USER-CENTRED DESIGN FOR DISASTER RISK VISUALISATION

Visual communication can provide disaster risk managers with the information they need to prepare for and respond to crises. This brief outlines key learning from the SHEAR programme to guide the development of usable and useful disaster risk visualisations.

Science for Humanitarian Emergencies and Resilience (SHEAR) is an interdisciplinary, international research programme jointly funded by the UK’s Foreign, Commonwealth & Development Office (FCDO) and the Natural Environmental Research Council (NERC).

It aims to support improved disaster resilience and humanitarian response by advancing monitoring, assessment and prediction of natural hazards and risks across sub-Saharan Africa and South Asia. SHEAR is working with stakeholders to co-produce demand-led, people-centred science and solutions to improve risk assessment, preparedness, early action and resilience to natural hazards.

The effective communication of risk information plays a crucial role in connecting advances in hazard assessment science with improved preparedness for and response to hazards. The use of visualisations means that complex information can be conveyed to users efficiently and effectively.

Disaster risk management contexts are highly complex, as are the end-users of disaster risk communication visualisations. Individual characteristics can greatly affect how a user interprets, perceives, and acts on the risk communicated by a disaster risk visualisation.

Tailoring visualisations to users and their contexts through user-centred design (UCD) presents an opportunity to develop effective disaster risk visualisation. UCD involves tailoring communications to specific users or user groups, rather than solely focusing on the information being conveyed. The characteristics of a product’s end-users (i.e. their wants, needs, contexts, capacities etc.) are thoroughly researched and explicitly considered by designers throughout the whole design process when a product is developed through UCD.

Summary

There are many widely recognised advantages to communicating information through visualisations.

Visualisations improve users’ ability to make informed decisions, complete tasks and understand a situation.

However, the context within which disaster risk operates is highly complex.

This document presents a user-centred design framework that can be utilised to develop visualisations for different user groups and across different disaster contexts.
Phase 1- Define

This phase aims to define and characterise the disaster risk management context and end-user group who will benefit from a visualisation. Stakeholders and available information should be mapped, and challenges within the disaster risk management context should be identified.

Socio-demographic profile, culture, numeracy, literacy, personal preferences, profession, prior hazard experience, and pre-existing knowledge of the hazard and vulnerabilities affect a user’s risk perception, risk appetite, interpretation and understanding of a disaster risk visualisation.

Designers need to understand fully how these characteristics vary between and among end-users.

Phase 2- Design

This phase is highly iterative and presents an opportunity to test how users interpret different design elements. It involves carrying out many rounds of design, prototyping, and regularly seeking and incorporating feedback from end-users.

Colour, texture, and symbols should be continually assessed and adjusted according to feedback to ensure maximum usability and understanding. It is the designers’ decision to work reflexively and determine when an appropriate number of iterations have been reached.

Phase 3- Refine

This phase focuses on evaluating how users understand, respond to, and make decisions based on the visualisation when it is “in use” in a real-world context. A key element of disaster risk visualisations is that they may evoke emotional and behavioural responses.

It is crucial that this response is properly characterised during the evaluation phase, to ensure that the visualisation is useful to the end-users. Testing for Type 1 or Type 2 decision making will reveal the degree of cognitive load imposed by the visualisation.

This will highlight whether there are information gaps that end-users complete using prior knowledge, resulting in Type 2 processing.

Tailored Visualisations

This image, taken from Grainger et al., 2016, shows weather forecast information tailored for a farmer (top) and a scientist (bottom).

In the top image, displaying the relative values and trends in rainfall is more useful than the actual values for farmers. Symbols provide an easy comprehension and interpretation, aided by the differences in colour hue and saturation. The simplicity of the visualisation ensures clarity because the most important information is salient and the text is minimal but relevant.

In the bottom image, the graph follows the traditional graphing protocols that a scientist would expect to find when looking at such a graph. This helps the scientist to employ Type 1 processing, and easily understand the graph.
Type 1 and Type 2 Processing
Humans assess new information and make decisions based on visualisations with either fast, intuitive thinking, (Type 1), or slow analytical thinking (Type 2).

The 3-phase iterative framework presented in Figure 1 is based on existing visualisation and risk communication frameworks, and can be applied in any natural hazard context.

The questions and suggested methods in Table 1 underpin the framework and guide visualisation development.

Table 1: Guiding questions that underpin the framework

<table>
<thead>
<tr>
<th>Phase of Framework</th>
<th>Important Questions</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Define</td>
<td>What is the natural hazard? Where is the natural hazard? Who is vulnerable?</td>
<td>• Ethnographies</td>
</tr>
<tr>
<td></td>
<td>How do those vulnerable understand the hazard, and the risk it poses?</td>
<td>• Contextual studies</td>
</tr>
<tr>
<td></td>
<td>What is the actual challenge and risk posed?</td>
<td>• Institutional mapping</td>
</tr>
<tr>
<td></td>
<td>What data, information and forecasting tools are available? Who would benefit from access to this?</td>
<td>• Stakeholder mapping</td>
</tr>
<tr>
<td></td>
<td>Who are the end-users of the visualisation?</td>
<td>• Gap analysis</td>
</tr>
<tr>
<td></td>
<td>What information about the natural hazard do end users have access to?</td>
<td>• Discourse analysis</td>
</tr>
<tr>
<td></td>
<td>What medium do end users utilise to access information? What are their trusted sources?</td>
<td>• Interviews</td>
</tr>
<tr>
<td></td>
<td>How will users use this visualisation?</td>
<td>• Focus groups</td>
</tr>
<tr>
<td></td>
<td>How is uncertainty understood?</td>
<td>• Surveys</td>
</tr>
<tr>
<td>2 Design</td>
<td>Is this design colour-blind friendly?</td>
<td>• Expert review</td>
</tr>
<tr>
<td></td>
<td>How is uncertainty represented? Is this representation accurately understood by end-users?</td>
<td>• Surveys</td>
</tr>
<tr>
<td></td>
<td>Are the symbols and colours accurately understood by end-users?</td>
<td>• Focus groups</td>
</tr>
<tr>
<td></td>
<td>Is the information in the visualisation accurately understood by end-users?</td>
<td>• Interviews</td>
</tr>
<tr>
<td></td>
<td>Has the most appropriate medium been used?</td>
<td>• Questionnaires</td>
</tr>
<tr>
<td></td>
<td>Is the information useful, relevant, and helpful for the end-users? Is more information necessary?</td>
<td>• Storyboarding</td>
</tr>
<tr>
<td></td>
<td>Is the visualisation interesting, attractive, and useful to the end-users?</td>
<td>• Mix and match cards</td>
</tr>
<tr>
<td></td>
<td>Is the visualisation clear in its messaging?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>How would end-users improve the visualisation?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>What information is missing?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In what context will the visualisation be used?</td>
<td>• Surveys</td>
</tr>
<tr>
<td></td>
<td>How are end-users intended to make decisions based on the visualisation?</td>
<td>• Focus groups</td>
</tr>
<tr>
<td></td>
<td>To what extent do end-users understand the information represented in the visualisation?</td>
<td>• Interviews</td>
</tr>
<tr>
<td></td>
<td>How do end-users make decisions based on the visualisation?</td>
<td>• Questionnaires</td>
</tr>
<tr>
<td></td>
<td>How effective are the decisions made based on the visualisation?</td>
<td>• Observations</td>
</tr>
<tr>
<td></td>
<td>Do the end-users understand the uncertainty represented in the visualisation?</td>
<td>• Scenarios</td>
</tr>
<tr>
<td></td>
<td>How do the end-users emotionally respond to the visualisation?</td>
<td>• Serious games</td>
</tr>
<tr>
<td></td>
<td>What behavioural changes do end-users make based on the visualisation?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Is Type 1 (Fast) or Type 2 (Slow) cognitive processing occurring?</td>
<td></td>
</tr>
</tbody>
</table>
Figure 1: User-centred design framework for disaster risk visualisation

1 Define
What is the hazard context? Who are the end-users?
What is the problem and risk posed? What information do they use?
What data are available? How will they use this visualisation?

Feedback
User groups
User characteristics
User requirements
User’s understanding of hazard
Information about hazard
Social networks and information flows

2 Design
Prototyping
user profiles
storyboarding
user testing
Visual Encoding
salient features
colour
texture
shapes
Information
relevant
useful
helpful
Medium
website
poster
dashboard
map

Feedback
User testing
Cultural context
Level of understanding
Missing information

Many iterations

3 Refine
Decision Making
Type 1 Processing/Fast Decision
Little working memory is used, occurs outside of the decisions maker’s consciousness, and does not require controlled attention.

Type 2 Processing/Slow Decision
Significant working memory is used, and thus prior knowledge and context are important. Requires controlled attention.

User Response
Understanding
Increased understanding of the need to build resilience.

Emotion
Emotionally feel the need to build resilience.

Behaviour
Changes in behaviour to build resilience.

Further Reading


More information at www.shear.org.uk

Cover image by Yu Luck via the Noun Project