Ref. Ares(2024)3937000 - 31/05/2024

Deliverable D4.2

The web-based simulation and information service for multi-hazard impact chains. First version.

Revision	Organization	Date
Written by	University of Twente	28-05-2024
Checked and approved by	RAN & FI & DB	30-05-2024
Validated and released by	University of Twente	31-05-2024

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101073954

Information Table

Deliverable Number	D4.2
Deliverable Title	The web-based simulation and information service for multi-hazard impact chains. First version.
Version	V2
Status	Final
Responsible Partner	University of Twente
Contributors	Cees van Westen, Iqra Naz, Funda Atun, Bastian van den Bout (UT); Jon Hall, Sjirk Meijer (RAN); Silvia Cocuccioni (EURAC); Michalina Kulakowska (CRS); Bettina Koelle (RCCC); Sonia Matera (DBL); Serge Monturat, Beate Kreisel (FI) (with special thanks to Melanie Duncan (BGS) and Philipp Ward (VU)).
Contractual Date of Delivery	31-05-2024
Actual Date of Delivery	31-05-2024
Dissemination Level	PUBLIC

Abstract

The overall objective of the PARATUS project and the platform is the co-development of a web-based simulation and information service for first and second responders and other stakeholders to evaluate the impact chains of multi-hazard events with particular emphasis on cross-border and cascading impacts. This deliverable provides a first version of the platform and its components. A central theme in the PARATUS project is the co-development of the tools with stakeholders. The central stakeholders within the four applications case studies are therefore full project partners. They will be further involved in the development of the platform through stakeholder workshops and user consultations.

The aim of the platform is to have a combined function of a stakeholder hub, with relevant updated information on new events, trainings, resources, and opportunity for stakeholders to interact through discussion fora and live feed posts; a directory of suitable tools for multi-hazard and risk assessment, and the data required for that; as well as tools for disaster risk reduction planning, and serious games.

Whereas the original idea was to generate a platform exclusively for the PARATUS stakeholders, the current platform is aimed at stakeholders in general. The platform is now called Disaster Risk Stakeholder Hub, and is hosted on the CMINE (Crisis Management Innovation Network in Europe) platform. The aim is to bring together results from all European funded projects dealing with Societal Resilience Societies in the SRC cluster of projects, in order to promote its sustainability. The original idea was that the platform would have two major blocks: an information service that provides static hazard and disaster information for stakeholders (or regularly updated information) and simulation service, which is a dynamic component where stakeholders can interactively work with the tools in the platform. These two functions are still there but not presented as two individual blocks, as they are interrelated. This is the first version of the Hub, and we expect that it may undergo changes throughout the rest of the project, depending on user interactions and collaboration with other projects.

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Document History

Version	Date	Author	Description
VI	17-04-2024	Cees van Westen	Initiation discussions on the development of the hub in CMINE
VI	22-04-2024	Bastian van den Bout, Cees van Westen (UT)	Short online course on Hazard and Risk Modelling tools for stakeholders
VI	30-04-2024	Cees van Westen, Funda Atun, Iqra Naz (UT),	Defining the focus on hosting the hub in a collaborative mode
VI	01-05-2024	Jon Hall, Sjirk Meijer (RAN), Michalina Kulakowska (CRS), Cees van Westen, Funda Atun, Iqra Naz (UT), Melanie Duncan (BGS), Philipp Ward (MYRIAD-EU)	Hosting Platform for PARATUS & Cluster Sustainability, discussion on including DisasterRiskGateway
VI	02-05-2024	Funda Atun, Iqra Naz (UT); Silvia Cocuccioni (EURAC)	Discussions on how to include input on stakeholders and impact chain tools
VI	06-05-2024	Bettina Koelle (RCCC)	Provided input on adaptation measures
VI	10-05-2024	Cees van Westen, Funda Atun (UT)	Developing test version of the tool
VI	10-05-2024	Cees van Westen, Funda Atun, Iqra Naz (UT)	Adding contents to the hub
VI	28-05-2024	Cees van Westen (UT)	Developing the accompanying report
VII	29-05-2024	Cees van Westen, Funda Atun, Iqra Naz (UT)	Completing the editing and making the deliverable ready for review
VII	29-05-2024	Sonia Matera (DB), Serge Monturet/Beate Kreisel (FIG), Sjirk Meijer (RAN)	Review
VIII	30-05-2024	Cees van Westen, Funda Atun (UT)	Incorporating the comments and final check
VIII	31-05-2024	Cees van Westen (UT)	Submission of the deliverable

Disclosure Statement:

About PARATUS:

The PARATUS project aims at increasing the preparedness of first and second responders in the face of multi-hazard events and to reduce the risks related to impacts on various sectors that result from complex disasters. The outcome is to develop a cloud-based Online Service Platform that offers support in reducing dynamic risk scenarios and systemic vulnerability caused by multi-hazard disasters. To achieve these objectives, the project will perform in-depth assessments of complex interactions between hazards and their resulting impacts in various sectors, as well as analyse the current risk situation and study how alternative future scenarios could change multi-hazard impact chains. Based on these analysis, scenarios of multi-hazard impacts will be co-designed with stakeholders and developed in four case study areas (including the Caribbean, Romania, Istanbul, and Alpine areas).

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List of Acronyms

Acronym	Definition
AAL	Average Annual Losses
ABM	Agent-Based Model
AIT	Asian Institute of Technology
API	Application Programming Interface
ASFINAG	Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft
BGS	British Geological Survey
CAPRA	Comprehensive Probabilistic Risk Assessment
CEP	Citizen Engagement Platform
CERIS	Community for European Research and Innovation for Security
CMINE	Crisis Management and Innovation Network Europe
CMIP	Coupled Model Intercomparison Project
CRA	Community Risk Assessment
CRS	Centrum Rozwiązań Systemowych
CVaR	Conditional Value-at-Risk
DB	DeepBlue
DLR	Deutsches Zentrum für Luft- und Raumfahrt e.V.
DMOP	Disaster Monitoring and Observation Portal
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DRS-HUB	Disaster Risk Stakeholder Hub
DSS	Decision Support System
ESFG	Earth System Grid Federation
ESDI	Earth System Dynamic Intelligence
EU	European Union
EURAC	EURAC Research
EWS	Early Warning Systems
FAIR	Findable, Accessible, Interoperable and Reusable data
FEMA	Federal Emergency Management Agency
FEWES	Food, Energy, Water, Environment and Social Security
FI	FI Group
GDES	Gender, Diversity, Ethics and Security
GUI	Graphical User Interface
IBF	Impact-Based Forecasting
ICRAMM	Integrated Catastrophe Risk Analysis and Management Modelling
IIASA	International Institute for Applied System Analysis
IMHRRF	Integrated Multi-Hazard Risk and Resilience Framework
IPAI	Information Physical Artificial Intelligence
IPCC	Intergovernmental Panel on Climate Change
ITU	Istanbul Technical University
KNMI	Royal Netherlands Meteorological Institute
M	Month
MAAS	Multi-Agent Accounting System
MHRIN	Multi-Hazard Risk Intelligence Networks
NRC	Netherlands Red Cross
PARATUS	Increasing Preparedness and Resilience of European Communities by Co-Developing Services Using Dynamic Systemic Risk Assessment
POC	Proof of Concept
PPCP	Public-Private-Civic Partnership
RAN	Resilience Advisors Network

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REA	European Research Executive Agency
CLI	RiskScape Command Line Interface
RCCC	Red Cross Climate Center
SMA	Social Media Analytics
SMCE	Spatial Multi-Criteria Evaluation
SMCS	Social Media and CrowdSourcing
SRC	Societal Resilience Cluster
UCPKN	Union Civil Protection Network
UNIVIE	Universität Wien
UB	University of Bucharest
UT	University of Twente
VaR	Value-at-Risk
VU	Vrije Universiteit Amsterdam
WP	Work Package

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Executive Summary

The overall objective of the PARATUS project and the platform is the co-development of a web-based simulation and information service for first and second responders and other stakeholders to evaluate the impact chains of multi-hazard events with particular emphasis on cross-border and cascading impacts. This deliverable provides a first version of the platform and its components.

A central theme in the PARATUS project is the co-development of the tools with stakeholders. One of the main challenges is understanding how the working process of stakeholders can be integrated into a service that is both generic enough to be usable in different settings and flexible enough to be applied to a specific situation. The central stakeholders within the four applications case studies are therefore full project partners. They will be further involved in the development of the platform through stakeholder workshops and user consultations. The aim of the platform is to have a combined function of a stakeholder hub, with relevant updated information on new events, trainings, resources, and opportunity for stakeholders to interact through discussion fora and live feed posts; a directory of suitable tools for multi-hazard and risk assessment, and the data required for that; as well as tools for disaster risk reduction planning, and serious games.

Whereas the original idea was to generate a platform exclusively for the PARATUS stakeholders, the current platform is aimed at stakeholders in general. The platform is now called Disaster Risk Stakeholder Hub, and is hosted on the CMINE (Crisis Management Innovation Network in Europe) platform, using the HiveBrite software tool. The aim is to bring together results from all European funded projects dealing with Societal Resilience Societies in the SRC cluster of projects, in order to promote its sustainability. The original idea was that the platform would have two major blocks: an information service that provides static hazard and disaster information (or regularly updated information) and simulation service, which is a dynamic component where stakeholders can interactively work with the tools in the platform. These two functions are still there but not presented as two individual blocks, as they are interrelated. This is the first version of the Hub, and we expect that it may undergo changes throughout the rest of the project, depending on user interactions and collaboration with other projects.

This deliverable is the accompanying report of the platform and its components. The Disaster Risk Stakeholder Hub can be accessed through 'http://drs-hub.eu'.

The Disaster Risk Stakeholder Hub (DRS-Hub) contains the following information components: a terminology WIKI and links to other platforms developed by Horizon Europe projects with similar objectives; an impact chain WIKI which contains the standardized impact chains for a number of historical disasters, and which can be queried by users on several aspects; a module linking to hazard and exposure datasets and modelling results; a tool guiding users to various resources on risk reduction measures, and climate adaptations, and a tool linking to relevant datasets of the case study sites.

The simulation service contains a series of tools that the users can use to develop new hazard and risk information for their own geographic area and develop future scenarios and risk reduction alternatives. The following tools are foreseen: an impact chain builder, where users can develop their own impact chain of past events, or possible future disaster events, which is used as a basis for quantifying direct damage and prioritizing secondary losses in different sectors; the FastFlood and FastSlide tools which will provide fast estimations of multiple hazards and can be used as basis for risk reduction planning; the RiskChanges tool for the quantification of losses; a resilience indicator tool; a tool for developing future scenarios and risk reduction alternatives; an impact-based forecasting tool; a component for serious games for training with the other simulation tools ; and a tool for collaborative planning. The exact number of components, and the final structure of the platform will be determined iteratively through a series of stakeholder consultations, following a user-centred design. It is important to state here that the design will be a compromise between the stakeholder needs of the stakeholders involved in EU funded projects focusing on Societal Resilience. The platform will be further developed in a flexible way to be able to cater for stakeholders that work in different sectors, geographic settings, and interacting hazards, and at the same time to address (a number of) their needs for analysing the impact of compounding and multi-hazard events, with cascading impacts.

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1. Introduction to Work Package 4 and Deliverables

Work Package 4, the User-Centred Risk Assessment and Mitigation Service, is the core of the PARATUS project, as all the information and knowledge from other work packages come together in WP4 to develop the outcome that is an open-source platform for dynamic risk assessment. The project started with the idea of creating the PARATUS platform that will allow to analyse and evaluate multi-hazard impact chains, risk reduction measures, and disaster response scenarios in the light of systemic vulnerabilities and uncertainties.

The services in the platform will be co-created with the support of various projects and stakeholders. The objective of WP4 is fourfold: (i) design of multi-hazard impact chains and definition of the quantifiable components; (ii) model population with hazard, exposure and vulnerability data tailored to the specific user; (iii) co-development of future scenarios based on changes in causes (climate change, socio-economic changes), (iv) co-development of planning alternatives and selection of optimal risk reduction options.

The effort for WP4 contains the following five main tasks, and as outputs, we will have 8 deliverables (Table 1.1).

- Web-based simulation and information service (M06-M46);
- Cloud-based Decision tool on available methods and data sources for analysing changing risk components (M12- M36);
- Scenario formulation and selection approach and tools (M24-M44);
- Cloud-based Integration of tools for decision-making with respect to adaptation measures under possible scenarios. (M30-M46);
- Application of the tool in impact assessment for various sectors (M34-M48).

Table 1.1: Deliverables for WP4 related to the PARATUS platform (shaded are the ones that have been submitted thus far)

Del #	Name	Partners	Month
D4.1	The web-based simulation and information service for multi-hazard impact chains. Design document	**UT,** ASFiNAG, NRC, RCCC, RAN, IIASA, DLR, EURAC, CRS	July 2023 (M10)
D4.2	The web-based simulation and information service for multi-hazard impact chains. First version.	**UT,** ASFiNAG, NRC, RCCC, RAN, IIASA, DLR, EURAC, CRS	May 2024 (M20)
D4.3	The web-based simulation and information service for multi-hazard impact chains. Final version.	**UT,** ASFiNAG, NRC, RCCC, RAN, IIASA, DLR, EURAC, CRS	Aug 2026 (M47)
D4.4	Web-based data selection tool for multi-hazard impact chain modelling	**UT**, ASFiNAG, UPC, DLR, NRC, RCCC, RAN, IIASA	Sep 2025 (M36)
D4.5	Scenario formulation tool for selection approach and tools	**IIASA,** ASFiNAG, UT, NRC, RCCC, RAN	May 2026 (M44)
D4.6	Cloud-based Integration of tools for decision making with respect to adaptation measures under possible scenarios	**RCCC,** NRC, RAN, UT, CRS	May 2026 (M44)
D4.7	Report on the Evaluation of the tool in impact assessment for various sectors, with recommendations	**UT,** UNIVIE, ASFiNAG, KNMI, NRC, ITU, IMM, UB, DUR	July 2026 (M46)
D4.8	Report on the long-term development of the tool under CMINE and within the Red Cross Red Crescent Network	**RAN,** NRC, FI, UT, DB	Sep 2026 (M48)

Since PARATUS project started in October 2022, there were several occasions to collaborate with various EU funded projects on the same topic. After discussions with representatives of other EU projects, with whom we are collaborating within PARATUS, with the members of the External Advisory Committee, and with the external reviewers and EU project officer, we have decided to integrate the platform and the stakeholder hub, and also to make it generic and not specific for PARATUS. Therefore, we have decided to name the platform: **Disaster Risk Stakeholder Hub (DRS-Hub).**

Co-funded by the European Union

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2. Introduction to Disaster Risk Stakeholder Hub (DRS-HUB)

As already written in the Deliverable 4.1, the overall objective of the Disaster Risk Stakeholder Hub is:

> ***Co-development of a web-based simulation and information service for first and second responders and other stakeholders to evaluate the impact chains of multi-hazard events with particular emphasis on cross-border and cascading impacts.***

Disaster Risk Stakeholder Hub (DRS-HUB) integrates the originally planned PARATUS stakeholder hub and the platform. It is presented as a product of the Societal Resilience Cluster (SRC) of related EU funded projects on CMINE without mentioning specifically the name of the PARATUS project. The decision was made by considering the nature of stakeholder involvement, collaboration efforts between various EU funded research and innovation projects and to ensure sustainability of the platform.

- **Stakeholder involvement:** A central theme within the PARATUS project is the co-development of the tools with stakeholders. The central stakeholders in the four application case studies are therefore full project partners. They are directly involved in the development of the platform. The joint effort of EU funded projects will ensure the involvement of various and extensive number of stakeholders as co-designers of the DRS-HUB. Therefore, the access to the platform will go through the stakeholder hub hosted by CMINE and registered users are informed of new developments regularly.
- **Collaboration:** having a general stakeholder hub, rather than a project specific one, is more beneficial for integrating the efforts from different EU funded projects that are partly dealing with the same topics, reduce the redundancy and optimising the spending of EU funds.
- **Sustainability**: We envisage a generic Stakeholder Hub to be much more sustainable in the long term. After the PARATUS project ends it is important to keep the results alive and integrate them with results from other past, ongoing and future projects.

DRS-HUB is an open-source platform for dynamic risk assessment that allows to analyse and evaluate multi-hazard impact chains, risk reduction measures, and disaster response scenarios in the light of systemic vulnerabilities and uncertainties. It will be generic so as to be applicable in different contexts, geographical scopes, sectors, and end-users.

2.1 Accessing the DRS-HUB

The **Disaster Risk Stakeholder Hub** is hosted through the CMINE, the Crisis Management and Innovation Network, which is an open professional network for anyone involved in Crisis Management (CMINE)[1] .

The Hub uses a pre-existing Online Community Platform - The Crisis Management Innovation Network Europe to host a network of global partners. It is important to identify and 'sign-up' relevant members to partake in the activities (e.g., online activities, stakeholder consultations, and stakeholder workshops).

The DRS-Hub operates from a sound ethical foundation with clear rules and governance procedures with the aim of it becoming fully self-sustainable after the end of the PARATUS project. Within the Hub, a specific End-User Board, specifically composed of end-user organisations (notably practitioners and decision and policymakers) external to the consortium has been established and will be expanded during the lifespan of the project. A fully inclusive approach will be taken to all potential members of the Hub, regardless of individual or organisation. All opinions will be welcomed, and diversity and innovative thinking encouraged.

[1] https://www.cmine.eu/

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Building the Hub is a long-term activity which will be undertaken over the next 2.5 years, creating in a dynamic network of people interested in continuing the project's contribution to Societal Resilience long after it finishes

The Hub can be accessed through:

https://www.cmine.eu/topics/35391/page/home

with the following Alias:

http://drs-hub.eu

Figure 3.1: The Disaster Risk Stakeholder Hub on the CMINE platform.

2.2 Activities of DRS-HUB

DRS-HUB will facilitate engagement between EU projects and their own stakeholders. It also will create opportunities for stakeholders with other EU projects in the Societal Resilience cluster. It will:

- Feature updates on activities and initiatives;
- Promote events;
- Support a chat and discussion area;
- Offer a repository for key documents relating to the project and its wider aims;
- Provide the opportunity to interact with the much broader resilience and crisis management community;
- Provide guidance to stakeholders.

DRS-HUB contains the following information components:

- a terminology WIKI;
- links to other tools and platforms developed by Horizon 2020 and Horizon Europe projects with similar objectives;
- an impact chain WIKI which contains the standardised impact chains for a number of historical disasters;
- a module linking to hazard and exposure and risk information;
- a tool guiding users to various resources on risk reduction measures, and climate adaptation;
- an overview of serious games for disaster risk reduction.

The simulation service will contain a series of tools that the users can use to develop new hazard and risk information for their own area and develop future scenarios and risk reduction alternatives. The following tools are already available:

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- an impact chain builder, where users can develop their own impact chain of past events, or possible future disaster events;
- the FastFlood tool for rapid flood hazard assessment and decision making on the effect of risk reduction measures;
- the FastSlide tool for rapid landslide and debris flow hazard assessment;
- the RiskChanges tool for the quantification of losses.

Some other tools are foreseen in the coming periods:

- a tool for characterizing multi-hazard events (both historically and for future scenarios) and which can include a time component and a hazard and impact quantification, and which can be extended to include recovery and resilience;
- an impact-based forecasting tool;
- a component for serious games for training with the other simulation tools; and
- a tool for collaborative planning.

Stakeholders can get involved, through:

- registering an account on CMINE and free membership of the Hub, which is issued;
- providing informed consent for limited use of the personal data (within the project only);
- once confirmed, admission to the Hub with the encouragement to engage in a range of activities and to provide input and opinions on specific activities.

3. Co-designers and Users of DRS-HUB

Co-designing the DRS-HUB is one of the core objectives. The Hub is built upon an **inclusive approach** that aims to establish a unified Stakeholder Hub, which gathers not only representatives from the Disaster Risk Management (DRM) field but from a wide range of other relevant groups, sectors, and disciplines, including academia, large and SME technology providers, civil society, governmental and non-governmental organizations as well as standardization bodies and competent authorities.

3.1 Collaboration with EU funded Research and Innovation Projects

The PARATUS project builds on the achievement of many previous EU funded projects and the same effort continues during the implementation of the project by active collaboration of various projects. In D4.1, we shared an evaluation of projects that could be helpful for the development of the proposed methodology in PARATUS (D4.1[2], pp:9-11). We combined the efforts with the support of "Societal Resilience Cluster" within the CMINE community, which was established to enable closer cooperation between the Horizon 2020 projects RESILOC, ENGAGE, BUILDERS and LINKS, joined in 2021 by RiskPACC and CORE, in 2022 by MEDIate and PARATUS (Horizon Europe), followed by DIREKTED, SYNERGIES, The HuT and Myriad_EU in 2023. The Cluster is hosted on the CMINE platform and is together with other project clusters on CMINE (Responder Technologies and CBRN Standardisation) in close contact with Community for European Research and Innovation for Security (CERIS) and the Union Civil Protection Knowledge Network (UCPKN). CMINE was launched in 2019 by the DRIVER+ project to bring together governmental representatives, research agencies, industries, practitioners, etcetera together. It developed further by enabling the project teams to interact with other resilience focused Horizon 2020 supported projects, while engaging in an open dialogue about joint cooperation. CMINE is effective in creating a baseline for closer interaction, building up on synergies and generating added value collaboration, based on the conviction that community platforms simplify

[2] D4.1 - PARATUS (paratus-project.eu)

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communication exchange, mandate cooperation, and calibrate joint efforts in the research arena. The closer cooperation provides a window to co-create, participate in, and observe discussions on innovation. CMINE operates under a Memorandum of Understanding (MoU) with the European Research Executive Agency (REA)[3]

Currently, closer collaboration between the projects is evidenced by:

- The fact that the project coordinators of Mediate, Myriad-EU , HuT and PARATUS are partly members of each other External Advisory Boards;
- Organisation of individual exchange meetings between projects;
- The organisation of meetings between Multi-Hazard related EU funded projects, often during international conferences;
- Joint dissemination activities, like:
  - The organisation of joint sessions in conferences, such as during the EGU conferences (2023, 2024);
  - Joint development of Policy Briefs;
  - Joint lunch seminars that will be organised between MEDIATE and PARATUS as part of a UNESCO webinar series;
  - Joint presentations and interaction during CERIS meetings;
  - Joint organisation of a Multi-Hazard Young Researchers Academy in Barcelona in October 2024;
  - A joint booth at the Civil Protection Forum 2024.

The collaboration with other projects implies that the set-up of the DRS-HUB can change to accommodate other projects' conceptual frameworks and tools. For project purposes it will be recorded which parts are part of the initial 'PARATUS-platform' concept.

3.2 Stakeholders Involvement

Stakeholders will engage with the DRS-Hub at different levels, depending on their characteristics, needs, interests, and relevance. The Hub applies the five engagement levels defined by the International Association of Public Participation (IAP²) to ensure a balanced representation of all stakeholder group; these are:

- ***inform*** stakeholders with little interest, or influence in;
- ***consult*** stakeholders that are supportive but with little time/capacities to dedicate to the hub;
- ***involve*** stakeholders that are influential and maintain periodic exchanges to adequately inform them;
- ***collaborate*** with stakeholders that are key with respect to both, interest, and influence;
- ***empower*** stakeholders through the development process and the knowledge gained, so that they can decide whether to adopt or boost the final developments and endorse the uptake of the tools and information in the Hub.

DRS-HUB offers various tools, databases, methods, toolboxes for various purposes like learning, assessing systemic risk, making decisions, increasing awareness or just to be trained. Therefore, the intended user profile covers a wide range of stakeholders, i.e., scientists, DRR specialists, planning experts, climate change modellers, participatory planning experts, hazard assessment experts, vulnerability experts, technical staff, first and second responders, local and regional authorities, insurance companies, consultants, critical infrastructure managers, humanitarian organisations, secondary school children and university students. Constant interaction with stakeholders at various levels will allow to better tailor and develop DRS-HUB. It furthermore allows stakeholders and project partners, to exchange on best practises and lessons learnt which will also help to explore new innovative technologies and solutions supporting stakeholder operations across

[3] https://rea.ec.europa.eu/index_en

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different countries. Those innovations need to be considered to ensure that the user-centred risk assessment service tool developed is compatible and can be interconnected with other existing and emerging solutions.

3.3 DRS-HUB Activities with Stakeholders

Stakeholders from different groups will participate in specific activities throughout the projects' duration to improve DRS-HUB according to the needs of various stakeholders.

- **Needs and Requirement Workshops** on user requirements for the services to be developed in DRS-HUB. For a better overview of stakeholders' needs, expectations, *and* motivation, every participant had the chance to give input regarding wishes and possible contributions to DRS-HUB.
- **Focus group meetings** discussing impact-chains of past events and what determined the impact chains levels and defining required information for estimating the impact chains of possible future events.
- **Scenario co-design** meetings and evaluation meetings. Scenario co-design is another method that we use in our meetings with external stakeholders.
- **Testing**. Testing of the platform prototypes and evaluating modifications is done in an iterative process etc. Short cycle user testing will keep the user engaged and involved during the development of the platform, introducing innovative training elements to the platform.
- **Stress testing workshops.** The stress testing workshops will be integrated into the Learning Lab process and aims to support various sectors in integrating climate-related risks in their projects and equip stakeholders with operational climate knowledge. These workshops address questions about what the hazards and climate projections (and uncertainties) are, what these mean for their project (impacts) and what can be done to reduce vulnerability (actions). It aims to move discussions from hazards to impacts to action. The approach focuses on cross sectoral learning through the exchange of challenges and solutions. Interaction, visualisation, and engagement will be core focus points – drawing on the extensive experience of the Climate Centre in innovative online facilitation and creative learning.
- **Social Simulations.** Social simulations are characterized by the social aspect of the tool in which different groups of interest interact in a fictional environment that emulates the real-world system and interlinkages between its key elements. DRS-HUB will host social simulations to explore possible futures and new pathways towards risk reduction, adaptation, mitigation, and creating more resilient communities. This will allow users to learn different perspectives and individual challenges, through narration-based gameplay and include them meaningfully in navigating future challenges and testing possible solutions. One of the most important distinctions of this social simulation is that it will be future-oriented. Seeing and experiencing the possible future outcomes of their own decisions, players will be able to confront their hidden assumptions and actively learn from their mistakes within a safe environment. This will build the capacity of users of DRS-HUB for actual disaster situations.

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4. General set-up of the platform

This chapter gives a first impression of the **Disaster Risk Stakeholder Hub**.

The general set-up of the Disaster Risk Stakeholder Hub will evolve over the time, depending on the interaction and feedback from Stakeholders, the ongoing collaboration with other projects, and the PPARATUS project development. Some new pages may appear later, and existing pages might show differently after some time. The changes will be described in the final document. It is important to state here that the final design will be a compromise between the stakeholder needs of the stakeholders involved in the PARATUS project as project partners, and stakeholder requirements of stakeholders outside of the consortium. The platform should be both generic enough to be able to cater for stakeholders that work in different sectors, geographic setting, and interacting hazards, and specific enough to address (a number of) their needs for analysing the impact of compounding and multi-hazard events, with cascading impacts.

4.1 The Main Page

Home page includes a main block to access the key components of the project, and two information sectors related to upcoming events, and live feed posts, aimed at exchanging information among stakeholders. Special attention has been paid to avoid showing the link with the PARATUS project on the main page but to show the link with CMINE and the Societal Resilience Cluster instead. The colour scheme is taken from the PARATUS website design, though with its base colours. At the top of the page the menu items of the CMINE main page are shown, whereas the part under the banner will be the menu items specific for the Hub. Currently, the version of the HiveBrite software that is used by CMINE does not allow the use of sub menus under the tabs. We hope to have solved this problem in the coming period, so that we can have more dedicated menu items under the tabs. There is also a number of tabs that are standard in the design of the software related to projects, events, news items etc. (Figure 4.1)

The platform is designed to allow stakeholders to navigate considering their needs. When these stakeholders click for more information, they are directed to a specific page in the Hub for them, where they can find information that is specific to the stakeholder group. (Figure 4.2)

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Figure 4.1: Overview of the main page of the Hub.

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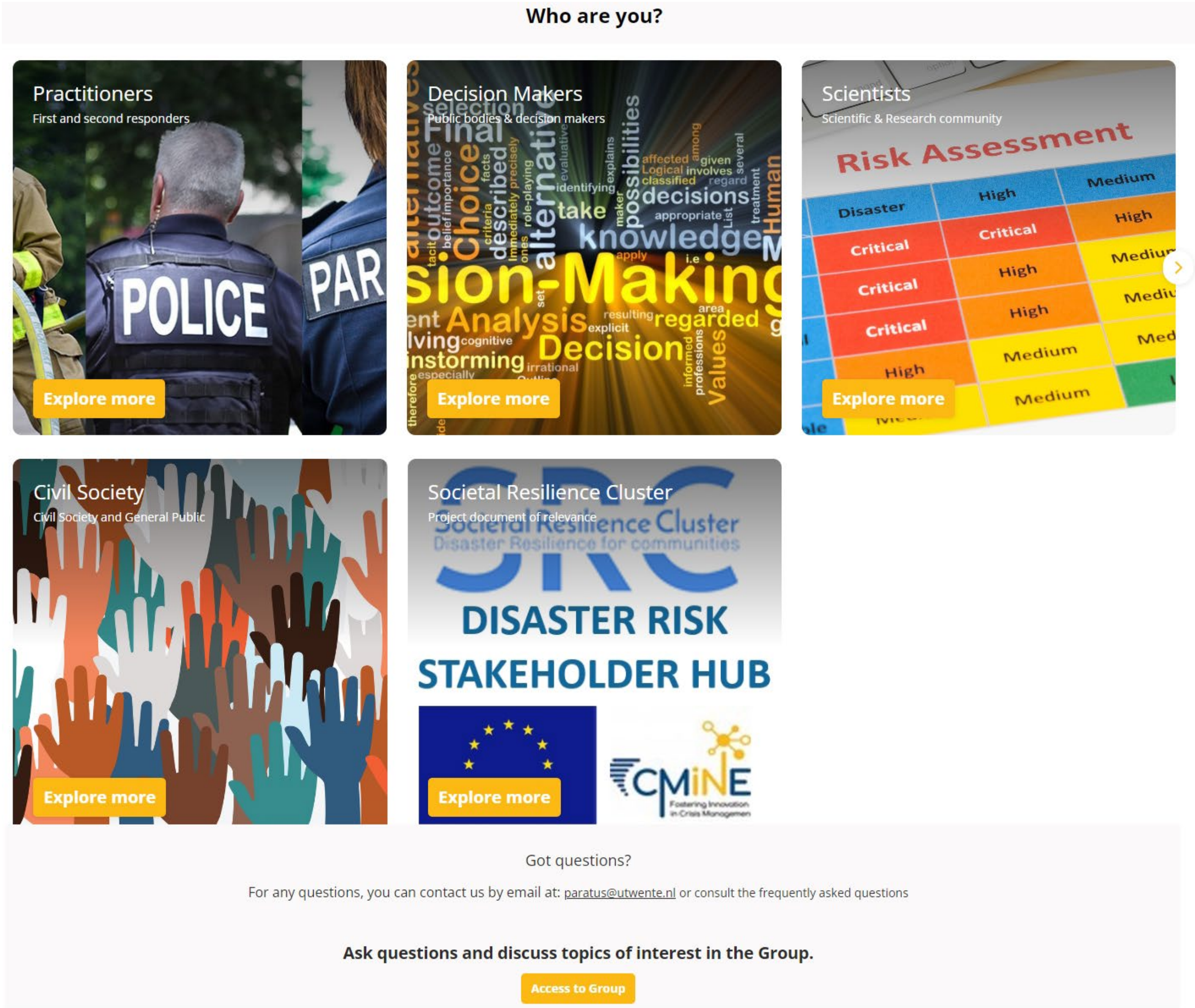

Figure 4.2: Selection option for different Stakeholders, to get access to specific information.

4.2 The Terminology Page

Mastering disaster risk terminology is one of the challenges. We dedicated one page in the Hub for terminology bringing together information on terminology related to Disaster Risk Management, and to Multi-Hazard risk. The user is directed to several main sources for the terminology, such as the UNDRR directory, and specific Hazard profiles.

There are several other EU funded projects that have developed useful tools and repositories that the DRS-HUB can link to, without reinventing the wheel. The SR-cluster has previously developed a joint glossary of terminology[4]. As part of the MYRAID-EU project[5] a wiki-style online crowdsourcing platform (**DisasterRiskGateway**) was developed with examples of qualitative and quantitative multi-hazard, multi-risk methods, models, and tools (approaches), including examples of their application. The wiki design, development, and deployment were undertaken by the British Geological Survey BGS. It was created using the

[4] https://www.cmine.eu/topics/20936/media_center
[5] https://www.myriadproject.eu/

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freely available software, MediaWiki, which is designed for open content, and is hosted by the BGS. Functionality and the appearance of the wiki has been customised through the installation of extensions that are attached to the core software. The wiki, Disaster Risk Gateway[6] has a nested structure and pages are responsive allowing for page optimisation across all devices. We have considered to develop the hub under the DisasterRiskGateway and we had several meetings on this with the representatives of the MYRIAD-EU project. However, it was not clear how the hosting of that platform would be solved on the long term, given rise to uncertainty on the sustainability. Also the general set-up was considered to be rather basic, with limited options for including figures and graphics, and without clear options for user interaction. Therefore it was decided to link to it, and where it is relevant add items to it, but not make DisasterRiskGateway our main platform.

Figure 4.3 gives an impression of the terminology page. It will be further extended with specific terminology related to multi-hazard, and their interactions, related to triggers, and spatial and temporal relations.

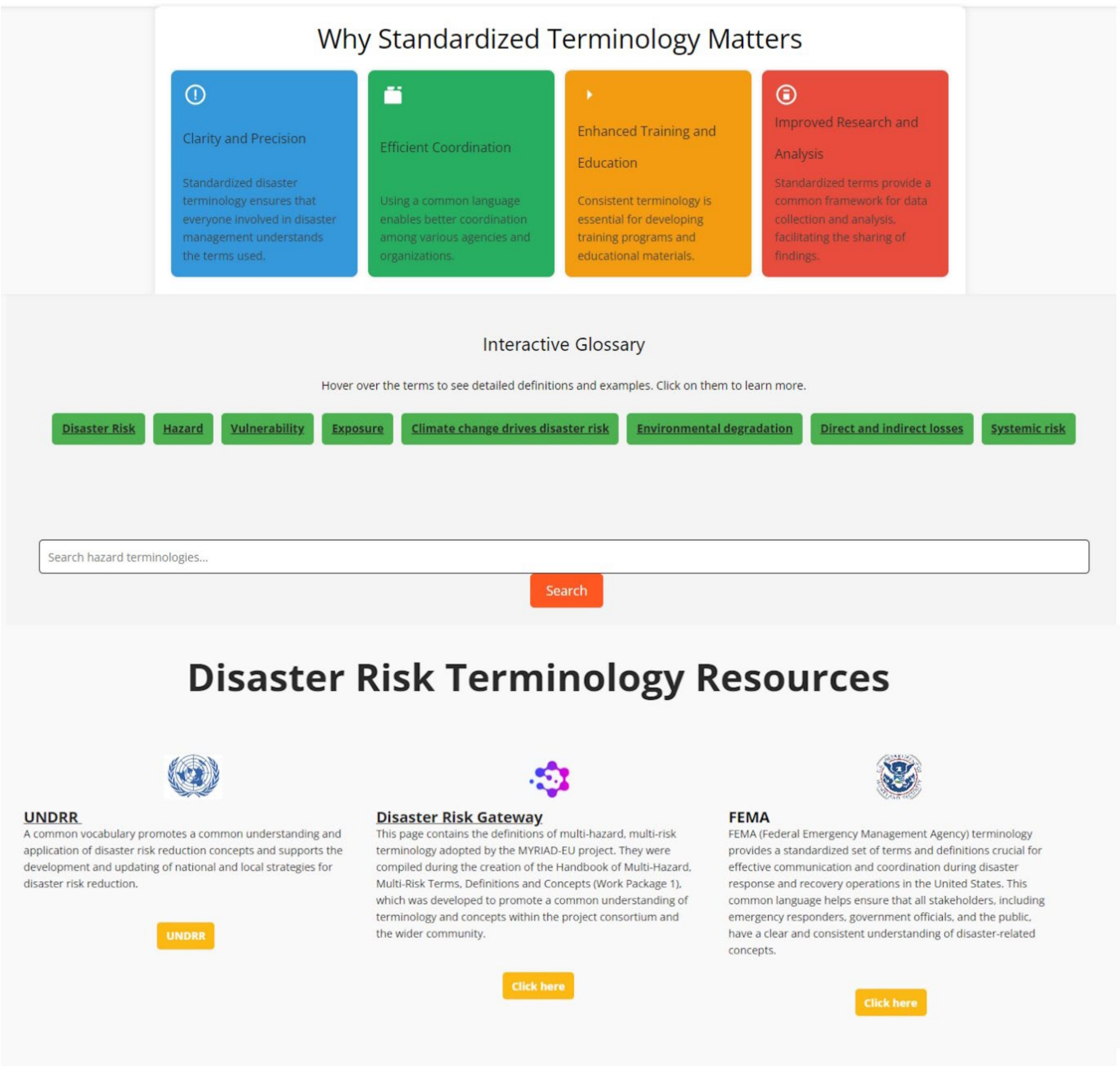

Figure 4.3: Page for Disaster Risk Terminology

[6] https://www.disasterriskgateway.net/index.php/Main_Page

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4.3 The Impact Chain Page

One of the key components of the PARATUS project thus far has been the development and use of impact chains, which are graphical representative of the factors that cause multi-hazard impacts. Initially we considered to develop a specific tool for the generation and storage of these impact chains. However, after careful consideration of the available software tools, it was decided to develop the impact chains with the KUMU software tool, as this tools contains nearly all requirements related to entry , storage, standardisation, querying and documentation of impact chains. We have now developed the impact chains for the case study areas, and for a number of learning case studies, using a standardized approach. The impact chains are presented in the impact chain page (Figure 4.4).

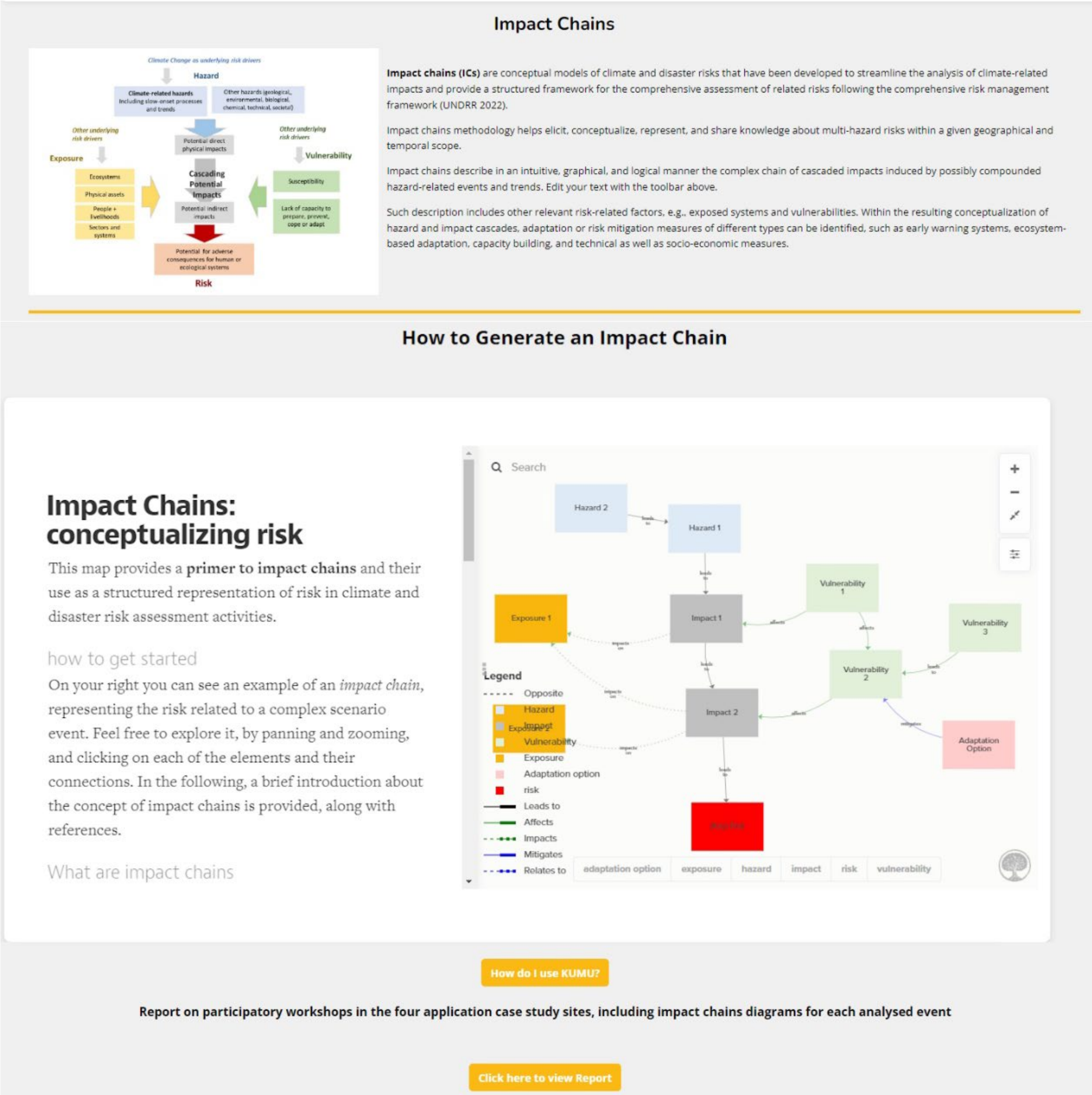

Figure 4.4: Impact chain page on the Disaster Risk Stakeholder Hub.

The impact chains analyse how the hazardous event impacted different sectors, such as society, human health, cultural heritage, environment and biodiversity, public finance, and key economic sectors. They are based on reports, interviews with specific stakeholders, testimonies, videos, virtual workshops for learning cases and meetings for application cases organized in WP6. EURAC has developed a guideline for the generation of impact chains, and all the partners were asked to make several impact chains for historical events. The first

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component is a direct link to a KUMU example impact chain that described the components. A tutorial is given on how to develop impact chains for the specific areas of the interested user. These can also be then linked to the Hub. Following that is a list of impact chains organised by country, where each impact chains is classified according to specific criteria (Where, Which hazard, What and which sector). Figure 4.5 shows the example of the page from which the impact chains can be selected. Figure 4.6 gives one example of an impact chain when it is opened in the KUMU application.

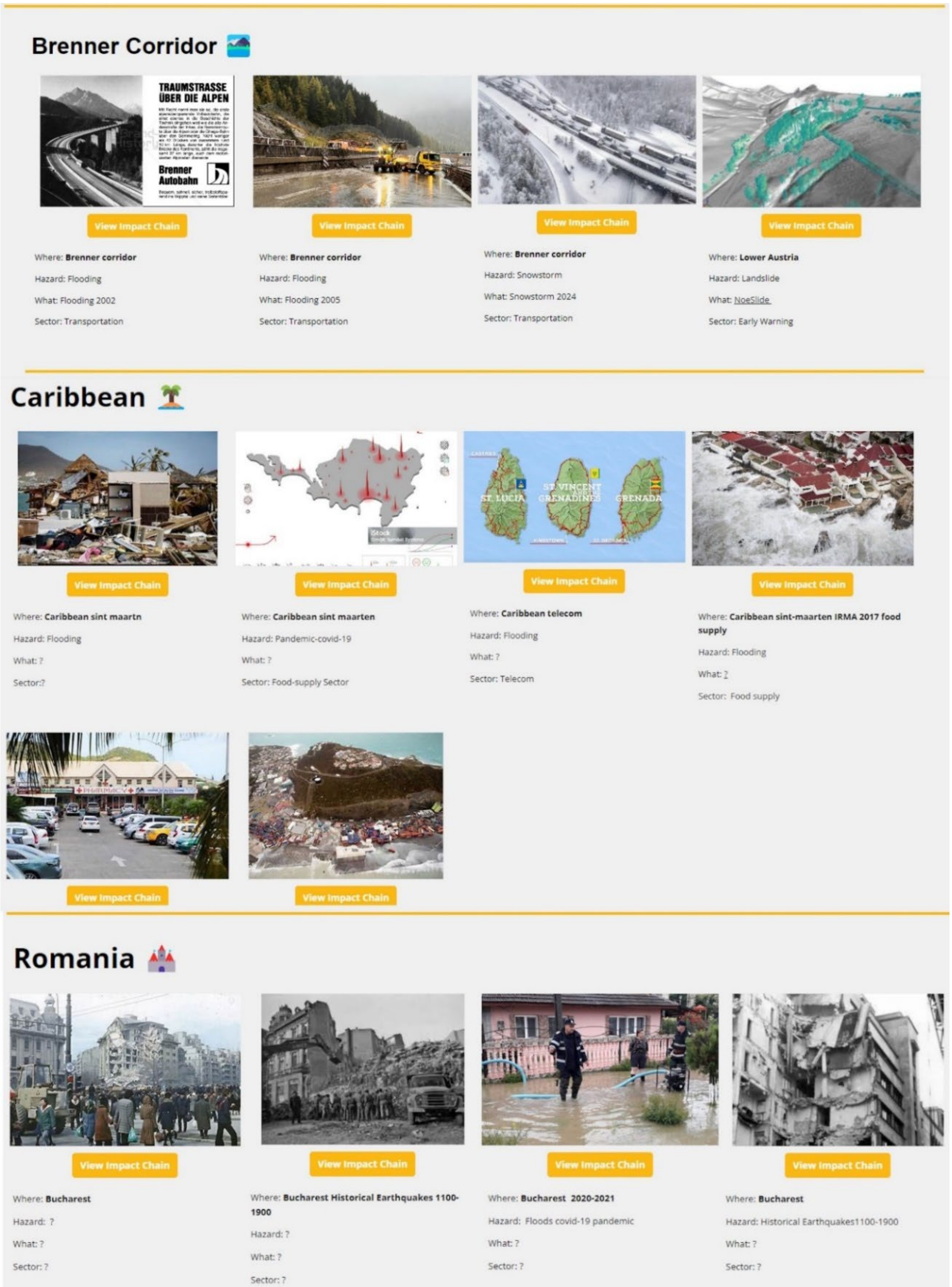

Figure 4.5: Selection of Impact Chains for different countries and events.

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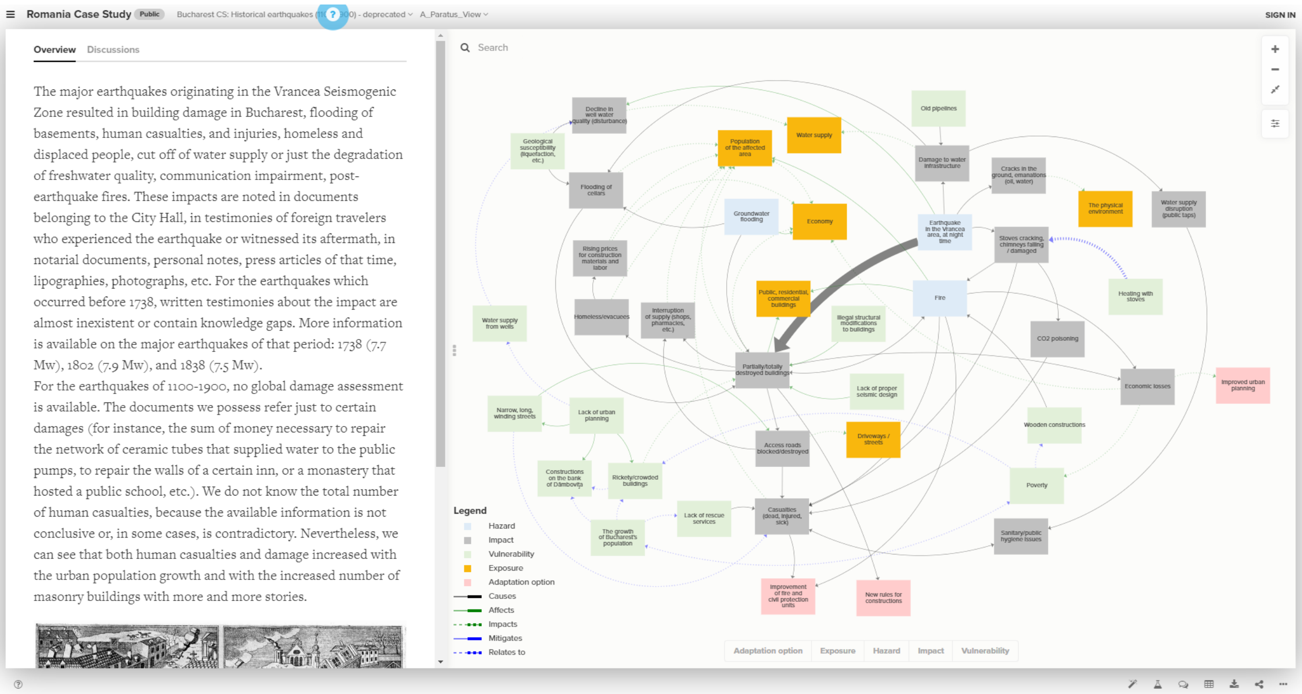

Figure 4.6: Example of an impact chain for historical earthquakes in Romania which appears when clicking a button on the previous page (Figure 4.5).

4.4 The Data Resources Page

The data resources page will provide an overview of the spatial data links that are developed in the project or that are internationally available to deal with data sources related to historical disaster events, hazard maps, elements-at-risk maps (build-up areas, land use, building footprints, transportation infrastructure, population etc.). The results of the remote sensing time series analysis that was used in combination with Artificial Intelligence and crowdsourcing techniques to improve data on historical events and for multi-temporal exposure datasets will be made available through this component. Climate scenarios for the different study areas will be provided from simulations by global climate models (CMIP6), including high-resolution models (HighResMIP) and regional climate models (CORDEX). These climate model data are freely available using the Earth System Grid Federation (ESGF). Post-processing of that data for selected case studies will be done to provide metrics for hazards, such as frequency and intensity of heavy rainfall, temperature, droughts, or wind. If available, already post-processed data will be used. In addition, information from regional climate reports produced by national governments and other agencies, such as IPCC, WMO and the World Bank, will be applied. For the Caribbean region (which is one of the case studies in the PARATUS project), climate scenarios are being developed by the KNMI with a focus on the Caribbean islands.

The data resources page also provides the opportunity to guide stakeholders towards the most suitable data types for specific applications. It serves therefore as an improved directory, where users can have more directed information than by using normal web-searches.

We are planning to add specific AI-based search tools to this page, that allow user to make more dedicated searches for data. Also a separation will be made between data that can be directly consulted in web-mapping applications and data that has to be used in specific applications or downloaded, which requires more detailed skills of the stakeholders.

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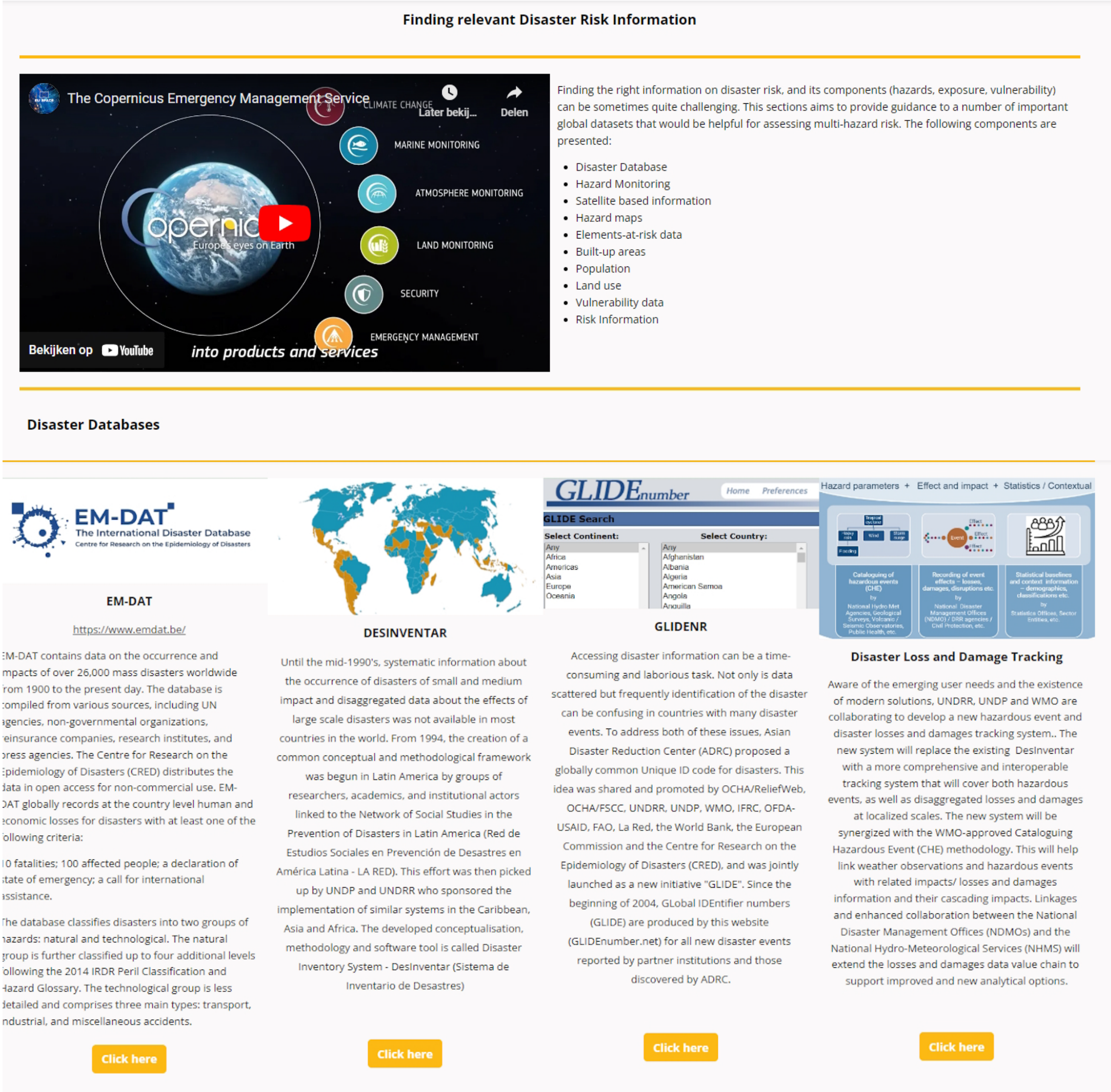

Figure 4.7: The initial version of the data search page of the Disaster Risk Stakeholder Hub, which will be further modified in the coming period.

4.5 The Hazard Assessment Tools Page

An important component of the DRS-HUB is a directory of hazard assessment tools, for different types of hazards, with a specific focus on freely available (and open source) tools. We want to collaborate with other EU funded projects that have partly overlapping objectives. Based on experience on other project the platform will contain a section with links to (online) tools for hazard assessment. Some of these are derived from the repository of hazard assessment algorithms that have been collected within the ANYWHERE[7] project and other projects. These will be further expanded with hazard models that consider certain hazard interactions. One of

[7] http://anywhere-h2020.eu/the-challenge/hazards/

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these is an integrated physically based modelling tool related to extreme rainfall events, earthquakes, and volcanic eruptions, called OPENLISEM[8] and FastFlood.org

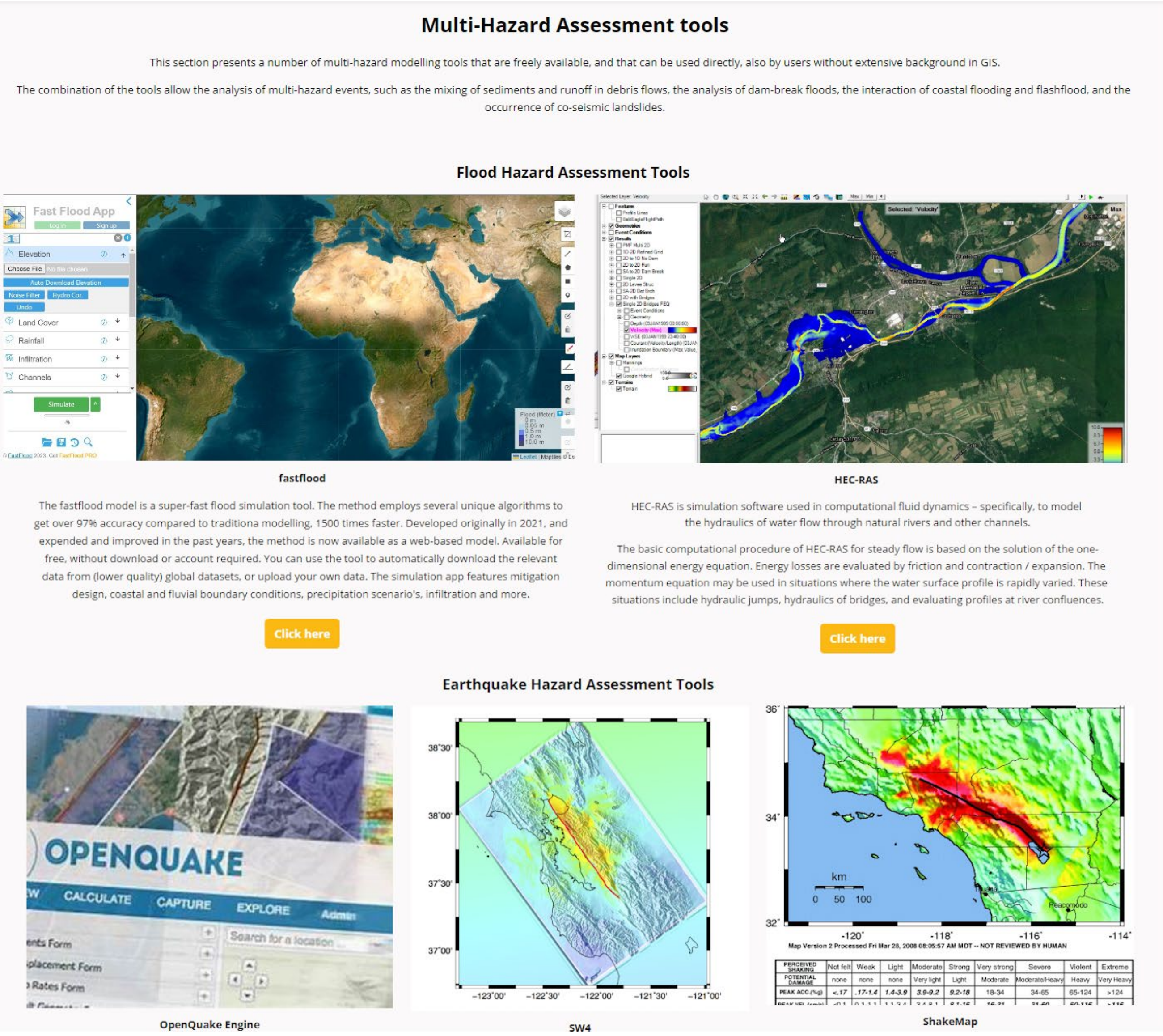

Figure 4.8: The page on Hazard Assessment tools.

4.5.1 The FastSlide Modelling Page

The combination of the two tools allow the analysis of multi-hazard events, such as the mixing of sediments and runoff in debris flows, the analysis of dam-break floods, the interaction of coastal flooding and flashflood, and the occurrence of co-seismic landslides.

There are currently several tools available for landslide susceptibility assessment, and for landslide runout assessment. Most of these tools require detailed information on soil depth, geotechnical and hydrological parameters, which are often difficult to obtain, especially at a watershed scale. Also the link between slope stability and landslide runout is often not done within the same tool. In order to address this problem the FastSlide tool has been developed. It allow super-fast simulation of Slope stability and Mass movements. It has three main components. First the soil depth is calculated using a numerical and statistical approach, after

[8] https://lisemmodel.com/

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which the slope stability is analysed and the volume of potential landslides is determined. The last step is the analysis of the runout of landslides. It runs directly from the website on the computers of the stakeholders without the requirement of installing the software. It uses initially a global dataset for a first estimation, but users can upload data their own area to improve the results. FastSlides considers both rainfall and earthquake-induced. For rainfall-induced landslides, design storms can be selected with intensity-duration-frequency. For earthquake-induced landslides Peak Ground Acceleration data can be used as input.

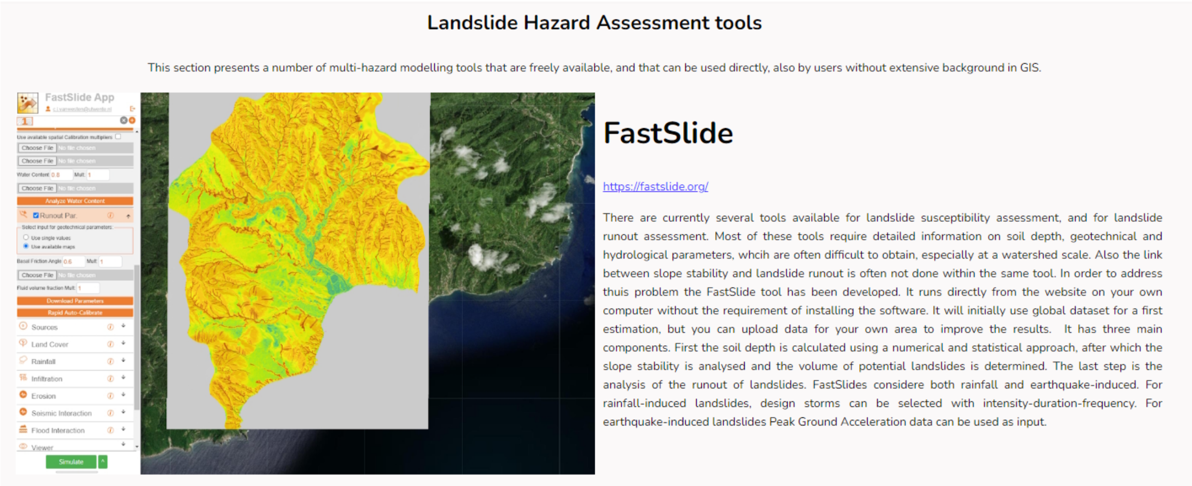

Figure 4.9: The Webpage on the FastFlood tool

4.5.2 The FastFlood Modelling Page

Although it is not possible to develop multi-hazard modelling tools for all hazards considered, we have developed tools for several hazard types. The first of these is the **FastFlood** tool. The current status of technological advancement does not allow to generate complete flood simulations in real-time for large geographic areas. This hinders warning-systems, interactive planning tools and detailed forecasts, and, consequently, the population cannot quickly or reliably be informed of where large masses of water will flow. Our novel method computes flood hazard maps much faster than current state-of-the-art methods. It applies physically based principles of steady-state flow to evade full dynamic aspects of flood simulations and directly estimates the relevant information for flood hazard, such as peak flow height, velocity, and flood arrival time. Performance indicators show similar or exceeding accuracy compared to traditional flow models depending on the type of event and quality of the used elevation data. In our tests, computational costs are reduced on average by a factor 1500. As a result, the developed method provides new perspective for the field of flood hazards, flood risk reduction through new types of early-warning systems, and user-interactive hazard assessment systems. As climate change is expected to aggravate flood hazard, the presented method can bring necessary efficiency to flood simulation, thereby saving lives and livelihoods. The tool allows the users to evaluate the effect of risk reduction measures (such as embankments, levees, deepening of the river bed etc) in an interactive manner.

The FastFlood tool is now fully operational and has been used by a wide range of users. It has attracted over 100 unique visitors per month, and has attracted several large organisations (such as the World Bank, and DG Echo) that want to utilise the tool in day-to-day disaster management practise. A start-up company has been established to further develop the tool, and apply it in different applications and environments.

Also training courses have been given to stakeholders in different parts of the world.

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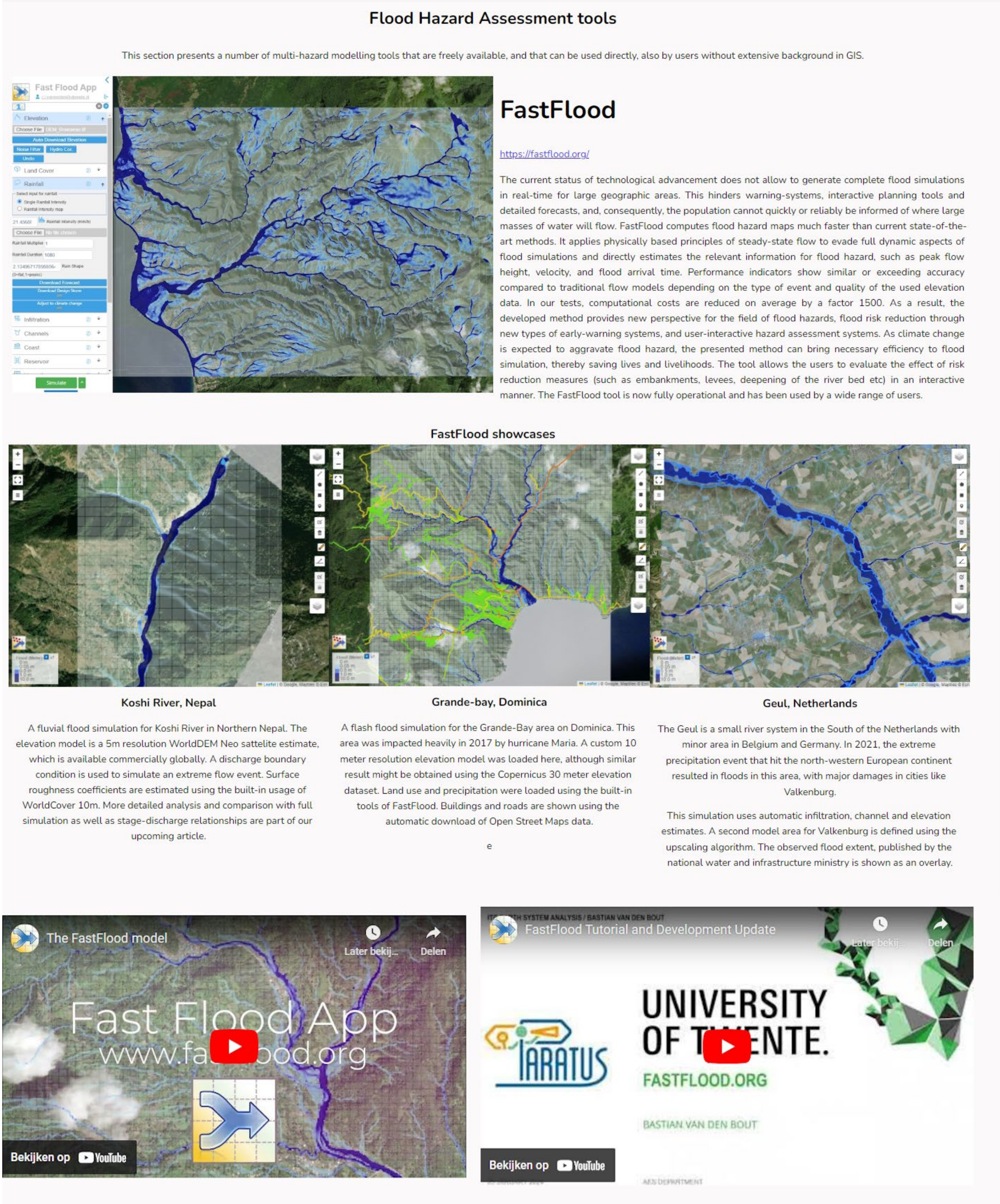

Figure 4.10: The Webpage on the FastFlood tool

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4.6 The Risk Assessment Tools Page

Another crucial component of the Disaster Risk Stakeholder Hub is composed of the tools for Multi-Hazard Risk Assessment. The page presents a number of the available tools and explains their main characteristics (open source, standalone, with GUI, requiring programming skills etc.) (Figure 4.11).

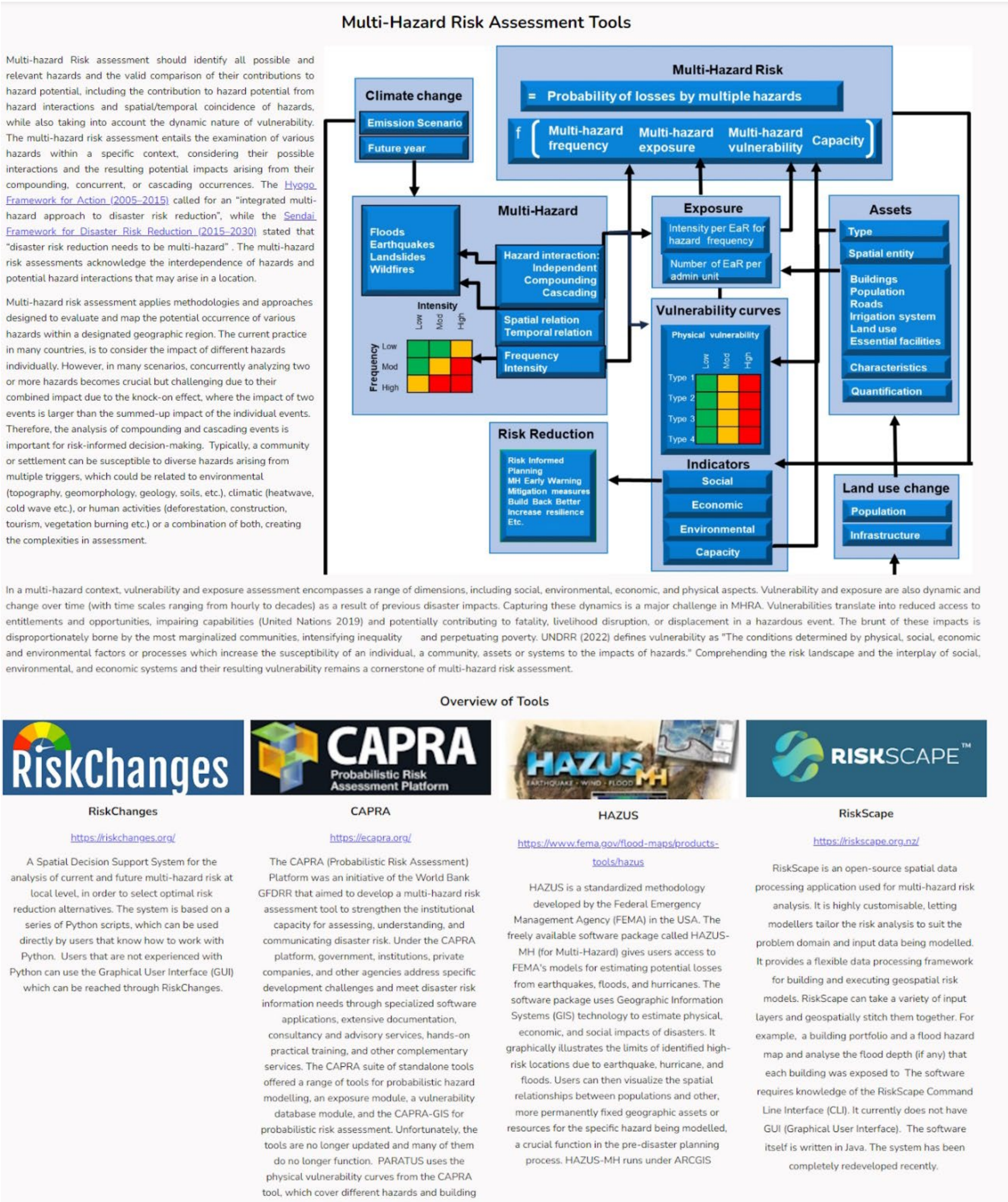

Figure 4.11: The page for the Risk Assessment tools

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One of the open source tools is developed within the PARATUS project: RiskChanges. (Figure 4.12)

Figure 4.12: The Webpage on the RiskChanges tool

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RiskChanges tool is for analysing dynamic exposure, vulnerability, and systemic risk, that can be applied in all phases of the disaster risk management cycle. RiskChanges is a Spatial Decision Support System for the analysis of current and future multi-hazard risk at local level, in order to select optimal risk reduction alternatives. The system has originally been designed in a European Research Project[9] by the University of Twente and other partners. Later the system was newly implemented using the most recent developments related to web-based open data analysis, by the University of Twente in collaboration with the Asian Institute of Technology, Geoinformatics Centre.

The current version of the RiskChanges tool[10] is an Open-Source tool for multi-hazard risk assessment. The system is based on a series of Python scripts, which can be used directly by users that know how to work with Python. The code[11] is available in GitHub. This version of the RiskChanges Library is customized for local computation, and users can install the library[12] directly from GitHub or from PIP and start working with their own data, modifying the code. To further understand how the codes work, there are Jupyter notebooks in this project. More information can be found in the ReadTheDocs[13]. Users that are not experienced with Python can use the Graphical User Interface (GUI) which can be reached through RiskChanges.

4.7 The Risk Reduction Page

The risk reduction page will guide stakeholders to the optimal risk reduction alternatives, given their specific situation in terms of scale, geographic area, hazard interactions, and applications. They will consider the specific needs of stakeholders (including especially vulnerable groups), incorporate the uncertainty of the scenarios, and compare different alternatives for risk reduction.

PARATUS will actively involve a range of stakeholders to develop and test methods and tools for selecting appropriate disaster risk mitigation measures that address Social Sciences and Humanities aspects (including gender aspects and disadvantaged groups, i.e., migrants). We will later on in the project develop a wiki-type with suggestions for adaptation measures based on multi-hazards, scale of application and sector. This is based on extensive literature analysis considering examples such as the GreenBook[14], and Dynamic Adaptation Pathways[15]. This component will critically assess existing approaches and offer a special selection in the DRS-HUB, to be used in processes of the case study sites, but also offered to the learning sites. Co-production of adaptation and mitigation options will utilise The Learning Lab approach[16]. This approach is founded on principles of participation and trans-disciplinary action research. The Learning Labs are a series of interactive and deeply participatory workshops to facilitate the co-creation of adaptation and DRR options. This approach has been developed and tested by the Climate Centre and University of Cape Town in the FRACTAL[17] project - testing the City Learning Lab approach in 9 African cities. In PARATUS the Learning Lab approach will be used to facilitate deep stakeholder engagement with a range of stakeholders using an action research process.

4.8 The Best Practices and Examples Page

In order to address the specific requirements of the stakeholders we are also developing a page with best practices and examples, which are organised by country. Through these examples, stakeholders might get ideas to implement specific actions related to DRR in their own area. This page is still under development and will also take further shape after more stakeholder interactions.

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[9] http://www.changes-itn.eu/
[10] http://www.riskchanges.org/
[11] https://github.com/RiskChanges/RiskChangesDesktop
[12] https://pypi.org/project/RiskChangesDesktop/
[13] https://sdss-documentation.readthedocs.io/en/latest/
[14] https://greenbook.co.za/
[15] https://doi.org/10.1016/j.envsci.2020.11.003
[16] http://www.thelearninglab.nl/
[17] https://www.fractal.org.za/wp-content/uploads/2020/03/IS1-FRACTAL-city-learning-lab-approach.pdf

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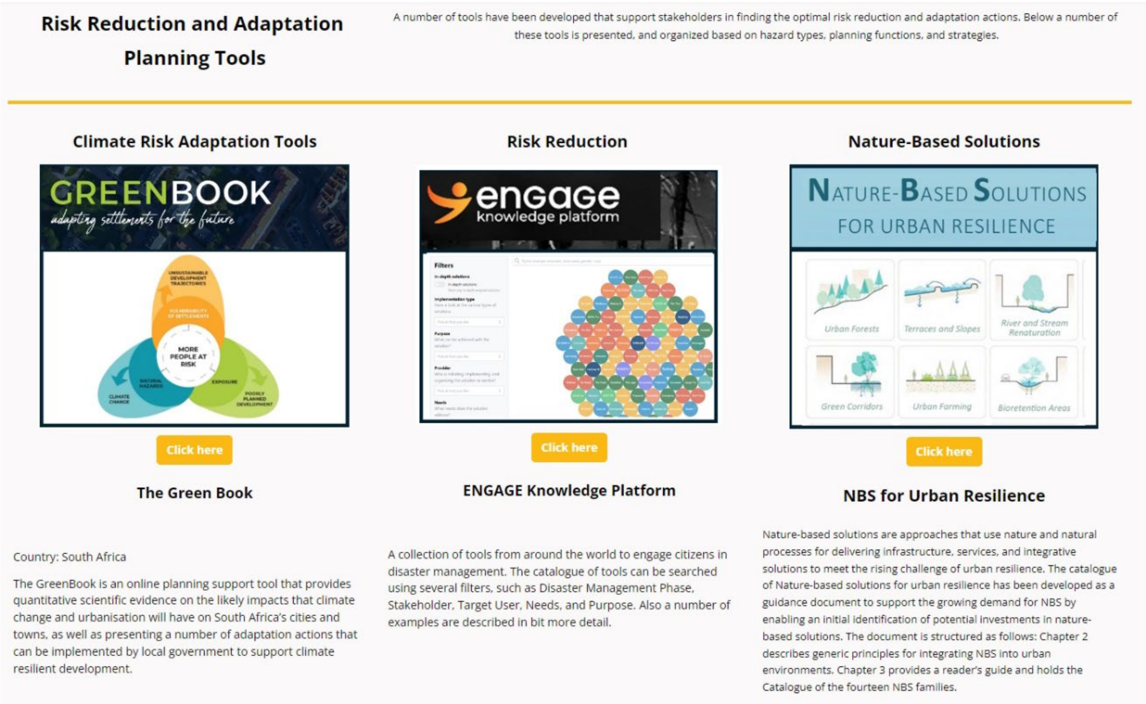

Figure 4.13: The Webpage on the Risk Reduction Page

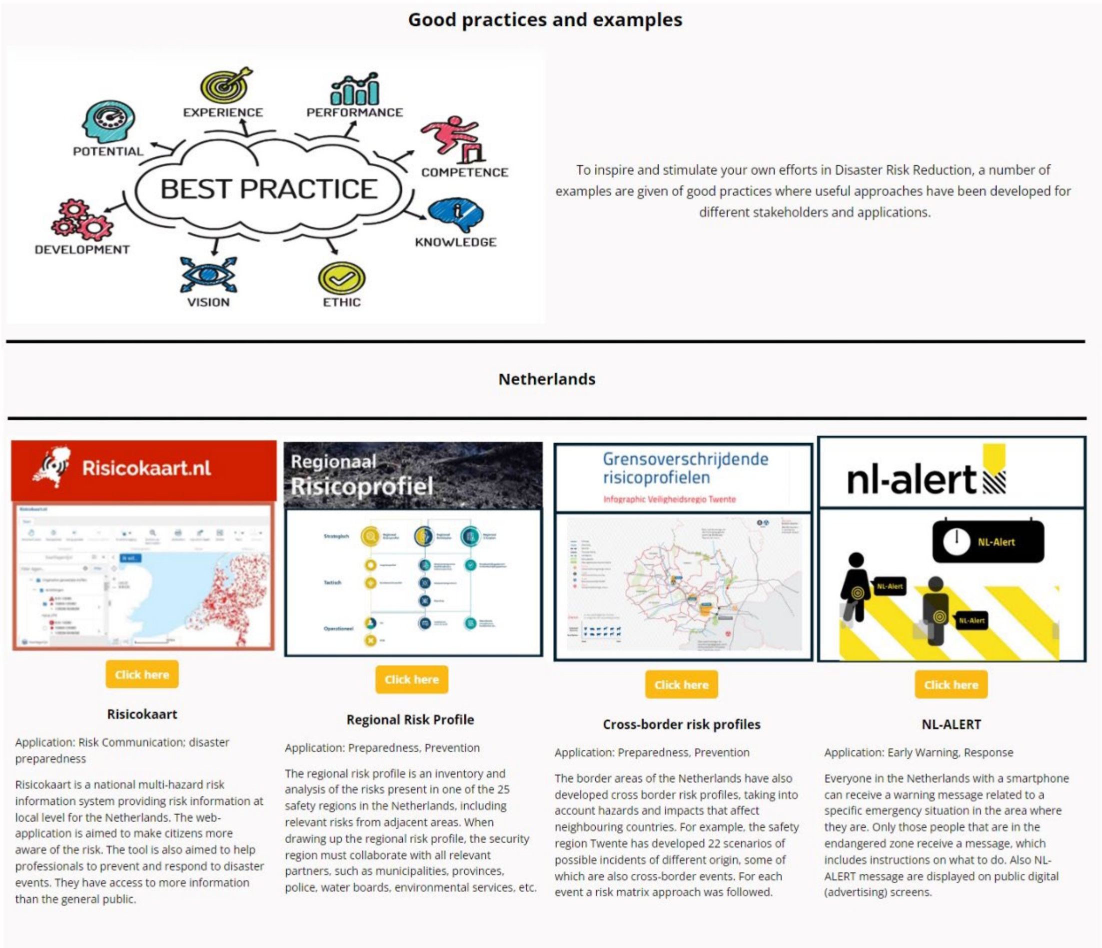

Figure 4.14: The Webpage on the Best Practices and examples. Here examples from the Netherlands are shown

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4.9 The Serious Games Page

With stakeholders, we will co-develop two serious games exploring creativity and experiential learning, using in-person/video processes and augmented reality. Serious Games are facilitating deeper learning in complex contexts, enabling participants to learn experientially and harness their creativity. The Climate Centre and CRS have been working with Serious Games for more than a decade[18]. They will collaborate with other groups[19] [20] that have a wide experience with Serious Gaming, an experiential process rooted in a more active, experiential methodology based on Kolb's Cycle[21]. This approach highlights the fact that knowledge acquisition is "created through the transformation of experience" and requires a more interactive environment that the players may explore. We are also collecting information on serious games related to DRR and will offer a guided directory. The example shown in Figure 4.15 is only the first version, and throughout the project more examples will be added, and guidance given on the target audience, aim of the game, duration etc.

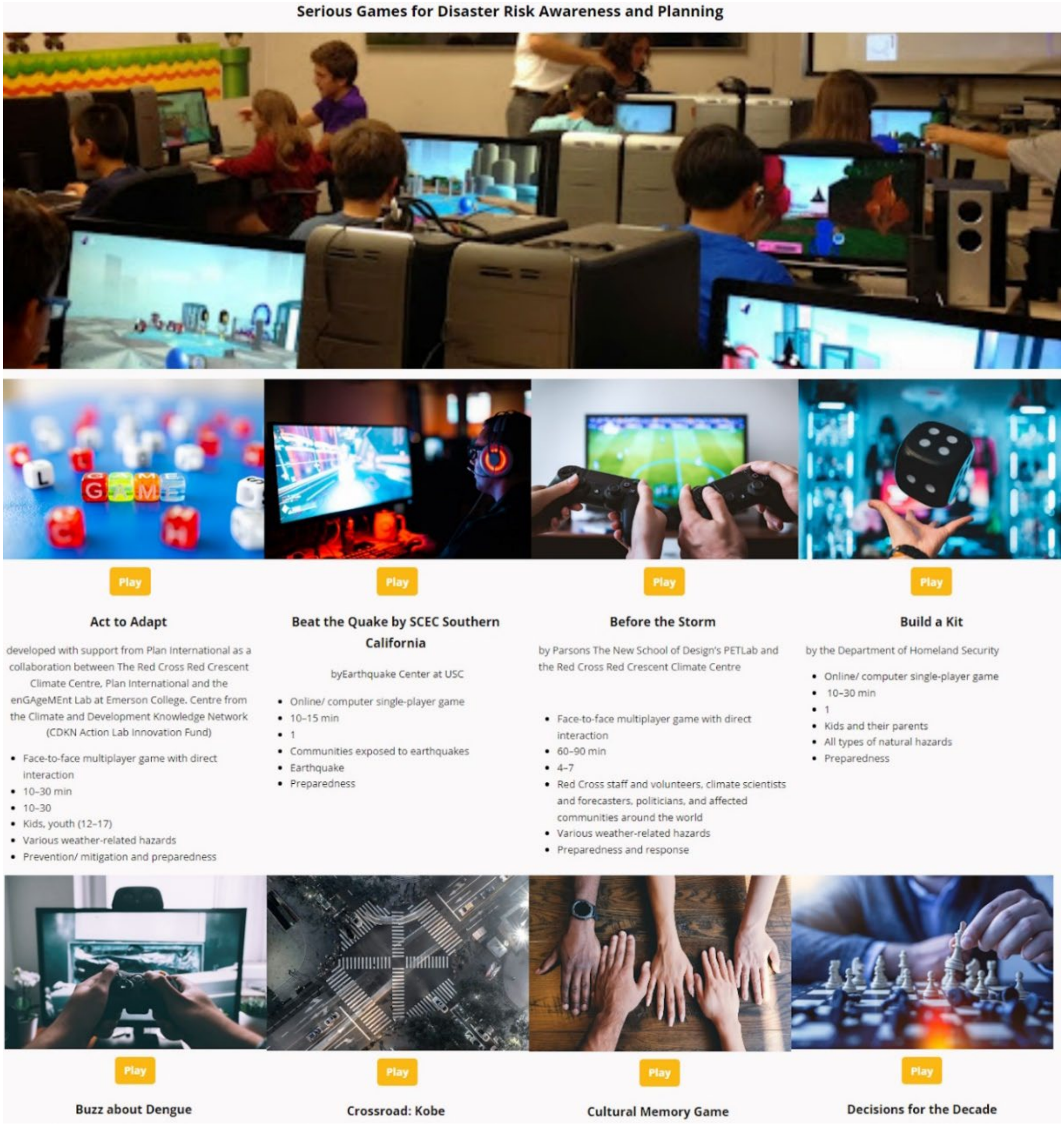

Figure 4.15: The page for the serious games

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[18] http://www.climatecentre.org/downloads/files/Games/CDKNGamesReport.pdf
[19] https://www.dkkv.org/de/serious-gaming
[20] https://www.fastcompany.com/90323110/these-board-games-play-out-how-climate-change-will-reshape-our-cities
[21] https://www.researchgate.net/publication/235701029_Experiential_Learning_Experience_As_The_Source_Of_Learning_And_Development

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5. Further Development

The PARATUS information service will consist of components that provide useful information to first and second responders and other stakeholders in Disaster Risk Management to evaluate the impact chains of multi-hazard events with particular emphasis on cross-border and cascading impacts. This PARATUS platform can be visualized as a website with several blocks. When users click on a block, they will be taken to a new page in which the specific component is worked out, and where the information is given. This can be also a page on another location (e.g., the WIKI on terminology is hosted on another website). *Figure 5.1* gives an impression of the PARATUS information service.

5.1 Further Development of Existing Pages

The PARATUS project will contain a section that links to the terminology used in disaster risk management. This can be quite confusing, even though there are international agreed guidelines for terminology, such as:

- UNDRR Sendai Framework Terminology on disaster Risk Reduction[22]
- UNDRR Hazard definition & classification review (2020)[23]
- UNDRR Hazard Information Profiles (2021)[24]

The terminology used for compounding and multi-hazards and their impact is still rather confusing. Due to multiple hazards or drivers (such as heatwaves and droughts) occurring at once, earlier events or climate conditions making a system more vulnerable to subsequent events (for example intensive rainfall on saturated soils), or spatially coexisting events leading to local or global compounding effects (for instance globally harmonized heatwaves disturbing global production of food), when multiple drivers and/or hazards combine, their effects are frequently amplified[25]. The term *compound events* were introduced by IPCC Special Report on Climate Extremes (SREX) in 2012, and now, it is integrated within the risk framework of IPCC as "a combination of multiple drivers and/or hazards that contributes to societal or environmental risk"[26]. Studying compound events is a complex task, which often requires a multidisciplinary approach involving the understanding of the underlying physical processes beyond the impact, climate, weather elements, and advanced process-based and statistical modelling (Bevacqua et al., 2017). Better understanding their occurrence, quantifying key characteristics, analysing their drivers, and projecting how they will change in the future is of high societal importance (Sillmann et al., 2019). Traditional risk assessment approaches often consider only one driver at a time, which consequently causes the underestimation of risk. The Independent multi-hazard approach does not consider hazard interactions and directly deals with international policies of sustainability and risk reduction, for example: Agenda 21[27], the Johannesburg Plan[28], and the Hyogo Framework for Action[29]. The spatial approach was used for these policies, using the "all-hazards at place approach" by Hewitt and Burton (1971) and Gill and Malamud (2014) debated it as a "multilayer single hazard" approach, which involves approaches for single and multi-hazard risk assessment[30]. Currently, more attention is being called to multi-hazards and multi-risks[31,32]. The PARATUS platform will link to other resources that provide a review of approaches to multi-hazard risk assessment.

The 'Wiki-style online crowdsourcing platform of multi-risk methods, models, and tools' was produced as part of the MYRIAD-EU project. The aim of the task was to develop a Wiki-style online crowdsourcing platform of

[22] https://www.undrr.org/terminology
[23] https://www.undrr.org/publication/hazard-definition-and-classification-review-technical-report
[24] https://www.undrr.org/publication/hazard-information-profiles-hips
[25] https://www.nature.com/articles/s41558-018-0156-3
[26] pp. 1513–1766, doi:10.1017/9781009157896.013.
[27] https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf
[28] https://digitallibrary.un.org/record/478154
[29] https://www.unisdr.org/2005/wcdr/intergover/officialdoc/docs/Hyogo-framework-for-action-english.pdf
[30] https://www.sciencedirect.com/science/article/pii/S2212420922000486?via%3Dihub
[31] https://meetingorganizer.copernicus.org/EGU2018/EGU2018-5439.pdf
[32] https://doi.org/10.5194/nhess-22-1487-2022

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examples of qualitative and quantitative multi-hazard, multi-risk methods, models, and tools (approaches), including examples of their application. The wiki design, development, and deployment were undertaken by BGS. It was created using the freely available software, MediaWiki, which is designed for open content, and is hosted by the BGS. The current content is classified into two main categories: 'multi-hazard risk assessment' and 'multi-hazard risk management'. In addition to overviews of multi-hazard risk assessment and management approaches, the wiki, called the Disaster Risk Gateway[33], also contains definitions for key terms.

The PARATUS platform will contain a section that links to the platforms developed by a number of "sister projects", which are funded under HORIZON Europe programme. Especially the projects MEDIATE, C2IMPRESS, MYRIAD-EU and the HuT Nexus.

The European research and innovation supporting programmes Horizon 2020 and Horizon Europe connect diverse actors, engaged to strengthen the impact of research and innovation in developing, supporting, and implementing EU policies, while tackling specific global challenges. Their active communication and collaboration through platforms such as the Community for European Research and Innovation for Security CERIS and clusters leads to deeper exploration of challenges and broader uptake of generated solutions, strengthened synergies and magnified benefits of research in strategic societal challenges. The Crisis Managers Innovation Network Europe CMINE is offering a dynamic, safe workspace to the established Clusters of projects, supporting their interaction-focused objectives throughout the project implementation cycles. PARATUS is collaboration with a number of other projects in the Societal Resilience Cluster.

With these projects we are having regular exchanges planned in the form of joint webinars, joint sessions during conferences, and attending each other's general assembly meetings. We are also actively investigating how we can reach a certain level of synergy, and potentially co-developing certain components. However, this needs to be in accordance with the Grant Agreements of the projects, which may make the joint development of tools more difficult.

In any case we are planning to work together with other projects and explore if and how we can incorporate other tools in the DRS-HUB.

5.2 Planned Pages

There are also a number of pages that have not yet available as the contents will be developed only later on in the project period.

- **Impact-based forecasting tool**

The Impact Based Forecasting (IBF) Portal takes the theory about risk, vulnerability and exposure and transforms it into actionable practice for local users such as disaster managers (see section 3.1). It is meant to be the one stop shop for disaster managers to find all the relevant information for them to respond adequately to an upcoming hazard.

- **Resilience to systemic risk evaluation tool**

It will not be possible to quantify all the indirect impacts using the RiskChanges tool, either because the conditions that lead to an indirect impact are unknown or the data for that is missing. Therefore, the aim is to also develop an indicator-based approach, which is linked to the components of the impact chains, and the relation between the components.

- **Scenario development tool**

PARATUS will develop a method to assess multi-hazard and multi-sector impact chains that will be applied to co-developed scenarios considering changes in climate conditions and dynamic exposure information and their interactions. Scenarios can be co-created with stakeholders using participatory planning tools. The scenarios

[33] https://www.disasterriskgateway.net

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refer to possible changes in hazard, exposure, and vulnerability. Hazard changes are related to changes in hazard types, frequency and intensity following climate change scenarios presented by the latest IPCC reports. These are translated into the components needed for risk assessment. Changes in exposure are evaluated based on the changes in drivers (demographic, economic, social, political, and climate change feedback), resulting in different land use, population, and infrastructure patterns. Changes in vulnerability will be represented in changes to physical vulnerability curves and holistic vulnerability indicators.

- **Adaptative scenario development tool**

PARATUS will co-develop context-specific decision-making tools suitable for stakeholders in different sectors and risk governance settings. They will consider the specific needs of stakeholders (including especially vulnerable groups), incorporate the uncertainty of the scenarios, and compare different alternatives for risk reduction.

- **Collaborative planning tool**

The aim of collaborative decision support procedures is to involve stakeholders in decision making to solve conflicting issues. Consensus building methods include developing alternative planning scenarios, brainstorming jointly on evaluation criteria for certain plans, sketching different plan alternatives, or assigning individual priorities and criteria weights during an assessment. Structuring decision making processing following a sequence of converging and diverging steps helps to better integrate consensus building steps into the process.

It is important to stress that the final set of components will be determined based on further interaction with stakeholders.

One of the key components of the PARATUS Information Service will be the Impact Chain WIKI. This is an entirely new concept, and this will be one of the central components. It will offer a new way of viewing the impact of historical disaster events, though an impact chain, which can be seen as a tree-like structure showing the interconnections between the triggering event(s), the hazard interactions, exposed elements-at-risk and their vulnerabilities and their direct and indirect impacts.

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101073954