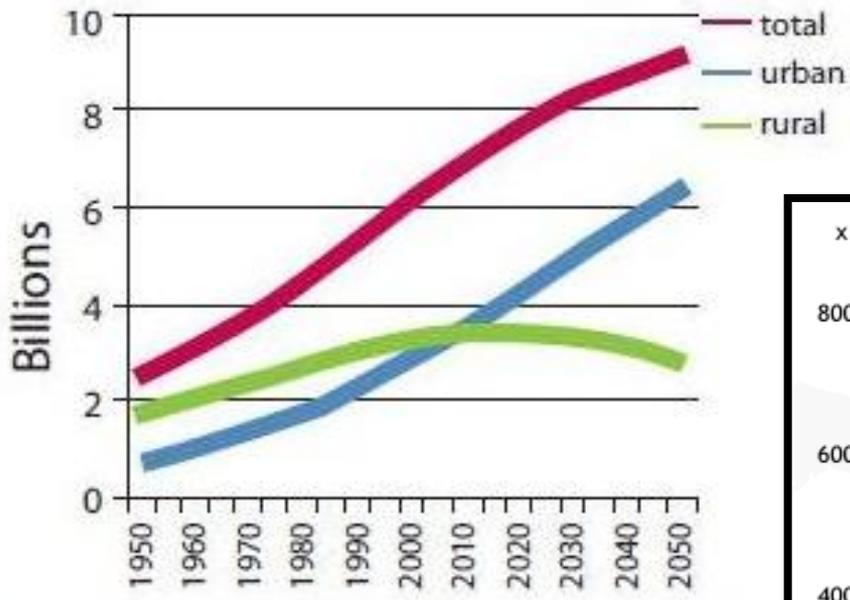
More severe damages

Disasters in inexperienced regions

- Limitation in centralized protection by infrastructure
- More important for human to adjust & living with nature

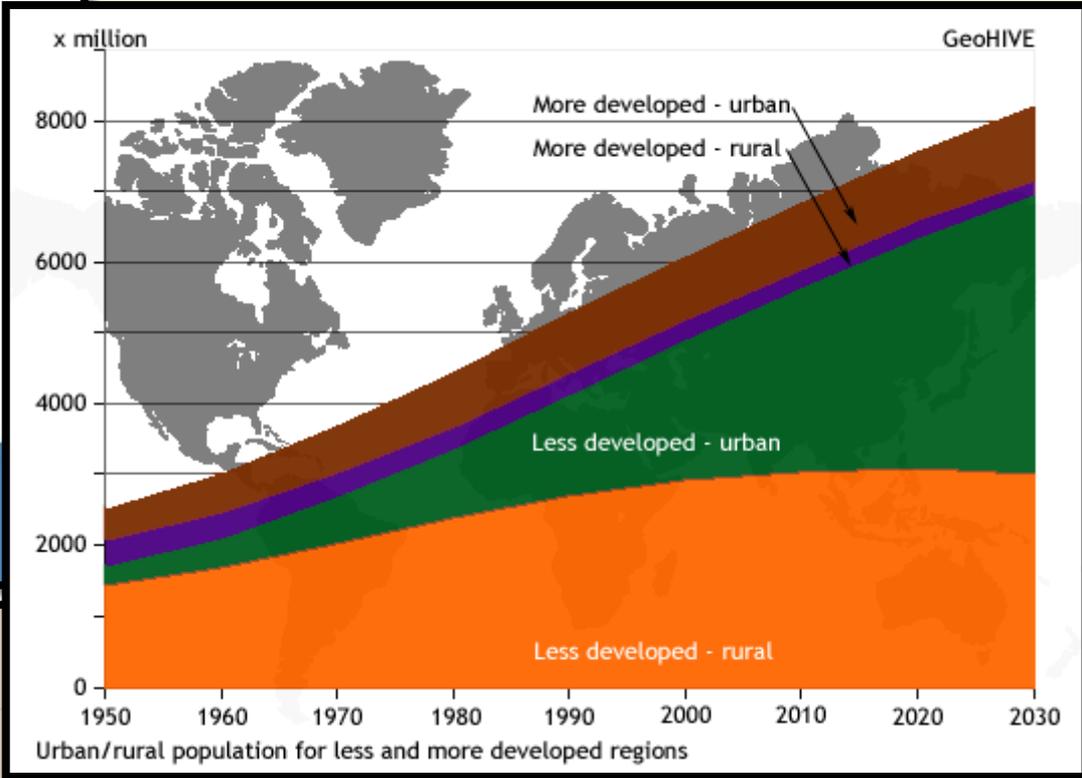
More important are early warning & preparedness

Increasing urban population mostly in developing regions and aging population



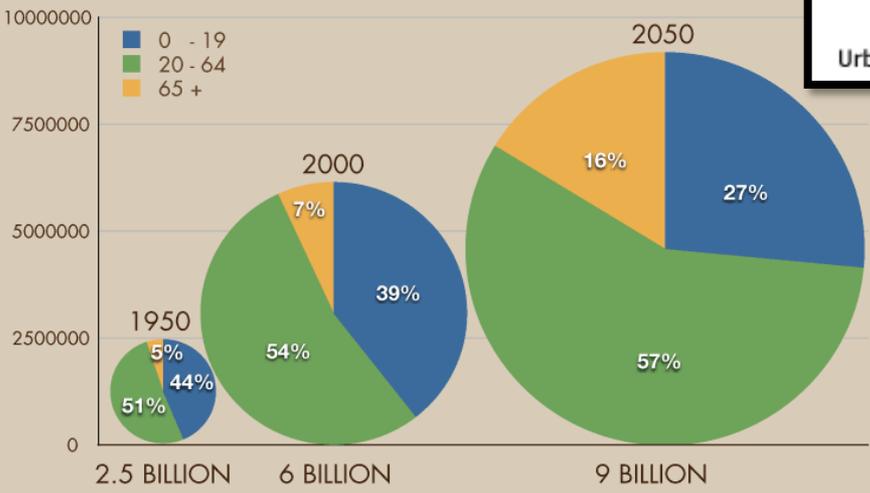
World Population: Urban and Rural 1950-2050

(source: UN Dept of Economic and Social Affairs, 2007)



Urban/rural population for less and more developed regions

POPULATION BY AGE GROUP





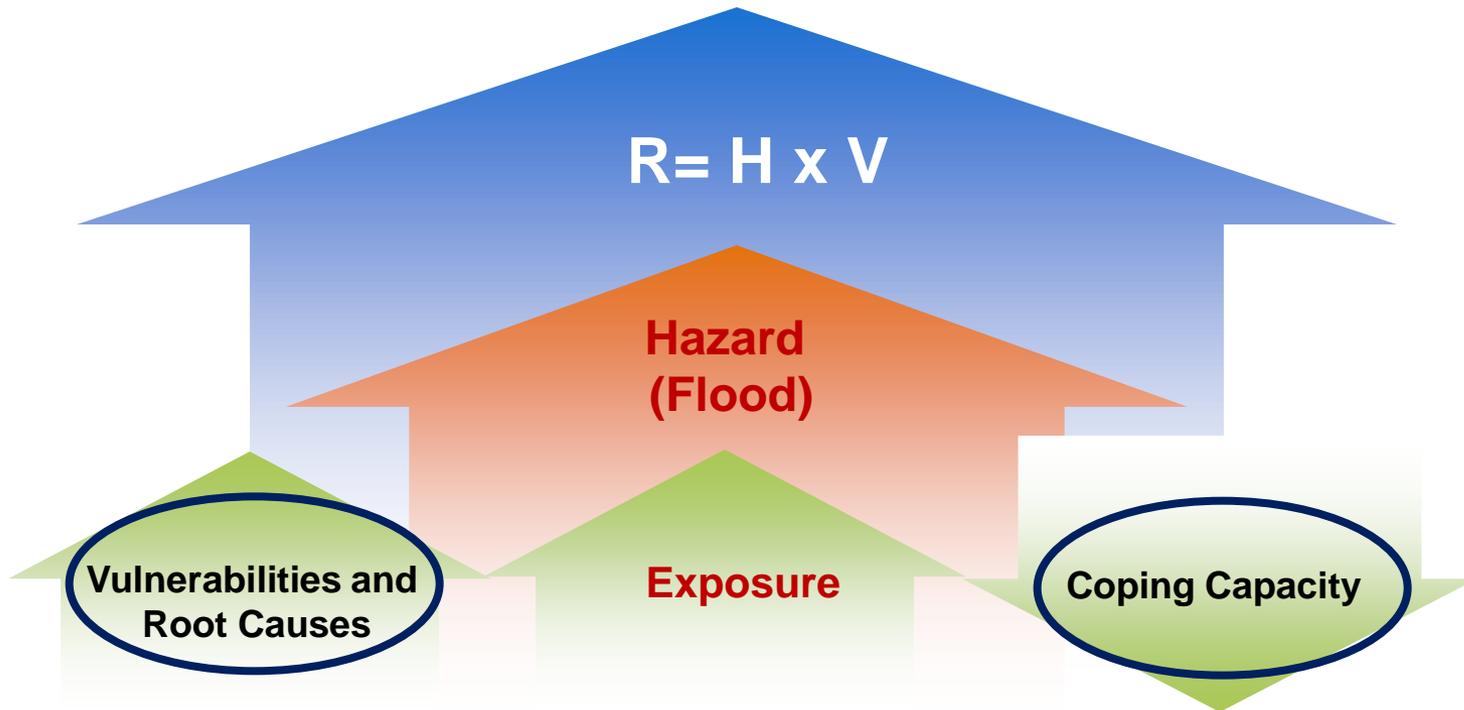
In Lower Mekong Basin (LMB)², the TA will support the Mekong River Commission Secretariat in developing flood vulnerability indices, which have been identified as a priority requirement for preparing further investment projects in the LMB region. The TA will help the countries in LMB to develop investment projects and improve the ability of communities to prepare for, respond to, and recover from the negative impact of floods, together with other regional TA (RETA 6456) for flood and drought risk management and mitigation in the Greater Mekong Sub-region. The TA will help with the following:

- (i) Defining flood vulnerability indices relevant to future flood management at the community level (the impact of floods on health, food security, livelihoods, poverty, education, and others), and relating them statistically to the underlying socioeconomic factors.
- (ii) Defining and measuring the factors that affect the various flood vulnerability, through supplementary community surveys (at the family level) of flood and impact in flood-prone villages where the basic socioeconomic profile has previously been determined by community surveys of other agencies (typically nongovernment organizations).



Objective and Scope

The objective of this study is to identify and quantitatively evaluate a set of flood vulnerability indices (FVIs) and map them by considering changes in both hazard and exposure components.





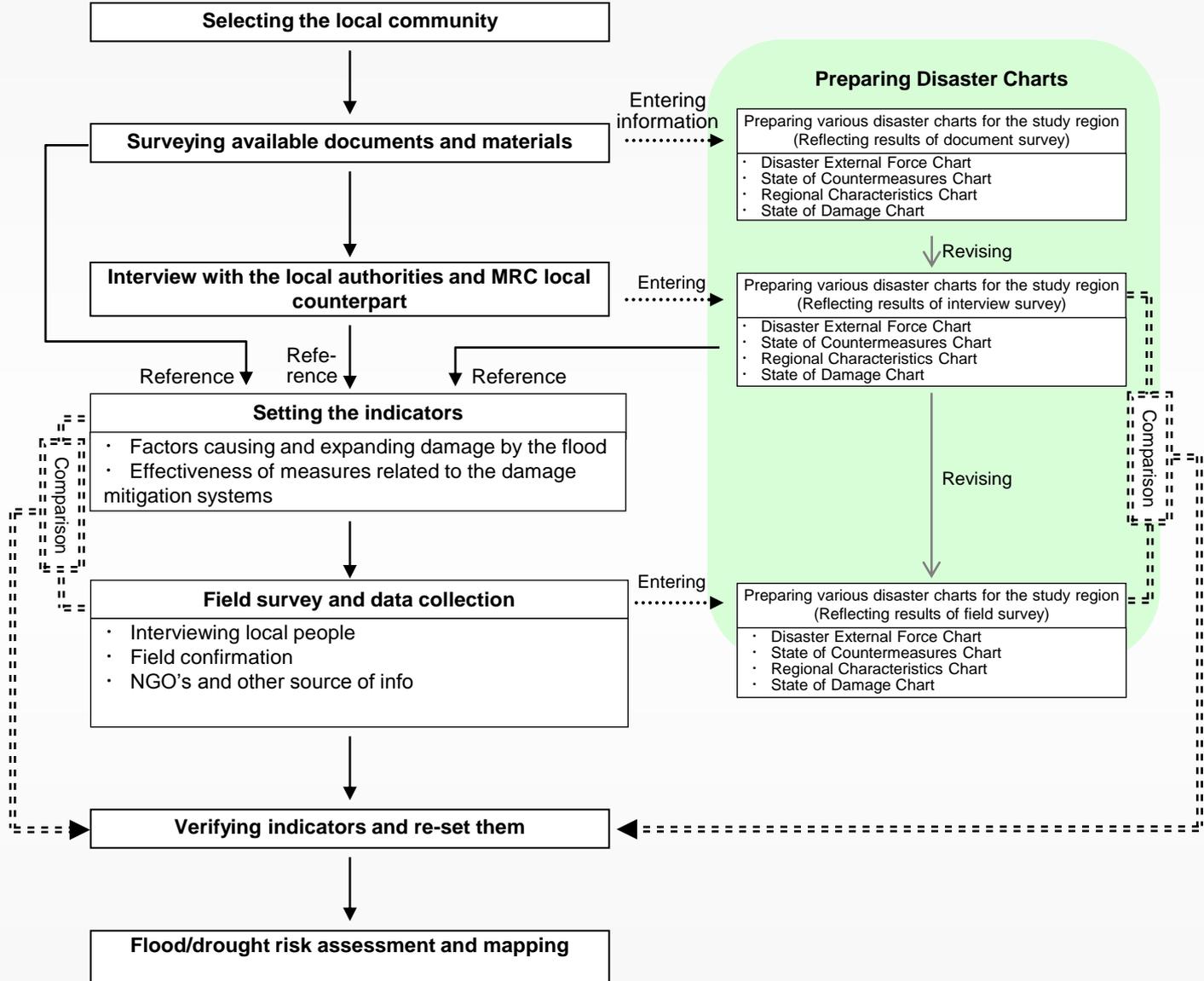
Indicator Quantification Process

- Data collection on community and county level
- Calculations are made for communities intersected by inundation areas of an HQ_{extreme}

- Composite Index is created from the quantified indicators

Indicator $\xrightarrow[\text{aggregating}]{\text{ranking, weighting,}}$ **Indices**

Working Layout



Relationship of Socio-economic indicators and flood damages

- In order to statistically analyze the relationship of socio-economic indicators and local flood vulnerabilities, there is a need to have geographically distributed flood disaster damages (at least human losses and total economic damages) at province level in the Lower Mekong Basin as most of the socio-economic data are available at province level as well.
- An intensive survey has been conducted to collect local flood damages data. Spatially distributed flood damages data at province level are collected for the following cases:
 - Cambodia floods in 1996 and 2002 (FAO report of 1999 and 2003)
 - Lao PDR floods of 1995 and 1996 (FAO report, 1999)
 - Viet Nam floods of 1998 and 2002 (UNDP report 1998 and 2002)

1996 Flood Damages in Cambodia at Province Level

Flood-affected areas		Damages (Million USD)	Human Losses	Damaged Rice Field (ha)	House Damaged
Province	Flooded people				
Rattakan	17410	0.93	3	2583	118
Stung Treng	51781	1.11	3	5958	253
Kratie	71333	1.23	4	6588	78
Kompong Cham	519632	2.42	1	28991	856
Phnom Penh	73149	1.8	1	6270	943
Kandal	332559	2.7	18	14826	583
Prey Veng	458437	8.71	75	80885	1044
Svay Rieng	100343	1.41	4	17876	55
Takoe	149814	4.56	34	29712	291
Kompot	12104	1.18	1	3811	200
Pursat	120545	4.3	8	37131	120
Battambang	98189	3.52	6	20173	167
Banley Meanch	35641	1.47	2	4250	192

Source: FAO, FLOOD MANAGEMENT AND MITIGATION IN THE MEKONG RIVER BASIN, 1999



Correlation determination (r^2) of selected socio-economic indicators and flood damages (at province level) in Cambodian in 1996

Indicators	Human Losses	Economic Damages	Indicators unit/definition
Population density	0.40	0.58	Person per km ²
Population growth	0.15	0.41	Percentage
Rural population	0.34	0.10	Percentage to total population
Vulnerable ages (Dependency ratio)	0.55	0.01	The dependency ratio measures the number of dependents who must be supported by working-age adults. Dependents include children under 15 years and the elderly (65 years and older). A dependency ratio of 100, for example, means that each working adult must, on average, provide for the needs of one other, non-working household member. This indicator shows Vulnerable age to natural disaster as well.
Unemployment	0.01	0.24	Proportion of labor force unemployed
Employment in agriculture sector	0.04	0.53	Proportion of employment that are working in agriculture sector. Much agriculture sector employment is based around subsistence production. Such agricultural activity involves very low levels of productivity and income and is an important part of the pattern of poverty in rural areas.
Poverty rate	0.27	0.31	Poverty is measured in terms of people's consumption levels for food and basic necessities. In each country a poverty line has been defined that represents the minimum value of goods and services consumed on a daily basis to adequately sustain an average adult.
Access to safe water	0.18	0.37	Proportion of population with access to safe water
Access to electricity	0.12	0.41	The data for Lao PDR overestimate the proportion of households with access to electricity. They report the percentage of villages with electricity supply, although there may be households in these villages that do not have access to this service.
Literacy rate	0.46	0.01	The proportions of people over the age 15 years who can read and write

AHP Method

Flood Risk Factor Analysis

Intensive Rainfall Intensity

Human Losses

Long Inundation Time

Economic Damages

High Inundation Depth

Houses

High Flood Flow Velocity

Farmland and Agriculture

Living in Flood Prone Area

Industries

Large Inundated Area

Fishery

Low Societal Capital

Cattle

Poor Infra Development

Properties

Lack of Forecasting & Early Warning

Business Discontinuity

Lack of Emergency Response and Evacuation

Indirect Damage

Human Losses

1/91

Economic Damages





Indicator's weights

Method 1 - Eigenvalue/Eigenvector Method

- Eigenvalues are important tools in several math, science and engineering applications
 - Changing coordinate systems
 - Solving differential equations
 - Statistical applications
- Defined as follows: for square matrix A and vector x ,
 $\lambda =$ Eigenvalue of A when $Ax = \lambda x$, x nonzero
 x is then the eigenvector associated with λ
- Compute by solving the characteristic equation:
 $\det(\lambda I - A) = |\lambda I - A| = 0$

Indicator Weights

(continued)

- Method 2: Geometric Mean

– Definition of the geometric mean:

Given values x_1, x_2, \dots, x_n

$$\bar{x}_g = \sqrt[n]{\prod_{i=1}^n x_i} = \text{geometric mean}$$

– Procedure:

(1) Normalize each column

(2) Compute geometric mean of each row

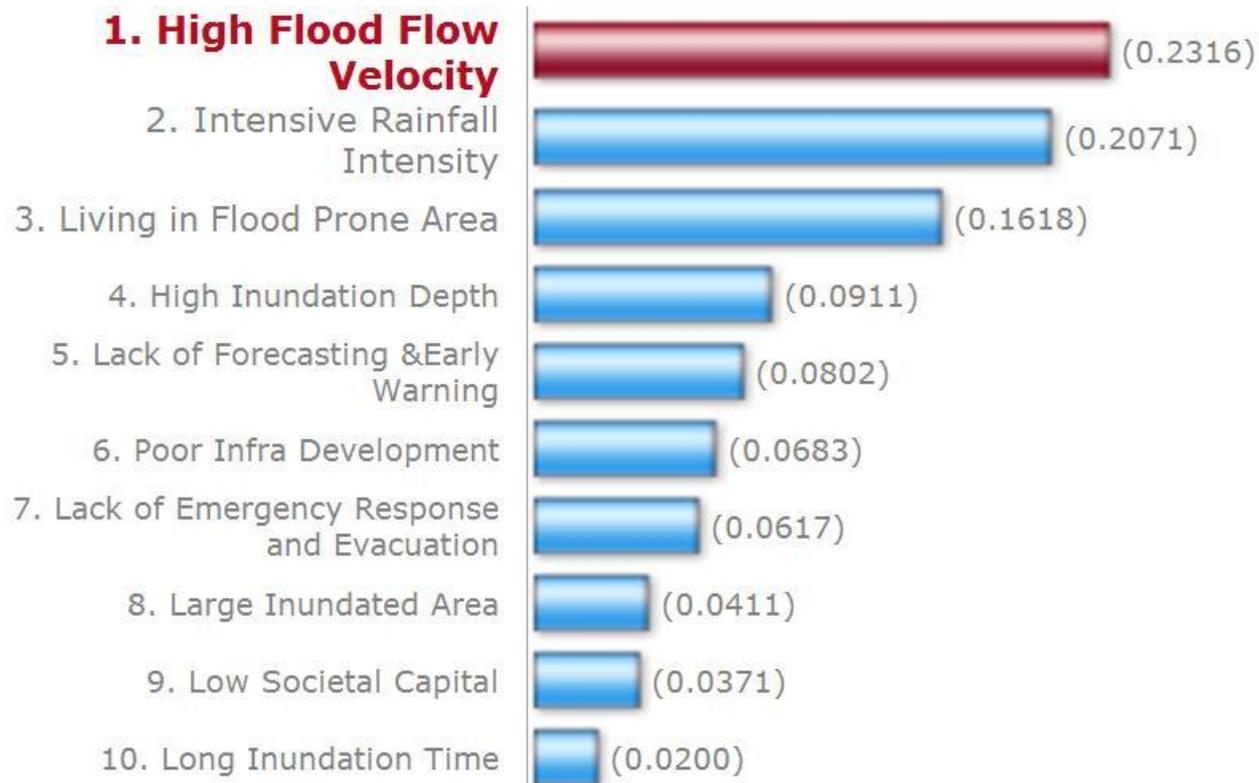
– Limitation: lacks measure of consistency

Intensive Rainfall Intensity	Long Inundation Time	High Inundation Depth	High Flood Flow Velocity	Living in Flood Prone Area	Large Inundated Area	Low Societal Capital	Poor Infra Development	Lack of Forecasting & Early Warning	Lack of Emergency Response and Evacuation
1	3	1/5	1/7	1/5	1/3	2	1/5	3	5
1/3	1	1/3	1/4	1/5	1/4	1	1/4	1/2	1
5	3	1	1/3	1/3	3	4	1	2	3
7	4	3	1	1	3	5	2	3	5
5	5	3	1	1	5	4	3	3	4
3	4	1/3	1/3	1/5	1	3	1/3	2	3
1/2	1	1/4	1/5	1/4	1/3	1	1/3	1/2	1
5	4	1	1/2	1/3	3	3	1	4	5
1/3	2	1/2	1/3	1/3	1/2	2	1/4	1	2
1/5	1	1/3	1/5	1/4	1/3	1	1/5	1/2	1

CI: 0.1062 CR: 0.0712 λ : 10.9554

criteria preferences	Human Losses	Economic Damages
Intensive Rainfall Intensity	0.2362	0.0616
Long Inundation Time	0.0179	0.0307
High Inundation Depth	0.0841	0.1258
High Flood Flow Velocity	0.2347	0.2160
Living in Flood Prone Area	0.1482	0.2297
Large Inundated Area	0.0332	0.0805
Low Societal Capital	0.0381	0.0324
Poor Infra Development	0.0533	0.1435
Lack of Forecasting & Early Warning	0.0863	0.0497
Lack of Emergency Response and Evacuation	0.0680	0.0300





criteria importance



consistency ratio (CR): 0.0657

1. Living in Flood prone area



2. Extreme Rainfall (0.2094)



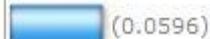
3. Low Infra Development (0.1147)



4. Low Societal Capital (0.1056)



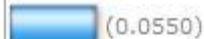
5. Poor Governance (0.0714)



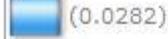
6. Lack of Emergency response and Hazard maps (0.0596)



7. Intensive Rainfall (0.0550)



8. Lack of Forecasting and Early Warning (0.0550)



9. Poor Economy (0.0282)

criteria importance

1. Human Loss



2. Economic damages (0.2000)



1. Lack of Forecasting and Early Warning



2. Lack of Emergency response and Hazard maps (0.1683)



3. Extreme Rainfall (0.1300)



4. Poor Economy (0.1094)



5. Poor Governance (0.1088)



6. Living in Flood prone area (0.1081)



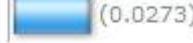
7. Low Societal Capital (0.1000)



8. Low Infra Development (0.0754)



9. Intensive Rainfall (0.0273)



criteria importance

1. Human Loss



2. Economic damages (0.1000)



	Indicators	Human Losses (%)	Economic Damages (%)
Hazard	Intensive Rainfall Intensity	24	6
	Long Inundation Time	2	3
	High Inundation Depth	8	13
	High Flood Flow Velocity	23	22
Exposure	Living in Flood Prone Area	15	23
	Large Inundated Area	3	8
Vulnerability	Low Societal Capital	4	3
	Poor Infrastructures Development	5	14
Coping Capacity	Lack of Forecasting and Early Warning System	9	5
	Lack of Emergency Response and Evacuation	7	3

Human Losses	Weight Averages	Maximum Weight	Minimum Weight
Hazard	40%	45%	13%
Exposure	25%	28%	19%
Vulnerability	13%	9%	25%
Coping Capacity	21%	17%	44%

Economic Damages	Weight Averages	Maximum Weight	Minimum Weight
Hazard	28%	34%	18%
Exposure	40%	36%	47%
Vulnerability	23%	22%	18%
Coping Capacity	10%	8%	18%

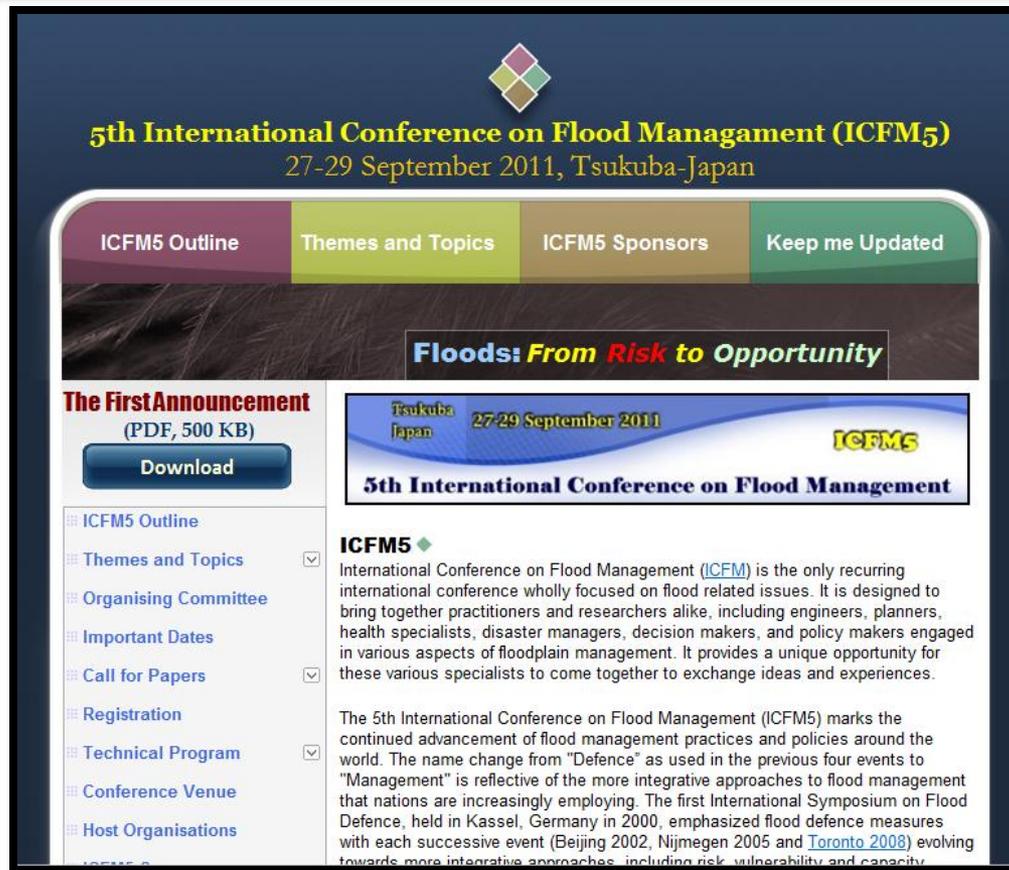
5th International Conference on Flood Management (ICFM5)

Tsukuba
Japan

27-29 September 2011

ICFM5

5th International Conference on Flood Management



5th International Conference on Flood Management (ICFM5)
27-29 September 2011, Tsukuba-Japan

ICFM5 Outline Themes and Topics ICFM5 Sponsors Keep me Updated

Floods: From Risk to Opportunity

The First Announcement
(PDF, 500 KB)
[Download](#)

- ICFM5 Outline
- Themes and Topics
- Organising Committee
- Important Dates
- Call for Papers
- Registration
- Technical Program
- Conference Venue
- Host Organisations

ICFM5 ♦
International Conference on Flood Management (ICFM) is the only recurring international conference wholly focused on flood related issues. It is designed to bring together practitioners and researchers alike, including engineers, planners, health specialists, disaster managers, decision makers, and policy makers engaged in various aspects of floodplain management. It provides a unique opportunity for these various specialists to come together to exchange ideas and experiences.

The 5th International Conference on Flood Management (ICFM5) marks the continued advancement of flood management practices and policies around the world. The name change from "Defence" as used in the previous four events to "Management" is reflective of the more integrative approaches to flood management that nations are increasingly employing. The first International Symposium on Flood Defence, held in Kassel, Germany in 2000, emphasized flood defence measures with each successive event (Beijing 2002, Nijmegen 2005 and Toronto 2008) evolving towards more integrative approaches, including risk, vulnerability and capacity



ICFM5 Topic Areas (Parallel Sessions)



居安思危 Be aware of risk while you are safe
思則有備 Awareness leads you preparedness
有備無患 Preparedness leaves you no worry

「春秋」左氏伝

Source : Zuo Qiuming "Zuoshi Commentary"
in Confucius ed. "Spring and Autumn", 480BC

**ICHARM cares people's well-being
and empowerment!**

www.icharm.pwri.go.jp



preparedness for floods