Report
on options for contribution to Sendai Reporting

Report prepared by THK and DKKV as part of work package 8.3 of the BMBF-funded project "INCREASE - Inclusive and integrated multi-hazard risk management and engagement of volunteers to increase social resilience in times of changing climates"

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1. Introduction

The Sendai Framework for Disaster Risk Reduction 2025-2030 (SFDRR) is a crucial instrument for building a safer and more resilient world. It serves as a global blueprint to reduce existing disaster risks and prevent new disasters. Adopted during the Third UN World Conference on Disaster Risk Reduction in Sendai in the year 2015, it outlines four priorities for action and seven clear targets. The four priorities encompass *Understanding Disaster Risk* to assess vulnerabilities and exposure; *Strengthening Disaster Risk Governance* to manage disaster risk for effective policies and coordination; *Investing in Disaster Risk Reduction for Resilience* to ensure funding for risk reduction measures; and *Enhancing Disaster Preparedness for Effective Response* and to build back better in recovery, rehabilitation and reconstruction focusing on early warning systems and community readiness. Thereby the seven targets guide for and against which to assess progress by substantially reduce the global disaster mortality; the number of affected people globally; the direct economic loss in relation to GDP; and to reduce disaster damage to critical infrastructure and disruption of basic services as well as substantially increase the number of countries with national and local disaster risk reduction strategies; enhance international cooperation to developing countries; and increase the availability of and access to multi-hazard early warning systems.

However, its success depends on the effective integration of disaster risk reduction into all aspects of development, as well as the participation and empowerment of all actors, especially the most vulnerable and marginalized groups. This requires a collective and coordinated effort from all levels of government, civil society, private sector, academia, media, and international organizations.

Therefore, also the INCREASE project is looking into options of contributions to the Sendai Reporting. INCREASE stands for: 'Inclusive and integrated multi-hazard risk management and volunteer engagement to increase social resilience to climate change' and is a joint project funded by BMBF. The INCREASE project aims to contribute to short-term disaster risk reduction, long-term strategic planning and overall resilience of Iran and Germany by closing the gaps between theoretical knowledge, strategies, disaster management plans, capacities, and actual practice in the context of multi-hazards. INCREASE focusses on two major points. On the one hand on an integrated analysis and assessment approach for hazards, risks, vulnerabilities, and resilience and on the other hand on an integrated management approach for emergencies and disasters. In an iterative and transdisciplinary process between the German and Iranian partners (from science, administration, the private sector, emergency services and other end users), the INCREASE project works on the basis of multi-hazard scenarios: pandemics, severe earthquake, and extreme meteorological events (i.e. heavy rains, floods, heat waves and droughts). These three scenarios serve as a starting point for the assessment of risks, needs, and capacities and for the development of the integrated disaster risk management (IDRM) framework. With this complex and dynamic societal process of all actors involved, effective and efficient measures can be taken in a coordinated manner to prevent disasters and, in case of their occurrence, to avert harm and ensure the well-being of the people at risk under dynamically changing conditions. INCREASE develops this IDRM by elaborating various specific frameworks, which are then incorporated into an overarching framework for a scalable and integrated DRM. The process is based on the specific social and cultural contextual conditions, risks, vulnerabilities, and needs of societies and its disaster risk management systems. To strengthen resilience in Iran and Germany, the framework will consider several aspects, such as specific risks and hazards,

emergency situations and scenarios, different geographical levels, such as the local, regional, and national levels, and others. Encompassing nine work packages (WP), one of them is looking into the co-development of advanced integrative disaster risk and resilience solutions and measures including a contribution to the Sendai Reporting in the form of a report on the viability of alternative and supporting indicators to monitor the SFDRR's resilience, recovery and transformation of society and critical infrastructure.

The task of DKKV and THK is to analyze the options of the INCREASE project to contribute to the SENDAI framework monitoring and the viability of alternative and supporting indicators for monitoring the SFDRR objectives related to resilience, recovery and transformation of society and critical infrastructure. Furthermore, expert interviews with the German national focal point are planned as well as the presentation of the results on international conferences. This report shows the finalization of these tasks and outlines the methodologies used to analyze project outcomes that can contribute to the Sendai Reporting based on which alternative and supporting indicators were elaborated for monitoring the objectives of SFDRR. The next two chapters will show the outcomes for the priorities and the seven targets of SFDRR. In the discussion results will be discussed with a focus on how INCREASE can contribute to Sendai monitoring process. In the end recommendations for the National Focal Points for the Sendai Framework (in Germany) will be given.

2. Methodology

The methodology behind this report is based on three methods, which are briefly outlined below.

- **Literature Review and Desk Study:** This involves a comprehensive search and analysis of existing literature related to the SFDRR, the related target and indicators as well as its monitoring and reporting. On the other side existing output of the INCREASE project was scanned for possible contributions to the Sendai Reporting. The aim is to assess vulnerabilities, exposure, and current strategies in disaster risk management, focusing on multi-hazard scenarios like pandemics, earthquakes, and extreme weather events and put them in context with SFDRR. Based on the gained overview of the literature review and the desk study the workshops were designed.

- **Workshop:** The workshop with INCREASE partners was used to analyze project outcomes that can contribute to the Sendai Reporting. Based on that alternative and supporting indicators were elaborated for monitoring the objectives of SFDRR in relation to resilience, recovery and transformation of society and critical infrastructure. Beforehand all INCREASE partners were asked to send possible contributions to the Sendai Reporting from their focus areas. The contributions were sorted according to the four Sendai priorities. During the workshop each priority was represented by one group of participants. The task of each group was then to analyze (give short explanations why and how the project outcome contributes) all contributions and then to transform contributions into alternative and supporting indicators. The last step was to put the new indicator into one or more of the monitoring categories of resilience, recovery, transformation of society and critical Infrastructure. The results were then digitized and form a basis for this report (can be found in the Annex of this report).

- **Expert Interview**: An expert interview was conducted with the German National Focal Point for the Sendai Framework. This interview helped to bridge the gap between the workshop and project results and actual practice and policy of SFDRR. It allowed to evaluate the INCREASE outcomes and their contribution and to understand gaps and challenges, that can be approached by future research projects.

3. Four Priorities of SFDRR

Based on the learnings from the Hyogo Framework for Action and to ensure that the goal of substantially reducing disaster risk and with it the loss of live, health, and livelihoods till 2030, the four priorities for action were developed. Their function is to ensure that the work done by states or at local, national, regional and global level is focusing the same direction. While those provide a common basic direction, they must be interpreted by each state or institution itself for the local circumstances. The INCREASE project provides numerous outputs, which can support the four Sendai priorities. Based on the workshop findings, Table 1 provides detailed information about every relevant INCREASE outcome and to which priority it contributes. This chapter summarizes the contributions per priority and reflects on the gained insights.

#1 Understanding disaster risk

In order to reduce disaster risk, it is essential to understand its origins and underlying drivers. The focus can not only include past losses but must also consider future trends and dynamics. Uncertainty also plays an important role in analyzing and understanding risk and must be taken into account. The Sendai Framework emphasizes that understanding risk cannot only be achieved through the generation of new knowledge, but that already a great deal of knowledge is available today, which has to be better interconnected in order to make it accessible to all to efficiently draw conclusions. The INCREASE project, with its focus on disaster risk management, naturally has an emphasis on understanding disaster risk. This is achieved by the systematic sharing of knowledge between different scientific disciplines as well as a variety of analysis methods and approaches that integrate disaster risk components.

The transfer and the interconnection of knowledge between different scientific disciplines on national level but also in between in Germany and Iran is one main contribution to *#1 Understanding disaster risk*. Several methods and approaches were conducted by the consortium for that purpose.

An actor mapping, which specified the relevant stakeholders and their tasks in disaster management was developed, which helped to understand how information in disaster management is shared, decisions are made, and which differences exist between both countries. This facilitated the necessary alignment of knowledge of basic disaster management systematics for the scientists from both sides, which is crucial for further efficient knowledge exchange. Due to the added value of the measure, similar approaches are also planned for follow-up projects.

A data exchange platform as well as a report about the common understanding and definition of disaster risk relevant terminology was jointly developed. The most relevant topics were

approached in knowledge transfer workshops, where different methods were used to align the state of knowledge and discuss the perspectives from different scientific fields. WP1 facilitated the knowledge transfer between both countries as well as between different scientific disciplines inside each country. The resulting reports can furthermore provide insights into the used methods and how these can be used to improve the understanding of disaster risk, not by generating new knowledge, but by connecting what is already available.

A core research interest of the project is IDRM which strives to develop understanding as well as management approaches for a holistic disaster management, that involves all actors. A systematic collection of knowledge from already existing IDRM approaches and the consecutive analysis established a foundation for a novel IRDM framework. The resulting insights in IDRM, like reports on existing IDRM tools, their implementation efforts or hazard assessments with reference to IDRM, can provide a valuable overview of which approaches are already existing for disaster management and where gaps remain unfilled. To make the insights available to the international research community, the outcomes were published in a scientific paper about international IDRM approaches. The results were then used to systematically develop a new IDRM framework, with the aim to develop an approach, that would allow to integrate the spatial, temporal, and sectoral dimensions of disaster risk management. Besides deep discussions between different scientific disciplines, which resulted in a strong increase in interdisciplinary understanding, this resulted in framework concepts about for multi-hazard and multi-risk analysis, a culture and catastrophe visualization method, and a final IDRM framework in the form of a working paper. The gained knowledge from the IDRM framework development process contributes to better understand disasters and especially disaster management, by providing insights about how important sector overarching perspectives are and how they can look.

Besides knowledge gathering and transfer as well as framework development, the INCREASE project also includes an analytical part, which focuses on multi-hazard and risk assessments as well as critical infrastructure dependencies. A data quality analysis and an OpenStreetMap Mapathon were conducted to generate the necessary data foundation for the critical infrastructure analysis. Two models were consecutively developed, one analyses the road network criticality for rescue services and can be used to measure and predict disaster impact. The second one calculates the accessibility to critical infrastructure facilities like hospitals during normal and during disaster situations. Since disaster impact is strongly connected with the functionality of critical infrastructures, these efforts can likewise contribute to *#1 Understanding disaster risk*. Furthermore, a server based automated landslide assessment tool was built, which can monitor and analyze the landslide hazard for a case study area based on earth observation data. This approach is transferable to other countries and can generally support in understanding landslide risk.

Many further project outcomes, which contribute to *#1 Understanding disaster risk* in various ways, like a conceptual social media app or multi hazard social vulnerability assessments, can be found in Table 1. In summary, it can be seen that most of the results of the project contribute to *#1 Understanding disaster risk*. Overall, a great amount of knowledge could be generated as well as existing knowledge could be collated and transferred. In addition, the transdisciplinary exchange between researchers on the topic of disaster risk contributed to many new insights. The aim now has to be, to transfer these findings from the research group and beyond the two focus countries of Germany and Iran to other researchers and international disaster managers. First

steps have been undertaken in this direction, by presenting the findings at several international conferences or discussing them in an extensive field trip with a large number of disaster research organizations from Kyrgyzstan and Kazakhstan. Additionally, a wiki platform is developed, which makes the INCREASE outputs available in a structured and understandable manner.

#2 Strengthening disaster risk governance to manage disaster risk

The second priority focuses on the regulatory and organizational side of disaster management. It calls for clearly defined responsibilities during all timeframes of the disaster management cycle and over all levels, from government to local initiatives. Furthermore, national and local disaster risk reduction and management strategies have to be developed and coordinated between stakeholders, to ensure that their efficiency over different levels. This has to be fostered by providing incentives and guaranteeing a periodical assessment of the state of the national disaster risk management. Strong disaster risk governance can only be achieved, by including all necessary stakeholders, like politics, private sector, civil society, professional associations, scientific organisations and the United Nations.

Several of the INCREASE outputs can support such efforts. The stakeholder analysis of disaster management, and the consecutively developed policy paper “Comparative Analysis of Local and National DRM and IDRM Structures, Gaps and Needs in Germany and Iran" are one example. The identified gaps and needs can serve as base for further improvements, while the analysis methods could theoretically be transferred to other countries.

The IDRM framework has been developed for the international level, but exists already as a working paper for Germany, which shows, that a national implementation is also possible. It provides rich insights, in how the integration and collaboration between different sectors, spatial scales, and dimensions can be achieved efficiently. The IDRM focused output can therefore provide scientifically sound points of improvement for *#2 Strengthening* existing *disaster risk governance to manage disaster risk*.

An important pillar of the INCREASE project with regards to disaster risk governance is the inclusion and organization of volunteers. The outcomes are based on the experience the Federal Agency of Technical Relief has with its extensive volunteer network in Germany. A matrix on types and meanings of volunteering in Germany and training guidelines can be used to establish and similar networks in other countries and integrate them efficiently in existing governance structures.

Further outputs like a wiki-based report platform or a resilience toolkit can be found in Table 1. As demonstrated, the results of INCREASE can also make a valuable contribution to *#2 Strengthening disaster risk governance to manage disaster risk*. However, the so often prevailing gap between research and practice must be addressed here. Too often, research does not overcome the “valley of death” to generate relevant impact in practice, in this case the governance sector. INCREASE tackles this issue by anchoring several practice partners in the consortium. Still, it would be advisable to focus attention on this issue and to strengthen dissemination efforts of results in the field of governance in the future.

#3 Investing in disaster risk reduction for resilience

The third priority focuses on public and private investment in disaster risk prevention and reduction. The appropriate allocation of resources, finance, and logistics to all administrative

levels can be a driver of growth innovation and job creation and therefore cost effectively increase disaster resilience. To promote the uptake of disaster focused approaches in urban planning and rural development, to strengthen investments in critical infrastructure, as well as the development of public and private insurance mechanisms are important steps to achieve this priority.

From the INCREASE projects outputs, only few are suitable to support this priority, and if so, only in an indirect way. The risk and resilience toolkit, which is developed in form of a dashboard, to provide information about multi-hazard and risk for cities and critical infrastructures, can provide valuable information for decision makers on where to allocate money and can also support evaluation the measures impact. The methodology developed and the associated indicators for IDRM can also provide information on areas in which measures would be useful and can also show how to proceed methodically to identify particularly critical areas and gaps.

Overall, the priority *#3 Investing in disaster risk reduction for resilience* has the lowest contribution of the INCREASE project. This can be explained by the fact that this is a very application-focussed field, while INCREASE is still a research project, even if it has already had a tilt towards an application focus. Furthermore, did the project generally not focus on investments in its objectives, which could be a point to adjust in future proposals.

#4 Enhancing disaster preparedness for effective response and to BBB in recovery, rehabilitation and reconstruction

The last priority focuses on effective disaster preparedness to strengthen the response efforts during a disaster impact. Disaster response thereby includes several perspectives. Response and recovery capacities range from rescue services and community centers to financial support and organizational structures in the highest levels. For this a level and institution overarching structured collaboration has to be ensured, by regular tests and disaster response plans and guidelines. Multi-hazard early warning systems, that reach all of the population are also crucial. To built back better, respective policies and guidelines have to be developed before disaster impact and the local population, including women or marginalized groups must be included.

From the INCREASE project, a variety of outputs serves the fulfillment of *#4 Enhancing disaster preparedness for effective response and to BBB in recovery, rehabilitation and reconstruction*. The collaborative efforts to develop an IDRM framework can support the structuring of the organizational disaster management entities, to generate more response capacities by efficiently integrating existing structures. Other outputs contribute by improving the access to disaster risk information, for example working papers on "Floods, drought, heat, IDRM, and the effects of climate change in Iran and Germany" or "Social vulnerability and resilience of the people in Tehran".

The resilience wiki, a wiki platform, that covers many of the INCREASE outputs and makes them available in a structured and understandable way for public and end users, includes information that help *#4 Enhancing disaster preparedness for effective response and to BBB in recovery, rehabilitation and reconstruction*. For example, Iran focused chapters like "Earthquakes in Iran" or "Culture and Catastrophe in Iran" or content to the inclusion and strengthening of volunteer engagement like "Cooperation and integration of volunteers in German DRM" and "Comparison of motivation for voluntary engagement, integration and cooperation with volunteers in Germany and Iran".

The previously mentioned, more practical outputs, like the road network criticality and the Critical Infrastructure Access Road Identification Model are transferable to other cities on a global scale and can therefore support by providing measurable input. The likewise before mentioned resilience toolkit comes as a data and information dashboard, that displays information about various hazards and climate change indicators on global, national, and municipality or even city level. It also combines the data into an IDRM composite index, that allows decision makers insights into hazard exposure and vulnerability to a variety of hazards. This gets further improved by a self-assessment questionnaire for critical infrastructures like hospitals or schools, that semi-automatically analyses their resilience towards the investigated hazards.

Further outputs, like reports on gaps and capacities of civil protection in Germany in the context of climate-related hazards or GIS based outputs, can be found in Table 1. In summary, the INCREASE project provides a broad range of outputs, that can contribute to *#4 Enhancing disaster preparedness for effective response and to BBB in recovery, rehabilitation and reconstruction*, either directly or by providing methods, that can be transferred to other case study areas.

4. Seven Targets of SFDRR

Based on the four priorities, seven global targets were developed, along with a set of 38 indicators which provide means to measure the progress on disaster risk reduction and the respective implementation of the Sendai Framework per country. The Sendai Framework Monitor functions as a management tool, that allows countries to gather and evaluate the indicator data. The contribution to the Sendai Indicators is on voluntary base and connects seamless into the Sustainable Development Goals (SDG) in particular SDG 1 – End poverty in all its forms everywhere, 11 – Make cities and human settlements inclusive, safe, resilient and sustainable and 13 – Take urgent action to combat climate change and its impacts.

Figure 1: Seven global Sendai targets (Sendai Framework Monitor)

Some of the outputs of the INCREASE project can also contribute to fulfill the seven global targets. Either by providing background knowledge or possible methods to derive the necessary indicator data. These outputs with a possible contribution are presented in Table 1 (column "Sendai Tared and Indicator relation").

Since the SFDRR indicators are qualitative measurements that capture disaster risk management-related data at the national level, only few INCREASE outputs can directly contribute to the 38 indicators themselves (an overview of all 38 indicators can be found in Table 2).

To gain a better understanding of how useful the developed outcomes are for the indicator measurement, and what could be improved, to increase their potential, an interview with the National Focal Point for the Sendai Framework in Germany (NKS), located in the Federal Office of Civil Protection and Disaster Assistance (BBK) was conducted. During this interview, the INCREASE outcomes were presented in a first overview. After the first discussion round, three outputs were identified that offer potential to contribute to the measurement of these indicators due to their high application relevance. The Road Network Criticality Model, the Critical Infrastructure Access Road Identification Model and the resilience toolkit were then presented in more detail and the possible contribution as well as improvements that would increase the Sendai indicator measurement, were worked out jointly. The results and learnings of this interview are summarized below for each of the three outcomes.

The Road Network Criticality Model uses a routing algorithm developed for fire and rescue service vehicles in combination with iterative road blockages, to find out, which roads in a city are most important for a timely emergency response, and which roads are less relevant. If emergency call data is available to weight the algorithm, like for the case study of Cologne, the model's accuracy can be highly increased. The model can be transferred to any other city, provided data about road network, road types and rescue stations is available.

The Critical Infrastructure Access Road Identification Model calculates the number of access roads to critical infrastructure like hospitals in different distances to the facility. The advantage of this approach is, that also bottlenecks in the road network, that are further away from a facility are taken into account. The model was then used, to investigate the change in accessibility to hospitals in the city of Hamburg in Germany in a storm surge scenario and to fire stations in Tehran and Karaj in Iran in an earthquake scenario. Nevertheless, as long as road network data and the facilities locations as well as hazard maps are available, the model can be transferred to any other city.

In the evaluation with the NKS, it became clear that both models (see Figure 2) can be helpful in disaster prevention, by highlighting problematic critical infrastructure bottlenecks. In terms of Sendai indicators, target D: “Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030” would be the fitting field. Unfortunately, the indicators are focused on a post-disaster situation, where for example the number of disruptions due to a past events have to be counted. Since the models have been developed for disaster prevention they are more out of a predictive perspective. Nevertheless, in discussion with NKS, the idea to test the models based on historic events arose. In those cases, the models could provide the estimation of disrupted services, especially for regions, where a collaborative recording of post disaster damages is still a challenge, like in Germany.

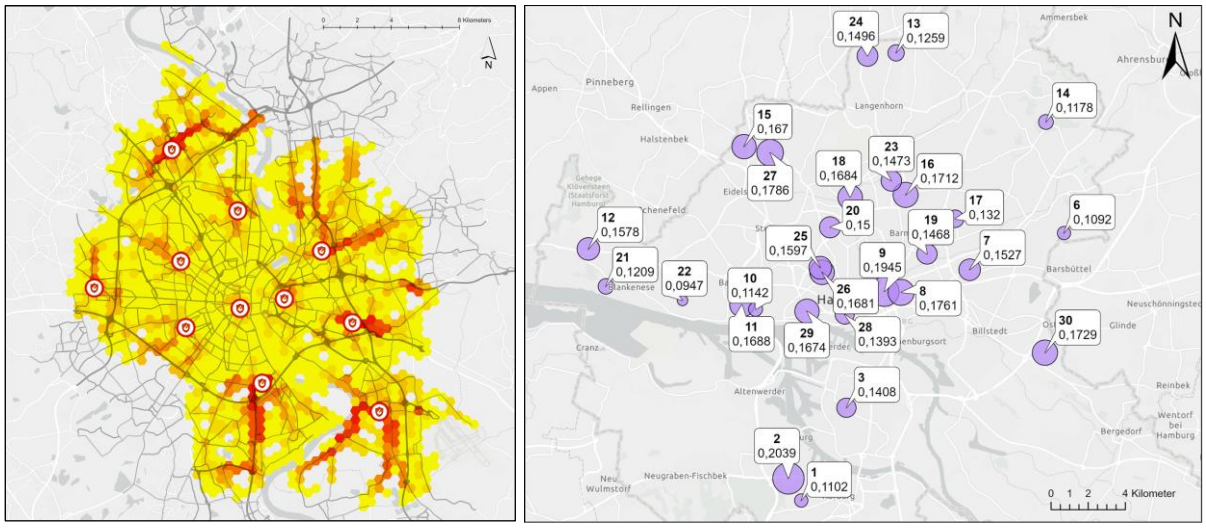

Figure 2: Exemplary outputs of the Road Network Criticality Model (left) and Critical Infrastructure Access Road Identification Model (right) (source: INCREASE project)

The resilience toolkit (see Figure 3) combines several analysis and information display methods to generate an information system for local or regional stakeholders. Connected to global hazard databases, it can be used to provide hazard exposure information for cities or critical infrastructures. With detailed hazard maps and socio-economic and demographic population information, the dashboard can be extended by social vulnerability analyses and compounding disaster risk indices. In discussion with the NKS, the advantage which information systems like that can have for local and regional authorities and decision makers was confirmed. Like the previous models, the resilience toolkit focuses on a predictive approach, based on hazard maps and risk analyses, to identify critical spots before a disaster strikes. This does generally not correspond with the post disaster measurements, that the Sendai indicators need. But the

resilience toolkit has also the potential to include disaster prevention measures and to track the respective progress over time, which allows to measure disaster risk reduction on local level even if no disasters happen, which can be under certain circumstances more helpful for the local responsibility.

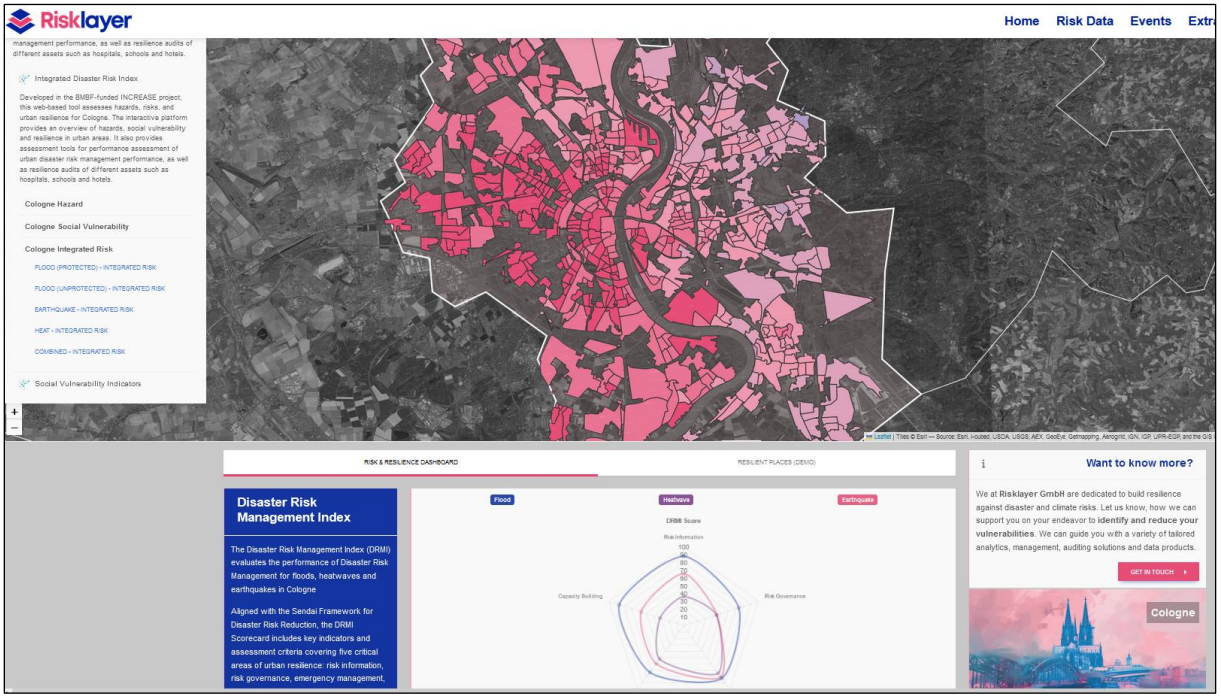

Figure 3: Example of the web-GIS platform of the resilience toolkit for Cologne (source: INCREASE project)

5. Discussion

Overall, the evaluation of the INCREASE results and their usefulness for the Sendai Framework in collaboration with the NKS pointed out the strength and challenges, that the INCREASE project faces in this regard. While the project can contribute a great deal to the four priorities of SFDRR, particularly in the area of knowledge generation and transfer, as well as disaster prevention. The seven targets and their qualitative measurements are more difficult to capture by a research project. However, in discussions with the NKS, it became clear that this is a general problem. Germany decided not to monitor targets A – D (deaths, affected, economic losses, infrastructure disruption) at all. The reason for this is difficulties in data collection. Due to the federal system in Germany, municipalities and federal states cannot be obliged to collect post-disaster data. Although data is collected voluntarily in many cases, it does not follow a common format, meaning that the individual surveys cannot be combined with one another. This means that if figures were to be given for Germany in the Sendai Monitor, they would be inaccurate, while they might suggest a non-existing accuracy at the same time. It was therefore ultimately decided not to monitor the first four targets, which can be seen controversial, since Germany is one of the states, that strongly supported the Sendai implementation. The problem here appears to be a political and organizational one and has less to do with insufficient research. However, research projects such as INCREASE can still contribute to improving the monitoring process by critically reflecting the existing process and identifying possible alternatives. For example, possible new indicators based on existing INCREASE outcomes were developed in the knowledge transfer

workshop. Measurements like the number of volunteers, the number of cities that use information systems to collect and analyze disaster data in a structured way or the number of people who have access to critical services in a certain period of time could improve monitoring. It also became apparent that Sendai Monitoring in its current form is strongly geared towards post-disaster values. However, this means that disaster risk reduction measures that have been implemented are often not recorded in the monitoring, as the associated disaster does not occur or was even prevented by the measure. It could therefore make sense in future to measure the actions that have already been implemented before a disaster occurs instead of post-disaster values. Based on internal discussions and the project outputs, a new possible target "transparency" was also developed. This is based on the idea that the public accessibility of disaster-relevant (geo) data such as census, critical infrastructure, building information, hazard maps, etc. promotes cooperation between national stakeholders and makes it easier for scientists to conduct relevant research. In addition, the population and the economy can inform themselves and strengthen their resilience on their own responsibility.

6. Conclusion

Overall, the evaluation of the INCREASE results and their usefulness for the Sendai Framework in collaboration with the NKS showed that INCREASE can contribute a great deal to the four priorities. INCREASE outputs are particularly strong in the area of knowledge generation and transfer, as well as disaster prevention. In terms of the seven Sendai targets and the respective indicators INCREASE had less potential to contribute, which fits in line with Germanys decision to not provide measurements for the Sendai indicators A – D (deaths, affected, economic losses, infrastructure disruption). This decision was made due to difficulties in the data gathering process, which would need severe organizational changes and political decisions, like a national data gathering structure that aligns the post disaster data collection process for al federal states. While the direct solution of this problem can not be solved by research alone, there might be future indirect ways of supporting the German Sendai monitoring process. Methods, that estimate the necessary indicator measures (e.g. number of affected people) could for example be developed based on geo and remote sensing data. To enable the time dependent comparison and thereby the efficiency of disaster risk reduction measures, the indicator values are needed for every year since 2015. Methods that estimate the respective values for past events would therefore be particularly helpful. In addition, newly developed indicators, which have a more qualitative approach, could help to identify other relevant key points for disaster risk reduction. Similar demands are not only relevant for Germany, but also for example for Kyrgyzstan and Kazakhstan, which could be discussed on an extensive field trip to central Asia. This calls for further research engagement and a cross-country collaboration to strive towards a global efficient Sendai monitoring.

7. Annex

Table 1: Detailed contributions of INCREASE to the Sendai Framework

INCREASE contribution to Sendai Framework					
This table shows possible contributions of the INCREASE project based on the four priorities, the seven targets and the 38 indicators. **#1 Understanding disaster risk** **#2 Strengthening disaster risk governance to manage disaster risk** **#3 Investing in disaster risk reduction for resilience** **#4 Enhancing disaster preparedness for effective response and to BBB in recovery, rehabilitation and reconstruction**					
Priority	**Sendai Target and Indicator Relation**	**Contribution**	**Analyses/ Explanation**	**Alternative Indicators**	**In relation to resilience, recovery, transformation of society, critical infrastructure**
1	G, H (new Target for Transparency)	Actor Map on Actors in Disaster Risk Management in Iran & Chapter Resilience Report Wiki "Stakeholders and key actors" (WP1.2)		Publicly available actor mapping	Resilience, Transformation of Society
1	D, G, H (new Target for Transparency)	Report “Analysis of Basic Infrastructure Services data status in Iran “ (WP 5.4)	Analysis of geo data availability and quality for Iran		
1	A,B,G, H (new Target for Transparency)	Humanitarian OSM Mapathon (WP 5.4)	HOT mapathon to train volunteers in humanitarian data collection and produce data for INCREASE research		

1	D, G, H (new Target for Transparency)	Draft report and database for initial assessment of geomorphological activity. Morphodynamic activity maps (WP5.2)		Number of Municipalities with Open Data Portal/ Percentage of area covered	Resilience, Transformation of Society
1	A,B,D	Automated Weighted Access Road Identification Model (WP 5.4)	Model to evaluate road access to CI under normal/disaster conditions. Helps to understand CI-resilience and to improve disaster response	Number of disruptions to "Disaster Response Critical Infrastructure"	Resilience, Transformation of Society
1	A,B,D	Road Network Criticality Model based on rescue service driving times (WP 5.4)	Model to analyze roads that are critical for timely disaster response. Contributes to local disaster risk understanding and improves disaster response		
1	B	Report “Literature research on Exposure mapping in Tehran, Iran” (WP 5.4)	Overview of disaster exposure maps produced for Tehran		
1	D	Chapter Resilience Report Wiki “The state of research on multi-hazard and multi-risk analysis” (WP2.4)			
1	D, G	Draft report on the decision on hazard modeling approaches and cost-benefit analysis. Semi-automated hazard maps (WP5.3)			
1	G	Working paper "Social vulnerability and resilience of the people in Tehran" (WP6.2)			
1	G	Working Paper “A Systematic Review of Multi-Hazard and Multi-Risk Research in the Context of Natural Hazards in Iran” (WP 5.4)	Momentarily paused working paper with the purpose of giving an overview of the state of multi-hazard knowledge in Iran		

1	G	Report on options and results of vulnerability and resilience assessment (delayed, WP 6.3 and 6.6)	Analysis of social vulnerability against multi-hazard, especially outage of critical infrastructures and relevance of indicators for Sendai Reporting		
1		Report on international IDRM policy and scientific discourses (WP 2.1)	Assessing international level policy and scientific discourses on IDRM		
1		Report on implementation efforts of existing IDRM tools (WP 2.1)	Assessing the implementation efforts of existing IDRM tools, their actual and potential capacities, as well as their enhancers or inhibitors		
1		Report on existing IDRM tools (WP 2.1, 6.1 + 8.1)	Report on existing tools, methods, usage examples for assessment of risk and resilience based on an integrative approach		
1		Report on multi-hazard assessment approaches in Iran (WP 2.2)	Evaluating the current state of the art on multi-hazard and multi-risk assessment approaches, as well as community vulnerability and resilience measures		
1		Report on data requirements of and feasibility of an integrated index (WP 3.3 + 8.1)	Outline on the data requirements and the feasibility for producing an integrated index		
1		Report on demands for a risk and resilience toolkit (WP 6.1 + 8.1)	Outline on the demands for a risk and resilience toolkit including a conceptual framework, software architecture and user needs		
1		Report on methodology for and assessment of IDRM composite index (WP 8.1)	Outline of the methodology for the production of the IDRM composite index, assessment criteria and targets		

1		Social Media App Concept (WP 8.4)	Developing a Social Media App concept for all involved persons, i.e. decision maker, rescue teams and population		
1		Paper on IDRM approach at international level (WP2.1)			
1		Framework concept "Culture and Catastrophe Tehran and Iran" as visualization (WP3.2)			
1		Working paper IDRM framework (WP3.2)			
1		Chapter Resilience Report Wiki "Culture and Catastrophe in Iran" (WP6.1)			
1		Dissemination of overall project results (WP9.4)			
1		Documentation on Workshop on Central Terminology, Protection Goals, and Scenarios (WP1.3)			
1		Documentation on Knowledge Transfer Workshops (WP1.4)			
1		fundamental exploration of the hazard potential and the validation of methods for measuring this potential			
1		Exchange platform for the joint data collection of all partners (WP1.5)			
1		Report on the evaluation of adaptive and practicable GIS modeling approaches (WP2.1)			
1		Report on the existing basis of hazard maps with reference to the IDRM concept at urban area level (WP2.2)			

1		Report on the framework concept for multi-hazard and multi-risk analysis (WP3.2)			
1		Report on the conceptualization of the multi-risk and hazard assessment (WP5.1)			
1		Report on transferability criteria of geo-morphological modeling and multi-hazard and multi-risk assessment in Iran (WP9.2)			
1		Report on the bilateral working meeting to evaluate the multi-hazard and multi-risk assessment framework (WP9.3)			
2	F	Paper on IDRM approach at international level (WP2.1)		Cross-sectional measurement (International) F9	
2	E	Working paper on approaches to IDRM in Germany (WP2.3)		Cross-sectional measurement (Local + national scale) E3	
2	F7	Policy Paper "Comparative Analysis of Local and National DRM and IDRM Structures, Gaps and Needs in Germany and Iran" (WP2.4)			
2	E	Working paper "Feasibility of an IDRM in Iran" (WP3.3)			
2	F	Matrix on different meanings and types of volunteering in Germany (with THW) (WP7.1)			
2	E	Wiki-based report platform			
2		Actor mapping and responsibilities in the field of DRM in Germany (WP1.2)			

2		Report on demands for a risk and resilience toolkit (WP 6.1 + 8.1)	Outline on the demands for a risk and resilience toolkit including a conceptual framework, software architecture and user needs		
2		Report on methodology for and assessment of IDRM composite index (WP 8.1)	Outline of the methodology for the production of the IDRM composite index, assessment criteria and targets		
2		Social Media App Concept (WP 8.4)	Developing a Social Media App concept for all involved persons, i.e. decision maker, rescue teams and population		
2		WebGIS Layer			
2	F5	Exchange platform for the joint data collection of all partners (WP1.5)	Technological innovation (International)		
2	G5; E2	Report on the evaluation of adaptive and practicable GIS modeling approaches (WP2.1)	Support for desicion makers		
2	G5	Draft report on the decision on hazard modeling approaches and cost-benefit analysis. Semi-automated hazard maps (WP5.3)	Data Generating		
2	G5; F7	Web GIS, including demonstrator and instructions for using the Web GIS and for the automated creation of hazard maps (WP8.4)	Data Sharing (International cooperation)		
2	E2	Training guide and report on working meetings; report on the application tests in the study areas and on the requirements for training measures (WP.9.1)	DRR		

3	E2; F5; G5	Report on demands for a risk and resilience toolkit (WP 6.1 + 8.1)	Outline on the demands for a risk and resilience toolkit including a conceptual framework, software architecture and user needs; exchange of science, technologies and innovations	amount of cities using toolkits (local indicator)	resilience, recovery, transformation of society, critical infrastructure
3	E2	Report on methodology for and assessment of IDRM composite index (WP 8.1)	Outline of the methodology for the production of the IDRM composite index, assessment criteria and targets; input (measurement) to local strategies	amount of cities using IDRM composite index	resilience, recovery, transformation of society, critical infrastructure
3	G5	WebGIS Layer	As input for establishing EWS (indirect)		
3	G5	Risk/hazard map	Only national and local level		
4		Chapter Resilience Report Wiki "Gaps and Capacities" of past events in Germany (WP1.1)			
4	G5	Working paper "Floods, drought, heat, IDRM, and the effects of climate change in Iran and Germany" (WP4.1 & 4.2)	Improving access to DR information		
4	G5	Chapter Resilience Report Wiki "Earthquakes in Iran"	Improving access to DR information		
4		Chapter Resilience Report Wiki "Culture and Catastrophe in Iran" (WP6.1)			
4	G	Working paper "Social vulnerability and resilience of the people in Tehran" (WP6.2)			
4		Research report "History of dealing with disaster risks in Germany and Iran" (WP6.4)			

4	F	Matrix on different meanings and types of volunteering in Germany (with THW) (WP7.1)			
4	A1; B2; G5	Chapter Resilience Report Wiki "Cooperation and integration of volunteers in German DRM" (WP7.2)	increased understandment of recruiting	number of volunteers	Transformation of society
4	A1; B2; G5	Chapter Resilience Report Wiki "Comparison of motivation for voluntary engagement, integration and cooperation with volunteers in Germany and Iran" (WP7.3)	increased understandment of recruiting	number of volunteers	Transformation of society
4		Report on gaps and capacities of civil protection in Germany in the context of climate-related hazards (WP1.1)			
4		Report on data requirements of and feasibility of an integrated index (WP 3.3 + 8.1)	Outline on the data requirements and the feasibility for producing an integrated index		
4	A1; B2; D2; D4; D7	Automated Weighted Access Road Identification Model (WP 5.4)	Model to evaluate road access to CI under normal/disaster conditions. Helps to understand CI-resilience and to improve disaster response; Imporoves emergency access to hospitals	accessibility to different services (15 minutes)	Critical infrastructure
4	A1; B2; D2; D4; D7	Road Network Criticality Model based on rescue service driving times (WP 5.4)	Model to analyze roads that are critical for timely disaster response. Contributes to local disaster risk understanding and improves disaster response; Imporoves emergency access to hospitals	accessibility to different services (15 minutes)	Critical infrastructure

4	G2; G5	Humanitarian OSM Mapathon	HOT mapathon to train volunteers in humanitarian data collection and produce data for INCREASE research; Improve humanitation and information in real time	Measurable: number of users, posts	Resilience, Transformation of Society, Critical Infrastructur
4	E1;E2	Report on demands for a risk and resilience toolkit (WP 6.1 + 8.1)	Outline on the demands for a risk and resilience toolkit including a conceptual framework, software architecture and user needs	Number of cities that have measured IDRM performance	Resilience, Recovery
4		Report on options and results of vulnerability and resilience assessment (delayed, WP 6.3 and 6.6)	Analysis of social vulnerability against multi-hazard, especially outage of critical infrastructures and relevance of indicators for Sendai Reporting		
4	E1;E2	Report on methodology for and assessment of IDRM composite index (WP 8.1)	Outline of the methodology for the production of the IDRM composite index, assessment criteria and targets; Supports governments DRR strategies	Number of cities that have measured IDRM performance	Resilience, Recovery
4	G2; G5	Social Media App Concept (WP 8.4)	Developing a Social Media App concept for all involved persons, i.e. decision maker, rescue teams and population	Measurable: number of users, posts	Resilience, Transformation of Society, Critical Infrastructur
4		WebGIS Layer			

Table 2: Detailed version of the seven global Sendai targets and respective 38 indicators (preventionweb.net)

Global target A: Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020-2030 compared with 2005-2015.

A-1 (compound)	Number of deaths and missing persons attributed to disasters, per 100,000 population.
A-2	Number of deaths attributed to disasters, per 100,000 population.
A-3	Number of missing persons attributed to disasters, per 100,000 population. *The scope of disaster in this and subsequent targets is defined in paragraph 15 of the Sendai Framework for Disaster Risk Reduction 2015-2030 and applies to small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters caused by natural or man-made hazards, as well as related environmental, technological and biological hazards and risk.*

Global target B: Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020-2030 compared with 2005-2015.

B-1 (compound)	Number of directly affected people attributed to disasters, per 100,000 population.
B-2	Number of injured or ill people attributed to disasters, per 100,000 population.
B-3	Number of people whose damaged dwellings were attributed to disasters.
B-4	Number of people whose destroyed dwellings were attributed to disasters.
B-5	Number of people whose livelihoods were disrupted or destroyed, attributed to disasters.

Global target C: Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.

C-1 (compound)	Direct economic loss attributed to disasters in relation to global gross domestic product.
C-2	Direct agricultural loss attributed to disasters. *Agriculture is understood to include the crops, livestock, fisheries, apiculture, aquaculture and forest sectors as well as associated facilities and infrastructure.*
C-3	Direct economic loss to all other damaged or destroyed productive assets attributed to disasters. *Productive assets would be disaggregated by economic sector, including services, according to standard international classifications. Countries would report against those economic sectors relevant to their economies. This would be described in the associated metadata.*
C-4	Direct economic loss in the housing sector attributed to disasters. *Data would be disaggregated according to damaged and destroyed dwellings.*
C-5	Direct economic loss resulting from damaged or destroyed critical infrastructure attributed to disasters. *The decision regarding those elements of critical infrastructure to be included in the calculation will be left to the Member States and described in the accompanying metadata. Protective infrastructure and green infrastructure should be included where relevant.*
C-6	Direct economic loss to cultural heritage damaged or destroyed attributed to disasters.

Global target F: Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030.

F-1	Total official international support, (official development assistance (ODA) plus other official flows), for national disaster risk reduction actions. *Reporting of the provision or receipt of international cooperation for disaster risk reduction shall be done in accordance with the modalities applied in respective countries. Recipient countries are encouraged to provide information on the estimated amount of national disaster risk reduction expenditure.*
F-2	Total official international support (ODA plus other official flows) for national disaster risk reduction actions provided by multilateral agencies.
F-3	Total official international support (ODA plus other official flows) for national disaster risk reduction actions provided bilaterally.
F-4	Total official international support (ODA plus other official flows) for the transfer and exchange of disaster risk reduction-related technology.
F-5	Number of international, regional and bilateral programmes and initiatives for the transfer and exchange of science, technology and innovation in disaster risk reduction for developing countries.
F-6	Total official international support (ODA plus other official flows) for disaster risk reduction capacity-building.
F-7	Number of international, regional and bilateral programmes and initiatives for disaster risk reduction-related capacity-building in developing countries.
F-8	Number of developing countries supported by international, regional and bilateral initiatives to strengthen their disaster risk reduction-related statistical capacity.

Global target G: Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030.

G-1 (compound G2-G5)	Number of countries that have multi-hazard early warning systems.
G-2	Number of countries that have multi-hazard monitoring and forecasting systems.
G-3	Number of people per 100,000 that are covered by early warning information through local governments or through national dissemination mechanisms.
G-4	Percentage of local governments having a plan to act on early warnings.
G-5	Number of countries that have accessible, understandable, usable and relevant disaster risk information and assessment available to the people at the national and local levels.
G-6	Percentage of population exposed to or at risk from disasters protected through pre-emptive evacuation following early warning. *Member States in a position to do so are encouraged to provide information on the number of evacuated people.*

Global target D: Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030

D-1 (compound)	Damage to critical infrastructure attributed to disasters.
D-2	Number of destroyed or damaged health facilities attributed to disasters.
D-3	Number of destroyed or damaged educational facilities attributed to disasters.
D-4	Number of other destroyed or damaged critical infrastructure units and facilities attributed to disasters. *The decision regarding those elements of critical infrastructure to be included in the calculation will be left to the Member States and described in the accompanying metadata. Protective infrastructure and green infrastructure should be included where relevant.*
D-5 (compound)	Number of disruptions to basic services attributed to disasters.
D-6	Number of disruptions to educational services attributed to disasters.
D-7	Number of disruptions to health services attributed to disasters.
D-8	Number of disruptions to other basic services attributed to disasters. *The decision regarding those elements of basic services to be included in the calculation will be left to the Member States and described in the accompanying metadata.*

Global target E: Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.

E-1	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030.
E-2	Percentage of local governments that adopt and implement local disaster risk reduction strategies in line with national strategies. *Information should be provided on the appropriate levels of government below the national level with responsibility for disaster risk reduction.*