

Periodic Technical Report M1-M18



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Periodic Technical Report M1-M18

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With contributions from all project partners and participants

Abstract

This report summarises the work carried out during the first 18 months of the MYRIAD-EU project. It reports on progress related to the project objectives, Work Packages and Tasks, expected impacts, communication and dissemination, data management, and financial aspects. Several major achievements of this reporting period have been:

- Completing a thorough diagnosis of multi-hazard, multi-risk management challenges (WP1);
- Launching a WIKI-platform (www.disasterriskgateway.net) (WP1) and designing a prototype dashboard (WP2);
- Co-developing an initial framework for multi-hazard, multi-sector, systemic risk management (WP2), and testing its usefulness during five Pilot Workshops (WP3);
- Successfully starting the 5 MYRIAD-EU Pilot studies and holding first Pilot Workshops (WP3);
- Designing methods for capturing evidence of dynamic feedbacks between risk drivers (WP4);
- Developing a first global multi-hazard database, MYRIAD-HESA (WP5);
- Publishing a conceptual approach for designing Dynamic Adaptive Pathways in a Multi-Risk setting (WP6);
- Developing MYRIAD-EU as a well-recognised brand and organisation of /participation in scientific, practice, and policy events (WP7);
- Developed effective and inclusive project management practices and held two hybrid General Assemblies (WP8)
- Publishing output on our [MYRIAD-EU Zenodo Community page](#).

Dissemination level of the document

- Public
- Restricted to other programme participants (including the Commission Services)
- Restricted to a group specified by the consortium (including the European Commission Services)
- Confidential, only for members of the consortium (including the European Commission Services)

Version History

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V3	20/06/2023	See authors list	Explanations for personnel costs added for UHAM to Section 5.3 (Use of resources) as requested by the EC. New submission date for revision to D1.3 added to Table 1.
V4	29/06/2023	See authors list	Extra information added to Section 1.1.1 to explain what is lacking and what will be corrected in D1.3, as requested by P.O.

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1 Explanation of the work carried out by the beneficiaries and overview of the progress

MYRIAD-EU's vision is to catalyse a paradigm shift in how complex natural hazard risks are assessed and managed. To achieve this, the overall aim of MYRIAD-EU is that by the end of the project we will be able to develop forward-looking disaster risk management pathways that assess trade-offs and synergies of various strategies across sectors, hazards, and scales. This report summarises progress towards this overall aim during the first reporting period (Months 1-18).

The project workflow and timeline are designed around 5 major steps, as shown in Figure 1. Months 1-9 were dedicated to Step 1, "Common Baseline". During the first 6 months of this step the vast majority of the scientific work was dedicated to Work Package (WP) 1 "Diagnosis", in which all consortium partners were involved. This proved to be a useful strategy for starting a project with the complexity of MYRIAD-EU. It allowed time and resources for partners to get to understand each other's perspectives, challenges, and ways of working, as well as for us to properly review past methods, models, tools, policies, policy-making processes, and governance for multi-hazard, multi-risk management. This was essential for the "handshake" with WP2 (Framework and synthesis), during Months 6-9, in which the baseline knowledge from WP1 was used to co-develop an initial framework for multi-hazard, multi-sector, systemic risk management. At Month 10, we moved into Step 2 "Initial Design & development", which runs until Month 24. During this step, all scientific WPs have been in full swing.

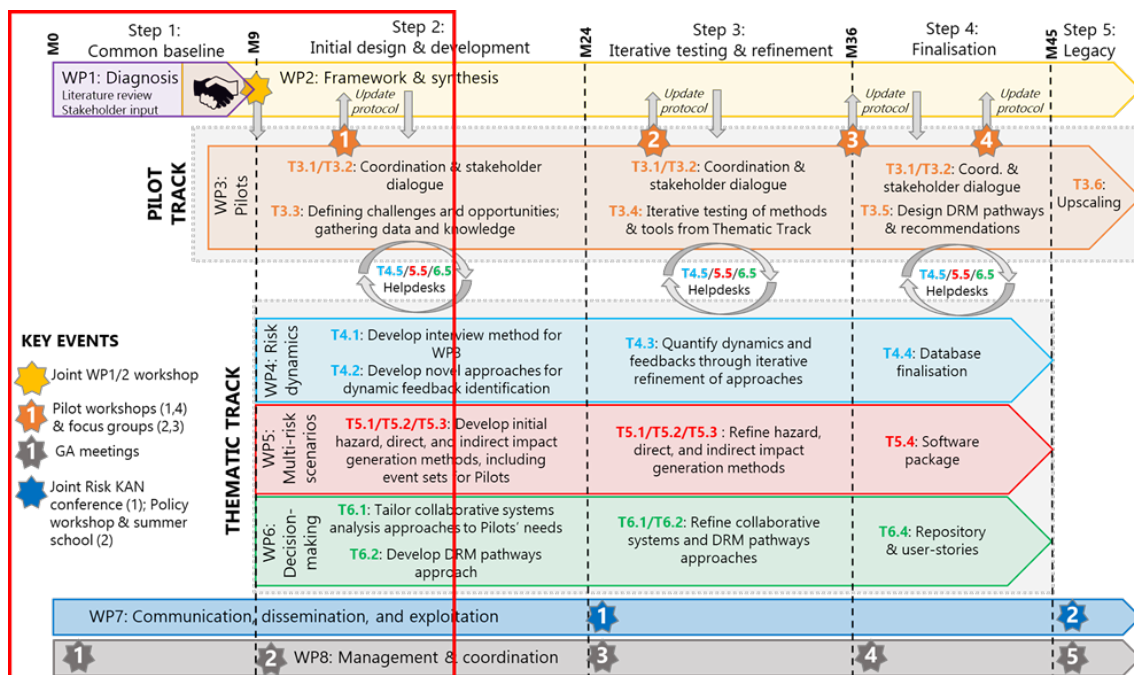


Figure 1: Timeline of MYRIAD-EU, with the first reporting period shown in the red box

Through this process, MYRIAD-EU has achieved all expected results of the first reporting report, with all planned deliverables and milestones achieved. Several major achievements of this reporting period have been:

- Completing a thorough diagnosis of multi-hazard, multi-risk management challenges, including the publication of a handbook of multi-hazard, multi-risk concepts, definitions, and indicators and a report on policies, policy-making processes, and governance for multi-hazard, multi-risk management (WP1);
- Launching a WIKI-platform (www.disasterriskgateway.net) (WP1) and designing a prototype dashboard, for further development during 2023 (WP2);

- Co-developing an initial framework for multi-hazard, multi-sector, systemic risk management (WP2), and testing its usefulness with our Pilot Core Users and Pilot Stakeholders during five Pilot Workshops (one in each pilot region (WP3));
- Successfully started the 5 MYRIAD-EU Pilot studies, including: developing detailed work plans, defining current challenges and opportunities, establishing Pilot Core User and Pilot Stakeholder groups, and holding first Pilot Workshops (WP3);
- Designing methods for capturing evidence of dynamic feedbacks between risk drivers, by designing studies using various novel methods including: interviews, literature reviews, AI-based approaches, and using remote sensing data to map recovery times (WP4);
- Developing a first global multi-hazard database, MYRIAD-HESA (WP5);
- Publishing a conceptual approach for designing Dynamic Adaptive Pathways in a Multi-Risk setting (DAPP-MR) (WP6);
- Developing MYRIAD-EU as a well-recognised brand through a bold graphic charter, and a range of communication and dissemination activities, including: website with news and blogs, active Twitter account, and organisation of /participation in scientific, practice, and policy events, including: UNDRR European Forum for Disaster Risk Reduction, DRMKC annual seminar, RISK KAN seminars, and annual meetings of practitioner organisations such as ERIAFF, FEHRL, HOTREC;
- Developed effective and inclusive project management practices and held two hybrid General Assemblies, as well as regular communication with External Advisory Board, Sectoral Sounding Board, and Early Career Researcher Board;
- Published >10 peer-reviewed scientific papers relating to MYRIAD-EU, all of which can be found on our [MYRIAD-EU Zenodo Community page](#).

A highlight of MYRIAD-EU (as also highlighted by our External Advisory Board) is the high and integral involvement of Early Career Researchers (ECRs) within the project, both in terms of content and management. MYRIAD-EU has installed an Early Career Researchers Board (ECRB), consisting of 4 elected members (with gender balance). The ECRB elects an Early Career Representative, serving for a 1-year term, who becomes a full member of the MYRIAD-EU management team. This ensures that the views of the ECRs are fully represented at the highest level within the consortium. Moreover, the ECRB organises various activities (including organising sessions at General Assemblies and external conferences, practice presentation sessions prior to conferences, and social events at General Assemblies and conferences) that have led to a very active and visible network of ECRs both within the project and to the outside world.

1.1 Objectives

In this section, we describe the progress achieved during this period towards the objectives listed in the Description of Work.

A. Develop a common baseline and understanding on multi-hazard and multi-risk definitions, indicators, functions, methods, tools, and policies

We have developed a handbook of multi-hazard, multi-risk definitions and concepts (D1.2), which brings together important terminology and definitions used in the multi-risk literature, as well as an overview of key indicators and approaches identified in the literature. We have also developed a report on policies, policy-making processes, and governance for multi-hazard, multi-risk management (D1.3), which investigates and reviews the current multi-risk governance practice in Europe. We used the findings of these deliverables to populate our WIKI-platform, Disaster Risk Gateway (www.disasterriskgateway.net) (D1.1). The platform is now online and we have been disseminating it at various policy and practice events. Activities are planned in the second reporting period to encourage people from within and outside the project to contribute content, and to promote its use within the multi-risk community.

B. Co-develop and co-evaluate a harmonised framework in five multi-hazard, multi-sector, multi-scale Pilots bridging science and practice

We have co-developed an initial version of our framework for multi-hazard, multi-sector, systemic risk management (D2.1), together with guidance protocols for implementing the framework. An initial version of the framework was developed based on the literature review and stakeholder interviews carried out as part of the Diagnosis (WP1). This version was discussed with stakeholders at the joint WP1/WP2 workshop at IIASA in April 2022, and the feedback from this workshop was used as input to the version presented in the deliverable. Since then, the visuals used to represent the framework have been improved, and the framework has been submitted as a paper to a scientific journal (in review). The initial version of the framework was presented to the Pilot Core User Groups and Pilot Stakeholder Groups during the Initial Pilot Workshops held in Autumn 2022. The general feedback on the usefulness of the framework was positive, and specific feedback has been used to update the framework and guidance protocols (Milestone 7). This iterative process of testing, feedback, and improvement will continue throughout the project.

C. Build a catalogue of dynamic feedbacks between risk drivers, including systemic vulnerability

A scientific paper has been published discussing challenges and opportunities of assessing dynamic vulnerability (De Ruiter and Van Loon, 2022). Various approaches are being developed within WP4 to identify empirical evidence of dynamics and feedbacks between risk drivers. This includes an interview methodology, which has been developed to be carried out within our Pilot regions (D4.2), and which will be implemented during the second reporting period. A range of other novel approaches are being developed, in particular by the ECRs involved in WP4, including: developing a global database of vulnerability indicators and datasets in cities; developing a method to examine post-disaster recovery times using nightlight data and a method to examine interactions and impacts of heatwave stress, droughts and wildfires in Scandinavia; using Machine Learning Methods to examine relationships between hazard impacts and their drivers; and using night-time light data to assess recovery times.

D. Develop and test software for generating quantitative and qualitative multi-hazard and multi-risk scenarios

Work has commenced on designing mock-up versions of the software and scoping its potential capabilities. This will be presented and discussed at the third General Assembly in May 2023, and takes input from the needs expressed during the Pilot Workshops carried out in Autumn 2022. The main concrete output contributing towards this software has been the development of the first global multi-hazard event database (MYRIAD-HESA). This database takes hazard footprints from 9 different single hazards, and uses an algorithm to derive a multi-hazard database that accounts for both spatial and temporal overlap between different single hazards (Claassen et al., 2023).

E. Develop forward-looking DRM pathways in five Pilots

The Pilots formally commenced activities in Month 7, and the Pilot activities during the first reporting period were: developing clear terms of reference for engagement with our Pilot Core User Groups and Pilot Stakeholder Groups (D3.1); developing a detailed work plan for the period covering Months 7-24 (D3.2a); engaging local stakeholders within the pilot regions to join either the Pilot Core User Group or Pilot Stakeholder Group; and planning and carrying out the Initial Pilot Workshops in Autumn 2023 (Milestone 11). The overall feedback from our stakeholders following the workshops was positive, with stakeholders expressing enthusiasm to remain committed, and we gathered useful feedback for improving the MYRIAD-EU framework and setting priorities for the pilots studies.

F. Synthesise the results

We have published a scientific paper (Ward et al., 2022) outlining challenges in multi-hazard and multi-risk thinking, which sets out the MYRIAD-EU research agenda. This will guide progress towards addressing the identified challenges in the coming years. We have also published a scientific paper

synthesising different approaches that can be used to assess dynamic vulnerability (De Ruiter and Van Loon, 2022). Several of these approaches will be tested within MYRIAD-EU.

G. Improve knowledge exchange on multi-hazard risk assessment and management.

The MYRIAD-EU website (www.myriadproject.eu) was launched in December 2021. It features blogs, regular news items (e.g. “Meet the young researchers behind MYRIAD-EU” and “What are our experts reading?”), and ad-hoc news items relating to new scientific papers, deliverables, and other project activities. MYRIAD-EU’s bold and bright branding makes the project easily recognisable. A dedicated Plan for the dissemination and exploitation of results (PDER, D7.1) is available. The Disaster Risk Gateway WIKI-platform (www.disasterriskgateway.net) has been launched, and a mock-up of the MYRIAD-EU dashboard has been developed and is currently being hosted on an internal server. We have published >10 peer-reviewed scientific papers, and attended a large number of scientific, practice, and policy events (see Section 2). Further two-way interaction has been ensured through a WP1/2 stakeholder workshop in April 2022, 5 Pilot workshops in Autumn 2022, and various interviews with stakeholders throughout the reporting period.

1.1.1 Deliverables produced in the first reporting period

Table 1: Overview of deliverables in the Grant Agreement in the first reporting period

No.	Title	WP	Lead partner	Status
D1.1	WIKI-style online crowdsourcing platform of multi-hazard, multi-risk methods, models, and tools	1	UKRI BGS	submitted
D1.2	Handbook of multi-hazard, multi-risk concepts, definitions, and indicators	2	UKRI BGS	submitted
D1.3	Report on policies, policy-making processes, and governance for multi-hazard, multi-risk management	3	UKRI BGS	In revision*
D2.1	Initial framework and guidance protocol document	2	IIASA	submitted
D3.1	Terms of reference for Pilot core user and stakeholder groups	3	UKRI BGS	submitted
D3.2	Detailed annual work-plan for each Pilot	3	CMCC	submitted
D4.1	Internal documentation of WP4 Helpdesk contacts and objectives	4	VUA	submitted
D4.2	Guidelines on methodology for extracting empirical evidence from Pilots	4	CMCC	submitted
D5.1	Internal documentation of WP5 Helpdesk contacts and objectives	5	Risklayer	submitted
D6.1	Internal documentation of WP6 Helpdesk contacts and objectives	6	DRES	submitted
D6.2	Guidance document for Pilots on collaborative systems analysis approaches	6	DRES	submitted
D7.1	Plan for the dissemination and exploitation of results (PDER)	7	Arctik	submitted
D8.1	Quality, Ethics, and Risk Management Plan	8	VUA	submitted
D8.2	Consortium agreement	8	VUA	submitted
D8.3	Data management plan	8	Risklayer	submitted
D9.1	POPD - Requirement No. 2	9	VUA	submitted

* Revision to deliverables based on review meeting of Months 1-18

D1.3 was originally submitted in July 2022. During the review meeting of the first reporting period, the reviewers raised several questions relating to this deliverable and revisions have been requested. We will resubmit a revised version of D1.3 by the new deadline of 1 October 2023, as agreed with the Project Officer. Specifically, we will: review the text to carefully address any of the inconsistencies identified by the reviewers; add details of the interviews and so forth that were used in guiding the review; clarify the inclusion/non-inclusion of some of the analysed policies in the main text/deliverable; strengthen the link between parts 1 and 2 of the report as much as possible; revise the recommendations in the executive summary.

1.2 Explanation of the work carried out per WP

In this section, we discuss the progress of each WP, as well as progress in each Task.

1.2.1 Work package 1: Diagnosis

Objectives of the WP

- Establish a set of common multi-hazard, multi-risk concepts, definitions, and indicators for use throughout MYRIAD-EU, and compile these in a handbook;
- Complete a comprehensive review of existing qualitative and quantitative methods, models, and tools (e.g. functions) relating to multi-hazard, multi-risk management, presented in a WIKI-style online platform;
- Complete and publish a comprehensive review and evaluation of policies, policy-making processes, and governance at multiple scales (e.g. local, national, EU-wide) relevant to multi-hazard, multi-risk management.

Highlighted outcomes of Months 1-18

Launching the Disaster Risk Gateway WIKI-style platform

The Disaster Risk Gateway (www.disasterriskgateway.net) is accessible online and it contains key information from the Handbook and the multi-hazard, multi-risk policy and governance review. The Gateway will continue to develop dynamically over time as new methods, models, and tools are developed within MYRIAD-EU and new content is crowdsourced from the community.

Establishing a common knowledge baseline and mobilisation of consortium-wide efforts

All deliverables were co-designed and co-developed with members of the consortium and outside the consortium (Pilot Core Users and Pilot Stakeholders, and members of wider stakeholder groups, such as UNDRR). The legacy of WP1 consists of both establishing the baseline knowledge for the project and creating a common understanding of the different perspectives and challenges associated with multi-hazard, multi-risk management, and emphasising the need to consider more closely the knowledge co-production process at project level.

Task 1.1: Review and development of multi-hazard, multi-risk concepts, definitions, and indicators (completed in Month 11)

Task 1.1 was led by UKRI BGS, with contributions from all consortium members, particularly WP1 participants (VUA, CMCC, DRES, Risklayer, IIASA, CICERO, ULL, MPG, ASE, FEHRL, CIEA, HOTREC, CICYTEX, AON, and TNO). The deliverable associated with this task is D1.2 (Handbook of multi-hazard, multi-risk concepts, definitions, and indicators), whose development required a wide consortium participation.

UKRI BGS completed an initial consultation with all MYRIAD-EU partners on the terminology required within the Handbook, and suggested definitions (through a proforma and exercises at the kick off meeting). From this exercise, >100 terms were suggested for the handbook, 30 search criteria for the WIKI-style platform and 14 policies (National to EU level) were identified. Based on this work, UKRI BGS drafted an initial glossary of multi-hazard, multi-risk definitions, and types of hazard relationship and identified gaps and points of contention. To complement these initial findings, a critical literature review was performed, focusing on existing glossaries and terms defined in academic papers and technical reports that align to the multi-hazard, multi-risk theme of MYRIAD-EU. This sub-task was coordinated by VUA with contributions from CMCC, ASE, Risklayer, and DRES. As a result, > 1100 peer-reviewed papers published between 2015-2021 were reviewed and put forward for analysis. Once the scoping and data collection stage was finalised, UKRI BGS coordinated internal meetings ('sprints') to co-develop content (i.e., definitions), integrating perspectives from internal experts and external stakeholders.

Specific content was requested from the MYRIAD-EU consortium to populate the Handbook, including definitions and short descriptions of key terms and concepts. Here, contributions focused

on technical terms and language describing the structure of activities in specific work packages. This supports both internal partners and external groups to understand the work being done in MYRIAD-EU, recognising that we are a community coming from multiple different disciplinary and sectoral backgrounds. Sectoral Representatives contributed brief descriptions of the scope of their 'sector', articulating the groups that make these up, key metrics that help to characterise this sector in the European context, and other useful information of relevance to the project. Perspectives on terminology and concepts from external stakeholders were captured through participation of the External Advisory Board at the first and second General Assemblies (Autumn 2021 and Spring 2022) and through the presentation of WP1 findings and a break-out session with external experts at the WP1/WP2 workshop at IIASA, Laxenburg (11–12 April 2022). To this end, the roles of Prof Virginia Murray as Chair of the External Advisory Board and Chair of the Technical Working Group on the UNDRR Definition and Classification Review, and the contribution of Jenty Kirsch-Wood, Head of Global Risk Management and Reporting at UNDRR were key in highlighting gaps and synergies with international frameworks and agendas.

Task 1.2: Review of methods, models, and tools for multi-hazard, multi-risk management (completed in Month 15)

Task 1.2 was led by UKRI BGS, with contributions from all consortium members, particularly WP1 participants (VUA, CMCC, DRES, Risklayer, IIASA, CICERO, ULL, MPG, ASE, FEHRL, CIEA, HOTREC, CICYTEX, AON, and TNO). The deliverable associated with this task is D1.1 (Wiki-style online crowdsourcing platform of multi-hazard, multi-risk methods, models, and tools), which was developed as the Disaster Risk Gateway WIKI-platform (www.disasterriskgateway.net).

The aim of the task was to develop a Wiki-style online crowdsourcing platform of qualitative and quantitative multi-hazard, multi-risk methods, models, and tools (approaches), including examples of their application. The purpose of the wiki is to serve as an information resource and starting point in our laboratory of systemic multi-hazard risk assessment and management. The Disaster Risk Gateway was developed using a mixed-methods approach, including traditional literature reviews and data gathering exercises (e.g., using Padlet), combined with participatory activities and data collection forms. All consortium partners contributed to the definition of scope and boundaries of the Wiki (including its interoperability with the Dashboard), selection of search criteria, identification of user personas, and name choice (at kick-off meeting, in Autumn 2021, and at subsequent online meetings). The assimilation and analysis of existing data and knowledge on methods, model, and tools required a close coordination with Tasks 1.1 and 1.3 and awareness of developments in past and current multi-hazard, multi-risk projects (work performed between Month 4 - 6, December 2021 - February 2022).

VUA led the literature review sub-task with support from Early Career Researchers from across the consortium who crowdsourced examples of existing approaches from the consortium members and examined the structure and ontologies applied in existing reviews. Based on this information, UKRI BGS proposed a Wiki structure and Risklayer informed its development with their experience in ontology-based semantic Wikis. The creation of the online website, including the Wiki design, development, and deployment was undertaken by UKRI BGS between Month 6-14 (February and October 2022), with an official launch in Month 15 (November 2022). UKRI BGS is currently working with IIASA, VUA, and Arctik to ensure the integration of the Wiki into the Dashboard (WP2, Task 2.3), giving access to the MYRIAD-EU products and services synchronously with key approaches from previous and ongoing external projects. Dissemination and uptake by external networks and stakeholders is continuing throughout the lifetime of the project, with positive responses and interest shown during the Pilot Workshops and external conferences and workshops. The presentation and further population of the Wiki with crowdsourced information at consortium level will take place in the early stages of the second reporting period.

Task 1.3: Report on policies, policy-making processes, and governance for multi-hazard, multi-risk management (completed in Month 11)

Task 1.3 was led by DRES, with contributions from all consortium members, particularly WP1 participants (BGS, VUA, CMCC, DRES, Risklayer, IIASA, CICERO, ULL, MPG, ASE, FEHRL, CIEA, HOTREC, CICYTEX, AON, and TNO). The deliverable associated with this task is D1.3 (Report on policies, policy-making processes, and governance for multi-hazard, multi-risk management).

At the kick-off meeting, in September 2021, DRES and UKRI BGS organised an interactive session for collecting preliminary information about the level of knowledge of multi-risk governance within the consortium. Stocktaking and analysis of collected information followed, with DRES, UKRI BGS, and CMCC defining the scope, objective, and tentative structure of the review report (Months 2-4). DRES developed a first draft, inviting WP leads for consultations regarding its completeness and relevance. In parallel, DRES and UKRI BGS performed a review of the state-of-the-art using peer-reviewed and grey literature (Months 5-8); the focus was on existing policies, policy-making processes and governance of multi-hazards and multi-risks; existing and proposed management approaches and guidelines (national/international scale), and barriers & opportunities for multi-risk management. The literature review was complemented by stakeholder interviews (Months 7-10), separate meetings with relevant partners for discussions and further clarifications of questions (Month 7), pre-screening of interview questions with focus on scoping the current understanding of multi-risk research in practice, and facilitation and transcription of interviews (by DRES, UKRI BGS, CMCC, and Early Career Researchers and MSc students from across the consortium). In addition to taking part in the interviews themselves, Pilot Leads reached out to their networks to provide further contacts for interviewing (Civil Protection Directorate of Veneto Region, Po River Basin Authority - Italian Ministry of Environment). The Sectoral Representatives participated in interviews during bi-lateral online meetings or at the second G.A., in April 2022. Further information from experts and stakeholders was collected during the joint WP1/2 workshop in April 2022, where the importance of risk governance for improved decision-making in the context of multi-risks was highlighted. The draft report on policies, policy-making processes, and governance for multi-hazard, multi-risk management was shared with the consortium for comments and final suggestions after which it was submitted by DRES (in Month 11).

Key reflections for WP1: A baseline (Diagnosis) work package proved to be important not only from a scientific perspective but also to emphasise the interdisciplinary space in which all subsequent project activities are undertaken. Given its strong participatory and stakeholder focus, we felt the need to consider some elements against which the project monitors and measures progress towards its goals. Such a task is relevant for the entire project, thus, the experience gathered in WP1 was transferred to WP3 and an initiative for monitoring and evaluating the co-development process is continued under its coordination.

WP1 required planning and parallel advancement of three tasks due to their intense participatory approach. Weekly WP1-wide meetings took place for the first 7.5 months in which specific data collection exercises and consultations were performed. This required an intensive effort of coordination and preparation at the same time as the project was taking off. Some cross-cutting activities (e.g. stakeholder engagement) were delayed to allow enough time for relationships to be established based on trust and common understanding both inside and outside the project. With hindsight, given the early stage of the project, some stakeholder activities necessitated earlier engagement, while others could have been less intensive. These learnings were an important lesson for other WPs relying on stakeholder interaction.

1.2.2 Work package 2: Framework and synthesis

Objectives of the WP

- Co-develop and co-evaluate a harmonised and standardised framework for multi-hazard, multi-sector, systemic risk management;
- Provide guidelines and protocols for multi-hazard, multi-risk assessment and management;
- Establish a web-based dashboard to assist users to navigate multi-hazard, multi-risk products and services;
- Synthesise results from across the MYRIAD-EU project.

Highlighted outcomes of Months 1-18

Research agenda published as perspective paper

We have published a perspective paper (Ward et al., 2022), outlining challenges in disaster risk management in a multi-hazard and multi-risk world, which sets out the MYRIAD-EU research agenda for a wide readership (almost 4000 views, as of 5 April 2023). This will also guide the progress towards addressing the identified challenges during the project period.

Initial framework for multi-hazard, multi-risk and systemic risk management

We have developed our initial framework based on a large-scale workshop with private and public stakeholders, as well as organizations and experts from within and outside of MYRIAD-EU. The framework is in review as a scientific paper (Hochrainer et al., in review).

Iterative improvement of framework through Pilots

A first iteration of improving the framework has been successfully carried out, based on the feedback from the first pilot workshops of WP3 in autumn 2022, including developing guidance protocols on how to navigate through the framework in regard to each step.

Prototype web-based dashboard

A prototype version of the dashboard has been developed based on the framework and guidance protocols. The prototype is online for internal development.

Progress in Task 2.1: Co-development of prototype framework (completed in Month 12)

Task 2.1 is led by IIASA, with inputs from all consortium members, especially VUA, UKRI BGS, DRES, and CMCC. Task 2.1 is now completed.

The development of the prototype framework necessitated high interaction between partners, especially regarding linking and merging different approaches and the information gathered in WP1. Monthly meetings between all WP2 project partners were established and bi-weekly meetings between researchers developing the framework were scheduled on a continuous basis. Additionally, individual interactions between researchers working on the framework occurred on a weekly basis. Furthermore, close interaction with other WPs was established to understand the advantages and limitations of the approaches developed.

The prototype framework development started with a literature review on frameworks and focused on the following topics in alignment with activities of WP1, including: (1) multi-hazard approaches and typologies; (2) multi-risk approaches and typologies; (3) multi-risk assessment approach and typologies; and (4) systemic risk approaches. Furthermore, information from WP1 and WP3 about Pilot Core User Groups and Pilot Stakeholder needs was gathered. Based on this information, a first draft framework for individual, multi-, and systemic risk analysis and management was developed, founded on emerging multi-hazard and multi-risk scholarship (e.g. focus on hazard interrelationships and dynamics of risk drivers) and with roots in systemic risk thinking (i.e. system boundaries and system dependencies). Furthermore, a stepwise procedure was developed for this framework and its initial drafts were discussed with WP2 participants as well as in close collaboration with WP1 and WP3. The resulting initial framework, presented below (Figure 2), was then used as input for a large-scale WP1/WP2 workshop in April 2022.

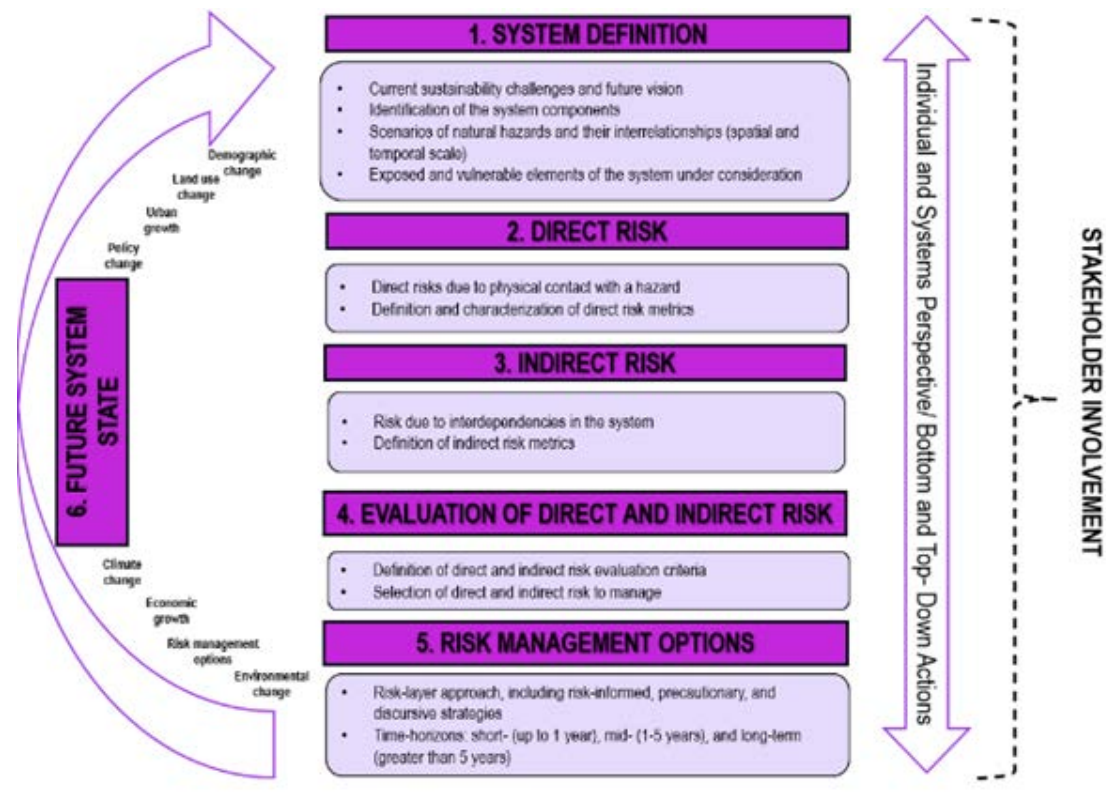


Figure 2 Prototype version of the MYRIAD-EU Framework

The workshop was organised at IIASA in April 2022 with scientific and practitioner experts and lasted for one and a half days. Its overall aim was to present the framework, have an informed discussion and to learn from the participants what is needed (in their perspective) to improve and update the framework. The workshop had a total of 62 participants, including representatives from the MYRIAD-EU consortium partners (n=37), external experts in the field of multi-risk (n=17), and case study pilot representatives and wider sectoral representatives (n=8). External experts were identified in a process of consultation with researchers and represented a mix of academic researchers, representatives of multilateral organizations (e.g. World Bank, UNDRR), and MYRIAD-EU pilot stakeholders. The workshop was interactive and held in a hybrid format, with roughly half of the participants joining in person and the other half online. The initial planning in the project proposal was to have a larger in-person attendance, in particular from non MYRIAD-EU project partners. In reality, the planning of the workshop took place during the initial wave of the Covid19 Omicron variant, which made it difficult for many external practitioners to commit to travel. Whilst this hybrid format meant larger efforts in terms of event preparation, in the end it also offered the benefit that several stakeholders who would not have attended an in-person event were still able to attend. The workshop consisted of plenary lectures and discussions as well as interactive discussions in smaller groups (three in-person and three online, with each group having a facilitator and a note-taker). The discussions addressed the following questions:

- What are the current gaps in risk assessment and management in a multi-hazard, multi-scale, multi-sectoral context?
- What are the strong aspects and weaknesses of the framework?
- What is currently missing in the framework?
- What are your suggestions for the improvement of the framework?

Regarding the required changes, several issues were raised during discussions that were incorporated into the updated version of the framework (see Task 2.2). In addition to the framework and stepwise procedure, initial guidance protocols were developed (Milestone 5). They accompany the framework, with the idea to guide the framework user during the implementation of multi and systemic risk assessment and management. The outcomes of the workshop have been written up

as extensive minutes capturing rich discussions which served as direct input to update the framework and initial development of guidance protocols.

Progress in Task 2.2: Iterative co-evaluation and updating of framework (continues until Month 45)

Task 2.2 is led by IIASA, with CMCC and VUA contributing to the work.

The framework has been continuously updated since its initial development (both in content as well as visual presentation), with the version at the time of writing this report presented (the ‘initial framework’) shown in Figure 3. In more detail, this version of the framework was updated based on the three main lines of the co-development process and feedback loops including: (1) the feedback received by the MYRIAD-EU project partners and external experts through the discussions during the WP1/WP2 workshop in April 2022 (described above), (2) continuous interactions with Pilot Leads in WP3 after the workshop and supporting WP3 in setting up the framework for the Initial Pilot Workshops; and (3) feedback received from stakeholders through the Initial Pilot Workshops.

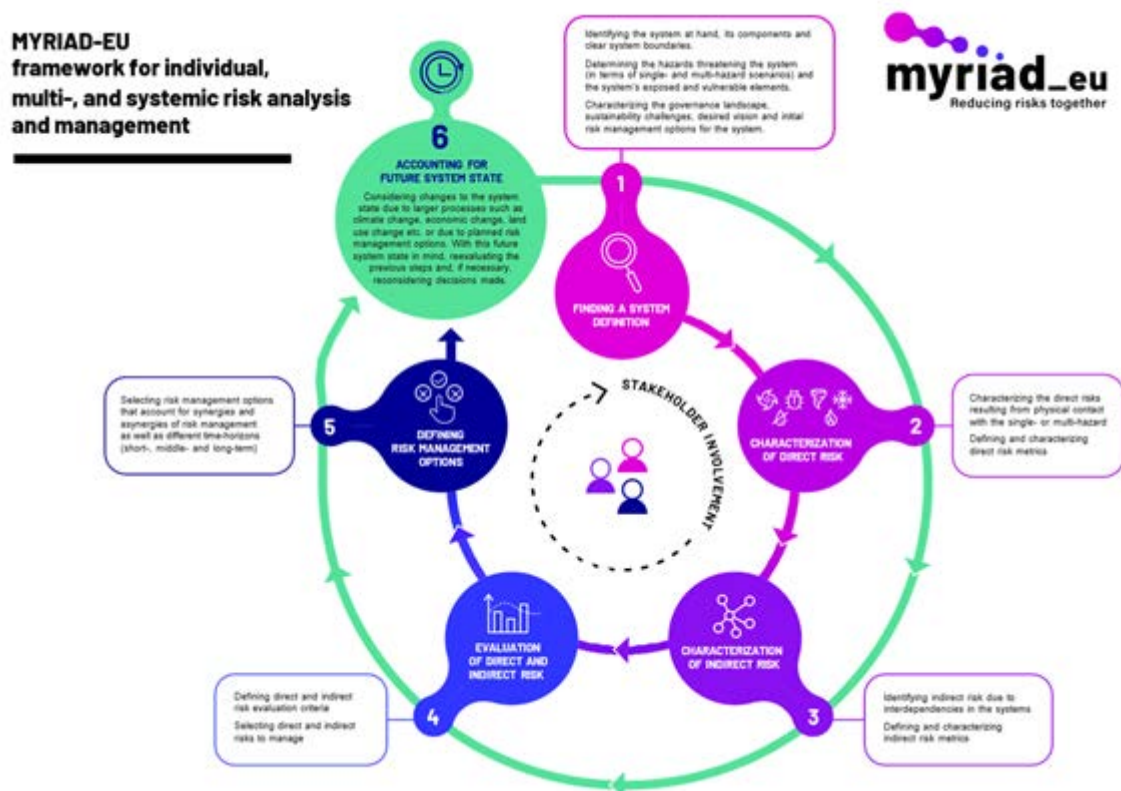


Figure 3: Updated initial version of the MYRIAD-EU framework within Task 2.2

A crucial design of MYRIAD-EU is that the framework will be tested and refined through its implementation in the pilots; hence, continuous feedback between WP2 and WP3 was and is essential. From June 2022 onwards, for instance, a series of dedicated meetings with WP3 was held to gather feedback on the initial framework, its implementation in the pilots, and the best ways to introduce the framework during the pilot workshops to the Pilot Core User Group and the Pilot Stakeholder Group. In that regard, Task 2.2 also developed a one-pager describing the framework and its six steps and shared this with pilot leads for input. Through their feedback, it became apparent that a set of communication materials needed to be developed to facilitate the framework implementation in pilots and communication on the framework beyond the MYRIAD-EU project partners. Task 2.2 has therefore developed an introductory and interactive presentation on the framework, including a graphical representation of its main aspects. These presentations were then used during the Initial Pilot Workshops to introduce the framework to the pilot practitioners.

Based on the Pilot Workshops (see WP3 below), feedback was received from Pilot Leads on how to improve the framework and guidance protocols (Milestone 11 document). Furthermore, based on

the feedback from the Pilot Leads, feedback collected in the Initial Pilot Workshops, and through initial discussions on the dashboard development, v2 of the guidance protocols (Milestone 7) was developed. The updated protocols were shared with the Pilot Leads. Within the guidance protocols, the questions related to the six steps were further refined, and grouped under sub-themes (in order to be easier to navigate and integrate into the Dashboard). Furthermore, the presentation developed to introduce the framework was added to the guidance protocols.

Task 2.2 will continue until Month 45, and hence the iterative updating of the framework has only just begun. The current version of the framework is in review as a scientific paper (Hochrainer-Stigler et al., accepted). Three more formal updates of the guidance protocols are planned (Milestones 8,9, and D2.2), following the Pilot Focus Group meetings and final Pilot Workshop.

Progress in Task 2.3: Dashboard (continues until Month 45)

Task 2.3 is led by Arctik, who are developing the technical aspects of the dashboard. Input on its conceptualisation and design are contributed by IIASA, VUA, UKRI BGS, Risklayer, and DRES.

The MYRIAD-EU dashboard is designed to help risk managers, decision-makers, and researchers within and outside the project to navigate the MYRIAD-EU framework. The dashboard aims to provide easy access to various products and services developed within the project and to link to key methods and tools from previous and ongoing external projects. The dashboard will have a user-friendly interface aligned with the general visual identity of the project that allows users to explore and understand the MYRIAD-EU framework more easily.

After a first meeting with WP1, 2 and 8 in February 2022 (Month 6), it was decided to delay Milestone 6 (Dashboard online) originally foreseen for Month 13 until the end of Month 18. The main reason was to allow us to gain a better understanding of the needs of the various stakeholders within the Pilots. In April 2022 (Month 8), the MYRIAD-EU General Assembly organised a dedicated meeting to gather collective input on the dashboard from all WPs. The goal of the meeting was to ensure that the dashboard would meet the needs and requirements of all stakeholders. The dashboard entered its active development phase between August 2022 (Month 12) and February 2023 (Month 18), with 6 brainstorming and scoping meetings taking place during this time. At these meetings, the responsible consortium members discussed, conceptualised and agreed on the content, structure, features, functionalities, layout, and style of the dashboard. In Month 17, the first visual mock-ups of the dashboard were made available (Figure 4). These mock-ups were revised based on the feedback received from the consortium members involved, and were made available online (password protected version) in Month 18, in line with the milestone's revised deadline.

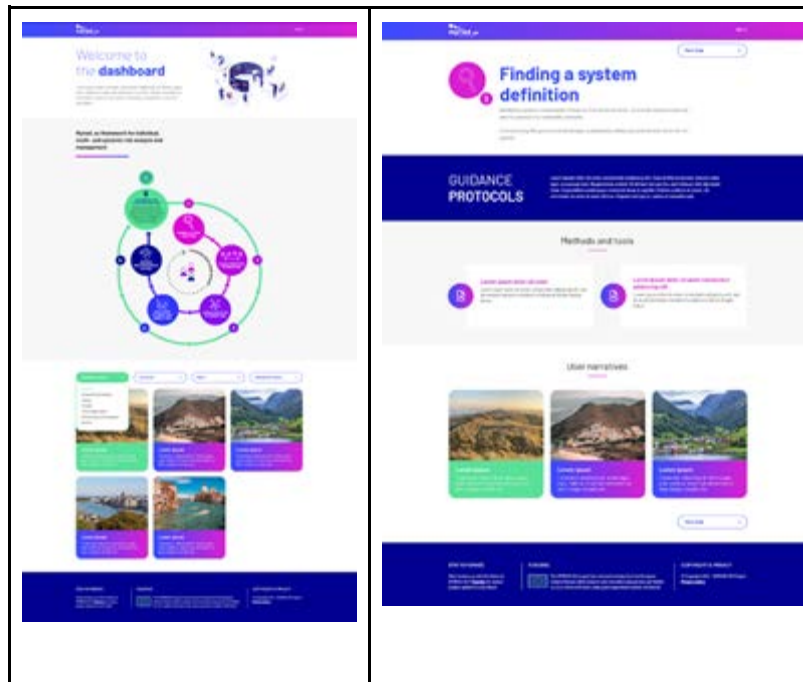


Figure 4: Examples of MYRIAD-EU dashboard's mock-ups

Task 2.3 is in its initial phases. The dashboard, which is designed with a 'living' format, continues to undergo rounds of revision and development. Currently, it is in its alpha stage, which is accessible to consortium members as well as Pilot Core User Groups (password protected). In a next round, a new collective session concerning the dashboard is planned during the upcoming MYRIAD-EU General Assembly in May 2023 (Month 21). Following the General Assembly, the dashboard will proceed to the beta stage of its development. During this stage, it will be released to a larger group of people within the consortium and eventually to the general public.

Progress in Task 2.4: Evaluation of pilots & scientific synthesis (Months 46-48)

Task not started during the first reporting period.

1.2.3 Work package 3: Multi-hazard, multi-sector and multi-scale pilots

Objectives of the WP

Develop forward-looking DRM pathways for each of the Pilots.

- Ensure a consistent implementation and co-evaluation of the framework (WP2) and innovative methodological developments (WPs 4, 5, 6) across the Pilots;
- Establish the Pilot Core User Groups and the Pilot Stakeholders Groups and the knowledge co-development process;
- Advance the understanding of systemic multi-hazard risk assessment and management across sectors and scales;
- Provide recommendations for developing forward-looking DRM pathways in other settings.

Highlighted outcomes of Months 1-18

Stakeholder identification and mapping

The identification and mapping of stakeholders was an extensive process that started prior to the project kick-off, with the collection of support letters, and was accelerated and advanced by Pilot Leads with the support of Sectoral Representatives. Guided by the selection criteria in the Terms of Reference), regular discussions within WP3 meetings, and their own experience, Pilot Leads performed an in-depth analysis of the stakeholder landscape in each Pilot and mapped the influence, expertise, relevance, capacity for engagement, and potential risks of involvement associated with each relevant institutions. Pilot Leads have established rapport with new stakeholders and secured participation for the Initial Pilot Workshops. Efforts to improve stakeholder engagement are ongoing and a strategy for concerted stakeholder communication and dissemination is currently discussed at Management Team level.

Initial Pilot Workshops successfully completed

The Initial Pilot Workshops resulted in a successful first handshake with the Pilot level stakeholders. The Pilot Leads properly conveyed the message that a multi-risk approach is crucial in a DRM context and that the work to be carried out in MYRIAD-EU is relevant for their daily work and can only be successfully implemented if it is co-designed in a collaborative manner. The stakeholders were active, provided input in terms of data, indicators, scenarios, needs, and expressed their availability at continuing the engagement over the next years via focus groups, workshops, interviews, webinars and other activities.

Progress in Task 3.1: Lab Management (continues until Month 48)

Task 3.1 is led by CMCC, with direct support from UKRI BGS. Regular discussions and meetings take place with VUA to ensure a smooth link between the Pilot activities and the rest of the project. The activities in this task will continue until the end of the project.

CMCC developed a common work plan (Deliverable D3.2a) to coherently and timely guide the simultaneous implementation of the research activities in the Pilots in Months 7-24, which is dedicated to formulate the multi-risk challenges in the Pilots and select, accordingly, a suitable combination of methods and tools that support the development of the DRM pathways. The work plan was reviewed by UKRI BGS and the Pilot Leads (DRES, ULL, CICERO, IIASA, CMCC) and submitted in June 2022 (Month 10). It has been organised into a set of sixteen well-defined and interconnected activities to be carried out in a specified timeframe. Despite providing a clear roadmap, the work plan gives the Pilot Leads the flexibility to follow their own path and decide on the level of detail to achieve based on their research goals, expertise, and resources. In the work plan, CMCC included a common guidance focused on data and information collection to enhance robustness and coherence across the Pilots. In the period Month 7-18, the Pilot Leads have carried out their activities in line with the agreed work plan.

During the WP3 kick-off meeting (Month 6), it was agreed to have regular Pilot Meetings (once a month) between CMCC, UKRI BGS and the five Pilot Leads to ensure a continuous information

exchange among the Pilots, create synergies, discuss concerns and possible solutions, monitor the progress, and agree on the next activities. In total, eleven web meetings were organised.

The Sectoral Representatives (FEHRL, WIEA, HOTREC, CICYTEX, AON, TNO) attended the first three meetings (Months 7-8) and provided useful input to identify stakeholders (D3.1). After this initial close exchange, the interaction mostly continued via email to keep them informed and collect input to deliverable and milestone documents. Recently, CMCC and UKRI BGS defined a series of inreach and outreach activities for 2023 (Months 19-28), which would very much benefit from the Sectoral Representatives' experience and input. The activities and deadlines were agreed.

WP2 lead (IIASA) joined the Pilot Meetings three times (Months 11-14) to present the Initial Framework (Deliverable 2.1), collect feedback from the Pilot Leads on its concepts and steps (co-design), and help the Pilot Leads effectively communicate these aspects to stakeholders. DRES participated once (Month 13) to give the Pilot Leads advice on collective systems analysis approaches and tools (D6.2). WP4/5/6 leads (VUA, Risklayer, DRES) attended twice (Months 9, 16) to align the work and discuss their need for stakeholder interviews. In Month 17, CMCC (supported by UKRI BGS and Pilot Leads) shared a proposal for concrete collaboration with WP4/5/6, ensuring that the objectives of all actors are achieved within the project deadlines. It included the establishment of the Pilot Teams, bringing together the project partners interested in contributing to each Pilot, and a timeline for the feasibility study aimed to prioritise the challenges and choose the methods to test and apply in each Pilot. The feasibility study is expected to be consolidated at the third General Assembly and its results reported in D3.3a (Month 24).

During Months 11-13, CMCC/UKRI BGS organised one Review Meeting dedicated to each Pilot to discuss in detail the preparation of the Initial Pilot Workshop and facilitate their work where possible. In the period Months 7-18, CMCC/UKRI BGS organised four WP3 general meetings to update all partners on the ongoing activities and discuss overarching issues; one meeting (Month 14) was focused on co-designing the agendas of the Initial Pilot Workshops.

Progress in Task 3.2: Stakeholder dialogue (continues until Month 48)

Task 3.2 is led by UKRI BGS (in collaboration with CMCC) with input and implementation by the Pilot Leads and Sectoral Representatives. The activities in this task will continue until the end of the project.

For the period Months 1-18, two main outputs are related with Task 3.2, namely the development of the 'Terms of Reference for Pilot core user and stakeholder groups' (D3.1) and the organisation of the Initial Pilot Workshops. Stakeholder involvement and co-development was central to maximising the impact of findings and ensuring their sustainability and relevance beyond the lifetime of the MYRIAD-EU project. The main aim of the Terms of Reference is to define the principles of stakeholder engagement and provide specifications about the objectives and structure of the four main events that stakeholders are expected to attend, including their responsibilities and expected outcomes. It also proposes a set of criteria that can be used to select stakeholders based on their relevance and capacity, and to assign them to one of the two groups, namely Pilot Core User Group and Pilot Stakeholder Group, which have a different level of involvement in the WP3 activities. In addition to setting the Terms of Reference associated with the Pilot Workshops and Focus Groups, this work contained a non-exhaustive list of guidelines and tools useful for the stakeholder engagement strategy. The work was delivered through a number of consultations and contributions from the consortium partners, specifically the Sectoral Representatives for the identification of stakeholder groups and Pilot Leads, who were actively involved in an intensive effort of networking, stakeholder communication, planning, and synthesis of research and activities related with other WP3 associated tasks.

Milestone 11 (Pilot Workshop 1 completed and feedback to WP2, 4-6) documents the delivery of the Initial Pilot Workshops between 7-24 November 2022. The Initial Pilot Workshops identified the needs of the Pilot Core User and Pilot Stakeholder Groups, prioritised the research questions, challenges, and opportunities, and discussed the initial Framework for multi-hazard, multi-sector, systemic risk management (WP2). Based on the workshop results, suggestions for improving the framework were fed back to WP2. The organisation and implementation of the Initial Pilot

Workshops was a time-consuming and challenging undertaking, underpinned by several WP3 activities starting with the identification and mapping of stakeholder networks, preparation of workshop invitations and event/project outreach flyers, continuous dialogue with stakeholders, and design of the workshop activities. In addition, and concomitant with the latter, Pilot Leads and their teams devoted time to stocktaking (i.e. exploring data availability and identifying gaps) and analysis of information available to identify interim DRM challenges.

The following list summarises the format and attendee numbers in each of the Initial Pilot Workshops (for a full list of named institutions, please refer to the Milestone 11 report).

- Canary Islands: 24 November 2022; in person; mainly in Spanish; 22 stakeholders; 2 MYRIAD-EU partner
- Scandinavia: 7 November 2022; in person; in English; 1 main stakeholder; 2 MYRIAD-EU partners
- Veneto: 14 November 2022; in person & online (hybrid); in Italian; 23 stakeholders; 2 MYRIAD-EU partners
- Danube: 15 November 2022; online; in English; 19 stakeholders; 7 MYRIAD-EU partners
- North Sea: 17 - 18 November 2022; in person; in English; 2 stakeholders; 4 MYRIAD-EU partners

Finally, one important outcome of this period was the strengthened collaboration between the different groups within the consortium and project stakeholders. The first few months were challenging in that sense and demonstrated the need for a concerted communication and engagement strategy with stakeholders across WPs. To improve this process, WP3 is coordinating an initiative to monitor and evaluate the knowledge co-development at consortium level. This entails undertaking a longitudinal study during the project that will aim to monitor and evaluate the internal (within the consortium) and external (between the consortium and project stakeholders) collaboration and co-design process using participatory and mixed-method approaches to collect data and information (e.g. questionnaires and feedback forms, focus groups, in-depth interviews, and systematic reporting via, for example, meeting minutes and deliverables).

Progress in Task 3.3: Defining current challenges and opportunities (continues until Month 24)

This task is overseen by CMCC through its lab management activities (see Task 3.1). The activities at Pilot level are led by the Pilot Leads. Contributions to the work are provided by all consortium partners.

The Pilot Leads have identified and partially collected data and information to characterise hazard, exposure, vulnerability, and risk in their regions and to develop a conceptual model connecting these elements (stocktaking). The regulatory and decision-making context overseeing the DRM process (and related adaptation measures) at local, regional, and national scale have also been investigated. The Pilot Leads discussed these aspects with their stakeholder networks at the Initial Pilot Workshops and used this input to formulate an initial list of multi-risk assessment and management challenges (and opportunities) in their regions. IIASA is leading the preparation of a common paper analysing the cross-cutting issues in the identified challenges. WP3, in collaboration with WP4/5/6, will carry out a feasibility study to prioritise the challenges and choose a suitable combination of methods for risk analysis and adaptation planning as a response to those challenges. The outcomes will be reported in Deliverable D3.3a (Month 24) and will shape the iterative testing from Month 25 onwards (Task 3.4).

North Sea (DRES) - DRES carried out a literature analysis to identify the relevant challenges and hazards for the North Sea. This desk work was presented and discussed at the Initial Pilot Workshop hosted by DRES on November 17-18th, 2022 (Month 15). The stakeholders were asked to address the challenges they face in their daily work in detail and made initial steps in developing policy pathways (reported in Milestone 11). Main challenges identified are: increasing spatial tensions in areas already under pressure, especially in coastal zones; increasing drive for upscaling of offshore wind energy; little international coordination and cooperation between countries in their marine spatial planning processes; awareness at governmental level for the need of multi-sector risk assessment and management only recently being acknowledged; limited implementation of

measures to address multi-risks. In close collaboration with WP6, DRES and VUA have co-designed a new conceptual approach for the development of the Adaptation Pathways, which is called DAPP-MR (Dynamic Adaptation Policy Pathways – Multi-Risk) (see WP6 reporting for details). This approach will be tested on the North Sea Pilot by DRES in April-May 2023 (Months 20-21). The scope of this exercise is to describe the decision-making context, further define system boundaries and constraints, map different system components and their interlinkages, and make a first step towards the concrete development of the forward-looking DRM pathways. The initial DRES team for WP3 was forced to undergo some changes due to unforeseen circumstances (long-term sick leave); a colleague joined the team to compensate for this.

Canary Islands (ULL) - A stocktaking of past hazard events in the Canary Islands has been carried out by ULL and will be complemented over the next months by formulating storylines (for volcanic eruptions and hydrometeorological events) based on the template developed by DRES in WP6 (manuscript in preparation). In March 2022 (Month 7), ULL hosted a team of students and professors from the VUA Earth Science Master and facilitated the organisation of interviews with local stakeholders. This contributed to collecting information about maladaptation experiences and social perception of natural hazards and risks in the Canary Islands. The 3rd edition of the VUA Earth Science Master fieldwork will be hosted at ULL in March 2023 (Month 19). On November 24th, 2022 (M15), ULL organised the Initial Pilot Workshop, with a great response from stakeholders and members of the ULL team. This allowed us to identify the initial challenges for the Pilot: (1) multi-hazard and multi-risk interdependencies in island settings; (2) lack of governance; and (3) information gaps. Some members of the ULL team were involved in the organisation of another workshop focused on the Tenerife Island Action Plan against Volcanic Risk (PAIV). This event aimed to promote the exchange of experiences, knowledge, opinions, and proposals among local stakeholders, many of them involved in MYRIAD-EU. Until Month 24, ULL will interview a number of stakeholders to acquire information on risk drivers. Work on the application of the DAPP-MR approach will also start with focus on developing Nature-based Solutions for tourist islands (manuscript in preparation).

Scandinavia (CICERO) - CICERO had its first meeting and interview with the Norwegian Directorate for Civil Society Protection (DSB) in June 2022 (Month 10) to present MYRIAD-EU and start discussing multi-risk assessment and management. This led CICERO to focus on heat stress, drought, and wildfires with cross-sectoral impacts on agriculture, energy, and forestry. DSB expressed interest in the economic cost of climate-driven hazard events and how adaptation can reduce losses. Data on climate-driven hazards and related impacts on agriculture, energy, and forestry were collected. The primary tool to work on these events and sectors in Scandinavia is the macro-economic model GRACE (in collaboration with WP5). On November 7th, 2022 (Month 15) CICERO organised the Initial Pilot Workshop in Tønsberg, which was attended by DSB. Preliminary work with GRACE was presented, focused on a compound event that happened in 2018 (a long and strong heatwave with several episodes of droughts that led to wildfires) and had major impacts on energy, forestry, and agriculture in Norway (manuscript in preparation with WP4). CICERO collected feedback on the Initial Framework (WP2) and the DAPP-MR approach (WP6). DSB stressed the need to include local governance as early as possible. A short workshop was organised on January 24th, 2023 (M17) with the Finnish Regional Council of Kymenlaakso (facilitated by CICYTEX), which emphasized the importance of spatial variability in forestry management. The two workshops allowed CICERO to identify several challenges: (1) the uncertainty of the hazard projections/scenarios; (2) the use of the same timescale for all sectors (short, medium, long term); (3) the lack of data at a sufficiently high spatial resolution; (4) the cross-sectoral impacts; (5) the variety of tools already existing for decision-makers; and (6) the role of local, national and international governance. Until Month 24, CICERO will continue expanding the data collection and work with WP4/5/6 to prioritise the challenges.

Danube (IIASA) - IIASA is focused on understanding the multi-risk in the Danube Region, which covers 14 strongly interconnected countries. The core stakeholder is the Danube Strategy Point (DSP). They attended the Danube Pilot kick-off meeting in February 2022 (Month 6) and confirmed that the region-wide outlook on risk management is not sufficiently considered. IIASA presented MYRIAD-EU and the Danube Pilot in three of the Working Group Meetings of the International

Commission for the Protection of the Danube River in Bucharest (Month 13), Munich (Month 14) and Vienna (Month 14) and in the closing meeting of the DAREnet project in Bratislava (Month 18). IIASA organised the Initial Pilot Workshop (online) on November 15th, 2022 (M15), which resulted in the identification and co-production of: (1) main challenges through stakeholders' eyes (lack of knowledge on how hazards interact, no multi-risk governance); (2) multi-hazard scenarios of interest (e.g., compound flooding, consecutive floods and droughts); and (3) direct and indirect impacts of multi-risk events in agriculture, finance, transport and infrastructure. This input is in line with the findings from a comprehensive stocktaking started in May 2022 (Month 10), which pointed out the lack of regionally-coordinated risk management. These outcomes will inform the Agent-Based Model (ABM) developed at IIASA and as a part of WP5 (e.g., through "shocking" the ABM with scenarios identified at the workshop). The team is now working on extending the economy-wide ABM developed for Austria (Bachner et al, 2022) to the whole Danube Region. By Month 24, IIASA plans to finalise two papers (multi-risk analysis of the EU Solidarity Fund with focus on the Danube Region; CATSIM analysis of fiscal resilience in the Danube Region) and conduct 3-5 stakeholder interviews to gain deeper insights into the interconnectedness between countries and inform a survey to be conducted via the Priority Area 5: Environmental Risk (PA5) (regional stakeholder focused on DRM).

Veneto (CMCC) - CMCC performed a scoping analysis and literature stocktaking to identify and describe the hazards, risks and vulnerabilities that the region would face in a multi-risk perspective. The analysis considered past risk assessments and recent updates from national/international research projects (e.g., ADRIACLIM, VENEZIA2021, TRANSALP). A review of up-to-date local, regional, and national datasets was performed to check the availability of indicators. This includes atmospheric, hydrological, marine, and soil data, future scenarios (e.g. from Copernicus and ARPAV), but also territorial and socio-economic data (e.g. from ISTAT and land use). Catalogues of extreme events and damages (e.g. from ARPAV and ESWD) were analysed, and the possibility to include newer data sources (e.g. Earth Observations) was explored. CMCC developed a conceptual model to illustrate the main hazards affecting the region and their interactions, the indicators to describe hazard, vulnerability and exposure, and the assessment endpoints to analyse the impacts on finance, tourism, and natural ecosystems. This showed that the region is affected by both "cold and wet" and "hot and dry" types of hazards. Two multi-risk scenarios were formulated: damages caused by extreme climate and weather events on infrastructures, population, and buildings; and impacts on environmental quality across diverse landscapes caused by climate change and anthropogenic/natural hazards. Machine Learning (ML) resulted in a suitable tool to analyse multi-risk scenarios in Veneto, as it allows to learn from past extreme events, integrate heterogeneous data sources and model previously unknown, non-linear relations. CMCC presented and discussed this work at the Initial Pilot Workshop in Venice on November 14th, 2022 (Month 15). The stakeholders provided CMCC with relevant input to refine the conceptual model. They pointed out governance-related challenges faced in their daily work. The proposed challenges for the Veneto Pilot are: (1) identification of multi-hazard spatiotemporal footprints and dynamics; (2) multi-risk impacts on ecosystem and forestry, tourism and finance; (3) future multi-risk assessment under different climate change scenarios; (4) governance: lack of coordination and miscommunication. Until Month 24, CMCC will continue to extend the stocktaking and develop the ML algorithms in collaboration with WP4/5/6.

Progress in Task 3.4, 3.5, and 3.6

Tasks not started during the first reporting period.

1.2.4 Work package 4: Dynamic feedbacks between risk drivers

Objectives of the WP

- Develop methods for empirically assessing how past multi-hazards have influenced dynamic feedbacks between risk drivers.
- Develop functions and methods for quantifying dynamic feedbacks between risk drivers for application in forward-looking multi-hazard risk assessment.
- Build an online database of empirical evidence of multi-hazard risk dynamics.
- Provide two-way engagement with the Pilots via the Helpdesk to ensure iterative learning

Highlighted outcomes of Months 1-18

Perspective paper on addressing dynamic vulnerability

We published a paper (De Ruiter and De Loon, 2022), in which we propose three different classes of methods (qualitative methods, agent-based methods & system dynamics models, and scenarios & storylines) that could be used for assessing dynamic vulnerability. This paper provides conceptual guidance for the work carried out in WP4.

Guidelines on methodology for extracting empirical evidence from Pilots

We developed a structured interview methodology to collect empirical evidence of feedbacks related to social and societal vulnerability which is now ready for implementation in WP3. The methodology was co-developed with the leads of the Pilots and is documented and explained in D4.2.

Set-up of WP4 helpdesk

The WP4 helpdesk has been set up in conjunction with WPs 5 and 6, and now serves as a central point for all inreach and outreach communication with the Pilots.

Progress in Task 4.1: Novel approaches for identifying empirical evidence of dynamics and feedbacks of risk drivers (continues until Month 24)

This task is led by VUA, with contributions from CMCC, MPG, Risklayer, IIASA, and DRES. For this task VUA, CMCC, MPG, Risklayer and IIASA are reviewing existing and developing new approaches for identifying evidence of dynamics and feedbacks of risk drivers. Moreover, Risklayer and DRES are providing feedback and input to ensure a smooth interface with WP5 and WP6, respectively. Below, several of the ongoing activities from the first reporting period are summarised.

Review of research of dynamics of vulnerability and proposal of methods for addressing it

The field of dynamic vulnerability assessment is still in its infancy, and as such VUA developed a perspective paper (De Ruiter and Van Loon, 2022) that: provides a brief historic overview of major developments in the field; discusses different dynamics of vulnerability and identifies knowledge gaps; and proposes possible methods from other sub-fields to improve our assessment of these dynamics. The paper identifies several key developments in the field of vulnerability research in recent years, focusing on three aspects: (1) changes in the common indicators that are used to measure vulnerability; (2) a shift from a focus on physical vulnerability to including social vulnerability; and (3) more recently a change from addressing static vulnerability towards addressing dynamic vulnerability. The paper also examines gaps in current research, by identifying three dynamics of vulnerability that are often excluded from current dynamic risk assessments. These gaps are related to: (1) the underlying dynamics of exposure and vulnerability; (2) changes in vulnerability during long-lasting disasters; and (3) changes in vulnerability during compounding disasters. As an assessment of multi-hazard risk requires a thorough understanding of these complexities in vulnerability, the paper proposes different kinds of methods that could potentially be used to better capture the dynamics of vulnerability, namely: (1) qualitative methods such as the narratives approach that can be used to get a better understanding of underlying processes; (2) agent-based models (ABMs) and System Dynamics, which can use the findings from qualitative assessments; and (3) scenarios and storylines, which can use the findings from ABMs and System

Dynamic models to explore plausible future scenarios. The findings of this paper provide a conceptual grounding for the further development of methods in this WP.

Literature and data reviews

Because a comprehensive overview of currently known vulnerability indicators does not exist yet, VUA carried out a systematic literature review to build a library of such indicators for cities. This library can serve as a guide for other studies in WP4, for example on which indicators to consider for various hazard types, locations and time frames. The vulnerability indicators identified in the review are being categorised by assessment approach (e.g., empirical, modelled or adopted from other studies), vulnerability type (physical or social) and vulnerability subtype (e.g., economic, demographic, governance or health for social vulnerability). First results also show that the indicators can be categorized in terms of their dynamics and pathways. So far the following categories have been identified:

- One-directional vulnerability: A characteristic that is generally considered as either increasing or decreasing a city/citizen's vulnerability to all hazards;
- Double-edged sword vulnerability: A characteristic that is sometimes considered as increasing and sometimes as decreasing a city/citizen's vulnerability, or that simultaneously makes a city/citizen more and less vulnerable to a hazard;
- Fickle vulnerability: A characteristic that increases the vulnerability to hazard X, but decreases the vulnerability to hazard Y;
- Compounding vulnerability: Two characteristics that are worse at their interplay compared to the sum of their individual parts;
- Conditional vulnerability: A characteristic that only makes someone more/less vulnerable when a certain condition is fulfilled;
- Transferable vulnerability: A characteristic that shifts vulnerability from one place/citizen to another, or which reduces the vulnerability of one place/citizen and increases the vulnerability of another.

VUA and IASA have developed plans to review the scientific literature to identify existing vulnerability functions that explicitly include vulnerability dynamics in order to provide insights into how these are affected by different hazards. The aim is to collect quantitative (e.g., index-based, structural vulnerability) as well as qualitative approaches (e.g., narrative descriptions in case studies, PAR model) to vulnerability assessments, focusing on different components of vulnerability to natural hazards, e.g., physical, social, economic and environmental components. Relevant information and references will be collected from well-known researchers of different hazard fields, rather than through a systematic literature review. Key contributors have already been identified for each of main hazard types (floods, droughts, landslides, earthquakes, volcanic eruptions, heat waves, wildfires and tsunamis).

Risklayer has collected a preliminary database of empirical vulnerability functions and tools for European contexts (with data also outside of Europe in some cases) for downtime, recovery and loss changes. The database consists of the following data:

- Digitisation of existing vulnerability functions where appropriate for systems components (infrastructure etc.) from SYNER-G, GAR, GEM and EU projects
- Collection of relevant PDNAs (Post-Disaster Needs Assessments), RDNA (Rapid Disaster Needs Assessments, and Reconstruction Plans) in order to extract loss progression for various sectors
- Aggregation of EUSF, Government and other European damage and loss data for use in analyses
- A review of duration considerations from hazard events, and their potential application within recovery frameworks such as TREADS, and post-disaster assessment
- Collection of downtime functions for various perils for direct and indirect risk applications

Disaster forensics approaches

Several activities are being undertaken within Task 4.1 to investigate dynamic feedbacks between risk drivers by applying the recently introduced approach of disaster forensics analysis (Keating et al, 2016).

Firstly, during the first year of MYRIAD-EU, several of the Task members (Philip Ward, Marleen de Rooter, VUA) were authors of a study investigating the impacts of 45 so-called “paired events” (Kreibich et al., 2022), i.e. flood or drought of events that occurred within the same area. For each paired-event, data were collected from literature review, expert interviews, and expert knowledge, on the following aspects: impacts of the first and second event, their hazard, exposure, and vulnerability characteristics, and management shortcomings during the events. These were collated in a database, from which the authors established “indicators of change” between the first and second event. The paired-events used, and the change in impact between the first and second event, can be seen in Figure 5. The research shows that risk management generally reduces the impacts of floods and droughts, but faces difficulties in reducing the impacts of unprecedented events, i.e. events with a magnitude not previously experienced.

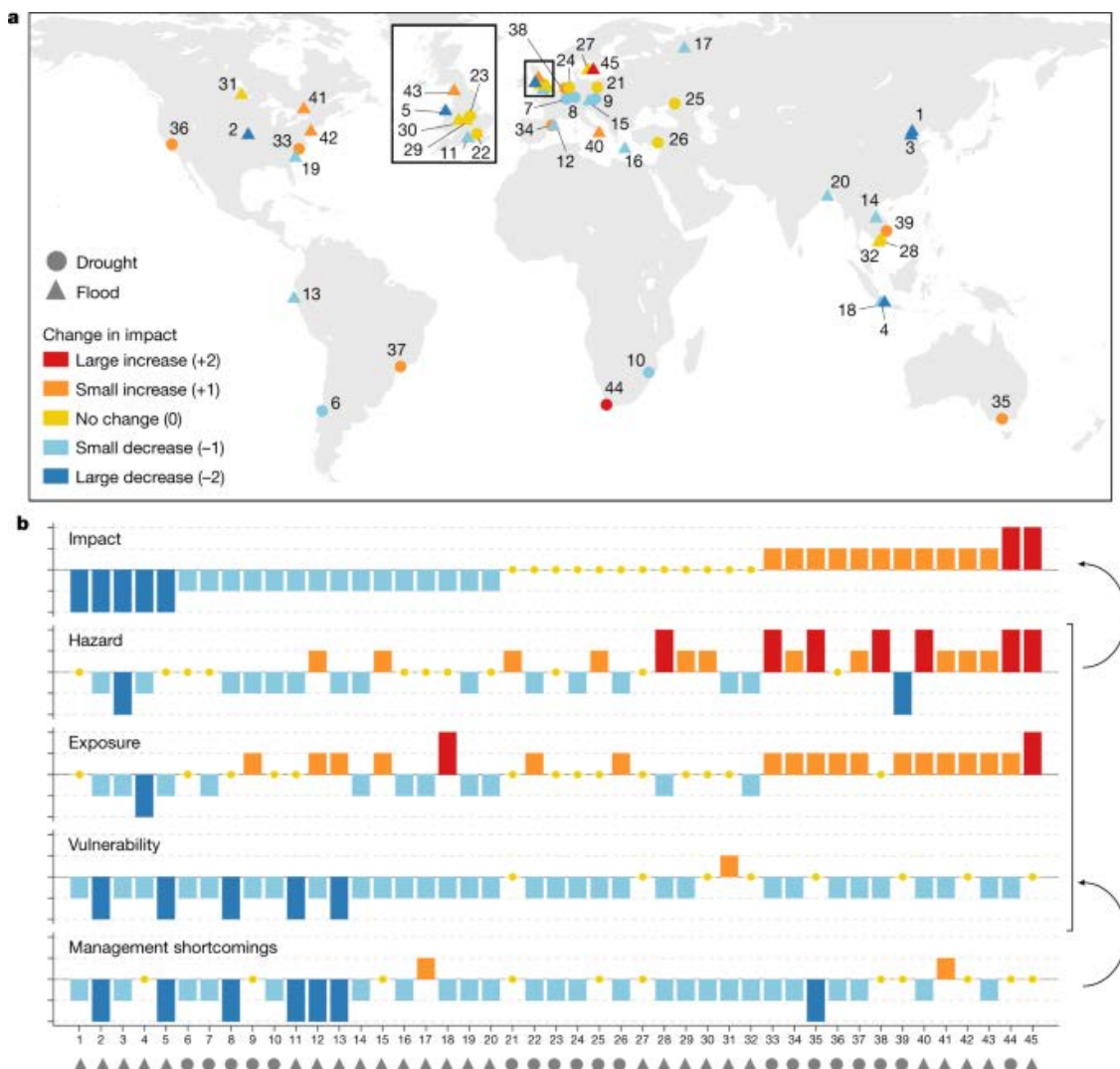


Figure 5: Location of paired-events and their indicators of change (Source: Kreibich et al., 2022)

Secondly, a plan has been developed to advance this approach to the assessment of other multi-hazard events. In 2022, VUA and IIASA had an initial scoping meeting to discuss the overall plan and concept. Since then, a concept note has been developed on the approach, which is intended to lead to the building of a global database of past paired events of any hazard combination. This is being carried out as a truly collaborative effort. A template has been designed for gathering

information on the paired-events, such as time and location of events, hazard types, description of the disaster, and type of hazard interrelationship. This has been shared with the broad community working on multi-hazard and multi-risk via several channels (Twitter, LinkedIn, email via contact lists of current and former EU projects including MYRIAD, RISK-KAN and Panta Rhei), with the request to identify potential paired-event case studies. To date, over 50 paired-event case studies have been identified. Collection of the data is planned until the end of April 2023.

Thirdly, VUA Task members Marleen de Ruiter and Philip Ward were involved in a study that used mixed-method approaches to understand the influence of human-water interactions during drought to flood events, with an application in the Horn of Africa (Matanó et al., 2022). They developed a step-wise, bottom-up approach, in which a range of qualitative and semi-quantitative methods was used iteratively to reconstruct interactions and feedback loops between risk components and impacts of consecutive drought-to-flood events, and explore their spatiotemporal variations. Within this approach, they conceptualize disaster risk as a set of multiple (societal and physical) events interacting and evolving across space and time.

Statistics and Machine-learning based approaches

Firstly, the recent heat wave and drought event in Scandinavia in the summer of 2018 and its severe repercussions on human health and ecosystems have demonstrated the urgency to better understand, prepare and develop risk reduction measures for multi-hazard, especially since the frequency and intensity of these types of event can increase due to climate change and land use changes (Åström et al. 2019, Schuldt et al., 2020, Sutanto et al. 2020). Responding to this need, task members from VUA jointly work with CICERO Pilot Leads for Scandinavia to understand interactions of heatwaves, drought and wildfires and resulting multi-hazard risk in Scandinavia (Ducros et al, in prep.). They use statistics and spatial analysis to assess and map multi-hazard hotspots and land cover data to derive multi-hazard risk (Figure 6). Important data inputs are the CORINE land cover data provided by Copernicus as well as the recently developed data set on drought, heat waves and wildfires by Sutanto et al. (2020).

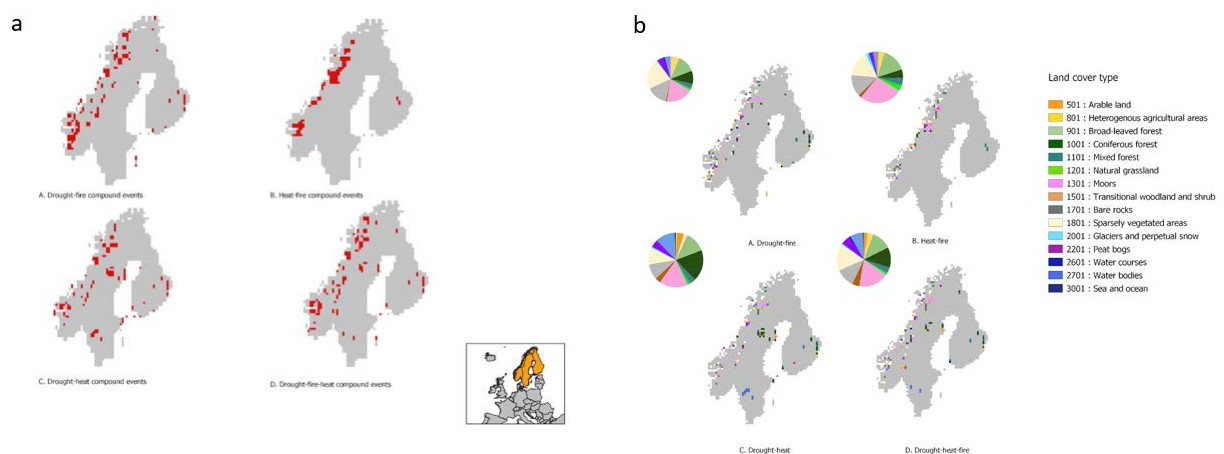


Figure 6: (a) Hotspots of multi-hazard events due to heat waves, drought and wildfires in Scandinavia and (b) associated land cover type and share.

Secondly, VUA is using ML methods to examine the differences in impact for single- and for multi-hazard events in existing and well-established global disaster loss databases, such as EM-DAT. This includes identifying additional data sources with suitable information on hazard intensities, exposure and vulnerability to complement the loss data sets followed by an application of statistical or machine learning methods.

Thirdly, CMCC has conducted a literature study to identify the main methods and algorithms for dynamic analysis of vulnerability and exposure in a multi-risk context. The methods identified in the review are being applied in the Veneto Pilot in order to: (1) identify spatial and temporal footprints of the different hazard events from climate re-analyses data; (2) test statistical methods and clustering algorithms to extract single hazard clusters and to combine them into multi-hazard

events; (3) assess the impacts of the multi-risk events taking into account not only the hazard indicators and their interactions, but also vulnerability and exposure factors; and (4) train algorithms on historical data and apply them to different scenarios (e.g., to understand the impact of climate change or different risk management practices in the Veneto region).

Use of night-time light data

Important societal aspects that remain relatively understudied by the scientific community are the post-disaster response and recovery phases of the disaster risk management cycle. They are still poorly understood from a multi-risk perspective. To address this, VUA is assessing differences in economic recovery patterns after single hazards and after multi-hazard events using satellite-based night-time light (NTL) data together with the MYRIAD-EU historical hazard events database derived with the MYRIAD-HESA algorithm developed in task 5.1 (Section 1.2.5). The NTL data serve as a proxy for economic activity. An additional aim of the study is to gain more information about the hazard characteristics and socio-economic conditions that affect the recovery patterns for both event types.

Use of various impact data sources to detect hazard intensity thresholds

MPG has developed a novel approach to characterise societal heatwave response using a variety of (novel) data streams for societal metrics related to health (excess mortality, hospitalizations) and public attention (google search interest, abundance of press articles). They detect hazard intensity thresholds (temperature threshold and durations) above which societal impact occurs by assessing and comparing the societal response between those periods to identify the heat wave durations with the most pronounced impacts. The results differ slightly between the considered societal metrics but indicate overall that heat waves are most relevant at time scales between 2 weeks and 2 months for Germany, as shown in Figure 7 (De Polt et al., in prep.). The approach can be extended to other societal indices, countries, and hazard types to reveal meaningful definitions of climate extremes and will help guide further research in this WP. Next steps will concentrate on variations in time and space and how they link to dynamics in vulnerability and exposure to heat.

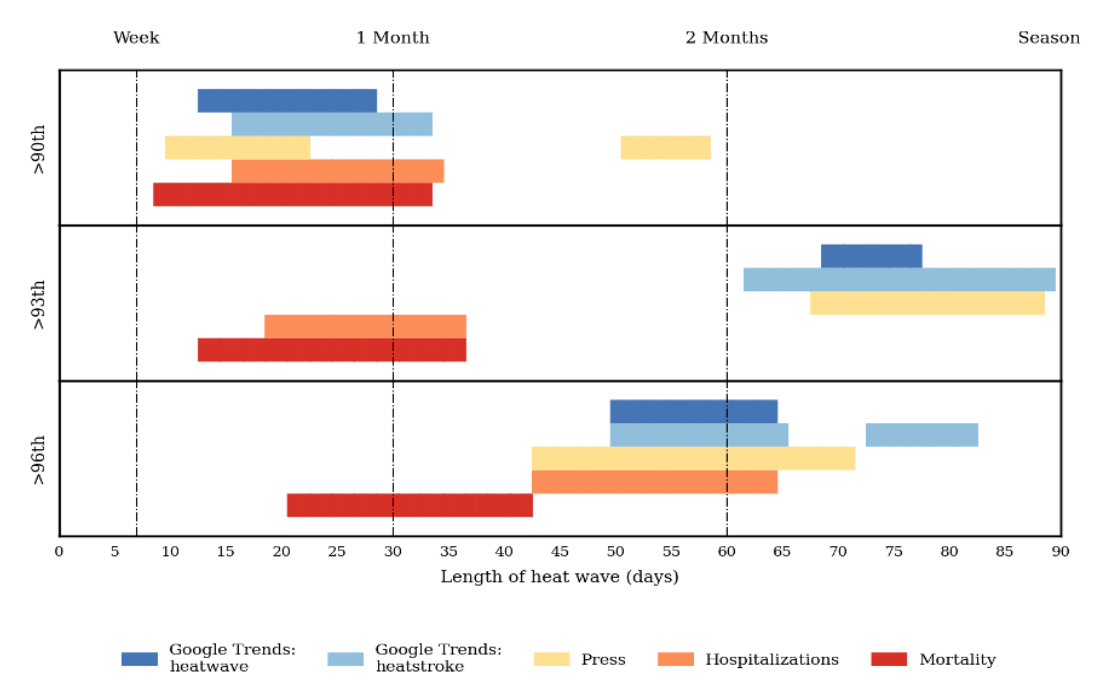


Figure 7: Summary (with outliers smoothed) of the determined heat wave lengths at which the societal response is most pronounced. Colours indicate the different attention and health-related metrics while the different panels show results for different heat wave magnitudes.

Progress in Task 4.2: Interview methodology for deriving dynamics and feedbacks of risk drivers from Pilots (completed)

Task 4.2 has been completed, with the interview methodology now ready for implementation in WP3. The task was led by CMCC, with input from UKRI BGS, ULL, IIASA, DRES, and CICERO.

The interview methodology is explained in D4.2 and has the goal to collect complementary information and knowledge about dynamic interactions and feedbacks between risk drivers, and how they are perceived and understood by risk practitioners and stakeholders in the Pilots. An initial stocktaking of the expected insights conducted with inputs from all Pilots and across WPs contributed to designing the scope (research problem), structure, and design of the survey methodology. The stocktaking revealed four areas of feedback sought: (1) subjective perceptions and individual judgments related to the importance of various hazards and their evolution; (2) determinants of vulnerability to multi-hazards/multi-risks; (3) performance of disaster risk reduction policies and measures; (4) questions concerning performance, deployment, and co-benefits and unintended consequences of nature-based solutions. The actual application of the methodology will be carried out in the Pilots in WP3, where the questions will be tailored to the needs of Pilot Leads and other partners from the Thematic Track (WPs 4, 5 and 6). The insights from the interviews will feed back to WP4 and will be used in Task 4.3. The guiding questions described in the report are to be contextualised and adapted to the scopes of the WP3 Pilots.

Progress in Task 4.3 and 4.4

Tasks not started during the first reporting period.

Progress in Task 4.5: WP4 Helpdesk (continues until Month 45).

The helpdesk has been set up in conjunction with WP5 and WP6. A deliverable has been produced (D4.1) to provide internal documentation of the WP4 Helpdesk contacts and objectives. The role of the helpdesk is to facilitate communication and collaboration between the WPs of the thematic track (WPs 4-6) and the Pilots (WP3). The main contact point of the Helpdesk is Marleen de Ruiter (VUA), with support from Rene Orth (MPG).

The helpdesk has taken part in the initial Pilot Workshops for the North Sea (Julius Schlumberger, Marleen de Ruiter), Canary Islands (Joël de Plaen), Scandinavia (Timothy Tiggeloven) and Danube (Philip Ward, Kelley de Polt) Pilots. The helpdesk could unfortunately not participate in the workshop of the Veneto Pilot due to language constraints.

1.2.5 Work package 5: Multi-risk scenarios

Objectives of the WP

- Develop multi-hazard event sets for multi-hazard, multi-risk assessment;
- Improve methods for assessing direct impacts in a multi-risk and multi-sector setting;
- Improve methods for assessing indirect and interregional impacts in a multi-risk and multi-sector setting;
- Develop a software package and user guide for multi-hazard and multi-risk scenario generation;
- Provide two-way engagement with the Pilots via the Helpdesk to ensure iterative learning.

Highlighted outcomes of Months 1-18

First global multi-hazard events database

We have developed the first global multi-hazard events database, based on the new MYRIAD-Hazard Event Sets Algorithm (MYRIAD-HESA), which is currently under review as a scientific paper (Claassen et al., 2023). The algorithm generates historically-based multi-hazard event sets - essentially an empirical analysis of overlapping events for hazards such as landslides, earthquakes, floods, cyclones and many others in order to look at the most common overlapping event types and to set up a multi-hazard testing lab for Europe.

Probabilistic, stochastic and scenario datasets from around Europe

We have put together probabilistic, stochastic and scenario datasets from around Europe to give a basis for multi-hazard analysis. These include a full stochastic event set for earthquake, windstorm, and probabilistic results for other hazards. In addition, a significant empirical database of past events has been collected for use in multi-hazard event identification. The stochastic and probabilistic hazard event sets designate two different types of methods to characterise the hazard events of many years (or possible years of potential disaster events).

Contribution to European review

WP5 contributed to a European review of software packages, risk assessment programs, risk methodologies and previous EU projects on multi-hazards, which fed into WP1.

Progress in Task 5.1: Generating multi-hazard event sets (continues until Month 36)

Task 5.1 is led by Risklayer, with input from VUA, UHAM, CMCC, and DRES. So far, three concurrent approaches have been used to develop hazard event sets, as described below. The development and refinement of the datasets is planned to continue in this task until Month 36.

Stochastic and probabilistic events sets

Risklayer have developed an extensive set of stochastic and probabilistic hazard events, which have been produced and uploaded to the MYRIAD-EU Zenodo Community. These event sets form the initial 'Coarse coinciding hazard event set produced at European scale' (Milestone 21), which are important for any multi-hazard event generation at a site anywhere in Europe. It is intended to produce a paper on the basis of the review of datasets, software and methods for European multi-hazard and risk scenarios.

As a start, Risklayer has developed a stochastic hazard set for earthquakes, representing a 10,000 year set, with each earthquake given a specific time associated with the record in order to compare against other hazards. The source zonations and methods are based on the work of the European Facilities for Earthquake Hazard and Risk (EFEHR (Danciu et al., 2021)) in the period up to 2020 as part of their SERA-EU project. Examples of two 100-year event set generations are shown in Figure 8. Some minor changes have been made to the source and calculation methodology with the assessment being undertaken in an adaptation of TsuPy (Schäfer and Wenzel, 2017). Stochastic event sets are not present in the original dataset, thus, the outputted dataset allows for singular event scenarios to be used at any location of the pilots for earthquakes (including secondary effects where applicable based on the original ground motions).

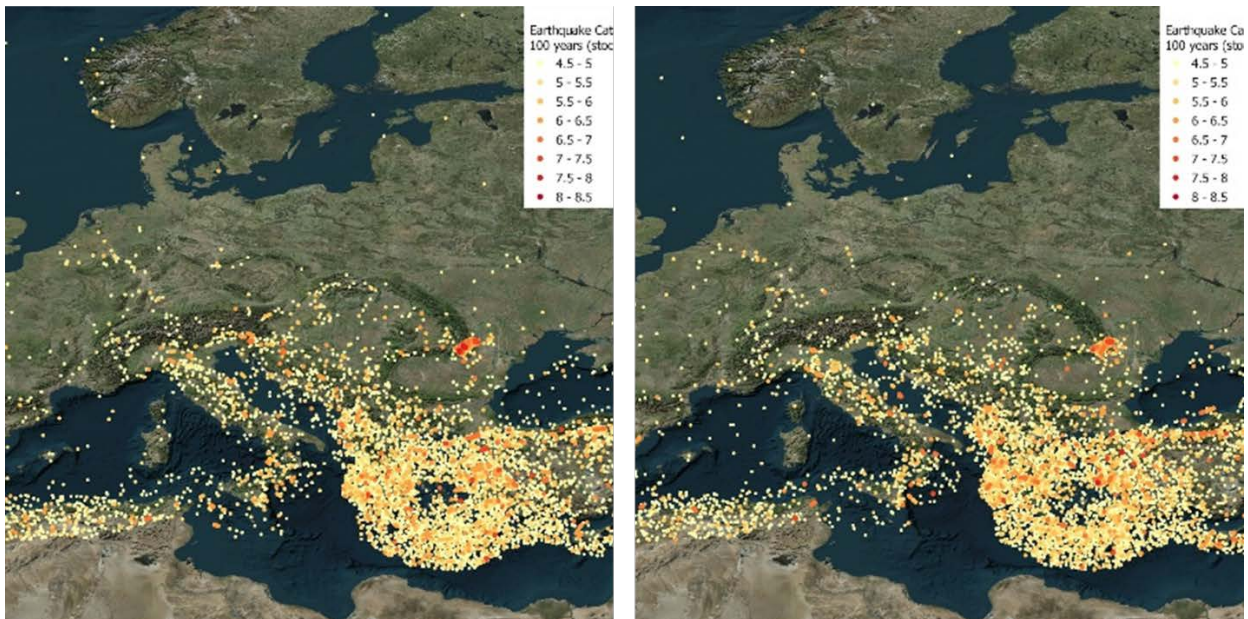


Figure 8: Example of two 100-year event set generations from the EFEHR adapted analyses, showing the magnitude of potential events. These sets, also have times associated with each event to aid multi-hazard overlap estimation.

The European windstorm event set has been produced as part of PRIMAVERA (Lockwood et al., 2022), and has been extracted for use in location-based event set results to give scenario footprints at any location. This is important for multi-hazard, as the events need to have a space and time component.

In terms of probabilistic models for other hazards, data from GloFAS were used in addition to RAIN, NARSIS, XWS and SYNER-G to produce additional European scale probabilistic maps for use in any form of combination of hazard thresholds at sites. The volcanic eruption database of LaMEVE of the GVM has also been used to derive simple volcanic eruption footprints for past events throughout Europe on the basis of the Volcanic Explosivity Index (VEI).

A number of these sets have been uploaded to Zenodo, however more will be added as they are finalised and metadata produced. The probabilistic sets that have been outputted from RAIN that can also be used at any point in Europe will not be re-released on Zenodo, although modifications to formatting and homogenisation of file formats have been undertaken.

Historically-based multi-hazard events sets

VUA and Risklayer have developed an algorithm that generates multi-hazard event sets. The method is called MYRIAD – Hazard Event Sets Algorithm (MYRIAD-HESA), and is currently in review as a scientific paper by Claassen et al. (2023).

MYRIAD-HESA is a fully open-access method that can create multi-hazard event sets from any hazard events that occur on varying time, space, and intensity scales, by incorporating historic hazard footprint data. Hazard footprint data must include where the hazard occurred, as a spatial polygon, and when the hazard occurred, as a start and end date. Additionally, the hazard footprint includes the hazard intensity in some cases.

In MYRIAD-HESA, two or more hazards are considered a multi-hazard event if they overlap in both space and time, as seen in Figure 9. For example, Hazard 2 and Hazard 4 overlap in space, but not in time, and are therefore not a multi-hazard event. However, Hazard 3 does overlap in space and time with Hazard 4, these are multi-hazard events. Multi-hazard events can also consist of more than two hazards. This is the case with Hazard 1, Hazard 2, and Hazard 3, as there is a point in time where they all occur at the same location.

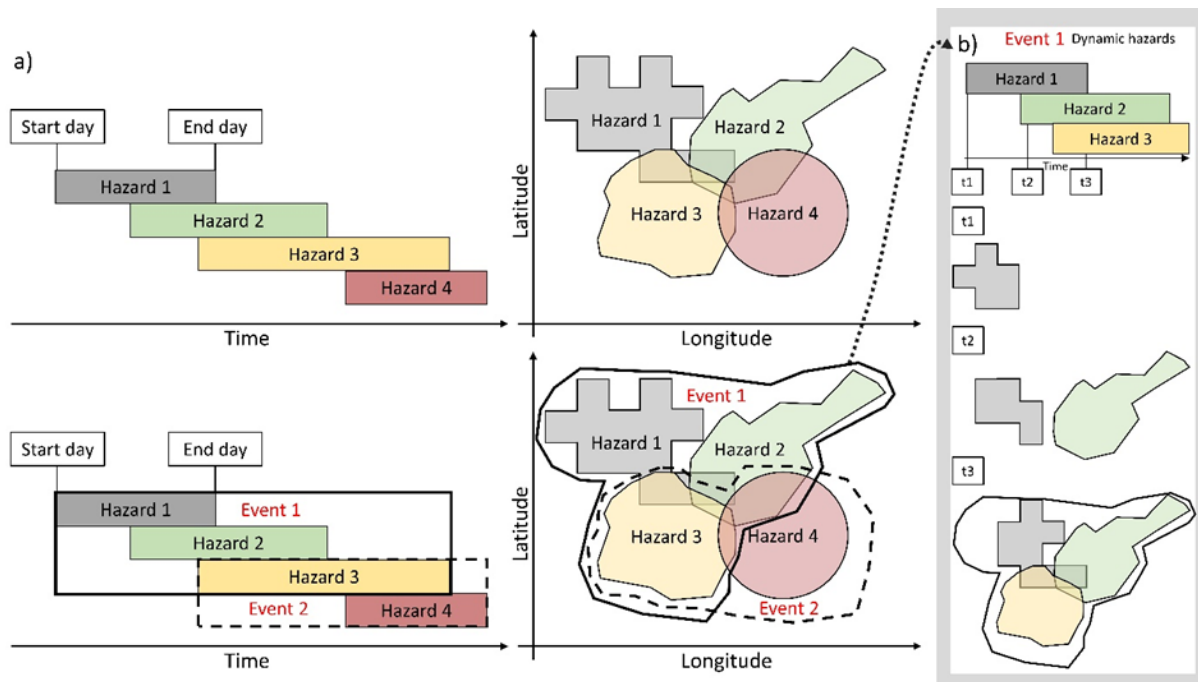


Figure 9: Example of a multi-hazard event set generation in MYRIAD-HESA without time-lag. This figure shows both hazard pairs and hazard groups. a) Hazards are a hazard group if all hazards overlap with each other in space and time as a pair. b) The dynamic hazards have to overlap with the other hazards during at least one of the overlapping time-steps

A hazard can also be classified as a dynamic hazard. Dynamic hazards are those for which there is information on their spatial development through time. For example, a wildfire can spread or diminish over the span of its lifetime, leading to multiple event polygons for each individual timestep. Therefore, if one or both hazards in a hazard pair are dynamic hazards, the dynamic polygons at each time step have to be checked to see whether the two hazards truly overlap at one point in space and time (as seen in Figure 9b).

MYRIAD-HESA can also consider multi-hazard events where the second event occurs after the first one has ended by introducing a time-lag (see Figure 9a). Such a time-lag is the number of days after the first event during which a second event can occur. Hazards must overlap spatially to be considered a multi-hazard event, but no longer have to overlap directly in time. The algorithm enables a time-lag to be introduced for each hazard, where multiple hazards are considered a multi-hazard event if they occur within one another's time-lag. Various time-lags based on the hazard intensity have been tested to understand the impact of a time-lag on the number and type of multi-hazard events globally. The time-lag has also been applied to the dynamic hazards, as can be seen in Figure 9b.

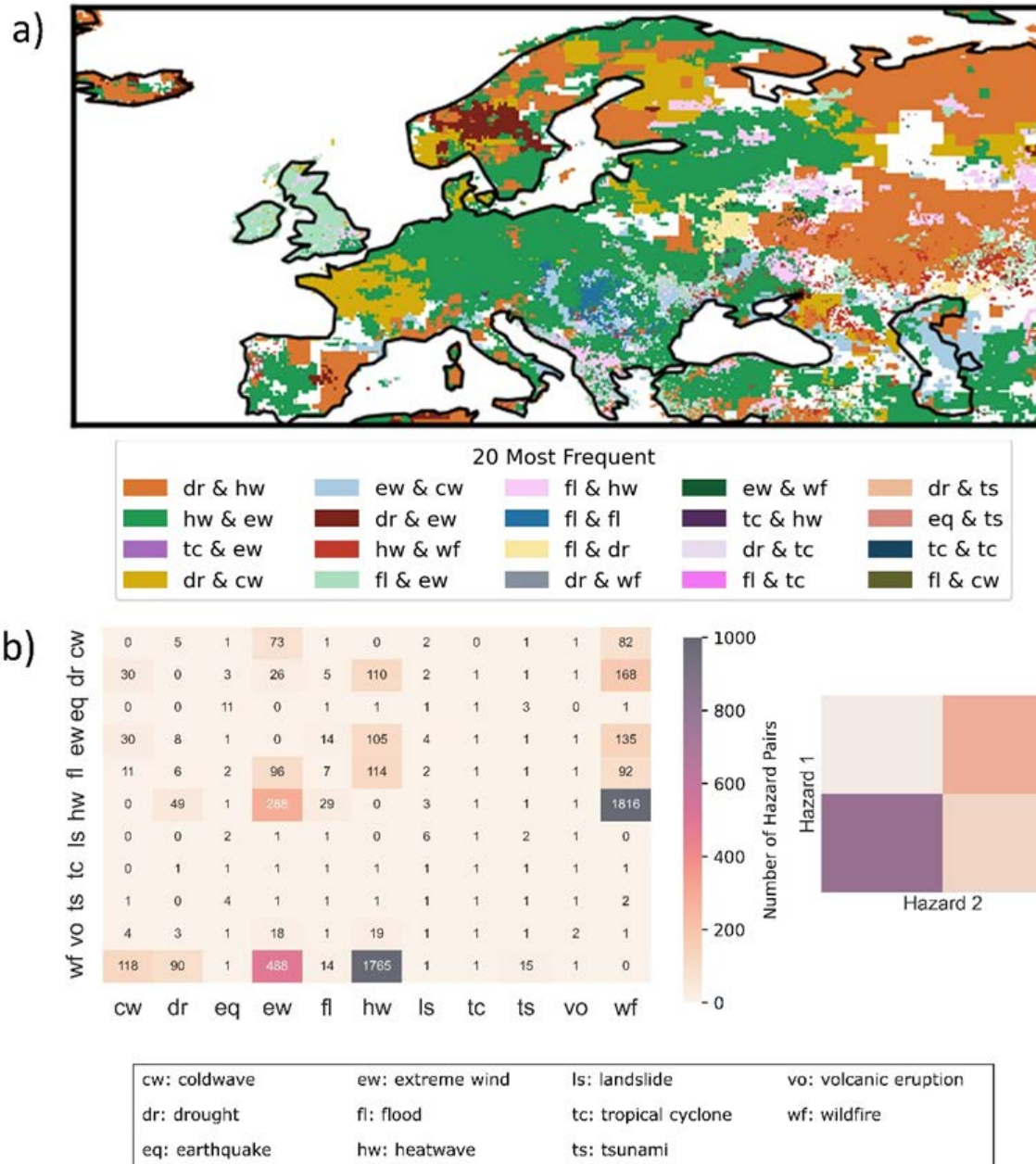


Figure 10: a) The most frequent hazard pair in Europe per location. Here, there is no distinction which hazard occurs first in the pair, for example, 'dr & hw' could be a drought followed by a heat wave as well as a heat wave followed by a drought. White areas are the ocean or a place with no hazard pairs. b) heatmap showing the number of hazard pairs in Europe. Hazard 1 is the hazard that has started first, followed by Hazard 2, showing the number of pairs from 2004-2017.

On a European scale, different hazard pairs overlap between two hazards. The two most prominent hazard pairs in Figure 10a are the combination of droughts and heat waves as well as the combination of heat waves and extreme wind. The link between drought and heat waves is evident, as high temperatures can lead to dry conditions and dry conditions can further increase temperatures. Moreover, the combination of a drought and a heat wave is a typical compound event that has received much attention in the past years as they usually lead to severe impacts on socioeconomic factors, are widespread, and are likely to intensify under climate change (Sutanto et al., 2020; Zscheischler et al., 2018). In contrast, the link between heat waves and extreme wind is less evident in literature. In this study, heat waves are based on above average temperatures of

specific calendar days. This means that heat waves during, for example the European winter storm season, may not necessarily be a typical 'hot' summer day. An extreme example of such a winter heat wave are the unprecedented temperatures Europe experienced in January 2023, where temperatures were 10°C above average and records were broken by 4°C. The overlap between extreme wind and heat waves in Europe are predominantly a result of such warm winter weather. Additionally, we observe many pairs that include a flood, such as in the UK where the combination between floods and extreme wind are the most frequent hazard pair. Here, the extreme wind event is likely a storm that is paired with storm surge and/or extreme precipitation, commonly referred to as a compound flood. Finally, there appear to be many hazard pairs that consist of heat waves and wildfires. This hazard pair is less visible in Figure 10a as there are many small events as seen in Figure 10b.

In summary, MYRIAD-HES showcases that Europe is at risk to a large range of different multi-hazards. To further study these multi-hazards event, MYRIAD-HESA will be available on the MYRIAD-EU Zenodo community, providing flexibility to conduct multi-risk assessments by, for example, incorporating higher resolution data for an area of interest. Alongside the MYRIAD-HESA, the multi-hazard event sets, MYRIAD-HES, will also be openly available to further increase the understanding of multi-hazard events in the disaster risk community.

Use of the EEA-CATDAT Database

Risklayer is using the EEA-CATDAT database (a database of past disaster events and impacts at the European scale), to identify past overlapping events. Earthquake intensity footprints, wind footprints from XWS and reanalysed wind footprints, volcanic eruption data from recent European eruptions, flood footprints from Cloud2Street have been applied, in addition to other storm and climatic hazard information from past events, but only on a timescale from 1980 onwards. An abstract has been submitted to EGU2023 on the topic and continued work is going on with EEA (<https://www.eea.europa.eu/data-and-maps/figures/total-economic-loss-caused-by-1>).

The outputs are now being combined for use in the risk scenarios of Task 5.2, for combination into D5.2 and eventually D5.3.

Progress in Task 5.2: Quantifying direct risk in a multi-risk and multi-sector setting (continues until month 36).

Task 5.2 is led by Risklayer, with contributions from VUA, UHAM, CMCC, and DRES with the overall aim of delivering methods and multi-hazard and multi-risk scenarios for use within the pilots, and at European scale. The scenario types may take many forms such as quantitative stochastic analyses, quantitative historic scenarios, semi-quantitative ("like" analysis), and qualitative/fuzzy analyses.

To achieve this, the starting point was to gather information from the Pilots on what indicators of risk are relevant to their Pilot cases. For this some activities were undertaken:

- As part of the Initial Pilot Meetings in November 2022, relevant risk outputs were collected as part of MIRO exercises for Veneto, and Canary Islands; and brainstorming exercises were undertaken in order to work out what risk outputs would be relevant from multi-hazard analyses for the 5 Pilots, and 6 sectors.
- A document was produced detailing some potential risk outputs, because MYRIAD-EU requires a series of risk outputs for each pilot location and sector in order to inform and guide the potential modelling analysis to be done in WP4-5-6 and because during the Initial Pilot Workshops there was confusion as to what risk metrics would look like. A logical starting point was therefore a theoretical analysis of different loss and damage parameters that are produced in sectoral risk assessments in order to determine what the best potential parameters are. From these loss and damage parameters (and definitions - as well as those worked out in the Handbook in WP1); and the hazard event scenarios above; the desired exposure and finally the vulnerability will be able to be calculated. Some examples of such parameters included are:
 - Ecosystems & Forestry Sector
 - Leaf area index (LAI) reduction (Environmental Metric)
 - Energy Sector

- Access to electricity at the household level (Social Metric)
- Business disruption due to power failures (Economic Metric)
- Tourism Sector
 - Reduction in the number of tourists (Social Metric)
 - No. of affected hotels (Economic Metric)
- As part of preliminary work, existing large scale European databases have been collected including SERA, residential exposure, OSM and some national level cadastral datasets. In addition, Risklayer has worked on improving their tourism exposure datasets for Europe for use within analyses. Work has started by Risklayer on the identification of potential risk thresholds for the scenarios in which various combinations of hazards and deterministic events meet that threshold (say 25% of hotels damaged in a particular zone). Empirical data in combination with WP4 is being examined to explore these types of metrics.

Progress in Task 5.3: Quantifying indirect and interregional risk in a multi-risk and multi-sector setting (continues until 36)

Task 5.3 is led by UHAM, with contributions from IIASA, CMCC, VUA and Risklayer. This work only started in March 2024 (after the first reporting period) as a suitable postdoc needed to be hired, which took considerable time as the first candidate could not start the position on time and a second one needed to be found. The later start to this Task than planned is not expected to affect any of the Milestones and Deliverables.

Going forward, UHAM will provide an overview of indirect risk modelling methodology/tools/models and how these can be used/complemented for investigating indirect impacts/risks. VUA, CMCC and IIASA will apply indirect models across various Pilot regions. Risklayer will provide input from the multi-hazard direct impacts for sectors and aim to help with subnational GDP, remote shocks such as Covid and conflicts, capital changes and other datasets where needed to support the indirect damage modelling. Concretely, UHAM will perform a review of (economic) impact models that are used in the project, and particularly in the pilot studies, to identify their strengths and weaknesses in terms of representing indirect effects. This review will form the content of D5.3 (Month 24). Based on the review and associated discussions, we will assess which pilots or with what model in general we could then actually model indirect impacts in the remaining project.

Preliminary work on indirect modelling has been carried out as part of the Scandinavian pilot (CICERO), in which the direct and indirect impacts of heat stress, focusing on cross-sectoral interactions within the region, is analysed for the agriculture, forestry, and hydropower sectors using the GRACE model. The GRACE model demonstrates how the production and consumption of intermediate goods and services reveals interdependencies among various sectors. Consequently, production disruptions in one sector can ripple through supply chains, affecting other sectors' outputs, changing market prices, shifting in consumer behaviour, and thus formulating indirect impacts. Preliminary results show that heat stress in 2018 caused a significant indirect impact on the refined oil sector (a nearly 3% drop in production in the current assessment) due to disturbances in energy inputs. Simultaneously, the substitution effect resulted in increased demand for crude oil and natural gas, boosting production in those sectors. The domestic price of fossil fuel energies moderately decreased in equilibrium due to these effects. Heat stress primarily drives a slight increase in CO₂ emissions in that year, mainly resulting from the indirect impacts on various sectors. The next step is to extend the research by isolating specific situations, for instance, focusing on the energy sector in Norway. We intend to evaluate both direct and indirect impacts to have a better understanding of the processes behind these impacts. After that, we will also explore the impacts in other sectors within different countries (i.e., the forestry sector in Finland and Sweden). This approach potentially provides valuable insights into the complex connection between multi-hazards and how they affect different industries and countries in the region.

As part of the General Assembly in May 2023, a dedicated session will be undertaken in order to examine the applicability of the different indirect damage methods to the project and in which pilots and to which stakeholders they are most applicable.

Progress in Task 5.4: Software package and user guide for multi-hazard and multi-risk scenario generation (Months 37-45)

Task 5.4 is led by Risklayer, with contributions from UHAM and VUA. The design of the software has been brought forward, due to stakeholders and pilots wanting more clarity on what will be built within MYRIAD-EU. To this end, although the development of the software package itself will formally take place in the final reporting period (hence, the start date of this task in the Grant Agreement is Month 37), the design of software requires thinking in an early stages. Several activities for planning the software package have already been started, with a framework set up as well as various questionnaires sent out to the consortium.

The MYRIAD-EU software intends to enable the choosing of multi-hazard scenarios at various MYRIAD-EU pilot locations, enabling input of hazard and risk results from stochastic, probabilistic and single event overlaps, and be extendable and usable for the whole of Europe.

An online workshop was undertaken in February 2023 in order to start the:

- Co-designing of a tool to output relevant MYRIAD-EU risk scenarios;
- Determine the key and desirable components and limitations of a software;
- Thinking about the end users and what has not been done before i.e. Multi-hazard qualitative, semi-quantitative and quantitative results for risk vs. hazard combinations.

The determination of the functionality of the software package is important, given the large range of backgrounds of the consortium and more so the end users on the stakeholder side. As part of the process to design the software, the consortium was asked for responses in an online board system (Padlet), in order to define if certain elements of a software were more important than others. In this Padlet, it was found that key multi-hazard scenarios are required more than probabilistic results, and understandable risk outputs required more than all risk outputs, which are important findings for the design of the final software. This activity led to the conceptual software design process show in Figure 11.

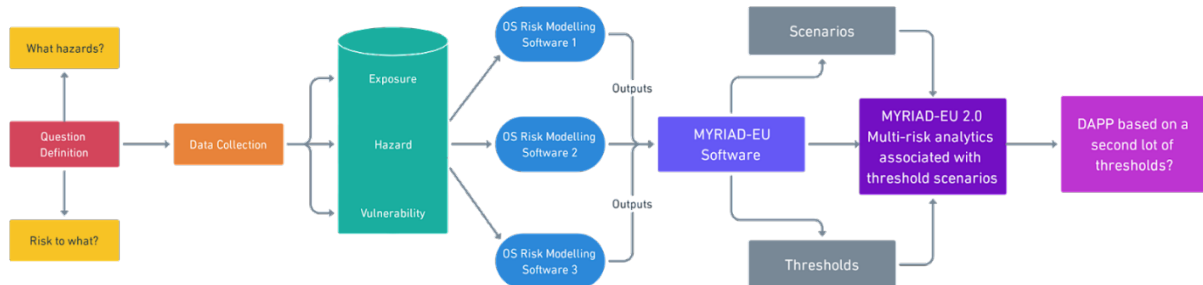


Figure 11: Conceptual software design process

Progress in Task 5.5: WP5 Helpdesk (continues until M45)

The helpdesk has been set up in conjunction with WP4 and WP6. A deliverable has been produced (D5.1) to provide internal documentation of the WP5 Helpdesk contacts and objectives. The role of the helpdesk is to facilitate communication and collaboration between the WPs of the thematic track (WPs 4-6) and the Pilots (WP3). The main contact point of the Helpdesk is James Daniell (Risklayer), with support from UHAM (Jana Sillmann).

The helpdesk has been involved in the Initial Pilot Workshops of November 2022 which was very important to determine the scope of the Tasks 5.1, 5.2 and 5.4 as a starting point.

1.2.6 Work package 6: Risk-informed decision making

Objectives of the WP

- Develop a collaborative systems analysis approach that allows decision-makers and policy-makers to accurately describe their decision-making context;
- Extend the existing Dynamic Adaptation Policy Pathways (DAPP) approach to be fit for use in a multi-hazard, multi-sector setting;
- Develop an online repository of narratives on multi-risk decision-making;
- Connect with the stakeholders within the pilots via the WP6 Helpdesk and refine the collaborative system analysis and extended DAPP approaches based on collected feedback.

Highlighted outcomes of Months 1-18

Dynamic Adaptive Policy Pathways-Multi Risk (DAPP-MR) approach published

We published a scientific paper (Schlumberger et al., 2022) that proposes DAPP-MR as a disaster risk management approach for complex, dynamic multi-risk. The paper reviews the recent multi-hazard and multi-sector research to identify relevant aspects of multi-risk management frameworks and illustrates the suitability of DAPP-MR using a stylised case.

Guidance document on collaborative systems analysis approaches

We produced a guidance document for our Pilots (D6.2), which presents promising tools for collaborative systems analysis. The document proposes a flexible, generic approach to collaborative systems analysis to be applied in the Pilots, and served as a useful reference for designing the Pilot Workshops.

Progress in Task 6.1: Collaborative systems analysis approach for forward-looking and adaptive multi-risk decision making (continues until Month 36)

Collaborative systems analysis approaches are needed for a variety of reasons, including: (1) to avoid negative consequences when approaching problems through a sector-specific lens; (2) to help in the formulation of system-wide objectives that both recognise and balance the inherent trade-offs within our systems, and (3) to ensure a more equitable distribution of system-wide resources, costs, and benefits.

Task 6.1 is led by DRES, with input from UKRI BGS, VUA, Risklayer, and ULL. In the first reporting period, Task 6.1 focused on two activities: (1) literature review on promising tools and approaches for collaborative systems analysis; and (2) development of a flexible, generic approach to collaborative systems analysis to be applied in the Pilots. The results of these activities are documented in D6.2 (Guidance document for Pilots on collaborative systems analysis approaches), which was made available to the Pilots prior to the initial Pilot Workshops (Milestone 6.1).

Given the findings of the literature review, a collaborative multi-sector, multi-risk system analysis approach was proposed that is capable of representing an integrated system and its key functions, risks, and opportunities. The proposed approach consists of the following iterative steps:

- Define system boundaries and constraints;
- Undertake sector-based analyses;
- Synthesise sector-based analyses into a whole-of-system analysis.

In D6.2, methods and tools are indicated for each of the steps, however, these are to be treated as suggestions only. Pilot Leads are welcome to apply alternative methods and tools that could assist in yielding the necessary information to define integrated decision contexts for their systems. The collaborative multi-sector, multi-risk system analysis approach will be further updated to incorporate insights and lessons learned from the experiences gained during the pilot-related activities.

Progress in Task 6.2 Tailoring DAPP approach for developing forward-looking DRM pathways in a multi-risk setting (continues until Month 36)

Task 6.2 aims to extend the existing Dynamic Adaptation Policy Pathways (DAPP) approach (Haasnoot et al. 2013) to be fit for use in a multi-hazard, multi-sector setting. In the first reporting period, the task was led by DRES, with close support of VUA, UKRI BGS, Risklayer, and ULL. Representatives of the Pilots provided useful feedback during the WP6 meetings and are expected to increase their contribution as activities evolve. The first months of the project were used to tailor the DAPP approach to DAPP-MR (DAPP for multi-risk). We have published a conceptual scientific paper on DAPP-MR. The following text summarises some of the key findings from Schlumberger et al. (2022).

In recent literature, three themes are detectable that are relevant to characterise multi-hazard and multisector interactions to design pathways: (1) effects of multiple, interacting hazards; (2) dynamics and interdependencies of sectors; and (3) trade-offs and synergies of DRM policy options across different sectors and different spatial and temporal scales. We assessed the capability of the analytical steps of DAPP to integrate these three themes. These aspects were attributed to one or more analytical steps of DAPP. It is important to note that hazard- and vulnerability-related interactions require additional information and iterations per analytical step.

Many of the identified aspects of multi-risk systems touch upon the spatial and temporal dynamics of vulnerabilities and opportunities. They further determine the adaptation tipping points (ATPs), which are defined as “the moment when the magnitude of change is such that a current management strategy can no longer meet its objectives. As a result, adaptive management is needed to prevent or postpone these ATPs.” (Nanda et al., 2018, based on Kwadijk et al., 2010) and Opportunity tipping points (OTPs), which are “points at which a particular action becomes feasible or attractive, for example because of lower costs of actions or technical developments.” (Haasnoot et al., 2019). Therefore, we investigated whether ATPs and OTPs are capable of dealing with the increased level of interdependence. In Figure 12, four different pathways are grouped together in varying combinations illustrating the implications of hazard interactions, cross-sectoral interdependencies, and policy option interactions on the shape of different pathways.

Colours represent different policy options. New policy options are implemented after an ATP (circle) or OTP (triangle) is reached. Dotted lines indicate the potential effects of interactions (red dashed lines) on pathways, ATPs, and OTPs. Generally, four effects can be identified:

- The timing of ATPs can be delayed (circle moves to the right) because of synergies between policy options (Figure 12a);
- New OTPs can emerge for various reasons (Figure 12b), e.g. multi-sector synergies could lead to additional available resources or willingness to cooperate in other ways to implement policy options that would not be feasible otherwise. Also, multi-hazard synergies (e.g. increased risk awareness) could reduce resistance regarding certain protection measures;
- Conversely, the timing of ATPs can occur earlier (circle moves to the left) when trade-offs between different policy options lead to asynergies or effects of multi-hazard interactions that exacerbate impacts (Figure 12c);
- Finally, certain policy options can be inhibited (red cross cuts off pathway) because of trade-offs, meaning that only one of the two measures can be implemented because of political, financial, or spatial reasons (Figure 12d). Policy options can also be inhibited by multi-sector trade-offs resulting from contradicting objectives or perspectives.
- The timing of ATPs can be delayed (circle moves to the right) because of synergies between policy options (Figure 12a);
- New OTPs can emerge for various reasons (Figure 12b), e.g. multi-sector synergies could lead to additional available resources or willingness to cooperate in other ways to implement policy options that would not be feasible otherwise. Also, multi-hazard synergies (e.g. increased risk awareness) could reduce resistance regarding certain protection measures;
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- Finally, certain policy options can be inhibited (red cross cuts off pathway) because of trade-offs, meaning that only one of the two measures can be implemented because of political, financial, or spatial reasons (Figure 12d). Policy options can also be inhibited by multi-sector trade-offs resulting from contradicting objectives or perspectives.

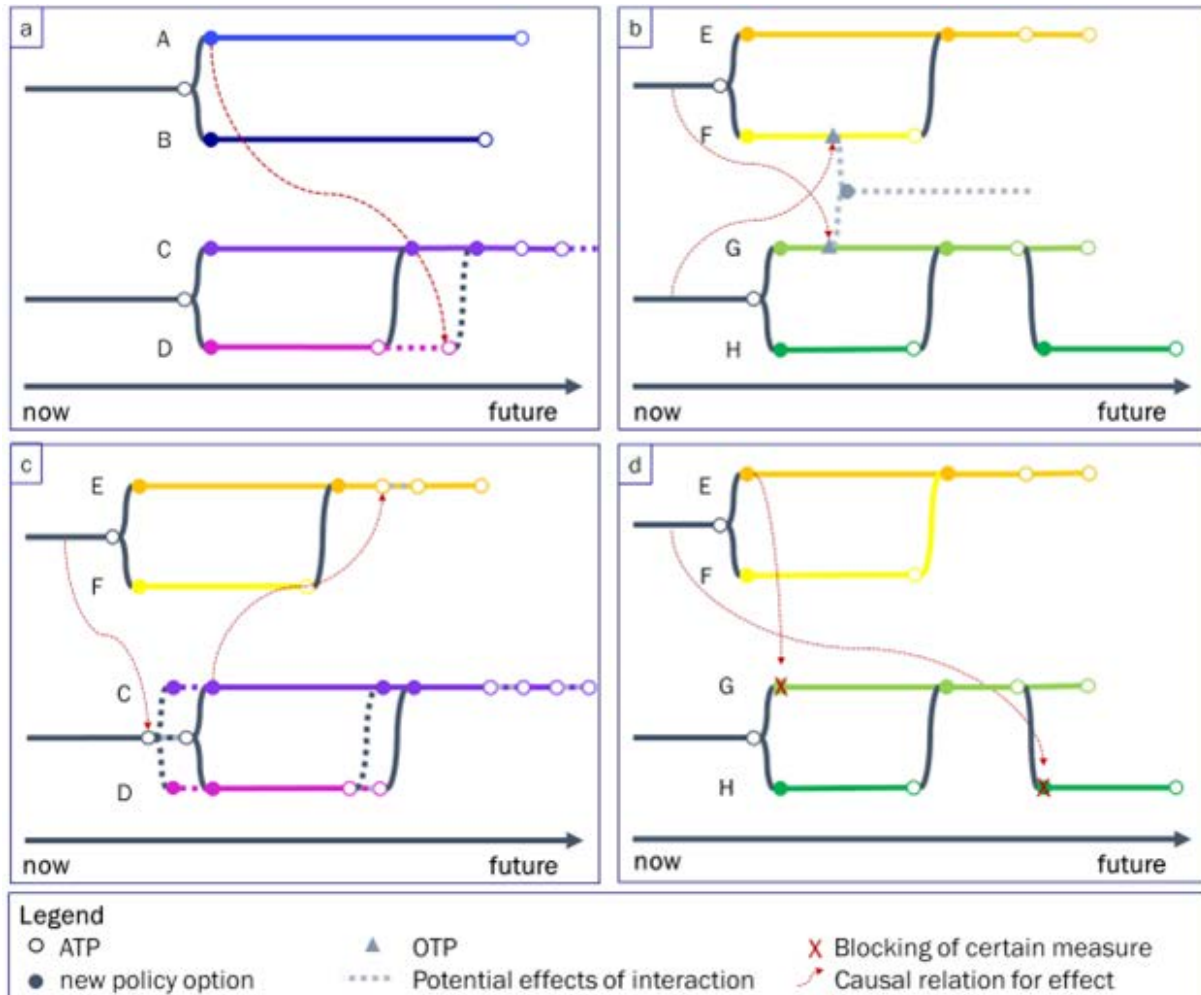


Figure 12: Set of illustrative combinations of two pathways. The coloured lines represent alternative portfolios of policy options (options A, B, C, D, E, F, G, and H). The panels visualise the potential interaction effects on the timing of Adaptation Tipping Points (ATPs) and Opportunity Tipping Points (OTPs) caused by hazard interactions, cross-sectoral interdependencies, and policy option interactions: (a) delaying ATPs, (b) new OTPs, (c) rushing ATPs, (d) and blocking of ATPs. cf. Schlumberger et al. (2022).

We showed how to enrich DAPP with contextual multi-risk elements without changing its step-wise approach. Furthermore, we discussed that the increased amount of information and cross step interconnectedness may require additional, iterative considerations when developing DRM pathways for complex, dynamic multi-risk. Accordingly, we propose DAPP-MR consisting of a rearrangement of the seven steps of DAPP, as shown in Figure 13. In addition to the original iterative steps of DAPP, three stages of iterations are included to characterize the decision context, vulnerabilities, and opportunities, potential promising policy options and promising pathways:

- Stage 1: DAPP-MR starts with a single-sector, single-hazard perspective;
- Stage 2: Subsequently, all single-hazard considerations are integrated per sector to result in a single-sector, multi-hazard perspective;
- Stage 3: The single-sector, multi-hazard information is integrated into a multi-sector, multi-hazard.

DAPP-MR helps to capture interactions, trade-offs, and synergies across hazards and sectors. We show that DAPP-MR may guide multi-sector processes to stepwise integrate knowledge toward multi-risk management. DAPP-MR can be seen as an analytical basis and first step toward an operational, integrative, and interactive framework for short-to long-term multi-risk DRM.

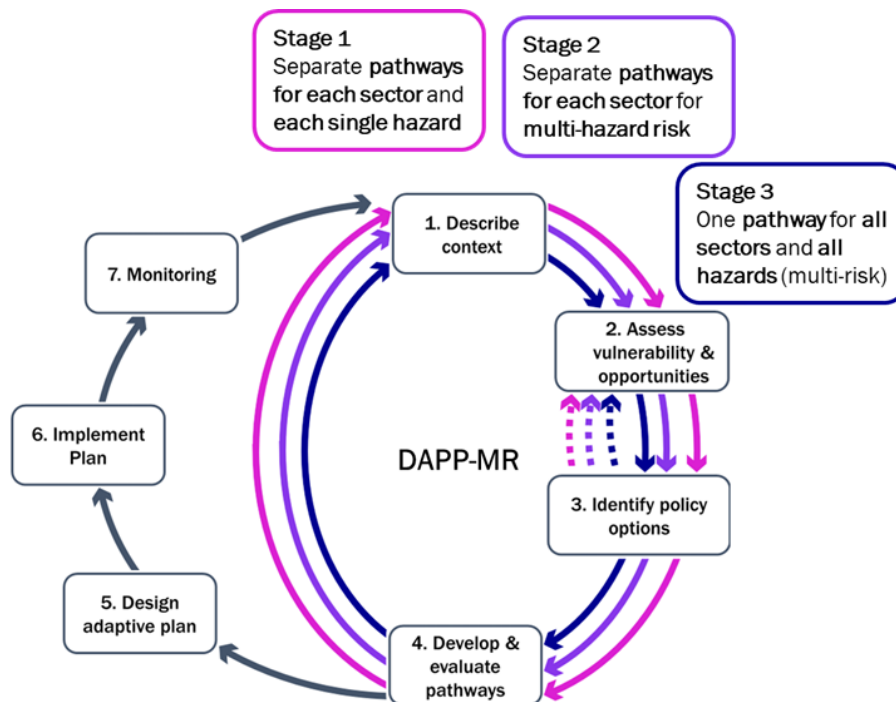


Figure 13: Analytical framework of DAPP-MR to develop and evaluate adaptation pathways to manage complex multi-risk systems. cf. Schlumberger et al. (2022)

In the next reporting period, we will test how the DAPP-MR framework is able to capture multi-risk interaction effects on the decision-options. We will test the DAPP-MR conceptual framework within (one of, or several of) the Pilot regions, starting with an exercise at the General Assembly in Venice in May. The testing will help to refine the proposed method. Additionally, tools like a Serious Game will be developed to make the concept/opportunities and challenges of DAPP-MR applications more accessible to potential users of the approach.

Progress in Task 6.3 Repository of storylines and narratives on multi-risk decision making (continues until Month 45)

Task 6.3 is led by UKRI BGS, with support from DRES, VUA, Risklayer, ULL and other partners. The focus of Task 6.3 is to create an online repository of storylines and narratives on decision-making for multi-risk events, highlighting good practices and lessons learned. A storyline is a “physically self-consistent unfolding of past events, or of plausible future events or pathways” (MYRIAD-EU Handbook of multi-hazard, multi-risk concepts, definitions, and indicators). Essentially a storyline is a qualitative description of the whole chain of events from hazards to impacts and recovery, considering decision-making, mitigation efforts, cross-sector dependencies and lessons learned. This task was initially planned to start at a later date (Month 37), but given the feedback from the second General Assembly and various stakeholder meetings it became clear that an earlier start was more advantageous.

We gathered example storylines from the literature and proposed case study storylines for each pilot, which were shared with the Pilot Leads ahead of the initial Pilot Workshops to aid workshop discussions. Following the Pilot Workshops, we held a WP6 meeting in December 2022, with a focus on Storylines. We invited WP6 team members to contribute to a Padlet to get insights on the use of multi-risk storylines through four questions:

- What does a storyline mean to you?
- What do you want or need from a storyline?

- Are there any existing multi-hazard/risk storylines (or events) that are of particular interest to you/your pilot/the project?
- How would you like to be able to view/access storylines?

These are being used to inform how we will collect and present storylines in general, and the look of the online repository. We are working closely with WP2 on the dashboard development, which is where the online repository will sit, and with WP4 (Task 4.1), in which a literature review will be carried out of past consecutive events.

Further, DRES hosted a 4 month internship from November 2022 to February 2023. The student focused on storylines (co-supervised by UKRI BGS), with an aim to create a template for collecting past multi-risk storylines. The student developed a storyline for the Hunga Tonga-Hunga Ha'apai 2022 volcanic eruption and subsequent tsunami, which formed the basis to build elements of a preliminary storyline template and guiding questions for understanding past multi-risk events. An initial report on storylines of past multi-risk events was produced by the student, which will form the basis of our continued work on this task.

In the next year we will develop case studies of past events into storylines, working closely with WP2 on how to present them, drawing out good practices and lessons learned for decision making. Further work is needed on the development of guiding questions for the collection of storylines, and on the development of a template to present Storylines. We aim to submit a publication on the application of storylines and narratives in multi-risk systems. In the coming year, we will work closely with the Pilots to ensure their needs are met, and to start developing future storylines and narratives.

Progress in Task 6.4: WP6 Helpdesk (continues until Month 45)

The helpdesk has been set up as part of WP6 in conjunction with WP4 and WP5. A deliverable has been produced (D6.1) to provide internal documentation of the WP6 Helpdesk contacts and objectives. The role of the helpdesk is to facilitate communication and collaboration between the WPs of the thematic track (WPs 4-6) and the Pilots (WP3). The main contact point of the Helpdesk is Dana Stuparu from DRES, with support from Julia Crummy from UKRI BGS.

Activities of the Helpdesk to date include a 4-hour long webinar to present DAPP to the Pilot Leads and consortium partners, so that they could familiarise themselves with the concept of long-term, adaptive thinking and planning. The webinar was recorded and remains available to the MYRIAD-EU consortium. Additionally, another webinar was offered to the Pilot Leads and project partners to present the analytical framework of DAPP-MR and to discuss what approaches/methods/tools could be used for the implementation in the Pilots. This webinar was recorded as well and remains available to the MYRIAD-EU consortium.

1.2.7 Work package 7: Communication, dissemination, exploitation

Objectives of the WP

- To promote MYRIAD-EU's results, products, and services among all potential users in order to maximise uptake of the resources created by the project.
- To raise awareness across sectors (public and private) of key messages around multi-hazard risk management.
- Foster and strengthen engagement across research in the field to ensure projects build on each other.

Highlighted outcomes of Months 1-18

Creation of eye-catching MYRIAD-EU visual identity

We have developed a bold, bright, and attractive visual identity, clearly documented in a graphic charter. The identity is well-used across the consortium and is already well-recognised across the broader scientific community.

Active project website and Twitter account

We have built a user-friendly website, which is regularly updated with news, events, blogs, and other information from across the consortium. In addition, we have an active Twitter account (@Myriad_EU), with almost 1500 followers.

MYRIAD-EU attendance at policy and practice events

MYRIAD-EU researchers have been involved in, or organised, several events related to policy and practice. Examples include: panelist roles at the UNDRR European Platform in a session on natural hazards and health and UNDRR Data Week panel discussion in a session on the UNDRR-ISC Hazard Information Profiles; organisation of a workshop at World Bank GFDRR Understanding Risk Conference; and presentations and discussions at annual meetings of various sectoral stakeholders, including the AON annual science-practice meeting, FEHRL Members Workshop, ERIAFF annual conference, and HOTREC annual General Assembly.

Progress in Task 7.1: Communication foundations (completed)

Task 7.1 was completed in Month 6. It was led by Arctik, with input from, and discussions with, VUA. The main activities carried out in the task are summarised below.

Visual and brand identity

To raise awareness about the MYRIAD-EU project, its research and impacts, we have created a bold, bright, attractive and coherent project visual and brand identity, documented in a graphic charter (Milestone 30) as a first step towards achieving this objective. It provides consistency in the communication and helps attract attention from the audience.

The logo and colour scheme were selected to align with the project's objectives and mission. The logo was designed to represent the interconnectivity of risks, which is the cornerstone of the project. The whole colour scheme was chosen to be bold and bright, to reflect the project's mission of catalysing a paradigm shift in how risks are currently assessed and managed (Figure 14).

As for the tagline, we chose '*MYRIAD-EU: Reducing risks together*', to emphasise the importance of interlinkages, joint efforts, and breaking silos in addressing risks and hazards.

- Multiple outputs have been produced in relation to the visual identity including:
- Visual Identity Guidelines
- Logo in various sizes, formats and colour versions
- Templates (PowerPoint, Word, Excel)
- Banners (including editable via PPT for all partners)
- Editable conference scientific poster,
- Editable leaflet.



Figure 14: The logo and colour scheme of the MYRIAD-EU project

Website & Social Media accounts

To ensure that our target audiences can easily find more information regarding MYRIAD-EU, we have built a user-friendly website (Milestone 31), <https://www.myriadproject.eu/>, which will be actively maintained and updated throughout the whole duration of the project. The full website was launched in Month 4. It currently has 7 pages, namely: Home, About, Pilots, Library, News, Events, and Contact Us. It is a living site, and there will be updates and changes to the current content as the project unfolds and further needs for the website are assessed.

In addition, a Twitter account with the handle @Myriad_EU has been set-up to further disseminate what is published and updated on the website: https://twitter.com/Myriad_EU. Between Months 1-18, 170 tweets were published on its account, and the project gained 1470 followers. We are planning to also create a dedicated LinkedIn account after the MYRIAD-EU General Assembly 2023, as an additional effort to maximise stakeholder engagement and outreach.

Plan for the dissemination and exploitation of results

In Month 6, we finalised the Plan for the Dissemination and Exploitation of results (PDER) (Deliverable 7.1). The purpose of the PDER is to define and establish an effective framework and strategy which will guide the communication, dissemination, and exploitation activities throughout the project. The strategy identified target groups and a set of relevant communication channels and tools. The executed strategy employs both digital and non-digital tools, including a well-designed interactive website and social media account (Twitter), and a good mix of offline activities such as videos and events. It is kept updated at set intervals (Month 18, 36) throughout the project.

In Table 2 we show an overview of our current progress of the KPIs set in our PDER. Based on the documented results we see that we are well on track.

Table 2: Overview of progress towards dissemination KPIs

Dissemination activity	Methodology	KPI	Target (end of project M48)	Results (M1-18)
Project website	Google analytics	Number of total visits	25,000	3,979
Twitter (social media)	Twitter analytics	Followers	2,000	1,470
		Campaigns	5	3
		Avg. impressions (reach) per tweet (non-sponsored)	500	770
		Avg. impressions (reach) per tweet (sponsored)	2,000	N/A

		Avg. engagements (like retweet, comments) per tweet (non-sponsored)	1.30%	3.1%
		Avg. engagements (like retweet, comments) per tweet (sponsored)	1.00%	N/A
Media	Communication activity reporting	Articles/press releases published on MYRIAD-EU channels	30	48
		Articles/press releases published on external channels	15	28
Events	Communication activity reporting	Total participants at MYRIAD-EU organised events	500	385
		External events attended by MYRIAD-EU partners	25	40
Publications	Communication activity reporting	Publications published in journals/magazines	15	13

Progress in Task 7.2: Targeted outreach activities (Continues until Month 48)

Task 7.2 is led by Arctik with content input from all consortium partners. VUA provides regular input through a monthly bilateral meeting with Arctik, and further ad-hoc meetings where necessary.

Editorial web content

To ensure that the website is kept relevant we have developed an editorial calendar containing events, publications, articles, and blogs. The topics are chosen as the project unfolds, whilst 'filler' content such as presenting Early Career Researchers (Meet the young researchers behind the MYRIAD-EU), Project Members (What our experts are reading) and events the consortium have organised/attended are added in the meantime to help raise awareness for the project.

To date we have published 25 articles/news in the 'Library' and 23 'News' items on the website. Among these publications was Milestone 32 (first blog online), entitled How can Dynamic Adaptive Policy Pathways (DAPP) help mitigate disasters? – written together with the project partner DRES and submitted in Month 10.

The top 5 visited pages overall are:

- Home – 3,593 page views, 2,778 unique visitors
- News – 1,110, page views, 994 unique visitors
- Pilots – 678 page views, 580 unique visitors
- Library – 642 page views, 486 unique visitors
- Team – 578 page views, 472 unique visitors

The top 5 visitors' countries are:

- Belgium
- United States
- Netherlands
- Italy
- United Kingdom

Visual production

The first – 100% animated – [introductory video about the MYRIAD-EU project](#) was designed and finalized in Month 13. In addition, there were several interactive website graphics created for the website (Figure 17). In the coming months, it is foreseen to produce more communication graphic materials (including videos, infographics, animation) to support the consortium in participation and organisation of upcoming events as well as to give direct visibility to new tools, methods and solutions created within the project.



Figure 15: Example of interactive website graphics

Events

The large consortium is active in taking part in numerous scientific, policy, and practice events, to disseminate and to raise awareness of MYRIAD-EU in various capacities. They include: several major scientific conferences (e.g. EGU General Assembly 2022 in Austria, Understanding Risk Global Forum in 2022 in Brazil, AGU Fall Meeting in 2022 in USA, DAMOCLES Compound Events Final Conference in 2022 in Portugal); high-level policy-events (e.g. UNDRR European Platform, UNDRR Data Week); and several practice-oriented events (e.g. AON annual science-practice meeting, FEHRL Members Workshop, ERIAFF annual conference, and HOTREC annual assembly).

Policy briefs and workshops

This subtask has not started during the first reporting period.

Challenge-based publications

This subtask has not started during the first reporting period.

Progress in Task 7.3: Creating synergies & supporting knowledge exchange (Continues until Month 48)

Strategy for synergies and knowledge exchange

Arctik created a Strategy for synergies and knowledge exchange (Milestone 33) in Month 18, together with the first update of the PDER. They were created in line with the central ambition of MYRIAD-EU, such as to facilitate two-way knowledge exchange and to unlock synergies across the multi-hazard risk management research community.

The proposed strategy relies on a variety of tactics, each contributing to the overall approach, namely:

- Supporting engagement with sister H2020/EU-funded projects;
- Integrating relevant research from outside the project;
- Linking in with research networks;
- Fostering cross-discipline knowledge exchange within the project;
- Monitoring progress.

A 'living' list of relevant H2020 and other EU-funded sister projects has been identified (Table 3).

Table 3: An example of the current non-exhaustive list of Horizon 2020 sister projects.

Title	Twitter handle	Website
Paratus-EU	@Paratus_EU	paratus-project.eu
The HuT Nexus	@TheHuT_EU	thehut-nexus.eu
PolarRES	@PolarRES_eu	polarres.eu
RECEIPT	@RECEIPT_eu	climatestorylines.eu
Cascades	@Cascades_EU	cascades.eu
RiskPACC	@RiskPacc	riskpacc.eu
ENGAGE	@EngageH2020	project-engage.eu
LINKS EU Project	@LINKS_EUProject	links-project.eu
CORE_EU	@CORE_EU_H2020	euproject-core.eu
BuildERS	@BuildERS_EU	buildersproject.eu
DAREnet	@DAREnet_EU	darenetproject.eu
INGENIOUS_EU	@INGENIOUS_EU	ingenious-first-responders.eu
RESILOC	@resiloc	resilocproject.eu
peers_eu	@peers_eu	peers-project.eu

MYRIAD-EU has designed a set of collaborative initiatives to facilitate communication and exchange of ideas among its sister projects. To name a few, one of the key activities is to tag each other on social media platforms, making it easier to share and amplify messages. Another is to share events calendars and to represent each other at events, as well as hosting side events or conference sessions together. It is also foreseen to attend each other's General Assemblies to learn from each other's good practices as well as to share communications strategies.

MYRIAD-EU collaborates closely with DRMKC, Risk KAN, and other established networks. The project coordinator and data manager of MYRIAD-EU have attended DRMKC Annual Seminar and Data Hub workshops. MYRIAD-EU and Risk KAN have intense collaboration with two project members co-chairing the board and working group on Multi-Hazard Early Warning. They have presented at Risk KAN working group on Compound Events and Impacts and AGU2023. MYRIAD-EU also engages with other networks such as COST Action DAMOCLES and Data Week panel discussion. In addition, as part of the UNDRR's network, MYRIAD-EU has registered a [voluntary commitment to the Sendai Framework for Disaster Risk Reduction](#), a global roadmap to reduce disaster risk by 2030.

Joint Conference planning

Arctik, VUA, UHAM, and MPG have held several preparatory meetings for the joint scientific conference planned for 2024 (Milestone 38 with amended date of Month 35). This will be a joint conference between MYRIAD-EU, RiskKAN, and NatRiskChange. Over the course of Months 1-18, the partners held four coordination meetings, during which they agreed upon the specific dates and host city (12-14 June 2024 in Amsterdam), as well as a general outline for the event (two full days with an optional half-day for early career researchers). Additionally, two committees were established (Programme Committee and Organisation Committee) to oversee further preparations, and venue scouting has begun. A save the date for the Joint Conference has already been announced, and formal news is slated for Month 21.

Progress in Tasks 7.4 and 7.5

These tasks have not started during the first reporting period.

1.2.8 Work package 8: Management and coordination

Objectives of the WP

- Effectively and efficiently manage all administrative, legal, and financial issues;
- Organise and implement an efficient project structure and day to day coordination;
- Monitor and ensure scientific quality and coherence of MYRIAD-EU;
- Monitor and maximise the impacts of MYRIAD-EU;
- Ensure effective strategic, operational, and risk management.

Highlighted outcomes of Months 1-18

Diversity and inclusiveness

We have a very strong gender balance at all levels of the project, with 5 (out of 8) of the current WP leads being female, and 8 (out of 11) of the current MT members being female. The External Advisory Board is composed of 2 female and 3 male members, and the Early Career Researcher Board (ECRB) is composed of 2 female and 2 male members. The inclusion of an ECRB as one of the project bodies, and an elected Early Career Representative as a member of the MT, has led to a very active network of early career researchers with high exposure and esteem within the research community.

Two hybrid General Assemblies

Despite the logistical and administrative challenges associated with the Covid19 pandemic, we organised two very successful General Assemblies (Zandvoort aan Zee in The Netherlands and Laxenburg, Austria). These events were instrumental in developing a very open and collaborative team and joint vision.

Progress in Task 8.1: Administrative, legal, and financial management

This task entails the execution of the overall administrative, legal, and financial activities to assure the functioning of the project, and is carried out by the Coordination Unit at VUA. During the first reporting period the main activities were: developing and coordinating the signing of the Consortium Agreement (D8.2), and its subsequent update following the amendment described in the next paragraph; the timely distributing the financial contributions of the European Commission (EC) to the project partners; submitting the deliverables to the ECAS portal; updating progress on milestones in the ECAS portal; and coordinating the preparation and submission of the first periodical reporting. Next to this, the Coordination Unit has ensured effective communication with the EC through: providing short quarterly progress reports to the Project Officer via email; and regular virtual meetings at ad-hoc intervals with the Project Officer.

An amendment to the Grant Agreement (AMD-101003276-4) was made during the first reporting period, following a unanimous vote in favour of all points. The amendment did not affect the content of the project, but rather referred to the following administrative changes:

- Addition of beneficiary University of Hamburg (UHAM) - the Principal Investigator (PI) from CICERO became Full Professor at UHAM. UHAM was added as beneficiary to retain the expertise of Prof. Sillmann in the project, with the responsibilities of co-leading WP5 and leading Task 5.3 being transferred from CICERO to UHAM;
- Transfer of budget and tasks from CICERO to UHAM - in relation to the above-stated amendment, a transfer of budget from CICERO to UHAM was arranged, namely direct personnel costs of €87,750 and other direct costs of €4,543.75.
- Inclusion of information with regards an in-kind contribution for Arctik

Progress in Task 8.2: Efficient project structure and day to day coordination

This task focuses on the day-to-day coordination activities, and is mainly performed by VUA, with support from CMCC and Arctik. The following main activities were performed:

- Two hybrid General Assemblies (G.A.s) were organised (29 September - 1 October 2021 in Zandvoort aan Zee in The Netherlands, and 7-8 April 2022 in Laxenburg, Austria). Both G.A.s took considerable organisational effort as a result of the Covid-19 pandemic. For the first G.A. we were only able to take a decision on whether to hold a hybrid or fully only event approximately one month prior to the event, due to uncertainty on the lifting of restrictions in the Netherlands. Moreover, VUA had to request special dispensation from the Dutch government (via the Netherlands Enterprise Agency) for 3 participants from the U.K. to travel to the G.A. due to ongoing restrictions related to non-EU citizens). For the second G.A., the date and location of the event were changed at late notice due to the change of dates of the EGU General Assembly (due to Covid-19 restrictions in Austria). However, the effort was beneficial: the first G.A. was very successful in creating an open atmosphere of collaboration and a joint understanding of the project, and the second G.A. was instrumental in developing the framework and ensuring clear linkages between the pilots and the other work packages. The second G.A. was held back-to-back with the WP1/2 stakeholder meeting to reduce travel.
- VUA arranges regular Management Team (MT) meetings, as well as preparing agendas and minutes, and monitoring of follow-up actions. During the first 12 months of the project, meetings were approximately 3 monthly by Zoom, with separate meetings of the “Impact Unit” and “Quality Unit”. Additional in person meetings of the full MT were held during the G.A.s. Since Month 12, the meeting frequency has been increased to monthly (with shorter length), with both the Quality Unit and Impact Unit involved. This increase in frequency and merger was implemented to be able to more quickly address emerging issues, to allow for better exchange of information across WPs, and to allow for better integration between the science and impact activities. During the MT meeting in July 2022, an online evaluation of the management activities and overall progress of the project was carried out, in order to ensure continued improvement. All agendas and minutes are available to all consortium partners on the shared drive, in order to promote transparency.
- Meetings between the project coordinator and the External Advisory Board (EAB) and Sectoral Sounding Board (SSB) have taken place during the first reporting period on an ad-hoc basis, at the request of either the MT or the boards themselves. In January 2023, it was agreed to plan regular 3-monthly meetings of these boards, with immediate effect.
- The Early Career Researcher Board (ECRB) meets approximately every 3 months, and information from the ECRB is shared with the MT via the Early Career Representative, who is part of the MT. The ECRB was elected from across the project’s Early Career Researchers (ECRs) in Month 5 and will be in place until Month 26 (at which point a new election will take place). The ECRB elects the Early Career Representative. During Months 1-5, the interim representative (before the first election) was Timothy Tiggeloven (VUA). During Months 5-13, the representative was Judith Claassen (VUA), and since Month 14, the representative is Kelley De Polt (MPG). The ECRB organises regular meetings, discussions, and social events for ECR within the project to present their research, share knowledge, and network. These events occur virtually, at the annual project G.A.s, and major European conferences (such as EGU). The ECRB also serves as a path of communication between ECRs and MT. Ways in which the ECRB facilitates this communication is through surveys and hosted events.
- At VUA, the Coordination Unit has a bi-weekly internal meeting to discuss overall progress and day to day issues.
- Arctik set up a shared project drive in Month 1 that is used for working collaboratively (not data storage), including working folders for each WP.
- Arctik set up and maintain mailing lists for the consortium, work packages, and project boards.

Progress in Task 8.3: Monitoring and ensuring scientific quality and coherence

This task is led by VUA with support from UKRI-BGS, IIASA, CMCC, Risklayer and DRES.

- A Quality Plan was developed as part of the Quality, Ethics, and Risk Management Plan (D8.1). The Quality Plan documents the main processes and procedures set-up to monitor and control the quality of all results and deliverables within MYRIAD-EU. It also provides all project partners with clear and concise summaries of: project management structure; roles and responsibilities of Project Bodies and persons; quality assurance procedures for deliverables and reports;

procedures for reporting on other publications and datasets; and internal collaboration procedures.

- The Quality Unit (part of the MT) oversees the implementation of the Quality Plan. This includes implementing our internal review procedure for all project deliverables. An integral part of this procedure is ensuring that all deliverables are reviewed by 2 reviewers who were not directly involved in its production.
- An Ethics Plan was developed as part of the Quality, Ethics, and Risk Management Plan (D8.1). It ensures compliance with all ethics requirements laid out in WP9, serves as an ethics guideline for all project partners, and provides all necessary information on templates to be used for the data collection activities in MYRIAD-EU that involve human participants. Our Ethics Officer was responsible for developing the Ethics Plan, and is responsible for overseeing its implementation. To that end, an Ethics folder is available on the shared drive, in which we store: partner's ethics policies; documentation of ethics reviews; and templates of consent forms and participant information forms. The Ethics Officer is available to all project partners for ethics-related questions. The Ethics Officer is a member of the MT.
- A Data Management Plan (DMP; D8.3) has been developed, and shared and discussed with all consortium partners. Our Data Manager was responsible for developing the DMP and is responsible for overseeing its implementation. The Data Manager is available to all project partners for ethics-related questions. The Data Manager is a member of the MT.

Progress in Task 8.4: Monitoring and maximising impacts

This task was led by VUA with contributions from Arctik and CICYTEX. Whilst the activities relating to dissemination, communication, and exploitation are carried out in WP7 (see reporting on WP7 and Section 1.3), this task monitors their impacts and suggests actions to further maximise impacts. Examples of specific activities include:

- External Advisory Board (EAB): our EAB consists of 5 members with expertise on the subject of multi-hazards and multi-risk from science, practice, and policy perspectives. During the first reporting period, the Project Coordinator met with the EAB approximately 3 times per year, including General Assemblies (which EAB members attended remotely). Other bilateral meetings took place between the Project Coordinator and different members of the EAB on an ad-hoc basis on the request of the EAB member or Coordinator, relating to specific activities for maximising impact.
- Impact activities are discussed at all regular MT meetings and during the G.A.s, including potential events at which the project can present.
- A dedicated MYRIAD-EU Zenodo Community page has been created for storing all project publications.
- Efforts are being taken to connect the project to various other EU-funded projects, notably several funded through the DRS calls of Horizon Europe: MEDiate, PARATUS, The HuT, and MIRACA. A joint call has been held between the coordinators of MYRIAD-EU, PARATUS, and HuT, with an additional call planned shortly with MEDiate. The Project Coordinator is in the Advisory Board of PARATUS, the Project Manager is in the Advisory Board of HuT, and both the Project Coordinator and Project Manager are directly involved in MIRACA.
- The Sectoral Sounding Board (SSB) and the Project Coordinator have met approximately 3 times per year, including General Assemblies to discuss activities to increase impacts for each sector involved in MYRIAD-EU.

Progress in Task 8.5: Strategic, operational, and risk management

This task is led by VUA, with contributions from all partners.

A Risk Management Plan was developed as part of the Quality, Ethics, and Risk Management Plan (D8.1). Its development was coordinated by the Project Coordinator, and it outlines the key elements of our risk management strategy. This includes discussing emerging project risks as a regular agenda point at all MT meetings, as well as the establishment of an online risk register, which is updated throughout the lifetime of the project. Current risk and mitigation strategies listed in the risk register can be found in Appendix A.

1.2.9 Work package 9: Ethics requirements

This WP is led by VUA, with contributions from all partners.

Objectives of the WP

To ensure compliance with the 'ethics requirements' set out by the European Commission.

Progress in the WP

The compliance statement for POPD requirement No. 2 (D9.1) was submitted on time in Month 5. Further activities related to Ethics are carried out within WP8 (Management and Coordination) and are discussed in Section 1.2.8.

1.3 Impact

The information provided in Section 2 of the Description of Work in the Grant Agreement remains accurate. In the following section, we provide a short overview of the progress towards the expected impacts and an overview of the main publications (not including deliverables).

1.3.1 Contribution to expected impact

This section outlines the contribution of the work executed in the first reporting period towards the expected impacts as foreseen and listed in the Grant Agreement.

“...consensus in better definitions, indicators and functions to characterise multi-hazard risk through enhanced inter-disciplinary collaboration...”

Our handbook of multi-hazard, multi-risk concepts, definitions, and indicators (D1.2) and report on policies, policy-making processes, and governance for multi-hazard, multi-risk management (D1.3) provide clear definitions related to multi-hazard and multi-risk, as well as reviewing existing functions, tools, and approaches used in the research community, and policies and policy-making processes. They have been viewed 326 times and 103 times on our Zenodo community page respectively (as of 5 April 2023). The content of these Deliverables has been used to populate our Disaster Risk Gateway multi-risk Wiki with definitions, existing tools and methods, and existing policies. The Wiki is intended as a common platform for sharing knowledge across the wider disaster risk community. It has recently been presented at several scientific and practice events, including: AGU session on multi-hazard and compound risks; COST Action DAMOCLES workshop on stakeholder engagement in compound and multi-hazard research; AON annual research meeting; DRMKC annual seminar, and the UK Alliance for Disaster Research Annual Conference 2022. Interest in the Wiki has been high, with several attendees of these events and several projects expressing their interest to contribute to it. To this end, we will plan events in the second reporting period to encourage people to actively contribute. A meeting will also be planned with representatives of UNDRR to discuss potential use within its activities.

“...prioritisation of investments & selection of effective DRM options...” & “...enhanced risk-informed decisions ... addressing trade-offs between... options”

The guidance document on collaborative systems analysis approaches available in D6.2 gives an overview of promising tools and approaches that can support system understanding and presents a flexible, generic approach to collaborative systems analysis to be applied in the Pilots. This further sets the basis for risk-informed decision making and the development of adaptation pathways that are effective for different natural hazards and that take into account perspectives from multiple sectors. We published a scientific paper (Schlumberger et al., 2022) that proposes DAPP-MR as a DRM pathways approach for complex, dynamic multi-risk. The paper identifies relevant aspects of multi-risk management frameworks and illustrates the suitability of DAPP-MR using a stylised case.

“...enhanced capacity for identification of vulnerable, threatened areas and infrastructures most at risk from multi hazards in Europe”

We have developed a multi-hazard event set based on hazard footprints of 9 single hazard events (VUA), which is currently in review as scientific paper (Claassen et al., 2023). There is explicit interest from the EU Horizon Europe project MIRACA to use this dataset in its assessment of

infrastructure risk at the European scale. We have developed an initial version of our framework for multi-hazard, multi-sector, systemic risk management (D2.1), along with guidance protocols for implementing the framework. The framework has been co-developed with stakeholders during interviews and workshops, and presented and discussed with our Pilot Core User Groups and Pilot Stakeholder Groups during the Pilot Workshops. Initial feedback on the usability was positive and has helped to improve the framework; the framework will be further tested in the pilots during the next reporting period. A prototype version of the MYRIAD-EU dashboard has been developed, and is so far being used for internal co-design purposes.

“...better informed forward-looking national risk assessments that take into account long-term drivers such as climate change...enhance implementation of existing legislation and streamlining of policies...”

The Pilot Leads have started a comprehensive analysis of the information needed to characterise multi-risk assessment and management challenges in their regions, and reviewed current data and policy gaps at local, regional, and national scale (stocktaking analysis), in a close dialogue with local stakeholders. The results of this analysis, presented during the first round of Pilots' Workshops, improved the awareness of the local stakeholders on multi-hazard, exposure and vulnerability issues, and enhanced potential for visualisation and benchmarking of multi-risk issues, in present and future climate change scenarios, in line with the goals of the Mission Adaptation to Climate Change. In close collaboration with the WP2, WP4 and WP5 partners, the Pilot Leads are also implementing a feasibility study, with the goal to choose the best combination of multi-risk methods and tools that can help them to: 1) analyse multi-hazard and risk dynamics over short and long-term scenarios; 2) develop multi-scale and multi-sector risk scenarios that are relevant to enhance the existing risk management policies; and 3) develop forward-looking DRM pathways as a response to the identified multi-risk challenges and gaps. This will help MYRIAD-EU pilot regions and communities to better understand, prepare for and manage multi-risk, by providing guidance for the development of comprehensive risk management plans.

MYRIAD-EU contributed to the European Commission's Science for Climate Action report (European Commission, 2022), accompanying the launch of the IPCC Working Groups 2 Assessment Report in 2022. This report showcases EU-funded research on topics related to enhanced adaptation and forward-looking risk assessment.

“...enhanced understanding of relationships and interactions of multiple hazards ... driven by ... changes on different time and spatial scales”

We have published two scientific perspective papers outlining current knowledge, challenges, and future directions in research for improving our understanding of relationships and interactions of multiple hazards. The MYRIAD-EU research agenda paper (Ward et al., 2022) has already received 3839 views (as of 5 April), and the perspective paper on methods for assessing dynamic vulnerability (De Ruiter and Van Loon, 2022) is well known in the community (no metrics available). A multi-hazard database has been developed and is in review (Claassen et al., 2023); the database is already available for internal project use and will be made available openly upon publication. Novel scientific developments are being developed in this direction are being developed especially in WP4-5 and have been presented at many scientific conferences, with several published already as research papers (e.g. Kreibich et al., 2022; Matanó et al., 2022; Couason et al., 2023)

“...better knowledge exchange through platforms such as DRMKC, and stakeholder networks on emergent risks and extreme events (e.g., Community of Users, Risk KAN)”

MYRIAD-EU has close connections with DRMKC through the inclusion of Antofie Tiberiu-Eugen (Research project officer at EU-JRC) in the External Advisory Board. The project coordinator was a panellist at the 6th DRMKC Annual Seminar (November 2022), presenting initial results from MYRIAD-EU, and the MYRIAD-EU data manager attended the DRMKC Data Hub workshops. There is intense collaboration between MYRIAD-EU and Risk KAN, with two project members (Prof. Sillmann and Prof. Reichstein) co-chairing the board, and two project members (Dr. Marleen de Ruiter and Dr. Robert Sakic Trogrlic) co-chairing the working group on Multi-Hazard Early Warning. We have given presentations at the Risk KAN working group on Compound Events and Impacts

monthly online seminars (Prof. Philip Ward, Judith Claassen), as well as a keynote speech (Dr. Marleen de Ruiter) at the Risk KAN session on compound and multi-hazard risk at AGU2023. Further, the Project Coordinator co-organised a workshop on stakeholder engagement in compound and multi-hazard risk management as part of the COST Action DAMOCLES in January 2023; Dr. Marleen de Ruiter gave an invited presentation at this event. The project coordinator was a panelist at the UNDRR European Platform at a session on natural hazards and health. Dana Stuparu was a panelist at the UNDRR Data Week panel discussion in a session on the UNDRR-ISC Hazard Information Profiles. We have also presented the MYRIAD-EU research at annual workshops/events of several network groups, including FEHRL Members Workshop, the ERIAFF annual conference, and the HOTREC annual assembly, and the AON annual research meeting.

1.3.2 Impacts for the MYRIAD-EU Sectors

Within the Pilots, MYRIAD-EU specifically examines impacts for six sectors: energy, food and agriculture, finance, tourism, transport and infrastructure, and ecosystems and forestry. Each of these sectors is represented within the consortium by the Sectoral Representatives. Below, our Sectoral Representatives reflect briefly on the impacts of the project to date on their sectors.

Energy (TNO)

In the North Sea pilot workshop of the MYRIAD project, held in Nov. 2022, a first inventory of natural hazards has been drafted by the multi-sectoral group from marine ecology, offshore wind R&D, offshore wind strategic planning and shipping safety. This has improved the understanding of the multitude of natural hazards, cross-sectoral impacts, and how to set up narratives that can be applied in a DAPP methodology. As it proved to be hard to involve the offshore energy sector in MYRIAD-EU, especially the industry parties, it is seen as important to develop and present concrete examples of risk inventory and mitigation pathways. Also, TNO and VUA have started an MSc project to develop a risk management database for the offshore energy sector, associated with a number of selected high-level future scenarios for the energy system scenarios by 2030 and 2050 (TNO scenarios)

Food and agriculture (CICYTEX)

Through the interviews carried out with the sector as part of WP1, we discovered that as part of the activities developed in MYRIAD-EU, the stakeholders from the food and agriculture sector were consulted in WP1. When revising the management of their activities, some of the consulted stakeholder institutions showed that there is, indeed, knowledge of risk management per se. While explaining the objectives of the project and the tools with will be achieved, there was a reflection on the need for a multi-risk, multi-hazard and even multi-sectoral study. In all cases, stakeholders from the sector asked for an update on the development of the project. In the progress of the project, MYRIAD-EU has been a point of reflection and the interactions with stakeholders have led to an opening of minds about the management of multi-hazards the systems in the sector.

Finance (AON)

MYRIAD-EU has initiated a number of conversations in the insurance sector on multi-hazards and multi-risks, specially how they may be defined and which historic events, previously considered unrelated, may be considered multi-hazards. At a recent event where AON hosted a number of its insurance clients, a presentation was given by Marleen de Ruiter (VUA) of MYRIAD-EU on the project outputs, which has led to further talks between Marleen de Ruiter and with individual clients. We have also discussed the project with a number of insurance and finance sector clients, and will be sharing the Wiki in future conversations.

Tourism (HOTREC)

During March 2022, HOTREC contacted several possible stakeholders, with a focus on tourism, to alert them about the project and asked them if they would like to be involved, either in the pilots or to provide general advice. It seems that the current expertise of the stakeholders focused more on the impact of climate mitigation action in the sector, and not on disaster risk reduction, illustrating the importance of this topic. With regard to the pilot projects: during the Veneto region Initial Pilot Workshop, tourism participants identified challenges, vulnerabilities and risks related to the

tourism sector. Participants recognised that multi-hazard risks are often inter-related. For the Canary Islands pilot, from the tourism sector perspective, the following challenges were highlighted: the island faces governance problems, regarding a complex regulatory framework; climate change and related hazards are perceived as a major threat from all sectors; and finally, tourism agents feel very vulnerable to climate change and indirect risks.

Transport and infrastructure (FEHRL)

Since the beginning of the project, MYRIAD-EU has been disseminated in the infrastructure sector as follows: at the FIRM2021 (FEHRL Infrastructure Research Meeting) conference, (Innovative roads for everyone's mobility), 7–8 December 2021, with participants from academia, road administration, policy makers, SMEs etc, a presentation of the MYRIAD-EU project was given by Elco Koks. The 18th issue of the FEHRL Infrastructure Research Magazine, February 2022, which is distributed to over 3500 stakeholders, featured a MYRIAD-EU article by the project coordinator, Philip Ward. FEHRL also took part in the stakeholder engagement activity based on an interview-based discussion with representatives of the MYRIAD-EU WP1 team. FEHRL discussed internally within the association to identify experts for the stakeholder group for the Danube pilot. These experts took part in the Danube Pilot implementation.

Ecosystems and Forestry (WIEA)

WIEA Wetlands International Europe is representing the ecosystems sector and will be consulted for the pilot projects in Veneto, Scandinavia and North Sea. Wetlands International Europe participated in the workshop on the Veneto Pilot and will be engaging its members, in particular the one active in Veneto to assess the impact and respond to the challenges. Climate change and environmental degradation exacerbate the risk of multi-hazards, but we have experienced that a lot of wetlands managers focusing on restoration and conservation do not take into consideration disaster risk reduction. WI-EA will share tools and solutions produced by MYRIAD-EU within its network to raise awareness and to advocating for a systemic and forward-looking risk management approach.

1.3.3 Selected publications produced by MYRIAD-EU

WP1

Deliverables

- Gill, J.C. et al., 2022. D1.2 Handbook of Multi-Hazard, Multi-Risk Definitions and Concepts. MYRIAD-EU project deliverable D1.2, doi:10.5281/zenodo.7135138
- Schlumberger, J. et al., 2022. D1.3 Report on policies, policy-making processes, and governance for multi-hazard, multi-risk management. MYRIAD-EU project deliverable 1.3, doi:10.5281/zenodo.7096835

WP2

Scientific papers

- Hochrainer-Stigler, S., Šakić Trogrlić, R., Reiter, K., Ward, P., de Ruiter, M.C., Duncan, M., Torresan, S., Ciurean, R., Mysiak, J., Stuparu, D., Gottardo, S., in review. Towards a systemic multi-hazard and multi-risk framework
- Ward, P.J., Daniell, J., Duncan, M., Dunne, A., Hananel, C., Hochrainer-Stigler, S., Tijssen, A., Torresan, S., Ciurean, R., Gill, J.C., Sillmann, J., Couasnon, A., Koks, E., Padrón-Fumero, N., Tatman, S., Tronstad Lund, M., Adesiyun, A., Aerts, J.C.J.H., Alabaster, A., Bulder, B., Campillo Torres, C., Critto, A., Hernández-Martín, R., Machado, M., Mysiak, J., Orth, R., Palomino Antolín, I., Petrescu, E.-C., Reichstein, M., Tiggeloven, T., Van Loon, A.F., Vuong Pham, H., de Ruiter, M.C., 2022. Invited perspectives: A research agenda towards disaster risk management pathways in multi-(hazard-)risk assessment, *Natural Hazards and Earth System Sciences*, 22, 1487-1497, doi:10.5194/nhess-22-1487-2022

Deliverables

- Hochrainer-Stigler, S. et al., D2.1 Initial Framework and Guidance Protocol Document. MYRIAD-EU project deliverable 2.1, doi:10.5281/zenodo.7215816

WP3

Scientific papers

- Hochrainer-Stigler, S., Šakić Trogrlić, R., Reiter, K (in preparation): A Multi-Scale and Multi-Hazard Risk Based Analysis of the Solidarity and Emergency Aid Response (SEAR): An optimistic assessment
- Hochrainer-Stigler, S., Šakić Trogrlić, R., Reiter, K (in preparation) Fiscal risks due to multi-hazards in the Danube Region: A CatSim and risk layers perspective

Deliverables

- Ciurean, R. et al, 2022. D3.1 Terms of Reference for Pilot core user and stakeholder groups. MYRIAD-EU project deliverable 3.1 (Confidential)
- Gottardo, S. et al., 2022. D3.2a Detailed annual work-plan for each Pilot (M7-24). MYRIAD-EU project deliverable 3.2a (Confidential)

WP4

Scientific papers

- Couasnon, A., Scussolini, P., Tran, T.V.T., Eilander, D., Muis, S., Wang, H., Keesom, J., Dullaart, J., Xuan, Y., Nguyen, H.Q., Winsemius, H.C., Ward, P.J., 2022. A Flood Risk Framework Capturing the Seasonality of and Dependence Between Rainfall and Sea Levels—An Application to Ho Chi Minh City, Vietnam. *Water Resources Research*, 58, e2021WR030002, doi: 10.1029/2021WR030002
- Kreibich, H. et al., 2022. The challenge of unprecedented floods and droughts in risk management. *Nature*, 608, 80-86, doi:10.1038/s41586-022-04917-5
- Matanó, A., De Ruiter, M.C., Koehler, J., Ward, P.J., Van Loon, A., 2022. Caught Between Extremes: Understanding Human-Water Interactions During Drought-To-Flood Events in the Horn of Africa. *Earth's Future*, 10, e2022EF002747
- De Ruiter, M.C., van Loon, A.F., 2022. The challenges of dynamic vulnerability and how to assess it. *iScience*, 25, 104720, doi:10.1016/j.isci.2022.104720
- De Polt, K., Ward, P. J., de Ruiter, M., Bogdanovich, E., Reichstein, M., Frank, D., and Orth, R. (in preparation): Quantifying impact-relevant heat wave durations.
- Ducros, G., Tiggeloven, T., Ma, L., Daloz, A.S., de Ruiter, M.C. (in preparation): Multi-Risk from Heat Waves, Drought and Wildfires in Scandinavia.

Deliverables

- De Ruiter, M. et al., D4.1 Internal documentation of WP4 Helpdesk contact and objective. MYRIAD-EU project deliverable 4.1 (Confidential)
- Mysiak, J., 2022. D4.2 Guidelines on methodology for extracting empirical evidence from Pilots. MYRIAD-EU project deliverable 4.2 (Confidential)

WP5

Scientific papers

- Claassen, J., Ward, P.J., Daniell, J., Koks, E., Tiggeloven, T., de Ruiter, M., 2023. MYRIAD-HESA: A New Method to Generate Global Multi-Hazard Event Sets. *Research Square preprint server*, doi:10.21203/rs.3.rs-2635188/v1
- Daniell, J.E. et al., in prep. The development of multi-hazard risk scenarios for use in sector specific analyses in Europe and beyond.
- Schäfer, A.M. et al., in prep. A combined stochastic and probabilistic hazard event set for Europe for use in multi-hazard studies.

Deliverables

- De Ruiter, M. et al., 2022. D5.1 Internal documentation of WP5 Helpdesk contact and objective. MYRIAD-EU project deliverable 5.1 (Confidential)

WP6

Scientific papers

- Schlumberger, J., Haasnoot, M., Aerts, J.C.J.H., de Ruiter, M.C., 2022. Proposing DAPP-MR as a disaster risk management pathways framework for complex, dynamic multi-risk. *iScience*, 25, 105219, doi:10.1016/j.isci.2022.105219

Deliverables

- De Ruiter, M. et al., D6.1 Internal documentation of WP6 Helpdesk contact and objective. MYRIAD-EU project deliverable 6.1 (Confidential)
- Warren, A. et al., 2022. Guidance document for Pilots on collaborative systems analysis approaches. MYRIAD-EU project deliverable 6.1 (Confidential)

WP7

Selected documents referring to MYRIAD-EU

- European Marine Board, 2022. Uncovering the hidden threat of marine geohazards in Europe. European Marine Board, doi:10.5281/zenodo.6376260
- FEHRL, 2022. Multi-hazard and systemic framework for enhancing risk-informed management and decision-making in the E.U.
- European Commission, 2022. Science for Climate Action. EU research contribution to IPCC Working Group II on Impacts, Adaptation and Vulnerability. Publications Office of the European Union, Luxembourg, doi:10.2777/236581
- European Commission, Directorate-General for Research and Innovation, 2022. Science for climate action : EU research contribution to IPCC working group III on mitigation. Drabicka, K., Acosta Gonçalves, A. (Eds.), Publications Office of the European Union, <https://data.europa.eu/doi/10.2777/401703>
- BGS, 2022. Disaster risk reduction through geoscience, <https://www.bgs.ac.uk/news/disaster-risk-reduction-through-geoscience/>
- BGS, 2022. MYRIAD-EU: shifting the paradigm in disaster risk management, <https://www.bgs.ac.uk/news/myriad-eu-shifting-the-paradigm-in-disaster-risk-management/>
- Deliverables
- Pundy, D., Witpas, K., 2022. D7.1 Plan for the dissemination and exploitation of results (PDER). MYRIAD-EU project deliverable 7.1 (Confidential)

WP8

Deliverables

- Ward, P.J. et al., 2021. D8.1 Quality, ethics, and risk management plan. MYRIAD-EU project deliverable D8.1 (Confidential)
- Daniell, J. et al., 2022. D8.3 Data Management Plan. MYRIAD-EU project deliverable D8.3 (Confidential)

2 Update of the plan for exploitation and dissemination of results (if applicable)

2.1 Updates to the PDER

The Plan for the Dissemination and Exploitation of Results (PDER) was completed as D7.1 in Month 6, and shared with the consortium. An update of the PDER was completed in Month 18. Even though the vast majority of the original document remained unchanged, the revised version included several changes such as:

- Structural changes to the Impact and Quality Units meetings. The consortium has made a decision to merge meetings of the Impact and Quality Units, as it was found to be more beneficial to have the entire Management Team present at once to ensure effective communication and participatory decision-making;
- Further elaboration on foreseen exploitation methodology for future results of the project. The updated version identifies active stakeholder engagement, knowledge management and continuous improvement as key exploitation methodologies for MYRIAD-EU.
- Practical communication updates including revised links, contact details, timeline updates and a future set-up of a new project's Social Media channel (LinkedIn).

2.2 General overview of activities in first reporting period

As explained in the Grant Agreement, MYRIAD-EU emphasises the importance of both inreach and outreach activities. Inreach refers to specific activities to integrate expertise and insights from outside the project and the immediate scientific community in order to enrich the research and ensure that the project's outputs align with real-world needs. Below, we list some of the main inreach and outreach activities during the first reporting period.

Inreach activities:

WP1

- Interviews held by the WP1 team with sectoral representatives to gain input for the reviews in D1.2 and D1.3
- Twelve interviews were held by the WP team with external experts to gain input for the review in D1.3
- Input from External Advisory Board (EAB) to contribute to the review in D1.2 was gathered at the first and second General Assemblies, and in follow-up bilateral meetings with individual EAB members
- Joint WP1/2 workshop: see WP2

WP2

- 25 external partners attended the joint WP1/2 workshop, to provide feedback on the MYRIAD-EU framework and additional insights for the reviews in D1.2 and D1.3

WP3

- Five Pilot Workshops (one per Pilot) held in November 2022. Attended by ~85 external stakeholders in total
- Pilot teams conducted many bilateral meetings with Pilot Core Users and Pilot Stakeholders prior to aforementioned Pilot Workshops

WP4-6

- Risk Output Scoping workshop at GSTC 2022 Annual Conference (12-15 Dec 2022, Sevilla, Spain). Risklayer took part in the session on "Climate Change, Heat Waves, and Fires: Influence on the Tourism Industry". The session explored the implications of climate change and climate policy for tourism stakeholders and destinations around the world, as well as mitigation and adaptation strategies. Risklayer will use input in the design of the multi-hazard analyses in WP5 for the tourism sector.

WP8

- Regular input obtained on project progress and potential outreach channels from External Advisory Board (EAB) and Sectoral Sounding Board (SSB)
- General Assemblies (G.A.s) held in two of the Pilot regions (North Sea and Vienna). Specific activities held around Pilot studies to bring in knowledge of the challenges faced, namely: mini-workshop identifying North Sea challenges at G.A.1 (facilitated by DRES and TNO) and presentation by Katharina Lenz (Danube Region Strategy) at G.A.2 (facilitated by IIASA)
- Bilateral meetings between Coordination Unit (VUA) and potential stakeholders interested in the project (e.g. UNDRR, Red Cross Red Crescent Climate Centre, UNESCO Regional Bureau for Science and Culture in Europe)

Outreach activities

A selection of outreach activities is listed below. Note that these are not listed per WP as the activities often bridge across different WPs.

- MYRIAD-EU researchers have an active involvement in the EGU General Assembly. Marleen de Ruiter (VUA) is Science Officer for the EGU multi-hazards subdivision, and MYRIAD-EU researchers were involved in convening the following multi-hazard/risk sessions in 2022:
 - Compound weather and climate extremes (Philip Ward, VUA)
 - Innovative approaches for multi-hazard risk assessments and their applications to disaster risk reduction and climate change adaptation (Marleen de Ruiter, VUA)
 - Advancing critical infrastructure modelling in a complex world (Elco Koks, VUA)
 - Climate extremes, biosphere and society: impacts, cascades, feedbacks, and resilience (Markus Reichstein & Dorothea Frank, MPG; Jana Sillmann, UHAM)
- Moreover, MYRIAD-EU researchers contributed the following presentations during the sessions, including:
 - Robert Sakic Trogrlic (IIASA): [A Systems Dependency Framework for Individual, Multi- and Systemic Risks](#)
 - Davide Mauro Ferrario (CMCC/UNIVE): [Harnessing Machine Learning and Deep Learning applications for climate change risk assessment: a survey](#)
 - Judith Claassen (VUA): [A Global Multi-hazard Perspective on Joint Probabilities of Historic Hazards](#)
 - Marleen de Ruiter (VUA): [A dataset for multi-risk analysis in the Philippines](#)
 - Sadhana Nirandjan (VUA): [Multi-hazard risk assessment of critical infrastructure at the global scale](#)
 - Julius Schlumberger: [Conceptualizing an adaptation pathway model for multi-hazard, multi-stakeholder systems](#)
 - James Daniell (Risklayer): [Multi-hazard open access software package review with the potential for conducting sectoral risk assessments on a European or local scale](#)
 - Philip Ward (VUA): [MYRIAD-EU: towards Disaster Risk Management pathways in multi-risk assessment](#)
- At the [Second International Conference on Natural Hazards and Risks in a Changing World 2021](#) (Potsdam, Germany), Marleen de Ruiter (VUA) presented on *Multi-hazard risk and the asynergies of disaster risk reduction measures: the need for an integrated approach* and Philip Ward (VUA) presented on the MYRIAD-EU project entitled *Towards a multi-risk, multi-sector, systemic approach to risk management*
- VUA and DRES took part in at the UNDRR European Forum for Disaster Risk Reduction (EFDRR), with Philip Ward participating in a [panel discussion](#) in a session on COVID-19 and Systemic Risk, and DRES leading a [side event](#) *Design your resilient future – Exploring impacts of water-related disasters in an online game*
- Philip Ward (VUA) presented the MYRIAD-EU project at the [ERIAFF Annual Conference 2022](#) (online presentation to event in Thessaloniki, Greece)
- Philip Ward (VUA) taught in two summer schools related to compound and multi-risk, bringing in knowledge from MYRIAD-EU, namely: the [Universitas Gadjah Mada Summer School](#) on

Ecosystem-based Disaster Risk Reduction and Climate Change Adaptation (Eco-DRR CCA) (online, 2022) and the [DAMOCLES Cost Action summer school](#) on Dynamical Modelling of Compound Events in Budapest, Hungary, in 2022

- Philip Ward (VUA) presented the MYRIAD-EU project at the September online [RISK-KAN webinar](#) on compound extremes.
- VUA discussed the integration of the MYRIAD-EU project with sectoral needs at various annual events of our Sectoral Representatives: HOTREC annual members meeting 2022 (Philip Ward); FEHRL members workshop 2022 (Elco Koks), AON annual research meeting 2023 (Marleen de Ruiter)
- Philip Ward took part in a panel discussion on DRM, introducing the MYRIAD-EU approach, at the [6th DRMKC annual seminar](#)
- Marleen de Ruiter and Philip Ward (VUA) both delivered keynote speeches at the [DAMOCLES Cost Action workshop](#) on Science-Policy-Practice in compound- and multi-risk science in 2023 in Glasgow. Philip Ward (VUA) was also in the organising committee of this event.
- Tristan Stolte (VUA) gave a presentation (online) on urban drought management at the European Environment Agency (EEA) workshop on monitoring and assessing the costs of climate related extremes
- VUA, UKRI BGS, and DRES organised a session (led by Timothy Tiggeloven, VUA) on Bridging Science to Practice for Multi-Risk Adaptation in a Diverse World: an Interactive Lab at the World Bank GFDRR [Understanding Risk 2022 Forum](#) in Florianopolis, Brazil
- Stefan Hochrainer-Stigler (IIASA) chaired a session on New Advances in multi-hazard and multi-risk analysis and management, at [IDRiM 2022](#) - The 12th International Conference of the International Society for the INTEGRATED DISASTER RISK MANAGEMENT. In the session, various methods from MYRIAD-EU were showcased in oral presentations from IIASA (Stefan Hochrainer-Stigler, Robert Sakic Trogrlic), DRES (Julius Schlumberger), UKRI BGS (Roxana Ciurean), and VUA (Alessia Matano)
- UKRI BGS were involved in the organisation of the [UK Alliance for Disaster Research Annual Conference 2022](#)
- UKRI BGS attended the [Scientific Assembly of IAVCEI](#) (International Association of Volcanology and Chemistry of the Earth's Interior) in New Zealand where informal discussions were held with various academic and non-academic researchers about the MYRIAD-EU project, WP1 outputs and WP6 storylines
- ASE (Eva-Cristina Petrescu) presented A multi-risk approach in studying consumer behaviour and the influence of education on the insurance market at the ETIMM conference in 2022 in Bucharest, Romania
- DRES researchers contributed knowledge from MYRIAD-EU to various workshops, including: [Transformationen im Bevölkerungsschutz!?](#) Gemeinsame Tagung des AK Naturgefahren/Naturrisiken und des Katastrophennetzes e.V. in 2022 in Berlin, Germany; and the [DMDU2022 Conference](#) for decision making under deep uncertainty in 2022 in Mexico City
- Dana Stuparu (DRES) was a panelist at the UNDRR Data Week panel discussion in a session on the UNDRR-ISC Hazard Information Profiles
- ERIAFF, FEHRL, HOTREC, and AON including presentations from MYRIAD-EU at their annual member's and/or stakeholder events
- Anne Sophie Daloz (CICERO) held an additional pilot workshop with the Regional Council of Kymenlaakso, Finland in 2023 online
- Benjamin Blanz (UHAM) presented research findings at the Risk-KAN workshop on Understanding and Modeling Complex Risks in Coupled Human-Environment Systems
- IIASA/ASE presented the MYRIAD-EU project in several external stakeholder meetings, including: the 56th River Basin Management Expert Group Meeting of the International Commission for the Protection of the Danube River (ICPDR) in October 2022 (online); the 42nd Flood Protection Expert Group Meeting of the International Commission for the Protection of the Danube River (ICPDR) in 2022 (Bucharest, Romania); the 14th Accident Prevention and Control Expert Group Meeting of the International Commission for the Protection of the Danube

River (ICPDR) in 2022 (online); and the closing workshop of DAREnet Project in 2023 (Bratislava, Slovakia)

- Kelley de Polt (MPG) participated in the [20th Swiss Climate Summer School 2022](#) in Grindelwald, Switzerland
- Researchers of ULL brought MYRIAD-EU knowledge into a workshop on the [Strategy for the Implementation of the Island Action Plan against Volcanic Hazards de Tenerife \(PAIV\)](#) in 2022 in Santa Cruz de Tenerife (Tenerife)
- Stefan Hochrainer-Stigler (IIASA) presented on Towards an applicable integrated multi-hazard and multi-risk framework at the Systems Analysis for Reducing Footprints and Enhancing Resilience workshop in 2022 in Vienna, Austria
- MYRIAD-EU researchers have had an active involvement in the AGU Fall Meetings in 2021 (New Orleans) and 2022 (Chicago), including co-convening the annual session on Compound, Consecutive, and Cascading Events: Challenges for Risk Assessment and Management of Multi-hazards (Marleen de Ruiter, VUA, and Robert Sakic Trogrlic, IIASA). Presentations included:
 - Marleen de Ruiter (VUA) 2022: Keynote: [The challenges of compound risk dynamics and how to assess them](#)
 - Robert Sakic Trogrlic (IIASA) 2022: [MYRIAD-EU Framework for Multi- and Systemic Risk Analysis and Management](#)
 - Philip Ward (VUA) 2021: [MYRIAD-EU: Towards a multi-risk, multi-sector, systemic approach to risk management](#)

3 Update of the data management plan (if applicable)

The first version of the Data Management Plan (DMP) for the MYRIAD-EU project was implemented in D8.3, and describes the guidelines, standards, and management policy with regard the datasets and deliverables to be produced, under the guidelines of Open Research Data Pilots. The DMP is a living document; at present the original version is still up to date for the needs of the project. The implementation is ensured through constant reminders to the consortium and discussions within WP meetings, MT meetings, on agendas at the General Assembly.

The DMP data management plan addresses the following among other concepts:

- Zenodo policies (Content, access, reuse, removal and longevity)
- Data discoverability, metadata and standards
- Versioning conventions
- What data, methods, software and documentation are needed
- Storage
- Data Interoperability (in combination with MS22 on data standards between WP4-5-6)
- Resources and Re-Use of data, scientific publications and third parties
- Data Security

All final datasets and collection activities will be based on the FAIR data management (Findable, Accessible, Interoperable and Reusable) within the project. The final datasets gathered and generated by the MYRIAD-EU project will be primarily stored on Zenodo, a general-purpose open-access repository developed under the European OpenAIRE program and operated by CERN ensuring longevity of the project. The main address is: <https://zenodo.org/communities/myriad-eu/?page=1&size=20>

4 Follow-up of recommendations and comments from previous review(s)

Not applicable

5 Deviations from Annex 1 and Annex 2 (if applicable)

5.1 General

In general, the project has progressed according to Annex 1 and Annex 2 of the Grant Agreement. An amendment to the Grant Agreement (AMD-101003276-4) was made during the first reporting period, following a unanimous vote in favour of all points. The amendment did not affect the content of the project, but rather referred to administrative changes (see Section 1.2.8).

Whilst Covid19 impacted progress, all deliverables and milestones of the first reporting period were met. Specific challenges were dealt with as follows:

- Impacts of restrictions on events: As detailed in Section 1.2.8, travel and social distancing restriction posed specific challenges to our two General Assemblies and our WP1/2 Joint Workshop. However, we were able to mitigate these impacts by following our risk-mitigation measures set out in the Risk Management Plan. In particular, all of these events were held in hybrid format and were carried out in accordance with the local restrictions. For example, special dispensation was sought and granted for non-EU based consortium members to travel to the second G.A., and local regulations regarding the wearing of face masks were followed at the second General Assembly and WP1/2 Workshop.
- Impacts of illness on project staff, tasks, and deliverables: during the first half of 2022, and in particular during the second quarter of that year, there was a high incidence of Covid19 infection amongst our consortium staff, including a large number of Management Team members and Pilot leads, often during the same period. This led to some short delays of several deliverables (see Section 5.2). All of these delays were first discussed with, and approved by, the Project Officer, and did not lead to knock-on delays for other tasks, deliverables, and/or milestones.

5.2 Tasks, deliverables, and milestones

In agreement with the Project Officer, WPs 2-6 started their work before the date planned in the Grant Agreement, specifically to carry out the preparatory activities (e.g. planning meetings, initial stocktaking and scoping meetings).

D1.2: Handbook of multi-hazard, multi-risk concepts, definitions, and indicators (relating to Task 1.1): Two month delay, initially due to Covid19 related illness (1 month) (deadline extension approved by Project Officer) and subsequently due to requirements of lead partner (UKRI BGS) to secure internal review, which further enhanced the quality of the deliverables. This had no influence on following milestones or deliverables.

D1.3: Report on policies, policy-making processes, and governance for multi-hazard, multi-risk management (relating to Task 1.3): Submitted with a 2-month delay after deadline extension approved by Project Officer. Reason for delay was related to illness of team members due to Covid19. This had no influence on following milestones or deliverables.

D1.1: Wiki-style online crowdsourcing platform of multi-hazard, multi-risk methods, models, and tools (relating to Task 1.2): Launched with 6 month delay. Initial deadline extension of 3 months approved by Project Officer in order to allow for the incorporation of stakeholder input gathered during the General Assemblies, joint WP1/2 workshops, and stakeholder interviews. Further 3 month delay due to various technical issues relating to security, IPR, and privacy, all discussed regularly with the Project Officer. This had no influence on following milestones or deliverables, except MS2 (Wiki-style platform online).

D3.1: Terms of reference for Pilot core user and stakeholder groups (relating to Task 3.2): Submitted with a 1-month delay after deadline extension approved by Project Officer. This allowed us to be able to properly collect input from our Sectoral Representatives and perform a thorough review. The short delay has two reasons: (a) illness of several task team members due to Covid-19; and (b) the need identified at the General Assembly to ensure larger sectoral input. The minor delay had no influence on following milestones or deliverables.

MS2: Wiki-style online platform launched: see explanation above for D1.1.

MS6: Dashboard online: In agreement with the Project Officer, it was agreed to push this milestone back by 6 months (M18 instead of M13). This is because it became clearer that it was important to take longer to scope the expectations and requirements of the different consortium members, and potential stakeholders. An internal version is now available online (password protected). A session will be held at the third G.A. (in May 2023) in which this version will be discussed and refined, before starting to add content to the dashboard. The delay had no influence on following milestones or deliverables.

MS13: Pilot Workshop 1 completed and feedback to WP2,4-6: In agreement with the Project Officer, it was agreed to push this milestone back by 2 months (Month 15 instead of Month 13). Originally, the Initial Pilot Workshops were planned for September 2022. The extension allowed Pilot leads more time to prepare for the workshops and thus ensure a more effective interaction with stakeholders. The delay had no influence on the following deliverables. The only milestone affected was MS7 (Guidance Protocol updated (v2) and available to Pilots) - see below.

MS7: Guidance Protocol updated (v2) and available to Pilots: In agreement with the Project Officer, it was agreed to push this milestone back by 2 months (Month 18 instead of Month 16). This is because this step requires input from the Pilot 1 workshops (see previous point, which were delayed by 2 months). The delay had no influence on following milestones or deliverables.

Upcoming deviations

In the second reporting period, the following modifications in timing are envisioned and have been agreed upon by the Project Officer.

D7.3: Report on joint conference with RISK-KAN (relates to Task 7.2): Originally, we planned to hold a joint conference with RISK-KAN around Month 25 (September 2023). An extension has been granted until M35 (July 2024). This is because the plan is now to hold the event around June 2024,

together with Risk-KAN and NatRiskChange, in order to increase visibility and impact. By doing so, we will be able to reach a larger audience and make a larger impact than originally planned. As Risk-KAN is organising another conference in 2023, it is more useful for the community to hold this event later. The delay has no influence on following milestones or deliverables, except for MS38 (Joint conference with Risk-KAN).

5.3 Use of resources

Table 4 and Table 5 give an overview of the project's financial realisation in the first reporting period Months 1-18, in terms of person months and reported costs. The general project effort up to M18 is 26.2% of the estimated available budget for the entire project, and 36.3% of the planned personnel effort for the entire project.

VUA and IIASA have agreed to transfer €19,905.81 (plus 25% indirect costs, i.e. in total €24,882.26) from the original IIASA budget to the VUA budget (transfer of €3,638.48 non-travel (+OH) and €16,267.33 travel) (+25% indirect costs) (see Table 5)). The calculation and motivation for this is as follows (all values stated below are **direct costs**; in all cases 25% indirect costs will be added):

- The WP1/2 workshop was originally budgeted at €24,250 (€5,500 non-travel and €18,750 travel); with the budget on the IIASA budget. The realised costs of the workshop were eventually lower than planned (total €3,525.61, of which €1,042.94 non-travel and €2,482.67 travel). This is due to the fact that the workshop was held as a hybrid event due to the Covid19 restrictions during the planning phase, which meant that the number of physical participants (and therefore travel costs and costs for dinners, lunches, refreshments etc) was much lower than planned. The difference between planned and realised costs (total €20,724.39, of which €4,457.06 non-transfer and €16,267.33 travel) will be added to the VUA budget to fund future events including the MYRIAD-EU conference and higher travel costs of the MYRIAD-EU coordination team.
- The second General Assembly was hosted by IIASA, at a realised cost of €818.58 (all related to non-travel costs). These costs were originally budgeted on the VUA budget, and are therefore transferred to IIASA.

We make the following observations regarding the registered efforts:

- The realised average personnel costs per month of UNIVE (€8580.20) are significantly higher than those stated in Annex 1 of the Grant Agreement (€2000). This is because the recruitment of a research fellow (junior staff) was originally foreseen in the budget of UNIVE, but then the PI considered the possibility to co-finance a PhD fellowship starting in September 2023. Therefore the preliminary activities related to this reporting period were carried out exclusively by the PI of the project, Prof. Andrea Critto (senior staff).
- The realised average personnel costs per month of ASE (€6519.26) are significantly higher than those stated in Annex 1 of the Grant Agreement (€4615.00). This is because during the first reporting period of the project the complexity of the work was very high, especially because it was necessary to lay the groundwork of the key activities on which the next steps in the project depend, and the importance of developing strong connections with the other partners and stakeholders. As a result, ASE used personnel with a relatively high average cost per month (Professor) for these activities. The total cost is (and will be) in line with the overall budget, as the Professor was able to carry out the work more efficiently than a more junior staff member.
- The realised average personnel costs per month of ULL (€5338.70) are significantly higher than those stated in Annex 1 of the Grant Agreement (€4150.00) for two main reasons. On the one hand, payroll for ULL personnel has increased due to their promotion (increase of category during the first 18 months) and two researchers with higher costs being added to the ULL team. On the other hand, since it has taken longer than expected to hire junior researchers, part of the work was carried out by more senior staff than envisioned, which resulted in higher average personnel costs per month.

- The realised average personnel costs of UHAM in the first reporting period are 0, as no person months were reported. This is due to delays in hiring a postdoctoral researcher – a new staff member was hired in March 2023 (after the first reporting period) who will work on D5.3. Hence, we expect the effort to proceed as per planning during the second reporting period.
- Overall, the realised effort in terms of Person Months (PMs) is 185.7 PM. If we assume a linear progression of each WP between its start and end dates (shown in the right hand side of Table 4), the projection in the Work Plan was 179.4 PM. Hence, at the project level, the personnel effort is well in line with the budget in the Work Plan. The overall reported costs are slightly lower than planned due to lower monthly tariffs of several partners (VUA, UKRI BGS, DRES, IIASA, Arctik, CICERO, MPG, WIEA, TNO) and the fact that some planned travel was not possible due to the Covid19 pandemic and restrictions. We expect that the reported costs over the project will be as per the Work Plan.
- The effort in terms of PMs across the different WPs is generally in line with the budget in the Work Plan for most WPs, with the following observations:
 - WP1 is now completed, and a total of 51.2 PMs are reported, as opposed to 46.0 PMs in the Work Plan. This represents a deviation of +11%, which we do not consider to be major. Two main contributing factors are the higher number of PMs reported on this WP by UKRI BGS and DRES. For UKRI, this reflects the large effort required to lead this important WP, including solving several technical issues relating to the Wiki platform, and also changes in staff availability and composition. For DRES this reflects the additional effort undertaken to carry out interviews with Sectoral Representatives to further enhance societal relevance and a change in personnel due to long-term sickness leave which meant that a more junior colleague undertook much of the work.
 - For WP5 the reported effort is lower than a linear projection, which is related to the fact that: (a) much of the effort in WP5 is actually planned in the second and third reporting periods, including the work on indirect impacts; and (b) UHAM have had delays in recruiting staff, but a researcher is now employed since March 2023 on Deliverable 5.3.
 - For WP6 the reported effort is significantly higher than expected. This is related to the efforts of DRES in the first reporting period, which were significantly higher due to multiple reasons. First, two consecutive sick-related leaves of key staff have led to additional take over efforts of project activities. Second, the activities undertaken in the first reporting period were more intensive than planned: the first reporting period was an exploration time for the consortium to further define key activities, approaches and connections with other partners. Third, the connection with WP2 was less than initially envisaged. Although WP2 and WP6 are in close contact to align activities, most of the DRES work have been done under WP6. We envisage a shift of DRES PMs from WP2 to WP6 to assure consistency of work activities, and would like to discuss this with the Project Officer. This will not affect the intended timing and quality of deliverables in WP2 and WP6.
- VUA has a lower realised effort than the linear planning as many of the activities are planned for the later reporting periods (including hiring of new staff member for later tasks).
- DRES has substantially higher effort than the linear planning, as per the explanation above.

Table 4: Realised effort per partner and WP for first reporting period (right), compared to estimation of planned effort in first reporting period at start of the project.

	Realised effort in first reporting period									PLANNING: estimated effort per WP (until end of Month 18) at start of project								
	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total PMs	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total PMs
1. VUA	6.9	3.1	0.6	3.1	3.5	1.9	0.4	1.4	20.9	5.5	4.0	2.0	5.8	4.5	2.5	1.5	4.9	30.6
2. UKRI BGS	13.6	1.9	4.0	0.5	0.0	1.7	0.7	1.6	23.9	10.0	1.4	3.4	0.8	0.0	2.3	0.8	1.1	19.7
3. CMCC	2.7	0.5	5.2	0.5	0.8	0.0	0.0	1.0	10.6	4.0	1.7	5.1	2.4	1.3	0.0	0.4	1.1	16.0
UNIVE	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.7	1.5	0.0	0.0	0.0	0.0	3.2
4. Deltares	13.8	0.3	3.7	0.0	0.0	26.0	0.0	0.6	44.3	8.5	2.6	3.4	0.5	0.5	6.8	0.4	0.8	23.4
5. Risklayer	2.0	0.3	1.0	0.7	4.3	3.3	0.3	0.9	12.8	2.0	0.3	1.1	0.8	4.0	1.8	0.4	0.8	11.1
6. IIASA	3.0	7.3	4.3	0.2	0.0	0.0	0.0	0.0	14.7	2.0	3.1	3.4	0.8	2.5	0.0	0.4	0.8	12.9
7. Arctik	0.0	0.8	0.0	0.0	0.0	0.0	10.4	2.0	13.2	0.0	1.7	0.0	0.0	0.0	0.0	8.0	0.8	10.5
8. CICERO	0.6	1.1	2.3	0.0	0.1	0.0	0.0	0.4	4.5	1.5	0.3	3.4	0.3	0.4	0.0	0.4	0.2	6.5
9. ULL	0.4	1.0	4.6	0.2	0.0	1.3	0.4	0.3	8.1	1.0	1.1	5.0	0.3	0.0	1.3	0.4	0.2	9.2
10. MPG	0.0	0.0	0.0	8.6	0.0	0.0	0.0	0.0	8.6	1.0	0.3	1.1	3.6	0.0	0.0	0.4	0.2	6.6
11. ASE	2.0	1.0	1.5	0.0	0.0	0.0	0.1	0.1	4.7	2.0	0.6	2.1	0.0	0.0	0.0	0.4	0.2	5.3
12. FEHRL	0.7	0.5	0.1	0.0	0.0	0.0	0.4	0.2	1.9	1.0	0.3	0.4	0.0	0.0	0.0	0.4	0.4	2.5
13. WIEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	2.0	0.6	1.1	0.0	0.0	0.0	0.8	0.4	4.8
14. HOTREC	1.5	0.0	0.4	0.0	0.0	0.0	0.0	0.0	1.9	1.5	0.4	0.9	0.0	0.0	0.0	0.6	0.4	3.7
15. CICYTEX	2.5	2.0	3.0	0.0	0.0	0.0	1.0	1.0	9.5	2.5	0.7	1.4	0.0	0.0	0.0	0.8	0.8	6.1
16. AON	0.5	0.2	0.3	0.0	0.0	0.0	0.3	0.4	1.6	0.5	0.1	0.3	0.0	0.0	0.0	0.3	0.4	1.6
17. TNO	1.1	1.7	0.4	0.0	0.0	0.0	0.2	0.6	4.0	1.0	0.4	0.6	0.0	0.0	0.0	0.2	0.4	2.6
18. UHAM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	2.5	0.0	0.2	3.2
Total	51.2	21.7	31.3	13.7	8.6	34.2	14.1	10.9	185.7	46.0	20.0	36.7	16.5	15.7	14.5	16.3	13.7	179.4

Note: estimate at start of project is based on a simple linear progression of work within WPs

Table 5: Realised effort per partner, provisional amounts. All costs indicated are total costs (i.e. direct + indirect costs)

	Grant Agreement (for entire project)		Realisation M1-M18					
	PMs	Total EC contribution	PMs	Budget adjustment RP1	Reported costs (RP1)	Total requested EC-contribution	Requested costs to Month 18 (as % of total)	PMs to Month 18 (as % of total)
1. VUA	94.5	947,218.75	20.89	+24882.26	136,014.65	136,014.65	14.4	22.1
2. UKRI BGS	44	400,950.00	23.86		148,347.93	148,347.93	37.0	54.2
3. CMCC	46.5	462,687.50	10.63		105,020.90	105,020.90	22.7	22.9
UNIVE	12	30,000.00	0.10		1,072.53	1,072.53	3.6	0.8
4. Deltares	63.5	471,922.50	44.32		184,535.50	184,535.50	39.1	69.8
5. Risklayer	36	473,175.00	12.75		165,762.93	165,762.93	35.0	35.4
6. IIASA	41	490,050.00	14.69	-24882.26	101,923.75	101,923.75	20.8	35.8
7. Arctik	29.3	338,312.50	13.22		89,225.43	89,225.43	26.4	45.1
8. CICERO	18.7	262,732.81	4.49		41,822.71	41,822.71	15.9	24.0
9. ULL	30	198,562.50	8.12		55,696.35	55,696.35	28.0	27.1
10. MPG	22	219,450.00	8.64		62,625.25	62,625.25	28.5	39.3
11. ASE	13	103,143.75	4.70		39,097.36	39,097.36	37.9	36.2
12. FEHRL	5.5	79,000.00	1.88		34,878.25	34,878.25	44.1	34.2
13. WIEA	11	80,292.50	0.37		2,259.14	2,259.14	2.8	3.4
14. HOTREC	8.5	89,937.50	1.93		20,678.34	20,678.34	23.0	22.7
15. CICYTEX	14	75,125.00	9.50		51,629.96	51,629.96	68.7	67.9
16. AON	3.7	79,625.00	1.60		34,227.84	34,227.84	43.0	43.2
17. TNO	6	82,250.00	3.99		36,818.56	36,818.56	44.8	66.5
18. UHAM	12	115,367.19	-		563.50	563.50	0.5	0.0
Total	511.2	4,999,802.50	185.7	0.0	1,312,200.88	1,312,200.88	26.2	36.3

5.3.1 Unforeseen subcontracting

Not applicable

5.3.2 Unforeseen use of in kind contribution from third party against payment or free of charges

Not applicable

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Appendix A Risk Register

Description of risk	Risk level	WPs	Risk-mitigation measures
Scientific			
Methods for quantifying dynamic feedbacks (WP4) delayed for integration in risk scenario tool (WP5)	Low	3,4,5	Diagnosis (WP1) provides review of existing methods and tools, which can be used as backup. Risk scenario tool can still be developed and run using scenarios of hazard, exposure, vulnerability without dynamic feedbacks, if necessary.
Multi-risk software (WP5) delayed for Pilots	Low	3,5	Tailored multi-hazard and multi-risk scenarios will be generated for the Pilots prior to their integration into the generic software. We build on existing open-source software developed by MYRIAD-EU participants.
Lack of accessibility of data/tools for development	Low	3,4,5,6	Key impact datasets required by WP4 are developed and owned by consortium members (e.g. CATDAT). Risk scenario tool (WP5) uses open data. Decision-making approach (WP6) enhances existing, open tools. Involvement of Pilot stakeholders provides access to regional data/tools.
Difficulty to generalise Pilot results	Medium but mitigated	3	Common guidance and workplan will be established in Task 3.1 to ensure coherence. A dedicated task (Task 3.6) will draw generalised results and lessons from the Pilots.
Methods and tools not sufficient to simulate site-specific issues in Pilots	Medium but mitigated	1-6	Framework is designed to produce generic products and services, but also allows and showcases use of alternatives. Alternative methods, models, and tools reviewed in Diagnosis (WP1), included in Dashboard (WP2), and reviewed at Pilot level (WP3). Laboratory approach and dedicated Helpdesks in WP4-6 designed to ensure alignment with user-needs.
Context and boundaries of the multi-risk assessment, conceptual model and interim DRM challenges may not be fully understood and defined in a Pilot study before the PW1. This may be due to a lack or paucity of information about certain aspects and their relationships, lack of knowledge on the available sources where to find the missing information, or general delay in the stocktaking process driven by poor coordination or resource shortages.	Medium but mitigated	3	Regular meetings with Pilot leads will be organised by the lab manager to share good practices on how to organise and coordinate the stocktaking process as well as how to define context, boundaries, conceptual model, and interim DRM challenges. The lab manager will organise a Review Meeting (RM1) with each Pilot lead at M12, just before the PW1, to closely monitor the progress in the stocktaking process and help find ad hoc solutions to improve the definition of context, boundaries, and conceptual model. A common guidance giving indications on what information to collect and where to possibly find them will be developed by the lab manager to facilitate the stocktaking process in each Pilot study. The common guidance is neither compulsory nor defines the level of detail to achieve. The work plan includes an activity aimed to analyse the collected data and information to identify gaps, including those related to the definition of the boundaries, context, and conceptual model. These gaps will be discussed

Description of risk	Risk level	WPs	Risk-mitigation measures
			at the PW1 and possibly closed thanks to the knowledge that stakeholders have on the Pilot region and will share in that occasion. After the PW1, a period of stocktaking refinement driven by stakeholder feedback is planned.
There is no tool to address a specific issue in a Pilot study or a suitable tool exists but cannot be applied because input data are missing or there is not enough expertise in the Pilot team or Pilot core user group.	Medium but mitigated	3	A continuous interaction between Pilot leads and tool developers is ensured by the Helpdesks of WPs 4-6. Pilot leads will closely follow the development of MYRIAD-EU methods and tools and thus learn what input data are needed as early as possible. Pilot leads will deliver to the Thematic WPs 4-6 data and information about Pilot needs in three steps: at M12, when a consortium-wide event will be organised to simulate and test some presentations and activities planned in the five local PW1s; at M15 when the minutes of the five local PW1s will be delivered; and at M18 when stocktaking and challenges will be finalised. This way, if a gap exists, it will be detected at an early stage, thus allowing the time to find an alternative solution or any missing data. Adjustments to the stakeholder network of the Pilot studies are possible for the entire project lifetime any time a new relevant stakeholder is identified or a replacement is suddenly necessary.
Significant delay in other WPs' deliverables may hamper the timing uptake of their results by WP3 and their integration in WP3 activities and deliverables.	High but mitigated	3	Regular meetings to update on the progress in other WPs' activities and deliverables. Webinars (or similar events) to enable the timely transfer of knowledge and results generated in other WPs to WP3 and vice versa, even if not final.
Impact			
Dissemination and communication strategies not effective	Very low	7	Dedicated dissemination, exploitation, and communication WP (WP7), led by highly experienced SME. PDER updated throughout project. Dedicated Impact Unit (IU) within MT. Sectoral representatives as consortium participants for direct sectoral dissemination.
Weak, inconsistent, or unbalanced stakeholder engagement	Medium but mitigated	All	Stakeholder engagement addressed at all project steps, and facilitated through laboratory approach. Two levels of stakeholders in the Pilots (Pilot core use group and Pilot stakeholder group (Table 1.3e), with different levels of commitment to limit stakeholder fatigue. EAB and SSB provide advice on outcomes and process. Helpdesks provide permanent and trusted point of contact between scientific WPs and Pilots. Sectoral representatives to increase stakeholder engagement.
Difficulty to address stakeholders' needs in Pilots due to their heterogeneity	Medium but mitigated	3	The Pilot-level workshops and focus groups (WP3) allow the research teams to develop and fine-tune methods according to user needs. Collaborative systems analysis approaches developed in WP6 designed specifically to address this issue.

Description of risk	Risk level	WPs	Risk-mitigation measures
Scientific participants ‘forget to communicate’	Low	1-6	Communication activities targeted towards MYRIAD-EU strategic objectives. Impact unit will monitor communication, and help WP and Task Leaders to define a particular and effective communication message and activity when a scientific milestone has been achieved.
COVID19 may prevent physical events (or prohibit travel by some attendees).	High but mitigated	All	In preparing physical events, we will strictly follow the regulations of the country involved, and guidelines of the host institution. Decision on whether attendees may travel in strict adherence to advice of national governments and guidelines of consortium participants. We will ensure remote access to attendees who are unable to attend physically and will have a backup plan so that events can be switched to remote if necessary.
Stakeholder identification may require more time due to gaps in the stakeholder network or a lack of interest/commitment by relevant stakeholders, thus resulting in a weak or unbalanced stakeholder engagement	Medium but mitigated	3	Two groups of stakeholders need to be established in each Pilot study with different level of commitment to avoid stakeholder fatigue. For each group of stakeholders, a minimum and maximum number of members has been established (3-5 for Pilot core user group and 10-15 for Pilot stakeholder group). The work to be carried out in each group is expected to be already guaranteed when the minimum number of members is met. We have already secured numerous Letters of Support from stakeholders in each Pilot study (attached to the project Consortium Agreement). Sectoral Representatives involved in the project will help Pilot leads identify stakeholders that can cover specific economic sectors. A standard email and two fliers will be developed containing information about the project, its context, the type of activities and events where stakeholder engagement is needed, and the added value for stakeholders that participate in the project. This material will be used when contacting the stakeholders for the first time. It is meant to increase the likelihood of their acceptance by making the expected collaboration and associated effort clear and by underlining what the benefits for stakeholders are. Adjustments to the stakeholder network of the Pilot studies are possible for the entire project lifetime any time a new relevant stakeholder is identified or a replacement is suddenly necessary. Regular meetings with Pilot leads will be organised by the lab manager to timely find solutions and share good practices on stakeholder identification and engagement across Pilot studies.
Operational			
Management, administrative or financial issues	Very low	All	Sound management organisation, clearly specified decision-making rules and responsibilities, contingency planning. Regular meetings of MT and its constituent units (CU, QU, IU), which all have clear tasks and responsibilities to ensure effective working.

Description of risk	Risk level	WPs	Risk-mitigation measures
Conflict arises	Very low	All	Creating a climate of trust where participants feel free to exchange ideas. Clear bottom-up, hierarchical structure for conflict resolution further detailed in Consortium Agreement.
Difficulties in internal communication	Very low	All	Consortium has a history of strong links between participants. Most have worked together on various projects/publications. Clear and regular plan of specific meetings (Table 3.2c). Use of internal project collaboration tool.
Information and data not shared effectively	Low	1-6	Data Management Plan will give clear guidelines for sharing of data and is monitored by Data Manager.
Personnel involved not able to fulfil task	Low	All	Monitoring by WP Leaders and MT and implementing adjustments where necessary.
Key staff changes	Low	All	Key staff (e.g., WP Leaders, Pilot leads) selected for expertise. Nevertheless, consortium includes other expert staff who could take over key roles. Science WPs have co-lead who can manage WP during absence of WP Leaders. All participants experienced in multi-year projects and have their own strategies in place to mitigate risks of staff changes.
Organisation of the PW1 delayed due to poor planning, resource shortages, lack of a minimum number of participants, Pilot leads feeling unprepared.	High but mitigated	3	<p>Pilot leads will be given the flexibility of organising the PW1 in a time window that ranges from M13 to M15, to cope with any organizational delays and maximise stakeholder participation.</p> <p>BSG will oversee the organisation of the five local PW1s ensuring that a common approach is followed, and the same objectives pursued. A common agenda will be developed with the possibility of adapting it to Pilot-specific needs.</p> <p>Regular meetings with Pilot leads will be organised by the lab manager to share good practices on how to organise the PW1.</p> <p>The lab manager will organise a Review Meeting (RM1) with each Pilot lead at M12, just before the PW1, to closely monitor the progress in the organisation and help find ad hoc solutions to avoid delays or other criticalities.</p> <p>At M12, a consortium wide event will be organised to simulate and test part of the presentations and activities planned in the five local PW1s. This will serve as a training for Pilot leads. At the same time, preliminary results from the stocktaking will be shared with the other WPs.</p>
Difficulties in communication and limited cooperation with Pilot leads and with other WPs.	Low	3	<p>Lab manager, Pilot leads and WP leaders have considerable experience in coordinating/leading cooperative tasks.</p> <p>Clear communication via email and organisation of regular meetings.</p> <p>Culture of open communication actively fostered with project, including interdisciplinary champion. Use of the Helpdesks of WPs 4-6.</p>

Description of risk	Risk level	WPs	Risk-mitigation measures
<p>Delay in one or more Pilot activities (see above) may cause delay in the drafting of D3.3a, due in M24.</p>	<p>High but mitigated</p>	<p>3</p>	<p>The lab manager will organise two Review Meetings with each Pilot lead to closely monitor the progress in the activities and toward the drafting of D3.3a.</p> <p>At the end of each activity, Pilot leads will be asked to send the lab manager a mini report summarising the work done until that moment.</p> <p>The structure of D3.3a with indications about sections and appendixes will be sent by the lab manager to the Pilot leads in advance so that any disagreements are identified and addressed at an early stage.</p>