Measuring flood resilience: Results from across the globe

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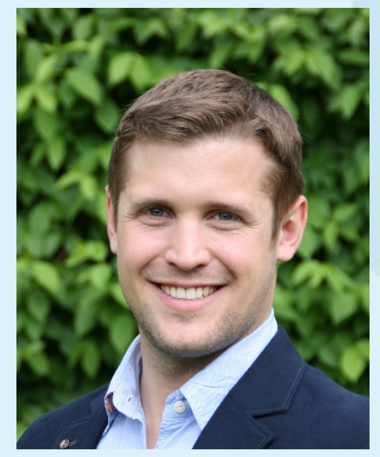

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1. Flood Resilience Measurement Approach

- The **Community Flood Resilience Measurement Framework** is developed by the **Zurich Flood Resilience Alliance** and is designed around the **5 capitals of the Sustainable Livelihoods framework (human, social, physical, natural and financial)**. It is an indicator-based approach consisting of **88 measures of 'sources of resilience' (variables).** Over the past 2 years **five NGOs collected baseline, endline, and outcome measures** (if a flood occurred) in 118 communities in 9 countries (Keating et al. 2017 a). This is the first consistent global analysis of the baseline data conducted through this approach.
- Measuring flood resilience is inherently complicated for two key reasons: **(1) it is a latent construct that is not tested until a flood occurs, and (2) the pre-event characteristics (sources of resilience) that influence this latent construct are determined by a complex set of holistic, interdependent, and difficult to quantify variables.**

The main objectives of the work are to enhance practitioners' ability to benchmark and measure flood resilience over time, compare how flood resilience changes as a result of different capacities and interventions, **and empirically explore a rich dataset originating from a standardized measurement.**

2. Measurement Tool Implementation Process

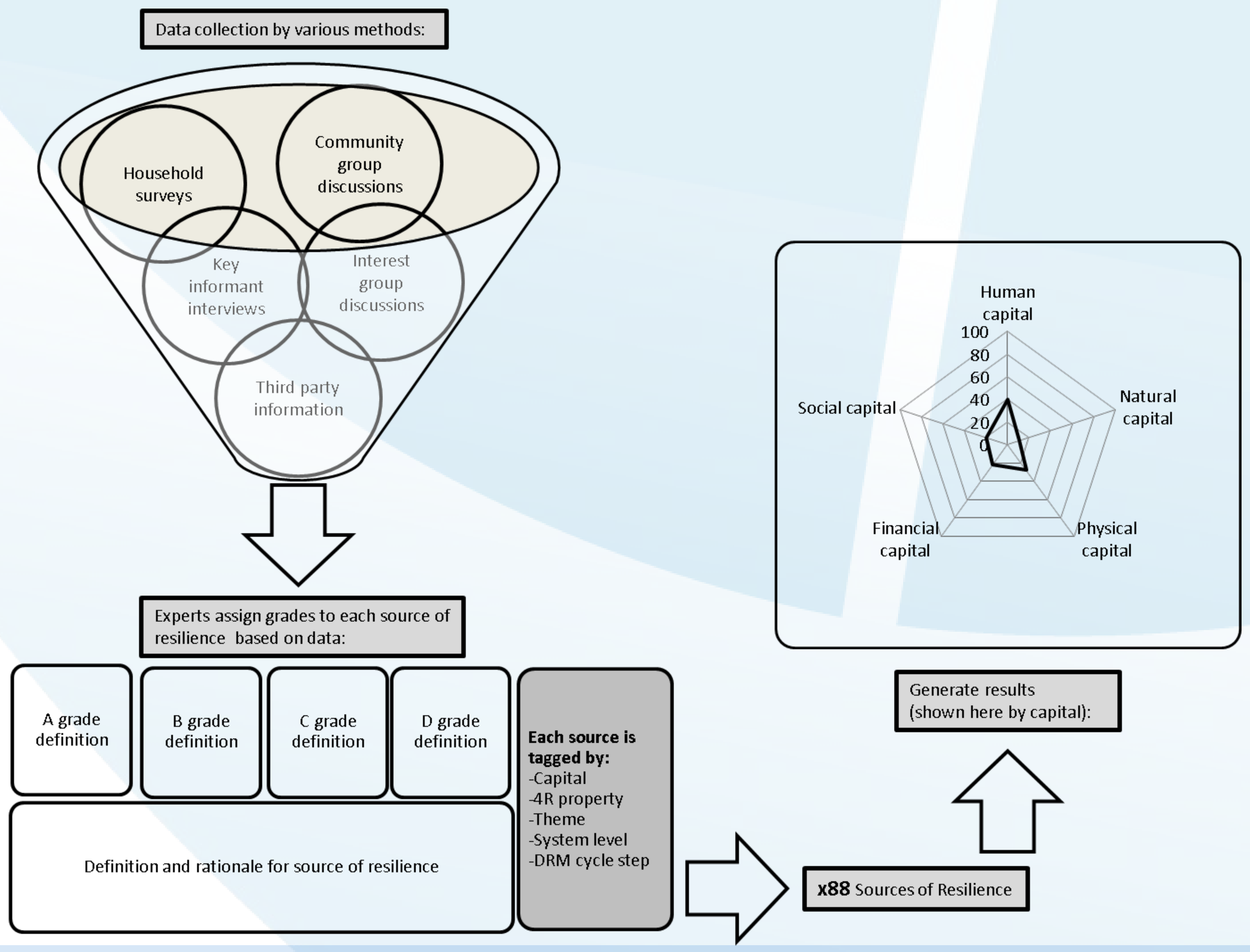

Figure 1: *Schematic illustration of the Flood Resilience Measurement implementation process. The Flood Resilience Measurement Tool designed for local NGOs operating in flood risk context. It is an integrated, web-based platform for creating questionnaires based on the flexible combination of data collection methods. Each source of resilience is graded from A to D by an expert judgement based on the collected data. Source: Keating et al. 2017(a)*

3. Global Application and Dataset

Communities per country	number	Reached population
Afghanistan	12	13 374
Bangladesh	9	39 237
Haiti	4	36 395
Indonesia	40	254 956
Mexico	19	552 402
Nepal	21	18 971
Peru	5	40 280
Timor-Leste	6	4 501
USA	2	265 512
Grand Total	**118**	**1 225 628**

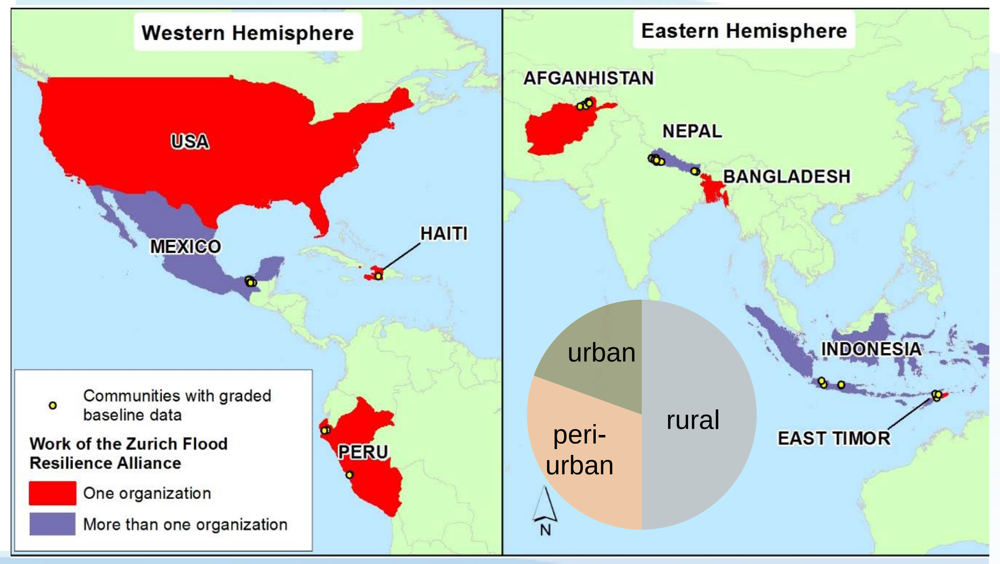

Figure 2: *The Flood Resilience Measurement Tool has been implemented in 118 communities across nine countries involving 1.25 million people directly or indirectly. Five NGOs have collected data and implemented the tool, mostly in rural communities; however the FRMT is also designed for an urban context. Source: Keating et al. 2017(b)*

4. Principal Component Structure of the Capital Framework

Capital	Principal Component Structure	# source	Mean grade
Financial Capital (α= 0.838)	Robust budget management (α= 0.815)	5	33
	Flood related financial management decisions (α= 0.799)	6	28
	Financial Safety Nets (α= 0.65)	2	6
	Financial market access (α= 0.817)	2	24
Human Capital (α= 0.790)	Proxy for human capital (α= 0.752)	5	55
	Vulnerability awareness (α= 0.645)	4	40
	Hazard awareness (α= 0.614)	3	42
	Exposure awareness	1	64
Natural Capital	Natural capital proxy (α= 0.801)	4	24
Physical Capital (α= 0.815)	Flood coping infrastructure (α= 0.781)	4	46
	Basic need infrastructure (α= 0.799)	5	40
	Emergency response infrastructure (α= 0.74)	4	34
Social Capital (α= 0.916)	Flood resilience governance (α= 0.924)	11	30
	Institutional capital (α= 0.807)	6	42
	Flood risk prediction (α= 0.624)	4	29
	Community engagement in flood resilience planning (α= 0.699)	2	30
	Contingency planning (α= 0.769)	3	21
	Cultural capital (α= 0.697)	2	35

Table 1: *The component structures are the underlying latent constructs of the capitals. From the 88 source of resilience 15 were deleted by a principal component analysis with Varimax Rotation. The remaining source build a consistent set of measures of the latent construct to measure flood resilience. (Cronbach's alpha in brackets). Source: Laurien et al (forthcoming)*

This research is part of the Zurich Flood Resilience Alliance. The Zurich Insurance Group funded and initiated the project. The Flood Resilience Measurement Tool was designed and implemented together with the partners International Federation of Red Cross and Red Crescent Societies (IFRC), the International Institute for Applied Systems Analysis (IIASA), the Wharton Business School's Risk Management and Decision Processes Center (Wharton) and Practical Action the Flood Resilience Measurement Tool was designed.

5. Capital Framework Cluster Analysis

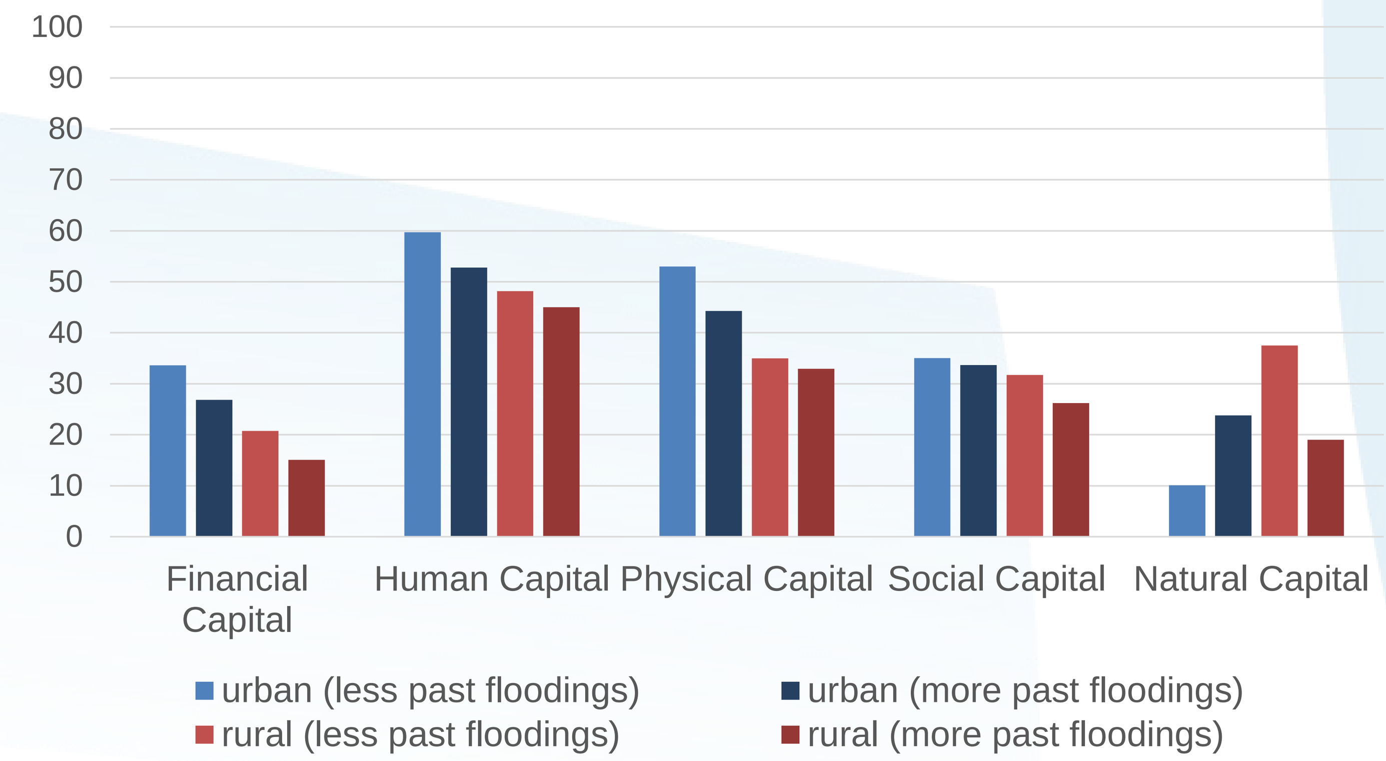

Figure 3: *K-mean cluster analysis with based on general community context variables (urbanization, education, poverty, flood history). There is a general trend that urbanization and flood history influence capacity building in flood resilience. Also, education and urbanization are not highly related. Interestingly, natural capital shows an opposite picture but this fits to the hypothesis of urban and rural communities. Source Laurien et al (*forthcoming*)*

6. Results

- **Initial results from FRM baseline studies in 118 communities across the globe show that building capacity needs a holistic approach and multiple dimensions are important.**
- Via a principal component analysis and K-mean cluster analysis, we identified a consistent component structure within the 88 sources of resilience of the Flood Resilience Measurement framework across the 5 capitals. Based on this analysis (and feedback from users) the framework is being **redesigned and will be implemented over the next five years in potentially hundreds of communities**.
- The principal component analysis, identified at least **18 latent component structures** for flood resilience across the 5 capital framework. The analysis also points towards ways to **reduce the number of variables without losing much of the explained variance.**
- The K-mean clusters identified 4 general community variables as important context variables **(urbanization, education, poverty, flood history**) which result in 4 cluster groups.
- The 4 cluster groups highlight **common flood resilience profiles for different community contexts:**
  - Human, physical and social capitals are related to the community context variables.
  - Interestingly, community financial and natural capital are less related to urbanization, education, poverty and flood history. This points towards a more complex latent structure for measuring flood resilience for these capitals.