Step 7: Analyse links between hazard magnitude and impact

What impacts can we expect from hazards with a certain magnitude?

Not every event with a return period of 1-in-5 years will be an extreme event with significant humanitarian impact. For this reason, it is necessary to demonstrate what impact a hazard of a magnitude that occurs for example every five years on average will have. This step – defines the relationship between impact and hazard magnitude that will be different for people of different vulnerabilities. Often called the impact-hazard curve or vulnerability function, it establishes expected impact hazard magnitudes and vulnerabilities. Ideally, this should be established for different sectors, impact types, and regions. For example, the impact of a cyclone with a certain windspeed will look much different in a refugee camp than in a nearby town.

How does this look?

Establishing the relationship between a hazard of a certain magnitude and the associated impact depends on data. For example, if the major impact of a given hazard is on shelter, then the impact-hazard curve in the context of FbF should be done for this sector. In places with very little data, the 'curve' may be a deterministic statement such as: "At 100 kph we expect 20 per cent of houses to be destroyed, and at 150 kph we expect all houses to be destroyed."

Development of the most simple impact-hazard curve would rely only on expert knowledge and qualitative categories rather than quantitative data from historical disasters. For instance, in the case of flood risk, this may involve expert judgment from water managers, irrigation experts, and dam operators, as well as disaster managers, DRR and hydrometeorological experts and others. When little data is available, another way of showing that hazards of a certain magnitude caused significant impact is to link them to past humanitarian response operations. E.g., in the past, whenever a cyclone hitting area X had a wind speed of more than 120km/h (1-in-x year return period), a DREF or emergency appeal was launched because the impact was so great that humanitarian assistance was necessary. The information can be created in a general sense for an entire region (river basin, coastal area, etc.), or be more geographically specific and targeted to specific groups, factoring in considerations like the different ways the hazard could play out in different parts of the country (e.g. in urban areas).

It is also important to consider, if data allows, how vulnerability and exposure change over time.

This step should provide decision-makers with a view of what impact can be expected for which people (or livestock/assets) a given hazard magnitude; step 9 will show for which area the (most severe) impacts can be expected.

Approaches to impact-hazard curves

Expert knowledge

This approach uses the expert judgement of people who work in the region and have an understanding of what kind of impacts can be expected when a hazard strikes. For example, experts can indicate that above 100km/hr winds, 20% of houses are likely to be destroyed, and above 150km/hr winds, all houses are likely to be destroyed. This expert view can be combined with a map of vulnerability information, to identify the most vulnerable administrative areas to be prioritized for early action according to budget available.

Predictions of absolute impact levels can instead use historical quantitative data and not expert judgement. This is where the following approaches come in.

Elementary modelling

Historical data from observations (as opposed to modelling) can point to the relationship between hazard magnitudes and impact.

A good example of this approach is the one used in the FbF project in Uganda. Impact data was collected, which recorded when there was impact of floods on the vulnerable population in the last couple of years. This impact was compared with forecasted water discharge levels for each day during those same years. A relationship was determined, which best discriminated the impact periods, from the non-impact periods. In this case, the project did not develop a full hazard-impact curve but selected a single level above which they could show there had been significant impact in the past.

This is the simplest relationship that can be established. It only establishes a correlation with one indicator (water discharge) and distinguishes two levels: no impact or flood with impact. This approach can also be expanded to allow for different levels of impact and establish separate relationships for different levels of vulnerabilities. This could, for example, produce a chart like Figure 4. (Quantitative modelling should be adjusted by experts.)

Note that establishing such a chart requires access to quality data, and the results should be verified against new data or expert judgement to ensure they make sense. From here, it is then only a small step to a formal statistical model.

Statistical modelling

Statistical modelling and machine learning, based on good impact data for past events, can test the potential of several explanatory indicators. These tools can create more complex relationships between the input information (e.g. vulnerability, hazard magnitude, exposure), and the predicted impacts. Impact differences between urban and rural areas might be explained through a statistical model of differences based on short-term forecast variables and others covering vulnerability and capacity. **Crop models for agro-hydrometeorological forecasting** are one example from the complex end of the spectrum.

Ultimately, whichever of these three approaches is used, the resulting model will give decision-makers perspective on the degree of impact – in absolute or relative terms – expected for a specific magnitude of hazard and given the vulnerabilities in different locations.

Machine Learning is an algorithm that can learn from data without relying on rules-based programming.

Statistical Modelling is formalization of relationships between variables in the form of mathematical equations.