Risk Nexus
Measuring flood resilience – our approach
Working together to tackle the challenges of floods

Floods affect more people globally than any other natural hazard; they can literally ‘wash away’ overnight what communities have gained over years in terms of development and growth. Responding to this challenge, in 2013 Zurich Insurance Group (Zurich) launched a global flood resilience program. The program aims to advance knowledge, develop expertise, and design strategies to help communities improve their ability to deal with recurring floods.

To achieve the program’s goals, Zurich formed a multi-year, interdisciplinary alliance of five organizations:

- **Zurich** provides the funding for the program, as well as contributing its risk management and risk engineering expertise.

- **International Federation of Red Cross and Red Crescent Societies (IFRC)** run community flood resilience programs in Mexico and Indonesia, and provide an opportunity to take best practice across the Red Cross’s 189 National Societies. The societies also have close ties to national governments and can help guide national policy and practice in disaster risk reduction.

- **International Institute of Applied Systems Analysis (IIASA)** provides an academic research program focusing on disaster management in a systems context, especially in the developing world.

- **Practical Action**, a UK-based international non-governmental organization (INGO), runs community programs in Nepal and Peru. Practical Action’s approach provides opportunities for technical innovation. It also has processes and expertise that support the program, allowing it to share what we learn more widely.

- **Wharton Risk Management and Decision Process Center** contributes through its academic research program with a focus on disaster management, especially in the developed world.

Drawing on alliance members’ complementary skills, we aim to increase knowledge and gain experience in community flood resilience. We thus provide insights that all stakeholders can learn from and apply. By ‘incubating’ ideas and sharing them, we can influence how the impacts of floods are tackled on a global scale.
The concept of resilience

Rather than merely alleviating the ‘symptoms’ of flood disasters through post-event recovery, evidence from a number of projects and studies suggests that it is more cost effective to address the underlying problems that result in flood losses.\(^1\) International agreements put in place since 2000 have created an ambitious platform to tackle the risks posed by such disasters. But, apart from some success in lowering global disaster mortality, there appears to have been little tangible progress in remedying the underlying causes.

Resilience bridges two seemingly conflicting goals to achieve the best of both worlds, encouraging strategies that both manage risk and promote development. By focusing on resilience, the Zurich Flood Resilience Alliance can help achieve sustainable, positive change. Bringing together skills from across public, private and humanitarian sectors, we can identify and implement strategies to enhance community flood resilience.

Measuring resilience

The key challenge is to demonstrate that the work we do has the desired impact. But how can resilience-building initiatives be measured? This is no easy task. As of 2014, no general measurement framework for disaster resilience had yet been empirically verified,\(^2\) according to the United Nations Development Programme (UNDP). While many organizations are looking for ways to measure resilience, and some have created specific tools that attempt to define indicators and assessment processes, few have moved beyond a theoretical concept based on only a few case studies. Even where an operational model appears to be in place, there is no evidence that what is being measured is, in fact, resilience.

Seeking to find a way to address this challenge, we formed a working group to develop a measurement framework and corresponding tools to measure flood resilience. By doing so, we aim to demonstrate empirically that ex-ante measures are more effective than ex-post ones. Acting to stem losses and increase resilience before a flood (ex-ante) as opposed to recovery after a flood (ex-post) is especially vital at the community level.

At least four factors must be taken into account when measuring resilience: There is no one-size-fits-all solution or tool; resilience is too big a concept to be measured in its entirety; efforts to increase resilience in one part of a system may undermine resilience in another; and any system measuring resilience should apply to a specific peril. Keeping these points in mind, and based on our knowledge and expertise as an insurer, we decided that we would focus on a single hazard – floods.

A community focus

Since floods have the most immediate impact on communities, our involvement at this level lets us demonstrate the tangible, positive impact that increasing resilience can have on people’s lives. And, by working with communities, we can create best practices from the ground up to shape and influence policy at a higher level.

---


But what makes up a community? In rural areas, for example, a ‘community’ could be defined geographically, while administrative boundaries may work in more urban situations. A community could also be defined in terms of social connections (for example, through trade, or how people and groups meet). However, no single community will ‘feel’ like another. Each one, just like every person, is an individual with its own characteristics.

Every community is unique and largely defined by its singular characteristics.

Developing a model – the 5C-4R framework

Our working group’s research includes looking at the origins of resilience. From among the many conceptual models already developed to assess resilience, we chose to combine two to form what we describe as our ‘5C-4R community-based flood resilience measurement framework.’

The 5C model uses the ‘five capitals’ described in the UK’s Department for International Development (DFID) ‘sustainable livelihoods framework’ (SLF). These ‘5Cs’ characterize the assets a community consists of and are complementary resources that sustain and improve communities’ wellbeing.

If these are used well, they can increase personal and collective wealth, provide a sense of security, and enhance environmental stewardship.

The 4R model developed by the Multidisciplinary Center for Earthquake Engineering Research (MCEER) at the University of Buffalo in the U.S. postulates that a system has four properties that determine resilience. Collectively known as the 4Rs, they were originally used in a built environment (one that comprises physical infrastructure), but we think they apply equally to all assets in a system; both tangible physical assets and less tangible ones.

The five capitals:

- **Human** (education, skills, health).
- **Social** (social relationships and networks, bonds that promote cooperation, links facilitating exchange of and access to ideas and resources).
- **Physical** (things produced by economic activity from other capital, such as infrastructure, equipment, improvements in crops, livestock).
- **Natural** (natural resource base, including land productivity and actions to sustain it, as well as water and other resources that sustain livelihoods).
- **Financial** (level, variability, and diversity of income sources and access to other financial resources that contribute to wealth).

The ‘5Cs’ characterize the assets a community consists of and are complementary resources that sustain and improve communities’ wellbeing."
The four properties of a resilient system:

- **Robustness** (ability to withstand a shock), for example, housing and bridges built to withstand a flood.
- **Redundancy** (functional diversity), for example, having many evacuation routes.
- **Resourcefulness** (ability to mobilize when threatened), for example, a group within a community that can quickly mobilize to convert a community center into a flood shelter.
- **Rapidity** (ability to contain losses and recover in a timely manner), for example, quick access to sources of financing to support recovery.

Resilience can come from many sources. For example, having a physical asset (a capital in the 5C model) such as a community center that doubles as a classroom during the floods adds ‘redundancy’ (a property in the 4R model) to the system, and so is considered a source of resilience.

When developing a practical, community-based flood resilience measurement tool, we have defined a set of these ‘sources of resilience.’ These can serve as proxies before a flood to measure how a community fares, or how it performs after a flood. How a community fares, or ‘performs,’ is referred to as ‘the outcome of resilience.’

Measuring the sources of resilience

Over the years, Zurich’s approach to measuring risk has evolved into a rigorous methodology. Zurich risk engineers use a technical risk grading standard (TRGS) to help make sense of the data they gather. The TRGS provides a consistent benchmark for quantifying risk. For any specific peril, a TRGS includes five to 10 risk categories. Each category is made up of several risk factors. Risk engineers compare the data to the benchmarks and, based on their professional judgment and experience, assign letter grades from A to D:

**Risk grading scale:**

- **A:** Best practice for managing the risk.
- **B:** Good industry standard, no immediate need for improvement.
- **C:** Deficiencies, room for visible improvement.
- **D:** Significantly below good standard, potential for imminent loss.

With the Alliance’s expertise, this measurement methodology has been adapted to assess communities’ resilience to flooding. The approach combines quantitative and qualitative data based on the ‘sources of resilience.’ These can then be graded, and with the expertise of trained resilience assessors, based on the outcomes of the analysis, actions can be identified to enhance resilience.
The Zurich Flood Resilience Alliance has thus established a framework that can meet not only the challenges of measuring resilience, but can do it in an empirically verifiable way."

Once all sources are graded, it is also possible to identify strengths and weaknesses in the community and how each of these might contribute to resilience. Each ‘capital’ and each ‘source’ can be assigned a weighting in the overall measurement framework (please see appendix for all sources included in the Zurich Flood Resilience Alliance measurement framework).3

Road-testing the measurement framework

The measurement framework has already been piloted by our community organizations, Practical Action and the IFRC, in over 20 communities in Nepal, Peru and Mexico. Based on the results of these pilots, in 2014 and 2015 we refined the tool, in particular enhancing its usability. We also invited peers to an event to review the system in June 2015, at which academic and humanitarian experts from around the world were asked to critically evaluate it. Their review was overwhelmingly positive, but they also identified some key issues that we have since addressed – specifically, the need to more clearly define terms: resilience, communities, capitals – and providing better ways to assess complex data.

As part of our methodology, we also needed a set of tools to make the measurement framework practical and allow us to test it in a real environment. Our tool set provides a process for ‘end-to-end’ flood resilience measurement.

Tools to establish a process to measure resilience:

• A training environment allowing people to be trained in using the framework.
• A flexible (online, web-based) application to set up measurement activities, select data collection methods and assign them to fieldworkers’ smartphones.
• A simple, practical smartphone-based application to collect the data through the collection methods chosen, store it and send it back to the web application once the job is completed.
• A web-based environment consolidating all data for the assessment, using our rigorous and consistent assessment methodology.
• A method for visualizing and analyzing the measurement results and the right guidance on how to interpret the results (and how to avoid misinterpreting them).
• A database to store the resilience measurement results for a comprehensive analysis, and allow a validation process to be started.

In addition to our core community organizations, four other organizations4 are now using the measurement toolbox in their community development work in flood-prone areas. Together with the IFRC and Practical Action, we are building a community flood resilience database; the data will be analyzed to validate the sources of resilience and this knowledge

---

3 In this version of the tool, we have decided not to weight any one source over another, or any one capital over another in terms of making up the overall scores. We currently have no evidence as to the relative significance of the sources of resilience. This may change as the data from the trial phase becomes available and provides insight onto which sources are more significant over others.

4 Mercy Corps, Concern Worldwide, Plan International and the National Academy of Sciences.
will be used to further refine the methods. The Zurich Flood Resilience Alliance has thus established a framework that can meet not only the challenges of measuring resilience, but can do it in an empirically verifiable way.

Assessing the strengths and weaknesses of pilot communities

By assessing the ‘sources of resilience,’ the tool generates an overall score and some ‘category’ scores, which are obtained by converting numeric values to letter grades (A through D). The sources of resilience can be grouped together and analyzed according to different methods, as outlined here.

Ways to analyze sources of resilience:

• The five capitals (5Cs).
• The four resilience properties (4Rs).
• Ten themes, effectively the topics used to formulate questions asked in communities, such as health, education, food, governance, and similar.
• The five steps of the disaster risk management cycle.
• The context or environment in which a source is embedded – i.e., internal (community) or external (environment).

Identifying, prioritizing and planning resilience-building actions

Identifying and describing factors that received a low resilience score, and determining how they relate to each other, can support and guide the process to increase resilience. Identifying community development priorities may be guided by this process, even though this is not its primary purpose. The method outlined here does not help users to automatically select interventions.

The outcomes of resilience – a validation approach

To demonstrate that we are building resilience, ultimately we need to verify that any actions we take have an impact. By using the framework described here to produce measurements between at least two points in time – comparing the end-line assessment with the baseline assessment (and possibly some mid-term assessments) – we can track changes in the sources of resilience. By comparing this change with empirical evidence about how a community manages during a flood event (gathered through a systematic review), we may be able to attribute outcomes of resilience to their relevant, underlying sources. This is key to verifying the framework.

We will continue to test the tool and work to establish methods and processes that can be used by anyone with an interest in resilience measurement, who is also open to testing and sharing their experiences and the data they obtain.

---

5 The Zurich Flood Resilience Alliance has developed a methodology to consistently assess what has happened during a flood event that turned into a disaster and why, the Post Event Review Capability (PERC). Learn more at https://www.zurich.com/en/corporate-responsibility/flood-resilience/learning-from-the-post-flood-events
The 88 sources of resilience used in our approach, divided according to the five capitals, as listed in Table 1.

Table 1: 88 flood resilience sources

<table>
<thead>
<tr>
<th>Human capital</th>
<th>Social capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood protective behavior and knowledge</td>
<td>Social participation in flood management related activities</td>
</tr>
<tr>
<td>Personal safety</td>
<td>Formal community emergency services integrate flood advice and management</td>
</tr>
<tr>
<td>First aid knowledge</td>
<td>Access to external, formal flood related services</td>
</tr>
<tr>
<td>Value of education</td>
<td>Strategies for the delivery of actionable information for flood management</td>
</tr>
<tr>
<td>Flood Water Control Knowledge</td>
<td>Social norms and personal security</td>
</tr>
<tr>
<td>Flood exposure perception</td>
<td>Functioning and equitable health system</td>
</tr>
<tr>
<td>Flood exposure management knowledge</td>
<td>Strategy to maintain or quickly resume healthcare services interrupted by flooding</td>
</tr>
<tr>
<td>Flood vulnerability perception and management knowledge</td>
<td>Functioning and equitable education system</td>
</tr>
<tr>
<td>Understanding of future flood risk</td>
<td>Strategy to maintain or quickly resume schooling interrupted by flooding</td>
</tr>
<tr>
<td>Non-erosive flood recovery knowledge</td>
<td>Mutual assistance systems and safety nets</td>
</tr>
<tr>
<td>Flood water and sanitation (WASH) knowledge</td>
<td>Social norms and security of assets</td>
</tr>
<tr>
<td>Waste management awareness</td>
<td>Appropriate and equitable access to mobility</td>
</tr>
<tr>
<td>Political awareness</td>
<td>Strategy to maintain or quickly resume provision of mobility services in the event of a flood</td>
</tr>
<tr>
<td>Flood provisioning ecosystem services awareness</td>
<td>Functioning and equitable food supply systems</td>
</tr>
<tr>
<td>Population health status</td>
<td>Strategy to maintain or quickly resume provision of local food supplies in the event of a flood</td>
</tr>
<tr>
<td>Educational attainment</td>
<td>Functioning and equitable water services</td>
</tr>
</tbody>
</table>

*Appendix*

8 Measuring flood resilience – our approach
<table>
<thead>
<tr>
<th>Physical capital</th>
<th>Natural capital</th>
<th>Financial capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to healthcare facilities</td>
<td>Basin health</td>
<td>Household financial savings that protect long term assets</td>
</tr>
<tr>
<td>Early Warning Systems (EWS)</td>
<td>Habitat connectivity</td>
<td>Income and affordability</td>
</tr>
<tr>
<td>Measurement and Forecasting</td>
<td>Natural habitats maintained for their flood resilience services</td>
<td>Communal social safety net</td>
</tr>
<tr>
<td>Flood emergency infrastructure</td>
<td>Sustainable use of natural resources</td>
<td>Household Credit Access</td>
</tr>
<tr>
<td>Access to school facilities</td>
<td>Conservation management plan</td>
<td>Business credit access</td>
</tr>
<tr>
<td>Individual (HH) flood vulnerability management</td>
<td>National legislation recognizes habitat restoration</td>
<td>Household flood Insurance</td>
</tr>
<tr>
<td>Communal flood protection (flood controls)</td>
<td></td>
<td>Business flood insurance</td>
</tr>
<tr>
<td>Basin level flood controls</td>
<td></td>
<td>Household income continuity strategy</td>
</tr>
<tr>
<td>Transportation and community access</td>
<td></td>
<td>Household budget management</td>
</tr>
<tr>
<td>Communication infrastructure</td>
<td></td>
<td>Continuity of business</td>
</tr>
<tr>
<td>Lifelines infrastructure</td>
<td></td>
<td>(Inter) National disaster response budget</td>
</tr>
<tr>
<td>Food security</td>
<td></td>
<td>Social safety net (legislative, national schemes)</td>
</tr>
<tr>
<td>Water supply</td>
<td></td>
<td>Mitigation financing (provided through public or private)</td>
</tr>
<tr>
<td>Sanitation facilities</td>
<td></td>
<td>Functioning financial market</td>
</tr>
<tr>
<td>Waste collection systems</td>
<td></td>
<td>Government appropriations for infrastructure maintenance</td>
</tr>
<tr>
<td>Energy sources</td>
<td></td>
<td>Community development investment vehicles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conservation budget</td>
</tr>
</tbody>
</table>
This publication has been prepared by Zurich Insurance Group Ltd and the opinions expressed therein are those of Zurich Insurance Group Ltd as of the date of writing and are subject to change without notice. This publication has been produced solely for informational purposes. The analysis contained and opinions expressed herein are based on numerous assumptions. Different assumptions could result in materially different conclusions. All information contained in this publication have been compiled and obtained from sources believed to be reliable and credible but no representation or warranty, express or implied, is made by Zurich Insurance Group Ltd or any of its subsidiaries (the ‘Group’) as to their accuracy or completeness. Opinions expressed and analyses contained herein might differ from or be contrary to those expressed by other Group functions or contained in other documents of the Group, as a result of using different assumptions and/or criteria. This publication is not intended to be legal, underwriting, financial, investment or any other type of professional advice. Persons requiring advice should consult an independent adviser. The Group disclaims any and all liability whatsoever resulting from the use of or reliance upon this publication. Certain statements in this publication are forward-looking statements, including, but not limited to, statements that are predictions of or indicate future events, trends, plans, developments or objectives. Undue reliance should not be placed on such statements because, by their nature, they are subject to known and unknown risks and uncertainties and can be affected by other factors that could cause actual results, developments and plans and objectives to differ materially from those expressed or implied in the forward-looking statements. The subject matter of this publication is also not tied to any specific insurance product nor will it ensure coverage under any insurance policy. This publication may not be reproduced either in whole, or in part, without prior written permission of Zurich Insurance Group Ltd, Mythenquai 2, 8002 Zurich, Switzerland. Neither Zurich Insurance Group Ltd nor any of its subsidiaries accept liability for any loss arising from the use or distribution of this presentation. This publication is for distribution only under such circumstances as may be permitted by applicable law and regulations. This publication does not constitute an offer or an invitation for the sale or purchase of securities in any jurisdiction.