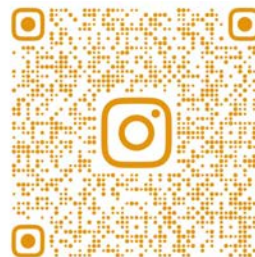


Strengthening social resilience and reducing poverty and inequality through flood protection investment as climate adaptation

Akiyuki Kawasaki

Professor, Institute for Future Initiatives,
and Department of Civil Engineering,
The University of Tokyo

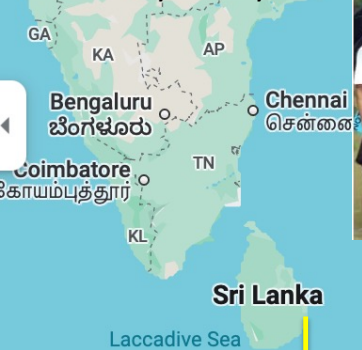
e: kawasaki@ifi.u-tokyo.ac.jp



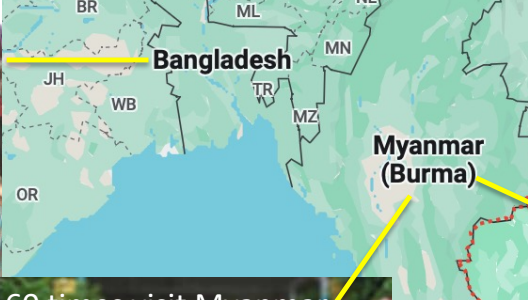
@KAWASAKIGROUP_UTOKYO



Community survey



Floods and drought



60 times visit Myanmar



Household Interview Survey

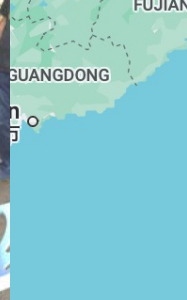


2010-2014@AIT, Thailand

Asian Institute of Technology (AIT), Thailand, 2012



JICA/IST SATREPS project



Working locally?



Urban poor

- Conducted **over 9,000 household visits** to date in Myanmar, Thailand, Sri Lanka, Philippines, Bangladesh, etc. 2



You are 16 years old living in a rural flood-prone area in low-income country.

- What are your daily interests and concerns?
- What are your future goals?

Q1. Any relationship between poverty and disaster?



17 Sustainable Development Goals and 169 targets

Q2. How can we make **long-term policy** for reducing **poverty** through **climate adaptation** / **DRR**?



Nature **569**, 327-329 (2019)



A family shelters from the rain in Mozambique after Cyclone Idai.

Put equity first in climate adaptation

Focusing on the bottom few per cent, not averages, is the best way to tackle poverty, argue **Mark Pelling** and **Matthias Garschagen**.

In September, the United Nations will set out a global agenda for helping communities adapt to climate change through the framework of the Sustainable Development Goals (SDGs). As nations draw up their strategies, we call on them to put equity first.

Poor people face a double burden of inequality — from uneven development

and climate change. In Mozambique, for example, two-thirds of the population lives in extreme poverty, on less than US\$1.9 per day. In March, the nation was hit by Cyclone Idai, followed by Cyclone Kenneth in April. Idai alone killed 1,000 people and left 3 million in need of help. Most were in poor, isolated rural communities and coastal settlements that were cut off from emergency responses.

People on extremely low incomes often live along coasts and riversides that are prone to flooding, and in other exposed areas. In Nigeria, the poorest 20% are 50% more likely to lose their lives, assets, livelihoods or health in a flood than the average Nigerian*. They are also 130% more likely to be affected by a drought, and 80% more likely to be affected by a heatwave.

Today's agenda

1. Relationship between **poverty** and **disaster**
2. Where should we **invest** in **climate adaptation / disaster risk reduction** for reducing poverty and inequality?

1. Relationship between poverty and disaster



Bago Region, Myanmar



SUSTAINABLE DEVELOPMENT GOALS

Goal 1: End poverty in all its forms everywhere



17 Sustainable Development Goals and 169 targets



SUSTAINABLE DEVELOPMENT GOALS

17 GOALS TO TRANSFORM OUR WORLD



Goal 1: End poverty in all its forms everywhere

→ In recognition of how poverty is complex, correlated with multiple issues such as food, energy, water resources, and education, and thus we cannot solve other issues without addressing poverty.

Target 1.5 By 2030, build the **resilience** of the poor and those in vulnerable situations and reduce their **exposure and vulnerability to climate-related extreme events** and other economic, social and environmental shocks and **disasters**

Floods exposure disproportionately concentrates in poorer countries and people

838 M people in poverty (2022, WB)

90% > are at flood risk

X Climate change
X Pop increase
X Urbanization



Floods are an extremely important matter for poverty issue!!

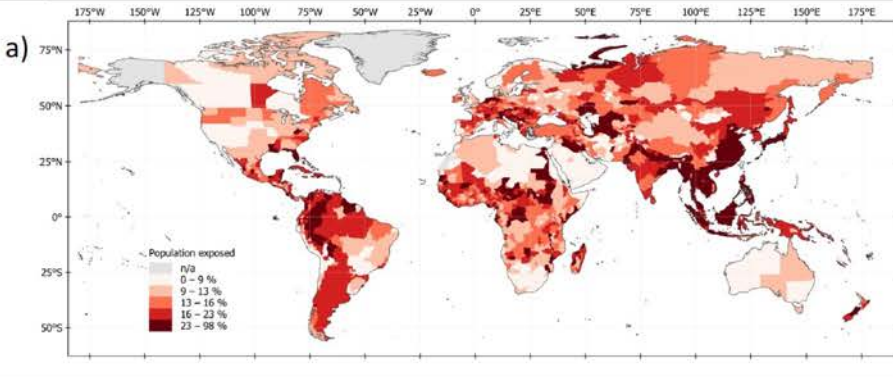
nature communications

(Rentschler, et al., 2022)

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Article | [Open access](#) | Published: 28 June 2022

Flood exposure and poverty in 188 countries



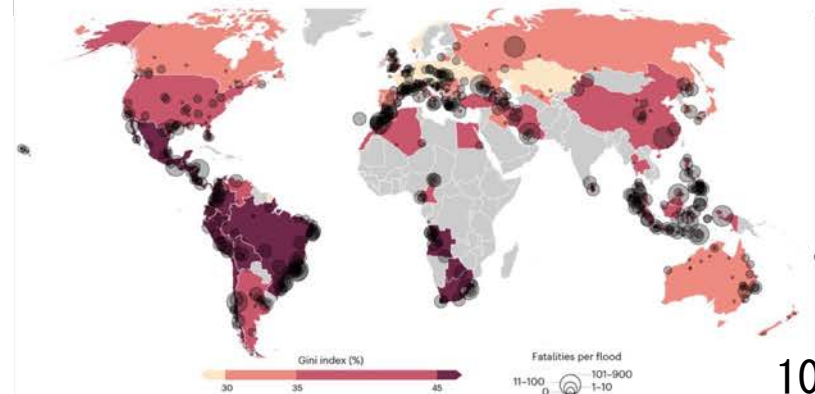
nature sustainability

(Lindersson, et al., 2023)

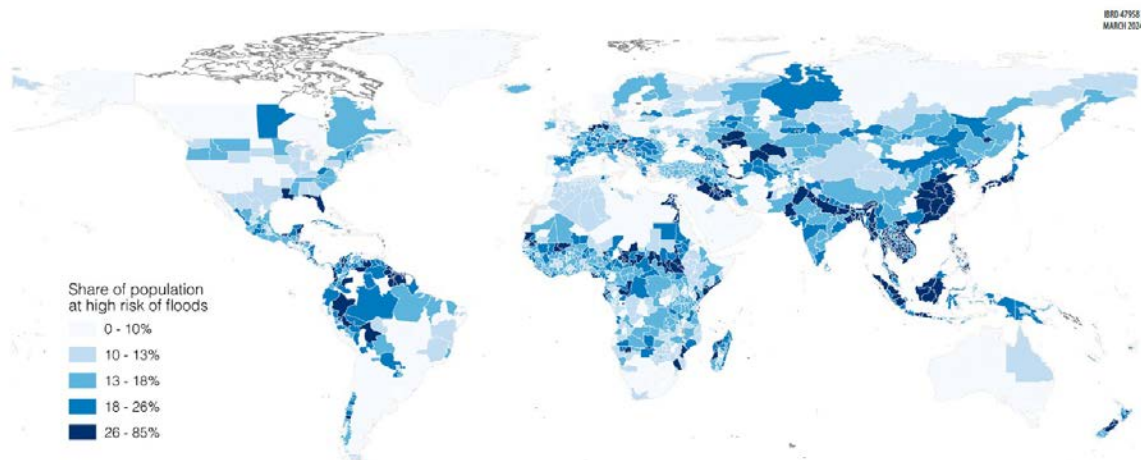
Analysis

<https://doi.org/10.1038/s41893-023-0110>

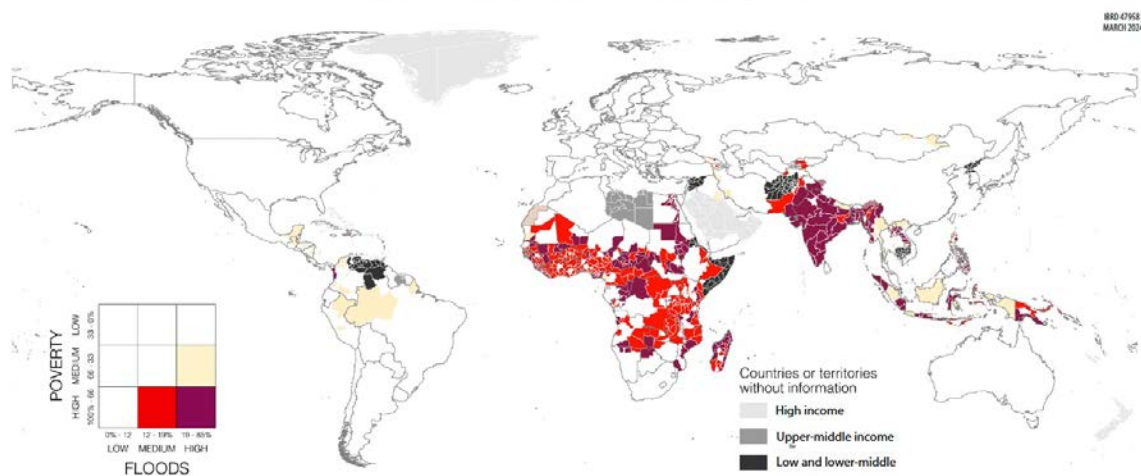
The wider the gap between rich and poor the higher the flood mortality



a. Location of floods



b. High-vulnerability hotspots of floods and poverty

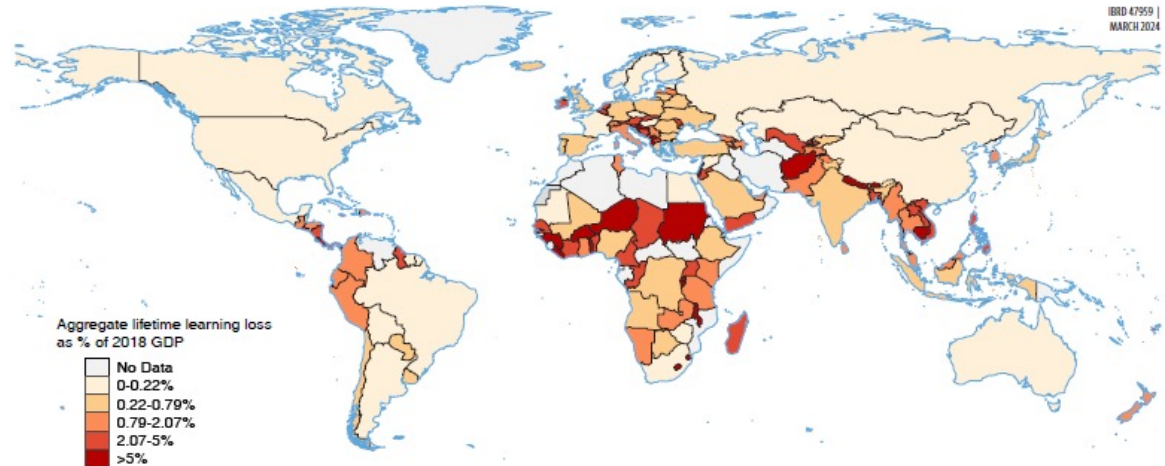


Vulnerability hotspots for poverty and floods are concentrated in Sub-Saharan Africa, South Asia, and East Asia and Pacific Region

- The impact of water-related disasters is **not uniform**; they have a greater impact on **socially vulnerable people**.
- These impacts are **not limited to economic losses**; **social impacts**, such as the loss of educational opportunities for children.

Total economy-wide effect of learning loss due to water shocks as share of 2018 GDP

Between 2000-2021,
140 M school-age children in 147 countries were affected by extreme wet shocks lasting an average of **1.8 months per year**



Extreme-floods induced learning and lifetime earning loss amounted to 2.2 % of GDP

Our approach

Floods and poverty are unevenly distributed at the national and subnational levels.



Addressing this issue requires clarifying the local-scale realities of floods and poverty and formulating appropriate flood protection measures.



However, in most developing countries, data is limited, so little is known about the situation on the ground.



My team conducts research and development beginning with data collection in flood-prone areas. Based on scientific analysis and simulation, we support the policy-making to reduce floods and poverty.



A framework for assessing the impact of flood protection investment on poverty and inequality



Household economy

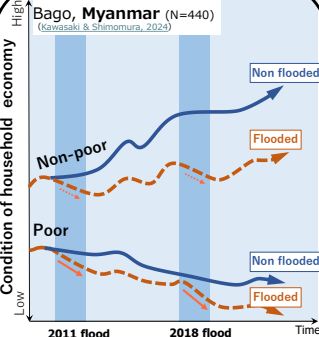


Damage and loss



House and asset distribution

Bago, Myanmar (N=440)
(Kawanishi & Shimomura, 2024)



Condition of household economy

2011 flood 2018 flood Time

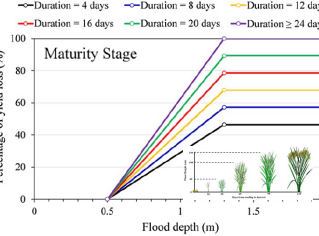
Non-poor

Poor

Flooded

Non flooded

Floods impact on household economy and education



Percentage of yield loss (%)

Flood depth (m)

Duration = 4 days

Duration = 8 days

Duration = 12 days

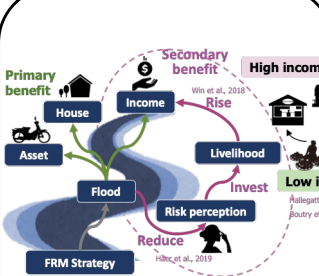
Duration = 16 days

Duration = 20 days

Duration = 24 days

Maturity Stage

Flood damage functions for agricultural crops



Primary benefit

Secondary benefit

High income

Low income

Invest

Risk perception

FRM Strategy

Flood

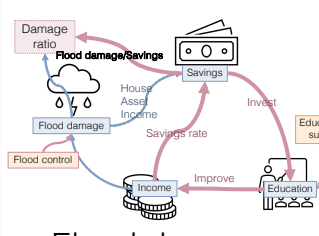
House

Asset

Income

Livelihood

Flood control - livelihood advancement model



Damage ratio

Flood damage/savings

Savings

Household Asset Income

Savings rate

Invest

Educational support

Education

Improve

Income

Flood control

Flood damage

Flood damage - saving estimation model

Future rainfall

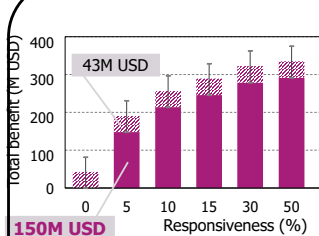
Inundation

Flood DRR measures

Socioeconomic impact

Long-term livelihood and social responses

Cost benefit analysis



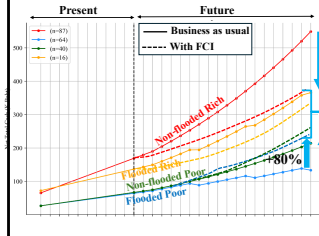
43M USD

150M USD

Total benefit (M USD)

Responsiveness (%)

Secondary benefit of flood DRR investment



Present

Future

Business as usual

With FCI

Non-flooded Rich

Flooded Rich

Non-flooded Poor

Flooded Poor

80%

Impact of DRR investment on economic disparity reduction



Myanmar



Ghana



Bangladesh

**9,000 households Interview surveys
in flood-prone areas in 6 countries**



Philippines



Thailand



Sri Lanka

Extreme poor live in isolation from society.....



Tucked away, out of sight from the main street



Remote areas far from towns and villages



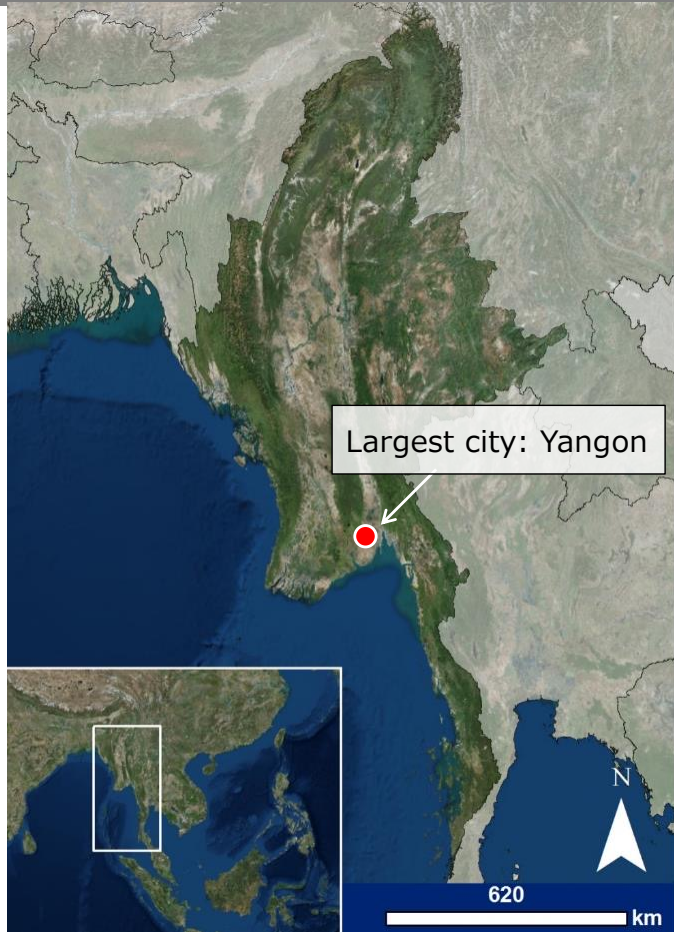


- **See** things you never seen before
- **Listen** to story you have never imagined before
- **Understand/verify** things you doubt before





Republic of the Union of Myanmar



Human Development Index (HDI)

Rank **150**/185 Countries (2025)

Population living on degraded land: **12.6**%

Disaster-affected population : **156** per 100,000 population

Source: Human Development Report 2020 Dashboard 4, UNDP



Bago Region: Houses



Walls made of wood and bamboo / Roofs made of tin and hay



Height of past flooding

Boats for evacuation



Flood plain + River for daily domestic use



Case : Poverty in Myanmar 1



- Family living on **illegally occupied land** from their parents' generation
- Only unstable and low-paying **day labors** due to **underdeveloped economy**.
- Landowners force them to evict owing to economic development and rise in land price
- Excluded from public assistance during floods due to **no resident registration**



Case : Poverty in Myanmar 2

- Creeks clogged with garbage in communities: one factor of inland flooding
- Lack of public waste collection services
- Cautions and awareness raising campaigns leaving no effect on residents
- Education to residents is the key challenge



Case : Poverty in Myanmar 3

- No early warnings, so **floods reaching floor level occur suddenly in the middle of the night**
- **No income during floods** since they do not own any farmland, and live on **a daily basis**
- No choice other than to evacuate to relief centers, due to lack of savings

Thailand



Human Development Index (HDI)

Rank **76**/185 Countries (2025)

Population living on degraded land: **21.0**

Disaster-affected population : **0.13** per 100,000 population

Source: Human Development Report 2020 Dashboard 4, UNDP

Urban poverty in Thailand

写真: シャンティ国際ボランティア会 <http://sva.or.jp/wp/?p=533>



- **1 in 5** Bangkok residents are slum dwellers
- Top 20% earn over \$23,460 per year, bottom 20% earn less than \$1,800
- **Motivation** to study and pursue higher education is **generally low** among the poor
- Many houses have TVs and refrigerators, but most jobs are **temporary day jobs**
- Many are tempted to engage in illegal work such as prostitution and drug trafficking
- **Discrimination** in employment remains for those from slums even if they obtain higher education through scholarships.

Rural poverty in Thailand



- Rural-urban income disparity, low productivity in the agricultural sector
- Photo shows a poor district along a river where the majority of residents are without farmland.
- Agriculture is damaged due to flooding of more than 1 m for more than 3 months every year.
- Many residents are day laborers in agriculture and have unstable and low income.
- Although there is public support for higher education, children from poor families have low motivation to study.
- Many elderly households due to the exodus of young generation.



















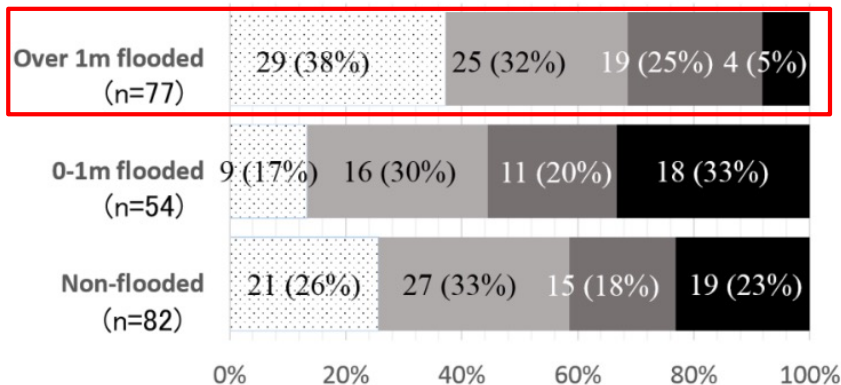


Relationship between flood depth and income/education level

Flood depth ↔ Income

$\chi^2=20.29$, $df=4$, $P<0.01$

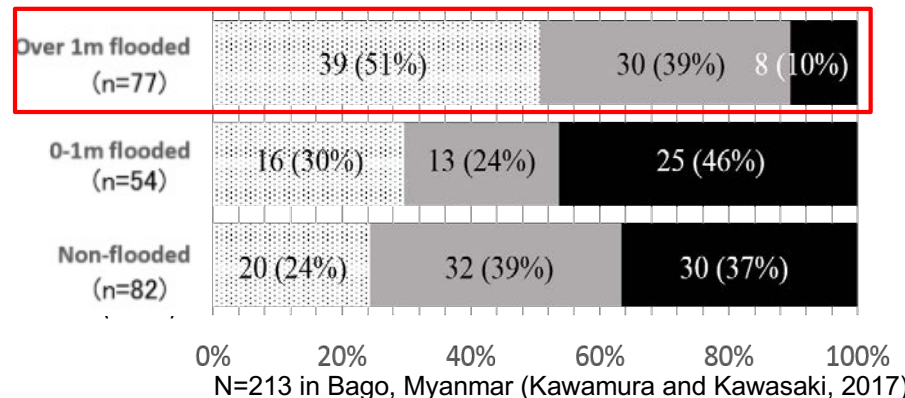
Low income Low-middle High-middle High income



Flood depth ↔ Education

$\chi^2=25.32$, $df=4$, $P<0.01$

Low-level education Middle High-level education



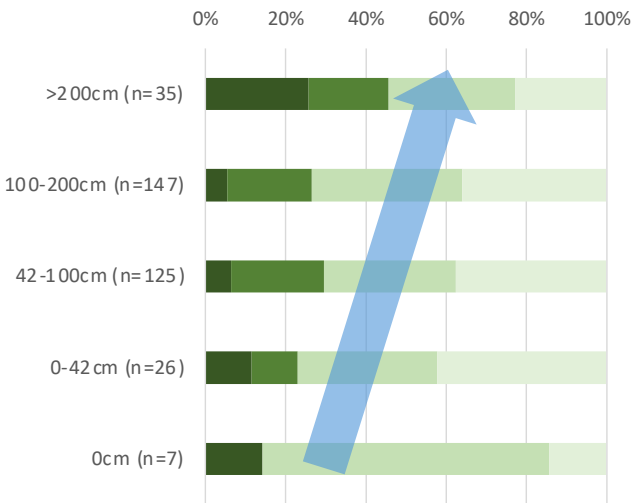
Data on the **socioeconomic impact of different social groups** is accumulating in various Asian countries

→ Provide implications for **policymaking** regarding flood DRR and its impact on **socioeconomic activities**.

Flood damage is more severe for the poorer

Bago, Myanmar (N=340)

(Shrestha, Kawasaki, Win, 2021)

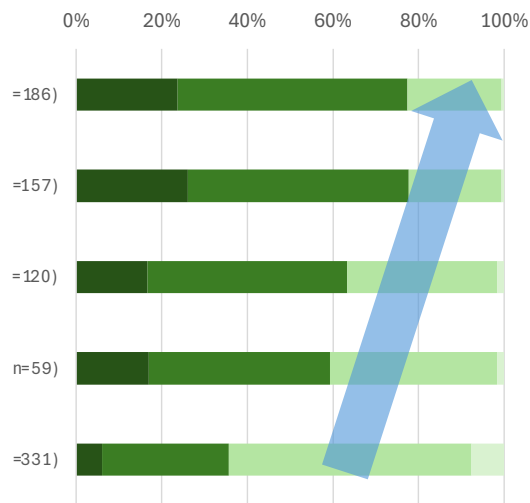


2018 flood

$\chi^2=23.98$, $df=12$, $p=0.02$, Cramer's V: 0.15

Ayutthaya, Thailand (N=886)

(Vin & Kawasaki, 2024)

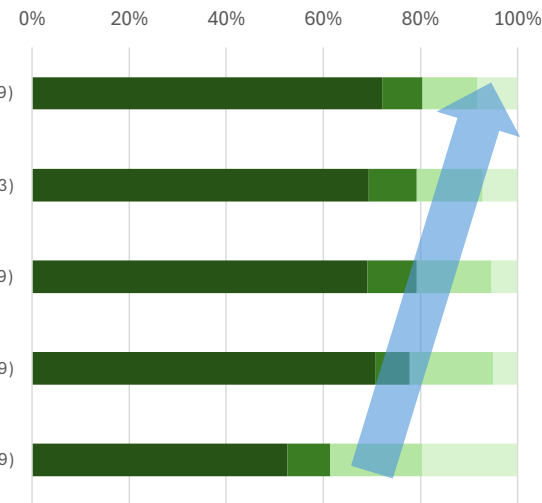


2021 flood

$\chi^2=139.34$, $df=12$, $p<0.01$, Cramer's V: 0.23

Marikina, Philippines (N=1309)

(Vin & Kawasaki, in preparation)



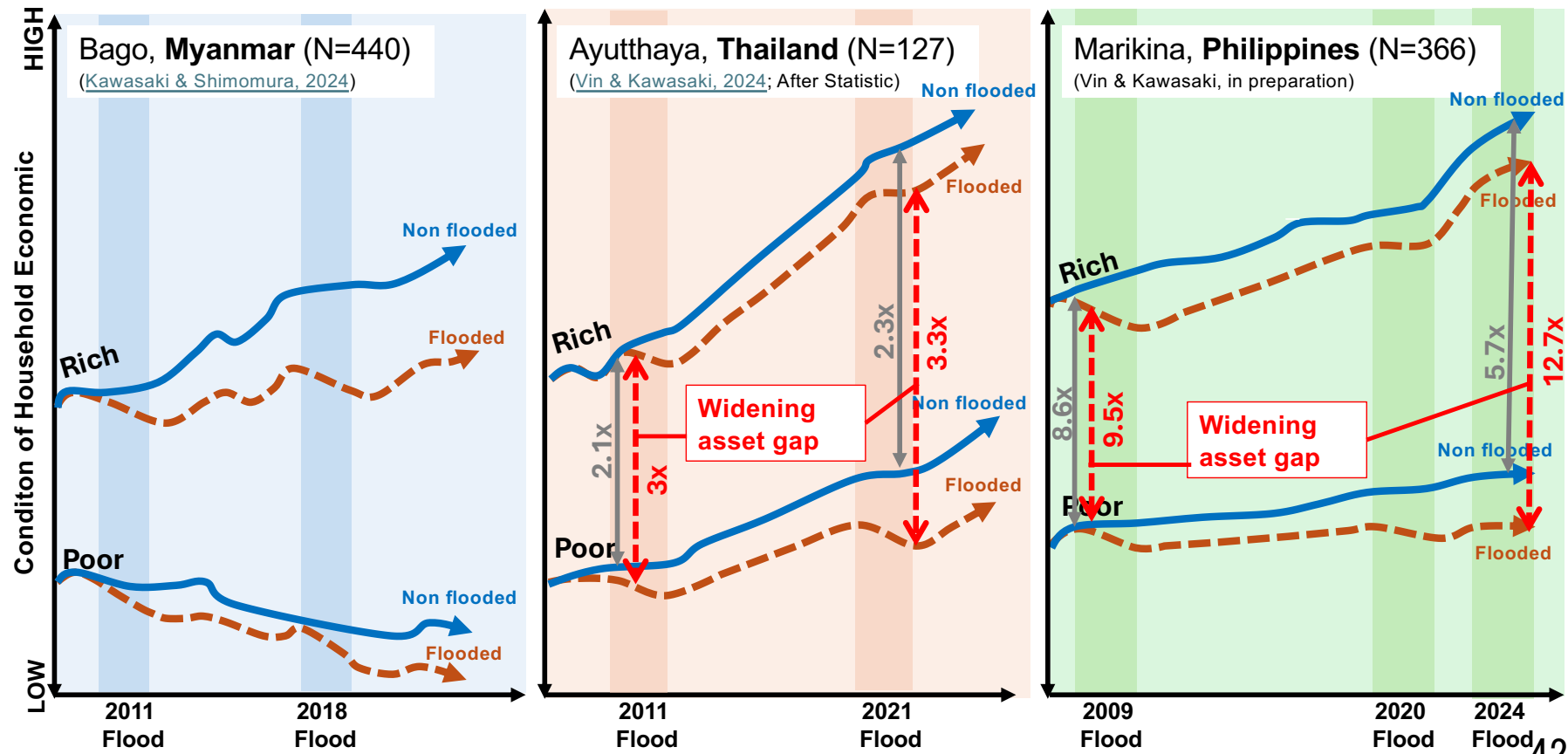
2024 flood

$\chi^2=64.57$, $df=12$, $p<0.01$, Cramer's V: 0.12

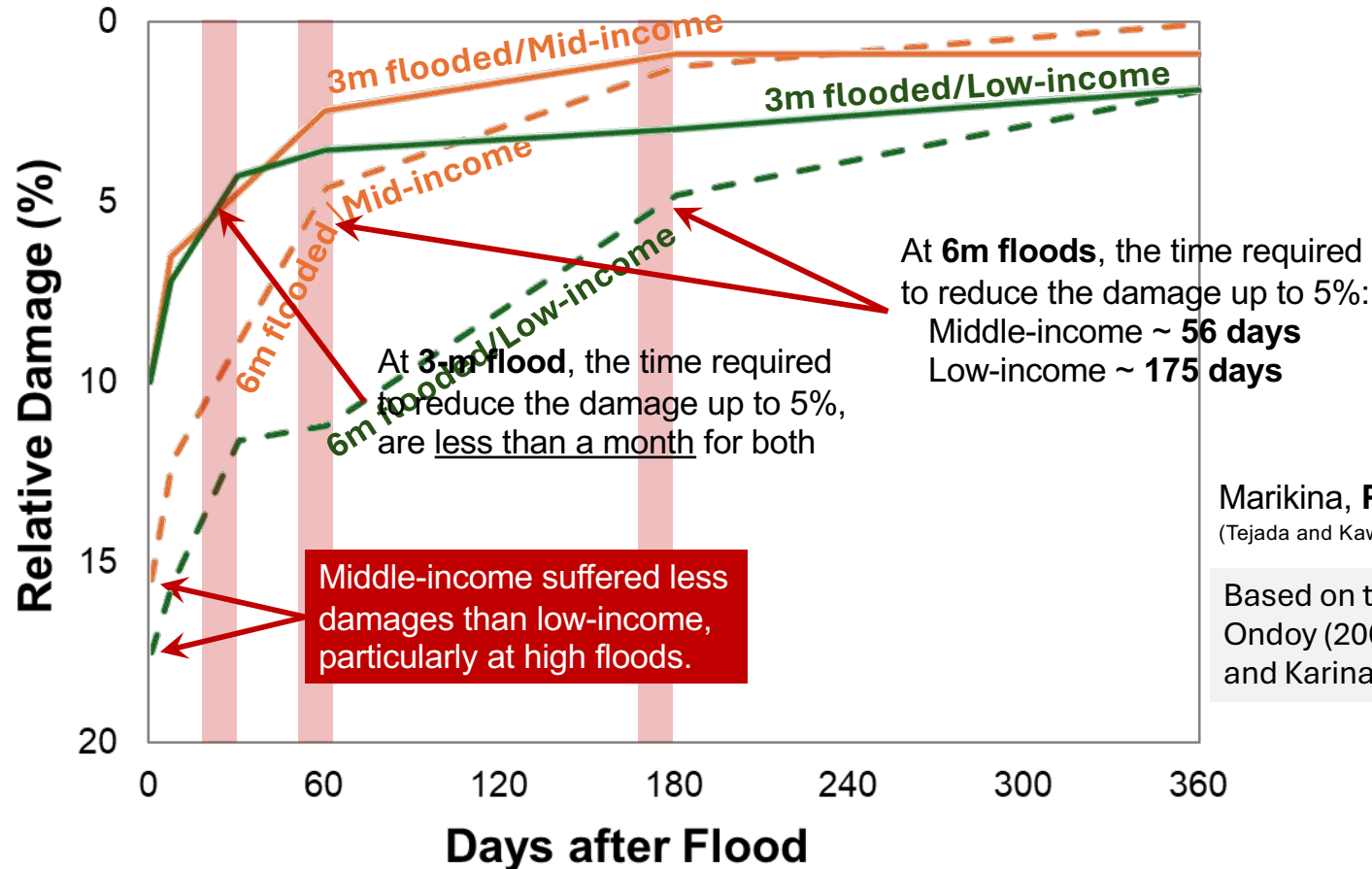
■ Very Poor ■ Middle Poor ■ Middle Rich ■ Very Rich

Similar trend was found in the relationship between flood depth and **education level**

Floods lead the rich to become richer while keeping the poor poorer



Low-income households need 3x times longer to recover



Marikina, **Philippines** (N = 306)
(Tejada and Kawasaki, in preparation)

Based on three flood events:
Ondoy (2009), Ulysses (2020),
and Karina (2024)

2. Where should we invest in climate adaptation / disaster risk reduction for reducing poverty and inequality?



Loei Province, Northeast Thailand

What's the benefit of investing in flood DRR?



Combination?

Uncertainty?

Benefit?

Assessment techniques developed in the latest studies (van Berchum et al., 2018; Muis et al., 2015)

Avoided loss

(**Primary benefit**) only assessed (Watkiss et al., 2015)

“ **Promotion and accumulation of socioeconomic activities** induced by increased safety and reduced risk perception due to successful Flood DRR (Tanner et al., 2015) ”

II

Secondary benefit (Spillover effect)



Modeling the secondary benefit and integrating to Flood DRR benefit analysis as a new approach

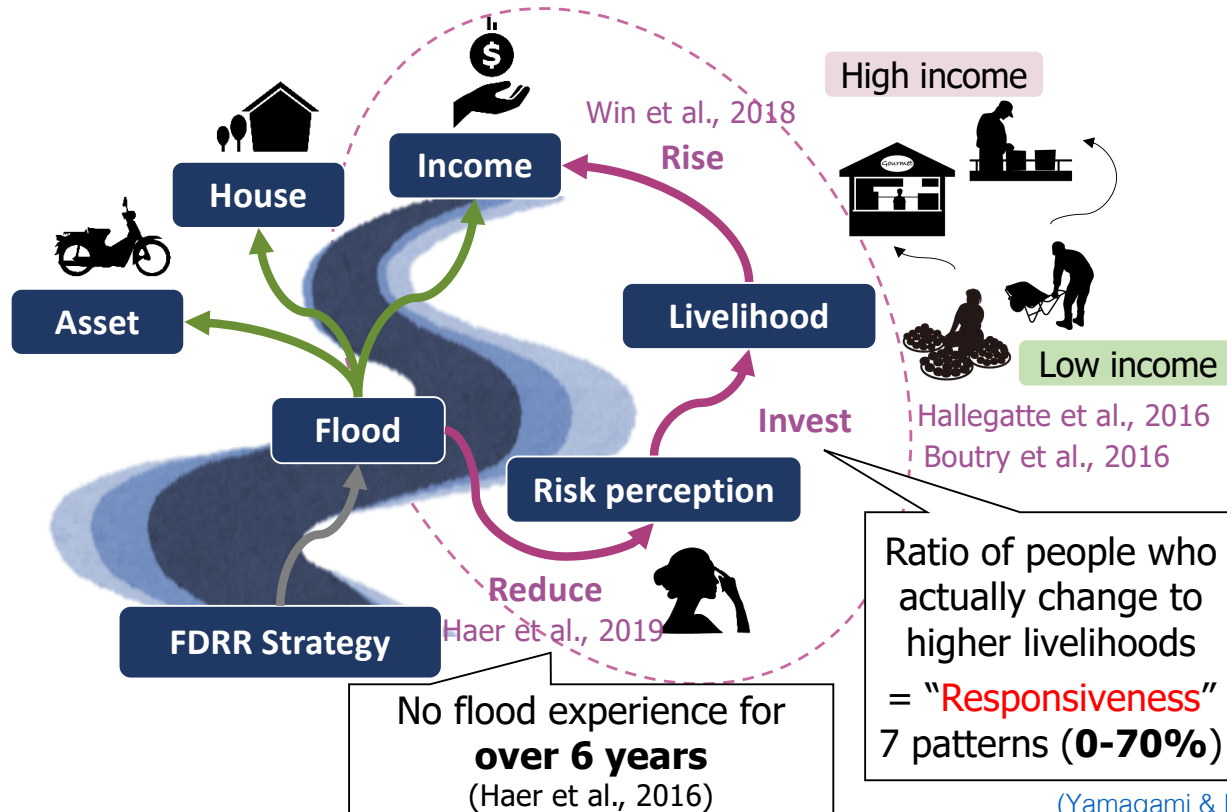


Address issues of developing countries' decision making in flood DRR investment

Livelihood advancement model

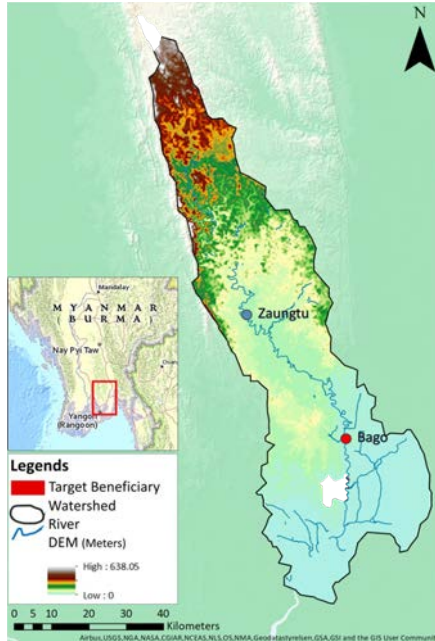
Model the mechanism of secondary benefit with insights from sociohydrological studies

※ Each process has been verified, but **linked together for the first time**

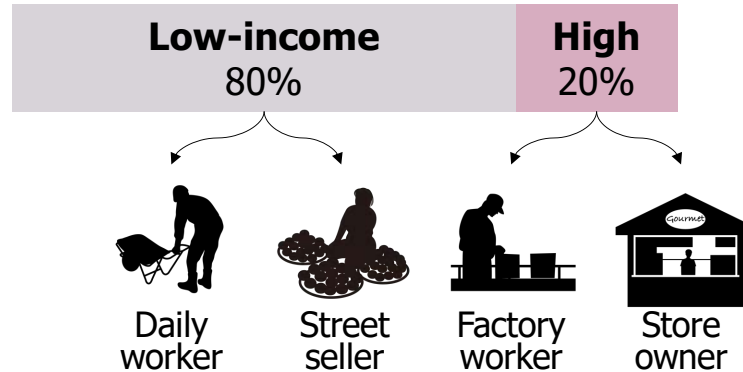


Case study

(Yamagami & Kawasaki, 2024)



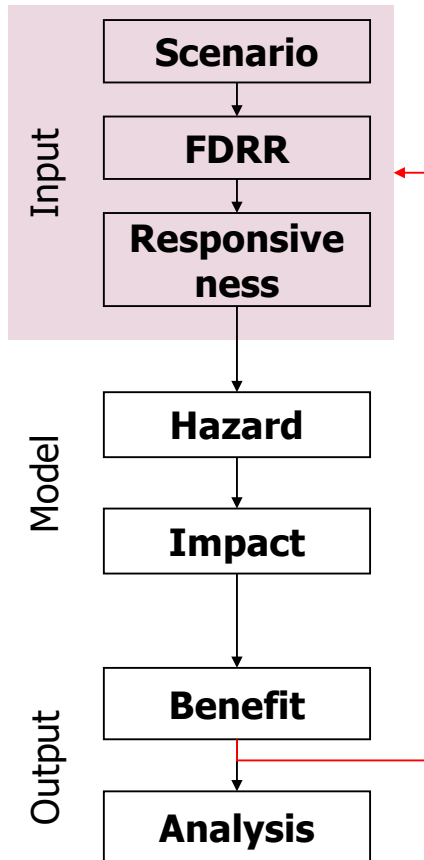
- Area Bago, Myanmar
- Floods Nearly every year during the monsoon season
- Economy Semi-urban



“Socioeconomic advancement induced by reduced flood risk”

(= **Secondary benefit**) would be reflected to people’s livelihood activities

Inundation simulations with various scenarios



3 Scenarios

Baseline
(Present data)

Intermediate
(RCP4.5-SSP2)

Intensive
(RCP8.5-SSP5)

127 combinations of FRM measures



Embankment

Residential
regulation

Dredge/Widen

Early warning

Retention area

Housing
elevation

Combine each with/without to
compose one FRM strategy

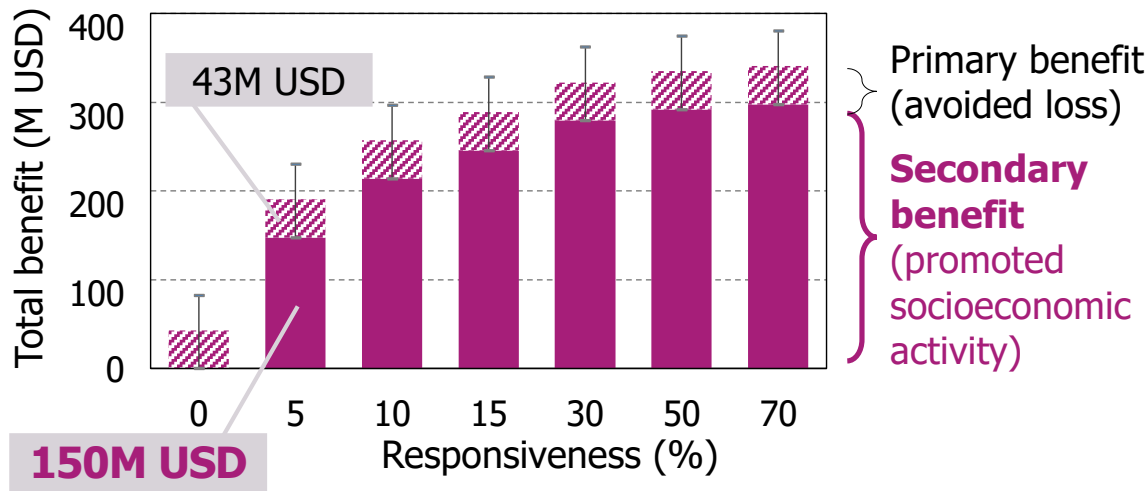
7 patterns of livelihood responsiveness

0% 5% 10% 15% 30% 50% 70%

Calculate **2,667** input patterns

Change in total amount of benefit

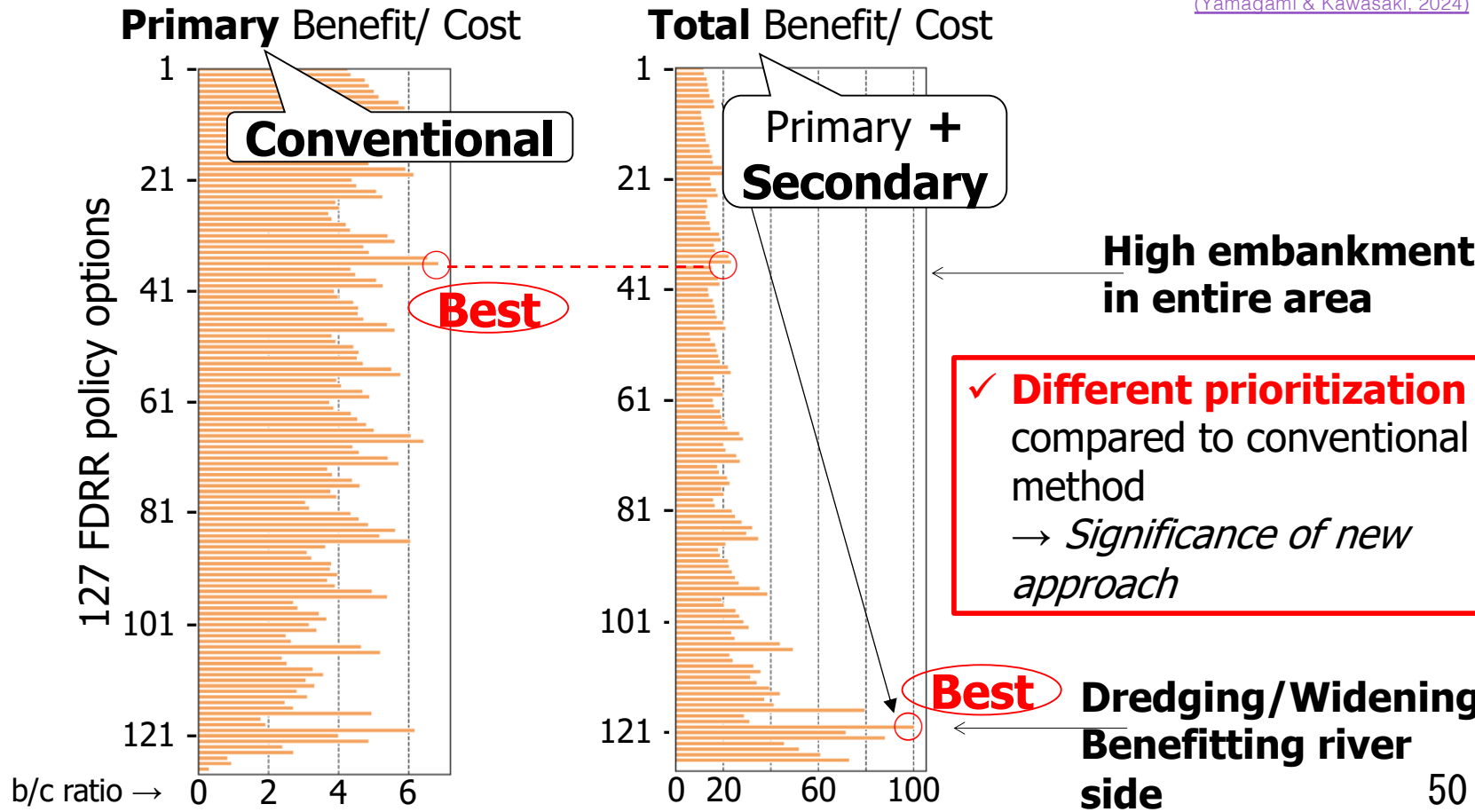
Intensive scenario (RCP8.5-SSP5), Average benefit of 127 FDRR strategies (**2040-70**)

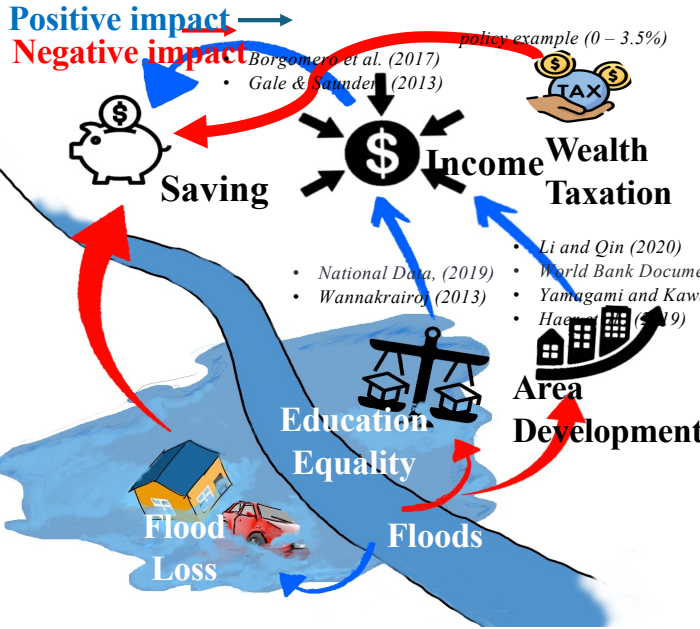


- ✓ **Secondary benefit** amounts up to **2-5 times** of primary benefit
- ✓ Primary benefits are achieved only if the hazard occurs, but secondary benefits could be achieved **regardless of whether the hazard occurs**.
- ✓ Suggests that conventional practices have overlooked large amount of benefit

The best policy option changes if a secondary benefit is included for B/C

(Yamagami & Kawasaki, 2024)

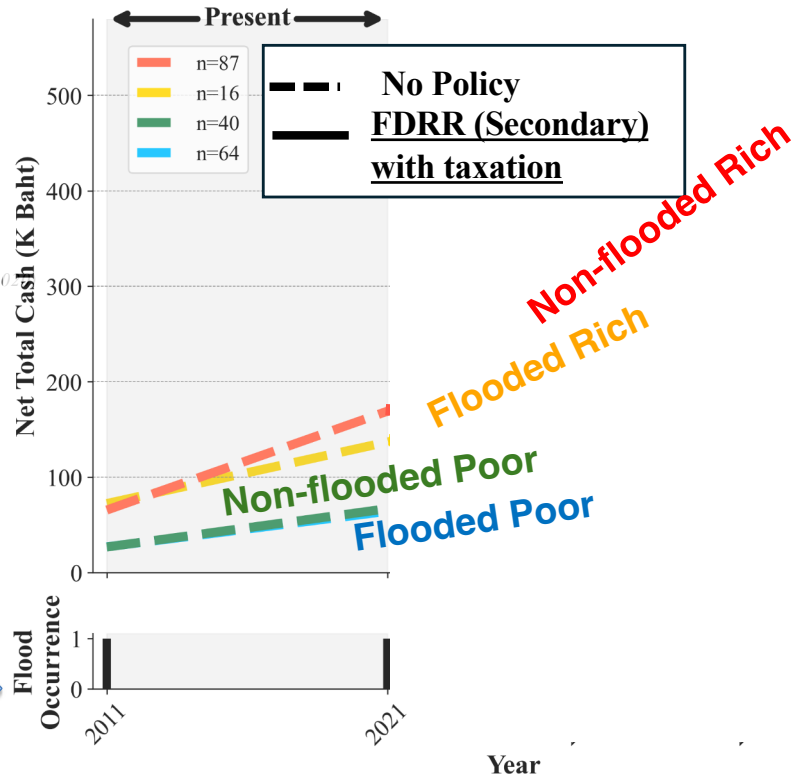




Disparity Reduction Intervention Model

(Vin and Kawasaki, in review)

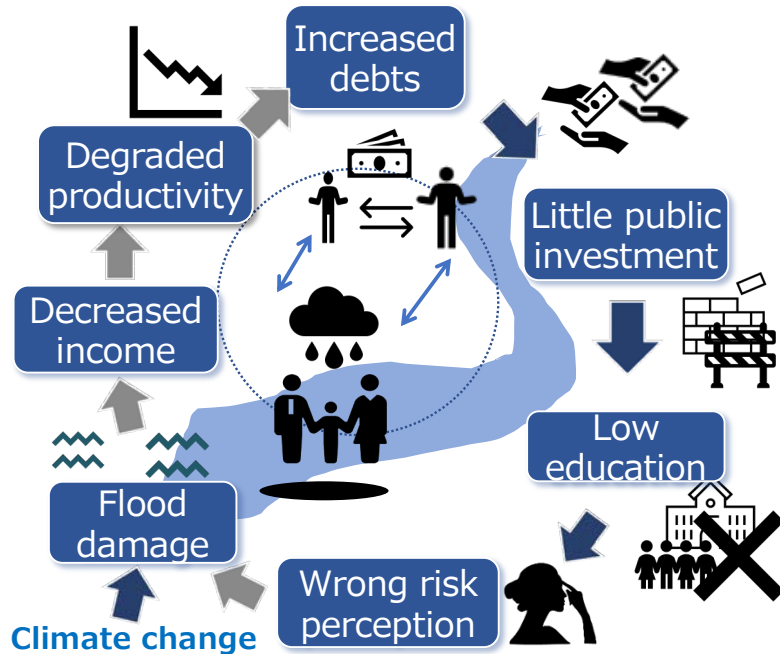
INPUT: Household Interview survey data



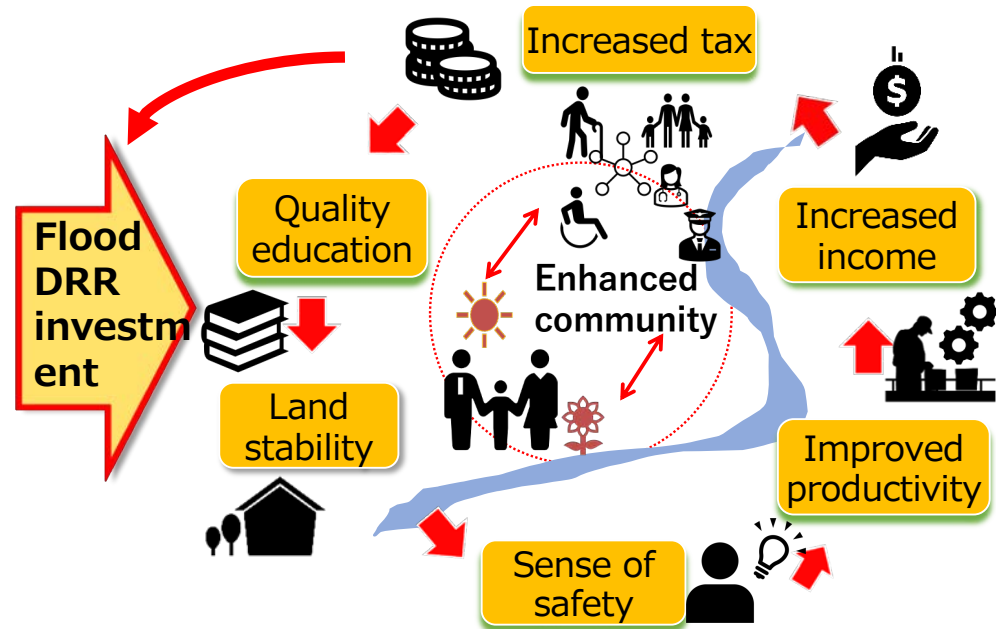
- ✓ **Secondary benefit** boost flooded poor's growth (84.5%) and reduce disparity (70.1%)
- ✓ Among various interventions, **FDRR** contributes the most to alleviate poverty and reduce inequality in flood prone-areas

Socioeconomic system transformation through flood DRR

Vicious cycle of poverty due to economic constraints and disasters



Virtuous circle through social system transformation



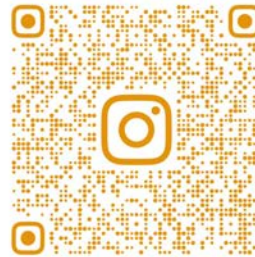
Flood Protection Investment as climate Adaptation can be considered as a promising strategy for reducing poverty and inequality besides education, job opportunities, & income redistribution.

Contact us!

Akiyuki Kawasaki

Professor, Institute for Future Initiatives,
and Department of Civil Engineering,
The University of Tokyo

e: kawasaki@ifi.u-tokyo.ac.jp



@KAWASAKIGROUP_UTOKYO

Related publications (1)

Field investigation on the impact of floods on livelihood

[Thailand]

- [Do floods widen the economic disparity gap?](#)
- [How recurrent floods create inequality in livelihood improvement through education](#)
- [Flood disaster risk reduction for urban collective housing in Thailand](#)
- [The impact of income disparity on vulnerability and information collection: an analysis of the 2011 Thai flood](#)
- [The impact of the Thai Flood of 2011 on the rural poor population living on the flood plain](#)

[Myanmar]

- [Accelerated widening of economic disparity due to recurrent floods](#)
- [Spatial and temporal impacts on socio-economic conditions in the Yangon slums](#)
- [A local level relationship between floods and poverty: A case in Myanmar](#)

[Sri Lanka]

- [Modeling the association between socioeconomic features and risk of flood damage](#)
- [A local-scale analysis to understand differences in socioeconomic factors affecting economic loss due to floods among different communities](#)
- [Socioeconomic vulnerability to disaster risk: A case study of flood and drought impact in a rural Sri Lankan community](#)

Related publications (2)

Development of assessment model for disaster risk reduction investment

- [Reevaluating the benefit of flood risk management for flood-prone livelihoods](#)
- [Effects of disaster risk reduction on socio-economic development and poverty reduction](#)
- [Quantitative evaluation of flood control measures and educational support to reduce disaster vulnerability of the poor based on household-level savings estimates](#)

Detection of the distribution of the poor people using AI and satellite imagery

- [Estimating the level of income in individual buildings using data from household interview surveys and satellite imagery: case study in Myanmar and Nicaragua](#)

Related publications (3)

Development of flood damage function curves

[Residential house]

- [Relationship between residential house damage and flood characteristics: A case study in the Teesta River Basin, Bangladesh](#)
- [Development of flood damage assessment method for residential areas considering various house types for Bago Region of Myanmar](#)

[Agriculture]

- [Development of flood damage functions for agricultural crops and their applicability in regions of Asia](#)
- [Development of flood damage estimation model for agriculture - Case study in the Bago floodplain](#)

[Residential house & Agriculture]

- [Establishment of flood damage function models: a case study in the Bago River Basin, Myanmar](#)

[Road]

- [Establishment of flood damage function model for rural roads: A case study in the Teesta River basin, Bangladesh](#)