myriad_eu
Reducing risks together

D6.5

Online repository of storylines on multi-risk decision-making

Version 2.0
May 2025

D6.5/Online repository of storylines on multi-risk decision-making

Lead by British Geological Survey

Authored by Julia Crummy, Vanessa Banks, Roxana Ciurean, Melanie Duncan, Lara Smale (British Geological Survey), Anne Sophie Daloz, Lin Ma (CICERO), Veronica Casartelli, Silvia Torresan (CMCC), Dana Stuparu, Sharon Tatman, David Geurts, Sarah Rautenbach, Andrew Warren, Leonie Toebrock*(Deltares), Robert Šakić Trogrlić, Stefan Hochrainer-Stigler (IIASA), Noemi Padrón Fumero, Sara García González, Jaime Díaz Pacheco (ULL).
*Internship student hosted by Deltares from November 2022 – February 2023

Report reviewed by Philip Ward (Vrije Universiteit Amsterdam)
Online repository reviewed by Jana Sillmann (CICERO)

Abstract

The MYRIAD-EU project has realised the value of storylines to use narratives of past or plausible future events to explore and characterise cause-and-effect relationships between risk drivers and impacts within a system. Storylines can be purely qualitative or include semi- or fully quantitative components enabling a holistic examination of a system that can account for non-quantifiable elements and high levels of uncertainties. Storylines can be used to understand why a system responded in a particular way to an event and explore how modifying elements within a system could change the outcome. This can include how decisions made can impact the system and the unfolding of events.

MYRIAD-EU has developed a storyline framework with guiding questions to support pilot teams in applying a storyline approach to break down the complexity and examine the interacting nature of multi-risk systems through analysis of past or plausible future events. The storylines approach has been used by MYRIAD-EU pilot teams in several different ways: (1) support their understanding of the complexities of multi-hazard, multi-risk events in their regions; (2) facilitate cross-sectoral engagement with stakeholders on multi-hazard, multi-risk decision-making; (3) facilitate communication of complex relationships to raise awareness of multi-risk events; and (4) support drafting of forward-looking decision-making pathways for plausible future events. The storylines are visualised using the Esri ArcGIS StoryMaps tool shared in an online repository hosted on the MYRIAD-EU dashboard.

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

Version	Date	Authors/Reviewers	Description
V1	02/05/2025	Authors: Julia Crummy (UKRI BGS), Vanessa Banks (UKRI BGS), Roxana Ciurean (UKRI BGS), Melanie Duncan (UKRI BGS), Susan Loughlin (UKRI BGS), Lara Smale (UKRI BGS), Anne Sophie Daloz (CICERO), Lin Ma (CICERO), Veronica Casartelli (CMCC), Silvia Torresan (CMCC), Dana Stuparu (Deltares), Sharon Tatman (Deltares), David Geurts (Deltares), Sarah Rautenbach (Deltares), Andrew Warren (Deltares), Leonie Toebrock	Sent for review to the MYRIAD Quality Unit.

		(Deltares), Robert Šakić Trogrlić (IIASA), Stefan Hochrainer-Stigler (IIASA), Noemi Padrón Fumero (ULL), Sara García González, Jaime Díaz Pacheco (ULL), Reviewers: Philip Ward (VUA), Jana Sillmann (CICERO), Anna Hicks (UKRI BGS)	
V2	30/05/2025	Authors: Julia Crummy (UKRI BGS), Vanessa Banks (UKRI BGS), Roxana Ciurean (UKRI BGS), Melanie Duncan (UKRI BGS), Susan Loughlin (UKRI BGS), Lara Smale (UKRI BGS), Anne Sophie Daloz (CICERO), Lin Ma (CICERO), Veronica Casartelli (CMCC), Silvia Torresan (CMCC), Dana Stuparu (Deltares), Sharon Tatman (Deltares), David Geurts (Deltares), Sarah Rautenbach (Deltares), Andrew Warren (Deltares), Leonie Toebrock (Deltares), Robert Šakić Trogrlić (IIASA), Stefan Hochrainer-Stigler (IIASA), Noemi Padrón Fumero (ULL), Sara García González, Jaime Díaz Pacheco (ULL),	Final version following internal review

Table of Contents

Table of Figures

1 Introduction

The storylines approach is increasingly applied in the climate risk and disaster risk communities to address the limitations of quantitative approaches in dealing with the complexities of multi-risk events and the high uncertainties associated with exploring and modelling plausible future events (e.g., Baldissera Pacchetti et al., 2024 and references therein; Marciano et al., 2024). The storyline approach enables a holistic examination of a system that can account for non-quantifiable elements and high levels of uncertainties, complimenting more quantitative and probabilistic approaches. Within the climate risk community, the definition of Shepherd et al. (2018) is widely used: *"a physically self-consistent unfolding of past events, or plausible future events or pathways"*; however, there are limited guidelines on the storylines approach, hence they are used and applied in diverse ways depending on user needs (e.g. Baldissera Pacchetti et al., 2024 and references therein).

Storylines were identified within the MYRIAD-EU project proposal as an approach that could be used by decision- and policy-makers to gain insights into complex multi-risk systems, interdependencies between hazards and sectors, and the development of robust forward-looking Disaster Risk Management (DRM) pathways. MYRIAD-EU developed an approach for the application of storylines for multi-risk decision-making building on climate-risk (e.g. Shepherd et al., 2018; Coulter and Dessai, 2020; Ciullo et al., 2021; Sillmann et al., 2021; van der Wiel et al., 2021) and disaster risk literature (e.g., Davies et al., 2015; Keating et al., 2016; Riddell et al., 2019; Lin et al., 2020).

Within the storyline literature, commonalities of the approach include the use of narratives, drawing out cause-and-effect relationships to understand how events have or could unfold, and exploration of the bounds of plausibility (e.g. Shepherd et al., 2018; Baldissera Pacchetti et al., 2024). In MYRIAD-EU, we have therefore adopted a definition of multi-risk storylines as: *narratives of past or plausible future events to explore and characterise cause-and-effect relationships between risk drivers and impacts within a system*. Storylines can be purely qualitative or include semi- or fully quantitative components paying attention to plausibility rather than probability focusing on the understanding of driving factors and the societal response.

This report is a supporting document for deliverable 6.5: Online repository of storylines and narratives on multi-risk decision-making. The report documents the development of the MYRIAD-EU storylines approach, including the visualisation of storylines in an online repository hosted on the MYRIAD-EU Dashboard, and its application within the pilot regions. A full description of the MYRIAD-EU application of storylines for multi-risk decision-making is presented in a forthcoming paper (Crummy et al. *in prep*).

2 MYRIAD-EU storyline approach

To understand the needs of the MYRIAD-EU pilot teams, a meeting was held in December 2022 to discuss storylines with the MYRIAD-EU consortium. An online tool (Padlet) was used to gather and share information on current understanding of storylines, whether a storyline approach is useful for pilot leads and what they wanted from a storyline, and how storylines could be presented and visualised. Engagement with pilot teams continued throughout the task to support the adaptation of the storyline approach to their needs, as understanding of the multi-risk systems and disaster risk management developed. Through engagement with the pilot leads and their teams, it became clear that a variety of

methods and models can be used to gather data in the storyline approach (including but not limited to, literature reviews, interviews, focus groups, facilitated discussions, forensic analysis, counterfactuals, numerical modelling, and scenario analysis). This enabled the pilot teams to apply the storyline approach in different ways depending on their needs and available resources.

2.1 Framework

Based on the literature, discussion with the MYRIAD-EU consortium and current understanding of multi-hazard, multi-risk events from work package 1 (WP 1, Diagnosis), we identified key elements influencing risk (building on understanding of dynamic feedbacks of risk drivers from WP 4) within a system during a past or plausible future events that storylines should consider (Fig 1). These elements, or categorisations, include the pre-condition of the system (such as exposure and vulnerability of assets, governance, and planning), hazards and their interrelationships, direct and indirect impacts, sectors and their potential interdependencies, short and long-term responses, as well as any lessons learned and underlying assumptions that may influence decision-making. The framework is purposefully presented in a non-linear structure (Fig. 1), allowing users to select the elements most relevant to their needs.

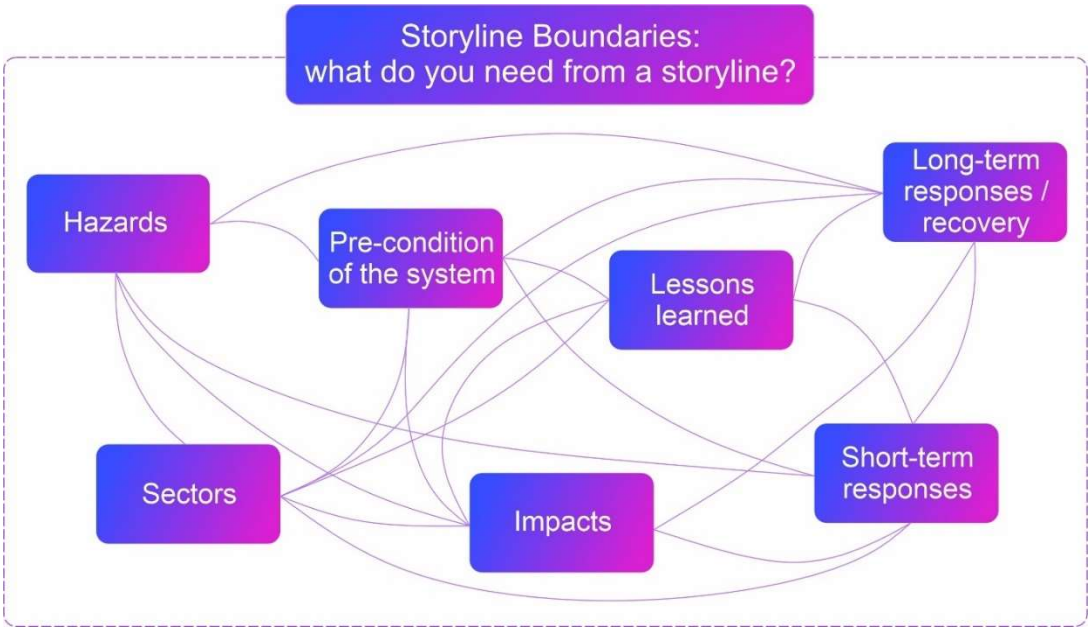

Figure 1 Elements of multi-risk storylines and their interconnections

2.2 Guiding questions

During November 2022 to February 2023 Deltares hosted a student to do an internship supporting the development of storylines in MYRIAD-EU. The intern created a list of questions to act as prompts for gathering data and information to develop a past event storyline. To support the pilot teams in the application of the development of storylines for their regions, we built on the questions (Appendix 1) and sought feedback from the MYRIAD-EU consortium during the MYRIAD-EU General Assembly in May 2023. The guiding questions are not an exhaustive list and have evolved iteratively as storylines have been developed.

Not all guiding questions need to be answered, nor need all key elements to be explored depending on the scope of the storyline and stakeholder needs. The guiding questions serve as prompts to enable detailed consideration of the multi-risk elements, interrelationships, tipping points and decision-making processes to create as robust a storyline as possible, with the information available. The questions can be used to identify data needs and most appropriate data collection methods, as well as for facilitation of discussions during stakeholder engagement. The guiding questions can be framed for either a past or plausible future event, giving users the flexibility to develop the storyline to suit their needs and interests.

2.3 Approach

While the key elements and guiding questions provide a framework for developing a storyline, the process of answering the questions does not result in a storyline: data need to be collected, analysed and synthesised. Therefore, we have developed an approach following five stages (Fig. 2) involving defining the purpose of the storyline and setting boundaries (Stage 1), identifying key elements (Stage 2), identifying data needs and methods of data collection (Stage 3), data collection and analysis (Stage 4), and synthesis into a final output (Stage 5).

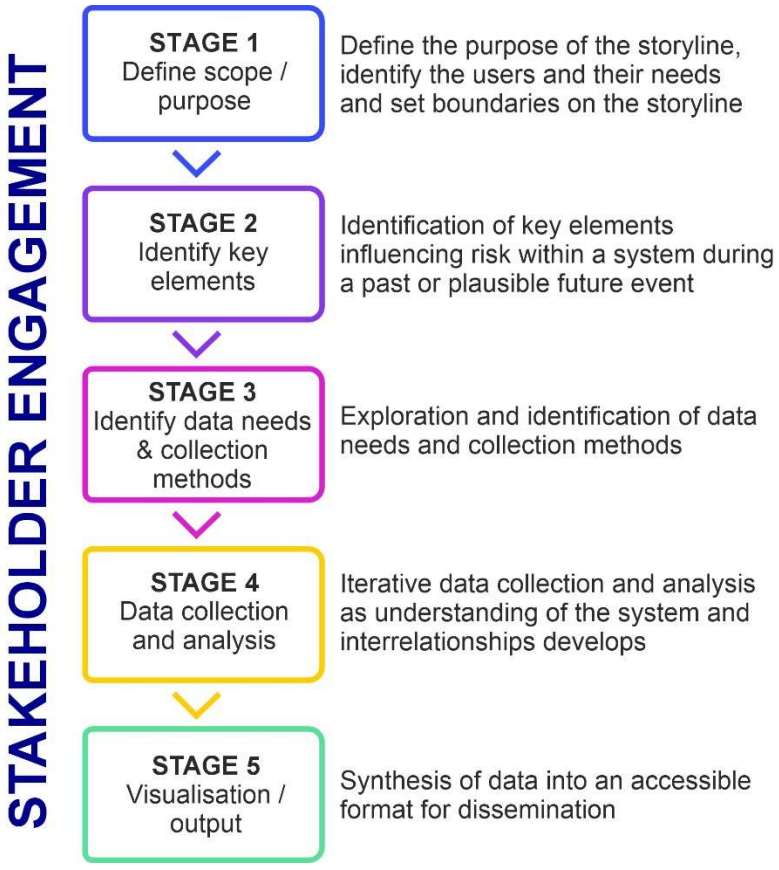

Figure 2 Stages for multi-risk storyline development

Stakeholder engagement is a key aspect in the storyline approach. Ideally storylines are co-created with stakeholders ensuring co-design from the onset to guide the needs of the

storyline, expert input and knowledge sharing during participatory workshops, data collection (e.g. via interviews), awareness raising or mapping of complex multi-risk relationships, and co-development of the visualisation of a storyline. Storylines can be developed and used as a communication tool to raise awareness of multi-hazard events with stakeholders.

Through discussions within the MYRIAD-EU consortium, ArcGIS StoryMaps were selected as a tool to visualise the MYRIAD-EU multi-risk storylines. The flexibility in design and content (including narratives, images, data plots, timelines, videos, and audio) and ease of use of makes ArcGIS StoryMaps ideal for storyline visualisation. ArcGIS StoryMaps are also used by the Red Cross Red Crescent Climate Centre to communicate the complexities of compound events involving climate change and conflict and the resulting humanitarian impacts (https://storymaps.arcgis.com/stories/e42f2459711d48b0a2ca0ac8b949b654).

ArcGIS StoryMaps (https://storymaps.arcgis.com/) can be created though a public or an organisational account, which individual users can request access to through their institution. ArcGIS StoryMaps provide online tutorials and resources to support StoryMaps creation. In collaboration with the North Sea pilot, we developed an ArcGIS StoryMap for the 1953 North Sea Flood event to share with the MYRIAD-EU pilots to gather feedback and to provide an example to follow.

3 Application of storylines in MYRIAD-EU pilot regions

Each pilot region has a unique set of geographic and economic characteristics that make them susceptible to the impacts of diverse multi-hazard events across varying scales and economic sectors. As such, each pilot region has adopted and adapted the storylines approach to suit their own particular context. Each pilot region is dealing with complex interconnected systems and a need to communicate with stakeholders across disciplines; therefore, storylines have been applied to raise awareness amongst stakeholders of multi-hazard risk events and improve understanding of the complexities of multi-hazard, multi-risk events.

The **North Sea** and **Veneto** pilot teams each developed two storylines. The first on a past event, which was used to engage with stakeholders and facilitate discussions to consider future plausible events. A second storyline was developed for a plausible future event (Veneto pilot) and to explore future plausible events (North Sea) and implications for planning. The **Canary Islands** pilot used the storyline approach to understand the complexities of cause-and-effect of interacting hazards and impacts of the 2021 volcanic eruption on La Palma, specifically focusing on disaster risk management decision-making. The **Scandinavia** pilot took a different approach, using storylines to synthesise and communicate quantitative modelling outputs (GRACE model) alongside qualitative data to develop a narrative around a multi-risk event: the compound heat-wave drought in summer 2018. Rather than focusing on a specific event, the **Danube** pilot instead considered varying combinations of hazards (both consecutive and compounding floods, earthquakes and droughts), and considered a worst-case scenario of these hazard combinations.

3.1 Categorisation of storylines

At the outset of the MYRIAD-EU project, we anticipated developing a catalogue of storylines for multi-risk decision-making for stakeholders to explore. To facilitate this, we

planned to categorise the storylines following multi-hazard and multi-sectoral interdependency typologies developed in WP1 and dynamics of risk drivers drawing on WP 4. However, as the project proceeded, and understanding of the storylines approach developed, it was agreed with the pilot leads to focus on one or two storylines to align with other MYRIAD-EU approaches and address specific needs (as described above).

All of storylines have explored multi-hazard and multi-sectoral interdependencies and risk drivers (drawing on WP 1 and WP 4) through the storyline key elements. As the online repository grows, having this categorisation through the key elements would enable us to catalogue the storylines facilitating the use of storylines developed in the MYRIAD-EU project for external stakeholders.

4 Online repository of storylines

Multi-risk storylines developed by the MYRIAD-EU pilots are presented in the online repository of storylines integrated in the MYRIAD-EU Dashboard.

Currently, there are three finalised storylines on the dashboard:

- 1953 North Sea Floods
- Future Climate implications on the North Sea
- Storm Vaia 2018 – Vaia 2.0, Veneto Region

As of May 2025, a further three are in development:

- Heatwave, drought and forest fire, Scandinavia
- Tourism Resilience under Multi-Hazard cascading Risks: Insights from La Palma 2021 (title TBC)
- Consecutive and compounding floods, earthquakes and droughts in the Danube region (TBC)

5 Conclusions

MYRIAD-EU has developed a storylines approach for application to multi-risk decision-making, including the development of a framework and guiding questions to support the pilot teams in developing storylines. The approach follows five stages from defining the purpose of the storyline and setting boundaries, through data collection, analysis and synthesis into a final output. MYRIAD-EU uses ArcGIS StoryMaps to visualise storylines, which are available in the online repository hosted on the MYRIAD-EU Dashboard.

The MYRIAD-EU pilots applied the storyline approach to engage with stakeholders to raise awareness and understanding of multi-hazard events, and to unravel the complexities of multi-risk decision-making. Feedback from the pilots highlighted that the key benefits of the storyline approach were found to lie in the:

- **Flexibility of the approach** enabling the integration of qualitative and quantitative methods and data
- **Accessibility of storylines** for awareness raising and as a communication tool
- **Use of narratives to break down the complexities** of the multi-hazard, multi-risk, and systemic components together with local stakeholders
- Identification of the **underlying vulnerabilities and plausible future scenarios** integrating social and physical sciences.

The impacts of the storyline approach are still being realised and will extend beyond the lifetime of the MYRIAD-EU project. For example, several workshop participants expressed interest in implementing the methodology in their workplaces and some stakeholders involved in the North Sea pilot have been using them to highlight planning needs. Within the MYRIAD-EU project, storylines supported the pilot leads in developing future pathways with stakeholders.

Future work could encompass follow-up surveys with pilot region stakeholders to understand and evaluate if the storyline approach and insights gained from storylines have made a difference in their decision-making processes. Future projects should consider a longitudinal engagement plan to track how the storyline approach influences decision-making over time.

6 References

Baldissera Pacchetti, M., Coulter, L., Dessai, S., Shepherd, T.G., Sillmann, J. and Van Den Hurk, B., 2024. Varieties of approaches to constructing physical climate storylines: A review. *Wiley Interdisciplinary Reviews: Climate Change*, *15*(2), p.e869.

Coulter, L. and Dessai, S. 2020. Generic internal guidance on storyline development. RECEIPT project deliverable 2.1 report. https://climatestorylines.eu/wp-content/uploads/2020/12/D2.1-RECEIPT-Generic-Internal-Guidance-on-Storyline-Development-v1.0.0.pdf

Ciullo, A., Martius, O., Strobl, E. and Bresch, D.N., 2021. A framework for building climate storylines based on downward counterfactuals: The case of the European Union Solidarity fund. *Climate risk management*, *33*, p.100349.

Davies, T., Beaven, S., Conradson, D., Densmore, A., Gaillard, J.C., Johnston, D., Milledge, D., Oven, K., Petley, D., Rigg, J. and Robinson, T., 2015. Towards disaster resilience: A scenario-based approach to co-producing and integrating hazard and risk knowledge. *International journal of disaster risk reduction*, *13*, pp.242-247.

Keating, A., Venkateswaran, K., Szoenyi, M., MacClune, K. and Mechler, R., 2016. From event analysis to global lessons: disaster forensics for building resilience. *Natural Hazards and Earth System Sciences*, *16*(7), pp.1603-1616.

Lin, Y.C., Jenkins, S.F., Chow, J.R., Biass, S., Woo, G. and Lallemant, D., 2020. Modeling downward counterfactual events: Unrealized disasters and why they matter. *Frontiers in Earth Science*, *8*, p.575048.

Marciano, C., Peresan, A., Pirni, A., Pittore, M., Tocchi, G. and Zaccaria, A.M., 2024. A participatory foresight approach in disaster risk management: The multi-risk storylines. *International Journal of Disaster Risk Reduction*, *114*, p.104972.

Riddell, G.A., van Delden, H., Maier, H.R. and Zecchin, A.C., 2019. Exploratory scenario analysis for disaster risk reduction: Considering alternative pathways in disaster risk assessment. *International journal of disaster risk reduction*, *39*, p.101230.

Shepherd, T.G., Boyd, E., Calel, R.A., Chapman, S.C., Dessai, S., Dima-West, I.M., Fowler, H.J., James, R., Maraun, D., Martius, O. and Senior, C.A., 2018. Storylines: an alternative approach to representing uncertainty in physical aspects of climate change. *Climatic change*, *151*, pp.555-571.

Sillmann, J., Shepherd, T. G., van den Hurk, B., Hazeleger, W., Martius, O., Slingo, J. and Zscheischler, J. (2021) Event-based storylines to address climate risk. Earth's Future, 9 (2). ISSN 2328-4277 doi: https://doi.org/10.1029/2020EF001783 Available at https://centaur.reading.ac.uk/94766/

van der Wiel, K., Lenderink, G. and de Vries, H., 2021. Physical storylines of future European drought events like 2018 based on ensemble climate modelling. *Weather and Climate Extremes*, *33*, p.100350.

Appendix 1: Guiding questions

STORYLINE BOUNDARIES (system definition)

- Users:
  - Who is the Storyline for / the user groups?
  - How will they use the Storyline?
  - What do users need from the Storyline?
- Focus:
  - Is there a specific element you want/need to consider? (e.g., understanding how events unfolded from a decision-making point of view; sector interactions; plausible multi-hazard events and how they unfold; decision-making in response to multi-hazard events, and impacts of those decisions; mitigation and recovery)
- Boundaries: specific timescale; spatial boundaries; particular issue

PRE-CONDITION OF THE SYSTEM

- Are there any conditions that influence the level of disaster risk by increasing levels of exposure and vulnerability or reducing capacity?
- How exposed is the system to hazards?
- Are there physical, environmental, social, economic, or cultural drivers that influence the exposure or vulnerability?
- How could vulnerability change over space and time?
- Are there any groups particularly susceptible to hazards?
- What is the Governance structure? What are the levels of responsibility?
- Are there any government or stakeholder policies that may influence the impact of a hazard?
- Is there multi-risk governance / preparedness in this area?
- Are there existing emergency response plans?
- Are there any assumptions regarding responsibilities / interdependencies etc. for planning?
- Are there any environmental conditions or factors that could trigger hazards / influence impacts?

HAZARDS

- Which hazards were/could be involved?
- How did the hazards interact / how were they connected (coincident/compounding/triggering/amplifying)?
- How quickly did/could one hazard follow another?
- What was the duration of hazard events?
- What was the spatial extent of the hazards (individually and combined)?
- Were they unexpected or were they detected by early warning systems?

SECTORS

- What sectors were impacted / have the potential to be impacted?
- How are sectors related (e.g., dependencies between sectors)?
- Do the sectors work together? e.g., any cross-sector planning for events?
- Are there any underlying assumptions about sector interdependencies?
- Are there any conflicts of interest that could influence impacts / responses in a multi-hazard risk event?
- What is the scale of sectors: local, regional, national, global (e.g., local transport routes / global transport links)?

DIRECT & INDIRECT IMPACTS

- What were the direct impacts (directly resulting from the hazards)?
- What were the indirect impacts (linked but not directly caused by the hazards themselves)?
- Can impacts be attributed to specific hazards?

- Were there any compounding impacts resulting from multiple hazards?
- What were the impacts to specific sectors?
- Were impacts different for different sectors?
- Were any impacts on a sector compounded/influenced by another sector?
- How were impacts assessed / reported?

SHORT-TERM RESPONSES

- Response management (for each sector and combined):
  - Who was involved?
  - Who coordinated the responses?
  - Was there a coordinated response across sectors?
  - Was there an existing emergency plan that was followed?
- Responses:
  - How were the needs determined?
  - What responses were needed?
    - Issuing of alerts / warnings?
    - Evacuation / provision of water, food, shelter
  - Timeline of responses
  - Was there damage assessment?
    - How was it coordinated/conducted?
- Communication:
  - How were the public informed?
  - How were the public involved?
  - How was the communication within the country/area managed?
- Aid:
  - What international aid/support was given?
  - How was aid delivered and distributed?
- Were there any short-term mitigations actions (e.g., strengthening of structures; use of sandbags; covering of openings)?

LONG-TERM RESPONSES

- What were the long-term responses for each sector?
  - Rehabilitation of sectors that were severely damaged.
  - Rebuilding of houses / infrastructure etc.
- Shift from response to recovery
  - How was recovery structured?
  - Timeline of recovery
- What long-term mitigation actions were taken?
  - e.g., building of dikes, modifying river morphology, installing early warning systems, developing emergency plans

LESSONS LEARNED

- Were there any lessons learned specifically from the decision-making process?
  - What could have been done differently for a better outcome?
  - What was done well and why?
  - What underlying assumptions influenced the outcomes of the event?
- How do sectors currently interact?
- How should sectors interact?
- How have lessons been captured?
- Were there any changes implemented as a result of lessons learned from the event (e.g., policy changes; development/modification of communication plans; development of emergency plans; cross-sector agreements etc.)?