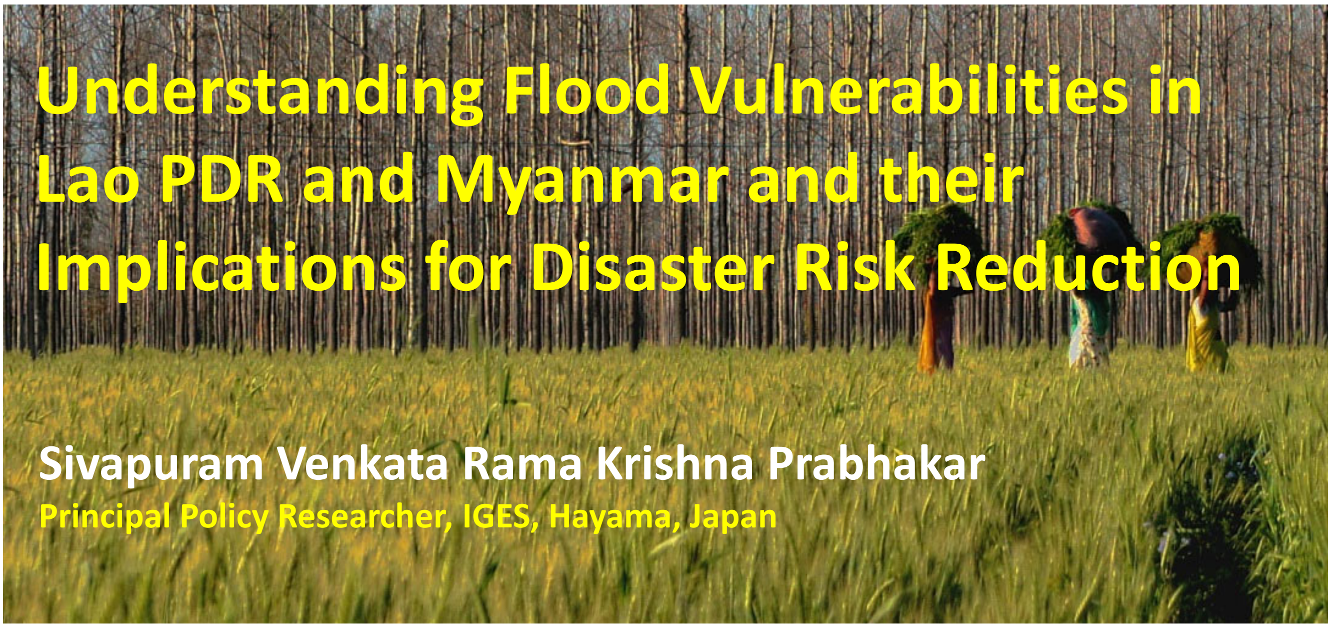
ASEAN-JAIF PROJECT ON DISASTER RISK REDUCTION BY INTEGRATING CLIMATE CHANGE PROJECTION INTO FLOOD AND LANDSLIDE RISK ASSESSMENT



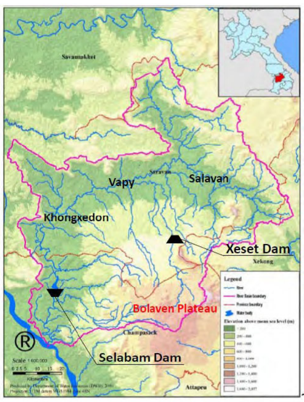
Understanding Flood Vulnerabilities in Lao PDR and Myanmar and their Implications for Disaster Risk Reduction

Sivapuram Venkata Rama Krishna Prabhakar

Principal Policy Researcher, IGES, Hayama, Japan

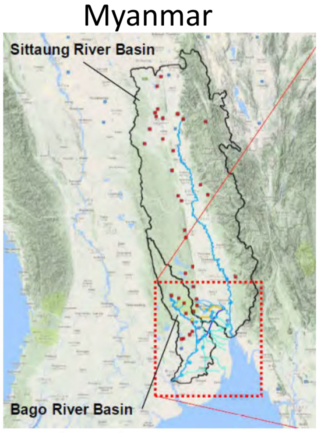
1. Background

Lao PDR



Xedon River Basin Xedon River: L=260km; Catchment area: 7,300km2

Myanmar

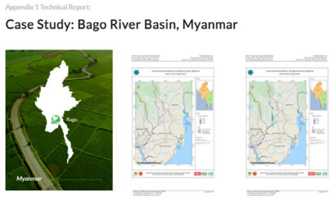


Bago River Basin Bago River: L=210km; Catchment area: 5,300km2

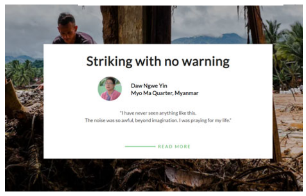
DISASTER RISK REDUCTION BY INTEGRATING CLIMATE CHANGE PROJECTION INTO FLOOD AND LANDSLIDE RISK ASSESSMENT

- Funded by JAIF, US$ 2.67 million (2018-2020)
- Implemented in **10 ASEAN countries**
- **2 pilot countries**: Myanmar and Laos
- **Target sites**: Bago, Taunggyi, Xedon, Phoukhoun
- Supports the ASEAN Disaster Portfolio, ASEAN Committee on Disaster Management
- Implemented by: IGES, CTII, ADPC
- **Objectives**
  1. Demonstrate the integration of climate change projections into flood and landslide risk assessment/mapping;
  2. Enhance technical capacities of government officials and national institutions;
  3. Enhance dialogue among local, national and regional stakeholders on integrating climate change adaptation policies and plans;
  4. Promote best practices and knowledge exchange among ASEAN countries.
- **Outputs**
  1. Guidelines and training modules for flood risk assessment
  2. Hazard maps and risk maps with different projected scenarios

Outputs and Outreach

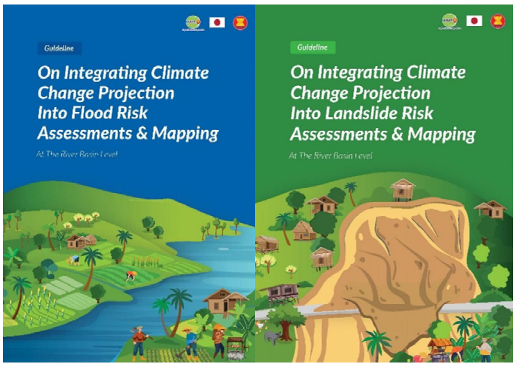


Case Studies



Impact Stories

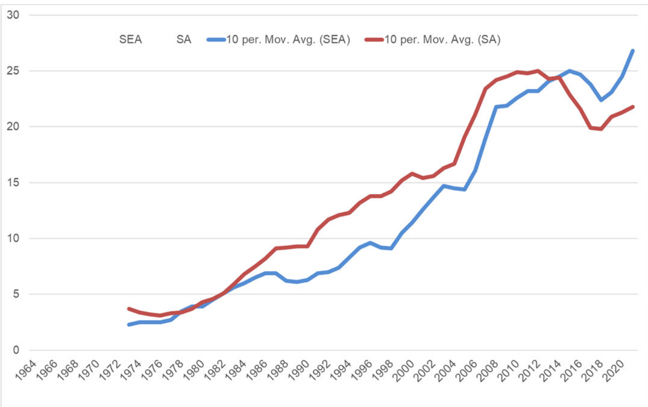
Project Website
https://aseandrr.org



Factsheets

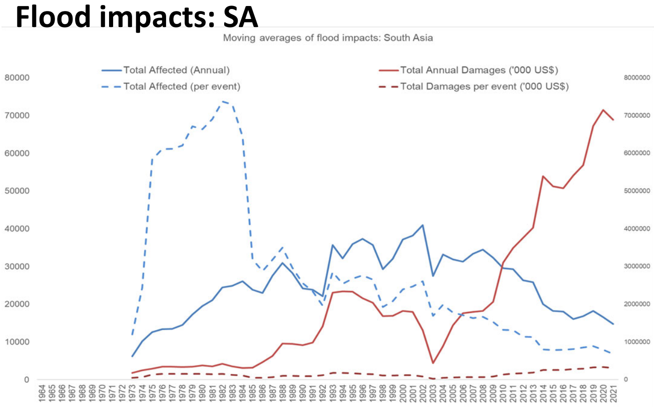
Floods: SEA vs SA

Annual flood events:

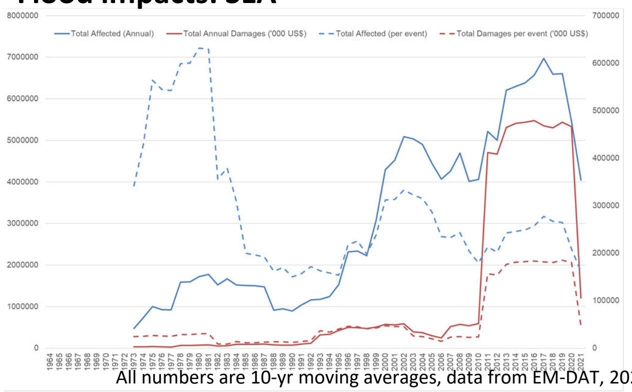


- SEA overtook SA in terms of number of flood events in the past decade
- SA and SEA exhibit a continuous increase in annual total flood damages.
- The total affected by floods came down significantly in the SA while it increased in SEA in the past decade

Flood impacts: SA

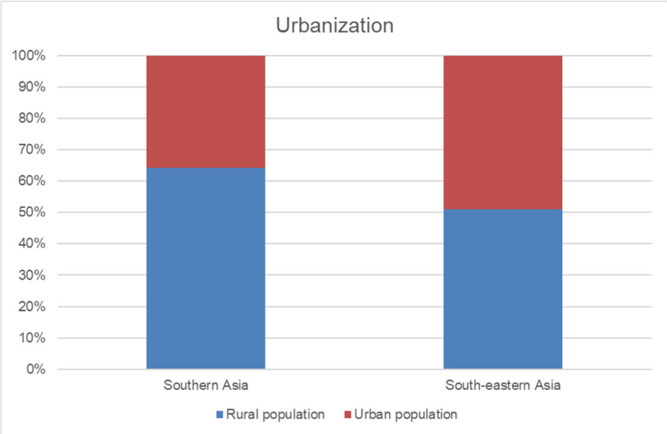


Flood impacts: SEA



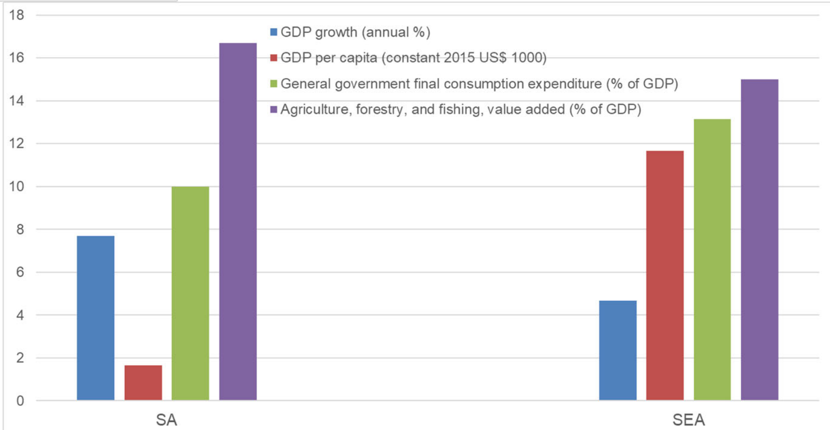
All numbers are 10-yr moving averages, data from EM-DAT, 2021

Developmental Contrasts of SA & SEA

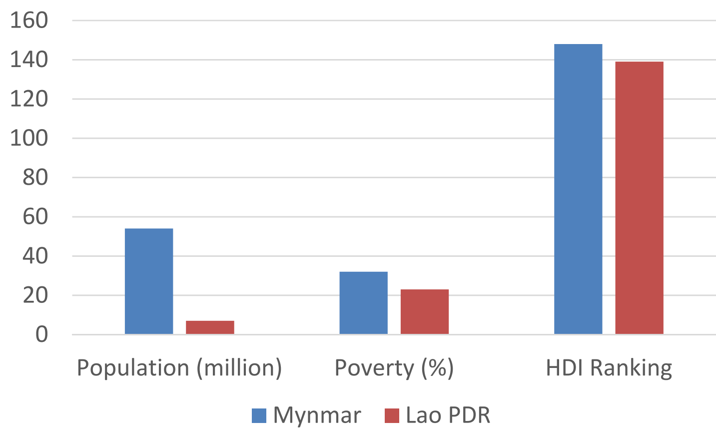


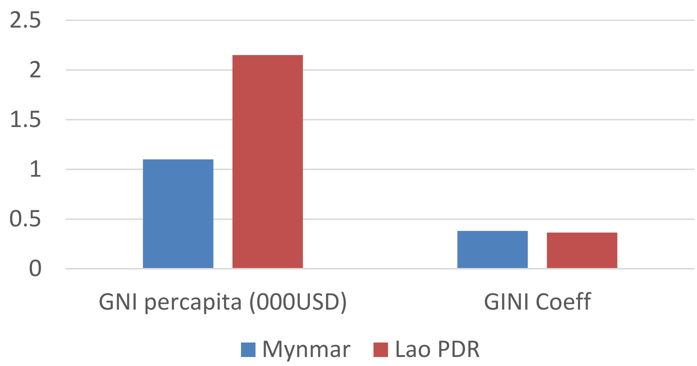
- SEA is marginally more urbanized
- SEA has better government expenditure and higher per capita GDP

- SA has relatively higher GDP growth rate (2016)
- SA has higher share of agriculture in GDP



Myanmar Vs Lao PDR

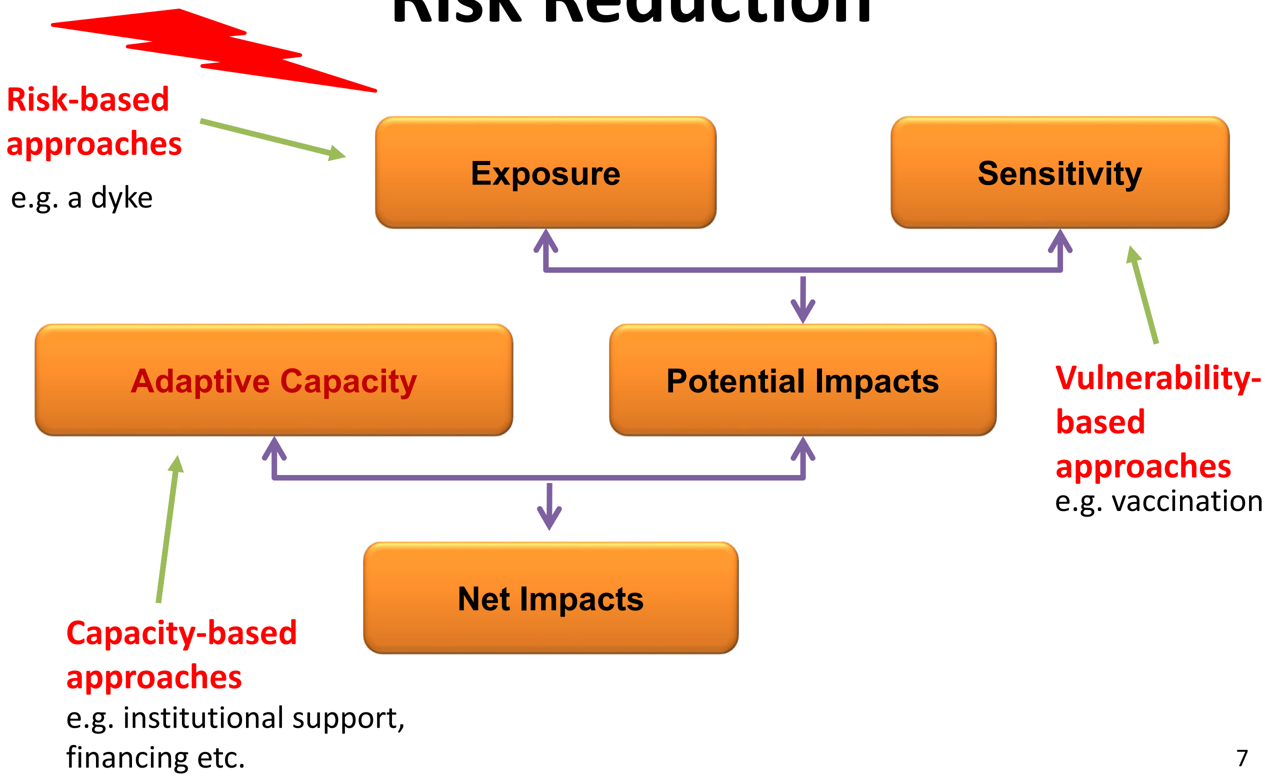




- Myanmar: high population, high poverty rate, high HDI rank, and high GINI coefficient (marginally higher inequality)
- Lao PDR: high GNI per capita

How do they reflect in terms of flood vulnerabilities?

Multiple Approaches to Disaster Risk Reduction



What is Vulnerability?

- There is no single agreed definition and vulnerability is subject to multiple interpretations and connotations
- There are at least two variations of vulnerability definitions and assessments
  - Engineering based definitions
  - Social and economic based definitions

- **Engineering definition:**

"… a measure of the damage suffered by an element at risk when affected by a hazardous process" (Wisner et al., 2005)

- **Social definition of vulnerability:**

"the presence or lack of ability to withstand shocks and stresses to livelihood" (Adger 2000)

IPCC Definition of Vulnerability

The degree to which a system is susceptible to [damage], or unable to cope with, adverse effects of [climate change], including climate variability and extremes.
Vulnerability is a function of the:

character, magnitude, and rate of climate variation ⇐ Hazard <> Impact

to which a system is exposed, its sensitivity, and its adaptive capacity.” ⇐ Inner state of system

Source: IPCC, 2021

VCA Methodologies: Tools

Frameworks and Tools	Vulnerability	Exposure				Sensitivity				Capacity			
	Vulnerability as function of S, E, & C	Current climate trends	Climate-induced events	Climate projections	Community based and scientific data	Current hazard trends	Biophysical impacts	Livelihood impacts	Hazard prioritization	Coping strategies	Livelihood assets	Awareness/knowledge	Capacity to plan and effect change
A framework for social adaptation to climate change, IUCN	✓	✓	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Climate vulnerability and capacity analysis, Care	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	✓
CVAAA, SPREP & CIDA	✓	✓	✓	✓	✓	✓						✓	
Vulnerability to resilience, Practical Action	✓	✓	✓	✓	0	✓	✓	✓	✓	✓	✓	✓	0
Participatory tools for assessing climate change impacts and exploring adaptation options, LFP & UKAID	Not clear	0	✓	0	✓	✓	✓	✓	✓	✓	✓	0	0
Adaptation toolkit, Christian Aid	Not clear	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	✓
CRiSTAL, IISD			✓			✓		✓		✓	✓		
CEDRA, Tearfund		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
CBA, IIED	Broad	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

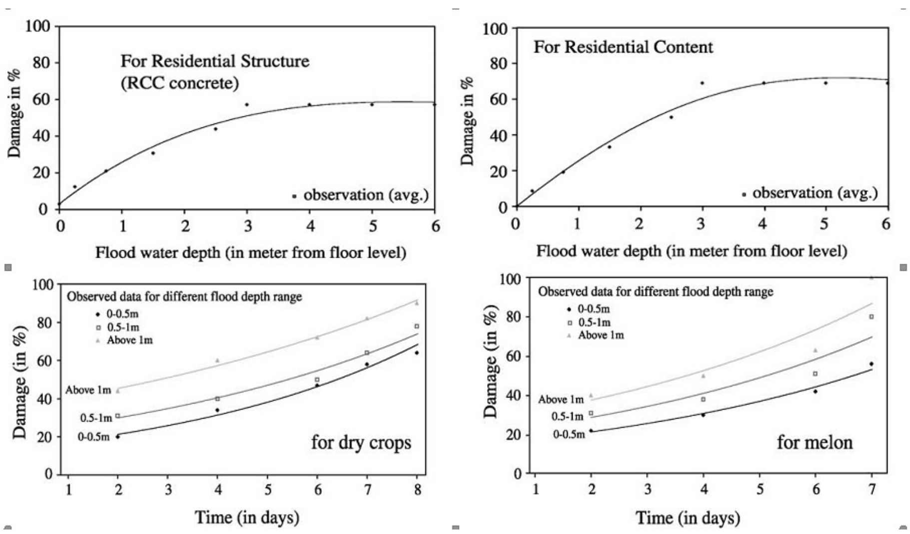
Prabhakar, 2019

Design Elements of Vulnerability Assessment Methodology

- Followed the vulnerability as a **function of exposure, sensitivity and capacity**
- A **mixed methods** approach was adopted where qualitative and quantitative vulnerability assessments were conducted
- **Employed indicators** for capturing the exposure, sensitivity and capacity factors both qualitatively and quantitatively
- Primary data was collected used **participatory approaches** including focused group discussions, and **stakeholder consultations,** to understand narratives of vulnerabilities
- Secondary data was collected from the published official records on demographic and socio-economic indicators

Damage Functions/Vulnerability Functions

- Empirical relationship between flood characteristics and physical damages/exposure element characteristics
- Crucial for dynamic models to estimate the risk



(Dutta et al.,2003)

Damage Functions have Space and Time Dimensions

- Buildings age over the period
- New construction standards and materials are used all the time
- New flood response and ealy-warning measures are taken up
- Nature of usage of building stock can change over the years depending the type and pace of the economic activities
- Change in the density of physical space and its interaction with humans change over the time

Location Specificity of Damage Functions

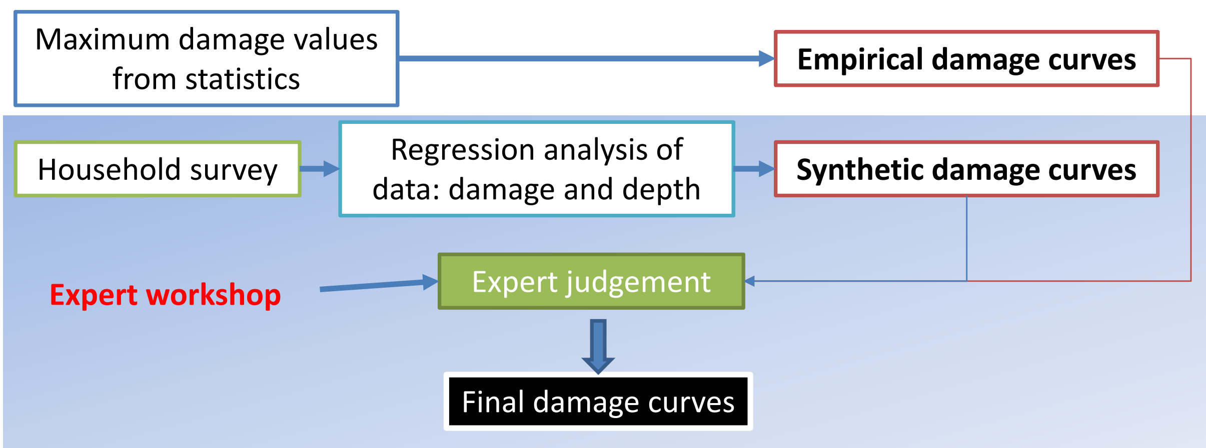
- Damage/vulnerability functions are highly location-specific since locations differ in
  - The type of building stock/infrastructure
  - Age of building stock/infrastructure
    - Socio-economic conditions of people
    - Economic activities performed that determine the type of infrastructure
    - Rural vs urban
  - Development of institutional systems including ability of local governments to form and enforce building bye-laws/regulations/land use plans etc.
- It also means that the damage functions differ from location to location and hence cannot be used with high degree of reliability.

Precautions for Developing Vulnerability Functions

- Clean up the data in terms of units, missing decimals (e.g. used commas in place of periods) etc.
- Check the depth and duration values reported by respondents with the flood simulation results
- Check same year is not reported in different flood severity categories by the same respondent.
- Check the frequency of responses for the highest depth of the flood: gives you an understanding on what proportion of people are affected by the given flood
- If there are multiple flood episodes in a single year: include highest and longest flood episode in the depth-duration-damage analysis since we are planning for the worst case scenario
- Damage rates are expressed as % of the physical structure damaged: Eliminates limitations associated with the economic valuation (changes in costs, inflation, quality of material etc.)

Developing Damage Function Curves

- **Sample surveys** were conducted to collect local flood characteristics and household damage data
- **Literature reviews** were conducted to cross-check the damage data with the past experiences

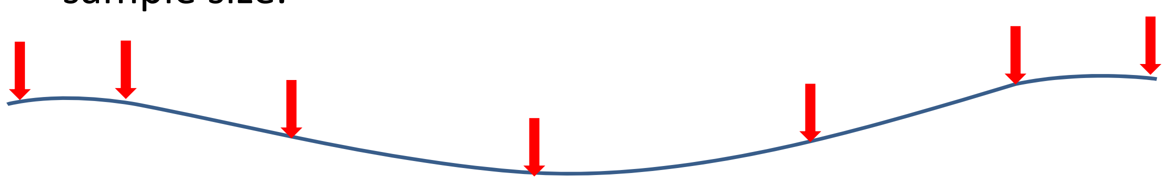


Literature to Build Damage Functions

- **Hazus model, USA**: 900 curves for structures, facilities based on US Federal Insurance Administration data
- **Blue Manual**: 150 Damage curves for commercial and residential properties in UK
- **Dias et al.,** 2018 detailed damage curves for Sri Lanka urban environment
- **Ngyuen et al., 2017**: agricultural damage functions for various provinces in Vietnam
- **Win et al., 2017**: Myanmar Bago floods damage functions

Sampling Design

- A 20% sample rate was used for sampling.
- Selected sampling in **different flood inundation zones** identified based on digital elevation data and suggestions from the local government
  - No of locations was determined based on the area of target flood zone to be covered for detailed risk assessment (i.e. covering the center, middle and periphery of the flood basin as much as possible taking the above points into consideration).
- Determined based on the **diversity of exposure elements** to be covered (e.g. types of buildings, age group of affected people, landholding size etc.).
- Administrative constraints such as number of days, human resources and finances also determined the final survey sample size.



Exposure Elements Considered

- Physical elements: Residential buildings
- Socio-economic elements:
  - Livelihoods: Arable crops (paddy)
  - Human health

Buildings

- Source of data: Direct survey
- The scale of survey:
  - Survey pinpointed house types based on the type of building stock present.
  - Mainly cover residential houses
- Data collected:
  - Type of buildings in the building stock
  - Nature of damage in the historical flood events
  - Cost of repair for each flood damage event
  - Flood depth and duration

Crops

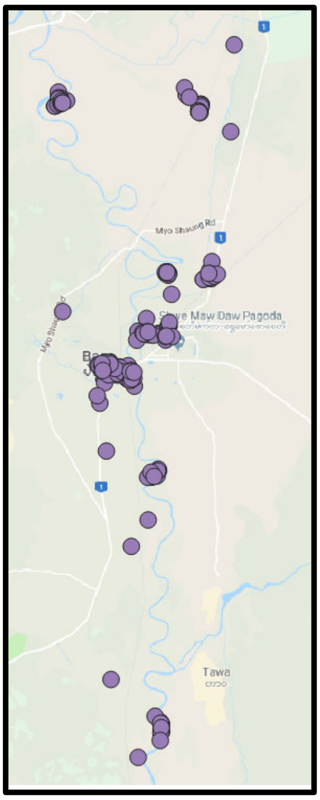
- Source of data: Direct survey
- The scale of survey:
  - Paddy crop
  - Same sampling approach as implemented for buildings
- Data collected:
  - Crop damage
  - Flood inundation depth
  - Inundation duration

Human health

- Source of data: Direct survey
- The scale of survey:
  - Cover major age and gender groups (women, children, aged)
  - Same sampling approach as buildings
- Type of data collected
  - Age
  - Type of illness
  - No of days illness
  - Cost of healthcare
  - Loss of income/livelihood due to illness if any
  - Duration and depth of inundation at home

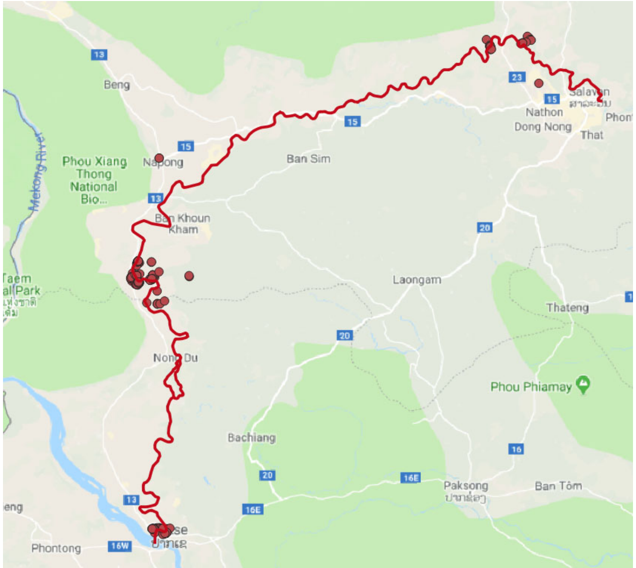
Flood Vulnerability Functions of Myanmar and Lao PDR

Myanmar: Sample Locations & Demographic Metadata



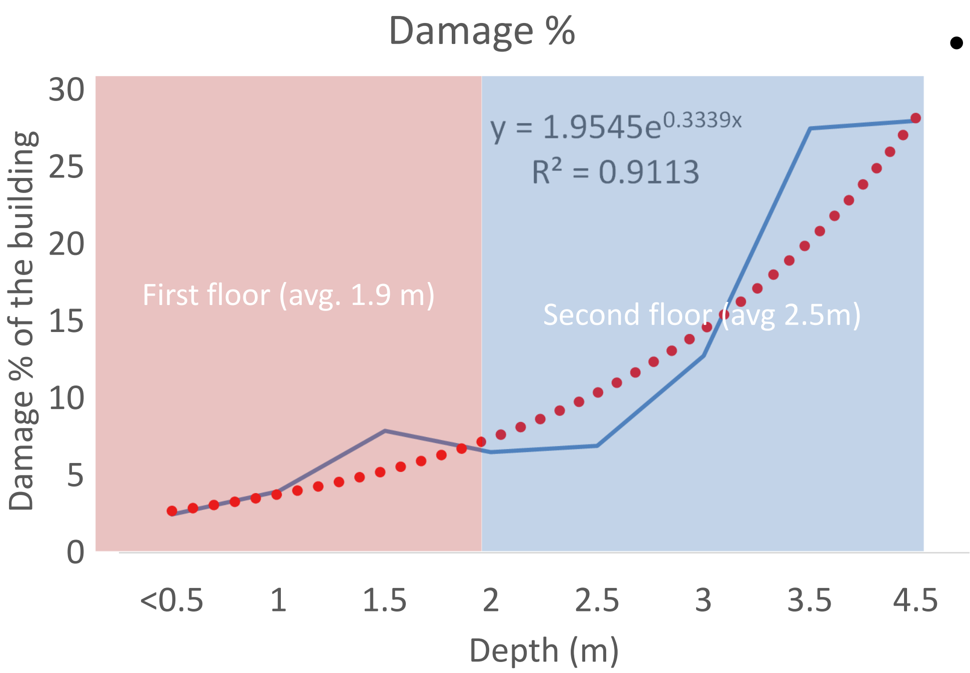
- Total No of samples: 198
- Total sampled population: 995
- Average age of the sampled population: 38
- Average household size: 5
- Sex ratio of sampled HHs: 0.86
- Predominant gender of the respondents: Female (due to survey time?)
- % of surveys responded by head of the household: 56%
- Poverty headcount (%): 12
- Composition of houses
  - Wooden stilts: 85%
  - RC Beams: 11%

Lao PDR: Sample Locations and Demographic Metadata



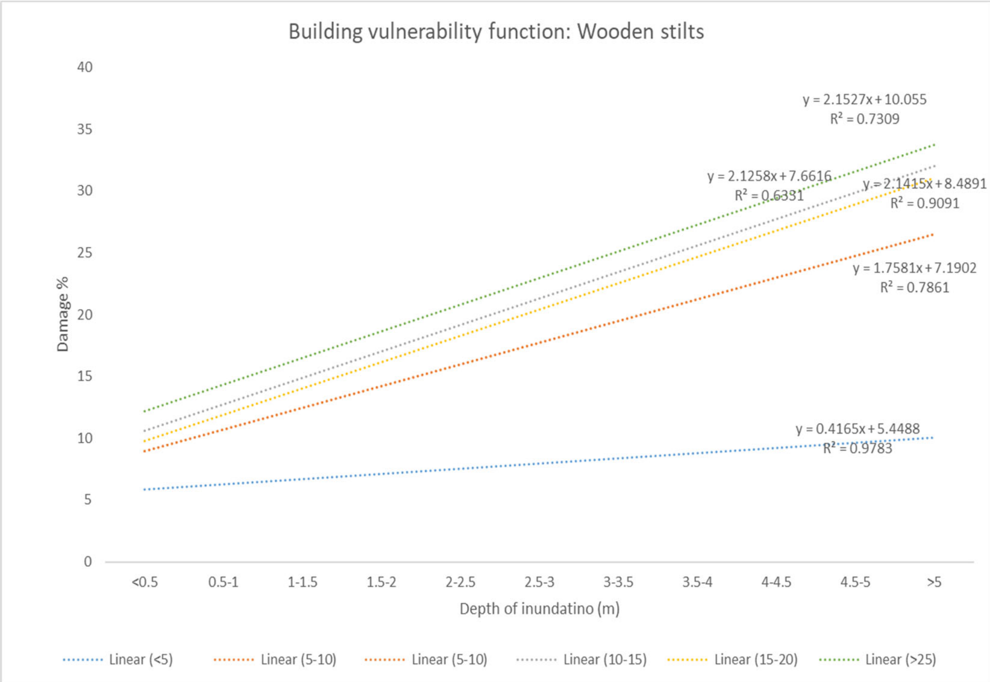
- Total sample size: 194
- Total sampled population: 1000
- Average age of sampled population: 51
- Average household size: 6
- Sex ratio: 0.92
- HH heads participation in the survey: 3%
- Poverty head count: 10%
- Composition of houses
  - Wooden stilts: 74%
  - RC beams: 21%

% Damage of Wooden Stilted Houses: Myanmar



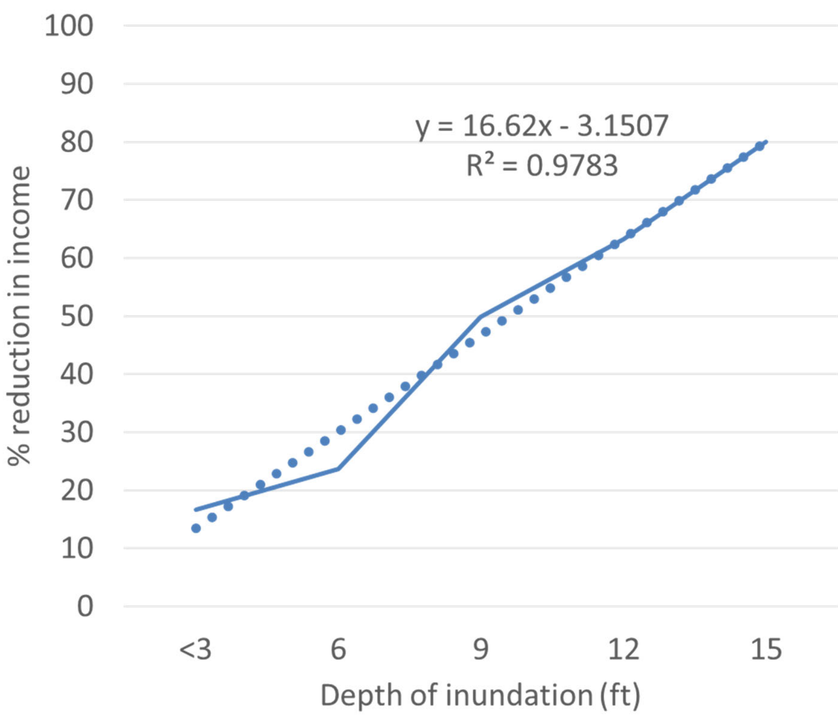
- Wooden stilted houses represent 85% of the total building stock in the survey location.

% Damage of Wooden Stilted Houses: Lao PDR



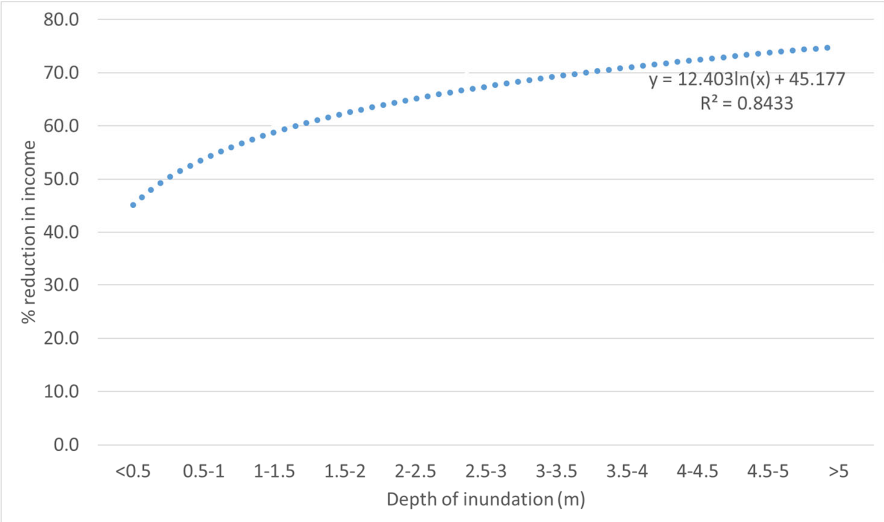
Wooden stilted houses represent 74% of the total building stock in the survey location.

% Income Loss vs Depth of Flooding: Rice Crop in Myanmar



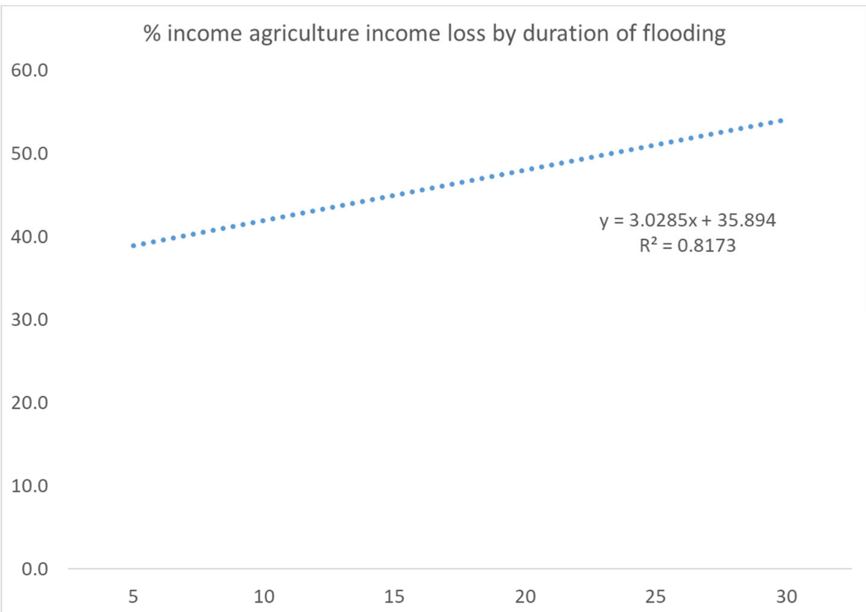
- Rice yields showed relationship only with the depth of inundation.
- The depth and duration interactions with the crop damage were not clear.
- Overall, the crop showed a **moderate resilience** to flooding as the crop yields declined only by **24%** for a rise from 6 ft.
- However, the damage below 3ft inundation was also high (17%)

% Income Loss vs Depth of Flooding: Rice Crop, Lao PDR



- The depth and duration interactions with the crop damage were not clear.
- Overall, the crop showed a **low resilience** to flooding as the crop yields declined by **40%** for a rise from 0.5m to >5 m.
- However, the damage below 0.5m inundation was very high (45%)

% Income Loss Vs Duration of Flooding: Rice Crop, Lao PDR



- Linear relationship between the duration of flooding and crop income loss
- Whereas, the relationship between the income loss and depth of flooding was exponential
- The interaction between depth and duration was not significant

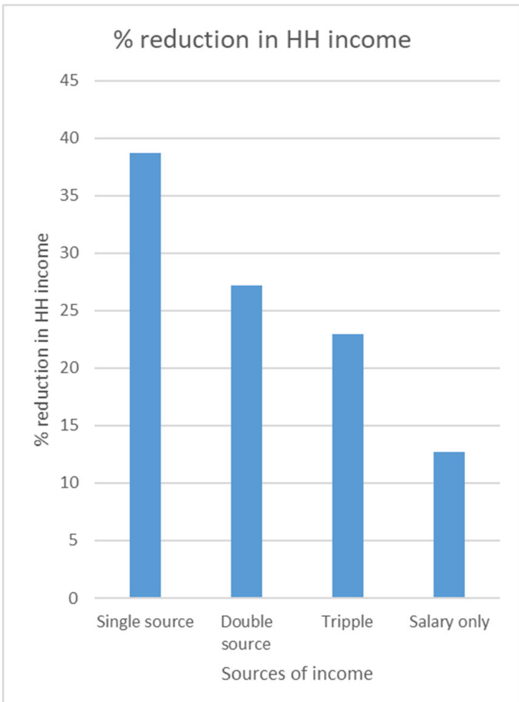
Agricultural Yield vs Agricultural Income

- Agricultural yields may provide independent evaluation of losses from the institutional and market (demand and supply) conditions. However, it may not completely reflect the actual economic impact on the households.
- Where as, agricultural income during flood years could provide more better picture on the impact of flood on family wellbeing
  - Agricultural commodities could fetch higher income during flood year than normal year on per kg basis due to higher demand and lower supply in the market.

Income Security vs Livelihood Diversification: Myanmar

- Households with more than one income source have less reduction in overall family income than households with a single source as agricultural income.
- Households with a salaried job have least reduction in their income (13% reduction).
- The reduction in **agricultural income was 38%**. In comparison, the **non-agricultural income** of households experienced an average **26%** reduction.
- Poverty doubled during flood years.*
  - Normal year: 12% poverty head count
  - Flood year: 24% poverty head count

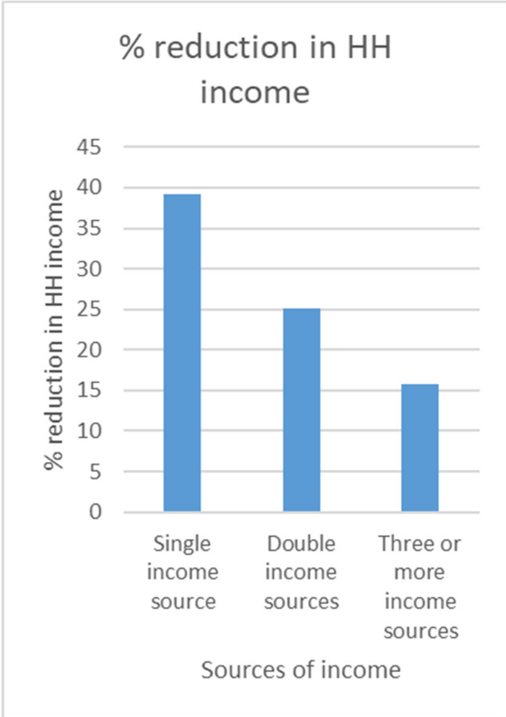
** Based on income and not consumption*



Farmers are highly likely to have more than one income source than business people

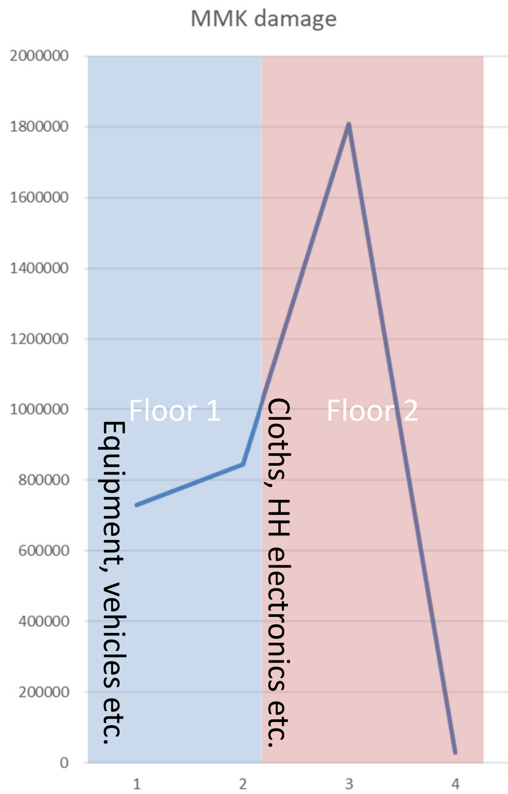
Income security vs Livelihood Diversification: Lao PDR

- Households with more than one income source have found less reduction in overall family income than households with a single source of agricultural income.
- Households with a salaried job have found the least reduction in their income. Only 16.4% reduction in the salary income.
- The reduction in agricultural income was 43.4%. In comparison, the non-agricultural income of households experienced an average 20.3% reduction.
- Poverty doubled during flood years.



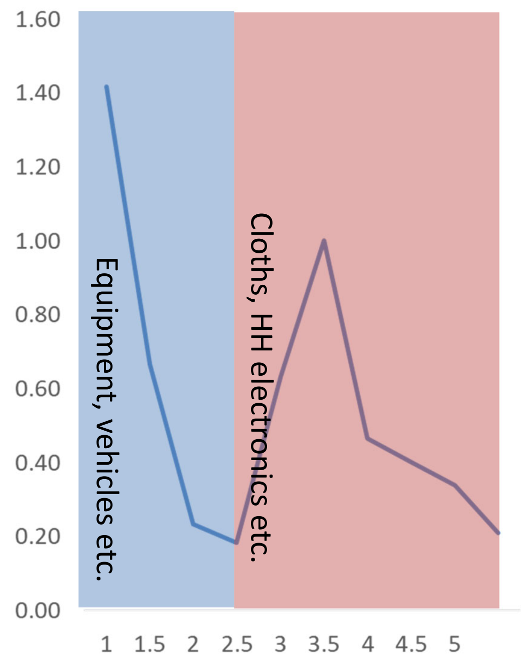
Damage to Household Assets: Myanmar

- Damage to assets show a complex trend with the depth of flooding.
- General observations:
  - **Highest damage occurred when the depth of flooding is at 3m**
  - 59% of HHs reported some kind of asset damage (47% higher than Lao)
  - Average loss of assets was at 1.6 million MMK per household (0.4 million MMK higher than Lao)
  - Most reported type of assets are electronics (44%), cloths (16%), and vehicles (14%)



Damage to Assets: Lao PDR

- Damage to assets show a complex trend with the depth of flooding.
- General observations:
  - **Highest damage occurred when the depth of flooding is between 0.5-3m and the duration of 1-5 days**
  - Only 13% of HHs reported some kind of asset damage spanning several years of data
  - Average loss of assets was at 1.2 million LKP per household (only among the 13% of the damage reported HHs)
  - Most reported type of assets are agricultural equipment (45%), cloths (35%), and furniture (12%)
  - Communities are evacuating the valuables for a severe floods of longer duration and higher depths



Human Health, Myanmar

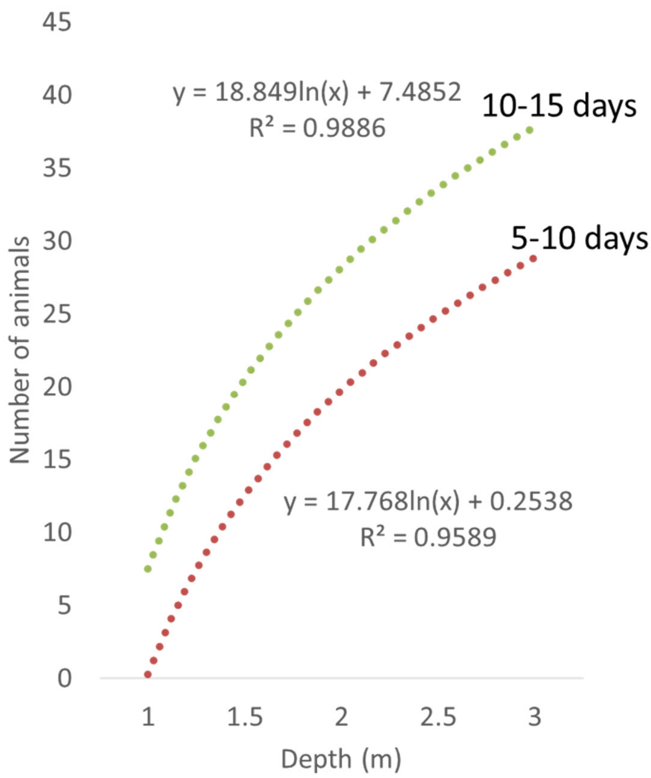
- **Flood duration of 8 days, and 6 ft of flood height have caused 85% of total human health costs.**
- No discernable trends were observed between the depth, and duration of flooding and number of people affected.
- No deaths in any of the villages surveyed
- 43% of the surveyed HHs (198) were affected by some kind of health problem (31% higher than Lao)
- Per capita increase in health expenditure: 12%
  - Per capita health expenditure and loss of income: 0.37 million MMK, **263 USD** (1.76 million LKP, **200 USD**)
- Per capita work days lost: 13 (6 days less than Lao)
- 38% men (Lao more children), 35% children, 22% women and 5% children

Human Health: Lao PDR

- **No discernable trends were observed between the depth, and duration of flooding and number of people affected.**
- Only 7% of the surveyed family members (1186) were affected by some kind of health problem.
- No deaths in any of the villages surveyed
- Children (52%), women (27%) and older (22%) are the most affected among the population.
- On an average, an affected family spent 1.76 million LKP, lost 19 working days, and lost an income of 5 million kip.

Animal Mortality, Lao PDR

- Poultry is most predominantly affected followed by cattle and pigs.
- Highest animal mortality happened at **1.5m depth of flooding for a 15-20** days duration.
- Only 5-10 days, and 10-15 days duration showed discernable trend with the depth of flooding.



Conclusions

- The differences in vulnerabilities between two river basins can be attributed to the developmental conditions.
- In terms of livelihoods, there is a clear role of livelihood diversification in flood resilience.
- Wooden stilts played a major role in mitigating the flood impacts. Early evacuation of valuable assets and storing calorie rich food is the key before floods.
- Poverty implications of floods were clearly demonstrated, floods resulted in doubling of poverty.
- More detailed survey measures are required to accurately capture the damage functions and for reliable risk assessments.

Thank You!

For more information, please contact: prabhakar@iges.or.jp