Towards an applicable integrated multi-hazard and multi-risk framework

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UNDERLYING PRINCIPLES

The framework is based on a **systemic perspective** where a **system** is a set of (partly) interconnected elements with clear boundaries and which foregrounds interdependencies between elements within a system (elements can be systems themselves). It allows for the assessment and management of both **individual risks** (risk to individual elements within the system) and **systemic risks** (risk of the system due to interdependencies). The implementation of the framework is an **iterative process**, with a possibility of including a range of methodologies, both qualitative and quantitative. As a framework, it does not prescribe methodologies and approaches, but rather provides a frame with which one can work.

STEP 1: FINDING THE SYSTEM DEFINITION

In this step, one defines the system boundaries and current state of the system. Depending on the identified systems boundaries (e.g., according to geographical area or decision maker), risks and elements at risk will differ. As a next step, challenges and visions of respective "system owners" (i.e., stakeholders) are identified and include, e.g., macroeconomic spillover effects due to natural hazards on a regional level. One then determines and characterizes multi-hazard scenarios of interest and the exposed and vulnerable elements of the system. In multi-hazard scenarios, one considers different types of hazard interrelationships (e.g., cascading, compound, amplifying).

STEP 2: CHARACTERIZATION OF DIRECT RISK

Direct risk is risk that is realized due to direct contract with a multi-hazard event. This includes risk of physical damage to assets (e.g., buildings, infrastructure) or physical health impacts due to a multi-hazard event. Characterization of direct risk in a multi-hazard setting takes into account dynamic changes of vulnerability and exposure in a multi-hazard scenario (e.g., changes in infrastructure vulnerability due to compound or cascading hazards, population relocation, …).

STEP 3: CHARACTERIZATION OF INDIRECT RISK

We consider indirect risk only through the lens of losses that are realized due to direct risks. Therefore, in this step one looks at indirect risk – but only the ones which can be related to multi-hazard events – and considers interdependencies between system components and/or different systems. Examples for indirect risks would be risk of losses in the agricultural sector due to direct risk to transport infrastructure or ripple effects along supply chains causing business interruptions. Similar to direct risk, changes in the dynamics of exposure and vulnerability due to a multi-hazard event should be taken into account.

STEP 4: EVALUATION OF DIRECT AND INDIRECT RISK

Given limited resources and mandates of different stakeholders involved, not all direct and indirect risks can be reduced and managed and some risks are tolerable/acceptable for the system of interest (e.g., due to insurance coverage). Therefore, evaluation of direct and indirect risk according to a set of pre-agreed criteria (e.g., costs, policy and legislation) is an integral part of the process towards the selection of risk management options. In this step, direct and indirect risks to be managed are selected.

STEP 5: RISK MANAGEMENT OPTIONS

This step engages with possible management options to reduce multi risks using, for instance, risk-layering for direct and indirect risks (if these are expressed through quantitative metrics). Risk management options can also be discussed through the lens of risk-informed, precautionary, and discursive strategies. Depending on the system owner interests, mandates, means, planning frame and identified risks, strategies can be developed for short-, middle-, and long-term risk management. One also explores what kind of different risks cannot be managed with current policy instruments and apply risk layering for different risks.

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framework for individual, multi-, and systemic risk analysis and management

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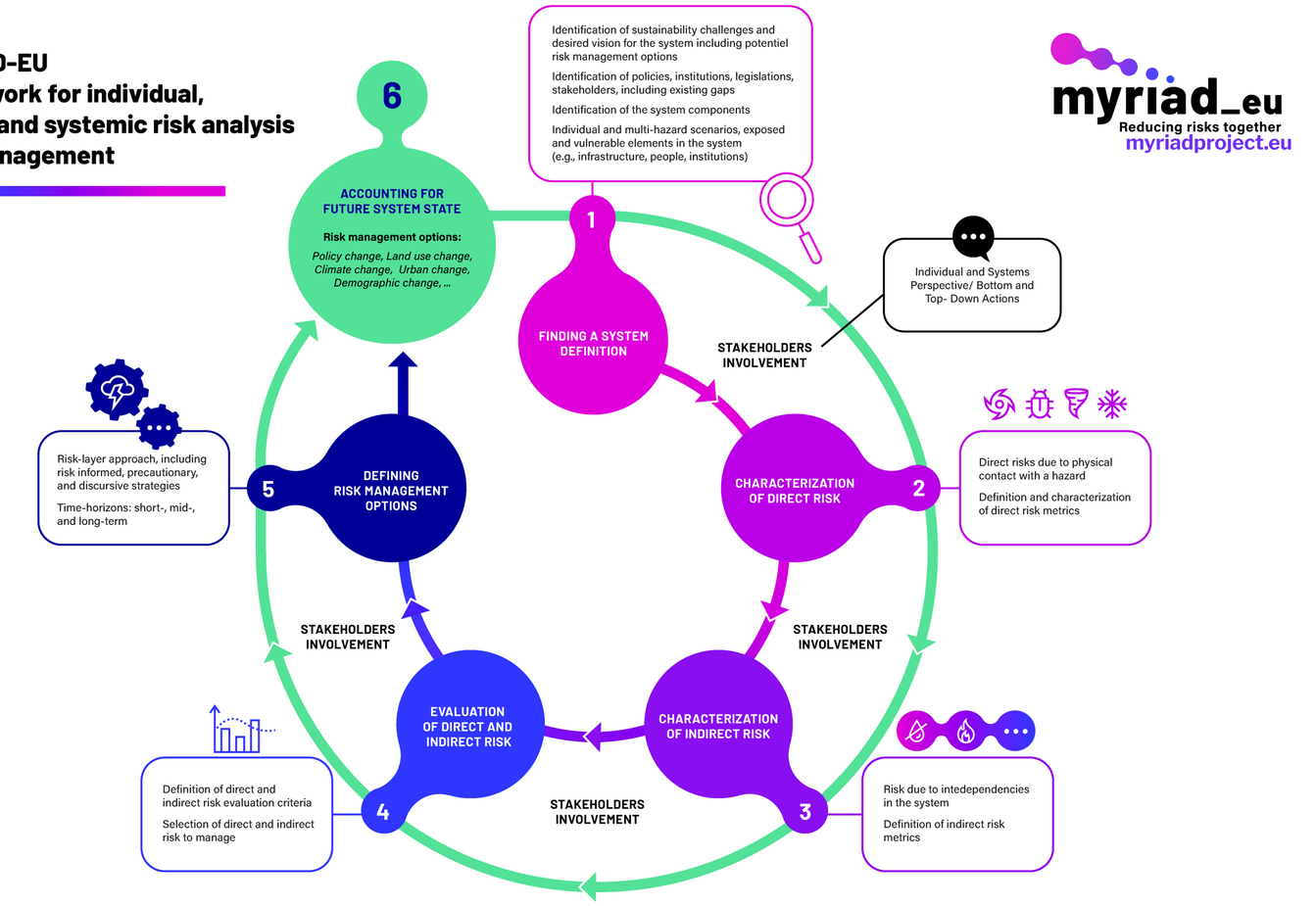

Prototype MYRIAD-EU framework for multi-hazard, multi-sector, systemic risk management

STEP 6: FUTURE SYSTEM STATE

The framework is iterative, and upon deciding on risk management options, the system state is updated. The system (and, consequently, the risk) changes due to:
a) risk management options (e.g., risk management option in sector X changes indirect risks for sector Y), and
b) natural and non-natural processes influencing risk components (e.g., climate change, urbanization, socio-economic changed)
With accounting for these changes, risk in a system can be further assessed and revisited.

CROSS-CUTTING THEMES

Stakeholder Involvement

Involvement of different stakeholders is integral and important in all four steps. For instance, the definition of system boundaries and multi-hazard scenario of interest will vary between different stakeholders (e.g. an agent in the tourism sector vs an insurance company). Furthermore, direct and indirect risk metrics as well as risk management options should be co-developed with stakeholders.

Individual and Systems Perspectives/Bottom Up and Top-Down Actions

Our framework assesses both individual and systemic risk as it is based on systemic risk and interdependencies between system elements and different levels of system. Individual risk manifests itself in the absence of interdependencies while systemic risk arises in the case of interdependencies. In absence of interdependencies, risks can be managed at an individual level (bottom-up perspective) while risk management takes place at a system level (top-down perspective) in the case of interdependencies.

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