DESIGN FOR IMPACT FRAMEWORK

Integrating Open Data and Risk Communication for Decision-Making

GFDRR
Global Facility for Disaster Reduction and Recovery

OPEN DRI Open Data for Resilience Initiative

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ABBREVIATIONS

CAT	Category
CI	Critical Infrastructure
CIrcle	Critical Infrastructures: Relations and Consequences for Life and Environment
DRM	Disaster Risk Management
FEWS	Flood Early Warning System
FOREWARN	Forecast-based Warning, Analysis and Response Network
FUNES	Functional Estimation
GAR	Global Assessment Report
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	Geographic Information System
GRM	Global Risk Model
I-REACT	Improving Resilience to Emergencies through Advanced Cyber Technologies
OpenDRI	Open Data for Resilience Initiative
MASDAP	Malawi Spatial Data Platform
MEL	Monitoring, Evaluation, and Learning
MMS	Multimedia Messaging Service
NGO	Non Governmental Organization
NMHS	National Meteorological and Hydrological Services
NOAH	Nationwide Operational Assessment of Hazards
OASIS LMF	Oasis Loss Modeling Framework
OSM	OpenStreetMap
QGIS	Quantum Geographic Information System
SESAME	Specialized Expert System for Agro-Meteorological Early Warning
SMS	Short Messaging Service
T+T	Tonkin+Taylor
UN	United Nations
UNISDR	United Nations Office for Disaster Risk Reduction
UP NOAH	University of the Philippines - Nationwide Operational Assessment of Hazards
URP	Urban Resilience Platform

EXECUTIVE SUMMARY

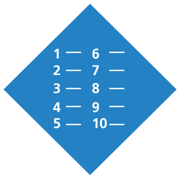
The most effective decision-making takes place when it is informed by reliable data. Pillar 3 of the Open Data for Resilience Initiative (OpenDRI) seeks to support the appropriate use of data in decision-making in a range of resilience planning, risk reduction, financing, preparedness, and recovery contexts. OpenDRI does this by supporting the adoption of tools and processes which support engagement, risk visualization, and communication.

Advances in technology are generating unprecedented volumes of data. Governments, international agencies, and scientific institutions are increasingly making their data available to planners, civil contingency managers, and responders as open data. Our knowledge, however, of how best to design projects that take advantage of these new data opportunities to create impact is inconsistent and unconsolidated. A clear and validated framework that relates the capture and analysis of risk data to decision-making is missing.

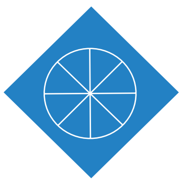
Design for Impact Framework: Integrating Open Data and Risk Communication for Decision-Making represents a foundational first attempt by OpenDRI to address this challenge. It aims to provide project designers with a framework to guide them in developing projects that have a tight handshake between the development of risk data and real world decision-making.

The Design for Impact Framework has its intellectual grounding in a review of academic literature related to risk communication, climate information services, civic technology, citizen science, and design for community resilience. It draws heavily on the guiding approaches and tactics used by over 23 successful projects developed to reduce disaster risk and build resilience in an extensive range of geographies and contexts.

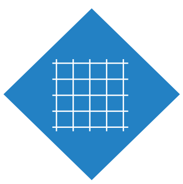
The Framework has three components:



A Set of 10 Guiding Principles that apply to a project at all stages in order to ensure that risk data is used effectively for decision-making on an ongoing basis. The Guiding Principles range from: engaging in *user-centric, context-based design; information appropriateness* based on *understanding the users of risk information; co-creating* risk data to generating *dialogue and debate*.



A Decision-Making Context Scoping Tool to help project designers identify contextual aspects of a project that can have a determining effect on the suitability of certain project design tactics. These aspects include the *disaster risk expertise* of the users of risk information, their *time availability* to engage in the project, and the *time criticality* of the decisions that the risk data will support.



A Tactics Selection Tool to help project designers select from the range of options available for co-developing and delivering a project with users of risk information. These tactics involve *collaboration & learning* techniques, *data & modeling* approaches, communication options around *visualization* of data, and the selection of appropriate *communication channels.*

The Framework has been developed to enable what is best viewed as an informed art rather than an exact science to increase the impact of risk data and information projects. Every project is unique. This Framework is not meant, therefore, to be a 'color by numbers' project or a hard and fast prescriptive guide. Rather, it is meant to help the project designer think about the different components and approaches that can support a successful risk information initiative.

This first iteration of the Framework has been peer-reviewed by a panel of over 15 experts from the disaster risk management, risk modeling, weather services, and communication sectors.

The experts shared a number of insights regarding deployment of the Framework. These insights cover four key areas related to the existing institutional landscape, data and modeling, risk communication, and monitoring, evaluation, and learning. They are relevant to using the Framework both for new projects in their own fields, as well as in many of the sectors that work with risk data.

This publication presents a first iteration of the Framework. OpenDRI anticipates further refinement and customization of it following feedback from the Understanding Risk and OpenDRI communities.

Design for Impact Framework: Chapter by Chapter Snapshot

- **Chapter 1** introduces the **Design for Impact Framework**, how it relates to the work of OpenDRI, and how it is reinforced by a number of key expert recommendations.
- **Chapter 2** covers the Framework through a step-by-step project design guide illustrated by examples from impactful projects.
- **Chapter 3** presents a scenario in which the Framework is applied in a preparedness planning context for a coastal city.
- **Chapter 4** features eight projects that use open risk data effectively and are mapped against the Framework.
- **Chapter 5** showcases a further 15 impactful projects in the light of the Framework.

CHAPTER 1

Introduction

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Introducing the Design for Impact Framework

Deploying Open Data to Advance the Sendai Framework

The Open Data for Resilience Initiative (OpenDRI) has its operating rationale in the Principles for the Implementation of the Sendai Framework for Disaster Risk Reduction:

> *"Disaster risk reduction requires a multi-hazard approach and inclusive risk-informed decision-making based on the open exchange and dissemination of disaggregated data, including by sex, age and disability, as well as on easily accessible, up-to-date, comprehensible, science-based, non-sensitive risk information.[1]"*

Since its establishment in 2011, OpenDRI has successfully applied the open data-based approaches called for in the Sendai Framework to address the challenges of reducing vulnerability to natural hazards and the impacts of climate change in over 50 countries. Open data is data that anyone can access, use, or share.[2] OpenDRI has pioneered new projects and platforms across three program areas, or pillars:

1) **Sharing Data:** increasing public access to risk information through dialogue with governments on the value of open data through working groups and pilot projects. Many of them have evolved into long-term, locally-owned open data projects supported by GeoNode[3], a free and open source data sharing platform.

2) **Collecting Data:** engaging communities to create accurate and timely data for risk analysis and response planning. These initiatives utilize simple, collaborative, crowdsourced mapping tools such as OpenStreetMap (OSM).[4]

3) **Using Data:** communicating risk to decision makers more effectively in planning, preparedness, and response activities. OpenDRI works with governments and partners to develop accessible tactics, applications, and software that use risk data to support decision-making in a range of contexts.[5]

OpenDRI's portfolio of projects under the Using Data program pillar covers collaborative open source catastrophic risk modeling (InaSAFE), the application of civic technology (Code for Resilience), and gamification (Serious Games).

OpenDRI seeks to take full advantage of the growing opportunities related to placing open data in the service of disaster risk management (DRM) and efforts to build resilience. These opportunities are being created by new advances in technology, such as satellite-enabled remote sensing, drone based surveying, and internet-enabled crowdsourcing. They are driving the production of vast new flows of data. These flows are being matched by the open release of existing datasets by many governments, international agencies, and scientific institutions.

A Missing Framework

OpenDRI has identified a number of challenges related to strengthening the role that data can play in risk management and resilience. These include:

- *Low capacity in the governance, management, and curation of local data relevant to exposure and vulnerability analysis.*
- *At the project level, there is a lack of engagement with stakeholders to identify the problem to be addressed and in the data to be collected and analyzed.*
- *A disconnect between data and modeling approaches and collaboration and communication techniques, which constrains the use of data in decision making.*

Many risk information projects are, in fact, initiated with no clear roadmap as to how they will support decision-making in DRM contexts. The impact of these initiatives on decision-making can be difficult to ascertain. A clear and validated framework that relates the capture and analysis of risk data to decision-making by the stakeholders is missing. This is not merely an issue of investing in risk communication but reflects a deeper challenge that goes to the very heart of the design of projects that utilize risk data.

A Foundational Response

Design for Impact Framework: Integrating Open Data and Risk Communication for Decision-Making represents a foundational first attempt by OpenDRI to address this issue. It aims to provide project designers with a framework to guide them in developing projects that have a tight handshake between the development of risk data and real world decision-making.

The **Design for Impact Framework** has its intellectual grounding in a review of academic literature related to risk communication, climate information services, civic technology, citizen science, and design for community resilience. It draws heavily on the guiding approaches and tactics used by over 23 successful projects developed to reduce disaster risk and build resilience in an extensive range of geographies and contexts.

The Framework was designed to assist project managers (Task Team Leaders) inside The World Bank to design new projects that involve the use of risk data. However, it is also aimed at project managers in other institutions who engage with a variety of stakeholders in disaster risk information. It will also assist the wider Understanding Risk (UR) Community in creating risk information that is informed by decision makers, by the context in which they operate, and by the channels and devices through which they communicate.

A wealth of practical and technical inputs from the submitters of the 23 projects has contributed to the development of the Framework. The most recurrent inputs were validated by a range of academic sources. They underpin the 10 Guiding Principles for the Effective Use of Risk Data laid out in Chapter 2. These principles cover core approaches to project design such as user centricity, information appropriateness, channel suitability, and the importance of developing shared understanding and co-creation processes. The Guiding Principles also build on and reinforce OpenDRI's existing body of policy work and practical guidance.[6]

Informed Art Rather than Exact Science

The Framework has been developed to enable what is best viewed as an informed art rather than an exact science to increase the impact of risk data and information initiatives. Every project is unique. Technology and culture are continually generating new techniques, approaches, and channels of information. This Framework is not meant, therefore, to be a "color by numbers" project, nor a hard and fast prescriptive guide. Rather, it is meant to help the project designer think about the different components and options to successfully implement a risk information initiative.

Expert Insights on Deployment

This first iteration of the Framework has been peer-reviewed by a panel of over 15 disaster risk management, risk modeling, weather services, and communication experts.

The experts shared a number of insights regarding deployment of the Framework. These insights cover four key areas related to the existing institutional landscape, data and modeling, risk communication, and monitoring, evaluation and learning. The insights are relevant both to using the Framework for new projects in their own fields and to many of the sectors that work with risk data. The experts encourage project designers to:

Institutional Landscape:

- *Create linkages to existing national government policies and international frameworks;*
- *Reinforce the capacities of existing actors and build on existing networks and initiatives;*
- *Seek to reinforce the roles of and relationships with regional and in-country information providers such as national science institutions and the official services that supply national hazard, weather, and climate risk data.*

Data and Modeling:

- *Place priority on the accuracy and reliability of data and information that is being used to assess risk;*
- *Adopt data and modeling standards and ensure that methodologies are transparent;*
- *Understand the ethical responsibilities of data providers and modelers towards the users of their data and models.*

Risk Communication:

- *Consider risk communication as an integral component of project design by incorporating elements of risk communication from the beginning of the project, rather than as a supplementary appendage;*
- *View the generation of dialogue and debate between stakeholders as both a guiding principle and a key indicator of impact;*
- *Place emphasis on the value of the effective communication of actual or potential financial losses under various risk management scenarios.*

Monitoring, Evaluation, and Learning (MEL):

- *Build in MEL planning at the project design stage;*
- *Seek to adopt standard approaches to MEL that draw upon the 10 Guiding Principles and indicators based on them.*

This publication presents a first iteration of the Framework. OpenDRI anticipates further refinement and customization of it following feedback from the Understanding Risk Community.

CHAPTER 2

Design For Impact

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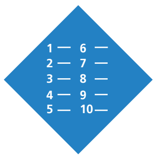
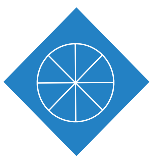
A step-by-step project design guide illustrated by examples from impactful projects

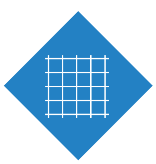
The Design for Impact Framework seeks to help a project designer utilize and communicate open risk data and information to support informed decision-making by the users of risk information. The Framework does so by presenting:



10 Guiding Principles to guide all risk information projects.



A Decision-Making Context Scoping Tool to help understand key elements of a project.



A Tactics Selection Tool to help match these contextual elements to appropriate project tactics to deliver impact.

Who is the Framework for?

The Framework is designed for project designers in DRM who use risk data and information for real-world decision-making. This includes, for example, technical staff in international, national, or local organizations. The Framework also has direct relevance to broader creators and users of risk information, including senior policymakers, insurance and reinsurance brokers, civil contingency managers, engineers and infrastructure managers, investors, national and local media, and community members and leaders.

Users of Risk Information

Users of risk information are defined as groups or individuals who make decisions based on risk data and information. Users of risk information includes terms used in DRM such as "end users" and "decision makers". It may include those in formal positions of authority, such as government officials, but can also refer to members of the public who are being encouraged to take action in light of the risk information available to them. There can be multiple audiences for any given DRM project, and each audience should be considered separately. For example, communicating with governments as opposed to local community leaders will inevitably require very different risk communication strategies, even if the underlying risk data is the same.

Overview Of The Framework: Guiding Principles, Context Elements, and Design Tactics

The Framework has three components:

A Set of 10 Guiding Principles

A Decision-Making Context Scoping Tool

A Tactics Selection Tool

The **10 Guiding Principles** are the overarching approaches or considerations that apply to a project at all stages in order to ensure that risk data will be used effectively for decision-making on an ongoing basis. These principles are based on the growing consensus regarding the steps involved in the process of developing decision-relevant information from risk data. The Guiding Principles cover considerations such as **cultural, social, and psychological appropriateness; inclusivity; sustainability; financial viability;** and the generation of **dialogue and debate** as a critical indicator of impact.

Decision-making context elements are aspects of a project that can have a determining effect on a specific set of project tactics. These elements include **objectives of the project; characteristics of the users of risk information** that the project is engaging with and supporting; **time related aspects** of their engagement in the project; the **decisions** that they will be making; and their **access to data, internet,** and **media systems**. These elements can be selected and combined to develop, use, and communicate risk data.

Project design tactics are the specific range of options that are available for co-developing and co-delivering the project with the users of risk information. Project design tactics include approaches from **collaboration & learning** to **data & modeling** to **communication.**

Using the Framework and its tools enables the development and implementation of projects to maximize the impactful use of risk information. **Impactful use** is defined as the effective development and communication of data or information in ways that result in decision-making that reduce the consequences of disaster risk.

Definitions of Context Elements and Project Design Tactics are listed at the end of this chapter in Tables 2.2 and 2.3 on pages 26 and 28.

Using The Framework Involves Six Key Steps:

1) Understanding the 10 Guiding Principles

2) Scoping the Decision-Making Context

3) Selecting Collaboration & Learning Tactics

4) Selecting Data & Modeling Tactics

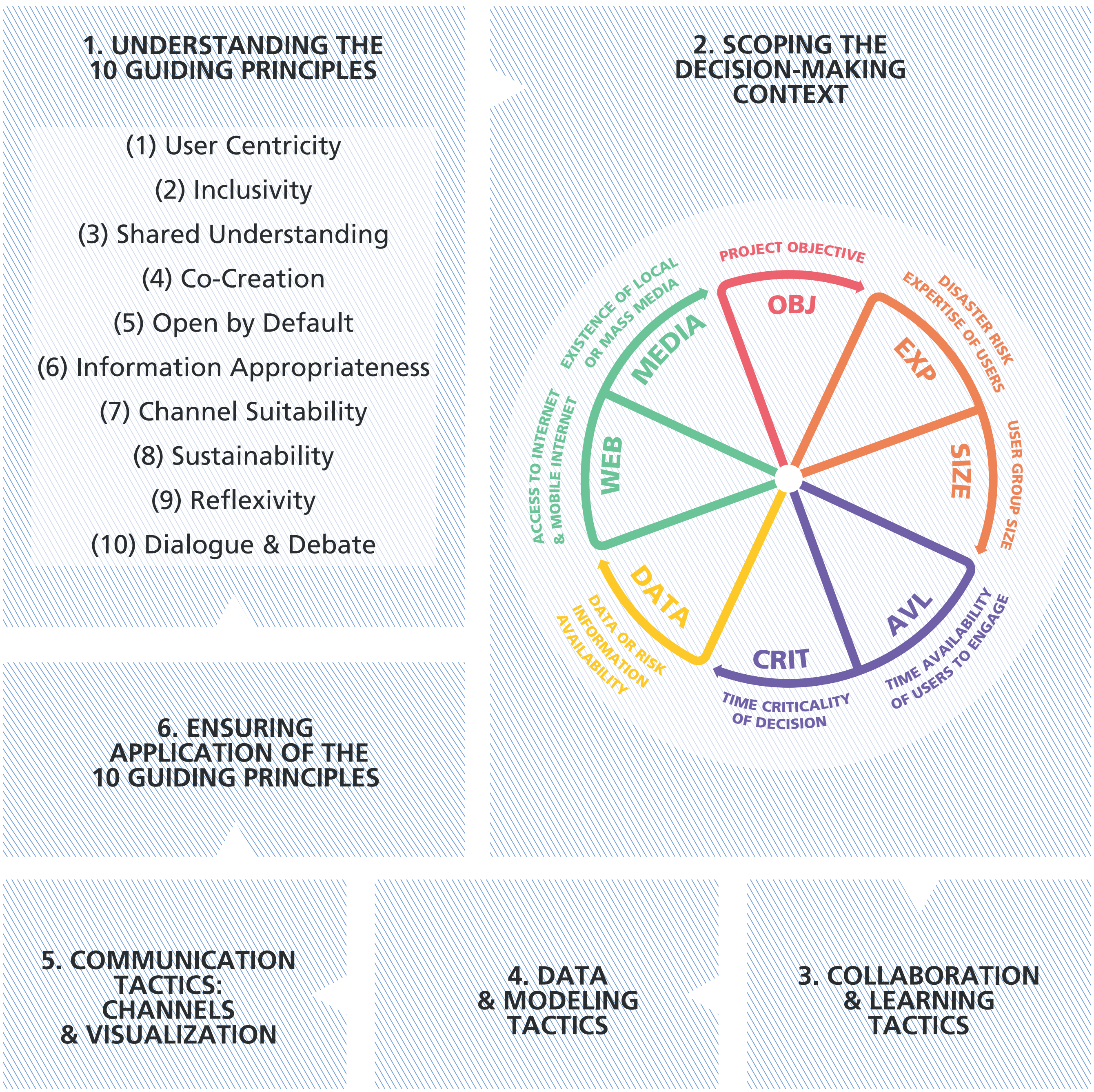
5) Selecting Communication Tactics

6) Ensuring application of the 10 Guiding Principles

Project designers do not have to select tactics from all three tactic areas. It may be the case that some tactic areas do not apply to their risk information project. For instance, in cases where a project has already developed and modeled its data, it will be more relevant to focus on the areas that cover collaboration & learning and communication. However, working through the tactics step-by-step will create a more systematic understanding of the key tactic areas and options available to use risk data for effective decision-making.

Figure 2.1

The six key steps for using the Design for Impact Framework



See more detailed flowchart of the Framework at the end of this Chapter.

Step 1: The 10 Guiding Principles for Effective Use of Risk Data

Applying the 10 Guiding Principles at all stages of a project ensures that risk data is effectively used. These principles have been compiled from over 40 years of academic research and experiences of expert DRM project designers. A number of academic and reference papers that underpin the principles are listed at the end of this publication.[7] They build upon the growing consensus on the steps involved in the process of developing decision-relevant information from risk data. The 10 Guiding Principles are as follows:

1. ENGAGE IN USER-CENTRIC CONTEXT-BASED DESIGN	Developing risk information that is grounded in the needs of specific decision makers at relevant geographic and time scales through accessible and understandable formats and channels increases the likelihood of its uptake and impact on decision-making.[8]
2. ENGAGE INCLUSIVELY	Addressing the decision-making needs of those people most directly impacted by natural hazards through active collaboration will ensure appropriate prioritization of concerns across social groups.[9]
3. CREATE SHARED UNDERSTANDING	Consensus among the providers and users of risk information about the core problem that a project is seeking to address will support the development of understandable, decision-relevant risk information.[10]
4. CO-CREATE RISK DATA	The generation of data and information with the users of risk information strengthens long-term risk data creation, builds trust, and increases ownership of the risk information being developed.[11]

5. **PROMOTE OPENNESS**	A policy of 'open by default' for data sharing, coding, and innovation processes will support local open data infrastructure, local ownership of risk information, local modeling capacity, and scalability of the risk information project.[12]
6. **UNDERSTAND THE USERS OF RISK INFORMATION**	Not all users of risk information are the same. Over 70 years of risk perception and communication research has highlighted the importance of **cultural, social, cognitive, and psychological factors** that influence how individuals receive and respond to risk information. Effective risk communication needs to take this into account through the appropriate use of visualization formats and channels covered in the Tactics Selection Tool.[13]
7. **SELECT APPROPRIATE COMMUNICATION CHANNELS**	There is no single best channel to communicate information. Channels should be accessible, trustworthy, interactive, scalable, and resilient to natural hazards.[14]
8. **ENSURE THAT STRATEGIES ARE SUSTAINABLE**	The effective use of risk data requires a viable and sustainable business model combined with support from local communities and networks.[15]
9. **PROMOTE REFLEXIVITY**	The ongoing relevance of a risk information project will be determined by its reflexivity, or the degree to which it develops a project culture of ongoing learning, review, and self-assessment to identify what is working and what is not. It should further identify new and emerging risks dynamically.[16]
10. **GENERATE DIALOGUE AND DEBATE**	The key indicator of the impact on decision-making is the degree to which it generates discussion by the users of risk information via channels that are appropriate and credible.[17]

These principles should be applied during the project design phase as well as during the project implementation and assessment phases. Applying Steps 2 to 5 of the Framework will help you ground a risk information project in these principles.

2

Step 2: Scoping the Decision-Making Context

Once the Guiding Principles have been discussed and understood, the next stage is to scope and assess the decision-making context of the project. The Scoping tool in Figure 2.2 captures the key elements and sub-elements related to the decisions that the project will support. It also indicates the sequence in which the Scoping Tool should be followed.

The Decision-Making Context Scoping Tool lays the groundwork for selecting project tactics and facilitates application of the Guiding Principles. The Scoping Tool involves deploying user-centric context-based design, engaging inclusively, and understanding the users of risk information.

For definitions of Context Elements, see Table 2.2 on page 26.

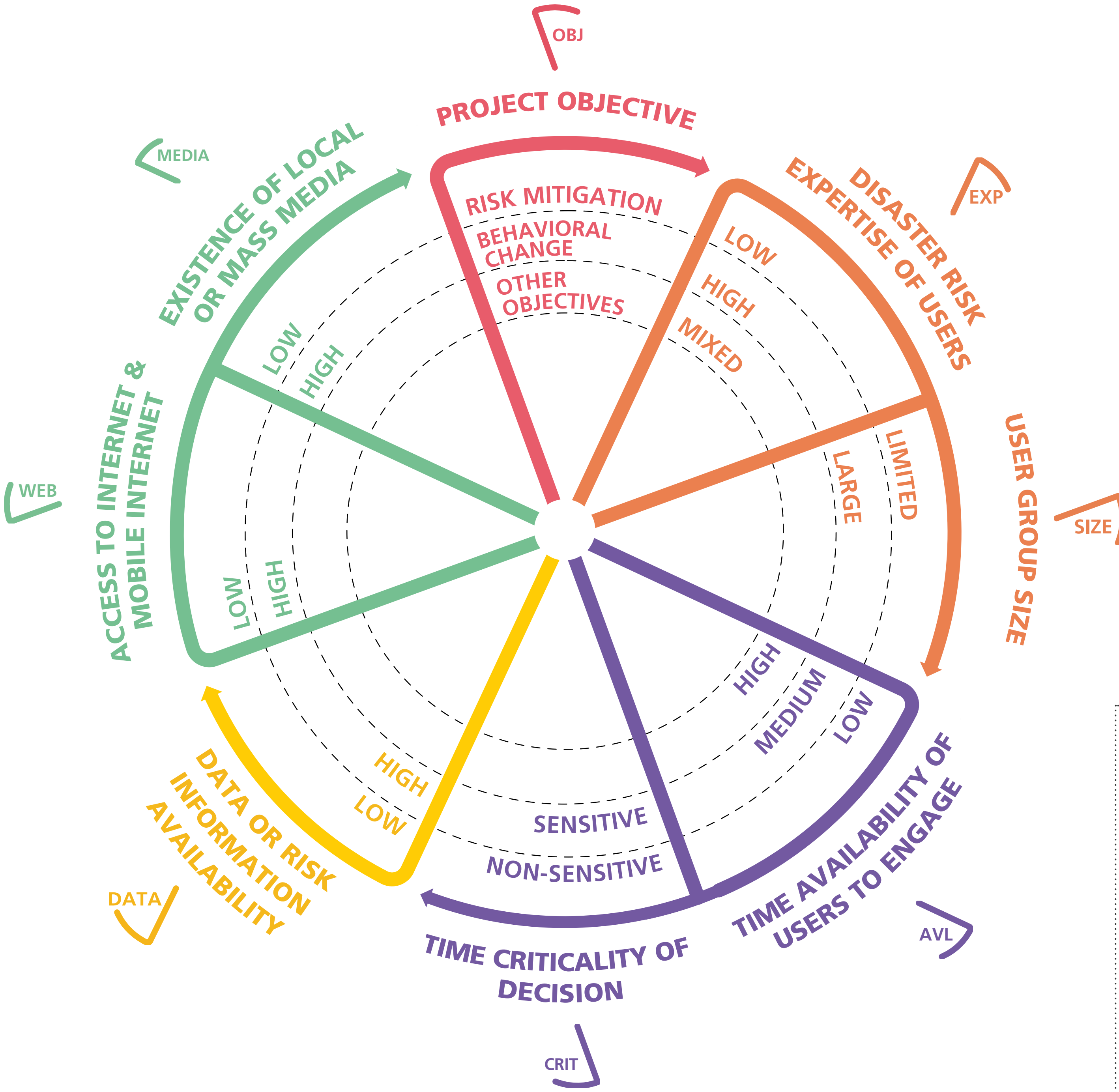
“

In 2014, InaSAFE users said that they ‘want to be able to use their own data and generate reports relevant to their organization.’ We listened to that feedback and targeted the software development to ensure it supports disaster managers to make decisions and communicate information in the way they need.

”

Charlotte Morgan, Geoscience Australia

Figure 2.2
Decision-Making Context Scoping Tool



What are the project objectives?

OBJ

Project objective: What types of decisions does the risk information project aim to support? It is important to have clarity on the purpose of the risk data that is being produced. This involves understanding whether the project objective is to **mitigate risk, promote behavior change,** or any other objective. It is possible that the project involves a combination of objectives.

Who are the target users of the risk information and what are their characteristics?

EXP

Disaster risk expertise: What is the disaster risk expertise of the users? Consider their disaster risk expertise – how **high** or **low** is the level of knowledge of risk concepts, analysis, data, modeling, and understanding of probabilistic risk? Many decisions around risk will involve a range of users of risk information with a **mixed** level of disaster risk expertise.

SIZE

Group size: How many users of risk information are there? Is it a **limited** number of users who will use the information to make a decision, or it is a **large** number of (or groups of) individuals who will make the decisions? Are they **congregated** in one geographic area or is the project trying to reach a more geographically **dispersed** group of users?

What are the time constraints of the users of risk information?

AVL

Availability to engage with the project: How much time does the audience(s) have to engage with, receive, use, or understand the information? Is their availability **low**; for example, less than half a day? Is it **medium**; for example, over a period of days? Or is it **high**; for example, are the users able to engage with the risk information on a regular basis?

CRIT

Time criticality of decision-making: Consider the time criticality of decisions supporting the risk information. Project design selection tactics should take into account the likely time frame a decision maker will have to use the risk information to make a decision. Is the decision **time-sensitive**, such as an early warning or emergency alert, or **non-sensitive**, such as a planning decision that involves risk mitigation?

What is the availability of risk data and information?

DATA

Data or risk information availability: Consider how much access the project has to existing risk data and information to inform the decision-making. Is it **low,** which means that data does not exist or is not accessible? Is it **high,** which means that data exists, is largely complete, and is accessible? Keep in mind that data may exist but may be of poor quality. It may not be open and accessible to the project for technical, commercial, security, or political reasons.

What types of communication channels are available and accessible?

WEB

Internet and mobile internet availability: There are several ways to develop and communicate risk information, depending on the project objectives and who the users of risk information are. One of the most important communication systems for risk data and information is (mobile) internet. However, internet does not always have to be present or of high-quality for the successful implementation of risk information projects. One should consider whether the project users have access to internet, and/or mobile internet. If so, how reliable is it? Is reliability **low** with no or very **limited** access, or **high** with virtually **unrestricted** access?

MEDIA

Local and mass media: What are the existing local and mass media channels that are widely available and used? Will the project have access to them? Will the access be **low** or **high**, with access to a wide range of local or mass media systems? It is important to understand which local media networks are most trusted by the users of risk information. Consider how **accessible** these media channels are (*e.g.,* are they free-to-air?) and how **open** they are to collaboration. Similar to internet, mass media does not always have to be present or of high-quality for successful implementation of risk information projects.

How does contextual understanding affect the project objectives?

OBJ

Project objective: Does understanding the decision-making context in these ways affect the original project objectives? Does it validate them? Should the project objectives be modified or possibly extended in light of this analysis? Should the geographic scope of the project be modified to take into account high data availability in some areas but not in others? The accessibility of local media channels along with access to internet, for instance, could lead to adding a project component to **change attitudes and beliefs** or to promote **behavior change**.

Table 2.2

Definitions of project context elements

Element	Definition	Level	Description
PROJECT OBJECTIVE(S)	The objective that the project is aiming to achieve.	**RISK MITIGATION**	The prevention of new, and reduction of existing disaster risk, and the management of residual risk.
		RISK FINANCING	Measures to support financial resilience to the economic losses caused by disasters through instruments, such as insurance and social protection.
		BEHAVIORAL CHANGE	The encouragement of personal behaviours or actions that help reduce personal, family, or community risk.
DISASTER RISK EXPERTISE OF USERS	Level of knowledge and/or experience in Risk Analysis and DRM.	**LOW**	No or little prior knowledge of risk concepts and analysis.
		HIGH	Good-to-advanced knowledge of risk analysis, modeling, and understanding of probabilistic risk.
		MIXED	Combination of low, medium, or high levels of knowledge of risk concepts and analysis, modeling, and understanding of risk.
USER GROUP SIZE	The number of individuals involved in making the decision.	**LIMITED**	Restricted number of individuals making a decision such as the heads of infrastructure services of a city
		LARGE	A large number of (or groups of) individuals making a decision.
TIME AVAILABILITY TO ENGAGE WITH PROJECT	Time available for the decision-maker to engage with the project.	**LOW**	Less than half a day.
		MEDIUM	Up to 5 days continuous availability.
		HIGH	More than 2 days available on a regular period basis.
TIME CRITICALITY OF DECISION	Time-sensitive nature of decisions to be made about actions to be taken to mitigate, prepare for, or respond to disasters.	**NON-SENSITIVE**	Decision-making may not be time critical but key cut-off dates may be necessary.
		SENSITIVE	Decision-making will be time critical such as inearly warning contexts.
AVAILABILITY OF/ACCESS TO DATA OR RISK INFORMATION	Availability of risk data, level of access and ease of access to this data.	**LOW**	Information or data does not exist or is not accessible.
		HIGH	Information or data exists, is largely complete, and is accessible.
ACCESS TO INTERNET & MOBILE INTERNET	The intended user's or decision-maker's level of access to mobile internet or internet in general.	**LOW**	Almost none or very limited access.
		HIGH	Has nearly unrestricted access.
EXISTENCE OF LOCAL OR MASS MEDIA CHANNELS	The project's access to mass communication channels and tools to reach users of risk information.	**LOW**	Limited access to local or mass media channels.
		HIGH	Has access to a wide range of local or mass media channels and tools.

Step 3 to Step 5: Selecting Project Design Tactics

After identifying the project's decision-making context, select the appropriate project tactics based upon the context in which the risk information project will operate.

For definitions of Project Tactics, see Table 2.3 on Page 28

Core Tactic Areas

The horizontal rows in Figure 2.3 indicate the context elements and sub-elements of a risk information project. The vertical columns indicate a range of tactics that can be used. These tactics have been clustered under three core areas (listed below) based on their similarities and purposes:

- **Collaboration & Learning**
  Tactics that involve a process of learning or knowledge transfer by bringing together various stakeholders.
- **Data & Modeling**
  Tactics aimed at data collection, data modeling, and data sharing.
- **Communication (visualization and channels)**
  Tactics aimed at communicating risk information to the users.

Suitability of Tactics

Tactics are either optimal, suitable, or not-suitable, depending on the context elements of the project.

- **Optimal tactics -** *refer to the most appropriate choices in specific contexts.*
- **Suitable tactics -** *those which are appropriate for general use in many different contexts.*
- **Not-Suitable tactics -** *considered inappropriate or unsuitable in a particular context and should be avoided.*

Importantly, designers of the most effective projects have not restricted themselves to a single optimal tactic. They have selected and combined a number of optimal tactics that work well for their project and reinforce each other. It may be that only some of the context sub-elements apply to a particular risk information project. It is not necessary to have at least one tactic from each category, i.e., collaboration & learning, data & modeling, and communication. The process of going through Steps 3-5 should result in the selection of a variety of project-specific tactics that complement and reinforce each other.

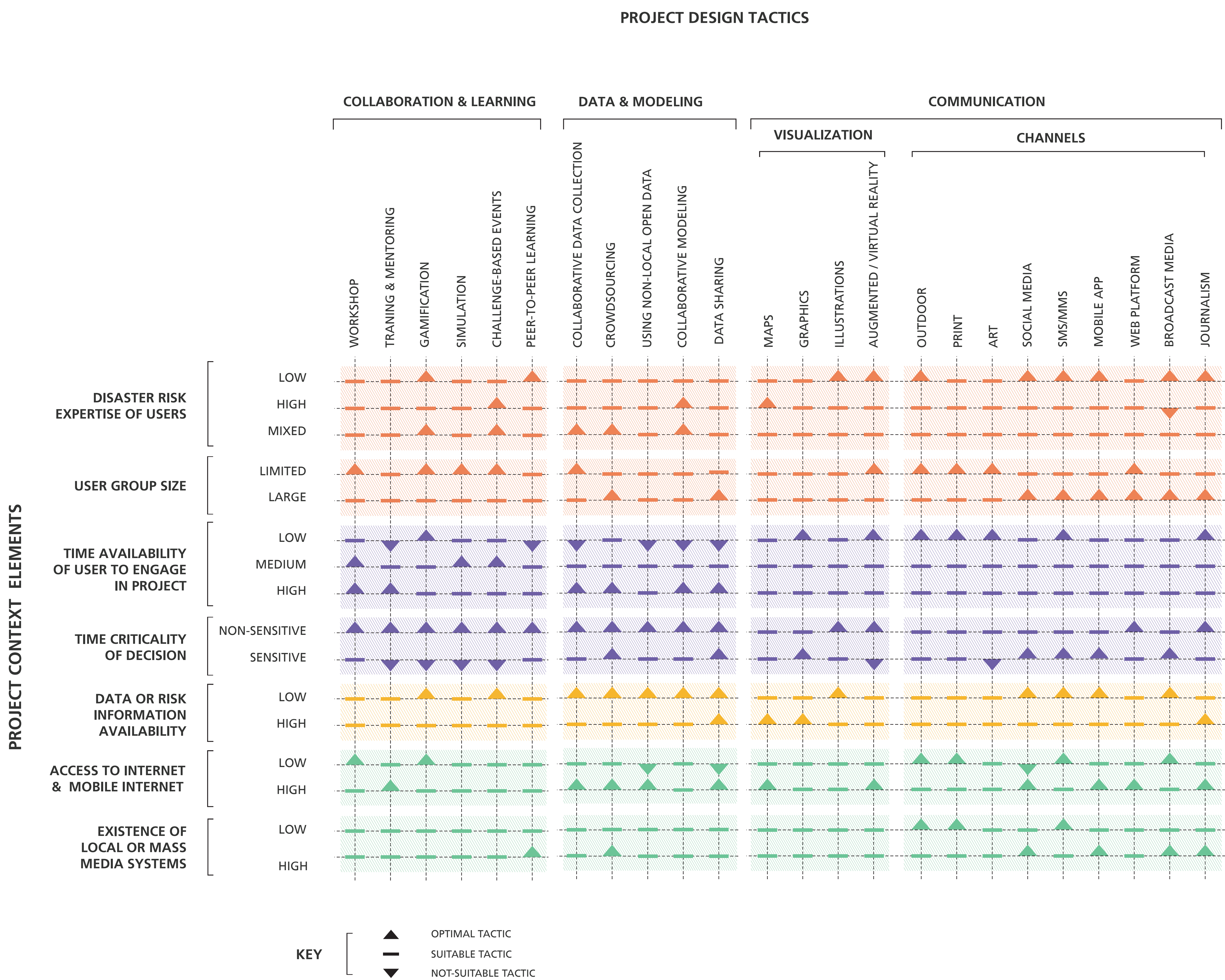
Table 2.3
Definitions of project design tactics

CORE AREA	TACTICS	DEFINITIONS
COLLABORATION & LEARNING TACTICS	WORKSHOPS	A group of people engaged in a purposeful discussion with a common or particular subject or area of interest.
	TRAINING & MENTORING	Formal and structured transfer of knowledge or skill or sharing of advice.
	GAMIFICATION/ SERIOUS GAMES	Gamification is the application of game design elements in non-game contexts or representation of real-world situations to improve user engagement and understanding of decision dynamics. Serious games are explicit and carefully thought out games for educational purpose—not intended to be played primarily for amusement.
	SIMULATION	In-person representation, imitation, or enactment of anticipated events or preparatory actions.
	CHALLENGE-BASED EVENT (e.g. HACKATHON)	A collaborative, short, time-bound event that engages experts from various fields who come together to create solutions addressing a particular challenge area.
	PEER-TO-PEER LEARNING	Transfer of knowledge and skills between professional peers, community, family members, and acquaintances through demonstration, observation, or group discussion.
DATA & MODELING TACTICS	COLLABORATIVE DATA COLLECTION	Data is sourced from multiple agencies and non-professional scientists that have pre-compiled data or datasets.
	CROWDSOURCING	A data sourcing model wherein members of the general public contribute to the collection and analysis of data.
	USING NON-LOCAL OPEN DATA	Using open datasets available from non-local external sources such as regional, national, or international agencies.
	COLLABORATIVE MODELING	A process that engages stakeholders in the development of an analytical model to aid them in better decision-making and enhance their awareness and knowledge.
	DATA SHARING	The publishing of data licensed for free use and reuse via an open data portal or geospatial data platform such as GeoNode.

COMMUNICATION TACTICS	VISUALIZATION	MAPS	A drawing of the earth's surface, or a part of that surface, showing the shape and position of different countries, political borders, and natural features, such as rivers and mountains and artificial features such as roads and buildings.
		GRAPHICS	Visual representations of information, data, or knowledge.
		ILLUSTRATIONS	Visual explanation or interpretation of a concept or process.
		AUGMENTED/ VIRTUAL REALITY	Integration of digital information with the user's environment" to be more reader-friendly.
	CHANNELS	OUTDOOR	Display of information in public places through notice boards, billboards, bulletin boards, etc.
		PRINT	Paper-based media used to disseminate information to members of the public or end-users.
		ART	The expression of risk information in imaginative and visual forms such as sculpture, paintings, etc.
		SOCIAL MEDIA	Websites and applications that enable users to upload and share content of various types and communicate with each other.
		SMS/MMS	Short Message Service (SMS) or Multimedia Messaging Service (MMS) are text messaging platform that allows cellular and smartphone users to communicate with one another by transmitting text, photo, and video messages via a central messaging center.
		MOBILE APPLICATION	An application software designed to run on a mobile device *i.e.* smartphone or tablet.
		WEB PLATFORM	Web-based applications that run on the web and are often independent of operating systems.
		BROADCAST MEDIA	Electronic means of communication that transmit information in audio or video format to a large, dispersed audience.
		JOURNALISM	Data-informed reporting that makes use of numerical data as means of analyzing and presenting potential news stories.

Figure 2.3

The Tactics Selection Tool



Using the Tactics Selection Tool

To use the Tactics Selection Tool, go through each context element that applies to your risk information project and consider each tactic in turn. Consider each core area of tactics as a step. Keep in mind that the whole step might not be applicable in the end.
Projects featured in Chapters 4 and 5 highlight how certain tactics work well with specific project-context elements. Understanding the choices made by the designers of these projects will help to select the most appropriate tactics for most risk information projects.

The following examples demonstrate a general approach to selecting tactics for the context elements that apply to the project. A few optimal tactics are highlighted for each context element, as well as the rationale for their selection. Keep in mind that ultimately, the tactics that best suit the project will be determined by a combination of factors, including available resources.

EXP

Risk expertise of users: The optimal tactics for various levels of disaster risk expertise leverage the existing level of risk expertise in an inclusive way to create a shared understanding of risk information.

When there is *low level of risk expertise*, **gamification** and **peer-to-peer learning** are optimal **collaboration tactics**. When there is *mixed level of risk expertise*, users with low risk expertise can work with users with higher expertise to define what information they require for their decision-making, as well as **contribute to data collection**. Optimal **communication tactics** are cognitively and culturally appropriate, accessible, and understandable by users of risk information. For instance, *higher level of specific technical information* can be communicated to users with high risk expertise through technical **maps** and **handouts**.

Resilience.io *used a range of optimal and suitable tactics to engage users with mixed risk expertise from across sectors and geographies. Resilience.io chose* **workshops**, **simulations**, *and* **games** *that are usable by a range of users to help identify local priorities for resilience developments. The project used* **collaborative data collection**, **non-local open data**, *and* **collaborative modeling** *to engage communities in contributing data, information, and knowledge to build trust and ensure existing culture and heritage is embraced (see page 110).*

SIZE

User group size: The user group size determines the level of engagement and coordination required.

Tactics like **workshops, gamification, simulation,** and **challenge-based events** require a high degree of coordination, which is most optimal in a limited group setting. With a *large, more geographically dispersed group* of users of risk information, **data & modeling tactics** that promote large-scale engagement such as **crowdsourcing** and **data sharing** are optimal. Similarly, for large groups, **communication tactics** such as **social media, web platforms, mobile apps** and **mass media** are optimal.

ROADAPT *elected to use* **roundtable sessions** *to bring relevant but limited number of stakeholders from district government to discuss the potential impacts of climate change on road networks in the Netherlands. Due to the limited number of stakeholders, the project effectively used a* **collaborative modeling approach** *and* **collaborative data collection**. *ROADAPT produced a guideline* **report/handout** *for its specific user group in which the results were visualized through vulnerability* **maps** (see page 116).

AVL

Time availability of users: The time availability of the users who will be engaged in the project is a key context element that can make certain tactics not-suitable.

When time availability is medium, an **optimal collaboration & learning tactic** is a **challenge-based event,** where the task is to complete a risk-related challenge against the clock. **Collaborative data collection, crowdsourcing, collaborative modeling,** and **data sharing** are all **optimal data & modeling** tactics where users of risk information have a *high level of time to engage* with the project on an ongoing basis. **Graphics** and **virtual reality** are optimal **communication tactics** to engage users when the *time available to engage is low.*

Oasis Loss Modeling Framework *engaged the global insurance and modeling community through* **workshops, seminars, online training,** *and* **collaborative modeling.** *As there was high time availability to effectively engage with the platform, Oasis was able to collaboratively build datasets and models and a community for sharing expertise* *(see page 82).*

CRIT

Time criticality of decision-making: The time criticality of making decisions based on risk data and information makes certain learning and collaboration tactics not-suitable. When time is *non-sensitive* and a decision is not required to be made within limited time, all tactics are optimal. In contrast, when *time is sensitive* and a decision is required to be made within a limited time, **collaboration & learning tactics** such as **training, gamification, simulation,** and **challenge-based events** are not-suitable. **Crowdsourcing** and **data sharing** are optimal **data & modeling tactics** in time-sensitive scenarios, such as early warning or response contexts. Social media, **SMS, mobile phone applications,** and **local and mass media** are optimal **communication tactics** for time-sensitive decision-making contexts.

UP NOAH *enables citizens and local governments to take protective action based on real-time information in a sensitive timeframe. UP NOAH utilized* **workshops** *and* **peer-to-peer learning** *to develop a culture of preparedness. Through* **crowdsourcing** *and* **collaborative mapping***, it developed a* **web tool** *to aid faster dissemination of geospatial information, thereby contributing to the* **shared data** *environment. UP NOAH used a range of communication tactics such as* **maps, illustrations, social media,** *and* **SMS** *to provide timely data to users* *(see page 90).*

DATA

Data/information availability: The existence and availability of reliable data impacts the selection of tactics, particularly those directly related to data collection, analysis, and modeling.

When there is *low availability of data*, use **challenge-based events** to identify and generate data in a collaborative and innovative way. All **data & modeling tactics** are optimal to generate the data required when there is low availability of data, as they support the generation of the data required for the project. Optimal **communication tactics** in this context leverage the existing data and information to communicate in a way that is **culturally, cognitively,** and **psychologically appropriate.**

FUNES *relies on collaborative processes due to the low availability of data. FUNES* **trained** *over 1000 Red Cross volunteers to collect and transmit data through* **mobile phones** *and* **mobile apps***. Through* **collaborative data collection** *FUNES integrated data from across different government agencies as well* *(see page 74).*

WEB

Access to (mobile) internet: While most tactics can be used without internet access, some tactics are made more effective by the internet. The benefits of using the internet are multifold - it increases the geographical reach of the risk information project, makes data and information interactive, creates access to various open data sources, and allows people to engage in dialogue and debate.

Optimal **collaboration & learning tactics** in this context, such as **training and mentoring** across geographies and sectors, impact access to expertise and other user information. When there is *high access to internet*, **sharing data** with various agencies and stakeholders becomes possible. This tactic is optimal to encourage data openness and sharing. High access to internet makes some tactics optimal to use, such as **interactive maps** and **mobile apps**. In contrast, where this is *low access* to internet, tactics that are independent of the internet are optimal, such as outdoor media and SMS.

CIrcle *aims to help users understand the impact of natural hazards on critical infrastructure. It does so by using an online tool where there is high access to internet and a* **non-digital board game (CIrcle-Bao)** *where there is low access to internet. Where there was high access to internet, Circle developed an online knowledge database to* **share data** *and used interactive modeling supported by* **videos** *and* **animated graphics***. Several offline communication channels were used as well, such as* **handouts** *and* **booklets** (see page 66).

MEDIA

Existence of local and/or mass media: Trusted local and/or mass media can help develop shared understanding of risk concepts. The best choice of local and/or mass media would be those that are accessible, trustworthy, interactive, scalable, and resilient to disruption from natural hazards.

Peer-to-peer learning is an especially optimal collaboration & modeling tactic to use. It can significantly extend the credibility, reach, and impact of risk information as peers act upon the information in concrete ways. Calls for data can be promoted by local radio and TV stations, resulting in higher rates of data collection from communities. The selection of communication tactics, particularly regarding how the risk information will be visualized, is dependent on the type of mass media systems available. For instance, when there are few local and/or mass media available, outdoor media can reach a large number of people.

BBC's Amrai Pari *worked with* ***TV*** *broadcasters in Bangladesh to create a reality TV show which showcased communities* ***learning from their peers****. Amrai Pari held* ***workshops*** *for the staff of community radio stations to enable a deeper understanding of local problems as they would be creating context-specific programs.* ***Social media*** *channels were also used to broadcast a series of short* ***films*** *on various urban-specific risks* *(see page 62).*

Working through Steps 3-5 should have generated a range of tactics across collaboration & learning, data & modeling, and communication. Case studies presented in this publication highlight how project designers have not restricted themselves to a single optimal tactic but have combined a number of optimal and suitable tactics that work well in their project context and reinforce each other.

Step 6: Ensuring Application of the 10 Guiding Principles

After assembling the collaboration & learning, data & modeling, and communication tactics through the Context Scoping and Tactics Selection Tools, revisit the 10 Guiding Principles to ensure that the risk information project is grounded in these principles. These steps and tools, along with the Guiding Principles, have been developed to increase the impact of risk data and information initiatives.

A way to ensure that a risk information project is grounded in the Guiding Principles is to use a checklist of indicators for each principle. To reinforce the application of these principles, Table 2.1 presents an indicative set of questions to help evaluate the project design against these principles. These indicators are broad and universal and can be adapted to a wide range of decision-making contexts. While going through the indicators under each principle, consider whether the project meets this requirement. If it does not, consider ways to include it in the project design.

Finally, these 10 Guiding Principles should be applied throughout all phases of the project: the project design, the project implementation and the project assessment phases. Additional checklists for project implementation and assessment phases are included in Annex B of this publication.

Table 2.1
Checklist to ensure the application of the 10 guiding principles

10 PRINCIPLES FOR THE EFFECTIVE USE OF RISK DATA	CHECKLIST TO ENSURE THE APPLICATION OF THE 10 GUIDING PRINCIPLES
1. USER CENTRICITY	i) Has the project analyzed the decision-making context through the Decision-Making Context Scoping Tool? ii) Has the project established an understanding of the risk information requirements of the intended users of risk information and the decision-making process?
2. INCLUSIVITY	i) Has the project assessed the specific information requirements of those most directly impacted by natural hazards across social groups?

3. **SHARED UNDERSTANDING**	i) Has the project developed a shared problem definition, and, where possible, has it engaged those most directly at risk in defining the problem through a range of collaboration tactics? ii) Has the project established common ground by strengthening scientist/modeler appreciation of the decision-making context and decision-makers understanding of risk information and how it can support decision-making?
4. **CO-CREATION**	i) Has the project taken steps to ensure that project partners recognize and respect the knowledge of both the providers and users of risk information?
5. **OPEN BY DEFAULT**	i) Has the project developed an open data and open source approach to technology and software? ii) Has the project developed an open approach to its innovation processes by documenting and publishing all its methodologies?
6. **INFORMATION APPROPRIATENESS**	i) Has the project used the Tactics Selection Tool to assess which channels and forms of visualization best promote understanding among the intended users of risk information? ii) Has the project assessed which forms of communication and visualization are most culturally, socially, cognitively, and psychologically appropriate among the intended users of risk information?
7. **CHANNEL SUITABILITY**	i) Is the project selecting communications channels with reference to their trust and interaction with the users of risk information? ii) Is the project selecting channels on the basis of their scalability and resilience to natural hazards?
8. **SUSTAINABILITY**	i) Is the project developing a business model that covers the costs of all partners and ensures that the users of risk information can access information affordably? ii) Has the project assessed existing capacities and mechanisms for supporting effective use of risk information, such as communities of practice, networks, and peer support groups, so that the project can usefully link with, support and strengthen them?
9. **REFLEXIVITY**	i) Does the project support open and critical self-assessment, and does it build in regular opportunities for review and revision?
10. **DIALOGUE AND DEBATE**	i) Have the opportunities to generate dialogue and debate been maximized across all tactic areas within the project?

THE DESIGN FOR IMPACT FRAMEWORK

Integrating Open Data and Risk Communication for Decision Making

STEP 1: UNDERSTANDING THE 10 GUIDING PRINCIPLES

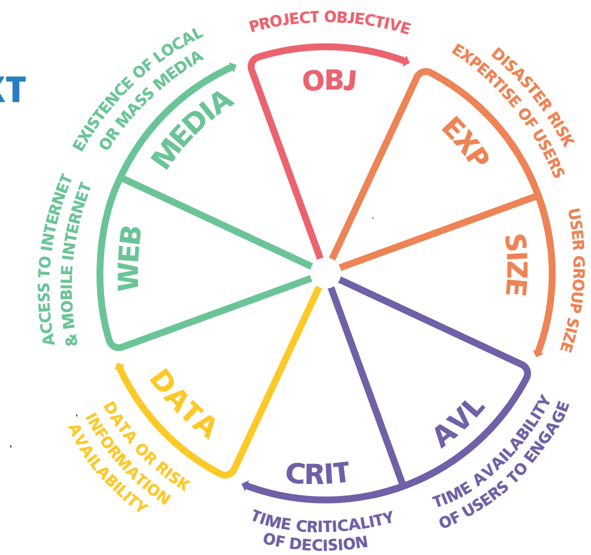
The 10 Guiding Principles are the overarching approaches and considerations that apply to a project at all of its stages to ensure that risk data is used effectively for decision-making.

(1) User Centricity
(2) Inclusivity
(3) Shared Understanding
(4) Co-Creation
(5) Open by Default
(6) Information Appropriateness
(7) Channel Suitability
(8) Sustainability
(9) Reflexivity
(10) Dialogue & Debate

STEP 2: SCOPING THE DECISION-MAKING CONTEXT

The next stage is to assess a range of local factors - including geography, technology, data and time availability - that determine the context in which your project will operate.

The Decision-Making Context Scoping Tool lays the groundwork for selecting project tactics and facilitates application of the Guiding Principles.



STEPS 3-5: SELECTING PROJECT DESIGN TACTICS

After identifying the project's decision-making context, select the appropriate project tactics based upon the context in which the risk information project will operate.

Project design tactics are the specific range of options that are available for co-developing and co-delivering the project with the users of risk information. These tactics range from workshops and peer-to-peer learning, crowdsourcing and collaborative modeling, to illustrations and mobile apps.

5. COMMUNICATION TACTICS: CHANNELS & VISUALIZATION

4. DATA & MODELING TACTICS

3. COLLABORATION & LEARNING TACTICS

STEP 6: ENSURING APPLICATION OF THE 10 GUIDING PRINCIPLES

After assembling the collaboration & learning, data & modeling, and communication tactics through the Context Scoping and Tactics Selection Tools, revisit the 10 Guiding Principles to ensure that the risk information project is grounded in these principles.

CHAPTER 3

A Deployment Scenario

◆◆◆

Applying the Design for Impact Framework in a preparedness planning scenario for a coastal city

Scenario Context: Coastal City Of A Small Island Developing State

City Profile

Residents of a coastal city in a small island developing state are at risk from the increasing occurrence of hurricanes. Intense rainfall and storm surges are placing many residents at risk of severe flooding. The most vulnerable populations are those living in high-density, low-income areas in poorly constructed buildings and are unaware of their level of risk.

With no formal city-wide evacuation plan, past events have left residents confused about what action to take and where they can seek safe shelter. Although public buildings have been used ad-hoc in the past for evacuation, there are no designated shelters or evacuation routes.

Project Snapshot

To address this gap, local government officials are developing a city-wide evacuation plan and community engagement program with the goal to increase awareness of flood evacuation procedures.

The evacuation planning and community engagement project is divided into two elements:

1) Risk modeling and visualization by local government officials to prepare the evacuation plan (User Group 1).

2) Engaging local community leaders and communities to raise awareness about risk modeling and the appropriate evacuation procedures (User Group 2).

1

Step 1: Understanding the 10 Guiding Principles

Using the 10 Guiding Principles checklist, each principle is considered by the local government officials. These principles will influence the final selection of tactics. They will revisit the Guiding Principles in Step 6 to ensure that they are being applied.

- User Centricity ✓
- Inclusivity ✓
- Shared Understanding ✓
- Co-Creation ✓
- Open by Default ✓
- Information Appropriateness ✓
- Channel Suitability ✓
- Sustainability ✓
- Reflexivity ✓
- Dialogue & Debate ✓

> *The Debris Tool is not a static machine. We redevelop and adapt for the different situations we meet, ensuring we can incorporate new data and formats, new considerations, and content. Self-reflecting after every implementation has allowed us to keep our tool up-to-date and relevant.*
>
> Aiden Short, Urban Resilience Platform

2

Step 2: Scoping The Decision-Making Context

	USER GROUP 1: LOCAL GOVERNMENT OFFICIALS	USER GROUP 2: COMMUNITY LEADERS & COMMUNITIES
PROJECT OBJECTIVES		
OBJ	**RISK MITIGATION** The project aims to establish a city-wide evacuation plan.	**COMMUNITY PREPAREDNESS** Develop community flood response plans.
DISASTER RISK EXPERTISE		
EXP	**HIGH** The users of risk information are the local government officials who are technical experts within their own respective fields. They have good, if not advanced, knowledge of risk analysis, modeling, and understanding of probabilistic risk.	**LOW** The community leaders and members have little prior knowledge of risk concepts and analysis.
USER GROUP SIZE		
SIZE	**LIMITED** A limited number of individuals across various agencies within the local government will be involved in evacuation planning.	**LARGE** Multiple communities spread across the city.

USER GROUP 1: LOCAL GOVERNMENT OFFICIALS	USER GROUP 2: COMMUNITY LEADERS & COMMUNITIES

AVL

TIME AVAILABILITY OF USERS TO ENGAGE IN THE PROJECT

USER GROUP 1	USER GROUP 2
HIGH The users are able to meet regularly to establish a plan in time for the subsequent hurricane season.	**LOW/MEDIUM** The communities do not have much time available to engage with the project. However, the community leaders do have reasonable time to engage with the project.

CRIT

TIME CRITICALITY OF DECISION

NON-SENSITIVE

The decision-making within the planning phase is not time-critical; however, these decisions will influence how time-sensitive decisions will be made around early warning and response.

DATA

DATA OR RISK INFORMATION AVAILABILITY

HIGH

There is high data available to access. Local hazard data (wind/floods) is openly available through the GeoNode platform. Key vulnerability data on population and density is also available through GeoNode. Local residents and communities have previously generated local data on communities and transport networks through OpenStreetMap.

	USER GROUP 1: LOCAL GOVERNMENT OFFICIALS	USER GROUP 2: COMMUNITY LEADERS & COMMUNITIES
	INTERNET & MOBILE INTERNET AVAILABILITY	
WEB	**HIGH** The local government authorities have high access to internet and are able to connect to the web through mobile phones.	**LOW** Some community members have access to smartphone and internet cafés, however, generally, access to internet is low. Community members predominantly communicate using basic mobile phones.
	EXISTENCE OF LOCAL & MASS MEDIA	
MEDIA	**HIGH** There are multiple national and local media systems. This is not relevant to the decisions of the local authorities themselves but pertinent to how they will engage with their local communities.	**HIGH** There is high trust in local media systems (radio stations) and the national television channel. Most households have access to a radio and television.
	RECONSIDER PROJECT OBJECTIVE	
OBJ	**RISK MITIGATION** The scoping tool has identified what data and information is available and validated the project objective. Therefore, the project objective has not been altered. It has, however, been refined to specifically support evacuation planning decisions through: (i) identification of areas exposed to flooding; (ii) designation of emergency shelters and evacuation points; (iii) identification of safe evacuation routes (or identification of impassable routes).	**COMMUNITY PREPAREDNESS** The scoping tool has identified what data and information is available and validated the project objective. Therefore, the project objective has not been altered. It has, however, been refined to specifically support evacuation planning decisions through enabling understanding community understanding of: (i) emergency evacuation procedures; (ii) where to evacuate to; (iii) what routes to use; (iv) when to evacuate.

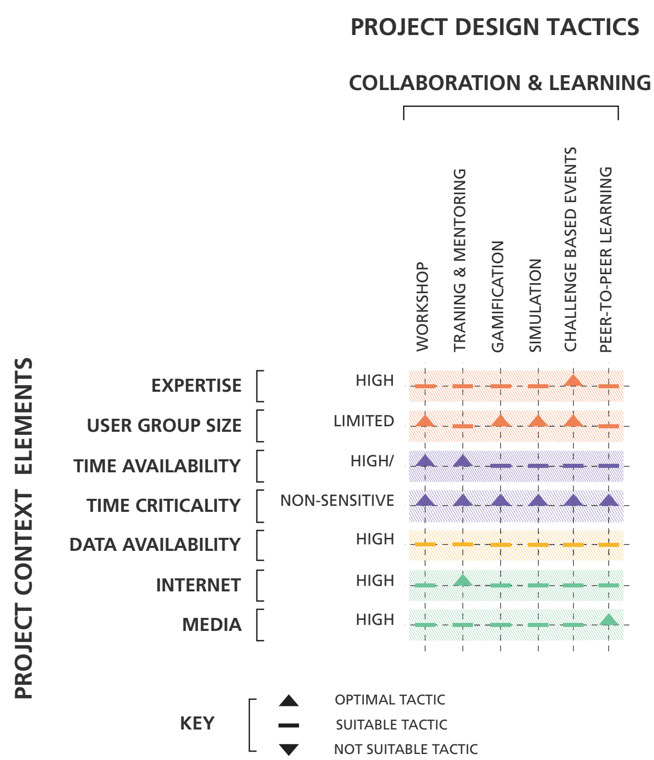
3

Step 3: Selection of Collaboration & Learning Tactics

Figure 3.1
Step 3 - Selecting Collaboration & Learning tactics for User Group 1 (left) and User Group 2 (right)

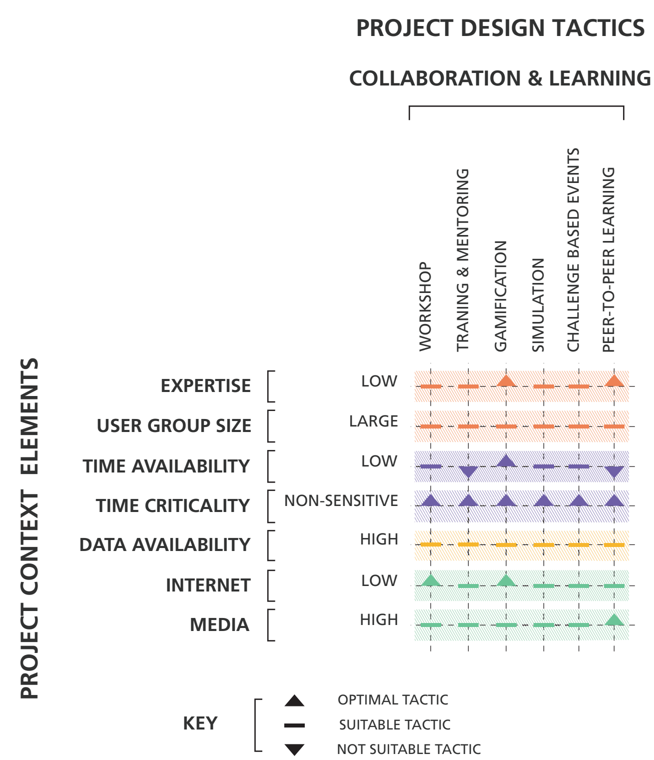
USER GROUP 1:

LOCAL GOVERNMENT OFFICIALS



USER GROUP 2:

COMMUNITY LEADERS & COMMUNITIES



Under the context elements outlined, the Tactic Selection tool indicates that for this context, **workshops** are the most optimal tactic due to the *limited group size* of local government officials and their *availability to meet regularly*. **Gamification** and **challenge-based events** have also been selected by the local government officials, whereas training and mentoring has not been selected due to limited resources.

The Tactic Selection tool indicated to the local government officials that **workshops** and **gamification** are also optimal tactics to engage with community leaders and representatives. **Peer-to-peer learning** will also be used as it is shown to be an optimal option for users with *low disaster expertise*. A constraining factor for these tactics is the *limited amount of time available* to engage with the community members.

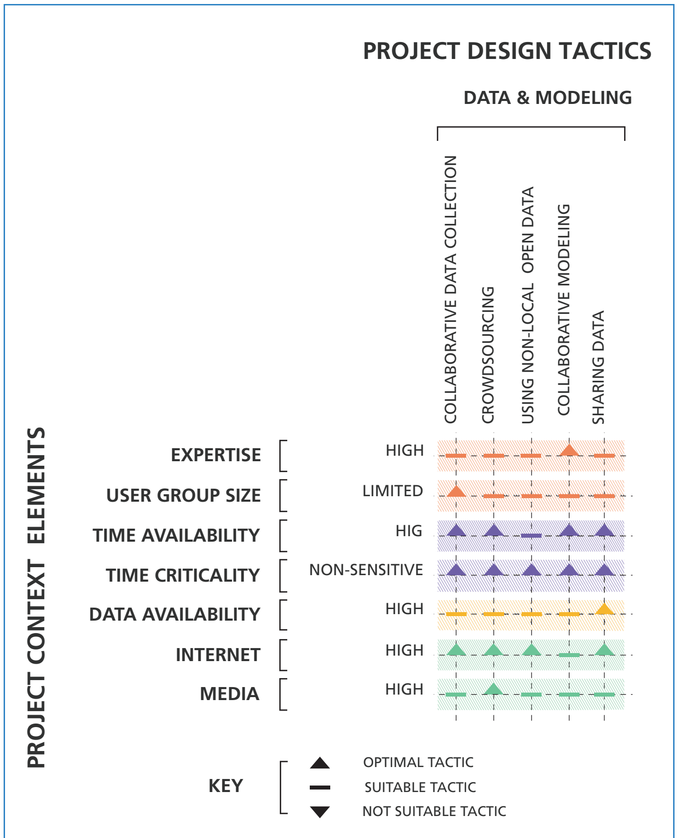
Step 4: Selection of Data & Modeling Tactics

Figure 3.2

Step 4 - Selecting Data & Modeling tactics for User Group 1 (left) and User Group 2 (right)

USER GROUP 1:

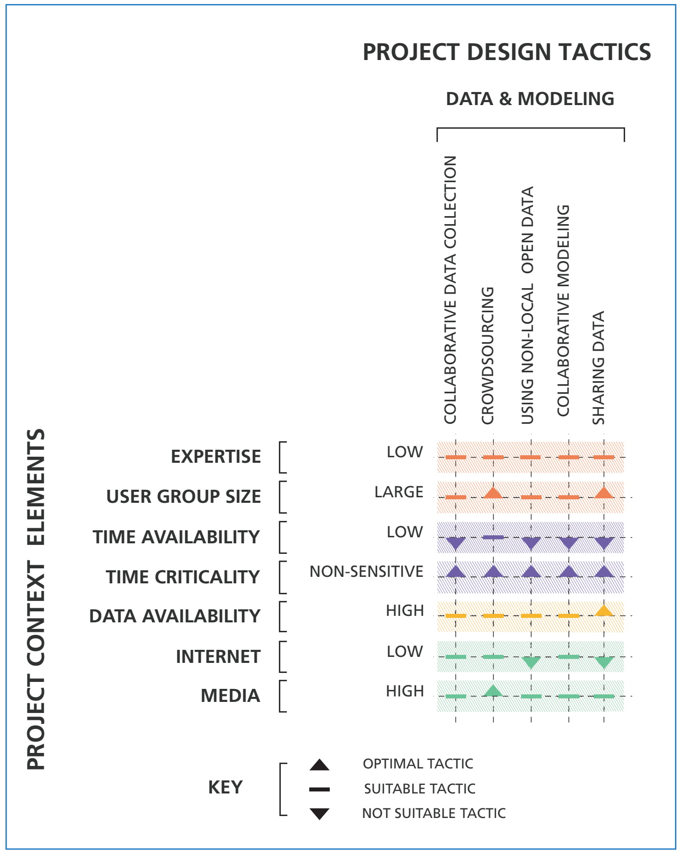
LOCAL GOVERNMENT OFFICIALS



The Tools present collaborative data collection, crowdsourcing, collaborative modelling, and data sharing tactics as optimal tactics. Although there is already *high availability of the required data*, **collaborative data collection** tactics will be used to build upon existing sources.
Local government officials will also use **collaborative modelling** and **data sharing**.

USER GROUP 2:

COMMUNITY LEADERS & COMMUNITIES



Crowdsourcing is selected to engage with community members to groundtruth, validate, and collect further data.
Both collaborative modeling and data sharing are less optimal tactics for community members as they have *lower internet access* and *limited time available to engage* with these tactics. However, community leaders who have *more time available* can engage with the project through **collaborative modeling** with local government officials.

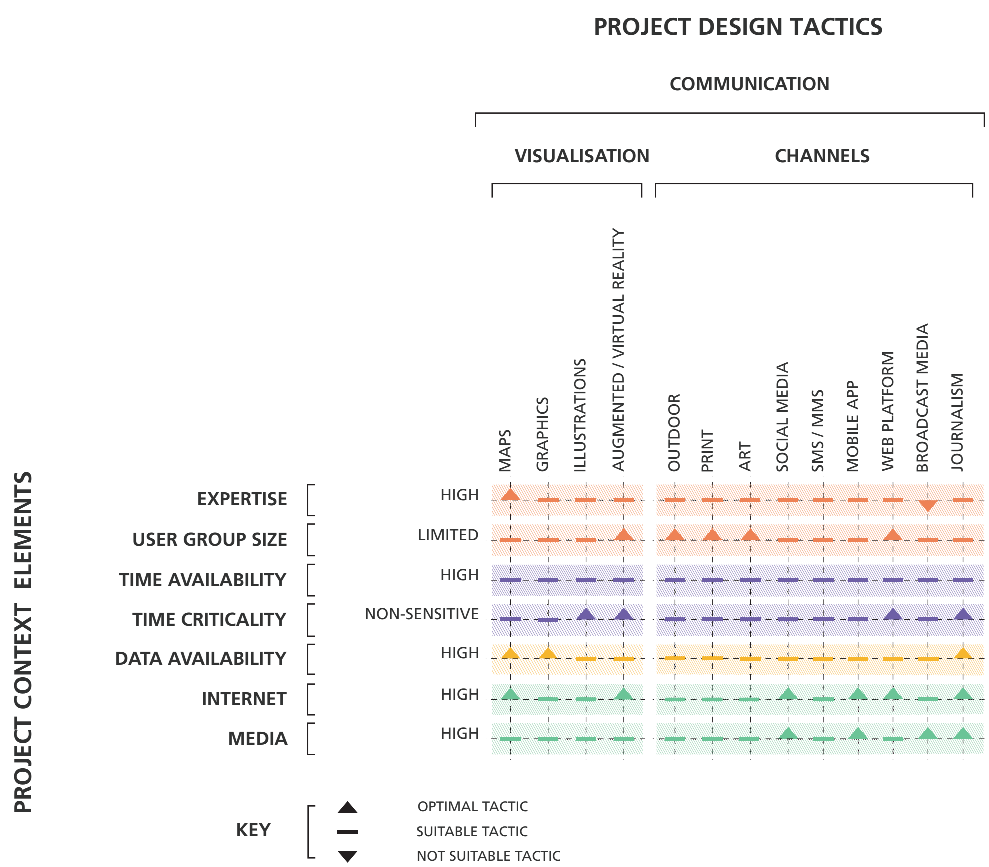
Step 5: Selection of Communication Tactics

Figure 3.3

Step 5 - Selecting Communication tactics for User Group 1 (left) and User Group 2 (right)

USER GROUP 1:

LOCAL GOVERNMENT OFFICIALS



The Tactic Selection tool shows **web platform, mobile app,** and **journalism** as optimal communication channels; and **maps, graphics,** and **augmented/virtual reality** as optimal **visualisation** channels.

While journalism is shown as an optimal channel, the local government officials decided that it is not appropriate for this phase of the project as the user group is limited and there is no requirement to communicate with the public. Similarly, augmented/virtual reality is not suitable due to resource constraints.

USER GROUP 2:

COMMUNITY LEADERS & COMMUNITIES

PROJECT DESIGN TACTICS

COMMUNICATION

VISUALISATION: MAPS, GRAPHICS, ILLUSTRATIONS, AUGMENTED / VIRTUAL REALITY

CHANNELS: OUTDOOR, PRINT, ART, SOCIAL MEDIA, SMS / MMS, MOBILE APP, WEB PLATFORM, BROADCAST MEDIA, JOURNALISM

PROJECT CONTEXT ELEMENTS		MAPS	GRAPHICS	ILLUSTRATIONS	AUGMENTED / VIRTUAL REALITY	OUTDOOR	PRINT	ART	SOCIAL MEDIA	SMS / MMS	MOBILE APP	WEB PLATFORM	BROADCAST MEDIA	JOURNALISM
EXPERTISE	LOW	–	–	▲	▲	▲	–	–	▲	▲	▲	–	▲	▲
USER GROUP SIZE	LARGE	–	–	–	–	–	–	–	▲	▲	▲	▲	▲	▲
TIME AVAILABILITY	LOW	–	▲	–	▲	▲	▲	▲	–	▲	–	–	–	▲
TIME CRITICALITY	NON-SENSITIVE	–	–	▲	▲	–	–	–	–	–	–	▲	–	▲
DATA AVAILABILITY	HIGH	▲	▲	–	–	–	–	–	–	–	–	–	–	▲
INTERNET	LOW	–	–	–	–	▲	▲	–	▼	▲	–	–	▲	–
MEDIA	HIGH	–	–	–	–	–	–	–	▲	–	▲	–	▲	▲

KEY
▲ OPTIMAL TACTIC
– SUITABLE TACTIC
▼ NOT SUITABLE TACTIC

As per the Tactic Selection Tool, the most optimal communication channels for community users is a combination of **outdoor, print, art, mobile app, SMS**, and **broadcast media**. The most optimal visualisation tactics are **illustrations** and **maps.**

Figure 3.4a
Project design tactics used for User Group 1

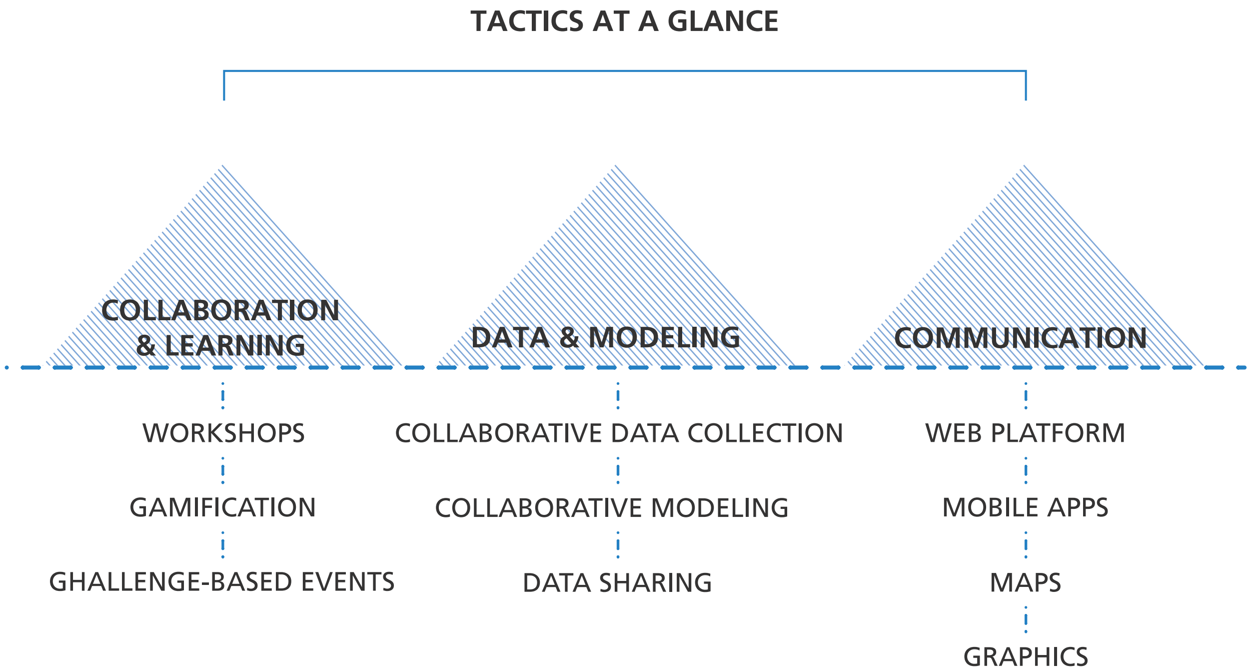
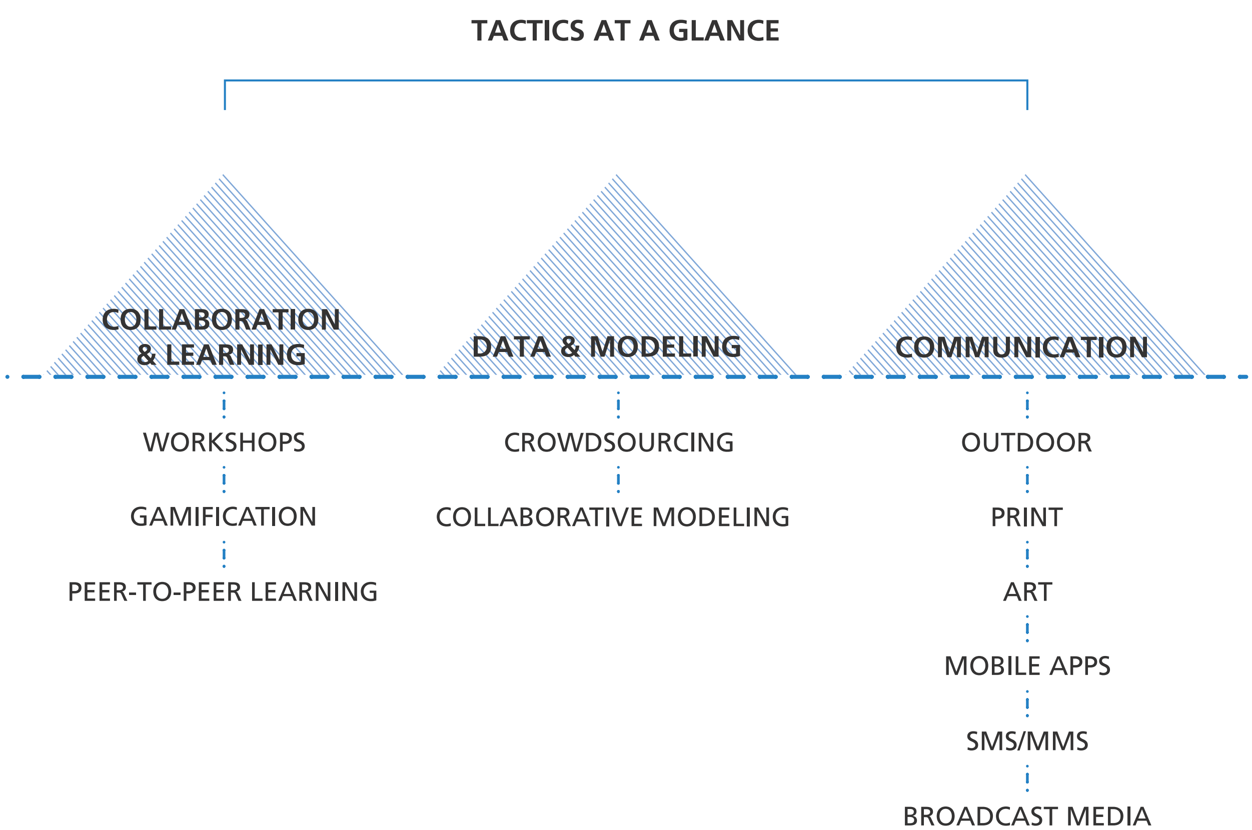


Figure 3.4b
Project design tactics used for User Group 2



Combination and Assembly of Tactics

Collaboration & Learning Tactics:

Specific **workshops** will be held to bring together multi-sector actors within the local government. Workshops with community leaders will occur at the early stages of the project to generate a shared understanding and definition of the core problem. Further joint workshops will occur strategically to provide feedback on visualization outputs and other aspects of the evacuation plan. This feedback will then be integrated into the evacuation planning process. Aspects of **peer-to-peer learning** will be used through facilitating workshops by community leaders. These workshops will discuss localized flood risk maps and engage inclusively with community members to understand the priorities and concerns of different groups.

Gamification will be used at workshops to familiarize local government officials with the dynamics of decision-making around an evacuation response plan. The data collected will inform a second iteration of the game. A **serious game** will be used in community workshops as a way to have focused discussions around location-specific disaster preparedness and evacuation points. The act of playing and the simulation of consequences will demonstrate how certain forecasts and early warning alerts are linked to protective actions. These sessions will also allow for input into planning from groups most at risk.

A **challenge-based event** will be held by local government officials to explore existing datasets and identify missing or outdated data. This will identify what data should be collected.

Data and Modeling Tactics:

Collaborative data collection and **crowd-sourcing** will build upon and enrich existing datasets. Community users will validate existing datasets via crowd-sourcing. There is commitment to promote openness of data through the collation and **sharing of datasets** and information on a single platform.

Collaborative modeling will take place during select workshops where multi-sector officials and community leaders will jointly define, prioritize, and visualize the key information required from the model. This will relate to questions around the project objectives such as:

- *(i) Who is exposed to floods and who is exposed to storm surges?*
- *(ii) Which public buildings earmarked as potential shelters are at risk and which are not?*
- *(iii) Which roads would be impassable and which would be intact?*
- *(iv) Which telecommunications and media installations are at risk and which are safe?*

A key part of the collaborative approach will be the inclusion of community leaders and local information to help inform the model.

Communication Tactics:

A combination of **maps** and **graphics** is the most optimal visualization output to present city-level flood risk. These outputs allow various local government officials to explore the dynamics between flood scenarios and exposure of population and assets. **Maps** are selected to geospatially indicate the extent of areas at flood risk under various flood scenarios (100 Year, 500 Year, and Hurricane Category 4). In addition, **graphics** and **infographics** are selected to clearly summarize key exposure data (infrastructure assets, demographics, and buildings at risk) and both direct and indirect economic losses by flood scenario and geographic area. The visualzation analysis table at the end of this chapter [Table 3.1] demonstrates how maps and graphics have been combined to meet the project objectives.

The local government officials decided the visualization outputs will be accessible through a **web portal**, **tablet**, and **mobile app**, thereby capitalizing on their access to internet and mobile internet. These communication channels also allow for interactive analysis of multiple layers of data. The communication outputs will be developed through collaborative modeling workshops and will be used to support dialogue and discussion on risk assessments in follow-up workshops.

Figure 3.5a
Communication outputs for User Group 1

1 - Tablet interface, 2 - Mobile app interface, 3 - Web portal interface

Local area flood **maps** will be used, along with various **illustrations**, to demonstrate to the communities the location of the nearest flood evacuation center and the safest evacuation routes. The **illustrations** will draw upon the datasets used in the collaborative risk modeling to visualize the probable storm surge heights in relation to a street scene. These illustrations will reference storm surge water heights against people and familiar buildings and objects.

Maps and illustrations will be shown on **outdoor community notice boards** and distributed via **printed handouts**. For community members with access to the internet, this information will be available on **web platforms** and **mobile apps** as well. Public service announcements will run on reliable and trusted local **television** and **radio channels** to reach multiple communities. Longer weekly feature radio programs will also be used to promote the sharing of information between community members to prepare for a flood event.

SMS is optimal to reach community members with no mobile internet access. It will be used to inform them of the location of their local evacuation point and where they can find more information about the flood event. Critical information and tips for preparedness can also be sent. SMS also has the potential to develop into an alert channel as part of an early warning system for the communities.

Figure 3.5b

Communication outputs for User Group 2

1 - Public service announcement, 2,3 - SMS, 4 - Community notice board, 5 - Web portal, 6 -Handouts

6

Step 6: Ensuring Application of the Guiding Principles

To ensure that the project is grounded in the 10 Guiding Principles, the local government officials used the checklist for the scoping of the decision-making context to consider each principle in turn against the set of indicator questions. This reinforces that the selection of each tactic was informed by these principles and that the use of data and information by the project will be impactful.

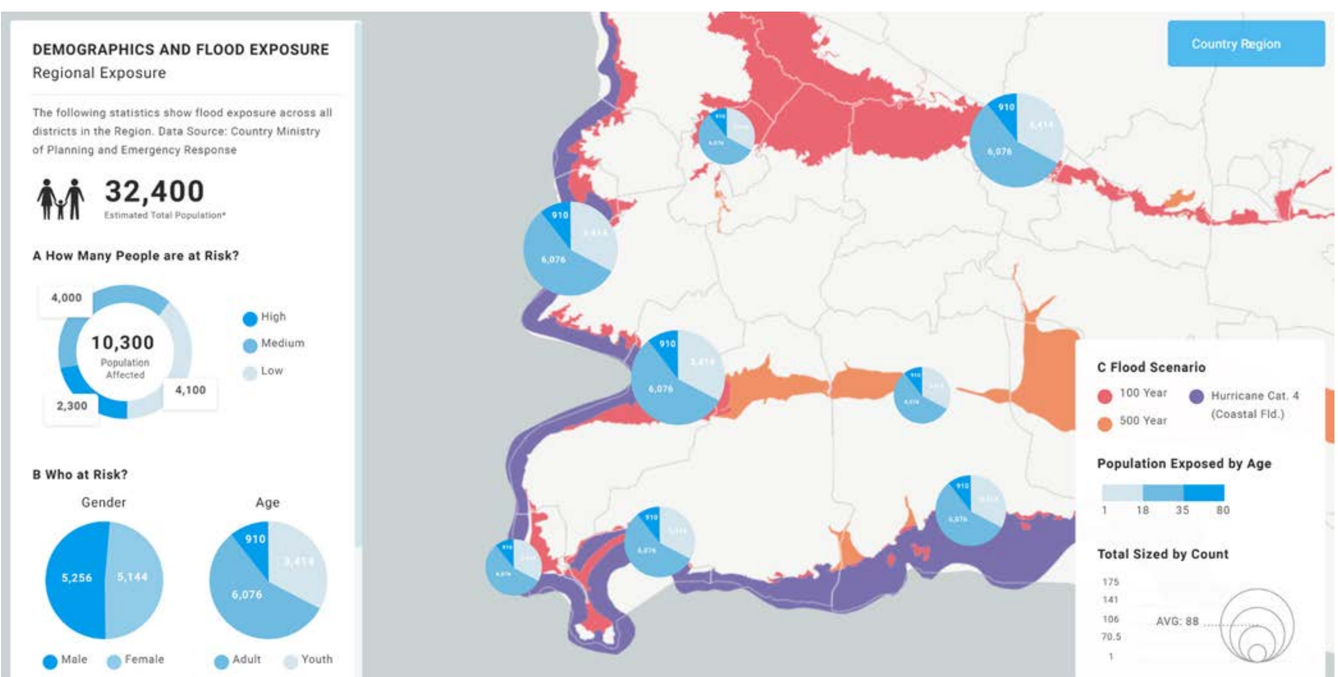
- User Centricity ✓
- Inclusivity ✓
- Shared Understanding ✓
- Co-Creation ✓
- Open by Default ✓
- Information Appropriateness ✓
- Channel Suitability ✓
- Sustainability ✓
- Reflexivity ✓
- Dialogue & Debate ✓

Visualization Analysis of Coastal City Scenario

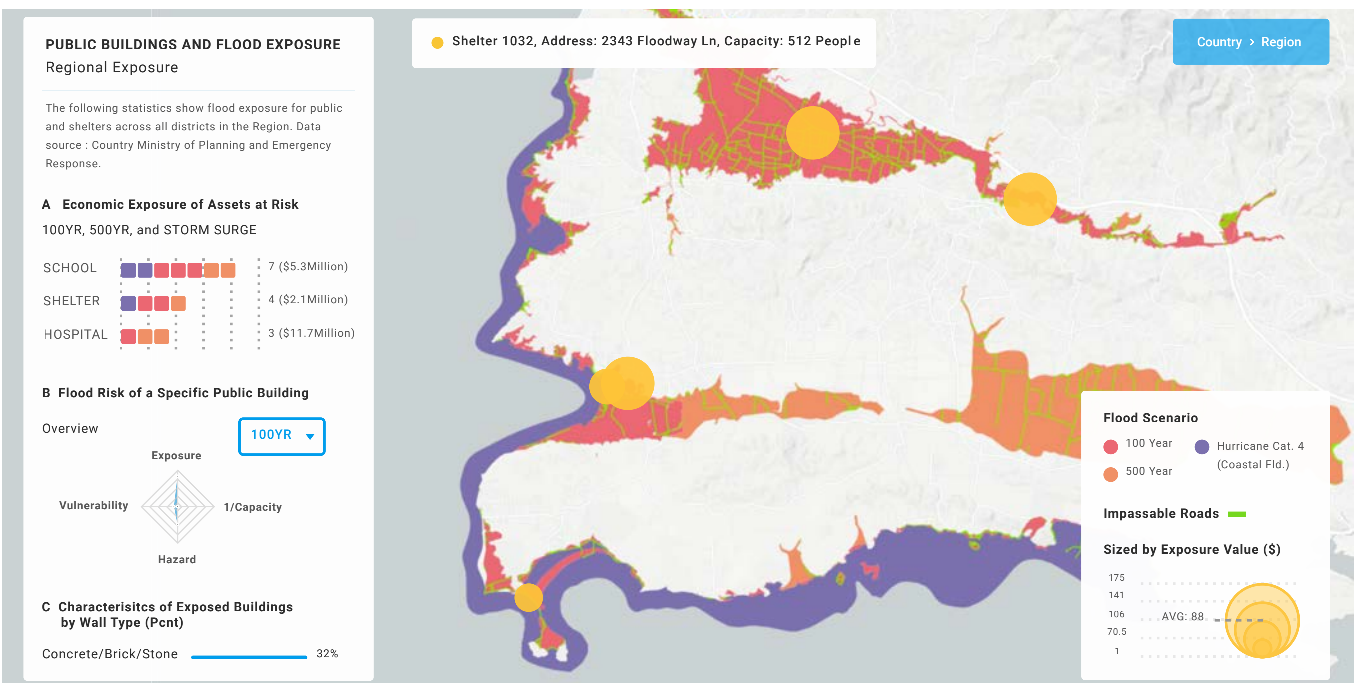
This section showcases a range of visualization types and how they have been used to answer different questions within the scenario.

Table 3.1:
Visualization Analysis of Coastal City Scenario

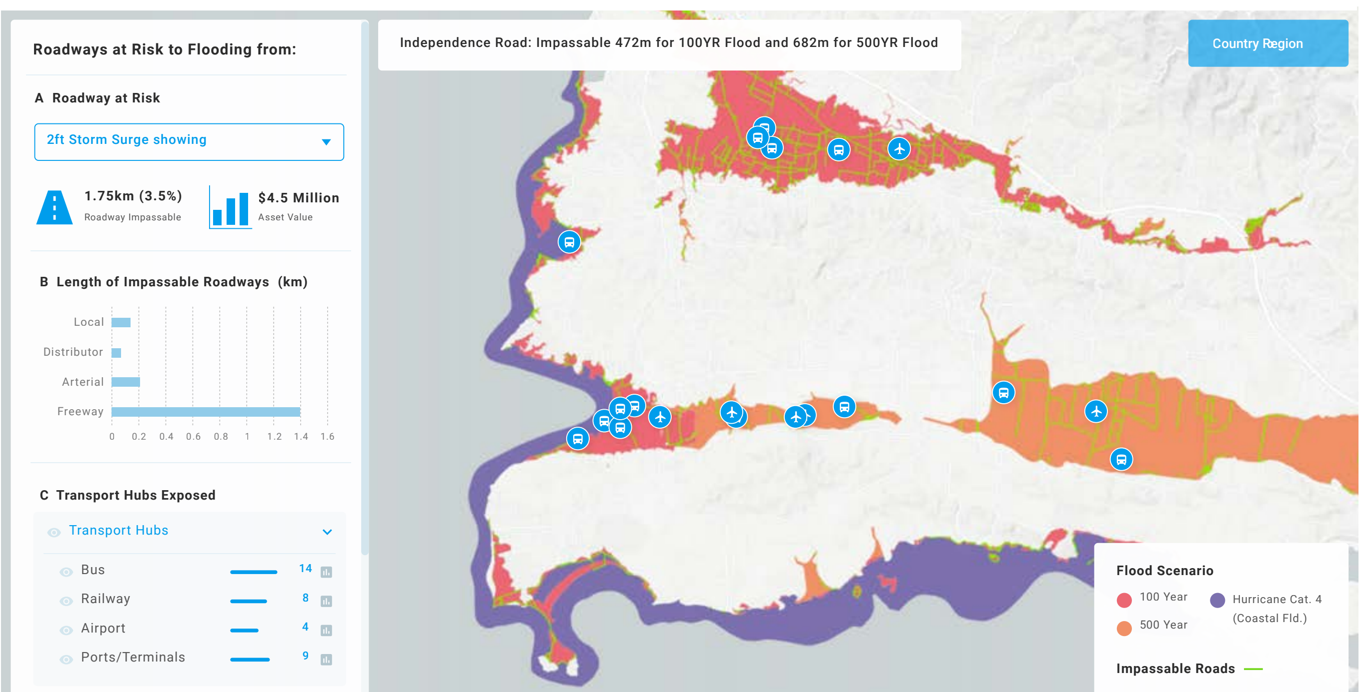
QUESTION	USER	DATA	VISUALIZATION CONCEPT
Who is exposed to floods in your area?	**Government/ Civil Contingency Managers**	**Demographic Data, 100YR Flood, 500YR Flood, Cat 4 Hurricane Flood**	**Flood map showing pie charts (percentage of population affected by age) for each district within a city.**
A How many people?	-------	-------	Graphics and donut chart to emphasize proportion by demographic profiles.
B Who is most vulnerable?	-------	-------	Pie charts indicating gender and age of population affected. May also include income level, disabled population, languages spoken, etc.
C Where are they located?	-------	-------	Map with multiple flood and storm surge (hurricane) scenarios.



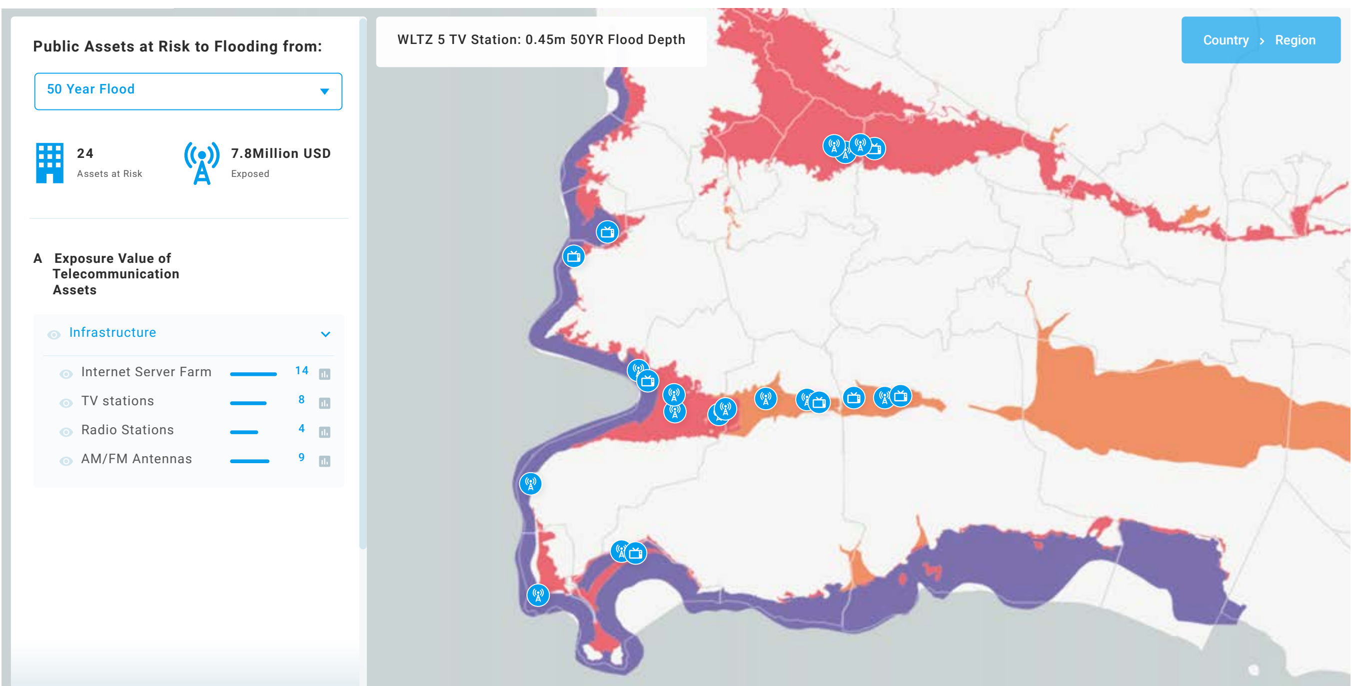
QUESTION	USER	DATA	VISUALIZATION CONCEPT
What public buildings for potential shelter use are at risk and which are not at risk?	**Government Infrastructure Managers**	**Building data, 100YR Flood, 500YR Flood, Cat 4 Hurricane Flood**	**Flood map with point chart overlay indicating exposure value for assets at risk.**
A What is the economic exposure of assets at risk to flooding?	-------	-------	Stacked bar chart showing exposure count and value per asset category and flood scenario.
B What is the flood risk of a specific public building?	-------	-------	Radar chart indicating vulnerability, exposure, hazard, and adaptive capacity.
C What are the characteristics of buildings exposed to flooding?	-------	-------	Bar chart indicating exposure count by wall type (other categories such as foundation type, occupancy type, year built, etc. may also be relevant).



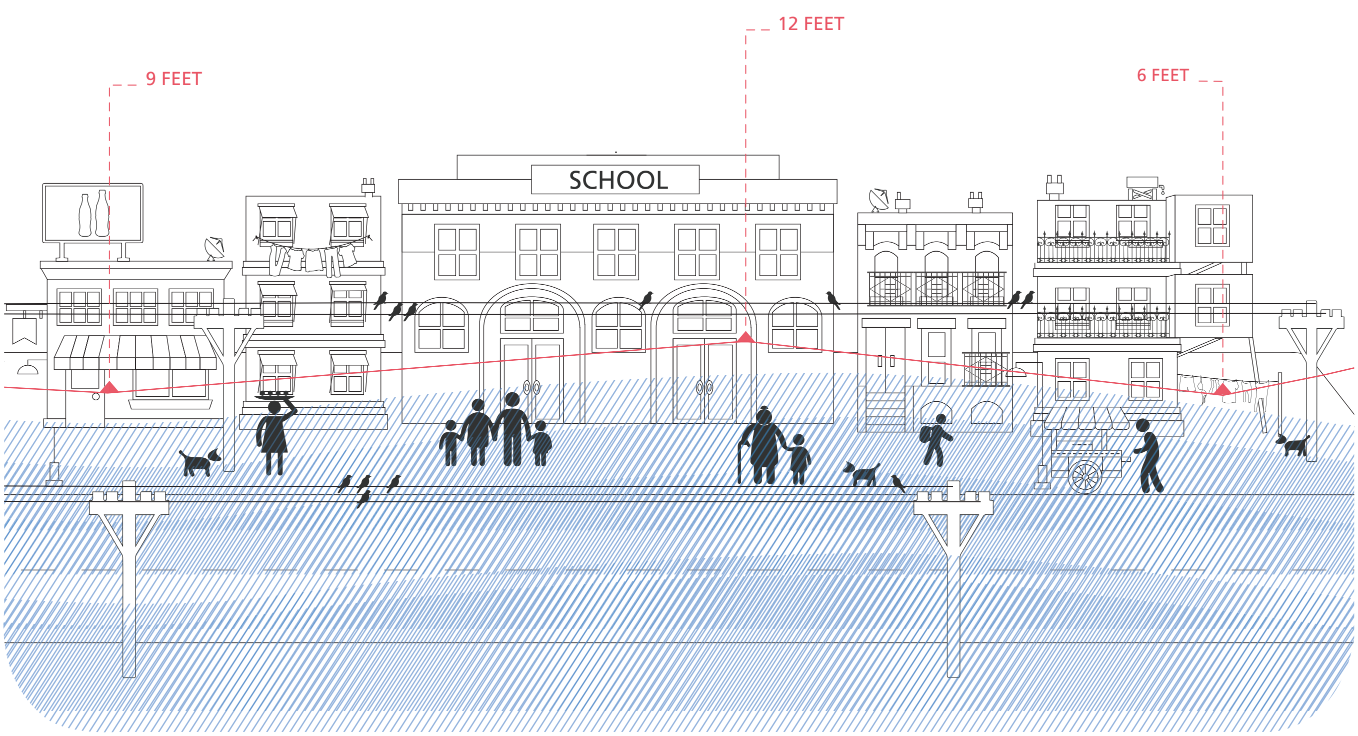
QUESTION	USER	DATA	VISUALIZATION CONCEPT
Which roads would be impassable?	**Transport Infrastructure Managers**	**Roadway data, 100YR Flood, 500YR Flood, Cat 4 Hurricane Flood**	**Flood map with impassable roads and exposure of key infrastructure hubs.**
A Which roadways are at risk per flood scenario?	-------	-------	Infographics and totals for impassable roads and exposed asset value.
B What is the length of impassable roadway per flood scenario?	-------	-------	Bar graph showing length exposed by roadway category.
C How many transport hubs are exposed per flood scenario?	-------	-------	Bar graph showing exposure count by infrastructure sub-category.



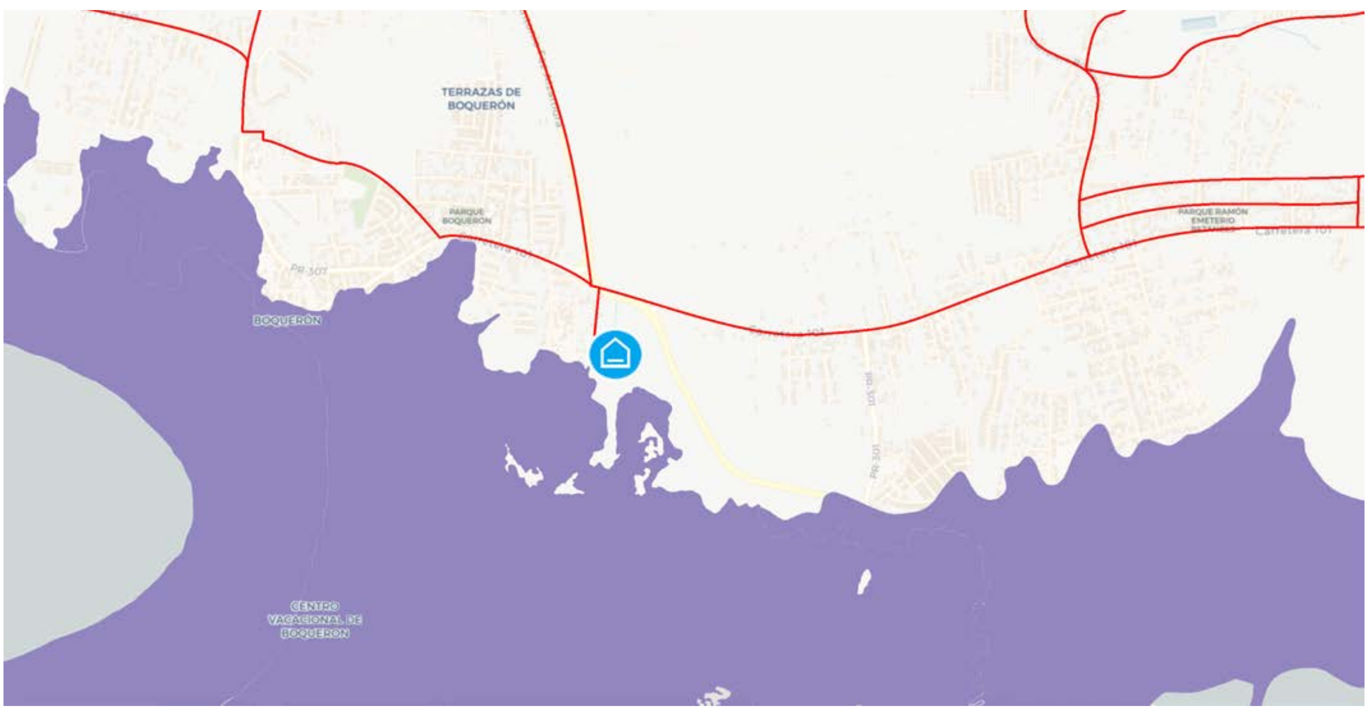
QUESTION	USER	DATA	VISUALIZATION CONCEPT
Which telecommunication and media installations are at risk and which are intact?	Infrastructure Managers/Civil Contingency Managers	Infrastructure (Telecom) data, 100YR Flood, 500YR Flood, Cat 4 Hurricane Flood	Flood risk map with icon overlay showing location of exposed telecommunications infrastructure.
A What is the exposure value of telecommunications assets?	-------	-------	Bar graph showing exposure count by infrastructure sub-category.



QUESTION	USER	DATA	VISUALIZATION CONCEPT
How high would flooding reach your home/school?	Community Members	Public Building Data (Schools, sports facilities, community centres etc.) 100YR Flood, 500YR Flood, Cat 4 Hurricane Flood	Illustration indicating storm surge heights



QUESTION	USER	DATA	VISUALIZATION CONCEPT
Where are the designated evacuation points?	**Community Members**	**Demographic Data, Roadway Data, Public Buildings Data (Schools, sports facilities, community centres etc), 100YR Flood, 500YR Flood, Cat 4 Hurricane Flood.**	**Localized flood map with the location of evacuation points and safe road routes.**
Where is the closest evacuation shelter to our community?	-------	-------	-------
Which roads will be safe to use per flood scenario?	-------	-------	-------

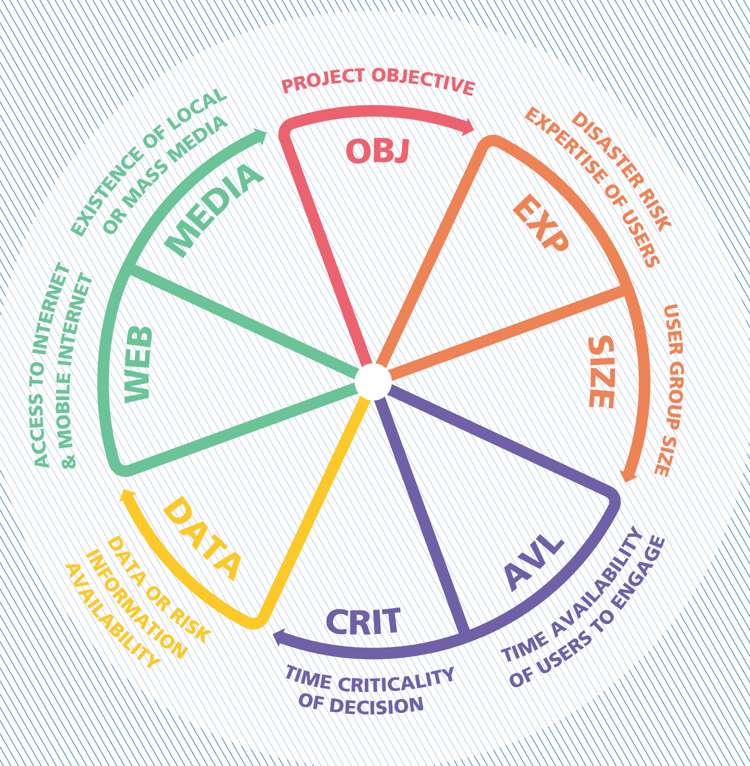


The projects in this chapter reference and demonstrate the six steps, various tactics, and guiding principles of the Design for Impact Framework.

1. UNDERSTANDING THE 10 GUIDING PRINCIPLES

(1) User Centricity
(2) Inclusivity
(3) Shared Understanding
(4) Co-Creation
(5) Open by Default
(6) Information Appropriateness
(7) Channel Suitability
(8) Sustainability
(9) Reflexivity
(10) Dialogue & Debate

2. SCOPING THE DECISION-MAKING CONTEXT



3. COLLABORATION & LEARNING TACTICS

4. DATA & MODELING TACTICS

5. COMMUNICATION TACTICS: CHANNELS & VISUALIZATION

6. ENSURING APPLICATION OF THE 10 GUIDING PRINCIPLES

CHAPTER 4

Project Mapping: Case Studies

◆◆◆

Eight impactful projects mapped against the Design for Impact Framework

Amrai Pari

Together We Can Do It

BBC Media Action

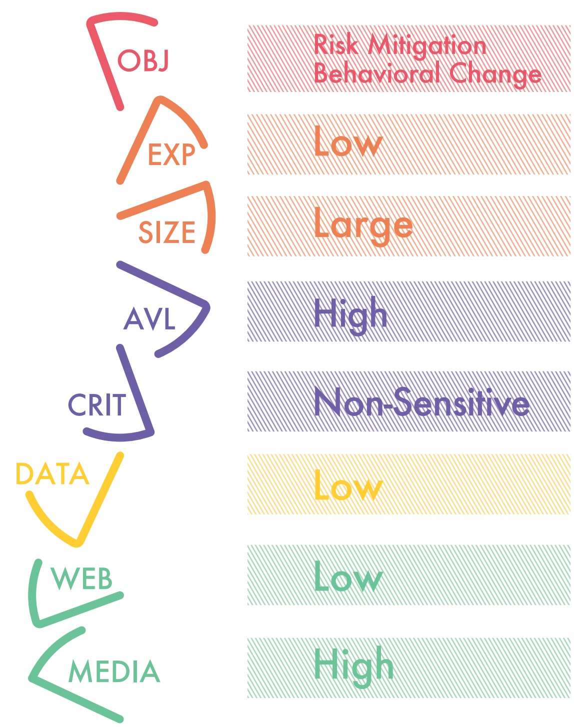
Bangladesh

Project Snapshot

Despite high levels of awareness and pockets of proactiveness within Bangladesh, research conducted by BBC Media Action found that many people were still not responding to the environmental challenges, changes in the weather, and related resource availability they were facing. The Climate Asia research study, undertaken across seven countries on "where, why and how people would be moved to take action," found that inaction stemmed from a lack of knowledge of risks and associated adaptive action. In addition, perceptions were that solutions were expensive and required government intervention.

BBC Media Action's Amrai Pari (Together We Can Do It), a reality television show in Bangladesh which ran from 2013-2016, sought to entertain and amplify a number of resilience drivers identified in the study, such as perceived risk, self-efficacy, collective efficacy, and discussion. The aim was to raise awareness and build networks to share information and showcase affordable, achievable solutions to everyday challenges around extreme weather. In addition, it focused on providing communication support to communities to work together to become more prepared, recover more quickly, and adapt effectively in the face of disasters. Extensive audience segmentation allowed the project to target local communities that were highly vulnerable to the effects of climate change. Target audiences include those experiencing drought and unpredictability in the north-west and frequent cyclones and salinity in the south-west, as well as cities with populations of over one million (*i.e.*, Dhaka and Chittagong) who experience distinct concerns such as inadequate electricity and water supplies.

Figure 4.1
Project context elements applicable to Amrai Pari



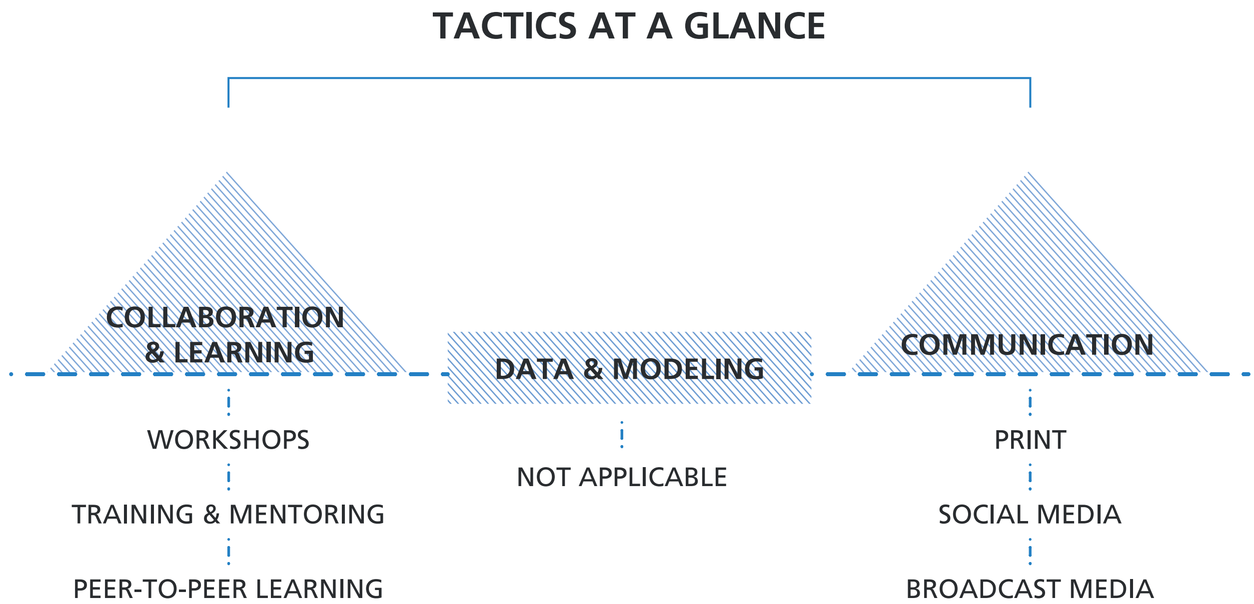
Interview with a local resident from the village of Baldahar in north-west Bangladesh. Picture credit: BBC Media Action

> "Encouraging discussion was a key aim of the project. We know that, when aiming to change behaviors, combining the provision of information with spaces for discussion can greatly increase the impact of a project. That's why our program model (encourages) communities to discuss and debate with each other with a particular focus on ensuring that women and other marginalized groups have space within those discussions. We were pleased that over a third of viewers said that they had discussed the program with others."
>
> Richard Lace, BBC Media Action Bangladesh

Design Tactics

Collaboration & Learning: The project used **peer-to-peer learning** by showing examples of communities working together with their neighbors and local disaster management committees to inspire people with *low disaster expertise* to take protective action. The reality TV show featured communities and local experts sharing knowledge around safeguarding their welfare and livelihoods by adopting simple and cheap "techniques" such as growing different types of vegetables, adapting their houses, and storing food. **Training and mentoring** programs and **workshops** were organized for the crew of Amrai Pari to ensure their understanding of risk information, as well as for the staff of community radio stations who created context-specific programs for a particular local area. Together, these enabled a deeper understanding of local-level problems within communities,

Figure 4.2
Project design tactics used in Amrai Pari



The project empowered residents to take action to develop proactive solutions together to build resilience for their communities.

Data & Modeling: As the project was geared towards changing behaviors, it drew from risk perception data previously collected through the Climate Asia research study. Data & modeling tactics were decided as less applicable to meet the project objectives.

Communication: In Bangladesh, nearly 90% of the population has access to television and consider it a credible mass media system**.** BBC Media Action decided that **broadcasted media** was the most optimal channel to showcase the project. It was included as three eight-episode seasons of a reality television program, broadcasted by Bangladesh Television (BTV) and a cable and satellite channel, AV Bangla. They also had public service announcements ("Working Together") on **TV** and two community **radio** stations that provided simple, practical advice on topics including agriculture, water, sanitation, and shelter. The show became a vital tool for government agencies and NGOs to facilitate information dissemination to more than one million affected people by extreme weather conditions.

More recently, Bangladeshis have gained *improved access to mobile internet* which brought further opportunities for Amrai Pari. *Internet availability* has increased audience participation, particularly of younger people in urban areas.
In response, BBC Media Action developed a series of films for social media channels (Facebook) was developed on earthquake preparedness, heatwaves, fire, and other urban-specific risks.

An interactive toolkit was also developed to widen community reach and launch a large-scale outreach partnership with the Bangladesh Red Crescent Society and other NGOs. In remote areas with *limited internet and mobile connectivity* or *access to local and mass media,* BBC Media Action supported the Bangladesh Red

Crescent Society to run community screenings of Amrai Pari. To ensure continued build-up of knowledge exchange across various communities, the Amrai Pari toolkit consisting of discussion guides, games, inspiring stories, and all the TV content was rolled out to community centers across the country.

Impact and Challenges

- Over the course of this three-year project, BBC Media Action's resilience program reached 22.5 million people in Bangladesh. Over time, risk perception among Bangladeshis increased from just 34% (2013) (among Climate Asia research respondents who felt their area was at high risk of experiencing a disaster) to 46% (2014) and 48% (2016) respectively.

- A large majority of the audience (78%) felt Amrai Pari improved their understanding on how to prepare for extreme weather conditions and make adaptable changes to their lifestyle and livelihoods in order to cope with longer-term impacts of environmental challenges. Almost half (47%) of Amrai Pari viewers reported they had taken action (such as storing food, learning a new skill, and diversifying the crops they grew) as a result of watching the program. Those who watched Amrai Pari regularly (69% watched five or more programs) were more likely to take action. Advanced analysis showed that even after controlling for other factors such as age, education, or income level, Amrai Pari viewers were more likely to take action than those who did not watch.

- The project's Facebook presence continues to grow as more and more Bangladeshis gain internet connection, particularly in smaller cities and semi-urban areas.

Lessons Learned

- Inspire cooperation between leaders and communities. Communities who felt there was support for their concerns from the local government and had confidence to act independently (i.e., those with higher levels of self or collective efficacy) had a better record of taking action to improve resilience.

- It is important that audience needs are well understood and interventions are relevant to the local context. Understanding people's behavior and needs at scale are necessary to identify sustainable and impactful interventions and can bring forth the required output to change behaviors among communities and influential stakeholders.

- Showcase more economic benefits. Individuals are motivated to take action triggered by a risk perception that could affect them at the local level. They are especially interested in learning techniques that are affordable, easily replicable, and make their daily lives more comfortable, especially with the potential for increased income.

Amrai Pari was funded by the UK Government's Department for International Development (DFID) and the European Commission Office for Humanitarian Aid and Civil Protection (ECHO).

You can learn more about the Amrai Pari project from here:
http://www.bbc.co.uk/mediaaction/where-we-work/asia/bangladesh/humanitarian

CIrcle

Critical Infrastructures: Relations & Consequences for Life & Environment

Deltares

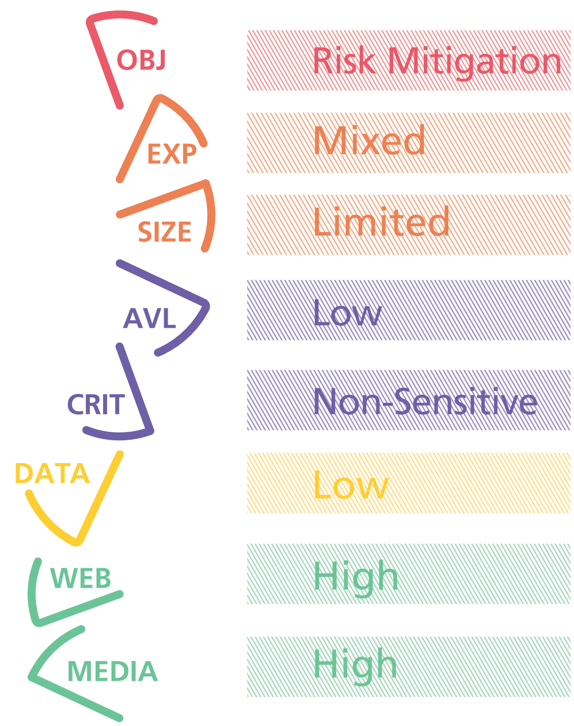
The Netherlands, USA, Tanzania, Turkey, Canada, Ireland, France

Project Snapshot

Climate-related hazards have the potential to destroy or significantly reduce the functionality of infrastructure in the critical sectors of health, water, energy, transport, and communication. The failure of critical infrastructure (CI) can cause devastating social and economic losses beyond the direct impact of a climate-related event. It can have indirect impacts or cascading effects on sectors or geographic areas other than those directly affected. The considerable uncertainty surrounding these cascading effects means they are often not considered in planning decisions.

The Critical Infrastructures: Relations and Consequences for Life and Environment (CIrcle) tool developed by Deltares in close cooperation with their research partners, water authorities, universities, and emergency responders, was designed to facilitate stakeholder engagement to assess the vulnerabilities of CI and learn about the dependencies between infrastructure sectors. The main strategic objective of CIrcle was to plan integrated, resilient infrastructure networks that are prepared for today's natural hazards and the changing climate.

Figure 4.3
Project context elements applicable to CIrcle



CIrcle has been used predominantly for flood-related risk assessments and has been recently extended to other hazards and multi-hazard risk assessments.

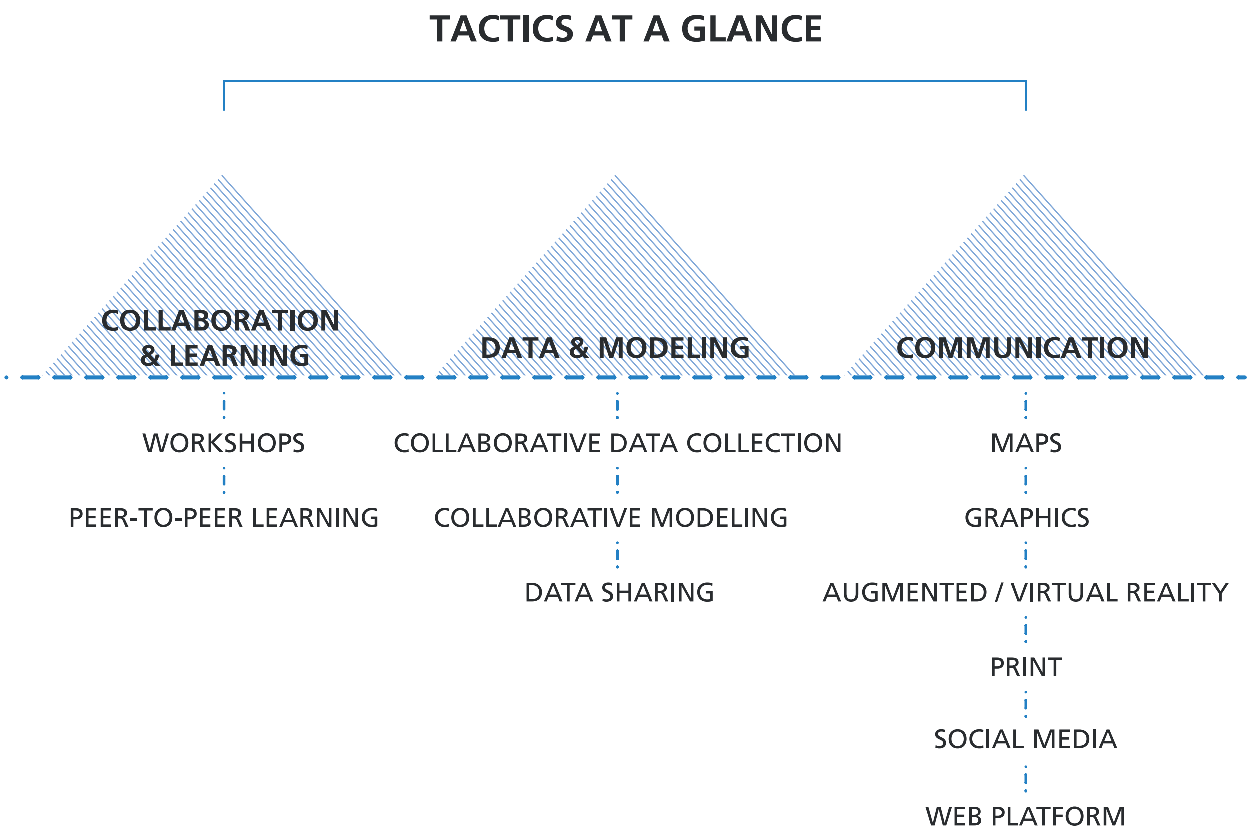
Workshop participants engaging with the CIrcle tool. Picture credit: Deltares.

> *When Deltares started CIrcle, we noticed that network owners and operators were very willing to discuss vulnerabilities of their networks to climate change hazards with us. Data, however, was difficult to obtain as this was seen as sensitive data. We decided to bring the different network owners and stakeholders together to discuss these vulnerabilities in a workshop setting and use open data instead of detailed network models.*
>
> Andreas Burzel, Deltares and Micheline Hounjet, Deltares

Design Tactics

Collaboration & Learning: The users of the CIrcle tool were infrastructure network operators, decision makers, and emergency service providers who have specific sector expertise and a *mixed level of disaster risk expertise.* **Workshops** and **peer-to-peer learning** were utilized to share expertise and knowledge between users and explore a shared understanding of interdependencies of CI. Follow-up workshops were held for stakeholders to verify the identified interdependencies and impacts of potential risk reduction measures. These sessions supported '*non-sensitive decisions'* on the preparedness of CI systems and prioritization of integrated planning strategies.

Figure 4.4
Project design tactics used in CIrcle



Data & Modeling: Datasets and information on CI are sensitive, often classified, and *difficult to access*. To overcome this, Deltares utilized available **open data sources** such as OpenStreetMap to screen existing CI in the area and integrated it with expert knowledge from users. **Data was gathered collaboratively** at workshops through interviews with participating users. Through **collaborative modeling,** different network owners, stakeholders, and authorities identified and assessed the interdependencies between the CI networks. A knowledge database was developed to **share data** from past CIrcle sessions for further research on risk perception. Past events can be modeled in order to verify the outcome predictions of the CIrcle tool.

Communication: The data gathered was visualized through an interactive modeling technique, supported by **maps**, **videos**, and **animated graphics.** The visualization tool enabled users to interactively explore the interdependencies between CI. A digital version of the CIrcle tool was used in locations with *computer (touch-table/tablet) facilities.* A simplified, non-digital board version (CIrcle-Bao) was also developed for use in contexts with limited access to technical facilities and **low internet.**

Several communication channels such as **handouts and booklets** and a **web platform** were also optimal means to convey information to a range of users.

Impact and Challenges

- CIrcle aimed at increasing resilience against natural hazards by identifying and protecting the most critical elements in CI networks. For example, a case study proved that a drinking water supply facility was the most crucial infrastructure of the city. In a previous flood event, the failure of this facility led to the breakdown of schools and other public buildings for several weeks, and the residents had to be provided with bottled water. The CIrcle workshop also found that protecting the water supply facility will lead to a substantial increase in the entire area's resilience.

- One of the biggest challenges encountered during the project was proving the added value of bringing stakeholders together in a workshop. Initially, the stakeholders were reluctant to participate, but once they attended the workshops and met other experts, they were very open to share information and collaborate with each other. This interaction between the stakeholders continued beyond the workshops, which led to long-lasting collaborations between different sectors.

Lessons Learned

- Risk perception varies tremendously for different sectors, even within the most developed countries.

- A holistic overview of the system is absolutely necessary to develop long-term risk reduction strategies.

- Stakeholders were not always open to share information, but when they realized the motive of the workshop and heard what other stakeholders were willing to share, they started to open up.

- When open data and knowledge are combined through processes of collaborative modeling, there is a reduced need to access closed datasets.

You can learn more about the CIrcle project from here:
www.deltares.nl/circle

FloodHelpNY

Preparing New Yorkers for Future Flooding

Center for NYC Neighborhoods and IDEO

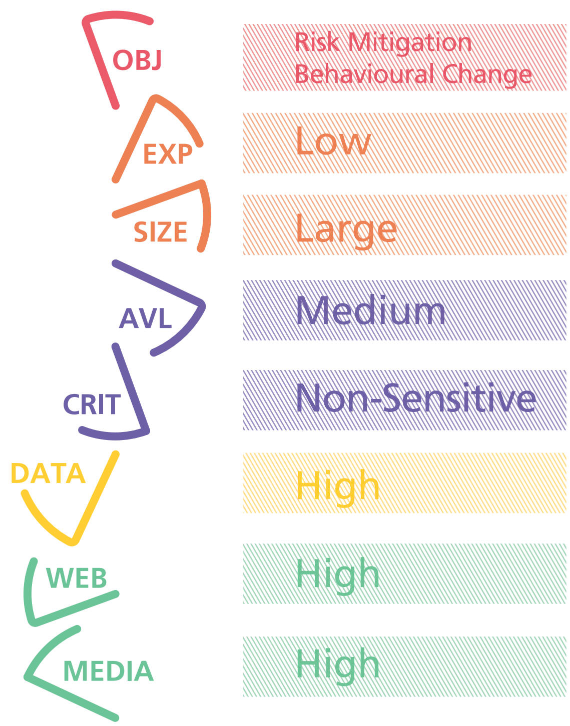
USA

Project Snapshot

In the face of increasing tides, many New York City (NYC) residents are not aware of their flood risk, or that they should even be thinking about it. A flood insurance policy can protect homes and properties from the financial damages of flooding. Yet with rising flood insurance rates and rising sea levels due to climate change, more than 400,000 people who live within NYC's floodplain are at physical and economic risk.

FloodHelpNY helps NYC residents to learn what flood zone they are in, or will be in, how that impacts their insurance rates, and how to prepare for future flooding. The FloodHelpNY web platform was designed to assist homeowners to make changes to their property to mitigate their risk. It provides consumer-friendly information about flood insurance and how to take advantage of benefits from the government, such as free engineering consultations and elevation certificates, which may also be able to lower rates. It aims to encourage two groups to take action: those individuals that have been affected by storms and are fatigued with the insurance system that has failed them; and those not yet affected by flooding.

Figure 4.5
Project context elements applicable to FloodHelpNY



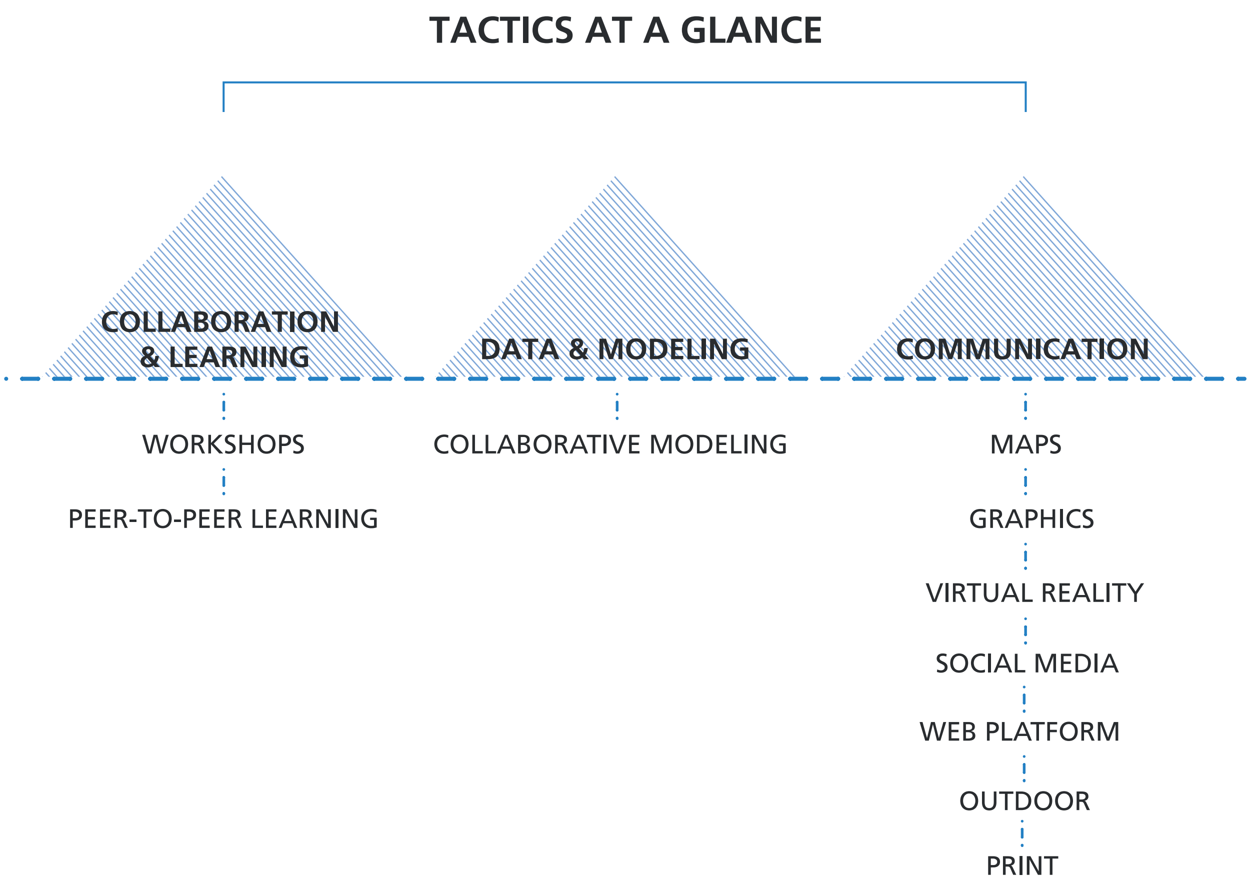
FloodHelpNY - Outdoor media encouraging citizens to visit the FloodHelpNY website to gain more insight into their flood risk. Picture credit: Twitter.com

Design Tactics

Collaboration & Learning: To gain insight into their *larger user group*, IDEO hosted interviews and community **workshops** at neighborhood meetings. They regularly engaged with a *limited group* of residents who had previously been affected by flooding. To encourage *behavioral change*, **peer-to-peer learning** was utilized through first-person accounts of how storms affected the community.

Data & Modeling: A *high availability of risk information and data* made it difficult for users to navigate, process, and trust the information available to them.
In response, IDEO and the Center for NYC Neighborhoods (CNYCN) decided to synthesize and communicate information in a clear and user-driven way. Utilizing **collaborative modeling**, flood-affected residents created paper prototypes of the platform they wanted in place the next time a storm hit. This process of co-design allowed for the development of a user-friendly platform that reduces the complexity surrounding decisions about flood insurance. IDEO learned how it could communicate information most effectively through understanding how residents contextualized their individual risk, what their prevalent questions were, and what type of information they prioritized to receive.

Figure 4.6
Project design tactics used in FloodHelpNY



Communication: A **web platform** was an optimal communication tactic, as there was *high availability of internet* and a *large number of users* to reach. The FloodHelpNY.org website features interactive flood-risk **maps** integrated with a first-of-its-kind flood insurance rate calculator, built from multiple disparate public datasets. It also provides address-specific information on mitigation options that homeowners can use to lower flood insurance rates. This serves as the main channel to connect home and property owners to free audits to assess how resilient their homes or structures are to flooding and future storms. In addition to the website, FloodHelpNY also distributed thousands of **postcards** and **flyers** to NYC homeowners and developed a mobile-optimized site for those accessing information from their smartphones.

Residents with a *low disaster risk expertise* and limited awareness of their flood risk were engaged through **maps** and **graphics** on **notice boards** at pop-up stations in Manhattan. They were offered a **virtual reality** viewer that simulated water flooding into the surrounding streets, giving a visceral understanding of flood risk. The aim was to stimulate discussion about flood recovery and direct viewers to the website. To convey flood risk in a captivating manner, the FloodHelpNY homepage featured an **animated graphic** that used tidal data to simulate the current sea level, relative to the height of Superstorm Sandy.

Impact and Challenges

- The FloodHelpNY website has attracted 120,000 users with 33,000 profiles and has helped more than 700 people sign up for the flood risk and insurance audits.

- The main challenge of the project has been to create a financially sustainable platform over the long-term, while ensuring that content remains up-to-date as flood insurance undergoes reform and flood maps change. Furthermore, a critical design consideration was to simplify complex user processes that were fatiguing program participants. FloodHelpNY minimized documentation burdens on homeowners and made more hands-on services available to assist individuals and reduce drop-off in participation.

Lessons Learned

- To communicate information without confusing users or oversupplying information. This provides people with guidance they can trust, easily grasp, and act on without leaving the website or even the page. The website provides information incrementally to prevent cognitive overload and provides an FAQ on every page to guide users through each activity.

You can learn more about the FloodHelpNY project from here:
https://www.floodhelpny.org

FUNES

Functional Estimation Model

Red Cross Red Crescent Climate Centre

Togo

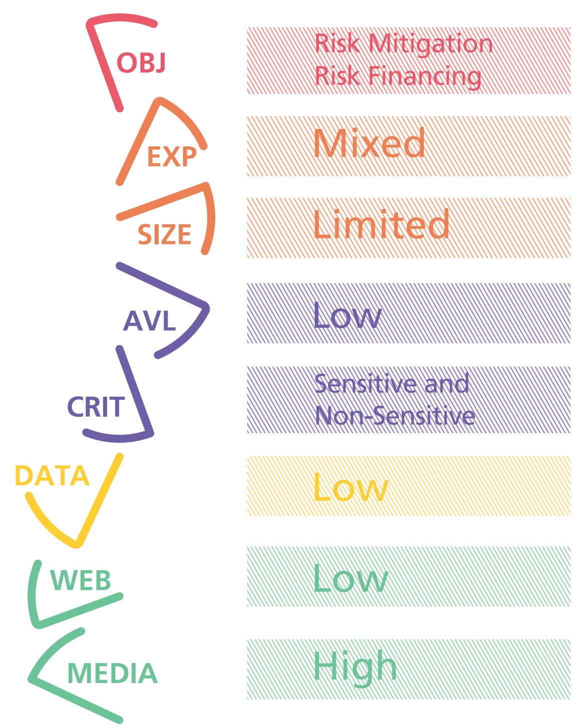
Project Snapshot

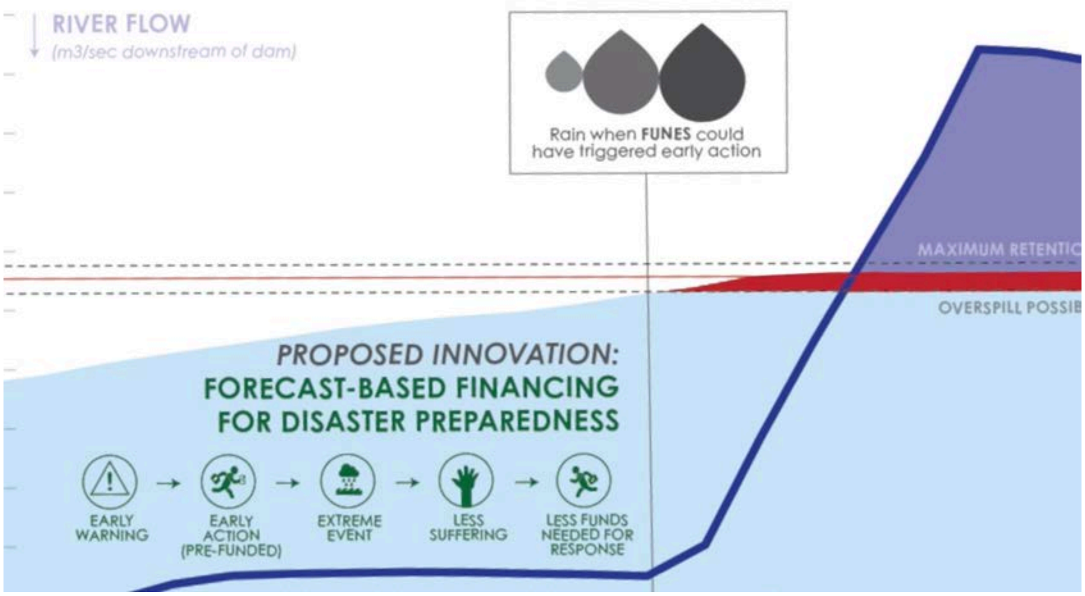
The Togo Red Cross uses an innovative flood risk forecasting tool, called FUNES, to trigger early action and the release of funding necessary for rapid risk reduction before the flood hits. FUNES (for "functional estimation") uses a self-learning algorithm to predict flood risk in the populous Mono River basin. It enables the Togo Red Cross to prepare communities to anticipate and absorb flood risk and to make a timely, accelerated request for Disaster Relief Emergency Fund assistance. FUNES helps the government, Togo Red Cross, and communities make three key decisions:

- *Early release of flood water from the binational Nangbéto hydropower dam on the Mono River.*
- *Alert and prepare downstream communities.*
- *Disbursement of funds for anticipatory and pre-defined actions.*

The FUNES hydrometeorological flood prediction tool shows a two-day forecast of risk levels specific to a locality, updated daily. For each location, the preparedness actions corresponding to the daily level of risk are shown on the map. Each level of risk triggers a specific set of actions in specific localities, which Togo Red Cross initiates before the anticipated level of flooding begins. It also triggers authorization to release the amount of funds necessary to carry out the standard operating procedures (SOP) from a designated contingency fund. With seed money from the German Federal Foreign Ministry and assistance from German Red Cross, Togo Red Cross established a preparedness fund and defined a fiscal management

Figure 4.7
Project context elements applicable to FUNES





FUNES - Detail of the cylindrical DataSculpture poster depicting how the FUNES self-learning algorithm can support Forecast-based Financing in Togo. Picture Credit - climatecentre.org

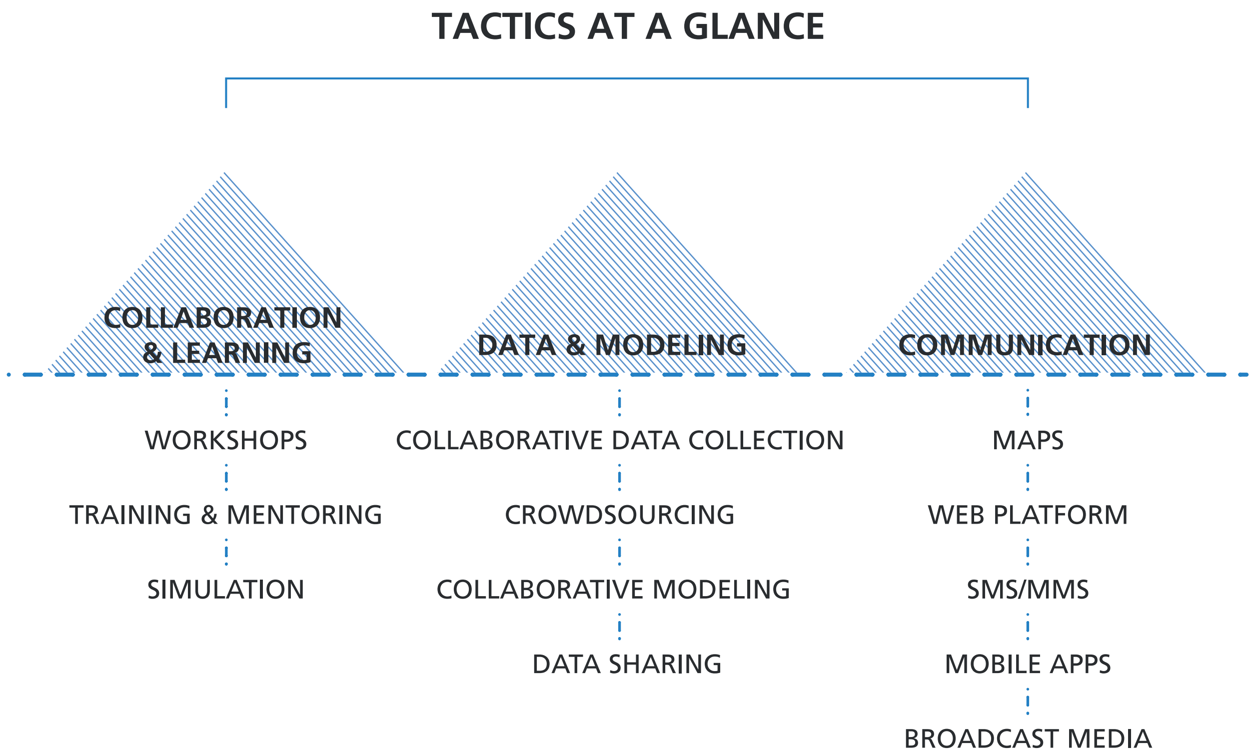
> *We looked into the practical exigencies of the Red Cross, the dam, the government technical services, and also the aspirations of a weak nascent disaster management policy process. As a result we were able to make a much more valuable contribution along with GFDRR's Code for Resilience: facilitating a dynamic process in which all of these stakeholders are defining their own vision and goals in a roadmap for taking over the maintenance and development of Funes.*
>
> Janot Mendler de Suarez, Red Cross Red Crescent Climate Centre

protocol to allow the release of funding for pre-costed early action based on forecast triggers.

Design Tactics

Collaboration & Learning: Since there was *mixed disaster risk expertise* among the project's stakeholders and *low availability of data,* Red Cross volunteers were trained in data collection at the ground-level. The volunteers underwent **simulation** and exercises of the SOP with the local DRM committees and selected communities to prepare for floods. In addition, a **workshop** was conducted to define the strengths and weaknesses of each of the key actors and generate a collaborative roadmap defining their respective goals and next steps (2016-2018).

Figure 4.8
Project design tactics used in FUNES



Data & Modeling: With the objective of *flood risk mitigation*, the project used **collaborative modeling** with the Togo Red Cross and Communauté Electrique du Benin's binational Nangbéto hydropower dam, funded through GFDRR's Code for Resilience project. FUNES integrated data that was collected collaboratively by key actors. For instance, dam operators provided daily flow data; upstream rainfall observers transmitted readings via SMS; and Togo Red Cross provided flood impact data during each annual flood season. Rainfall data was collected through **crowdsourcing**. Over 1,000 Red Cross volunteers were trained by the national meteorological and hydrological services to collect and transmit daily rainfall and river level observations through an SMS-based data entry and management system. Togo Red Cross also conducted mobile-based household flood impact surveys in communities downstream of the dam. Furthermore, crowdsourcing flood impact data directly from communities led to a large and rich dataset. Given the extremely *low initial availability of relevant datasets*, this approach to data collection was transformative. Togo's national disaster risk reduction platform has been considering how FUNES and its data collection, validation and **sharing** that might benefit other actors such as Ministries of Agriculture and Health.

Communication: The FUNES hydrometeorological flood prediction tool provides an interactive **web-based map** that shows a five-day forecast of flood risk levels. The FUNES user interface also displays annually updated associated preparedness actions and sends automated daily risk forecasts to the relevant end-user groups. While *internet access* for the general population is *low*, the web-based maps are primarily used by national risk management actors and Red Cross teams on the ground. Engaging communities in data collection using **mobile devices** has also been a method of communicating disaster risk, as it has significantly raised their awareness and understanding of the value and meaning behind the data they are collecting. Furthermore, Red Cross ground staff use FUNES forecast triggers to inform flood risk reduction programming and live interview sessions on **local radio.** This enables vital information to flow to local communities, leveraging high levels of trust in local-language mass media.

Impact and Challenges

- FUNES has significantly increased the lead time, extent of flood preparedness, and development of forecast-based financing by the Togo Red Cross. In mid-September 2016, when the Nangbéto dam reservoir was rapidly approaching the mandatory overspill level, FUNES accurately predicted flooding levels. This triggered the release of funding necessary to carry out pre-planned risk reduction measures, such as rapid procurement and distribution of non-food items like cholera prevention, water purification, and hygiene kits, as well as other evacuation site supplies.

- With 65,000 members, Togo Red Cross has transformed into an engaged collector and informed daily consumer of data collected for FUNES. This has introduced accountability and learning through new data-driven monitoring and evaluation which is fundamentally changing the way Togo Red Cross manages flood risk. In addition to considering expanded use of the SMS system as a content management system for ALL national data by the meteorological Service has begun to provide weekly rainfall forecasts to Red Cross. This represents a new level of end-user focus and opens the prospect for further development of climate services.

Lessons Learned

- A key lesson was the development of FUNES as an iterative process. This requires support for facilitated engagement of key actors and a realistic time horizon with adequate funding support to allow for uptake and learning by each agency. It has to be coordinated and consolidated as a "change management" process.

- Although the FUNES flood prediction tool and associated SMS data collection system is effectively a "free gift," the government actors requested further support for "technology transfer." While GFDRR provided additional technical assistance to automate data collection through the SMS system and entry into FUNES, there was not sufficient time or funding to accommodate the pace of learning and uptake required by each of the agencies.

- The project failed to capitalize on synergies between other projects supported by the World Bank. The project team was not fully cognizant of the wider potential of the FUNES flood prediction tool to improve wider government policy and strategic planning to reduce flood impacts.

You can learn more about the FUNES project at this link:
http://codeforresilience.org/2016/09/30/togo-funes.html

InaSAFE

Better planning saves lives

BNBP, Geoscience Australia, and GFDRR

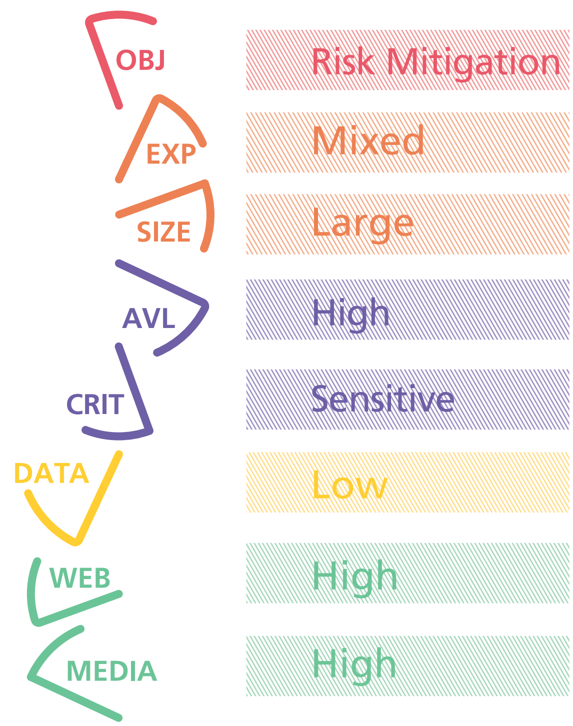
Indonesia

Project Snapshot

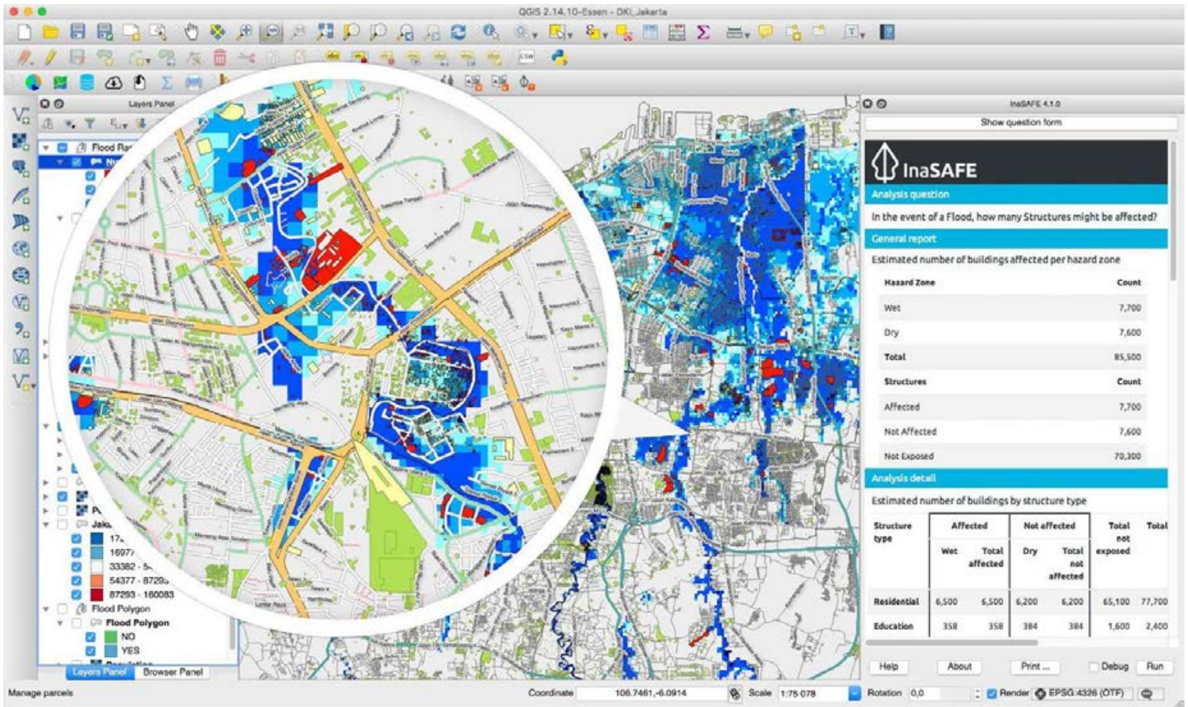
In almost every disaster-related event reported in Indonesia, planning and coordination of aid distribution has been a major challenge. Humanitarian response effectiveness may be enhanced if there is a better way to estimate the number and location of affected people prior to delivering aid.

InaSAFE is a free software that produces realistic natural hazard impact scenarios for better planning, preparedness, and response activities. It was jointly developed by Badan Nasional Penanggulangan Bencana (BNBP), the Australian Government, and GFDRR. InaSAFE provides a simple but rigorous way to combine data from communities, local governments, and scientists to help assess the possible impact of a disaster event. InaSAFE allows users to assess the possible impact of disaster events on a community, its assets, and infrastructure. It can calculate the resources required to support affected populations based on age, gender, vulnerability, and location.

Figure 4.9
Project context elements applicable to InaSAFE



The InaSAFE toolkit consists of a QGIS (Quantum Geographical Information System) plugin on the desktop, an online near-real-time component (in Indonesia), and a soon-to-be-released web version called GeoSAFE. These InaSAFE toolkit components support many stages of disaster management and are underpinned by the same InaSAFE concept.



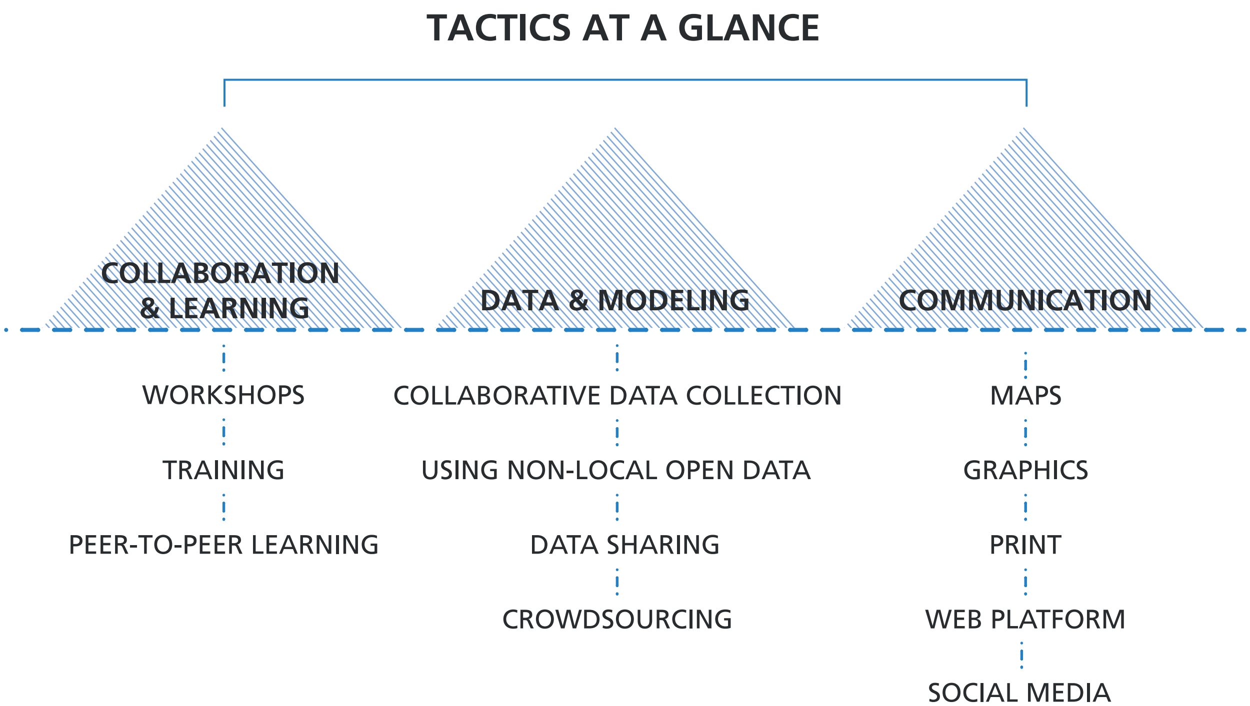
QGIS2.14 with the InaSAFE dock showing a map and indicative results for an assessment of the impact of flooding in Jakarta. Picture credit: InaSAFE.org.

> *We needed a platform that would be open to all users in terms of being usable in their own environment (e.g., places where there is no internet), in terms of being free to install and use, and in terms of being extensible and customizable by any interested developer. Based on this prerequisite we built InaSAFE as a desktop application using the open source QGIS software.*
>
> Charlotte Morgan, Geoscience Australia

Design Tactics

Collaboration & Learning: InaSAFE can be used by anyone who has computer skills, knowledge of GIS, and *mixed disaster risk expertise.* Different types of **workshops** and **trainings** were conducted to introduce the concept of realistic disaster scenario development and help participants understand how to obtain and use suitable data to estimate the impact of a disaster event. Participants in workshops and training events were then **mentored** as they applied their skills in the workplace. Through these collaboration & learning tactics, different users (*i.e.*, district/provincial officials, academics, students, civil society groups, faith-based organizations, NGOs) developed the skills and an increased capacity to use credible hazard science and exposure information to prepare contingency plans for priority regions and response plans following disaster events.

Figure 4.10
Project design tactics used in InaSAFE



Data & Modeling: InaSAFE is capable of integrating a wide range of datasets from multiple sources. Where local agencies have published open data through data sharing platforms, InaSAFE users can combine **data sharing** (from Indonesian government, science, and disaster management agencies) and **crowdsourcing** (OSM data) to develop credible scenarios affecting multiple sectors. Where local agencies have *limited data*, required data can be obtained from a **non-local open dataset** such as WorldPop or through **collaborative data collection.**

Following the 2016 Pidie earthquake Aceh in Indonesia, the combination of real-time hazard data with modeled population data was rapidly assessed and **shared on a website** so that the information was available to disaster managers and the community. Subsequent analyses of the same hazard scenario and local population census data using InaSAFE desktop tools provided disaster managers with estimates of affected populations at village-level, allowing disaster responders to prioritize their response activities. The results were shared on a GeoNode. The sharing of data and knowledge by scientists, governments, and communities supported the refinement of the InaSAFE scenario and the ability of disaster managers to prioritize their response and recovery planning. The support offered to disaster managers through this disaster has led to better understanding of the relevance of InaSAFE to support disaster planning, as well as greater confidence to use it in future.

Communication: The InaSAFE toolkit used a variety of communication channels, such as **print media** for **maps, reports, flyers,** and **postcards; social media** to share project updates and communicating with users in their own language; **YouTube** to share promotional videos and training materials; and a **web platform** to share the results obtained from InaSAFE Realtime.

The desktop version of InaSAFE was designed as a standalone system for users with low internet connectivity. PDF versions of maps and reports remained the best communication channel for remote users. These were produced in multiple languages and included maps, tables, and infographics with both generalized and detailed results. The rich analysis of data was stored so that users could easily prepare further analysis and products to suit their own requirements. PDF reports from InaSAFE realtime can be viewed online and downloaded from their web platform. Reports for earthquake events in Indonesia are linked directly to the hazard event in InAWARE, which is the BNPB supported early warning and decision-support platform. Following the Pidie earthquake of 2016, these PDF reports were shared online and through a GeoNode instance. The reports were promoted to the InaSAFE community through **social media.**

Impact and Challenges

- Using a participatory approach, the community prepared a number of contingency plans and identified evacuation routes which were signposted in the affected area in Maluku Province. Following the application of InaSAFE in OSM 'mapathon' exercises, the BNPB embraced the use of open data and open source technologies to map 136 priority districts in Indonesia and prepare 20 contingency plans in 2017.

- Disaster managers used InaSAFE Realtime to estimate the number of people affected immediately after the Pidie earthquake in 2016. InaSAFE desktop analysis and maps were used to show the location of affected people, helping first responders to locate the most affected communities. The InaSAFE Minimum Needs Tool was used to calculate resources required to support displaced people once actual numbers were collected from evacuation centers. The results of all analyses were shared on a GeoNode.

- Disaster managers who are not familiar with the InaSAFE toolkit may lack confidence to use the results. However, training and implementation at the subnational level in Indonesia has led to a greater level of engagement within the national organization.

- Limited availability of country-level consistent datasets that conform with national data sharing policies may make some users reluctant to use the system or trust the results.

Lessons Learned

- A consistent and easy-to-use interface allows users – even those with little training – to quickly and easily upload new hazard and exposure data, run an analysis, and generate maps, reports, and action lists.

- The effectiveness of risk assessment and preparedness activities increases when the community is directly engaged through participatory mapping and has access to open and accessible tools.

- The openness and scalability of a tool can save time and resources in developing a risk assessment methodology and hazard impact modeling tools.

- The effectiveness of such programs can be greatly improved by working with local partners to address their needs rather than taking a top-down approach.

You can learn more about the InaSAFE project from here:
http://inasafe.org

OASIS Platform

Open and Commercial Data for Climate Insurance and Adaptation Planning

OASIS

Global

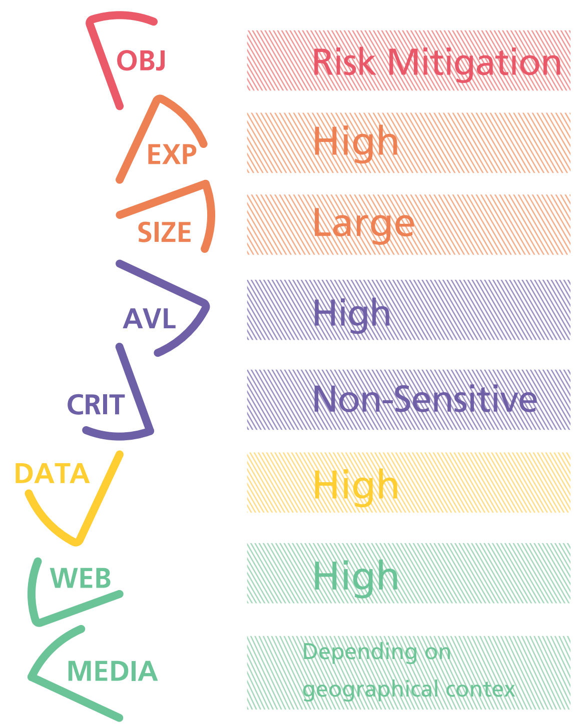
Project Snapshot

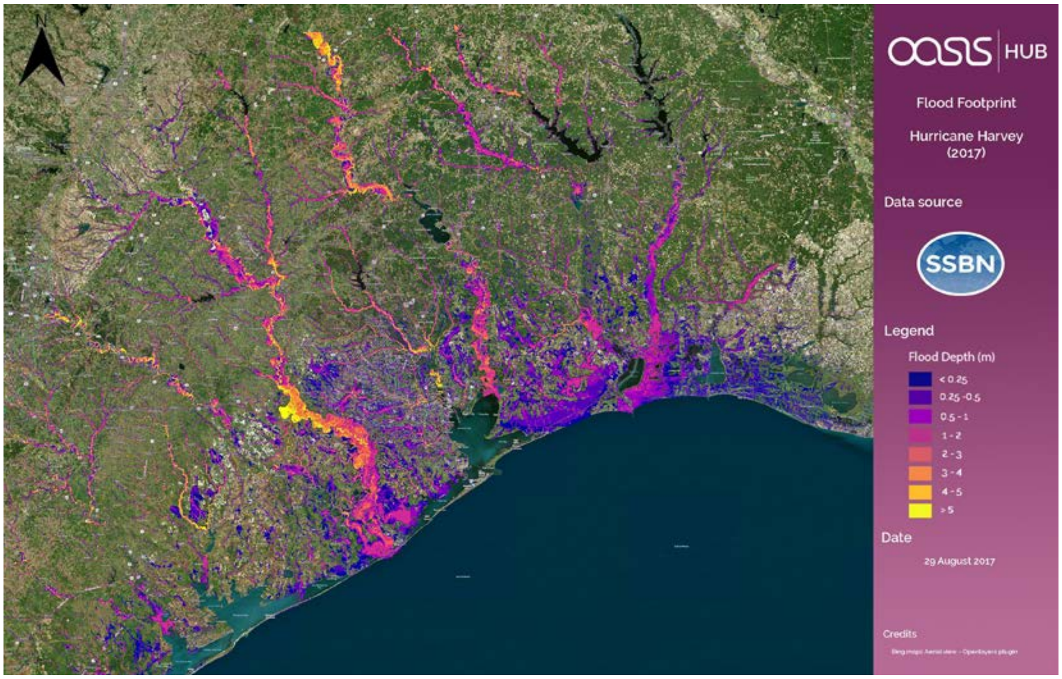
As the frequency and severity of natural disasters increases as a result of climate change, the impact and cost of a catastrophic event to governments, the private sector and to citizens are also expected to increase. Insurance, in the context of disaster risk management, can help increase communities' climate resilience and reduce the impact of disasters.

Oasis is an open source platform that provides catastrophic risk assessment and financial modeling to help a range of users, including (re)insurers, cities, and industries to better understand and financially plan for disaster mitigation and response. It encourages open access and increased availability of risk data through the Oasis Hub, an online portal in which free and commercial datasets can be uploaded, accessed, and crowdfunded. It also provides an open source calculation software - the Oasis Loss Modeling Framework (LMF) - to calculate damage and financial risk from catastrophic events.

Oasis Hub acts as a marketplace to connect practitioners looking for data with publishers of data. With the aim to address the challenges of sourcing, reviewing, and licensing environmental data, as well as tools and services for a growing community

Figure 4.11
Project context elements applicable to OASIS Platform





Hurricane Harvey flooding footprint (August 29, 2017). Picture credit: oasishub.co

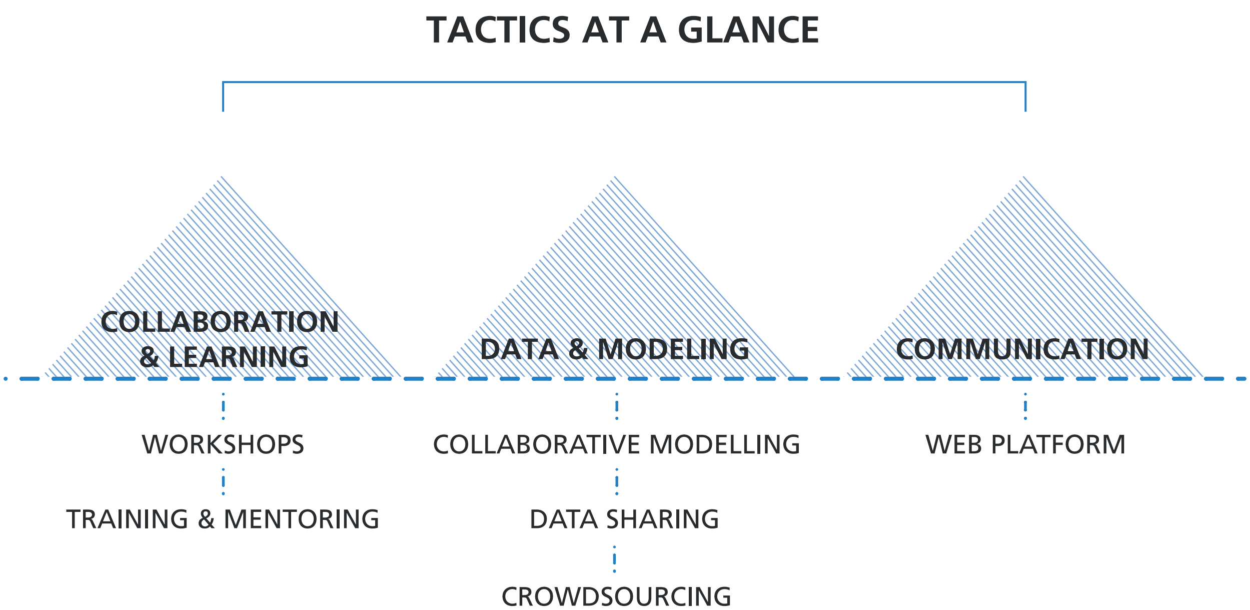
of practitioners, the Hub manages the licensing of, payment for, and access to the data. The focus of Oasis LMF is to make it easier for the insurance and reinsurance industries to identify and quantify risks in developing countries. LMF enables more accurate risk assessments, improved reliability of data, more models, and the

Design Tactics

Collaboration & Learning: Oasis offers support through a range of online learning tools, such as the ongoing Massive Open Online Course (MOOC) and webinars which assist users in developing or securing risk data needed for catastrophic risk modeling and climate adaptation planning. In addition, specific training on the use of the Oasis LMF is provided for those users who have less *expertise in risk modeling.*

Similarly, one of the ways to engage with Oasis LMF is by attending **workshops** and **seminars** to help improve existing tools and data within the platform, as well as the wider sector of catastrophic risk modeling.

Figure 4.12
Project design tactics used in OASIS Platform



Data & Modeling: The datasets available on the Oasis Hub are provided by a number of commercial partnerships with academic, government, and specialist organizations, as well as building upon openly available data. For contexts with *high internet access*, an online marketplace allows these datasets and tools to be **shared** either openly or purchased directly through the site.
The Hub assists data providers in getting their work to market quickly and cost-effectively by reducing the challenges associated with licensing, payment, and access of data.

Country, region, and worldwide datasets are available on Oasis Hub, with availability varying across multiple hazard categories. In order to combat *gaps in data availability,* the Oasis Hub has developed a crowdsourcing application where practitioners could request or offer data, as well as tools or consulting/advisory services across the Oasis community. **Crowdsourcing** facilitated collaboration between actors to satisfy a particular need which was previously not commercially viable.

The Oasis LMF was created through a process of **collaborative modeling** and engagement with members from within the global insurance and modeling community. The open source software can be used for the development and deployment of catastrophe models, with "plug and play" components packaged in standard formats, allowing for flexibility to support a wide range of deployment options. By bringing together expertise from across the EU and the broader modeling and services sector on catastrophe and climate change risk, Oasis LMF provides a range of tools on mapping (Quantum GIS), meteorological (WCT-NOAA's Weather and Climate Toolkit), hazard scenario (CAPRA Probabilistic Risk Assessment), vector (MMQGIS), statistical (R-project), programming (PYTHON), and hydraulic (HEC-RAS) services.

Communication: To share data and the LMF software with a *large and widely dispersed membership/user group,* the Oasis Hub and Oasis LMF are delivered through a **web platform.** Oasis recognized that the areas most vulnerable to the impacts of extreme weather events are those that are least able to cope. It is also these areas where the telecommunications infrastructure is not the fastest or most reliable. Oasis fulfills requests for the sharing of data and tools though a physical shipment of USB hard drives.

Impact and Challenges

- Oasis Hub has over 500 datasets from over 40 organizations.
- Oasis LMF consists of over 12 suppliers.
- The Platform is estimated to reduce modeling costs by 25-50% by lowering transaction costs and enhancing competition, thereby opening up the use of risk models to users beyond the re/insurance industry.
- The Platform could indirectly facilitate an additional US $1.4-6 billion of property insurance coverage in the three potential pilot countries. Proponents of the Platform have begun to develop strategic partnerships, such as with the Insurance Development Forum.

You can learn more about the Oasis project from here:
https://oasishub.co
and
https://oasislmf.org/

OpenDRI Serious Games

Simulating disaster risk management decisions through interactive games

OpenDRI

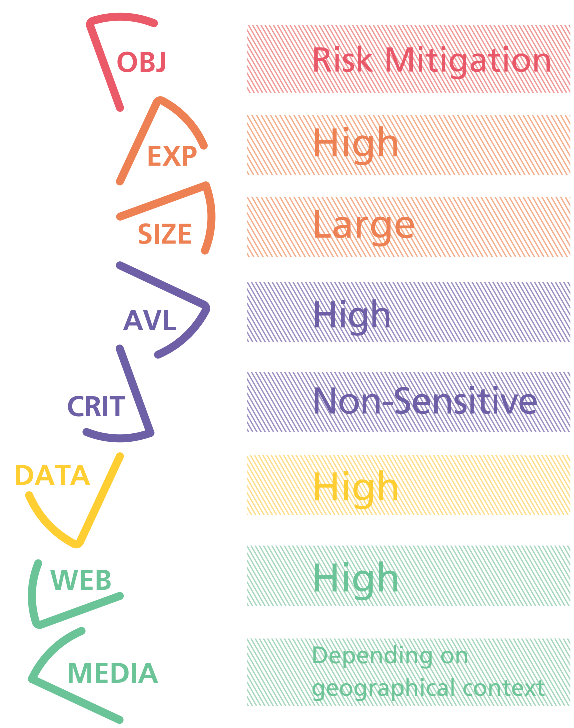
Global

Project Snapshot

In order to stimulate collaborative and integrated approaches needed for urban flood risk management, the Innovation Lab at GFDRR has developed two experiential learning games to engage diverse stakeholders in a way that is both serious and fun. These "Serious Games" allow participants to connect to the emotional and visceral decision-making process that drives real-life preparedness decisions. Each game has been designed as an interactive immersion in a complex system, and the game mechanics are underpinned by specific learning and dialogue objectives.

The goal of the OpenDRI Toolkit Game was to demonstrate the contingency planning process and the effect of planning decisions on outcomes in the event of a disaster. Additionally, it was developed to complement technical training on OpenDRI tools. Participants learned OSM, GeoNode, and InaSAFE through gameplay of a simulated flood scenario for the city of La Plata, Argentina. Participants were able to make decisions around managing school investments related to flood resilience and the evacuation of school children. This game balanced theory and practice to highlight the importance of free and open-source geospatial software in decision-making, while exposing the need for open data to drive shared analysis and negotiation over resource allocations.

Figure 4.13
Project context elements applicable to OpenDRI Serious Games



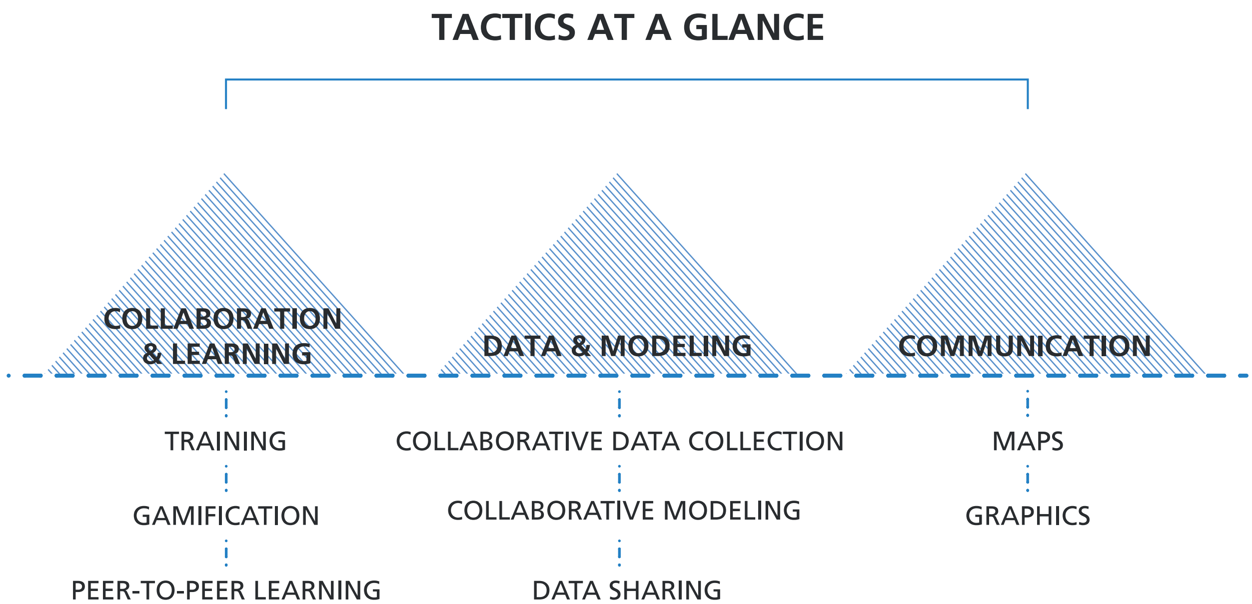
Participants actively engaging in a serious game aimed at better resource allocation. Picture credit: understandingrisk.org

The **Urban Urgencies Game** was developed in connection with the global Urban Flood Community of Practice. It was piloted at the Understanding Risk Forum 2016 among 40 risk identification professionals representing various governments and development partners. It focused on improving the ability of users to process flood early warning information and make strategic investment decisions under real-world budget constraints in order to keep residents safe. Through this immersive game, users were required to consider the importance of early warning information, as well as the costs and uncertainty associated with natural hazard impacts.

Design Tactics

Collaboration & Learning: As a **training** method for a *limited set of users,* **gamification** was used to enhance the understanding of government officials and technical experts and to draw in non-expert users. With only a *short time frame to engage* with users, the immersive nature of these games fostered bidirectional dialogue. This made training sessions more effective than the usual uni-directional presentations.

Figure 4.14
Project design tactics used in OpenDRI Serious Games



Gamification was selected as an optimal choice to understand the dynamics around *risk mitigation* decisions as it allowed users to experience the outcomes and consequences of investment decisions. Within the Urban Urgencies game, users became familiarized with interpreting geospatial data. This enabled them to weigh trade-offs in flood management and explore how to the balance investments in warning systems. Options include improving warning systems outright or investing in enhanced inclusion measures, such as reaching the "last mile".

Serious games encouraged **peer-to-peer learning** among users with different backgrounds, experience, and *mixed levels of disaster expertise*. Through a collective experience of gameplay, users shared moments of confusion and revelation, which generated deep discussion and focused dialogue. In addition, they enabled diverse stakeholders to network and build rapport by exploring new ways of working within the "real-world fiction" of the game.

Data & Modeling: Through the principles of the OpenDRI Toolkit game, participants deployed different open data software. This enabled access to open data to drive decisions on *risk mitigation.* To simulate **collaborative data collection,** participants used OpenStreetMap to collect new geospatial data. GeoNode, a data repository for storing and **sharing geospatial data** was also employed, as well as InaSAFE, a disaster scenario impact tool that helped to visualize and **collaboratively model** risk. Participants actively engaged with these open-source toolsets before applying newly acquired skills to *non-sensitive decisions* around disaster risk management. They worked on a common challenge of ensuring that resources are spent wisely. They had to find a balance between retrofitting the schools that were most vulnerable to flooding versus outfitting other schools with computers and food/water stockpiles, or some combination of both.

Communication: Maps and **graphics** were used to increase the realism of the game.

Impact and Challenges

- Based on feedback from players during the Understanding Risk forum, demand was expressed for the greater use of serious games as engagement tools.

- The games are time-intensive to develop. They can be too complex for all users to fully comprehend due to language barriers and differences in disaster expertise. There have been requests to translate the game into other languages and to adapt it into a simplified version for local government application.

You can learn more about the OpenDRI Games project from here:
https://understandrisk.org/simulating-disaster-risk-management-decisions-through-interactive-games

UP NOAH

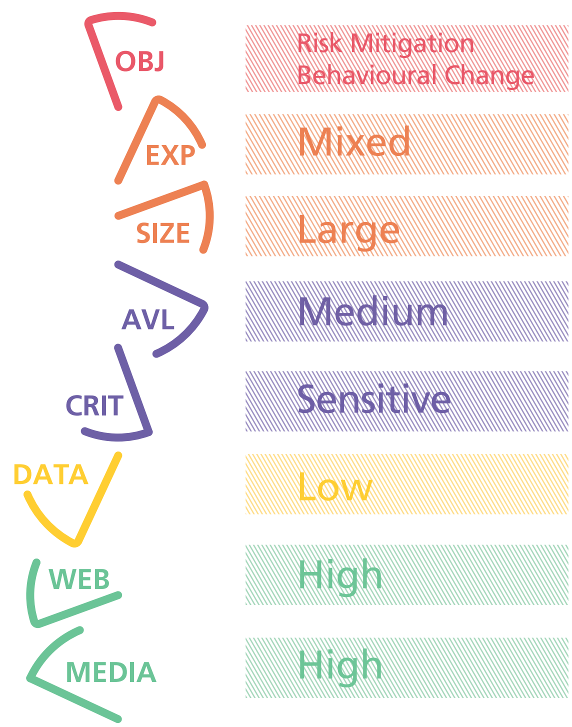
Nationwide Operational Assessment of Hazards

UP Disaster Resilience Institute

Philippines

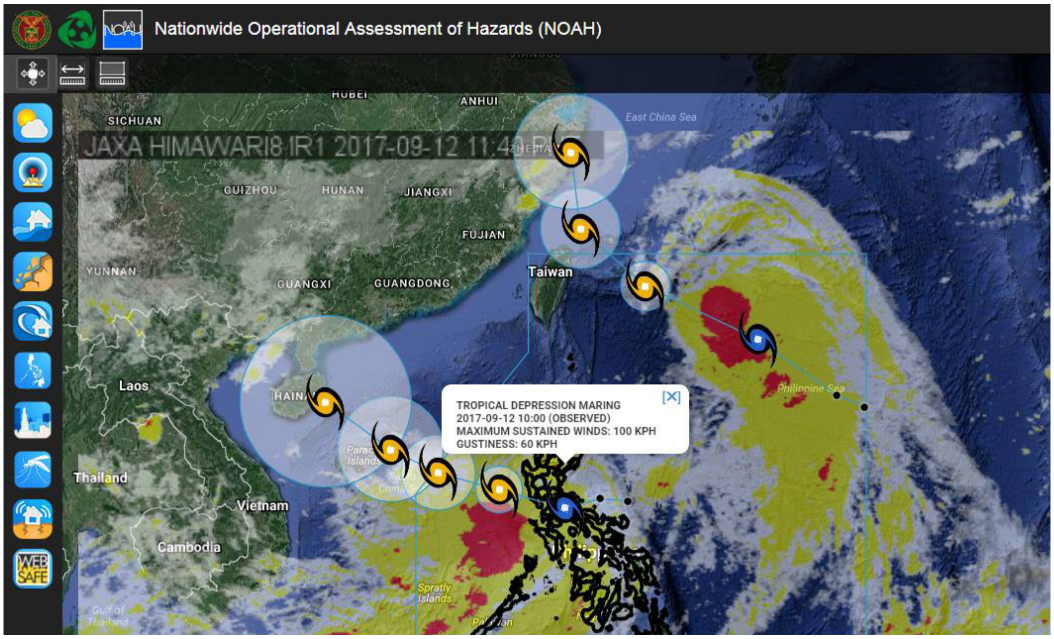
Project Snapshot

Figure 4.15
Project context elements applicable to UP NOAH



Extensive damage and devastation from natural disasters in the Philippines over the past 20 years has led to the creation of the Nationwide Operational Assessment of Hazards (NOAH), a flagship initiative from the national government. NOAH was founded to minimize the impact of disasters and make best use of science and technology by addressing the need to share information and knowledge. With the aim of building an "army of disaster scientists" (Lagmay, A.M., 2017), the project has focused on operationalizing outputs of the academic community on DRM.

Working in collaboration with communities, government agencies, and private institutions, NOAH has developed a set of tools for preparedness, early warning, and response to disasters. The project provides detailed hazard maps to enable citizens and local governments to understand their risk and take protective action based on real-time information.



Himawari Satellite Image - Tropical Depression Maring (12th September 2017). Picture credit: UP NOAH Center.

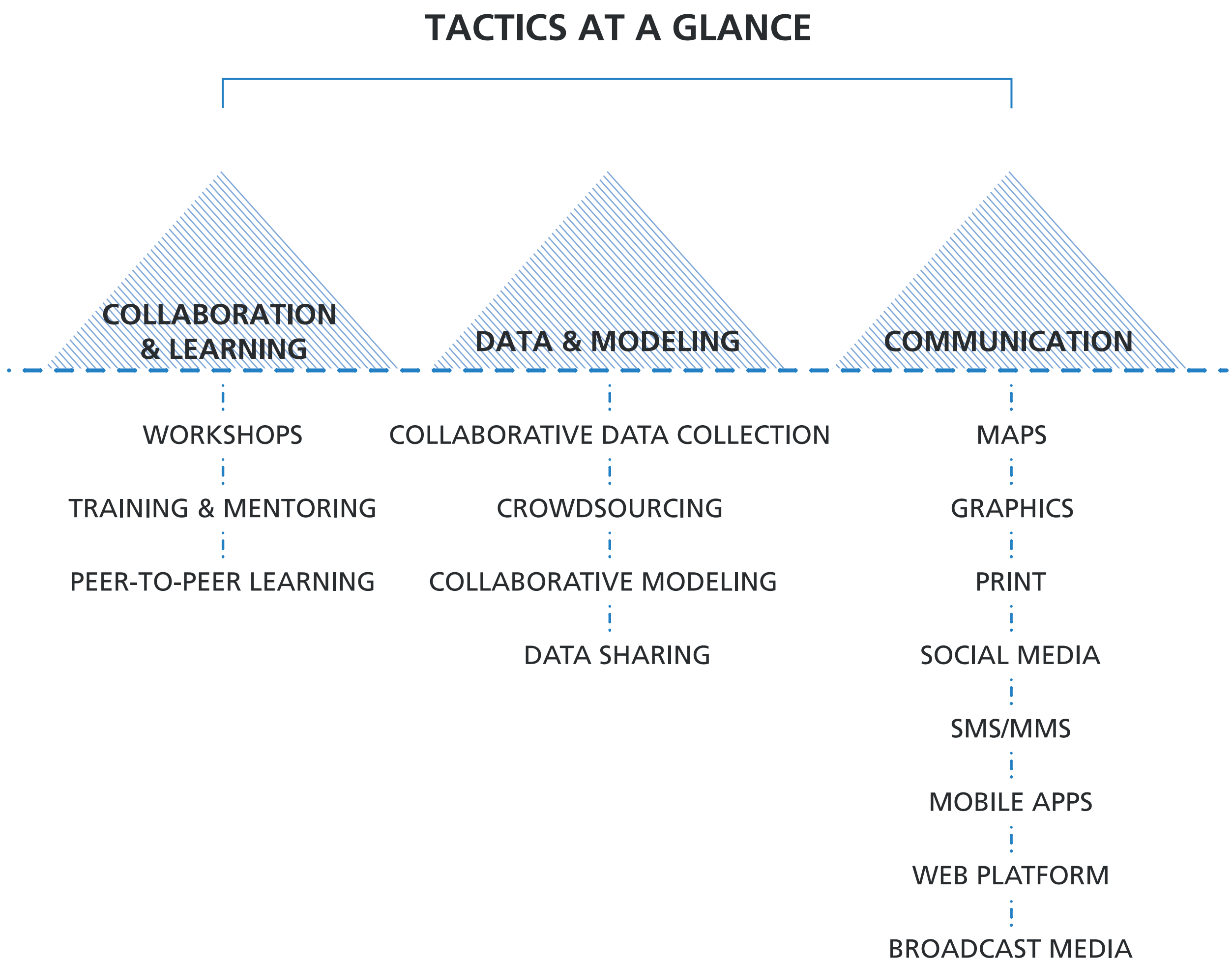
> *We need to understand the mindset of the Filipino people in order to effectively communicate. To do this, it is not only physical scientists that need to work on disaster preparedness but also social scientists. Creative ways to engage and encourage the Filipinos is critical.*
>
> Alfredo Mahar Francisco Lagmay, UP NOAH

Design Tactics

Collaboration & Learning: NOAH utilized **workshops**, **training**, and **peer-to-peer learning** for their field education campaigns (*i.e.*, community-based disaster preparedness workshops, multidisciplinary outreach programs, conferences with municipalities) to create awareness and develop a culture of preparedness. Since the project aimed to work with government agencies, NGOs, and local communities, education campaigns were the most optimal tactic to engage target users with *mixed levels of disaster risk expertise.*

Data & Modeling: Within the context of *mixed level of disaster risk expertise, low data availability,* and *high internet/mobile connectivity,* NOAH's risk mapping efforts embraced public participation and local capacity through **crowdsourcing** and **collaborative mapping** using OpenStreetMap. Using crowdsourced geospatial data, along with data sourced from satellite applications and other mapping technologies, NOAH generated a comprehensive and multidisciplinary assessment of hazards. The WebSafe tool of the NOAH website was developed to aid faster

Figure 4.16
Project design tactics used in UP NOAH



dissemination of geospatial information for *time-sensitive decision-making.* Through this modeling tool, local government units and members of civic groups were able to use and share information for damage assessment and analysis before, during, and after large-scale emergencies. Other collaborative modeling tools developed by NOAH are LiDar maps (topographic maps generated by light detection and ranging), Flood Patrol, and ClimateX. Several backend projects were also used, such as the installation of doppler radars, wind projectors, water level, and landslide sensors.

Communication: With the use of different visualization outputs such as **maps, graphics,** and **illustrations,** NOAH was able to provide appropriate, useful, and timely data to users with *mixed levels of expertise.* This led to strong relationships and support from the government (both data user and data provider agencies), media, communities, and individuals.

NOAH obtained maximum user engagement to *a large user group* by offering various options of communication channels. As the Philippines generally has *high access to internet/mobile internet* and high levels of engagement on social media, NOAH developed a **web platform** (NOAH website), **mobile app** (NOAH, Arko), and **social media** campaigns (Twitter, Facebook) to promote community participation. In addition, NOAH acknowledged the need for accessibility of risk information by communities in vulnerable areas with *limited internet/mobile connectivity,* and used offline channels such as **TV/radio** (radio interviews, video lectures), **handouts, brochures**, and training **videos** (available in English, Filipino, and five other dialects). Similarly, **SMS** was utilized as an extended channel, particularly by local government executives, in disseminating information (generated from NOAH) to their residents.

Impact and Challenges

- In December 2014, a small coastal community, Daram (Samar), survived a deadly storm surge caused by Typhoon Ruby (Hagupit) as a direct result of NOAH. NOAH identified Daram as one of the areas where the forecast storm surges were expected to be highest for that particular typhoon. Internet access allowed the town's disaster management office to monitor updates on rainfall and wind speed from state weather bureau Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA). Storm surge alerts from NOAH were disseminated two days before the typhoon struck. As a result, local government officials were able to provide a series of timely and specific information updates via text messaging to the barangay leaders (local village chiefs) who, in turn, helped prepare and convince residents to evacuate.

- One key challenge was relaying information to areas with **limited internet connectivity**, as well as ensuring that users with **low disaster risk expertise** or a language barrier understand the technical terms used by the scientific community. For this reason, local government officials and disaster management committees translated information to local languages and sent them to village leaders via **text messages.**

Lessons Learned

- The initiatives of UP NOAH have changed the landscape on weather forecasting and disaster risk awareness in the Philippines. Experiences from local government units have shown that technology and close coordination played an essential part in preparing communities for disasters.

- Despite promoting an open and free data ecosystem in the past five years of working with both data user and data provider agencies in the Philippines, it has proven to be difficult to work with some government agencies that have a different view on the functionality of open data. There is now a debate about whether data should be freely open to the public, as well as the extent by which government agencies screen data (prior to releasing it to the public) to ensure its authenticity and legitimacy.

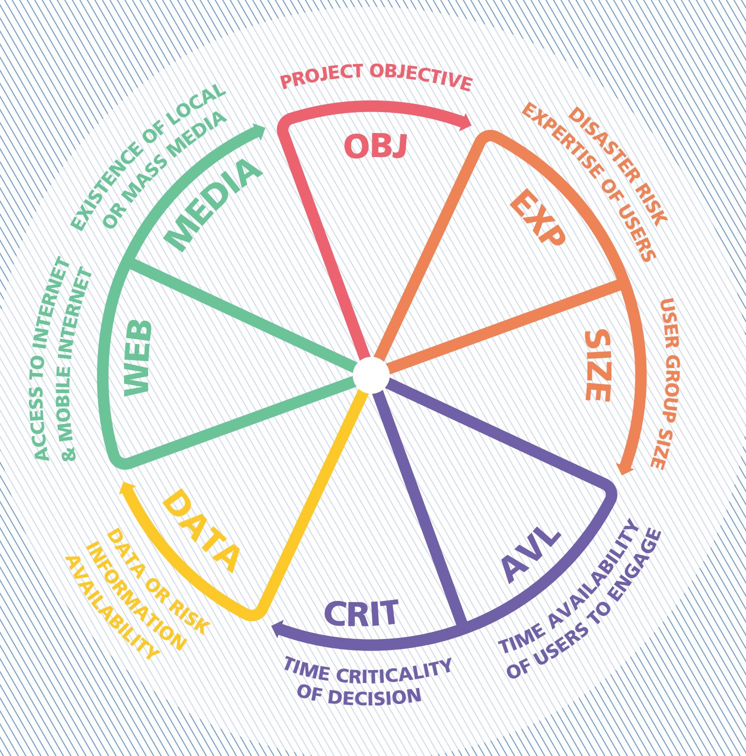
You can learn more about the UP NOAH project from here:
http://center.noah.up.edu.ph

The projects in this chapter reference and demonstrate the six steps, various tactics, and guiding principles of the Design for Impact Framework.

1. UNDERSTANDING THE 10 GUIDING PRINCIPLES

(1) User Centricity
(2) Inclusivity
(3) Shared Understanding
(4) Co-Creation
(5) Open by Default
(6) Information Appropriateness
(7) Channel Suitability
(8) Sustainability
(9) Reflexivity
(10) Dialogue & Debate

2. SCOPING THE DECISION-MAKING CONTEXT



3. COLLABORATION & LEARNING TACTICS

4. DATA & MODELING TACTICS

5. COMMUNICATION TACTICS: CHANNELS & VISUALIZATION

6. ENSURING APPLICATION OF THE 10 GUIDING PRINCIPLES

CHAPTER 5

Project Mapping: Case Studies

Highlights of key tactics employed by fifteen effective projects

FEWS-Risk

An Impact-based Flood Forecasting Framework

◆ ◆ ◆

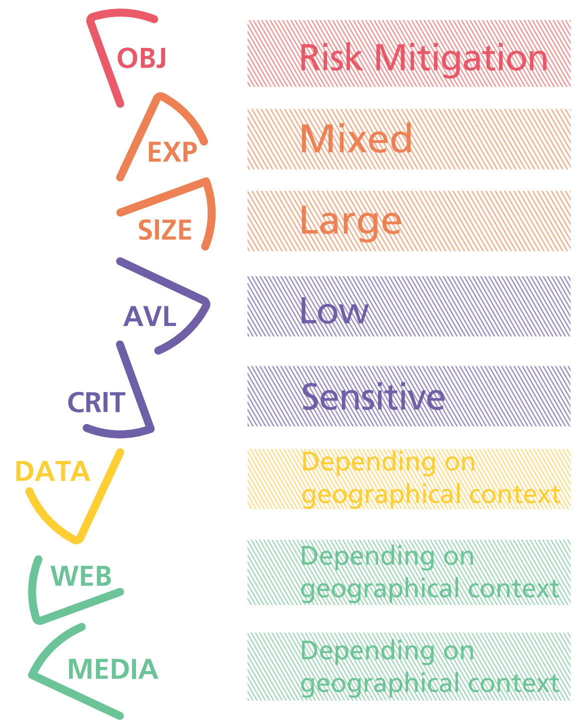
Deltares

◆ ◆ ◆

The Netherlands, United Kingdom, Sri Lanka, Philippines

Context

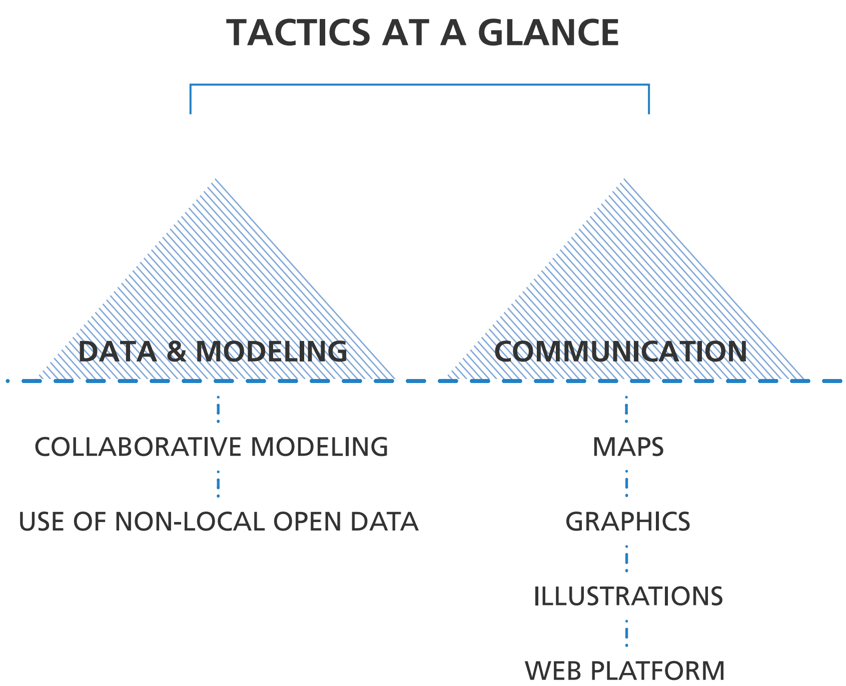
Figure 5.1
Project context elements applicable to FEWS-RISK



FEWS-Risk (Flood Early Warning System-risk) is an operational flood risk early warning framework which generates real-time flood impact information to enable better informed decisions for emergency responders during a flood event. Its aim is to support short-term decision-making, such as informing or evacuating communities at risk, preparation and placement of temporary flood defenses in vulnerable areas, closing of roads, and protection of endangered institutions and critical infrastructures.

FEWS-Risk is designed to provide useful forecasted risk information for emergency responders at both national and local level, depending on local needs and context. At the national level, this information gives an estimate of the severity and impact of the forecasted flood event and allows the government to allocate funds and resources. At the local level, decision makers and first responders, such as the local municipality, police, and firefighters, can install temporary flood defenses, inform communities at risk, and close schools and elderly houses based on the information from FEWS-Risk. While the FEWS-Risk framework mainly aims to reduce flood risk for citizens and livelihoods, it has benefits for other sectors as well. The tool has been utilized in several studies, including in the Netherlands, United Kingdom, Sri Lanka, and the Philippines, across cities and rural areas, and in both inland and coastal zones.

Figure 5.2
Project design tactics used in FEWS-Risk



Highlights

Data & Modeling: The **collaborative design** of the FEWS-Risk tool is flexible and modular. This allows for implementation dependent on user needs. While local data is preferred, a combination of local data and global open data is possible. In the case that local data is *not available* for hydrodynamic analysis and calculation of impacts, global models (bold) or open source data can be employed.

Communication: A **web platform** shows hazard and exposure **maps, graphics,** and **illustrations** that highlight high-risk areas to be evacuated or warned. The visualization of forecasted flood dynamics is helpful for taking non-structural measures in a highly sensitive timeframe, such as informing the elderly, closing roads, ensuring sufficient drinking water, and informing hospitals. One challenge of the tool is presentation of risk information in a way that is culturally and cognitively appropriate and easily understood by first responders and local and national authorities.

You can learn more about the FEWS-Risk project from here:
www.deltares.nl/impact-based-forecasting

FOREWARN

Forecast-based Warning, Analysis, and Response Network

Start Network

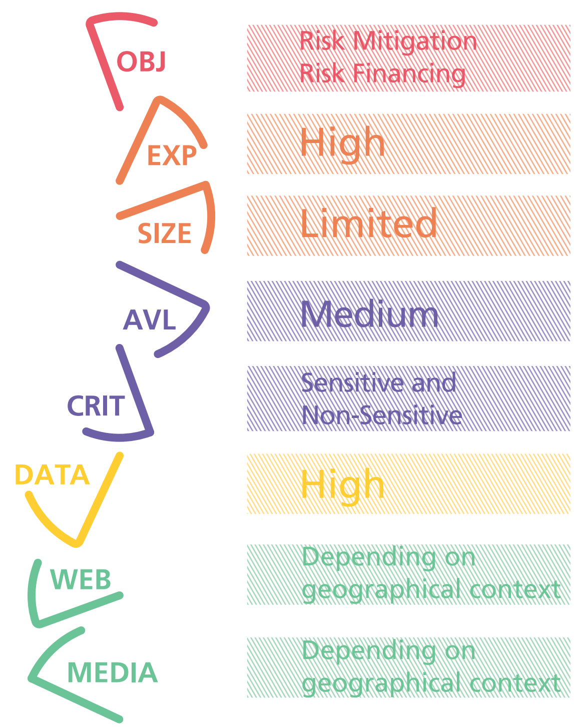
Global

Context

The Forecast-based Warning, Analysis, and Response Network, or FOREWARN, is a multi-agency network established by the Start Network. It was initiated to draw the forecast-based financing, anticipation, and risk-based financing communities together to drive alignment around critical issues and provide practical recommendations for anticipatory Start Fund alerts. FOREWARN consists of scientists from multiple disciplines including hazard modeling, behavioral economics, and humanitarian aid.

The Start Fund provides rapid financing to underfunded small to medium scale crises, spikes in chronic humanitarian crises, and to act in anticipation of impending crises, filling a critical gap in humanitarian financing. FOREWARN provides technical advice for each anticipatory alert for the Start Fund. It is the key mechanism to initiate learning from activated alerts and other risk financing pilots. These are then looped back into technical recommendations for improved project design. FOREWARN is an intentional community building initiative, enabling the exchange of risk information and best practice, as well as the creation of a space for members to contribute to a collective public good.

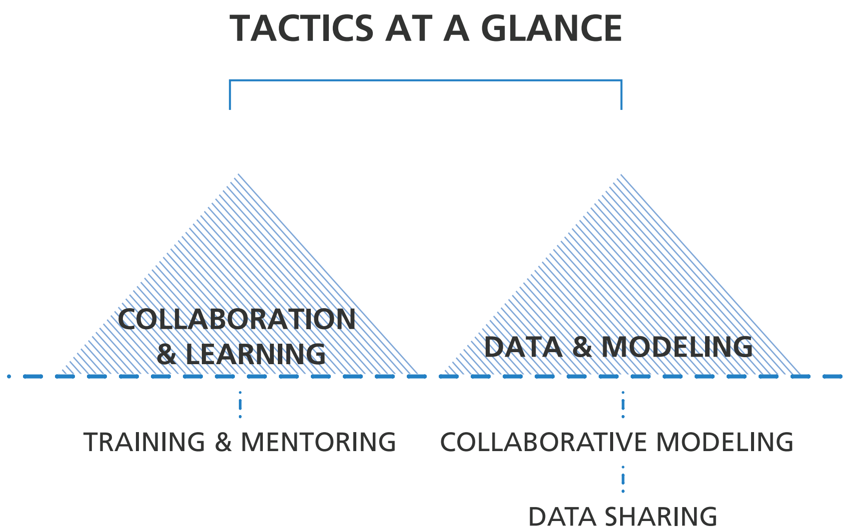
Figure 5.3
Project context elements applicable to FOREWARN



The anticipation window for the Start Fund is the first global forecast-based early action financing mechanism. In the mechanism:

- Decisions are made collectively by the 42 members of the Start Network based on their assessment of the expected emergency.

Figure 4.5
Project design tactics used in FOREWARN



- Independent advice and bespoke forecasts from FOREWARN and other technical experts are used to assess the risk of an emergency and gauge the most effective measures to respond.
- Funding is released within 72 hours of the alert if the Start Fund agrees that intervention is needed.
- Evidence is gathered using a common evaluation framework which compares the effectiveness and assesses the cost-benefit of early action.

Highlights

Collaboration & Learning: The FOREWARN group has a *high disaster risk expertise* and *medium time availability* to engage in this process. These elements allow them to **mentor** other member agencies on anticipatory interventions. In *time-sensitive* decision-making, they provide **advice** and bespoke forecasts to member agencies.

Data & Modeling: The FOREWARN group consists of a *limited number* of experts with *high disaster risk expertise*, such as early warning experts, scientists, academics, risk modelers, responders, and other stakeholders. Experts work **collaboratively** to conduct inter-agency risk analysis and produce bespoke forecasts to aid in anticipatory interventions. Three main methods are: a) informal information sharing through a Skype group; b) survey and discussion to produce recommendations for each anticipation alert to the Start Fund; c) specific analyses of emerging risk situations. FOREWARN also **shares data and models** with other member agencies of the Start Network. This enables faster action to make time-sensitive decisions, such as anticipatory fund allocations.

You can learn more about the FOREWARN project from here: https://startnetwork.org/start-fund/crisis-anticipation-window

GAR Atlas

Global Assessment Report on Disaster Risk Reduction

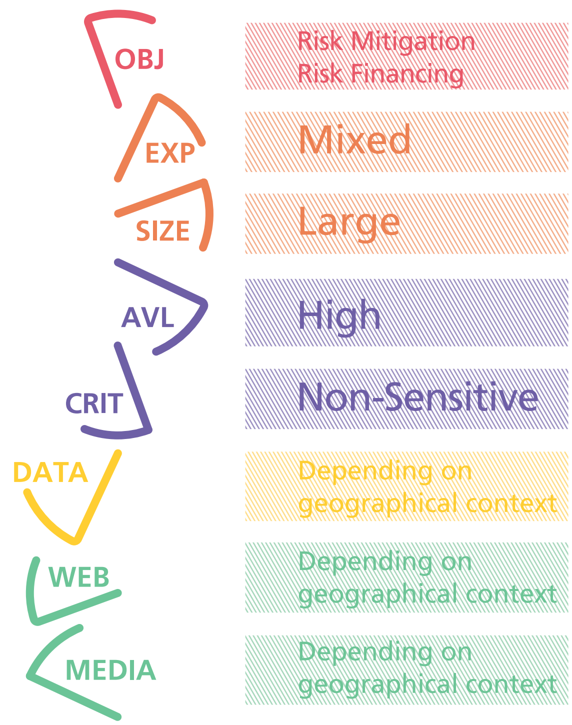
UNISDR

Global

Context

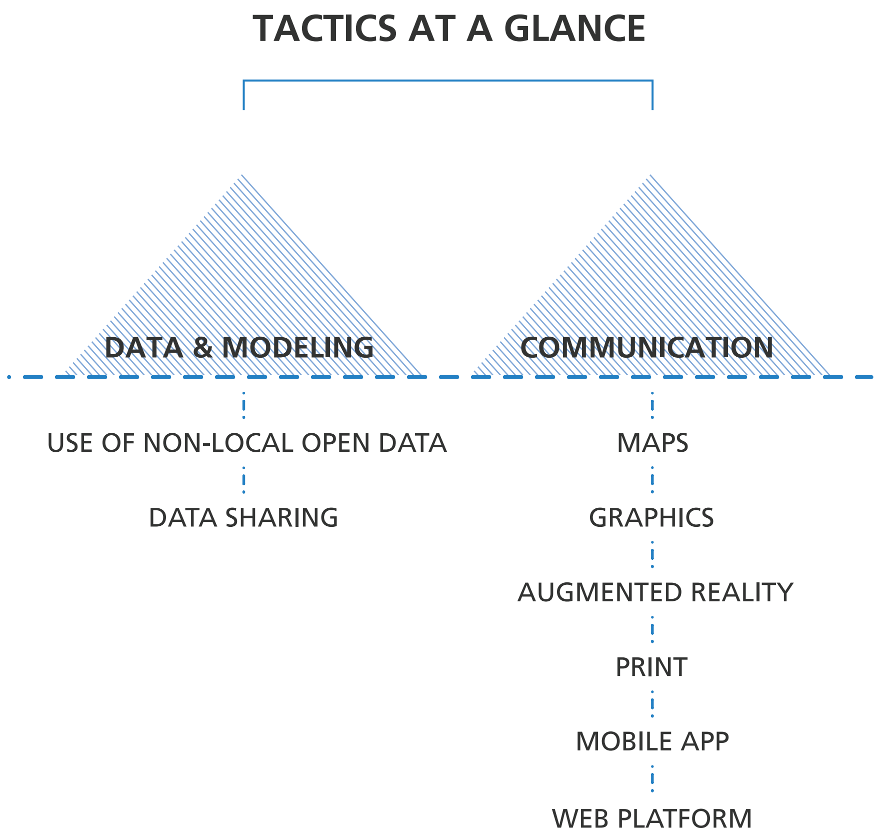
The Global Assessment Report (GAR) on Disaster Risk Reduction Atlas, published in 2017, can estimate the disaster risk associated with different kinds of hazards faced by national economies. It is based on the outputs of a UNISDR-run Global Risk Model (GRM). The GAR Atlas supports larger initiatives, such as the Sendai Framework for Disaster Risk Reduction 2015-2030, the Sustainable Development Goals 2015-2030, and the UN Framework Convention on Climate Change. This model has been developed by a consortium of leading scientific and technical organizations under the coordination of UNISDR. Initial results from the model have already been previewed in GAR13 and GAR15, using robust metrics, such as Average Annual Loss and Probable Maximum Loss.

Figure 5.5
Project context elements applicable to GAR Atlas



The GAR Atlas displays the risk associated with earthquakes, tsunamis, riverine flooding, cyclonic winds, and storm surges. It does this through a global level of observation and a national level of resolution. By using the same methodology, arithmetic, and exposure model to calculate the risk for all these hazards, the GAR Atlas provides globally comparable multi-hazard risk metrics. Users can make comparisions of risk levels between countries and regions and across hazard types. For example, the values associated with earthquake risk in Indonesia and flood risk in Colombia and their relevance to national economies can now be compared, as they have been calculated using the same methodological framework. In this way, the GAR Atlas facilitates a better understanding of the global risk landscape, estimates the order of magnitude of probable losses in each country, and takes into account the risk contributions from different hazards.

Figure 5.6
Project design tactics used in GAR Atlas



Highlights

Data & Modeling: The GAR Atlas presents the output of the GRM to address *risk mitigation* and *financing* objectives through state-of-the-art probabilistic approaches developed by a consortium of leading scientific and technical organisations. The Risk Data Viewer of the GAR Atlas is a spatial data repository that allows **data sharing**. Users can easily download or visualize data from the latest GRM presented in the GAR Atlas. Through the "Disaster Risk Implications," users can visualize diverse financial and social indicators, as well as provide a probabilistic representation of hazard events at different return periods.

Communication: The GAR Atlas was designed for a *large group of users* with *mixed level of disaster risk expertise.* It is intended to be read and explored as an online version via a **mobile application**, downloadable pdf format from the UNISDR **website**, and a book **print** format with **augmented reality** icons. By visualizing risk in cartographic form, the GAR Atlas is able to effectively communicate the overall scale, distribution, and patterns of disaster risk through a global level of observation and a national level of resolution.

You can learn more about the GAR Atlas project from here:
https://www.unisdr.org/we/inform/publications/53086

I-REACT

Improving Resilience to Emergencies through Advanced Cyber Technologies

Terranea UG

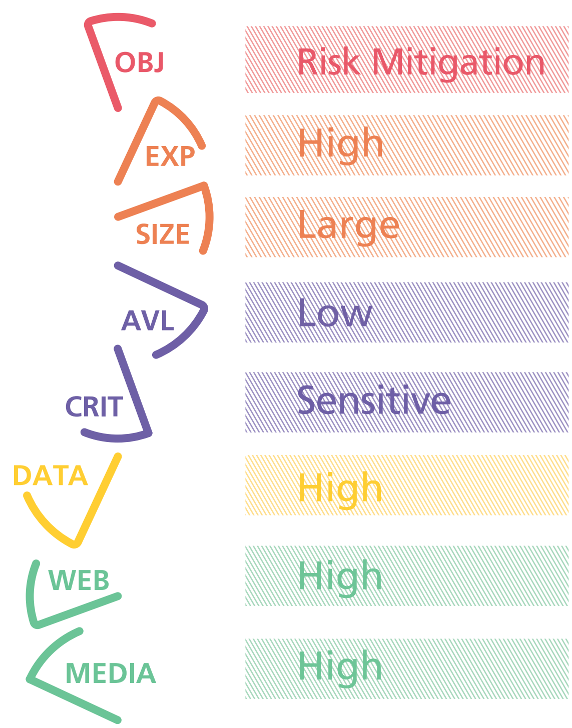
Europe

Context

The increasing frequency and impact of emergency events caused by natural hazards are exacerbated by climate change. In order to reduce the human and economic impact of such emergencies, there is a need to have a more comprehensive emergency management system that can enable the utilization of multiple data sources and citizen engagement.

The I-REACT (Improving Resilience to Emergencies through Advanced Cyber Technologies) project was born to tackle this need. I-REACT aims to create a platform that can provide greater emergency anticipation through accurate forecasting, crowdsourced reporting, and better emergency management. These strategies can integrate real-time data to improve the situational assessment and predict hazard evolution.

Figure 5.7
Project context elements applicable to I-REACT

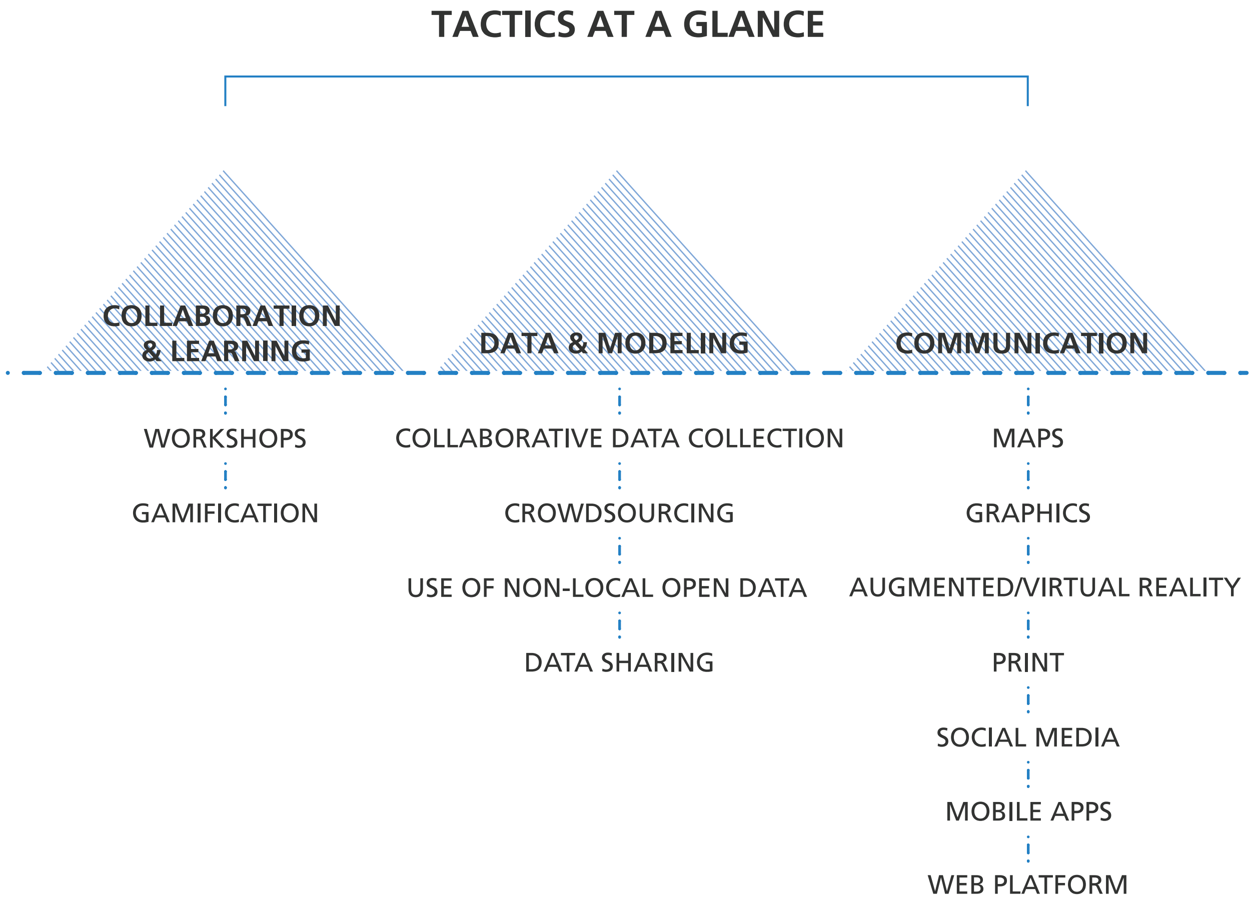


Highlights

Collaboration & Learning: Workshops and field demonstrations promoted knowledge co-creation and sharing among emergency responders, international advisors, and system developers. In addition, the project applied **gamification** techniques to actively engage citizens, crowdsource data collection, and validate tasks through a dedicated mobile application.

Data & Modeling: Collaborative data collection integrated data from multiple sources on a single European-wide platform. Information from European monitoring systems, earth observations,

Figure 5.8
Project design tactics used in I-REACT



satellite and risk maps, historical information, and weather forecasts was combined with real-time crowdsourced reports.

Crowdsourcing engages citizens in collaborative data collection and validation via the I-REACT mobile application. Additionally, a decision-support system (DSS) enables **data sharing** and supports policy makers over the entire emergency management cycle.

Communication: I-REACT uses a **mobile app** for cross-platform incidence reporting. Advanced technologies provide real-time emergency information, such as **drones** for detailed mapping, **wearables** for improved positioning, and **augmented reality** glasses for improved information reporting and visualization.

The **web platform** provides several **printable** brochures, videos, technical **illustrations, maps, infographics,** and news articles. **Social media** platforms such as Twitter are used to promote awareness of disaster risk and build a community of digital volunteers. Using two parallel social media accounts (one devoted to technical information and one of disaster-related information) helps to increase decision makers' disaster risk expertise. Social media analytics detect emergency events, extract information, and classify contents.

You can learn more about the I-REACT project from here:
http://www.i-react.eu

InfoAmazonia

Journalists and Citizen Network

O Eco and Internews

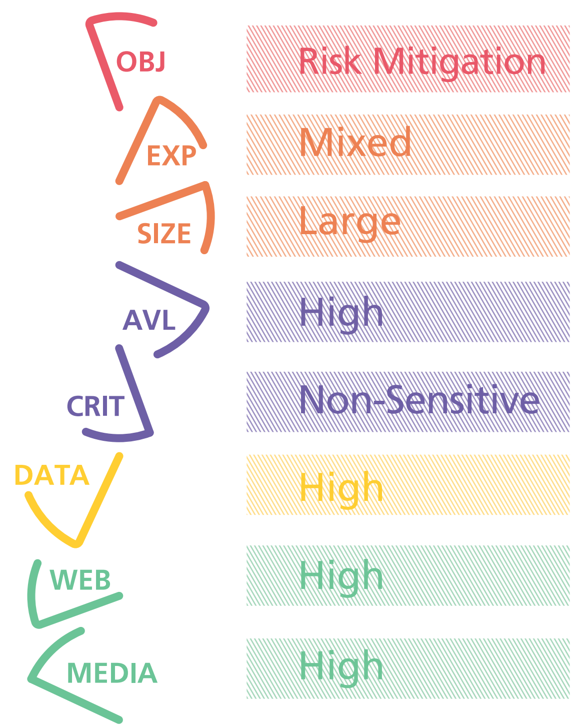
Amazon Region

Context

The Amazon rainforest is one of the most pristine and diverse ecosystems in the world, but it is increasingly facing environmental and developmental challenges, such as drought and deforestation. The Latin American public has little information about these challenges, since mainstream media has not conveyed the extent of the threat to the area's survival.

The InfoAmazonia project began as a partnership between O Eco and Internews with support from the Climate and Development Knowledge Network and Development Seed. It encourages journalists across the region to use open data in ways that would enrich and contextualize news stories to improve public understanding of the threats facing the rainforest. InfoAmazonia is an interactive online data sharing platform that provides timely updates delivered by a network or organizations and journalists to monitor the endangered nine-country Amazon region.

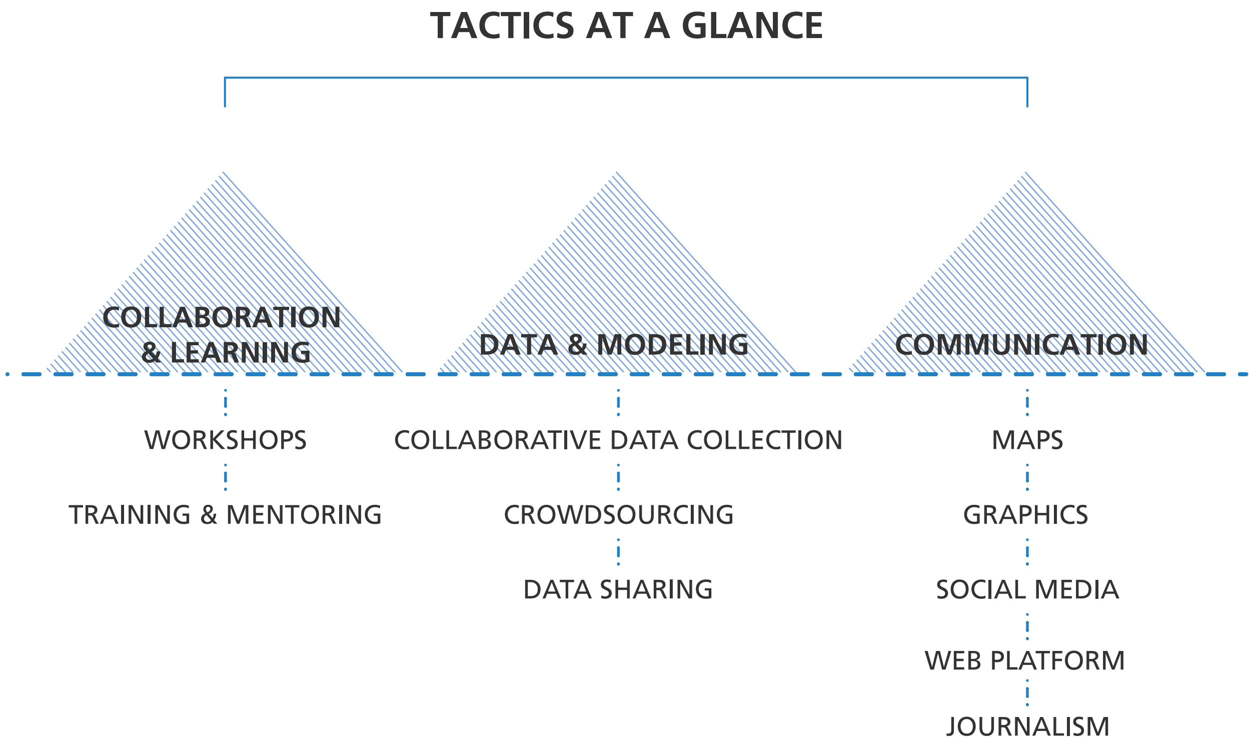
Figure 5.9
Project context elements applicable to InfoAmazonia



Highlights

Collaboration & Learning: Workshops and **training** sessions were held for journalists with *mixed disaster expertise* on how to create, share, and use digital maps for reporting. Additional training workshops have also been held for climate and development experts, citizen reporters, and other knowledge brokers.

Figure 5.10
Project design tactics used in InfoAmazonia



Data & Modeling: InfoAmazonia uses MapBox and Google Earth software to visualize and interpret trends on environmental issues. The visuals are built using data that is continuously and **collaboratively updated** from a wide range of stakeholders.

A large amount of data had been collected about the Amazon region by institutes and NGOs, but it had not been made available to the public. In order to obtain data needed to create maps, the InfoAmazonia team have collaborated and, at times, negotiated with government, civil society, and open-source organizations across the region to utilize and **share data** on the platform.

Communication: InfoAmazonia launched a **website** that offers users open access to a wealth of data, such as satellite images, database informaton, journalist blogs, and global news sites. It allows the user to locate data on **maps** to inform and enable dialogue about climate change and its related impacts. These maps can be customized and embedded into other websites and blogs. **Social media** provides reliable, up-to-date, and accessible data to *large user groups.* Other features of the platform include interactive **photo** galleries and **video** mashups for a unique storytelling experience.

You can learn more about the InfoAmazonia project from here: https://infoamazonia.org

Kaikoura GIS Viewer

Kaikoura Earthquake Rapid Disaster Mapping

Tonkin & Taylor

Huruni-Kaikoura, New Zealand

Context

On November 14, 2016, a complex sequence of 21 fault ruptures with a combined magnitude of 7.8 Mw rocked Hurunui – Kaikoura, New Zealand. Slips caused by the massive earthquake blocked arterial roads and severed rail links. Changes to the sea shore and seabed rendered the town's port-its economic heart - commercially inoperable. Kaikoura township, home to approximately 3,700 people and its wide rural catchment scattered with many farms and remote communities, was only accessible by air. Lying 250 km to the north of Kaikoura, the township of Wellington sustained significant damage to mid-rise buildings and its port. Fortunately, there were no fatalities.

The Hurunui – Kaikoura event highlighted the immense value of international cooperation following natural disasters. This is important not only at a local level but in terms of international research and understanding. Tonkin+Taylor (T+T) created a single spatial online viewer - the Kaikoura GIS Viewer - to assist all agencies involved in response and recovery. This viewer incorporated liquefaction, landslide and fault rupture maps, and shaking maps.

Figure 5.11
Project context elements applicable to Kaikoura GIS Viewer

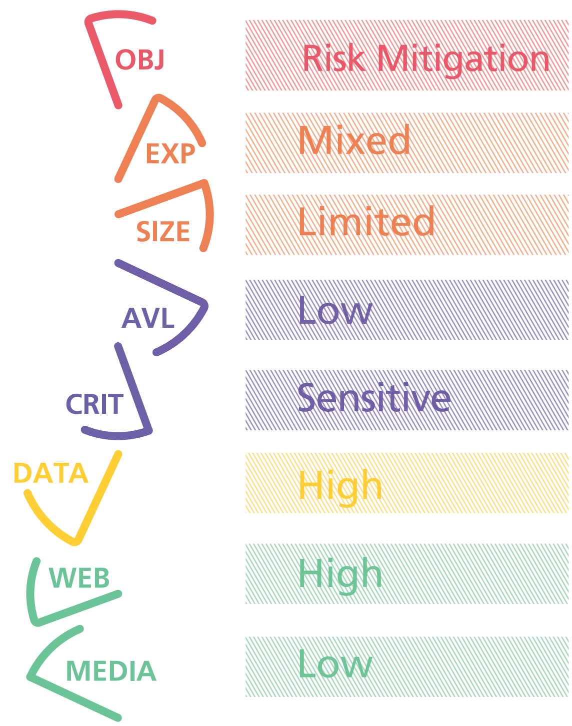
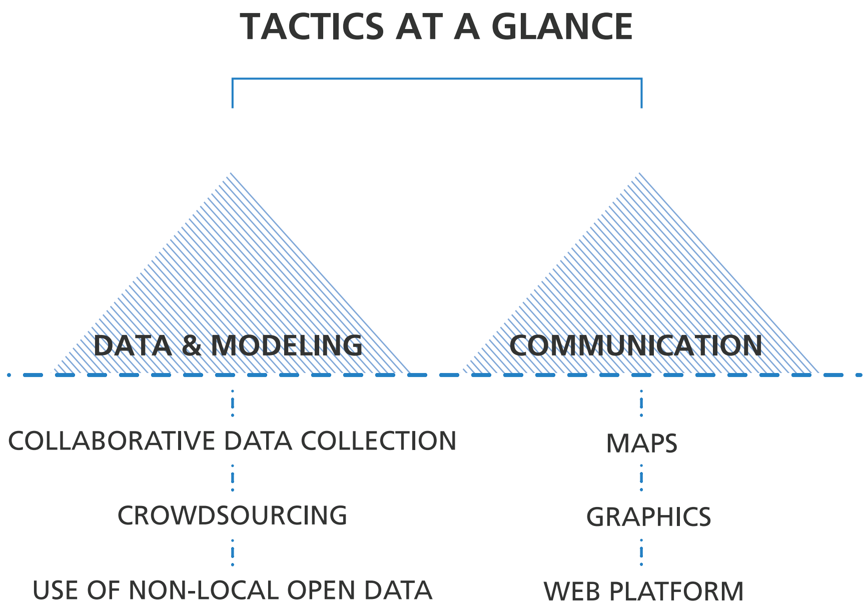


Figure 5.12
Project tactics used in Kaikoura GIS Viewer



Highlights

Data & Modeling: Tonkin+Taylor used a **collaborative data collection** approach, compiling geospatial data and reconnaissance surveys from various sources, which were regularly updated as more information became available. The building portfolio provided an indication of the number of buildings likely to be affected by different levels of shaking, liquefaction, landslides, and fault rupture. This infrastructure data went on to inform insurance assessments and responses. The public was encouraged to add their own photos and observations as **crowdsourced** data. This resulted in constantly evolving datasets, offering improved accuracy and best possible outcomes for all involved.

T+T also used **non-local data.** With the help of the Chinese Government, they obtained satellite imagery data (at different times) on affected areas obscured by cloud cover after the earthquake to augment pre-existing satellite images. This enabled T+T to provide a comprehensive report to the Earthquake Commission within 17 hours of the earthquake.

Communication: The viewer's "click and see" interactive **web-based maps**, geocoded **photos**, and damage **reports** allowed the Earthquake Commission, the Ministry of Civil Defence and Emergency Management, engineers, scientists, New Zealand Transport Agency, KiwiRail, and other first responders to effectively triage their efforts with limited time.

You can learn more about the Kaikoura GIS Viewer project from here:
http://www.tonkintaylor.co.nz/news/2017/6/kaikoura-earthquake-rapid-disaster-mapping
and
https://epm.projectorbit.com/SitePages/maps/Viewer.html

MASDAP

Malawi Spatial Data Platform

Government of Malawi and GFDRR

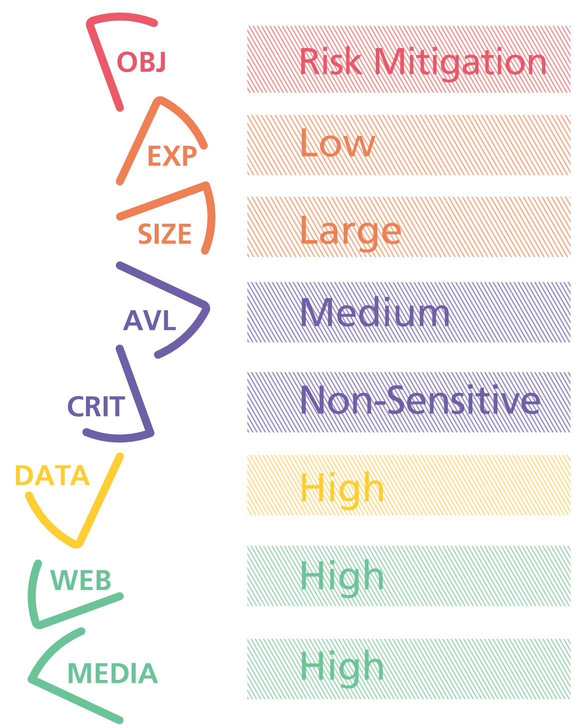
Malawi

Context

Scarcity of information after a disaster event may lead to further errors and damages, particularly in time-sensitive scenarios. Scrambling for context-relevant data on areas and assets affected has been a common problem in Malawi for several years.

Through the collaborative partnership between the Government of Malawi and GFDRR, a spatial data repository – Malawi Spatial Data Platform (MASDAP) GeoNode – was created to promote data sharing across government agencies and improve resilience by developing a culture of data preparedness. MASDAP was initially developed to allow partners in a flood risk assessment process to collaboratively share data. Following its success, it has now been used for other kinds of data. MASDAP is a free, open source, and geo-spatial data sharing platform managed by the National Spatial Data Center in collaboration with the National Statistics Office and other technical ministries.

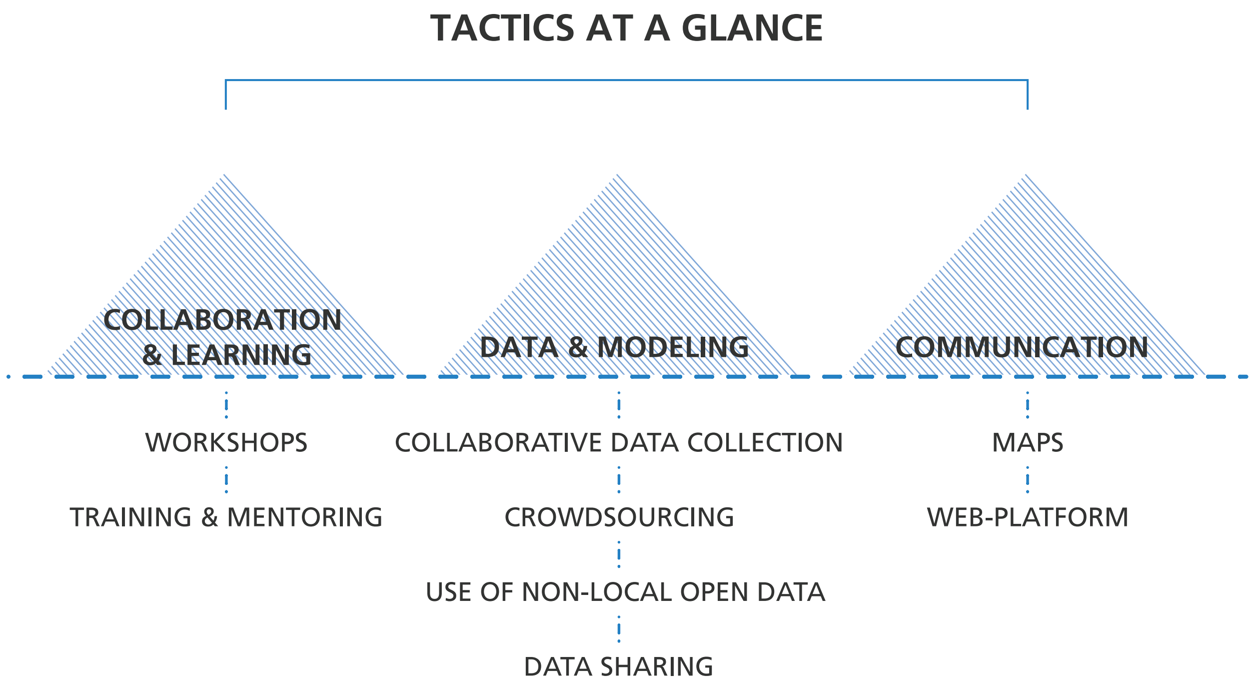
Figure 5.13
Project context elements applicable to MASDAP



Highlights

Collaboration & Learning: The collaboration between the government and villages utilized **workshops** and **training** as an optimal medium for engaging the public in a *non-time sensitive* decision-making context with *high risk data availability*. Participatory mapping exercises and a 6-month internship with an NGO has enabled the collection of exposure data and other geospatial information *(i.e.*, flood outlines, elevation data, soil types, land use etc.). MASDAP built a community of mappers trained on InaSAFE for

Figure 5.14
Project tactics used in MASDAP



disaster risk reduction and recovery. Other trainings include the ongoing Post Disaster Needs Assessment (PDNA) and preparedness programs.

Data & Modeling: GFDRR established the Malawi Spatial Data Working Group who have met regularly to update the platform, discuss the availability of data, and highlight training needs. This group also looked to increase **data sharing** across government ministries and other organizations to catalyze collaboration and inclusive decision-making.

Communication: The online **web platform** utilized **maps** to engage government officials with *high internet and mobile connectivity***.** By leveraging and customizing existing tools, such as the InaSAFE application to Malawi, the project was able to produce powerful visualization tools. These were used to advance users' understanding of risk, to better engage communities, and to ensure that emergency first responders and other technical agency groups had access to information before, during, or after a disaster event.

You can learn more about the MASDAP project from here: https://opendri.org/project/malawi

Resilience.io

Enabling Transformational Change

The Ecological Sequestration Trust

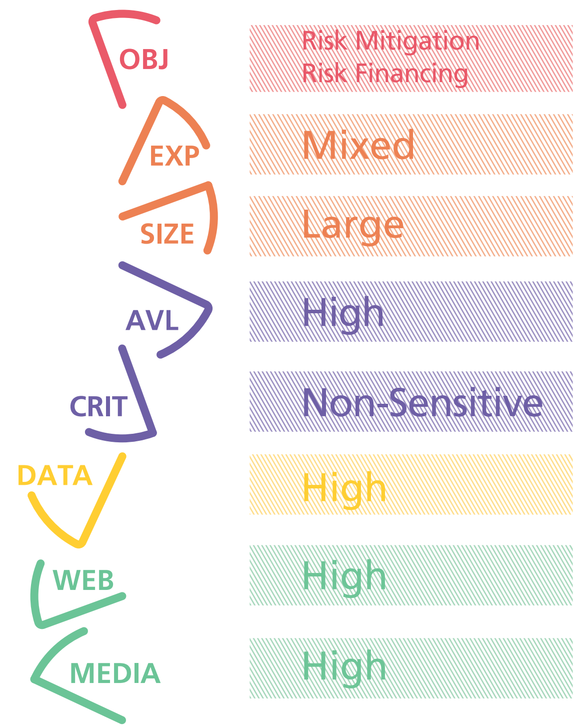
U.K., Africa

Context

Sustainable city development is particularly important for developing countries where the rapid pace of urbanization presents huge challenges to city-level planning. Simulation and optimization models can help understand socio-technical systems by providing insights on current and future demands under different scenarios. Resilience.io was designed to support regional investment and performance-based procurement in sustainable city-regions.

Resilience.io is an open source computer-based platform which is built on an agent-based, socio-economic simulation. It includes an integrated view of land use, agent activity, resource flows, and infrastructure networks. A systems approach was used to understand the interconnectivity of relationships between places, people, and the environment. Systems include transport, housing, energy, water, waste, food and human health, and the associated chemical and physical changes that function within a city-region over time.

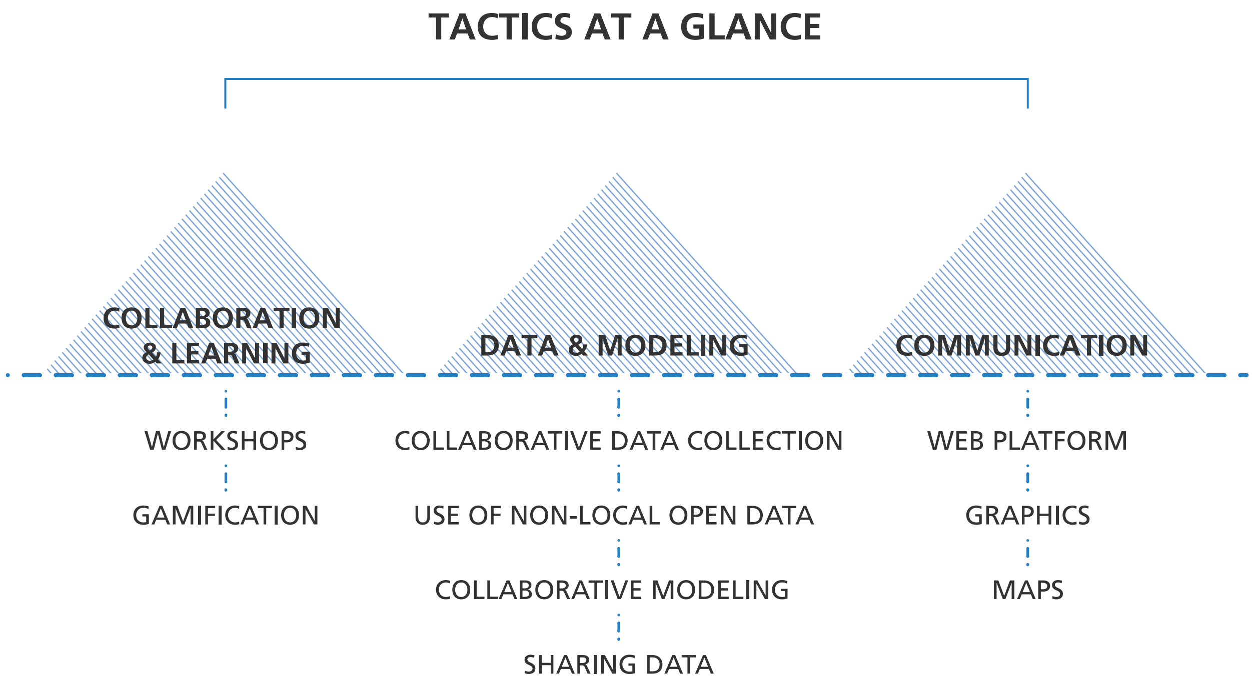
Figure 5.15
Project context elements applicable to Resilience.io



Highlights

Collaboration & Learning: Collaborative 'laboratory' workshops (collaboratories) were held to engage users with *mixed risk expertise* from across sectors and from communities in India, Mongolia, China, Ghana, Beirut, and the U.K. Collaboratories helped identify local priorities for resilient developments through a decision-making culture that encompasses more holistic information. A gaming version of resilience.io is being produced to allow school children and students to engage in local decision-making. A global learning and research network platform was developed to exchange best practices with a global community of users.

Figure 5.16
Project design tactics used in Resilience.io



Data & Modeling: Resilience.io uses **collaborative data collection** to collate available data from different local and **non-local data sources,** including earth observation satellites, government, and the private sector. In addition, communities contribute data, information, and knowledge to build trust and ensure existing culture and heritage is embraced.

Using a **collaborative modeling** approach allowed communities to inform the design of the local model of both the local economy and its critical supporting ecosystems.

Communication: Resilience.io was designed as an open source **computer/web-based platform** for users with *high access to internet/mobile internet.* **3D visualizations, maps**, and **graphics** were used to create and see the results of projects through scenario testing. Visualized results supported future investment and planning.

Sector-specific ''cockpits" of the city-region model combine visualization with intuitive user interfaces for quick and effective access to the platform. This allows users can explore how their area is connected to, may impact, or be impacted by other parts of the city-region.

You can learn more about the Resilience.io project from here:
https://resilience.io
and
https://resiliencebrokers.org

Resilient Hospitals

Using Climate Data for Better Healthcare Planning

Four Twenty Seven Climate Solutions

USA

Context

Hospitals play a critical role in engaging communities to build resilience and respond to patient needs during and after extreme weather events. Extreme weather events can cause power outages or flooding that can threaten a hospital's ability to stay open, driving up the number of patients that can overwhelm local emergency rooms. However, most hospitals are not yet able to integrate local climate change projections in their risk management and planning processes.

Working with a coalition of healthcare networks in the USA and the non-profit Healthcare without Harm, Four Twenty Seven developed a user-friendly dashboard for hospital leadership. The Resilient Hospitals Dashboard is an interactive, private dashboard that enables healthcare networks to identify hotspots, key drivers of risk, and the specific impacts faced by each of their hospitals. The dashboard provides local climate projections so that hospitals can better understand and assess the risks posed by climate change in their region and on their operations. It also contains sophisticated analytics to help hospitals understand the impact of climate change on their patients and health risk profile.

Figure 5.17
Project context elements applicable to Resilient Hospitals

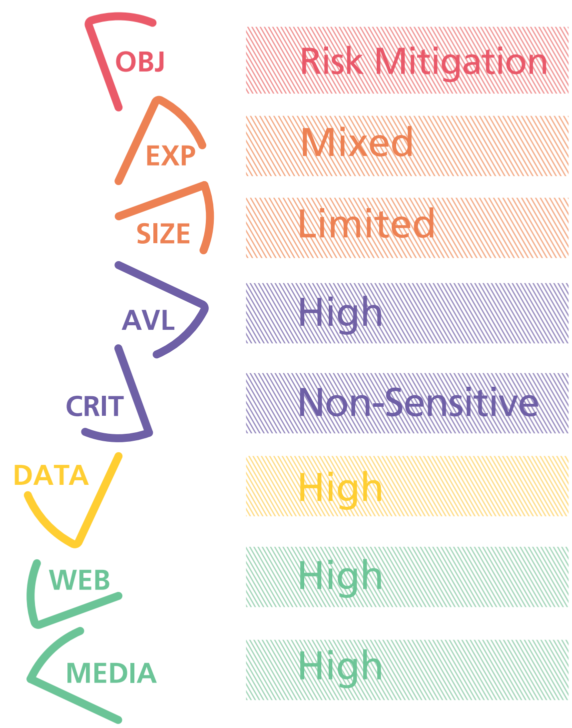
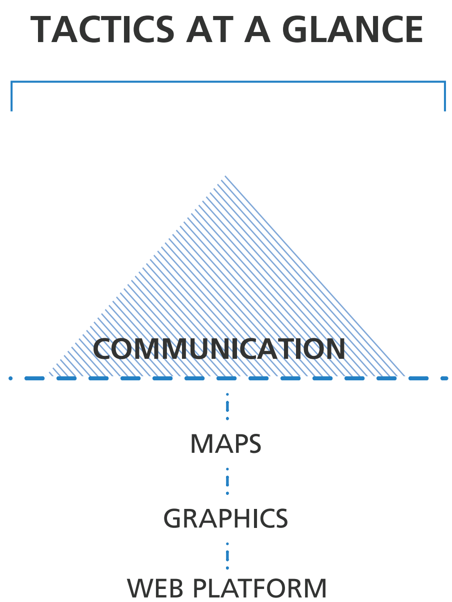


Figure 5.18
Project design tactics used in Resilient Hospitals



Highlights

Communication: The Resilient Hospitals dashboard provides: (1) local climate data and relevant patient data, (2) intelligible visuals, and (3) comparability across different spatial areas and risk types. Each dashboard presented through a **web interface** includes local climate projections that show changes in average and extreme weather conditions. It identifies the patients and geographies that are most exposed to heat hazards based on these projections. Finally, it provides a high-level assessment of critical operational systems by examining extreme weather vulnerability and readiness. Hospitals using this dashboard are able to integrate climate risk analytics into their hazard and vulnerability assessments, strategic communications, and long-term strategic planning.

The dashboard has also helped identify the populations most vulnerable to future changes in extreme heat and humidity conditions. Providing these analytics through **maps** at the zip code level is both a visually powerful and a practical way to communicate risks to clinical staff and patients who may have lower risk expertise.

You can learn more about the Resilient Hospitals project from here:
http://427mt.com/2016/02/10/resilient-hospitals-dashboard

RiskScape

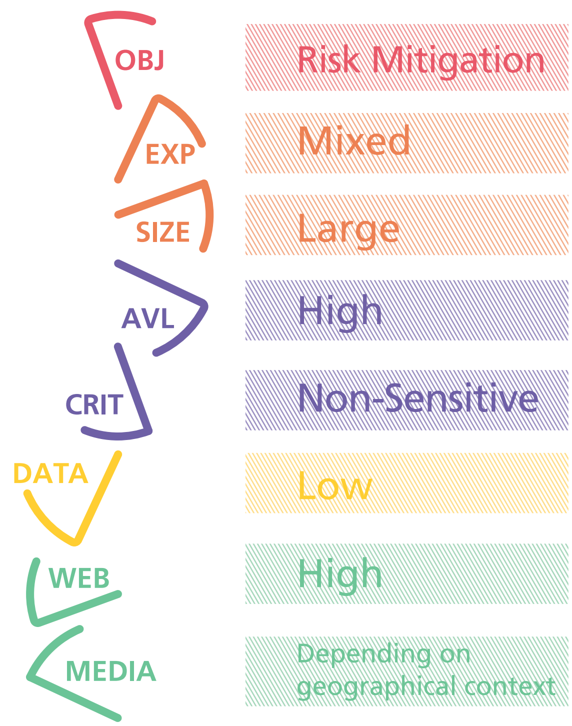
Estimated impacts from natural hazards

GNS Science and National Institute of Water and Atmospheric Research

New Zealand

Context

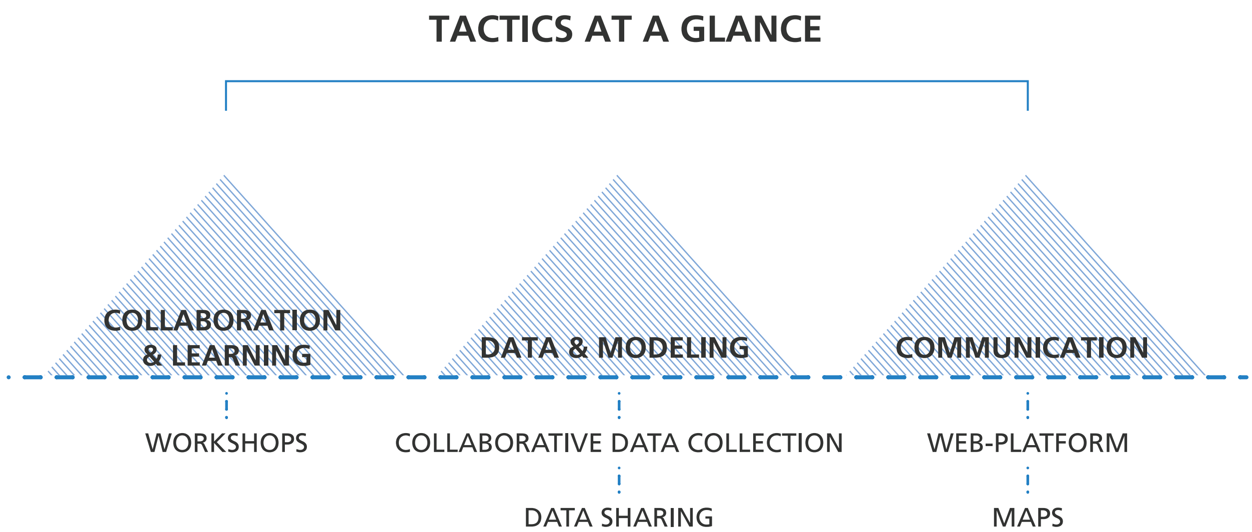
Figure 5.19
Project context elements applicable to RiskScape



Effective risk management decision-making requires tools and a decision support system that facilitates analysis and comparison of risks from different hazards. RiskScape is a multi-hazard loss modeling tool developed by GNS Science and the National Institute of Water and Atmospheric Research that can be used for a range of purposes including land-use planning, emergency management, contingency planning, cost-benefit analysis, and hazard research. It is intended for a wide user base such as infrastructure agencies, Civil Defense and Emergency Management, local government, and central government.

RiskScape is an easy-to-use decision support tool that combines exposure and vulnerabilities with a range of natural hazards. It draws on decades of natural hazards research to model estimates of damages, casualties, disruption, human displacement, human susceptibility and losses, number of people affected, and reinstatement cost for a region. RiskScape has been designed for New Zealand conditions; however, it can be adapted and applied globally, as is being done for Indonesia and Pacific Island nations.
It was most recently applied in the M7.8 Kaikoura earthquake (November 2016), where it provided a rapid impact assessment for building damages in Lower Hutt City, Wellington and a cost-benefit analysis for building retrofitting in Auckland.

Figure 5.20
Project design tactics used in RiskScape



Highlights

Collaboration & Learning: Workshops and **trainings** were conducted in New Zealand, Indonesia, and Pacific Island nations to introduce the risk modeling tool. The Risk-Scape team worked with universities and government agencies to identify risk data needs, potential barriers to uptake, and development of future policies.

Data & Modeling: The RiskScape team used a **collaborative data collection** approach to build a nationwide asset database using a mixture of satellite data, model outputs, and ground-truthing, which was shared with users. University students helped collect missing asset data and groundtruth models. The use of tailored tablet-based apps ensured data collection was rapid and as accurate as possible. Fragility models were developed using international data, including impact assessments in post-disaster contexts.

Communication: The visualization of results from the RiskScape tool includes **risk and exposure maps** through a **web platform.** These have been used to help identify areas likely to be impacted by hazards, find safe evacuation locations, and investigate the effect of changing building standards and mitigation plans to reduce the risk of natural hazards. It can also provide a rapid impact assess-ment for coordinating response efforts.

You can learn more about the RiskScape project from here:
https://www.riskscape.org.nz

ROADAPT

Roads for today, adapted for tomorrow

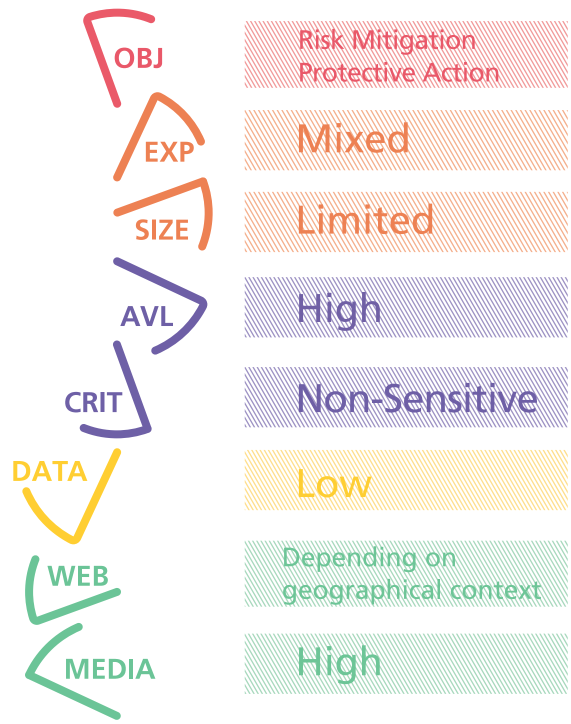
Deltares, Egis and The Royal Netherlands Meteorological Institute

The Netherlands, Turkey, Portugal, Paraguay

Context

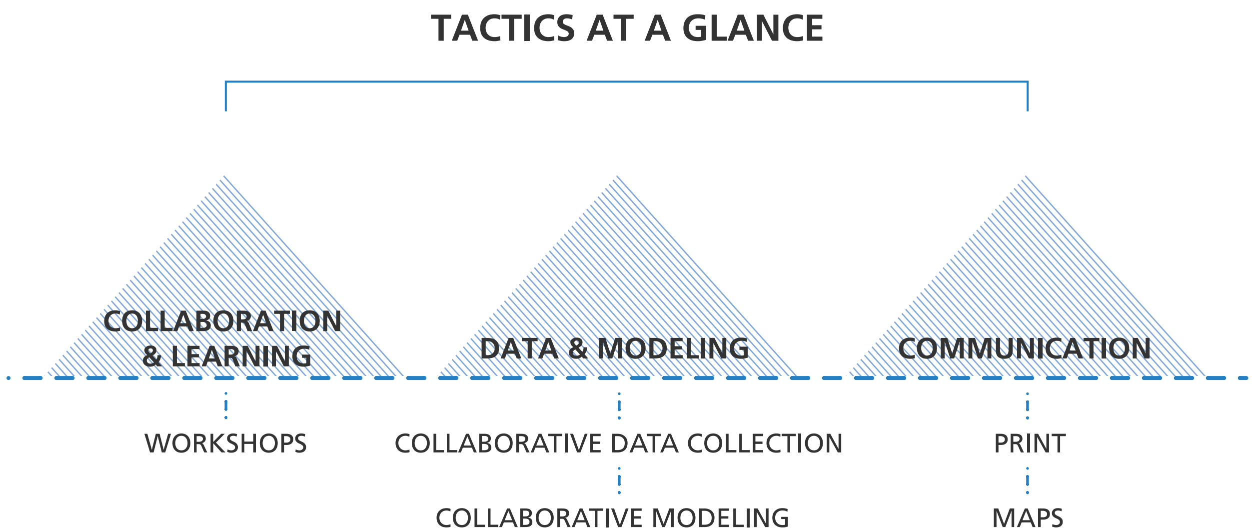
Extreme weather is an important factor in the reliability and safety of road networks. The ROADAPT project developed by Deltares in collaboration with the Swedish Geotechnical Institute, Egis, and The Royal Netherlands Meteorological Institute has been designed to guide transport planning for climate change adaptation. ROADAPT provides guidelines, methodologies, and tools to enable tailored and consistent climate data information to be communicated to road authorities. It adopted a risk-based approach using the RIMAROCC (Risk Management for Roads in a Changing Climate) framework to identify climate change-related risks for roads. This involves conducting a vulnerability assessment and socio-economic impact analysis and developing an adaptation action plan.

Figure 5.21
Project context elements applicable to ROADAPT



It is used by road authorities as well as a broad range of professionals including road engineers, asset managers, climate change adaptation professionals, and project managers. The methodology is best applicable on a district-or-sub-state level, but it can also be used for project-level decision-making. Although the guidelines are focused on roads, the topics and methodology are applicable to other infrastructural assets, such as railways or electricity networks. ROADAPT has been applied on a 60-kilometer road stretch in the south of the Netherlands and is currently being applied to the development of an industrial zone in Istanbul and a road network in Paraguay.

Figure 5.22
Project tactics used in ROADAPT



Highlights

Collaboration & Learning: Stakeholders were brought together in a round-table **workshop,** where they provided input on risk identification, and assessment of consequences, and likelihood and vulnerability. Subsequently, the information gathered and analyzed to produce risk matrices, vulnerability maps, and adaptation strategies.

Data & Modeling: The ROADAPT project used a **collaborative modeling** approach based on inputs from experienced staff of the road authority and other relevant stakeholders, such as water boards and municipalities.

Utilizing existing data, knowledge, and experiences of decision makers, **collaborative data collection** (via the quickscan method) was chosen to develop a structured ten-step approach that addresses the needs for selecting an adaptation strategy.

Communication: The output of ROADAPT was a guideline **report/handout**. The results were visualized through vulnerability **maps** which can be combined with detailed climate change projections.

You can learn more about the ROADAPT project from here:
http://www.rse-egis.fr/en/solution_egis/roadapt-2

SESAME (Agro Advisory)

Specialized Expert System for Agro-Meteorological Early Warning

UNDP

Myanmar

Context

The agriculture, water resource, livestock, and other related sectors within Myanmar's Dry Zone are highly susceptible to multiple hazards that could impact the loss of livelihoods and hurt the national economy. SESAME (Specialized Expert System for Agro-Meteorological Early Warning) is an agricultural advisory system developed to address the demand to improve access to information for farmers. It was built to provide early warning, advisory, and weather forecasts for farmers for effective crop management and long-term planning. Forecasts for precipitation, temperature, humidity, and evapotranspiration are integrated with crop information to generate advisories of risk information for farmers.

Figure 5.23
Project context elements applicable to SESAME

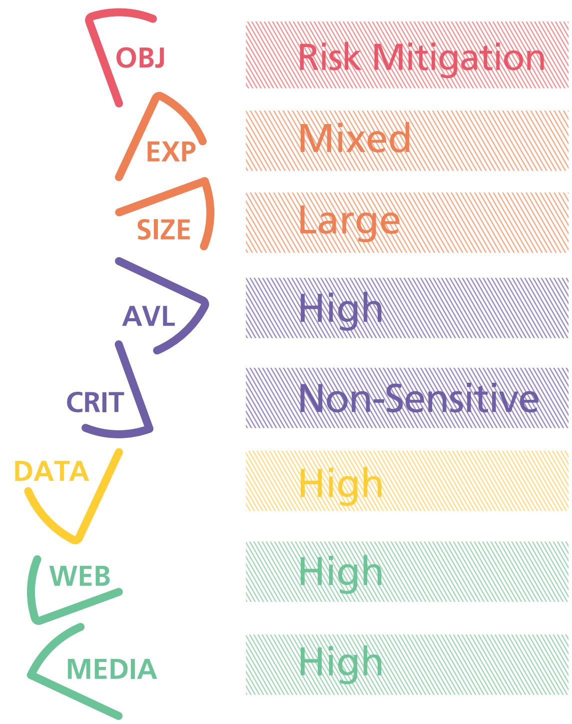
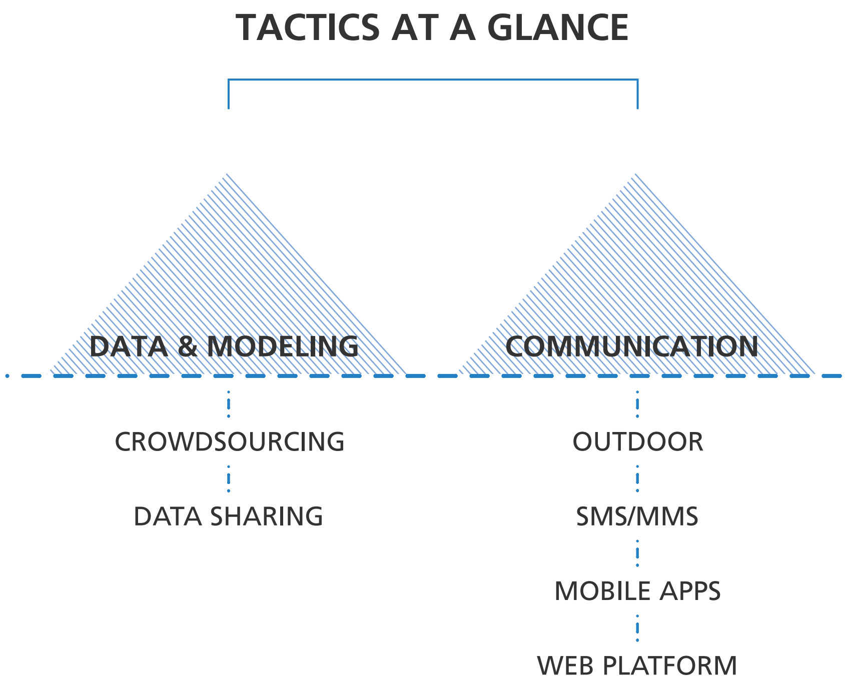


Figure 5.24
Project design tactics used in SESAME



Highlights

Data & Modeling: The tool was designed as a **data sharing platform** to respond to farmer requirements on information resource management and risk planning. Capitalizing on local knowledge and *regular time availability* from farmers, extension workers, and researchers, a feedback system was developed. Data collected from the agricultural department (Department of Meteorology and Hydrology, NMHS, and RIMES) was enhanced with user-generated and **crowdsourced** information from the farmers. This helped produce location-specific agro-advisories across multiple timescales, informed by local cropping practices.

Communication: The system provided crop-specific advisories for extreme weather and climate conditions based on weather forecasts, crop information, local soil, and other geographic characteristics. The information was communicated via a **web platform** and **mobile app** to agriculture extension workers, who in turn discussed the information directly with farmers. **Notice boards** and **SMS** were used as feedback mechanisms.

You can learn more about the SESAME project from here: http://sesame-dmh.rimes.int/index.php/login/login_form

SMS Lapli

"SMS Rain" in Haitian creole

GFDRR, Government of Haiti, and Climate Investment Fund

Haiti

Context

Tropical cyclone is the most prominent hazard that affects Haiti and causes severe economic damages to its agricultural sector. Much of the disaster risk data in Haiti is only available in hard copy, distributed in PDF format (which frequently results in errors), and suffers from poor record-keeping. This makes it difficult for government agencies to analyze data within a time frame that will allow them to provide rapid and effective decision-making. In response, the Haitian Government, in collaboration with GFDRR, and Climate Investment Funds' Pilot Program for Climate Resilience, aimed to strengthen their capacity to deliver reliable weather information to protect lives and support the needs of farmers across the country.

Figure 5.25
Project context elements applicable to SMS Lapli

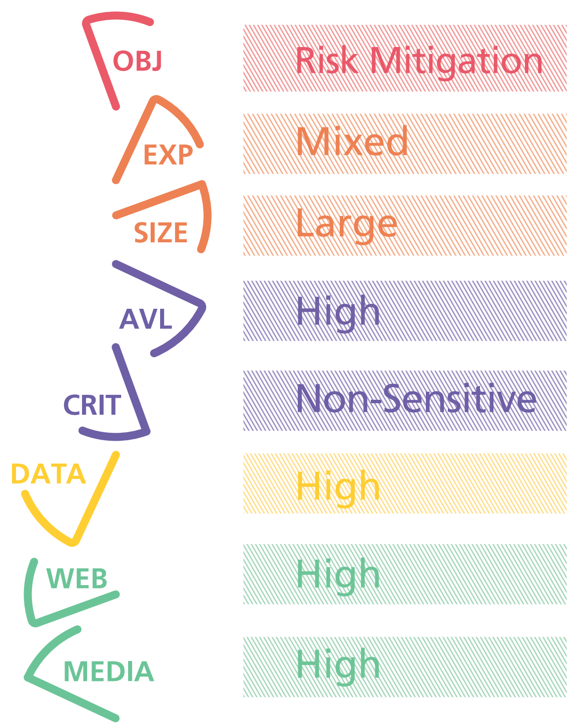
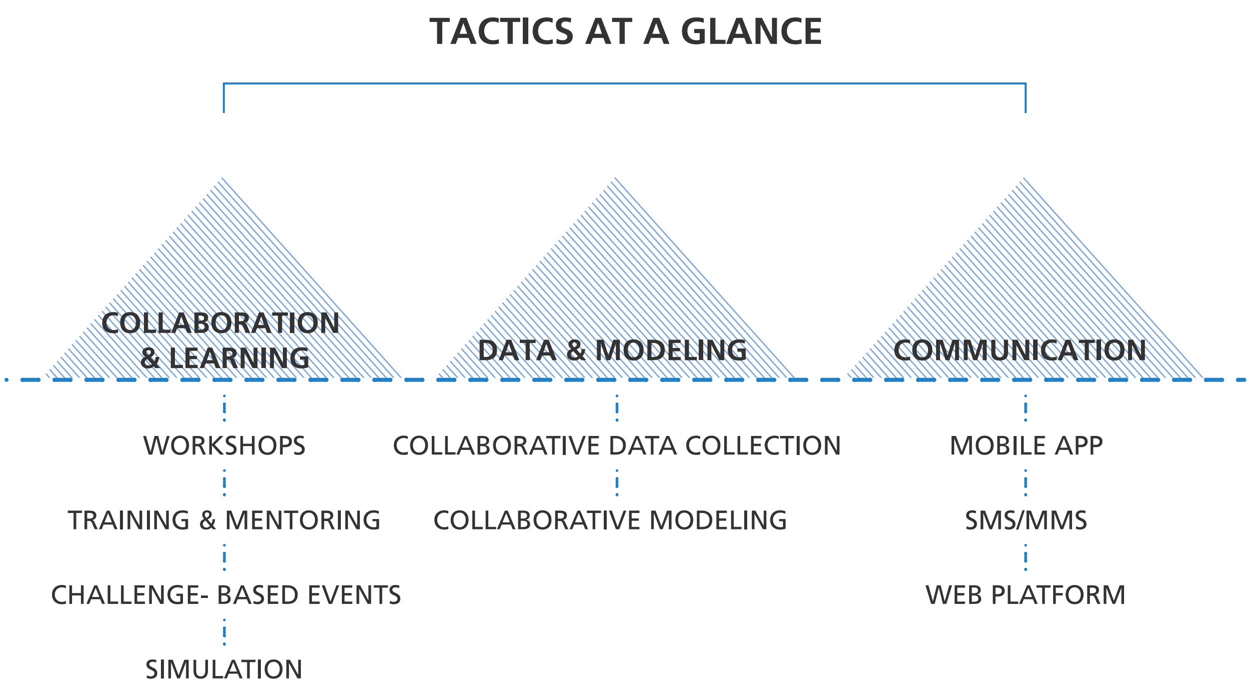


Figure 5.26
Project design tactics used in SMS Lapli



Highlights

Collaboration & Learning: Assistance from the GFDRR's Code for Resilience Initiative provided **training** for Haitian computer science students to develop the SMS Lapli program (a pilot project of the national hydromet data platform) in a **48-hour Code Sprint challenge.** The Code Sprint was developed at a **workshop** among government representatives from several institutions that produce and use hydromet data.

Data & Modeling: SMS Lapli is an open source application developed as an **engagement data** and **modeling** tool. It collects, analyzes, archives, and disseminates reliable hydrological and meteorological rainfall data to more than 100 agro-meteorological stations across the country.

Communication: SMS Lapli can receive hydromet data via **SMS** and other **mobile apps.** The use of a **web platform** and smartphone-based advisories to disseminate hazard information and seasonal rain forecasts was able to provide information on a timely basis and enhance farmers' productivity.

You can learn more about the SMS Lapli project from here: http://codeforresilience.org/projects/haiti

ThinkHazard!

World's hazard data on a single digital platform

GFDRR

Global

Context

Hazard information is often highly technical, difficult to find, and hard to interpret for non-DRM specialists. ThinkHazard! is a simple yet robust analytical tool dedicated to facilitating improved knowledge and understanding of natural hazards. It is intended for users who are not experts on natural hazards, specifically those working in the development sector. Users can undertake a rapid preliminary screening of a project area for multiple natural hazards and obtain guidance on how to appropriately reduce their impacts in their project planning. It is an open source online tool that provides information on eight hazards (earthquake, cyclone, landslide, river flood, coastal flood, volcano, tsunami, and water scarcity) based on a user's specified location.

Figure 5.27
Project context elements applicable to ThinkHazard!

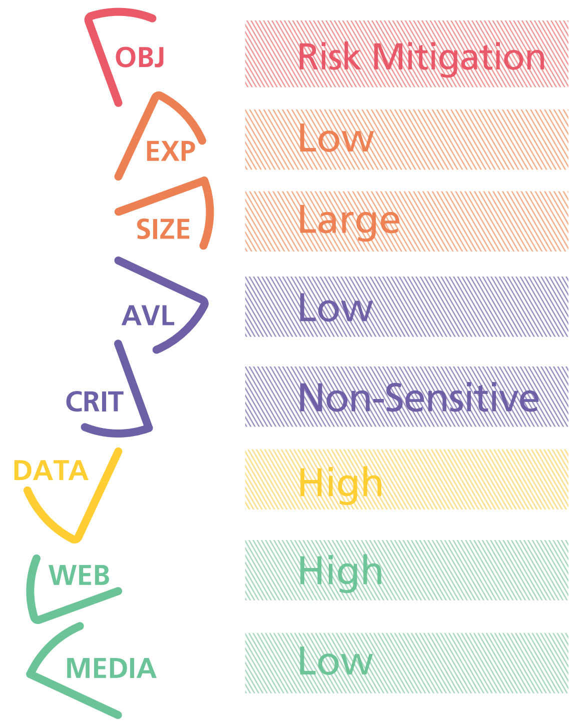
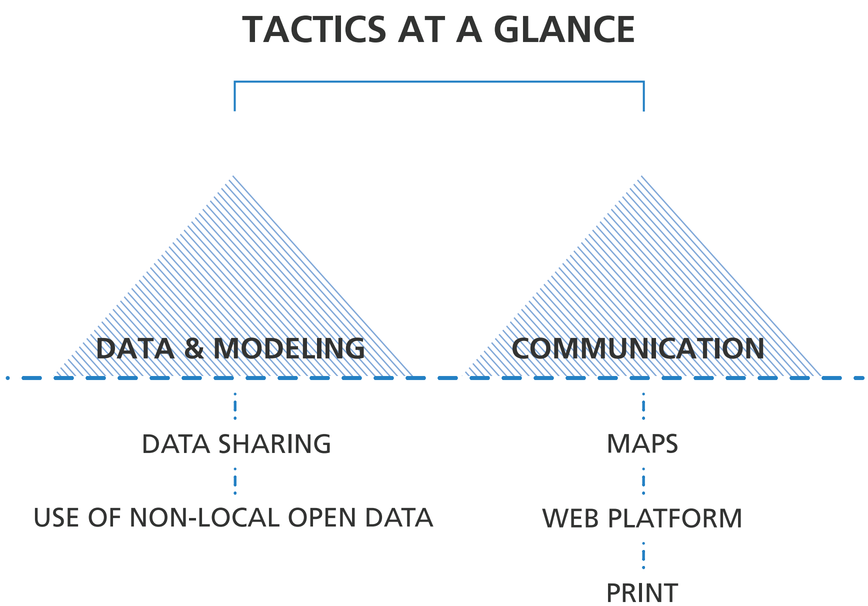


Figure 5.28
Project design tactics used in ThinkHazard!



Highlights

Data & Modeling: ThinkHazard! is a repository of hazard geospatial data and information that is flexible to use across multiple geographic scales (global, national, and local level). All information is **open source** and users are able to download all information freely, putting information in the public domain that was previously proprietary or for expert use only.

Communication: ThinkHazard! enables users with *low disaster risk expertise* to visualize hazard levels on a **map**. It does this by translating scientific characterization of hazards into easily understandable hazard classes. ThinkHazard! aims to communicate vital information on natural hazards and disaster risk impact by converting a myriad of different hazard datasets into a simple and consistent interface comprising of maps and text information. In a *non-time sensitive* decision-making context, it also delivers a series of recommendations on how to reduce risks by providing relevant documents, tools, websites, reports, and previous risk analysis from the DRM community.

You can learn more about the ThinkHazard! project from here:
http://thinkhazard.org/en

Urban Resilience Platform

Debris Tool

Urban Resilience Platform

France, Syria, Bangladesh

Context

The main objective of the Urban Resilience Platform (URP) is to enable a city or a group of cities to ensure that their waste management investments are "disaster ready" and that their disaster preparedness plans are "waste intelligent".

The first priority of URP is to raise awareness within the decision-making community that disaster waste management is a key component of disaster response. Planning appropriately will allow for huge time savings, economies of scale, and reduced negative environmental impacts. The types of vehicles chosen or accessible will also be of sizeable impact. URP has developed the Debris Tool which provides three key phases of information:

- *Predict quantities of waste by comparing risk profiles with types of architecture, predicting damage, and calculating outcoming waste from these data points.*
- *Model the cost, time, and environmental impact of managing waste using existing waste infrastructure (landfills, incinerators, trucks, sorting stations etc.).*
- *Propose theoretical scenarios of different infrastructure and show the marginal benefits of these possible investments.*

Figure 5.29
Project context elements applicable to Urban Resilience Platform

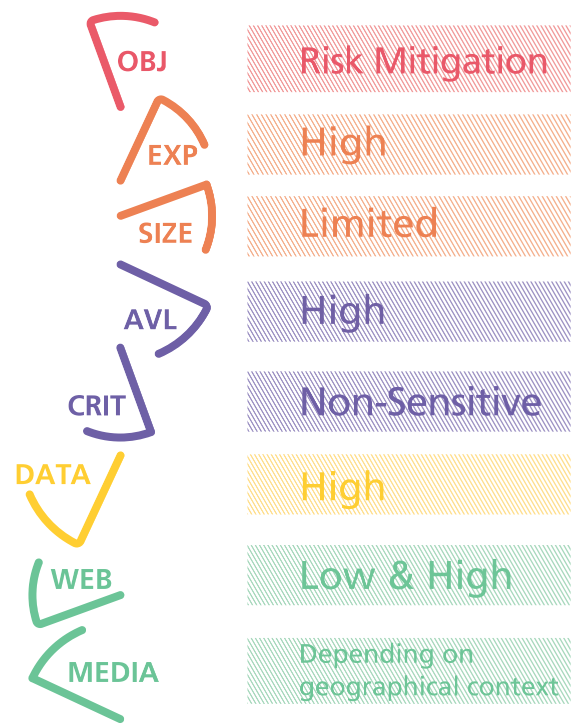
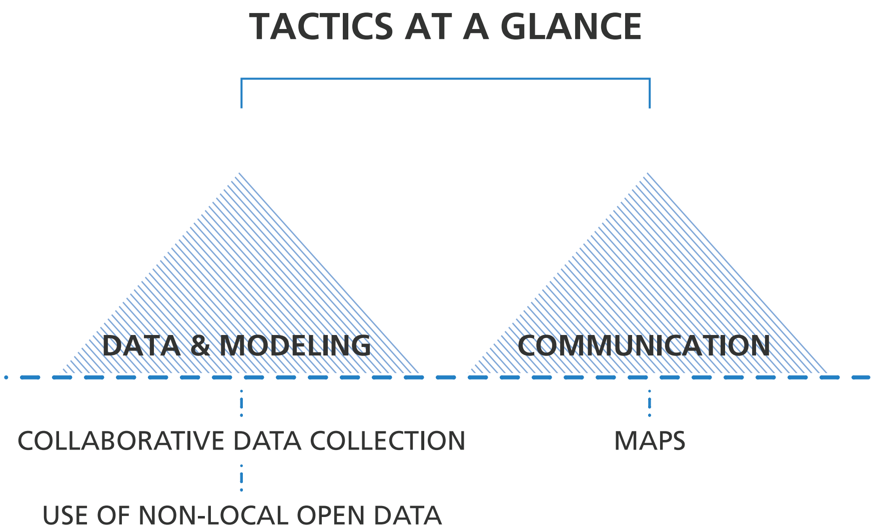


Figure 5.30
Project tactics used in Urban Resilience Platform



Highlights

Data & Modeling: The main tactics employed in URP are **collaborative data collection** and **use of non-local open data.** Data use and collection is completely dependent on the geographic location. In France, for example, URP uses government or government-affiliated data on construction, flood risk, and in-house generated factors for disaster waste generation. In Syria, URP has used satellite imagery coupled with a literature analysis of construction types and a imagery analysis of damage assessments.

Communication: Maps are used to show how the specific location of waste management infrastructure, both fixed and mobile, can have a huge impact on the disaster waste planning procedure.

You can learn more about the Urban Resilience Platform project from here: http://urplatform.eu

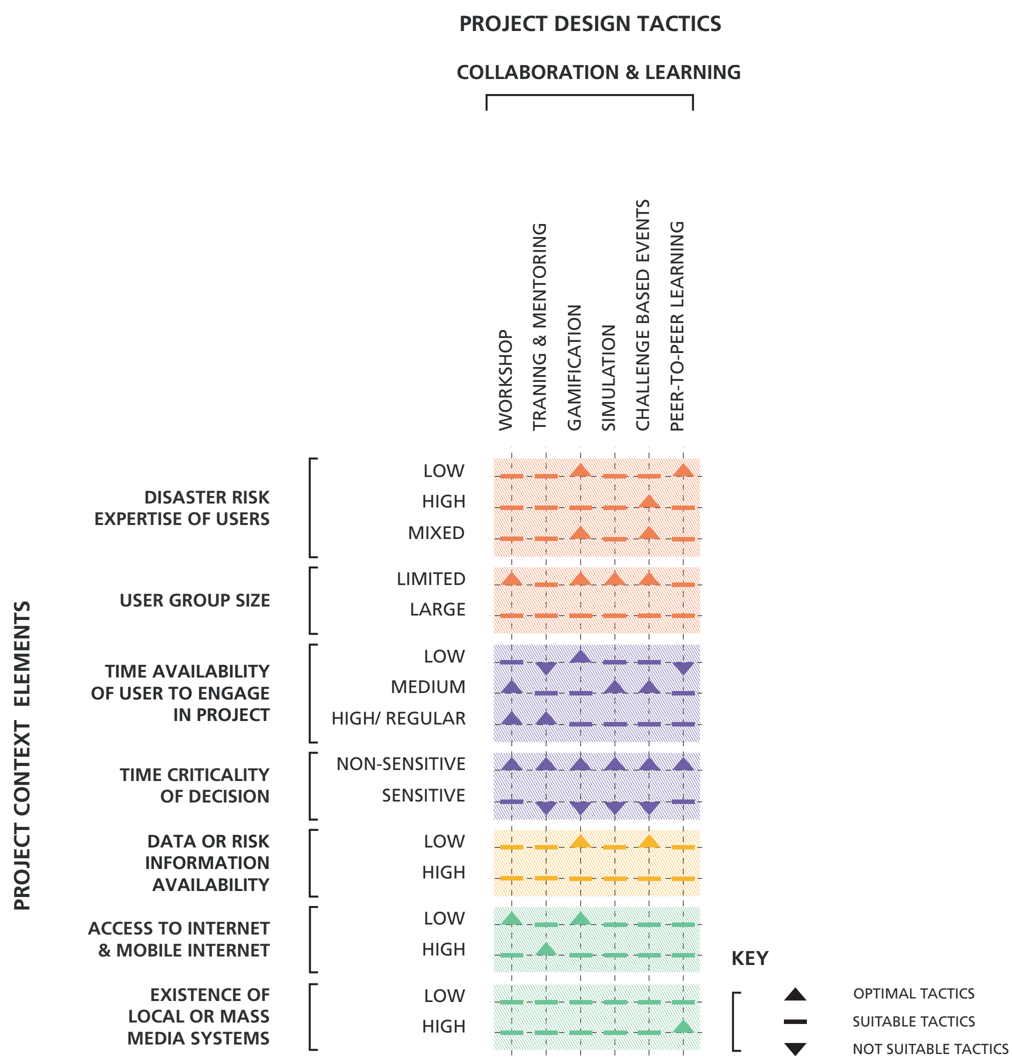
ANNEX

Annex A

Step 3 to step 5 of using the Design for Impact Framework: Selecting Project Design Tactics

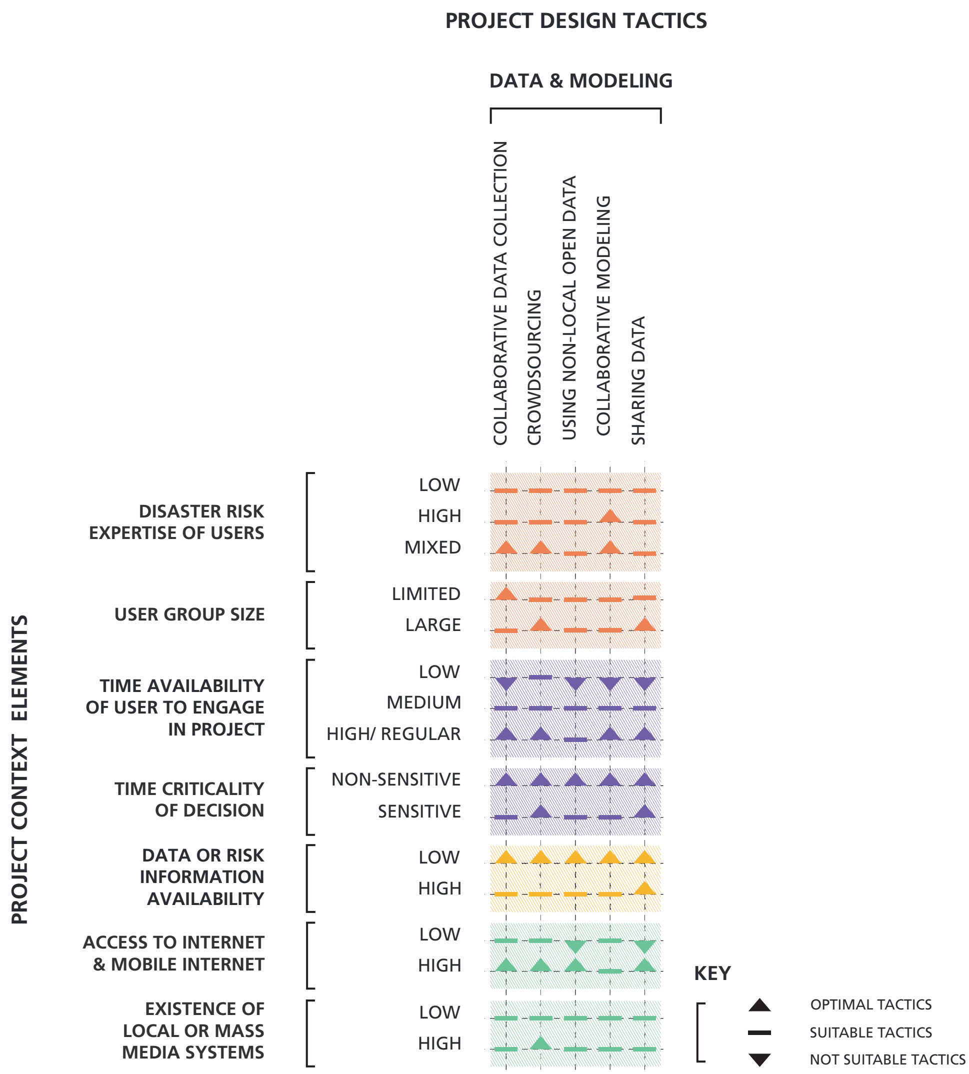
After identifying the project's decision-making context elements, the next steps are to select the project tactics that are most appropriate to the context in which the risk information project will operate.

Step 3: Select Collaboration and Learning Tactics



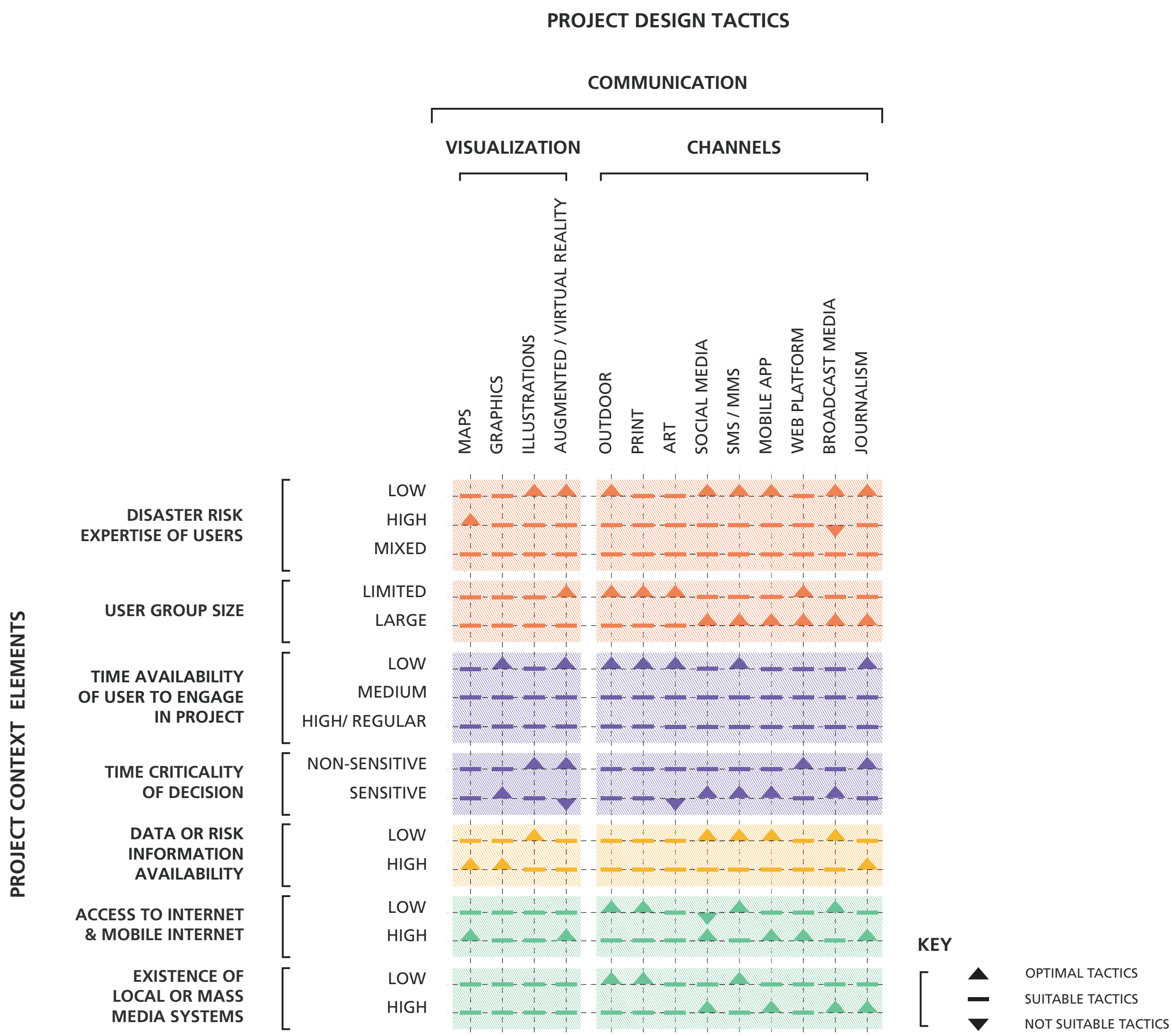
Go through each context element and consider each collaboration and learning tactic in turn. The **time availability** of the users of risk information who will be engaged in the project and the **time criticality** of the decisions that they will be making are the two key context elements that make certain learning and collaboration tactics not-optimal.

Step 4: Select Data and Modeling Tactics



Go through each context element and consider each data and modeling tactic in turn. The **time availability** of the users of risk information to engage in the project and their **access to (mobile) internet** are the two key context elements that make certain data and modeling tactics not-optimal.

Step 5: Select Communication Tactics



Go through each context element to consider each communication tactic in turn. The **disaster risk expertise of the users of risk information, the time criticality** of the decisions that they will be making and their **access to (mobile) internet** are the 3 key context elements that make some communication channels and visualisation related tactics not-optimal.

Annex B

The 10 Guiding Principles should be applied to the project during the project design phase, as well as at project implementation and assessment phases. Table 2.4 presents an indicative set of questions to help evaluate the project design of the risk information project against these principles.

Figure 2.4
Checklist for the scoping of the decision-making context across the project process: design, implementation, and assessing outcomes and sustainability.

10 GUIDING PRINCIPLES FOR THE EFFECTIVE USE OF RISK DATA	PROJECT SCOPING	PROJECT IMPLEMENTATION	SUSTAINABILITY AND ASSESSING OUTCOMES
1. USER CENTRICITY	i) Has the project analyzed the decision-making context through the Decision-Making Context Scoping Tool? ii) Has the project established an understanding of the risk information requirements of the intended users of risk information through-out the decision-making process?	i) Is the project creating risk information that is actionable, adjusted to time considerations and, in appropriate formats ? ii) Does the project support the engagement of risk information users at all stages: during problem definition, project design, development, implementation, and review?	i) Has the project resulted in risk information, visualization or decision support tools that are effective in supporting the intended decision making context?
2. INCLUSIVITY	i) Has the project assessed the specific information requirements of those most directly impacted by natural hazards?	ii) Is the project ensuring reach and relevance to the most directly at risk across social groups ?	iii) Does the project enable those most directly affected to inform prioritization of risk information initiatives ?

3. **SHARED UNDERSTANDING**	i) Has the project developed a shared problem definition and, where possible, engaged those most directly at risk in defining the problem through a range of collaboration tactics? ii) Has the project established common ground by strengthening scientists appreciation of thedecision-making context and decision makers' understanding of risk information and how it can support decision-making?	Is the project methodology and approach being implemented in ways that engage intended users of risk information, as well as scientists and risk information providers, through a range of collaboration tactics?	Is the project committed to collaboratively identifying new risk information challenges and beneficial impacts to reduce natural hazard risks?
4. **CO-CREATION**	i) Has the project taken steps to ensure that project partners (individuals or organizations) recognize and respect the knowledge of both the providers	i) Has the project developed a monitoring, evaluation, and learning framework that recognizes the differing impact requirements of all partners? ii) Has the project identified ways to engage local knowledge and knowledge systems with external scientific risk data and information?	Has the project resulted in changes in the way that project partners develop risk information?

5. OPEN BY DEFAULT	i) Has the project developed na open approach to data (including sourcing and sharing), technology, and software? ii) Has the project developed an open approach to its innovation processes by documenting and publishing all its methodologies?	i) Is the project actively developing open platforms and tools? ii) Is the project making its methodologies open to all parties beyond the project partners?	i) Has the project created open licenses for its code and its data? iii) Has the project documented and published its methodologies?
6. INFORMATION APPROPRIATENESS	i) Has the project used the Tactics Selection Tool to assess which channels and forms of visualization best promote understanding among the intended users of risk information? ii) Has the project assessed which forms of communication and visualization are most culturally, socially, cognitively, and psychologically appropriate among the intended users of risk information?	Is the project employing risk visualization and communication approaches that support understanding, stimulate dialogue, and debate?	Do the project's risk visualization and communication approaches support decision-making that addresses natural hazard risks?
7. CHANNEL SUITABILITY	i) Is the project selecting trusted communication channels that the users of risk information have the ability and the technology to interact with? ii) Is the project selecting communication channels on the basis of their scalability and resilience to natural hazards?	i) Are the communication channels trusted by the users of risk information and do they generate information flows, dialogue, and debate ? ii) Are the communication channels used by the project proving to be scalable and resilient to natural hazards?	i) Have the communication channels used by the project been accessed by the users of risk information and have they generated dialogue and debate ? ii) Have the communication channels used by the project been scalable and resilient to natural hazard impacts?

8. SUSTAINABILITY	i) Is the project developing a business model that covers the costs of all partners and ensures that the users of risk information can access information affordably? ii) Has the project assessed existing capacities and mechanisms for supporting effective use of risk information, such as communities of practice, networks and peer support groups, that the project can usefully link with, support, and strengthen?	i) Is the project trialling and adapting a business model to allow ongoing activity beyond the initial project timeframe? ii) How is the project engaging with existing capacities and mechanisms for supporting effective use of risk information, such as communities of practice, networks, and peer support groups?	i) Has the project developed a viable business model that is affordable to the users of risk information? ii) Has it supported mechanisms that enable continuation of effective use of risk information post-project?
9. REFLEXIVITY	i) Does the project support open and critical self-assessment, and does it build-in regular opportunities for review and revision?	Is the project enabling regular review, and is it sufficiently flexible to incorporate ongoing learning?	Has the project enabled spaces for challenging attitudes and supporting ongoing changes in behavior and practice?
10. DIALOGUE AND DEBATE	Have the opportunities to generate dialogue and debate been maximized across all tactic areas within the project?	Is the project generating ongoing dialogue and debate across all tactic areas and between all providers and users of risk information?	i) Has the project generated dialogue and debate between all providers and users of risk information? ii) Is dialogue and debate continuing on an ongoing basis?

Certain forms of visualization are more appropriate for certain types of data and information. The Data Visualization Guide provides a general outline of what types of graphs or maps are suitable.

Data Visualization Guide

Patterns - What to look for over time...

When looking at data over a long time frame, it is important to discern trends and characteristics of data use. Are there monthly, seasonal, or yearly cycles? Is the discrete data (buiding impacts from hazard) or continuous (monthly high temperature)?

DISCRETE DATA	Bar Charts and Histograms - ideal for discrete, temporal, or categorical datasets. Height and color of the bar is visual cue. For example, charts showing agricultural losses from a flood will highlight those bars where drought has also occurred.
	Stacked bar charts - ideal for categorizing datasets where sum is the most important (e.g., losses per hazard and from all hazards per year).
	Points or Scatterplot - provides more feeling of flow for temporal data (flood losses per year, with points sized by population affected per event). Unlike bar charts, visual cue is position of point (x,y).
CONTINUOUS DATA	Line chart - connect dots to provide appearance of trends. Implies steady change from Point A to Point B.
	Step chart - removes the implication of steady change found in Line Charts.

Proportions - What to look over among categories...

When looking at categorical data, discern maximum, minimum, and overall distribution. This is most useful when comparing distribution of proportions. For example, how are flood losses attributed to various infrastructure asset types?

CATEGORICAL AND RELATIONAL DATA

- Pie chart - ideal for proportions that add up to 100 percent (e.g., percent of population affected by age group for a given district).
- Donut chart - same as pie chart but with space to add a label. Group of donut charts can add a temporal element (e.g., percent annual losses attributed by hazard across five years).
- Treemap - same as pie chart where all rectangle areas represent 100 percent, but also represent parent categories, where rectangles within the parent rectangles are like sub-categories (e.g., percentage of infrastructure losses by asset type and sector).

Spatial relationships - What to look over across Locations...

MAPS

- Maps with dots/bubbles - ideal for highlighting x,y locations based on a numerical attribute (e.g. vulnerability index of schools from wildfire).
- Multiple Maps - ideal for highlighting patterns over time (e.g. 100YR flood risk in 2010, 2030, 2050, 2080 for a given area).

RESOURCES

OpenDRI and GFDRR Resources

GeoNode Deployment Guide

https://opendri.org/resource/geonode-deployment-guide/

OpenDRI Policy Note & Principles
https://opendri.org/resource/opendri-policy-note-principles/

Open Data for Resilience Initiative Field Work Guide

https://www.gfdrr.org/sites/gfdrr/files/publication/opendri_fg_web_20140629bs_0.pdf

Planning an Open Cities Mapping Project

https://www.gfdrr.org/sites/gfdrr/files/publicationPlanning-an-Open-Cities-Mapping-Project_0.pdf

Other OpenDRI Resources

https://opendri.org/resource/

Understanding Risk Community (UR)

https://understandrisk.org/

GFDRR Innovation Lab

https://www.gfdrr.org/innovation-lab

Global Frameworks

Sustainable Development Goals

https://sustainabledevelopment.un.org/sdgs

Sendai Framework for Disaster Risk Reduction
http://www.unisdr.org/we/coordinate/sendai-framework

The International Open Data Charter
http://opendatacharter.net

Tools and Platforms

ArcGIS

http://opendata.arcgis.com

CKAN - to streamline publishing, sharing, finding and using open data

https://ckan.org

Copernicus Emergency Management Service
http://copernicus.eu/main/

Geodesign Hub
https://www.geodesignhub.com/

Google Earth
https://www.google.co.uk/intl/en_uk/earth/

InAWARE
http://inaware.bnpb.go.id/inaware/

InaSAFE

http://inasafe.org/

Mapbox
https://www.mapbox.com/

Oasis Hub
https://oasishub.co/

ODI - Open Data Certification Platform
https://certificates.theodi.org/en/

OpenStreetMap
https://www.openstreetmap.org

The Nature Conservancy - Natural Solutions Toolkit
http://coastalresilience.org/natural-solutions/toolkit/

The World Bank Readiness Assessment Tool
http://opendatatoolkit.worldbank.org/en/odra.html

ThinkHazard!
http://thinkhazard.org/en/

Ushahidi
https://www.ushahidi.com/

Vizonomy Climate Risk Terminal
http://climate.vizonomy.com

Global Frameworks

European Data Portal
https://www.europeandataportal.eu/

GeoNode Platform
http://geonode.org/

GFDRR Innovation Lab GeoNode
https://www.geonode-gfdrrlab.org/

Humanitarian Data Exchange
https://data.humdata.org/dataset

NASA Earth Observations
https://neo.sci.gsfc.nasa.gov

NASA Socioeconomic Data and Application Center
http://sedac.ciesin.columbia.edu

Natural Earth
http://www.naturalearthdata.com/downloads/

Open Topography
http://www.opentopography.org

UNEP Environmental Data Explorer
http://geodata.grid.unep.ch

Guides and Other Resources

A Practical Guide to Public Risk Communication: The Five Essentials of Good Practice
http://webarchive.nationalarchives.gov.uk/20100104184839/http:/www.berr.gov.uk/files/file51458.pdf

Crisis and Emergency Risk Communication Manual
https://emergency.cdc.gov/cerc/resources/pdf/cerc_2014edition.pdf

Communicating Risks and Benefits: An Evidence-based User's Guide
https://www.fda.gov/downloads/aboutfda/reportsmanualforms/reports/ucm268069.pdf

Data-Pop Alliance Synthesis Report: Big Data for Climate Change and Disaster Resilience
http://datapopalliance.org/item/big-data-for-climate-change-resilience/

Global Assessment Report on Disaster Risk Reduction
http://www.preventionweb.net/english/hyogo/gar/2015/en/home/index.html

Guidelines for Open Data Policies
http://sunlightf.wpengine.com/wp-content/uploads/2016/09/OpenDataGuidelines_v3.pdf

National Disaster Risk Assessment
https://www.unisdr.org/we/inform/publications/52828

Risk Communication and Behavior: Best Practices and Research Findings
http://www.performance.noaa.gov/wp-content/uploads
Risk-Communication-and-Behavior-Best-Practices-and-Research-Findings-July-2016.pdf

Smart Cities Open Data Guide
http://smartcitiescouncil.com/resources/smart-cities-open-data-guide

The Cultural Side of Science Communication
http://www.pnas.org/content/111/Supplement_4/13621.full.pdf

The Sciences of Science Communication
http://www.pnas.org/content/110/Supplement_3/14033.full

Trends in Risk Communications Policies and Practices
http://www.keepeek.com/Digital-Asset-Management/oecd/governance/

Understanding Risk Communication Best Practices: A Guide for Emergency Managers and Communicators
https://www.start.umd.edu/sites/default/files/files/publications/

ENDNOTES

1. Sendai Framework for Disaster Risk Reduction 2015 -2030: http://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

2. Open Data Institute: https://theodi.org/what-is-open-data

3. Innovation Lab GeoNode: https://www.geonode-gfdrrlab.org

4. OpenDRI has also created and is supervising the Open Cities Project that facilitates community-mapping activities: http://www.opencitiesproject.org

5. OpenDRI has worked, for example, with the Governments of Australia and Indonesia to develop InaSAFE, free software to provide a simple but rigorous way to combine data from communities, local governments and scientists to help assess the possible impact of a disaster event: http://inasafe.org

6. Open DRI Policy Note and Principles: https://www.gfdrr.org/sites/default/files/publication/OpenDRI%20Policy%20Note.pdf

7. Open DRI Field manual (2014); UNISDR (2017); Kniveton et al (2016); Climate Services Partnership Working Group on Climate Ethics (2015); Visman et al (2016); Duncan et al(2014).

8. Visman (2014); Adams et al (2015); Medin, D.L. and Bang, M. (2014).

9. Open DRI (2014), p14.

10. LWEC (2012); Visman (2014); Kniveton (2016); Medin, D.L. and Bang, M. (2014).

11. Kniveton et al (2016); Visman et al (2016).

12. Open DRI (2014).

13. Medin, D.L. and Bang, M. (2014); Fischhoff, B., (2013).

14. Red Cross Red Crescent (2015), Kniveton et al (2016).

15. Kniveton et al (2016).

16. Visman et al (2016).

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