Water and Poverty

An Interdisciplinary Approach Linking Water-Related Disasters, Poverty, and Policy

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@KAWASAKIGROUP_UTOKYO

1

Floods exposure 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

Water-related disasters are an extremely important matter for poverty issue!!

nature communications (Rentschler, et al., 2022)

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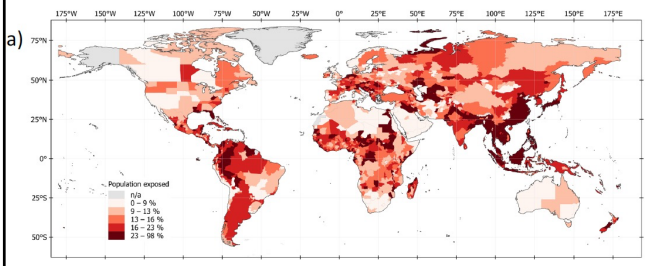
Article | Open access | Published: 28 June 2022

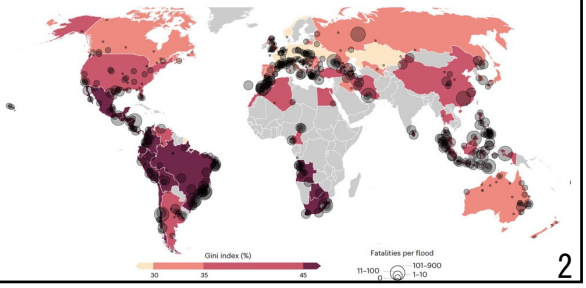
Flood exposure and poverty in 188 countries



nature sustainability (Lindersson, et al., 2023)

Analysis

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

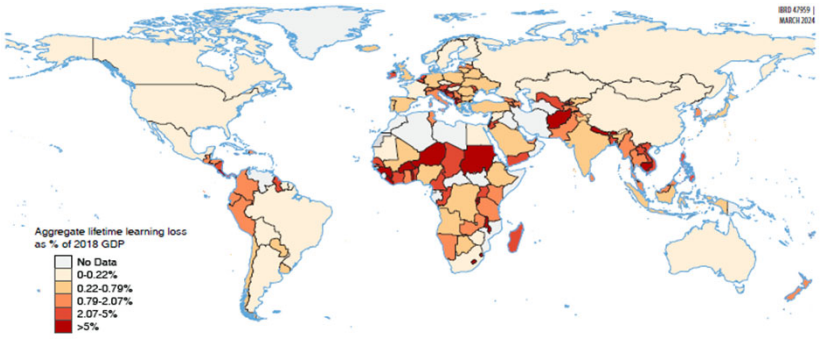


2

- 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.

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

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



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

3

Crossing disciplinary silos to **design a new course**

A major global socioeconomic challenge, yet academic and practical efforts have remained limited

Until now: treated as separate fields and sectors

- **Poverty & Development in Developing Countries** → Humanities & Social Sciences
- **Meteorology & Water Disasters** → Natural Sciences & Engineering
- **Administration & Practice** → Separate Sectors

Beyond Silos

This course: co-designed by academic and practitioners

Economics × Engineering × Practice

Integrating long-standing insights from academic and practitioners

Design a new course

Build cross-disciplinary learning at the intersection of water and poverty

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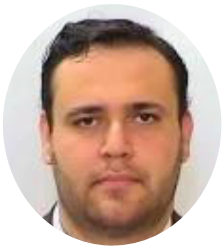
Water and Poverty course, lecturers

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



Christian Borja-Vega, PhD, Senior Economist, **World Bank**

Edoardo Borgomeo, PhD
Senior Environmental Specialist, **Global Environment Facility** &
Associate Professor,
University of Cambridge

Pavel Luengas Sierra, PhD, ETC Economist, **World Bank**

The world's only lectures by global experts in both academic and professional fields

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Course Goals: Understanding, Policy Design & Critical Thinking

Understand poverty–water relations and build capacity to design solutions and policies.

What learners will develop

1 **Poverty–water links**
Water disasters as a lens

2 **Solutions & policies**
Problem solving → policy design

Learning approaches emphasized

Multi-scale
Global × local

Evidence-based
Data + statistical methods

Critical thinking
Question assumptions

Evidence + critical inquiry

Use evidence and critical reflection across scales to design policy.

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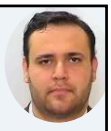
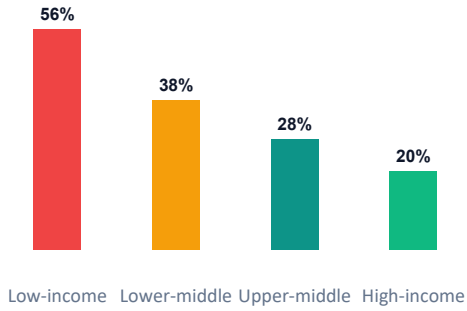
THE PROBLEM · INEQUALITY OF EXPOSURE



Floods don't hit everyone equally

% of water-intensive jobs in economic sectors, by country income group



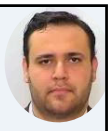
Floods last ~2× longer
in low-income countries than in high-income ones (2000–21).

+67% higher flood risk
share of population at high flood risk in middle- vs. high-income countries.

1.81 billion exposed
to a 1-in-100-year flood — and 89% of them live in low- & middle-income countries.

Sources: World Bank, Water for Shared Prosperity (2024); Rentschler et al., Nature Comms (2022).

THE PROBLEM · THE HIDDEN COSTS



The damage you see is only the tip

Broken buildings are the visible loss. The bigger bill is paid in lost work, lost schooling, and lost futures.

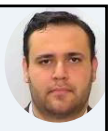
Jobs & income
Markets close, informal workers lose daily pay, firms cut staff. Indirect losses often ≈ direct asset damage.

Health & education
School closures and disrupted attendance — water shocks erase learning that compounds over a lifetime.

Peace & social cohesion
Disasters act as threat multipliers, straining institutions and deepening grievances in fragile settings.

Environment
Degraded watersheds and soils raise the cost — and probability — of the next flood.

2.2% of GDP. That is the economy-wide cost of flood-induced learning loss.
140 M children across 147 countries were hit by extreme wet shocks (2000–2021).



THE METHOD · THE MEASURING STICK

How an economist grades a flood project

Four tools turn “this seems useful” into “this returns 18 cents on the dollar, every year.”

EAD

Expected Annual Damage

Weight each flood size by its probability. Frequent moderate floods can hurt more than rare giant ones.

Damage curves

Depth–damage functions

Map water depth to % of value lost, by sector. Damage rises non-linearly once water passes the doorstep.

BCR / ERR / NPV

Cost–benefit verdict

Discount benefits and costs over 20–30 years. BCR>1, ERR>10% means the project beats the benchmark.

MBJ

Jobs protected

Translate avoided losses into job-equivalent years saved — the human bottom line.

National averages hide where the poor actually live

The core problem

- Most household surveys are representative only at national or first-admin level
- Yet poverty concentrates in specific districts, basins and communities
- **“Location is a powerful determinant of poverty”** — within-country gaps often exceed between-country gaps
- Decentralised governance needs information at the level where decisions are made

What poverty maps enable

- Locate investments, services and infrastructure where deprivation is concentrated
- Build district & municipal development plans; correlate poverty with water, hazards & access

THE TARGETING PAYOFF

< ⅓

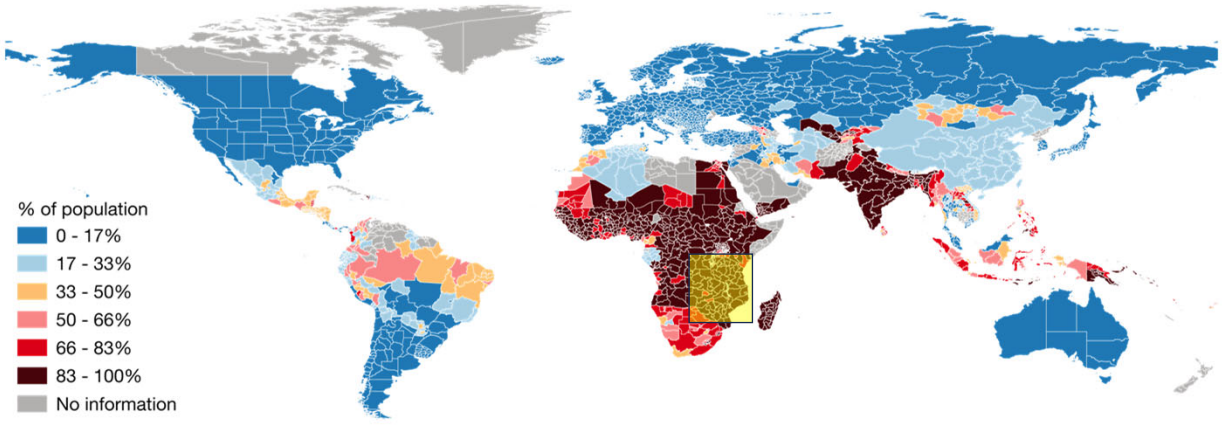
of the funds can achieve the same poverty reduction when resources are targeted to the poorest communities rather than spread evenly.

Sources: Bedi, Coudouel & Simler (2007) “More Than a Pretty Picture,” World Bank; Van der Weide, “Mapping Poverty” (KL Hub, 2023).

1 · POVERTY ESTIMATION

Poverty: Share living under the $6.85 (2017 PPP) poverty line

State or province level



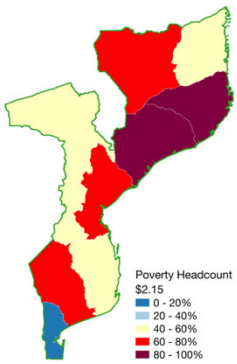
High heterogeneity in Brazil and low heterogeneity in Sub-Saharan Africa and in Europe

1 · POVERTY ESTIMATES

Zambia and Mozambique

MOZAMBIQUE - PROVINCES

$2.15 - A DOLLAR A DAY LINE



ZAMBIA - PROVINCES

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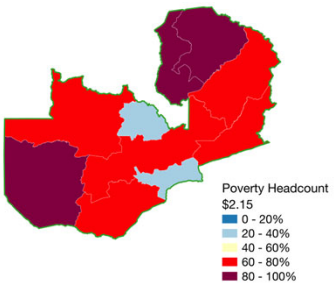


$2.15 - A DOLLAR A DAY LINE

$2.15	2002	Circa 2012	2022
Mozambique	80.6	64.6	74.5
Zambia	56.4	64.4	64.3
World	27.7	13.1	8.6
Sub-Saharan Africa	53.9	40.5	40.8
Low income countries	58.4	46.2	52.8

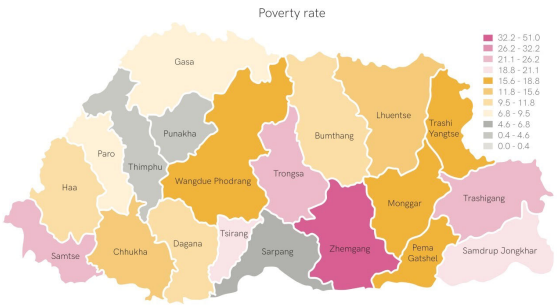
- Whereas poverty in Zambia increased, in Mozambique decreased.
- Poverty levels in Mozambique remain higher.
- Poverty in Mozambique concentrates in two provinces whereas poverty in Zambia is more widespread.

The distribution of the poor is spatially uneven. So, it's important to find priority areas by considering the hotspots of hardship, and the use of geospatial information is essential.

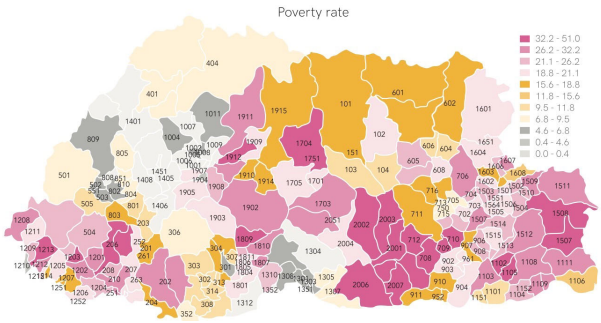
1 · POVERTY ESTIMATES

BHUTAN: Poverty map using the 2017 Census and 2022 household survey

District Poverty
National Poverty Line



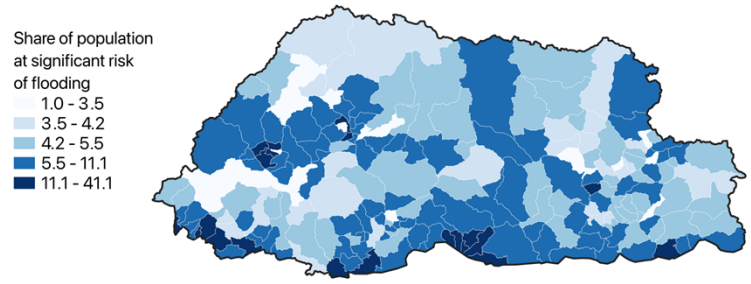
Town Poverty
National Poverty Line



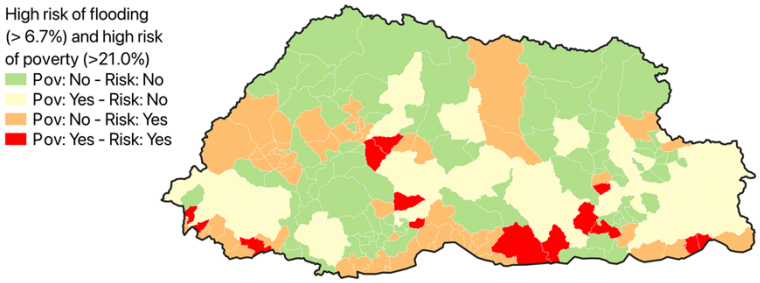
Spatial resolution is matter: The detailed poverty map allows for better targeting

3 · COMBINING POVERTY AND FLOOD HAZARD ESTIMATES

Bhutan



Flood risk map



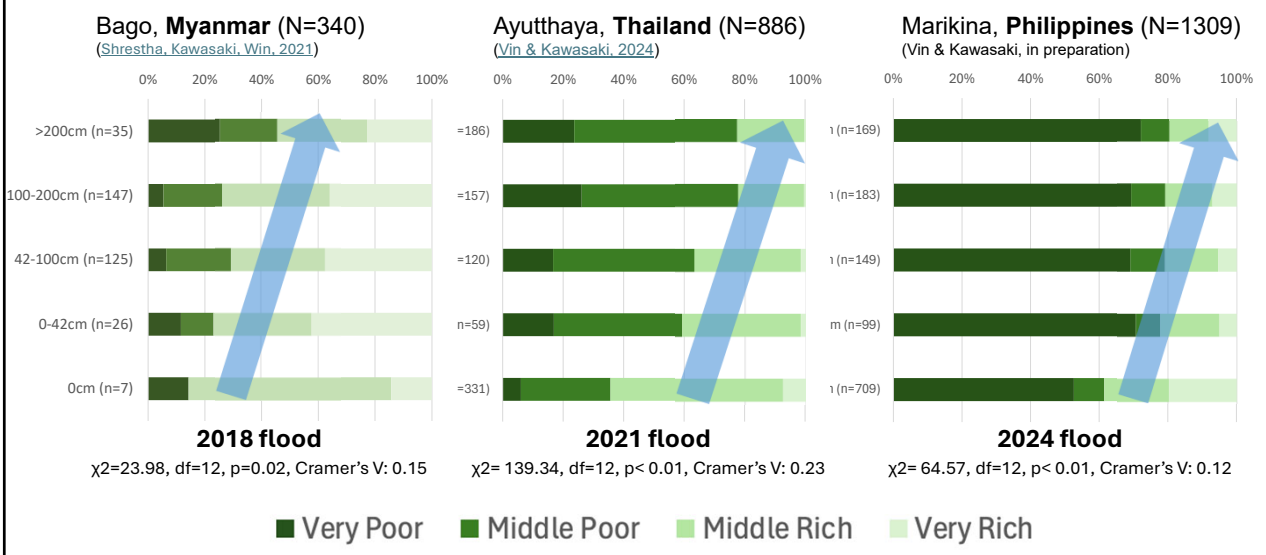
Flood risk X High poverty

Hotspots of high risk of flooding and high poverty


Myanmar
Bangladesh
Ghana
9,000 households Interview surveys
in flood-prone areas in 6 countries
Philippines
Thailand
Sri Lanka
15


Flood level Ondoy 2009
Flood level Ulysses 2020
Flood level Carina 2024
Flood-mark 2011
Flood-mark 2022
16

Flood damage is more severe for the poorer



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

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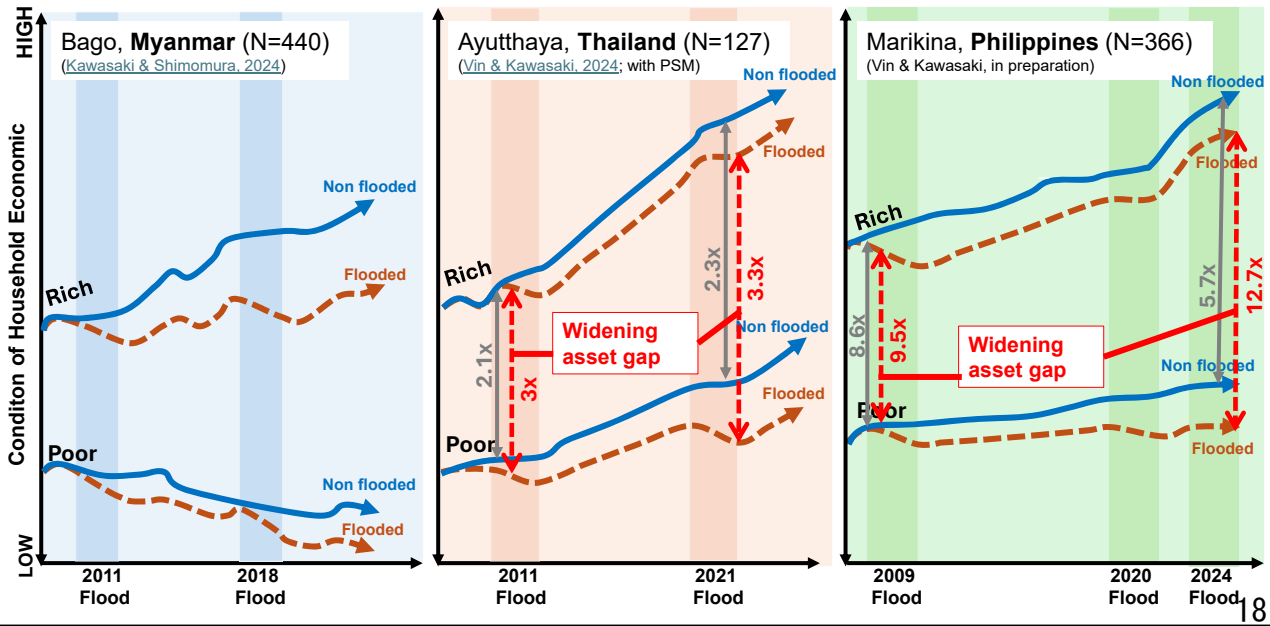
Floods lead the rich to become richer while keeping the poor poorer



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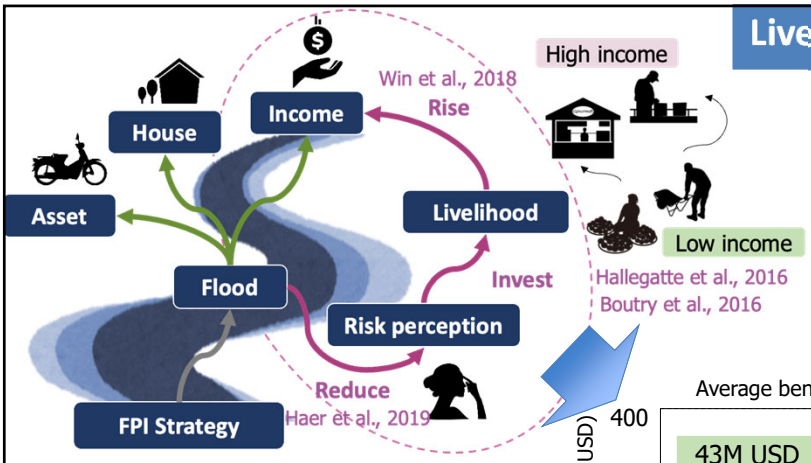
Livelihood Advancement Model

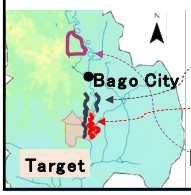
(Yamagami & Kawasaki, 2024)



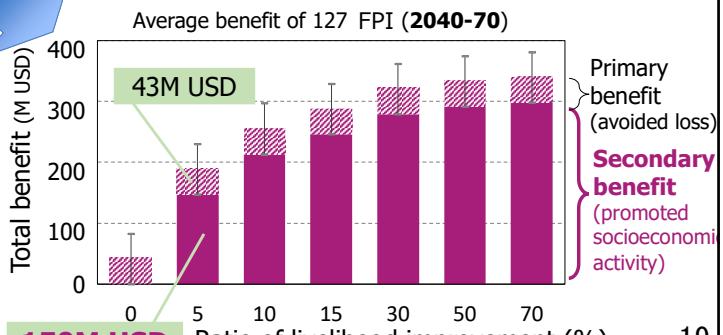
- ✓ **Secondary benefit** amounts up to **2-5 times** of primary benefit
- ✓ **Conventional practices have overlooked large amount of benefit**

Hydro-meteorological simulation

127 combinations of FPI measures

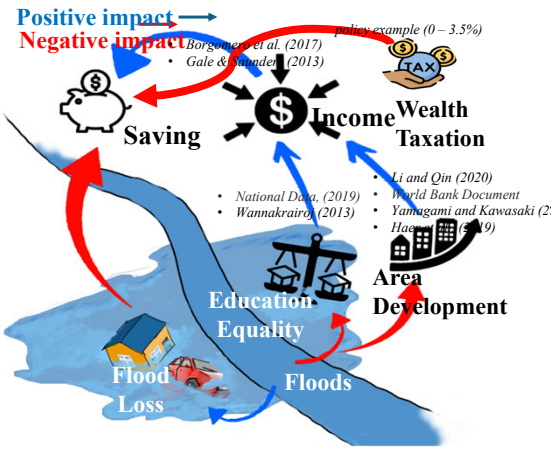


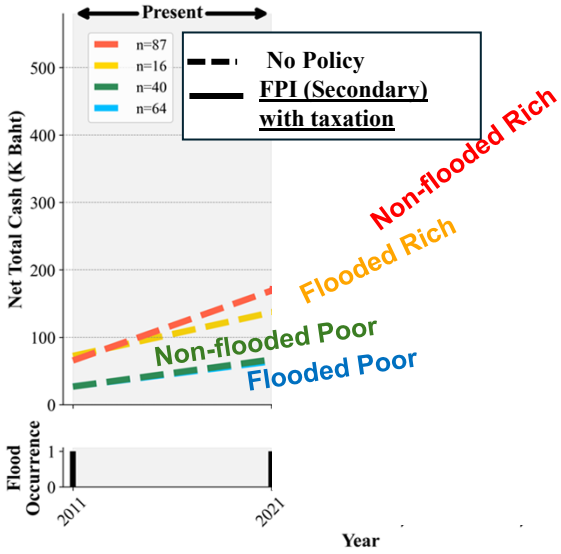
Embankment | Residential regulation
Dredge/Widen | Early warning
Retention area | Housing elevation



Disparity Reduction Intervention Model

(Vin and Kawasaki, in review)

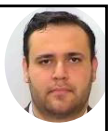




INPUT: Household Interview survey data

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

Discussion 1



III · FROM MAPS TO POLICY — THE PRIORITISATION PROBLEM

Whom should a flood defense protect first?

Most people

Maximise the number of exposed individuals shielded. Favours dense urban floodplains regardless of wealth.

Most assets

Protect the highest concentration of property and economic value. Favours wealthy, capital-intensive areas.

Most well-being

Minimise welfare loss by weighting the poor, who recover slowest. Favours vulnerable, low-coping-capacity areas.

These three are not the same map. Vulnerability-adjusted data make the trade-off explicit rather than hiding it inside an exposure metric. The choice is normative — but it should be informed and visible.

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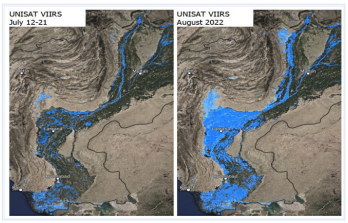
Discussion 2

PAKISTAN · 2022 SUPER-FLOODS — MAPS & FIGURES

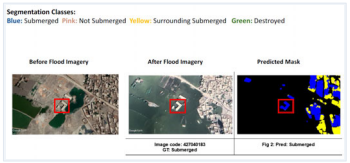
Pakistan 2022: satellites and machine learning map the flood

- Hydraulics



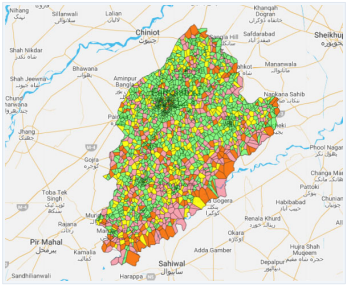
Seen from orbit. *VIIRS satellite imagery of the Indus basin — before (Jul 12–21) and during (Aug 2022) the flood.*

- Spatial risk segmentation



Classified by ML. *Machine-learning segmentation — before / after imagery and the predicted submerged mask, building by building.*

- Critical infrastructure (school) risk and damage



Schooling at risk. *Modelled school accessibility / out-of-school children by locality, used to target the response.*

Source: *Where Are Pakistan's Out-of-School Children? (World Bank PRWP, 2026).*

WORLD BANK GROUP · Water Global Practice

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We need to know where the poor people live in the area

Household interview survey (HIS) data

- Visit one by one
- Survey on income, occupation, number of years of residence, etc.

High-resolution satellite image

- Resolution 50cm

Develop a new method to estimate the distribution of poor people at the building level from household survey data and satellite image

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High-reso income distribution mapping over a wide area

Household interview survey data

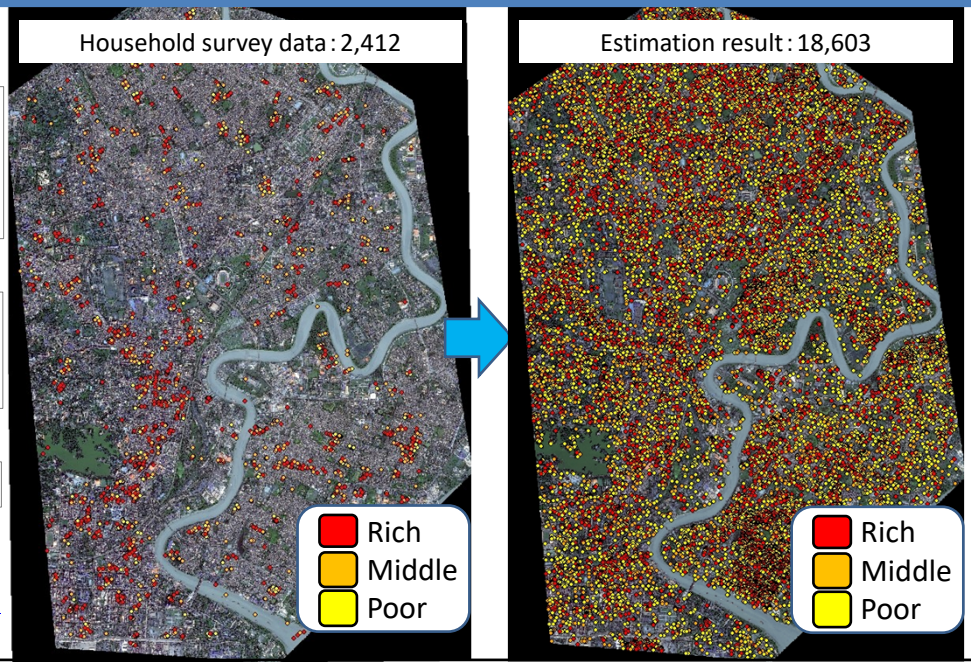
X

High-reso satellite imagery

X

AI

(Okuda, Kawasaki, Yamashita, 2023)



@Yangon, Myanmar

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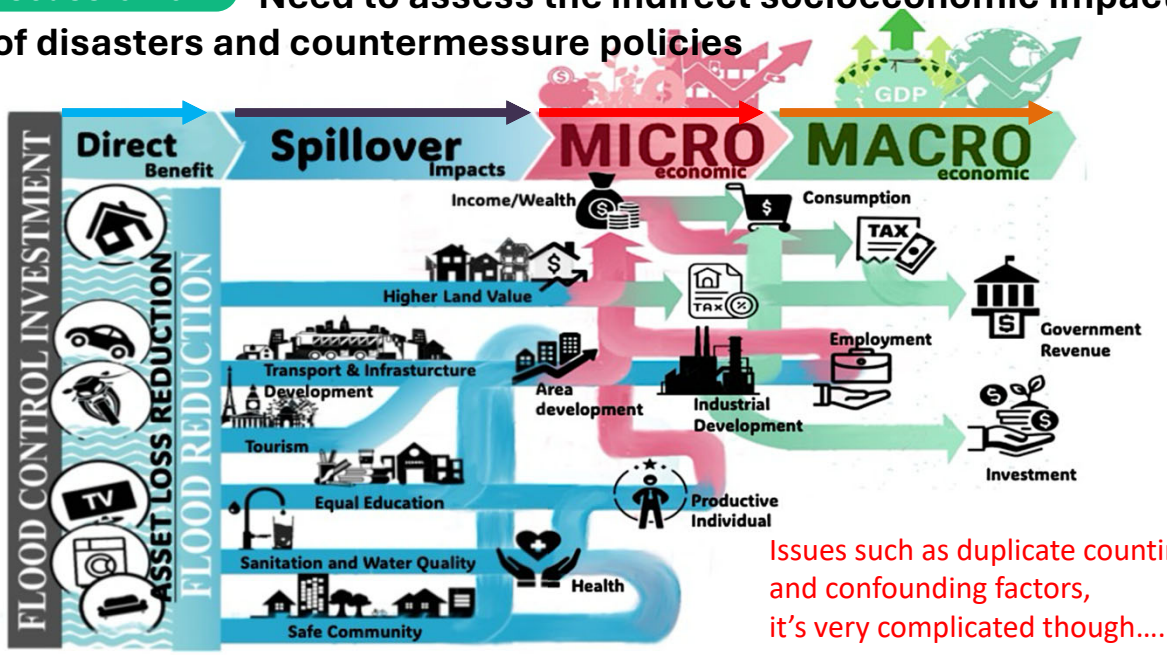
Discussion 3

Need to assess the indirect socioeconomic impacts of disasters and countermessure policies



Issues such as duplicate counting and confounding factors, it's very complicated though….

Summary: **Connecting Water Disasters and Poverty to Policy**

Reframing water disasters not only as "natural phenomena," but as issues of poverty, inequality, and social development

What we teach

- **Risk is unevenly distributed** — Exposure, damage, and recovery difficulties concentrate among poor people and low-/middle-income regions
- **Losses are not easily visible** — Capture long-term impacts on education, employment, health, and future income
- **Make vulnerability visible** — Use maps, household surveys, and satellite data to identify who is vulnerable and where

Integrate across multiple scales → Toward policy

- Evidence-based
- Critical thinking

Measure Visualize · Choose Priorities · Develop People

Outcome of this course

Link water disaster measures to poverty reduction and stronger resilience

Equitable policy design	Visualize whom to protect
Comprehensive evaluation	Include employment, education, and spillover effects
Cross-disciplinary practice	Connect economics, engineering, and practice

Toward experts who understand water–poverty relations and can create solutions and policies

Course schedule

March [Kawasaki]

1. **Relationship between Poverty and Disasters**
2. **Definition** of Poverty
3. **Empirical Survey Design** using Quantitative and Qualitative Methods
4. **Impact of Flooding to Livelihoods**
5. **Investing in River Basin Management for Socioeconomic Development**: Case in Tokyo
6. **Investing in Disaster Risk Reduction for Resilience** : Cases in Manila and Myanmar
7. **Understanding Risk to Build Resilience**
8. **Decision Making under Deep Uncertainty (DMDU)** in Flood Risk Management

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Course schedule

6/4, 6/5. [Borgomeo]

9. The Paradoxes Holding Back Progress on Global Water Security
10. Climate Change and Water Resources: Risk-based Approaches for Decision-Making

6/15. [Sierra]

11. Integrating Geospatial Analysis with Poverty Metrics: Theory
12. Integrating Geospatial Analysis with Poverty Metrics: Practice

6/16. [Borja-Vega]

13. Do Floods Pay? The Economics of Flood Risk Management - Part 1
14. Do Floods Pay? The Economics of Flood Risk Management - Part 2

6/19. [Kawasaki]

15. Student Presentation and General Discussion

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Course assignment: Final presentation and report

1. Collect and analyze information and data on water-related disasters and poverty in your country. Then, present your policy recommendation for addressing these issues during the final lecture on **June 19**.

2. Based on the discussion during your presentation, summarize your findings concisely in a report on A4 paper (maximum 5 pages). The submission deadline is **June 30** by email < kawasaki@ifi.u-tokyo.ac.jp >.

Evaluation Criteria
- Are the arguments supported by data and literature?
- Does the lecture content reflect in the analysis and discussion?
- Are effective policies proposed that consider the characteristics of countries and regions?
- Are innovative ideas and original opinions incorporated?

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