# Resilience Uncovered: A review of professional resilience measurement methodologies

*Markus Samuel Miettinen*

**Division of Risk Management and Societal Safety**
**Lund University, Sweden**

**Riskhantering och samhällssäkerhet**
**Lunds tekniska högskola**
**Lunds universitet**

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**Markus Samuel Miettinen**

**Supervisor: Professor Henrik Tehler**

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Abstract

Recent policy developments on the global, regional and national levels have materialised strategic goals for building resilience. Implementing resilience fundamentally requires operationalising the concept in order to make it measurable. This thesis scoped for professional resilience measurement methodologies across grey literature and analysed their organisational purposes and specifics of measurement indicators in the light of cohesion and collaborative potential. 55 methodologies from 52 organisations were found. It was concluded that resilience measurements are mainly used for strategic programming and monitoring and evaluation purposes. Overall, the methodologies clearly delineated to six sectoral groups; development/humanitarian, safety/disaster risk management, critical infrastructure/utilities, social welfare, economic and environmental. All of the sectoral groups were conceptually cohesive among their resilience operationalisations. Cross-sectoral cooperation was estimated based on the rates at which disaster risk management, climate change adaptation and complexity were integrated within each sector. Development/humanitarian and safety/disaster risk management sectors both integrated climate change adaptation with a high prevalence. On the other hand, disaster risk management was integrated by safety/disaster risk management and critical infrastructure/utilities sectors with a high prevalence. When it comes to the measurement designs, it was noted that higher scale measurements were more prominent in using secondary data sets than lower scale measurements. Furthermore, it was observed that qualitative measurements were somewhat more common (52.8% of all methodologies) than quantitative measurements (43.8%). The research aim was fulfilled by establishing scientific knowledge on how resilience is operationalised by professional organisations. Based on the resilience operationalisations, resilience seems to be used in a somewhat isolated manner among sectors. While in-sector conceptual cohesion exists, the outcome goals and used concepts vary between sectors. When it comes to inter-organisational cohesion, it was concluded that conceptual heterogeneity exists among most of the identified sectors.



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Riskhantering och samhällssäkerhet
Lunds tekniska högskola
Lunds universitet
Box 118
221 00 Lund

http://www.risk.lth.se

Telefon: 046 - 222 73 60
Telefax: 046 - 222 46 12

Division of Risk Management and
Societal Safety
Faculty of Engineering
Lund University
P.O. Box 118
SE-221 00 Lund, Sweden

http://www.risk.lth.se

Telephone: +46 46 222 73 60
Fax: +46 46 222 46 12

# Abbreviations and Acronyms

| | |
|---|---|
| BRIC | Baseline Resilience Indicators for Communities |
| CCA | Climate Change Adaptation |
| CGDAHRC | Center for Global Development–The African Population and Health Research Center |
| CI | Critical Infrastructure/Utilities Sector |
| DH | Development/Humanitarian Sector |
| DHS-FEMA | Department of Homeland Security–Federal Emergency Management Agency |
| DRM | Disaster Risk Management |
| FAO | Food and Agriculture Organization of the United Nations |
| IASC | Inter-Agency Standing Committee |
| IFRC | International Federation of Red Cross and Red Crescent Societies |
| IGAD | Intergovernmental Authority on Development–Resilience Analysis Unit |
| IO | International Organisation |
| IPCC | Intergovernmental Panel on Climate Change |
| M&E | Monitoring and Evaluation |
| MM | Measurement Methodology |
| NGO | Non-Governmental Organization |
| OECD | The Organisation for Economic Co-operation and Development |
| SDRM | Safety/Disaster Risk Management Sector |
| SOVI | Social Vulnerability Index |
| UN | United Nations |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNISDR | United Nations Office for Disaster Risk Reduction |
| WB | World Bank |

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# 1. Introduction

A recent policy development has resulted in the materialisation of a new resilience-building agenda. According to Fekete, Hufschmidt, & Kruse (2014), resilience has been established as a goal within global, regional and national disaster risk management and climate change adaptation strategies. Global level frameworks that define resilience as a goal include the Hyogo Framework for Action, the subsequent Sendai Framework on Disaster Risk Reduction from the United Nations Office for Disaster Risk Reduction (UNISDR) and OECD's[1] Recommendation of the Council on the Governance of Critical Risks (Fekete et al., 2014; OECD, 2014; UNISDR, 2015). When it comes to regional strategies, European Union's security strategy and the union's climate change strategy both state resilience as a goal (Fekete et al., 2014). On the national level, for instance Switzerland's critical infrastructure strategy, United Kingdom's civil protection strategy and United States' critical infrastructure policy define resilience as a core goal (White House, 2013; Fekete et al., 2014). The new resilience agenda has resulted in a conceptual shift. Now proactive disaster risk reduction, i.e. disaster prevention, mitigation and preparedness, has gained emphasis over reactive disaster response (Becker, 2014). In more practical terms, the emergence of resilience has established a risk governance perspective, in which risks are systematically identified and in which core risk reduction roles are designated for public authorities (OECD, 2014). It is clear that resilience is becoming an important concept on the policy level but it is still not clear what it is, and why it is important.

[1] The Organisation for Economic Co-operation and Development

## 1.1. Why is Resilience Important?

*"If everything is resilience, nothing is resilience"*

- Luca Russo, FAO[2]

Resilience is a multi-faceted concept. It is utilised in discussions by academics and by international organisations far and wide. In 2013, the Guardian called resilience "*the sexiest new buzzword in international development*" (Guardian, 2013-03-05). Additionally, at the end of the same year, the 100 Resilient Cities partnership was launched, which included a spectrum of geographically, culturally and economically diverse cities around the world, all developing and implementing urban resilience strategies (100 Resilient Cities, n.d.). In 2014, the third international resilience science and policy conference, Resilience 2014, was held. In the same year, the Overseas Development Institute started its resilience scan project, which reports on scientific and grey literature discussions quarterly (see Batra, Lovell, Morsi, Schofield, Tanner, Twigg, & Weingärtner, 2017). A lot has happened during the past two years. In 2016, the Journal of Applied Ecology featured a special issue on quantifying

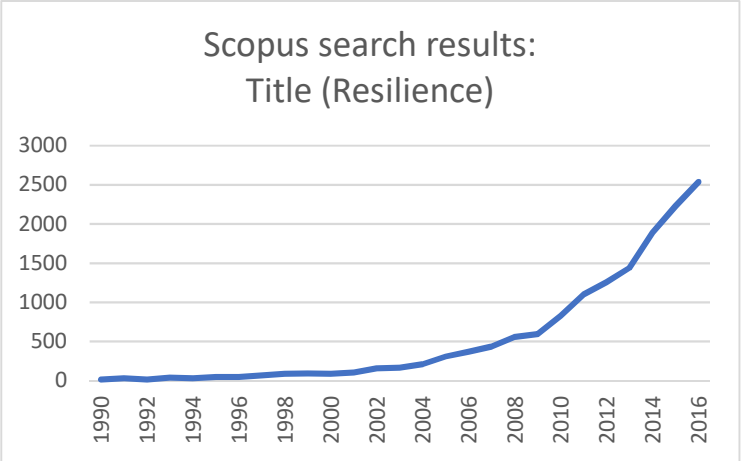


*Figure 1. General article trends with 'resilience' in the title (Miettinen, 2017). Data source: Scopus.com (Retrieved 2017-05-08).*

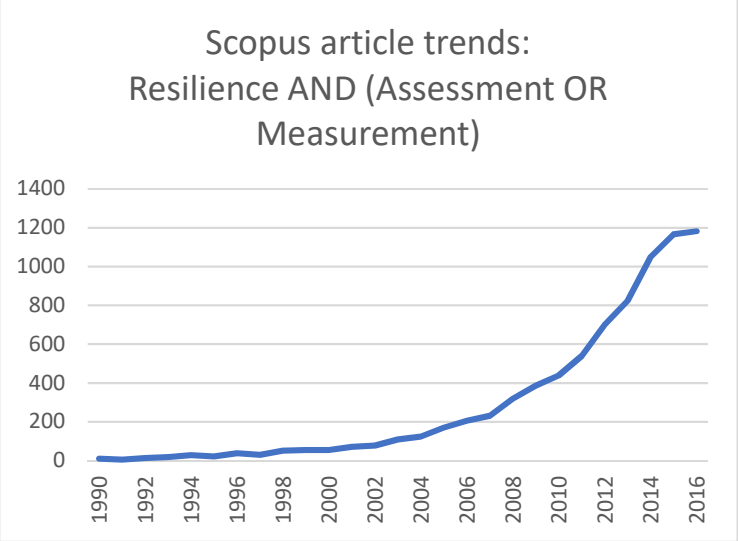


*Figure 2. General articles trends with 'resilience assessment' or 'resilience measurement' in the keyword, title or abstract (Miettinen, 2017). Data source: Scopus.com (Retrieved 2017-05-08).*

[2] Argument by Russo, L. (2016-06-03) during the webinar 'RIMA-II: What's new?'. FAO stands for the Food and Agriculture Organization of the United Nations.

ecologic resilience (British Ecological Society, n.d.); a step towards in-depth application of the concept. Also, during the same year, the World Disasters Report 2016 by the International Federation of Red Cross and Red Crescent Societies (IFRC) focused on promoting the recognition of resilience and its implementation in development and humanitarian settings (IFRC, 2016). Furthermore, at the end of the year the Rockefeller Foundation published its movie 'The Resilience Age' (Rockafeller Foundation, n.d.). Overall, Google Trends and Scopus article results indicate that there seems to be a rapidly increasing trend for using resilience in the academic fields and other fields (figures 1, 2 and 3).

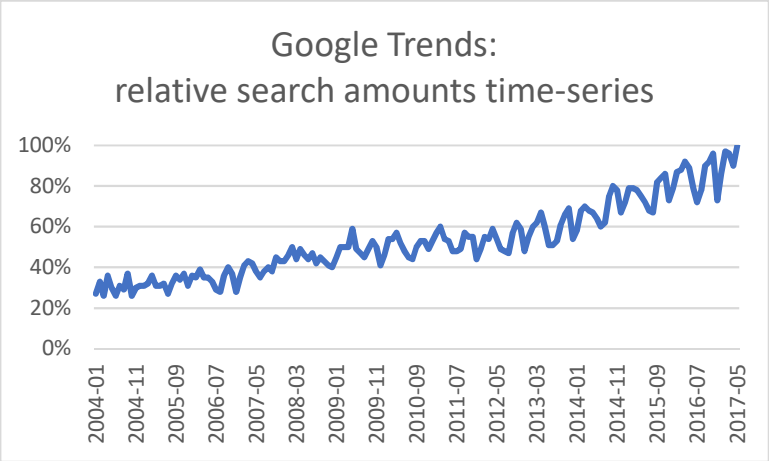


*Figure 3. Relative Google Search trends which include the search term 'resilience' (Miettinen, 2017). Data source: trends.google.com (Retrieved 2017-05-08).*

However, academics have not developed any common frameworks for resilience and the concept is used differently across disciplines (Alexander, 2013). Major historic foundations can be traced to engineering, where it is considered a property of materials to return or bounce back to the original state, and to ecology, where it is the property or capacity to maintain the normal or necessary functions of the ecosystem (ibid.). In business literature and psychology, resilience is depicted as an attribute of individuals, decision-makers and organisations, where it embodies, in addition to the bouncing back discourse, the ability to make tough decisions in an uncertain and/or ambiguous environment (see Syrett & Devine, 2012; Ovans, 2015-01-05; Lane, 2016).

In societal approaches, resilience is linked to disaster risk management (DRM) and climate change adaptation (CCA) under the safety and sustainability paradigm (Becker, 2014). Safety and sustainability refer to measures that constitute societal development in the short-term and in the long-term (ibid.). The paradigm promotes a proactive perspective, where disaster prevention and mitigation, preparedness, climate change mitigation and adaptation are endorsed over reactive disaster response and recovery (Becker, 2014; Wamsler, 2014; UNISDR, 2015). Even under the safety and sustainability paradigm, resilience has arguably become the train for new conflicting

ideas across sectors (see IFRC, 2016). A turf war for resilience seems to be already on the way. The IFRC for instance points out that the word carries an ecology-based 'package', which according the IFRC makes using the concept difficult within humanitarian and development frameworks (ibid.). On the other hand, Stockholm Resilience Centre and Stockholm Environmental Institute establish a firm basis for resilience as a socio-ecological term in development and beyond (Biggs, Schlüter, & Schoon 2015; see Arctic Council, 2016), while others take even more multi-dimensional approaches (see Cutter, Burton, & Emrich, 2010).

Furthermore, many safety and sustainability organisations focus conceptually only on DRM or CCA (Becker, Abrahamsson, & Hagelsteen, 2013), which prevents harmonised safety and sustainability approaches. Both DRM and CCA see themselves responsible for preventing and mitigating losses and human costs of rapid shocks and slow stressors (see IPCC, 2014; UNISDR, 2015), and thus conflicting frameworks are likely to undermine collaboration and integration, resulting in fatalities and economic losses. Therefore, it is necessary to develop some level of mutual understanding about resilience in the DRM/CCA context to enable harmonisation. Moreover, many have argued that piecemeal approaches do not work in a complex and interconnected world (Dryzek, 2012; Becker, 2014) and others have noted that there is a tendency to compartmentalise climate and disaster issues separately (Cutter, Barnes, Berry, Burton, Evans, Tate, & Webb, 2008; UN & WB, 2010; Becker et al., 2013). Therefore, it is no surprise that organisational attempts for a 'all-hazards approach', where all risks from climatic extremes to cybersecurity are under one mandate (Wyman, 2009; OECD, 2012; DHS-FEMA, 2016; Swedish Civil Contingencies Agency, 2016), have been established to avoid conflicting agendas and turf wars. Resilience has been seen as the way to systemise diverse organisations and purposes for harmonised proactive safety and sustainability approaches with focus on both rapid and slow-onset events (IFRC, 2016). Hence, it is important to evaluate the presence, or the lack of, conceptual cohesiveness to enable the development of collaboration strategies, such as those formed by the Inter-agency Standing Committee (IASC) (see IASC, 2015).

## 1.2. The Aim and Goal of the Thesis

While resilience has been discussed widely within the safety and sustainability paradigm, one needs to accept that there is a clear distinction between discussing the concept and implementing it. Much of the discussion on resilience has been done within the academics, but the implementation of resilience on the other hand is done by professional organisations. To improve safety and sustainability through resilience, the concept must not only be defined and operationalised, but also be made measurable so that sets of decisions with expected benefits and costs can be identified (see Anderies, Folke, Walker, & Ostrom, 2013). Furthermore, measurability is needed for monitoring and evaluation (M&E) to account for the benefits and costs during and after the implementation process (ibid.). Thus, it is important research how organisations measure resilience.

In order to support the development of professional collaboration strategies, the aim of this thesis is to contribute to the knowledge on how resilience is operationalised by professional organisations. Important aspects of that aim involve how resilience is defined in practice and how it is measured. Based on these aspects and the current harmonisation-focused discourse on resilience, the overall goal is to determine if conceptual heterogeneity exists among the professional resilience measurement methodologies. For simplicity, measurement methodologies are referred to as MM from this point on. In order to fulfil the research aim and the goal, a multi-faceted research formulation is used.

# 2. The Research Formulation

The aim and the goal of this thesis are answered through research questions. Answering the research questions requires the following phases. Firstly, organisations that use resilience need to be identified. Secondly, the 'grey literature' that constitutes the organisational methodologies must be retrieved. These two steps constitute the scoping phase which concludes who utilises resilience and which material constitutes their methodology. The next phase is content analysis of the identified material. Content analysis, as a method, is used to extract and structure data according

to the conceptual framework-based coding questions. The extracted data is then analysed in relation to the following research questions:

1) Which types of professional organisations have implemented a resilience measurement methodology and for what purposes?
2) Are professional resilience measurement methodologies cohesive in their resilience definitions and operationalisations?
3) How are professional resilience measures designed and used?

A set of objectives are defined to provide a pathway for answering the research questions and fulfilling the research aim and goal:

1) Extract all relevant professional methodological documents in grey literature through a literature scoping process;
2) Establish sectors, levels and purposes present within the identified methodologies;
3) Extract all resilience definitions and operationalisations from the identified material;
4) Extract all conceptual uses of DRM, CCA and complexity;
5) Analyse collaborative potential in relation to the conceptual cohesiveness within the established sectors;
6) Analyse inter-sectoral collaborative potential in relation to the prevalence of disaster risk management, climate change adaptation and complexity frameworks within each established sector;
7) Provide further knowledge about measurement methodologies by determining their data base, measurement type and use of risk assessments.

Completing the first objective provides the research material for answering all the research questions. The second objective determines the answer for the first research question. The objectives three, four, five and six establish the answer for the second research question. The seventh objective provides the answer for the third research question. When it comes to the linkages between research questions, the first research question provides the organisational sectors and other information for answering the second research question. When it comes to fulfilling the

research aim and the goal, the two research questions fulfil the overall research goal. The third research question is required to provide additional contextual information about resilience measurements in order to fulfil the research's overarching aim sufficiently.

# 3. Background Literature

This chapter depicts that there has been both quantitative and qualitative approaches in the literature to analyse resilience with focus on various levels of dimensionality, such as social, economic and ecologic. It is further argued that among all the approaches there is a lack of understanding about the professional application of the concept, as the academic literature seems to solely focus on discussing the work of academics.

A previous scoping of resilience methods (and a prominent basis for this thesis) has been written by Hassel & Johansson (2016). In the article, they scoped academic literature for articles discussing or utilising societal resilience measurement methodologies and then analysed the methodologies through nominal categories. These included, the definition of resilience, the purpose of method, the utilised indicators (pre-defined or context-specific), the hazard application area, the resilience dimension. Furthermore, they categorised measurement modalities, such as the data collection methods (Hassel & Johansson, 2016).

They concluded that indices, predefined and context-specific indicators were the most prominent measurement approaches in academic literature (ibid.). In general terms, index is a quantitative composition of multiple measurements into a single measurement value (Boslaugh, 2012, p. 327), while predefined and context-specific indicators simply refer to universal and situationally determined indicator sets, respectively. Furthermore, Hassel & Johansson (2016) asserted that there is a tendency to layer of resilience indicators so that higher level indicators are derived from lower level indicators. In most of the methodologies, the indicators were pre-defined. Also, a few ability-oriented, dimension-oriented and principle-oriented approaches were identified. The first defines resilience as a function of actions, e.g. 'recovery, absorption and adaptation'. The second suggests domains through which resilience could be perceived, e.g. 'physical, technical, social,

human, individual, economic, environmental, institutional, and organisational'. In short, the rest of the key findings were that academic resilience measurements focused mainly on the background conditions and processes of the observed community, but also measuring resources and abilities were common (Hassel & Johansson, 2016).

Within academics, Cutter, S. L.[3] has been an important advocate of resilience measuring. Cutter's earlier work included the development of the social vulnerability index (SOVI) in Cutter, Boruff, & Shirley (2003), where census data was utilised for the approximation of social fabric derived vulnerability. The indicator variables included racial, socio-economic, physical community characteristics. The measure however showed poor correlation to disaster declaration in the United States of America (ibid.). Cutter S. L. replaced her SOVI with the concept of resilience in her later studies (starting from Cutter et al. (2008)) in order to provide a more holistic perspective, and later provided a MM for analysing community resilience in Cutter et al. (2010). The MM was called the baseline resilience indicators for communities (BRIC). The early version suggests prospective indicators which are then adjusted to and compared to other scientific literature on resilience in her later studies, e.g. Cutter, Ash, & Emrich (2014), Cutter, Ash, & Emrich (2016) and Cutter (2016). The latest version of BRIC appears to be an updated version of the SOVI in the conceptual perspective. Instead of solely focusing on the social factors of a community, which SOVI did, multiple human system dimensions and several environmental risk and resource sustainability factors are now included. The full list of BRIC dimensions includes social, physical (housing/infrastructure), community capital (cohesion and inclusiveness), economic, institutional and environmental dimensions. The benefit of the BRIC framework is its concretely operationalised indicator set which enables comparative differencing for policy purposes. But at the same time, the suggested indicators are specified to the North American context with a focus on the state and county level aggregations (see Cutter et al., 2010). While the indicators can be adapted to new contexts and data sources, the reliance on national level census data is spatially limiting the method's application to counties and higher levels (see ibid.). Census data in many cases cannot be sub-set for low level analyses in a statistically proper manner (Pratesi, 2016). Furthermore, the BRIC provides a very static approach as it depends on national censuses and registers which are updated sparsely (see United Nations Statistics Division, 2001-08-06; Pratesi, 2016).

[3] Based on scopus.com analytics, she has been cited by 4145 articles, out of which 978 were in 2016, her record year. By the date, she has authored 129 articles (Retrieved 2017-08-18).

Another quantitative approach in the North American context is ResilUS which is solely focused on the modelling of seismic hazard damages of physical, economic and health dimensions and their recovery. Here, shocks work as the model inputs, while damage and recovery graphs are produced as the model output (Miles & Chang, 2011).

Qualitative approaches utilise guiding concepts to build nominal categories for resilience measurements. For instance, Folke (2006) provides social-ecological system concepts that enable evaluating both the ecologic and human system states and the interaction between the two. Kulig, Edge, & Joyce (2008) argue for the importance of qualitatively measuring social cohesion in communities as the main proxy for resilience. Jones & Tanner (2017) argue that the quantitative 'objective' measurements have validity issues, when it comes to resilience, due to their reliance on resource heavy survey data collections. The idea here is that in most cases there are not enough data to make quantitative measurements useful and therefore they do not constitute a better option over qualitative measurements. They promote complementing survey approaches with a 'subjective' human understanding of resilience. They continue by demonstrating that 'subjective' knowledge portrays social, cultural and psychological elements, such as norms, social cohesion, power, marginalisation, identity and risk perceptions, which are important for resilience-building. They further argue that subjective resilience can provide an easy and cost-efficient option for M&E (Jones & Tanner, 2017). Overall, articles that examine qualitative resilience measurements do not provide a complete framework for measurement itself, instead these articles mainly focus on discussing the theoretical foundation of resilience.

The academic literature seems to mainly focus on the theoretical foundation of resilience and the technical aspects around resilience indicators. The focus is entirely on how resilience is measured. Professional questions regarding collaboration, such as who measures resilience (actors) and for what purposes, seem to be ignored.

# 4. Conceptual Framework

This chapter presents the conceptual framework, which is used as the basis for content analysis and its coding. While the conceptual framework provides the 'thematic lenses' for data extraction and data classification, the coding provides a systemic framework which determines what data is extracted for analysis (Hermann, 2008; Bryman, 2012). In other words, the conceptual framework and coding together enable extracting the document sections which are relevant for answering the research questions. Hence, the purpose of this chapter is to provide the relevant conceptual definitions and backgrounds in order to enable the extraction of data and its classification. The coding takes the form of questions which are derived based on the conceptual framework. 'Answers' to these questions are then extracted as data.

The coded data itself is classified inductively and deductively depending on the data. The stated organisational purposes and sectors are derived inductively to answer the first research question. On the other hand, existing conceptual literature about resilience, DRM, CCA and complexity are used deductively in relation to the data to provide answers for the second research question. When it comes to the third research question, data collection types are determined inductively, while the use of measurement types and the presence of risk assessments are determined deductively. Inductive reasoning here refers to creating generalisation from the material (Bryman, 2012). Deductive reasoning here refers to comparing presented premises in the resilience MMs' conceptual frameworks to the conceptual framework of this thesis for interpretations. Ultimately, the purpose of deductive reasoning is also to provide generalisations about the use of resilience definitions, operationalisations and measurements. For instance, the existence of DRM, CCA and complexity within the conceptual framework of a resilience MM is determined by comparing the MM's framework to the conceptual framework of this thesis. If the MM uses, for example, concepts that are traceable to DRM functions defined by the thesis' conceptual framework, the MM is concluded to include a DRM framework.

This chapter has been arranged into sub-chapters according to the used concepts. All of the concepts have a dedicated coding question associated to them. These coding questions are

presented at the start of each sub-chapter and they are further presented in the methodology chapter. The concepts have been ordered from the most comprehensive to the most specific.

## 4.1. Foucault's Discourse

Foucault's discourse is a deductive tool which enables interpreting resilience operationalisations within each identified sector for conceptual cohesiveness. It is used to interpret data from the coding question; what concepts are used to define and operationalise resilience. The interpretations are subsequently used to answer the second research question. While content analysis is used to extract the resilience operationalisations, Foucault's discourse provides a linguistic-focused framework for finding and categorising the extracted data for common 'themes' (see McHoul & Grace, 1993). Overall, the operationalised resilience measurement indicators are evaluated for the existence of, or the lack of, common themes regarding resilience outcome goals and commonly used concepts within each sector. The existence of shared goals and concepts functions as a proxy for intra-sectoral cohesiveness.

When it comes to the conceptual foundation of Foucault's discourse, the concept is related to the systems of knowledge embodied in sciences. The components of discourses are as follows:

> *"[o]bjects (the things they study or produce), operations (the methods and techniques or 'ways of treating' these objects), concepts [and operationalisations] (terms and ideas which area routinely found in the discipline and which may constitute its unique language) and theoretical options (those different assumptions, theories and perhaps even hypotheses available within the discipline, and which might oblige physicists, say, to 'decide' between relativity theory and quantum mechanics)" (McHoul & Grace, 1993, p.44).*

The components of discourse can be used in the analysis of different meanings given to one respective concept. In general, organisations ought to be seen as subjectives that utilise existing discourses and contribute to the construction of discourses' components. Ontologically, as a poststructural theorist, Foucault takes a postmodern view on the subjective, which in the case of

organisations enables analysis of their internal belief structures, which in turn can be deriving from contextually constituted presentations through language (Woodward, 1997; Popke, 2003; see also Foucault, 1974). The central idea is that language itself is not neutral. When subjectives borrow existing categories, such as 'He' or 'She' and 'White' or 'Coloured', subjectives become linked to discourses and are hence susceptible to framing the world through discursive systems of knowledge (McHoul & Grace, 1993; Woodward, 1997; Parekh, 2008).

## 4.2. Measuring

The concept of measuring is used to evaluate the methodological choices of MMs. The associated coding question is: how is resilience measured. The extracted data is used to answer the third research question, which focuses on measurement designs and uses. Overall, measuring can be qualitative or quantitative. Stevens' nominal, ordinal, interval and ratio scales provide a structure for labelling and ranking data qualitatively in addition to differencing data quantitatively (Stevens, 1946). Nominal measuring uses qualitative categories without any indication of rank between them. Ordinal measuring on the other hand enables stating an order between the categories, but does not enable measuring the distance between them. Interval measuring provides a difference between the values of two reference points. Ratio scale denominates differences with ratios of the two reference points, for instance in percentages (Stevens, 1946).

Measuring social constructs comes with different ontological assumptions than measuring the physical world. Physical measurements are representative of a physical object or phenomenon. In a sense, the derived measurement corresponds to the physical nature of the phenomenon (Hand, 2016). On the other hand, pragmatic measurements are used to describe social constructs, such as utility, well-being and mood. Pragmatic measurements can embody multiple definitions and they are measured through proxies, as their physical measurement is impossible (Hand, 2016). Socially constructed phenomena include a definition, i.e. the description how the construct relates to the physical world or other constructs, and an operationalisation, i.e. the description how the construct can be measured (Bryman, 2012, p. 161-165). Hence, if a MM does not provide a clear description of how it measures resilience, operationalisations can be used to infer the type of used measurement. Stevens' scales are then used to categorise the MMs' measuring designs.

## 4.3. Risk Assessment

The content analysis extracts information regarding the use of risk assessments within resilience MMs in order to answer the third research question. The respective coding question is: what risk concepts are assessed. Although multiple definitions of risk across the academic field exist, here risk will be understood as a potential hazard or a scenario with its underlying basic metrics, likelihood (frequency) and consequence (Rausand, 2011). A risk assessment is the process of answering questions about risk to determine potential events and their respective likelihood and consequences based on historic or modelled data. Defining an event is dependent on the knowledge of potential phenomena and on the ability to measure or model its negative effects, such as the loss of assets and value, health or fatalities (ibid.). Depending on the chosen well-being reference point, metrics such as localised individual risk, annual individual risk, reduction in life expectancy, fatal accident rates and expected societal risks as fatalities can be derived and then further analysed based on risk thresholds (ibid.). Derived risk metrics and risk-related information are then used to support project planning or other decision-making (United Nations World Food Programme, 2012). If some risks are categorised as un-tolerable, management plans for risk prevention or mitigation are often done to decrease the probability or the potential consequences of the high-risk events (Rausand, 2011).

A generic risk assessment should at least include the following assessment and analysis processes: 1) defining objectives, 2) detailing a system model, 3) identifying hazards and risk scenarios, 4) deriving risk metrics, 5) visualising risk, 6) evaluating the scenarios based on safety regulations or other criteria and 7) clarifying data uncertainty and measurement quality (Rausand, 2011; Tehler, 2015).

## 4.4. Disaster Risk Management and Climate Change Adaptation

The concepts of disaster risk management (DRM) and climate change adaptation (CCA) are used to answer the second research question. The presence of cross-sectoral cohesion is proxied through the prevalence of DRM and CCA frameworks within the identified sectors. The used coding

questions for DRM and CCA are as follows. Are the disaster risk management functions of disaster prevention, mitigation, preparedness, response and recovery present in resilience framework? Is climate change adaptation present in the resilience framework?

DRM is an umbrella term for concepts and functions concerning management of societal risks. DRM combines proactive disaster risk reduction approaches, i.e. prevention, mitigation and preparedness, and reactive disaster management approaches, i.e. response and recovery (Becker, 2014; Wamsler, 2014; see also UNISDR, 2009; UNISDR, 2015;). Overall, prevention is about targeting the hazard itself by reducing its likelihood, while mitigation is targeting vulnerabilities and subsequently reducing event consequences. Preparedness concerned with developing capacities for disaster response and recovery, which in turn respectively focus on limiting the impacts of disasters and then reconciliating from these impacts (Becker, 2014). Prevention, mitigation and preparedness are all involved with both structural and non-structural methods (Becker, 2014; Wamsler, 2014). UNISDR and many studies suggest that there should be a focus on proactive measures over reactive measures in order to achieve optimal safety and sustainability (Becker, 2014; Fekete et al., 2014; UNISDR, 2015).

CCA is focused on long-term stressors and related extreme events rising from changes in environmental systems (Kelman & Gaillard, 2010). The effects of climate change according to the IPCC (2014, p. 7) include: *"a decrease in cold temperature extremes, an increase in warm temperature extremes, an increase in extreme high sea levels and an increase in the number of heavy precipitation events in a number of regions"*. Furthermore, global average precipitation patterns and variations are expected to change. The overall impacts include increased floods, coastal erosion and storm surges but also changes in agricultural yields (IPCC, 2014, p. 14. Adaptation itself concerned with understanding local impacts of climate change and thereafter managing these impacts (IPCC, 2014).

DRM and CCA overlap in many aspects and are therefore they might be difficult to separate. Both are conceptually involved in mitigating climatic extreme events (UN & WB, 2010). Additionally, both are concerned with similar governance levels, e.g. local, national, and global levels, and both make temporal distinctions to strategies over decades, years, and months (cf. Smit & Wandel, 2006; IPCC, 2014, p. 19 with Few, Scott, Wooster, Tarazona, & Flores, 2015; UNISDR, 2015). On the other hand,

Cutter et al. (2008) makes a distinction between DRM and wider adaptation by stating that the first focuses on individual stressors and the latter on more dynamic cross-scale phenomenon.

For the purposes of coding and analysis, the following distinction is made between DRM and CCA. When a MM mentions adaptation to climate change or climatic extremes without a reference to risks and the defined DRM function, the MM is classified to consider only CCA. If adaptation to climate change or climatic extremes is mentioned in addition to discussing risk and any of the defined DRM functions, the MM is classified to include both conceptual frameworks. If a MM mentions risk and any of the defined DRM functions without mentioning adaptation, the MM is classified to include only DRM. If a MM mentions adaptation to climate change and climatic extremes, but discusses only the extreme events or their secondary events in reference to risks and the defined DRM functions, the MM is classified to include only DRM. In other cases, no presence of CCA nor DRM is classified. The presence of DRM and CCA must be within the MMs conceptual framework or within its operationalised indicators to count towards the classification.

## 4.5. Complexity and Complex Systems

Similarly to DRM and CCA, the presence of cross-sectoral cohesion is also proxied through the prevalence of complexity frameworks within the identified sectors. While the DRM and CCA constitute the primary analysis of cohesiveness, the prevalence of complexity within sectors is used as a supplementary cross-sectoral analysis. The used coding questions for complexity is as follows. Is complexity present in the resilience framework?

To account for 'black swan'[4] events and to understand 'unpredictable' dynamic systems, there has been support for holism and its underlying complexity theorem as an analytical perspective (see Holling, 2001; Rockström et al., 2009; Walker & Cooper, 2011). The basic notion of complexity argues against universal application of the Newtonian reductionist view of the world (Heylighen, Cilliers, & Gershenshon, 2006). Complexity theorists argue that natural and social systems, such as

[4] Defined as "an event or occurrence that deviates beyond what is normally expected of a situation and that would be extremely difficult to predict" (Financial Times Lexicon, n.d.).

consciousness, immune system, economy, ecosystem and society cannot be understood by studying their individual components due to 'emergence' of irreducible functions (ibid.; Mitchell, 2009; Walker & Cooper, 2011). The consequence is that complex systems cannot be fully framed nor modelled as they are stochastic (Bergström & Dekker, 2014). The core concepts of complexity include but are not limited to:

*Dynamical system and looping:* These systems have a tendency to be temporarily and spatially nonstationary with or without a tendency to exhibit randomness in system variables. Dynamical system outputs can have 'looping' effects on the inputs of the same system and thus introduce unexpected changes on further temporal system iterations (Gros, 2015; Fieguth, 2017).

*Non-linearity/holism*: Non-linearity states that the emergence of properties cannot be explained by summation, but only with non-linear mathematics, such as differential equations in order to depict potential system behaviour across temporal iterations. (Holland, 2014; Fieguth, 2017). Systems with non-linear interactions are irreversible as the process through which exogenous variables impact endogenous variables might be discontinuous (Fieguth, 2017).

*System of systems/ panarchy:* Complex systems are fundamentally non-isolated due to their vertical connections to higher level complex systems (Folke, 2006). For instance, in social-ecological systems, an individual local level component can influence global level phenomena, which in turn has impacts on local level processes elsewhere (Bergström & Dekker, 2014).

*Self*-organisation: Complex adaptive systems have the tendency to exhibit diffusion and convergence as a reaction to the diffuse state, all of which result in non-deterministic opportunity to multiple open outcomes (Holling, 2001).

*Emergence:* A macro-system state cannot be used to predict a micro-system state or vice versa (Holland, 2014).

The presence of complexity within resilience MMs is tracked through the use of complexity concepts. A resilience MM is classified to include complexity if the MM discusses resilience in relation to dynamical systems, looping, non-linearity, system of systems/panarchy, self-organisation or emergence.

## 4.6. Resilience Definitions

The academic definitions of resilience are used to support the content analysis of resilience definitions in the scoped material. As was established in the introduction chapter, resilience is understood to be a multi-faceted concept. Therefore, it is important to derive a simplified framework, which provides the potential for establishing trends regarding the use different definitions. When it comes to coding questions, resilience relates to the research question; what concepts are used to define and operationalise resilience. It should be noted that the academic definitions are used to evaluate the utilisation of different resilience definitions in the scoped material, while Foucault's discourse is utilised in the content analysis of resilience operationalisations.

Resilience is fundamentally a contested concept. Multiple definitions can be found: 1) *"a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables"* (Holling, 1973, p.14); 2) *"the capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks"* (Walker, Holling, Carpenter, & Kinzig, 2004, p. 2); 3) *"ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change"* (Adger, 2000, p. 347); 4) *"the capacity to adapt existing resources and skills to new situations and operating conditions"* (Comfort, 1999, p. 21); 5) *"The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including*

*through the preservation and restoration of its essential basic structures and functions."* (UNISDR, 2009, p. 24). According to Jones & Tanner (2017) the focus on different system and different shocks explains the variation of resilience definitions. Hence, it is important to discuss resilience definitions in relation to their underlying conceptual frameworks.

One of the major resilience approaches is the social-ecological systems (SES) theorem. The SES is an umbrella term for conceptual frameworks, which build on the ecologic theorisation of resilience and which have moved to establish an integrated approach between human and ecologic resilience (see Biggs et al., 2015). The traditional ecologic view, relates resilience to a system equilibrium. Here, resilience is seen as the capacity to absorb shock, which directs the system towards disequilibrium, or as the capacity to recover back to the equilibrium from a disequilibrium state (Holling, 1973; Walker et al, 2004).

Later studies argue for the existence of multiple equilibria and derive adaptive and transformative capacities as additional conceptualisations of resilience. For Walker et al. (2004), adaptation is a cognitive process taken by individuals to change the SES structure in order to reach a new equilibrium with better development outcomes. In more practical terms, Smit & Wandel (2006) note that adaptation can be operationalised as the capacities to anticipate, plan for, prevent and mitigate shocks. Similarly, Bankes (2002) argues that adaptation is fundamentally a strategy, which focuses on learning and developing forward-looking planning scenarios.

Transformative capacity is very similar in functional terms to the adaptive capacity, but is used to describe changes in a longer time-span when compared to adaptation (Walker et al., 2004). While adaptive capacity is focused on more immediate and singular events, transformative capacity is fundamentally about altering whole system sectors, e.g. economic, environmental and social sectors. Hence, the focus is not only moving to a better equilibrium, but redefining which equilibria are achievable for the SES (Holling & Sanderson, 1996; Walker et al., 2004).

In addition to the single equilibrium and multiple equilibria approaches. A complex adaptive systems perspective also exists. Folke (2006) defines resilience as a property of an unbounded multi-scale system which he calls panarchy. Due to the unbounded system, no equilibria exist and therefore the system is in constant change. While the ontological assumptions about the system dynamics differ

between the equilibria-focused and the complex adaptive systems approaches, the two share a very similar approach on resilience (see Folke, 2006). Both define resilience in relation to the systems' adaptive and transformative capacity. Moreover, Folke (2006) uses practically the same definitions for adaptive and transformative capacities as the previously presented multi-equilibria literature. To conclude, absorptation, adaptation, transformation and recovery are well established and used definitions of resilience and therefore they provide a well-formed framework for the content analysis. Next, it will be shown how some other resilience definitions can be fundamentally be recoded into these definitions.

Coping is a concept that is used to describe positive or negative changes within human systems which subsequently impact the human systems' use of resources from the connected ecologic systems. Coping especially impacts the human systems' ability to gather or grow food from the resources of the ecologic systems (see Davies, 1993; Berman, Quinn, & Paavola, 2012). Coping is defined as a short-term phenomenon caused by acute and chronic stressors (Pelling, 2011). Studies have shown that social institutions (Berman et al., 2012), access to nutritional resources (Davies, 1993) and DRM capacities (Lemos & Tompkins, 2008) determine if coping has negative or positive consequences in the long term. Hence, coping is depicted as a mixture of short-term oriented absorption and long-term oriented adaptation. For clarity, the content analysis classifies coping as absorptive or adaptive capacity depending on the temporal approach taken by the analysed resilience MM. For instance, 'negative' coping, e.g. selling productive assets for food, which entails an increase in vulnerability, can be classified as adaptation when the stated purpose of resilience is to reverse negative coping into positive one, as this can be seen as a long-term process (see Smit & Wandel, 2006; Amendah, Buigut, & Mohamed, 2014).

Technology-focused approaches to resilience relate it to robustness. Anderies et al. (2013) define robustness as the stability or the non-sensitivity of system outputs. They suggest that robustness could be seen as the 'safe-fail' property where actionable plans can be implemented to prevent or decrease the system down-time (Anderies et al., 2013). Robustness is fundamentally similar to absorption with its objectives, which in sense target returning to the operational system equilibrium. Some would argue that robustness is closer to recovery than absorption, as the purpose is to return to the optimal equilibrium after an event. However, the time-scale of robustness is

focused on the immediate response to an event and hence it is better to categorise robustness as an absorptive capacity (see Bankes, 2010).

Some approaches seem to pass the ontological discussions about system equilibria and complex adaptive systems by focusing on resilience as a set of functions or capacities, which provide a straightforward operationalisation for application and analysis. For Becker (2014), anticipation, recognition and learning together with proactive and reactive DRM constitute the pathway to building resilience (Becker, 2014). He however notes that the DRM functions perform an adaptive purpose for a system (ibid.). Hence, defining resilience through a multitude of disaster risk management functions can also be categorised as adaptation.

Overall, the capacities of absorption, adaption, transformation and recovery can be used to categorise resilience definitions in order to make them comparable. As it was established, coping, robustness and disaster risk management definitions of resilience can be recoded into absorption, adaptation, transformation and recovery.

# 5. Methodology

## 5.1. Scoping Method for Grey Literature

The purpose of scoping is to retrieve a broad base of research material without introducing biasness in the process of material identification (Transfield, Denyer, & Smart, 2003; Denyer, Transfield, & van Aken, 2008). Overall, scoping is a systemic method for establishing a reproducible and transparent evidence-base for analysis (ibid.). No exact consensus of the method exists, but in general a mixed process is used in which a divergent phase, i.e. material inclusion, is followed by convergent ones, i.e. material exclusion (cf. Levac, 2010; Bryman, 2012; Shankardass, Solar, Murphy, Greaves, & O'Campo, 2012). One method suggests a four-fold process. It is initiated by a search for literature followed by three convergent steps. The search is set to establish a wide spectrum, or the maximum range, of articles based on pre-defined search terms. Next, the spectrum is shortlisted by

specific criteria to only include relevant literature for the study. Finally, the scoped material is used to answer research questions (Shankardass et al., 2012).

Based on these phases, this thesis adapted a five-step process of its own. First, an initial divergent search was done to identify the maximum range of grey literature. Due to the availability of search operations and advanced search options, Google Search was used as the main scoping tool. A pre-defined list of search queries was utilised to include a wide range of sectors. All combinations of the presented search term options were utilised to sub-set the massive amount of Google Search results. A search was always composed of synonymous resilience terms, synonymous measurement terms, a level of measurement or a sector of measurement (see figure 4). It was not possible to combine level and sector in a single search as the maximum limit of search terms was then surpassed. Furthermore, through Google Search operations, the results were limited to pdf files to exclude news articles. The search results, including document title and web domain, were then copied to Excel for further scoping steps. For each query, only 100 top results were included due to resource and time limitations.

Next, duplications were removed and all pdf documents were skimmed against inclusion criteria. The inclusion criteria were as follows: 1) resilience had to be mentioned in the title; 2) article had to specifically name its MM as a resilience measurement/assessment/analysis/monitoring or equivalent (see figure 4 for full list) and state measurement indicators for resilience; 3) the document had to be from a professional organisation, i.e. academic articles, theses and non-published academy-related papers hosted by academic associations and sites such as Researchgate were all excluded. Based on these criteria, for example, project and white papers without a measurement framework, vulnerability analyses and purely academic documents were excluded. If a document fulfilled the inclusion conditions, the authoring organisations were subjected for a further search to identify additional supporting documents and reported applications of the resilience MM. More specifically, a search limited to the respective organisation's domain was done with the Google Search operation 'site:*URL*' to reveal if additional relevant documents were available from the organisation. This was done to record all potential reports which relate to the identified methodology. The complete scoping process is depicted in the process model (see figure 5).

It was important to use a multi-faceted search process with a complicated set of search terms. Google Search utilises a proprietary 'ranking' algorithm, which changes the order of search results according the website quality, an arbitrary and undefined measure (Google, n.d.). Simply searching for 'resilience measurement' would be highly affected by this algorithm. A search for pdf documents with 'resilience measurement' provides 19 800 000 results, all of which cannot be scoped due to resource and time limitations. Therefore, it was important to sub-set the results in order to establish meaningful scoping results and to negate the effects of the Google ranking algorithm. The sub-setting was done by utilising 65 searches, each with different search query (see figure 4).

Overall, to focus on resilience within professional organisations, several specific scoping limitations were used:

1) Individual (and personal) level resilience was omitted in order to focus on organisations;
2) Purely psychology-related documents were omitted due to the first limitation;
3) Academic articles, academic theses and documents from academic repositories were dropped in order to focus on professional organisations;
4) Only methodologies naming themselves resilience measurements, or those using synonymous meaning (see figure 4), were included in the scoping process;
5) No limitations regarding the type of organisation were used;
6) Due to time and resource limitations, only 100 top results were included for document skimming from each search.

After the initial scoping phase and the removal of duplicates, exactly 1500 results were obtained by using 65 different search term combinations. After applying material limitations, the final scoping result was 55 methodologies from 52 organisations. The scoped material was then subjected to content analysis to retrieve critical information relevant to answering the research questions.

## 5.2. Content analysis

According to Hermann (2008), concept-based content analysis utilises 'lenses' or conceptual categories to withdraw data in accordance with the defined concepts and discourses. As Bryman puts it, content analysis is a flexible and interpretive method (Bryman, 2012). Content analysis was utilised to extract data from the scoped documents in order to answer the research questions. Open-ended coding was used to find text passages relevant for the research questions. Passages that 'answered' to the coding questions were extracted to Excel for further analysis. The coding questions were as follows:

1) What is the stated purpose of the resilience measurement methodology?
2) What are the sectors and levels to which resilience is divided into?
3) What concepts are used to define and operationalise resilience?
4) Are the disaster risk management functions of disaster prevention, mitigation, preparedness, response and recovery present in the resilience framework?
5) Is climate change adaptation present in the resilience framework?
6) Is complexity present in the resilience framework?
7) What risk concepts are assessed?
8) What data collection methods are utilised?
9) How is resilience measured?

The relevant text sections answering to the coding questions were extracted and classified in Excel. Classified data were then transferred to Statistical Package for Social Sciences (version 24) for data tabulation. In some cases, pictures, figures and graphs or sets of indicators were used for the classification. In these cases, only the classification was extracted, as saving the interpreted material was impossible.




*Figure 4. The Google Search terms that were used for the material scoping process. The complete search included all combinations of the presented 'boxes'. Only one term 3 or 4 was included simultaneously due to the maximum search term limitation (Miettinen, 2017).*

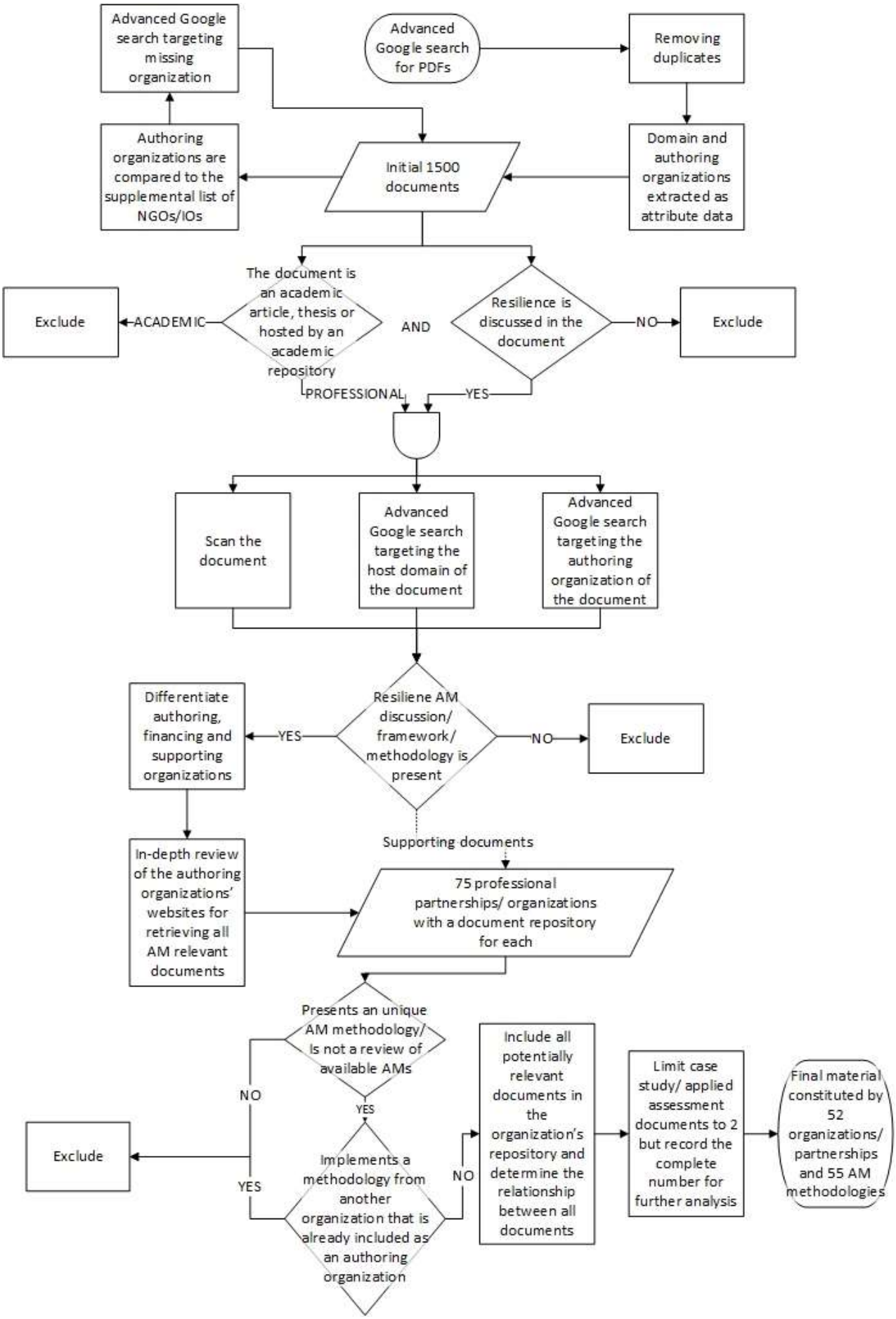


*Figure 5. A process model of the scoping process (Miettinen, 2017).*

# 6. Results

## 6.1. Which Types of Professional Organisations Have Implemented a Resilience Measurement Methodology and for What Purposes?

This section presents the stated organisational purposes, types and basic publishing information about the resilience MMs. Resilience measurements are fundamentally used as strategic tools for decision-making. The majority of the scoped methodologies stated the purpose of the MM as programming, i.e. strategy development for the assessed environment, with or without reference to program/project monitoring (M&E) (see table 1). The programmatic measurement purpose is fundamentally oriented towards axiomatic rational decision-making, where a multitude of indicators are used to prioritise potential decisions paths based on their expected (beneficial) consequences (see Basili, 2006; Grüne-Yanoff, Marchionni, & Moscati, 2014). This can be confirmed by evaluating the operationalised resilience indicators, which are analysed in the chapter 6.2. (see also Annex 2). While 'soft' elements, such as culture, governance, rights and equality, are included in the indicators, these are essentially constituted as factors needing optimisation or as components through which optimisation outcomes are measured. Societal equality and human rights are fundamentally value-based objectives, but they are subjected as system properties and as such constitute axioms for measurement.

**The purpose of the MM**

| | | Frequency | Percent |
|---|---|---|---|
| Valid | Unclear | 1 | 1.8 |
| | Intervention/Programming/Situational awareness | 26 | 47.3 |
| | M&E | 4 | 7.3 |
| | Programming + M&E | 10 | 18.2 |
| | Proof of concept | 12 | 21.8 |
| | Other | 2 | 3.6 |
| | Total | 55 | 100.0 |

*Table 1. The stated purpose for utilising or developing a resilience measurement methodology (Miettinen, 2017).*

Many factors indicate that the majority of the organisations with a resilience MM are still testing the implementation of resilience outside their core functions to determine its usefulness. Firstly, based on the scoping, all MMs seem to be applied to unique systems without any consecutive re-assessments.[5] Secondly, there is a relatively high number of MMs (21.8%) with 'proof of concept' as their stated purpose (see table 1). Thirdly, the high majority (76.4%) of the MMs merely provided a pilot study-based methodology or a guidance manual (see table 2). Fourthly, there is an increasing trend in the number developed resilience MMs (see table 3), which means that there are more pilot studies being done. The argument, that resilience is currently being tested by organisations, is also supported by literature. For instance, Fekete et al. (2013) notes that resilience is seen to be a complicated concept to measure. Furthermore, professional issues regarding the operationalisation of resilience are discussed in the World Disasters Report 2016 by the IFRC, who conclude that resilience carries conceptual 'baggage', or assumptions, which application in the humanitarian context is seen problematic (IFRC, 2016).

**The number of published reports per methodology**

| | | Frequency | Percent |
|---|---|---|---|
| Valid | Unclear | 1 | 1.8 |
| | Pilot/Guidance manual | 42 | 76.4 |
| | 2 | 5 | 9.1 |
| | 3 | 3 | 5.5 |
| | 5 | 1 | 1.8 |
| | 6 | 1 | 1.8 |
| | 10 | 1 | 1.8 |
| | 98 | 1 | 1.8 |
| | Total | 55 | 100.0 |

*Table 2. The number of published reports per methodology (Miettinen, 2017). Methodological documents have been included as one publications.*

**The decade published**

| | | Frequency | Percent |
|---|---|---|---|
| Valid | 2000s | 6 | 10.9 |
| | 2010-2014 | 28 | 50.9 |
| | 2015- | 20 | 36.4 |
| | Total | 54 | 98.2 |
| Missing | System | 1 | 1.8 |
| Total | | 55 | 100.0 |

*Table 3. The number of published professional resilience measurement methodologies in relation to temporal periods (Miettinen, 2017). Suggests an increasing trend for the number of publications.*

Another alternative is that subsequent reports are confidential and hence are not publicly available. For instance, in the case of critical infrastructure, MM report documents are likely to be kept inside the organisation for purely internal decision-making, as public access to the information could constitute a security risk.

[5] This is based on the assumption that the scoping process did not miss any relevant documents.

Resilience MMs are used by a variety of actors which were classified into six sectors. Many authoring organisations stated their sector clearly, but in some cases the sector had to be interpreted based on the MM's outcome/development reference point or the measured system. Furthermore, in addition to the sectoral data, the type of the authoring organisation or the publishing partnership was extracted. The derived sectors were development/humanitarian (DH) (43.6%), safety/disaster risk management (SDRM) (21.8%), critical infrastructure/utilities (CI) (14.5%), social welfare (7.3%), economic (7.3%) and environmental (5.5%) (see table 4). The DH mainly focus on food security, development related to Sustainable Development Goals (SDGs) or general well-being for 'the most vulnerable' (see Annex 2). The SDRM related resilience to DRM functions. The CI focused mainly on the properties of an individual system, technical or socio-technical. The social welfare sector related resilience merely to social characteristics of a community. The economic sector construed resilience in relation to economic well-being on national or sub-national level. The environmental sector focused on purely ecological resilience or in one case on socio-ecological resilience.

**The sector of the actor/partnership**

| | | Frequency | Percent |
|---|---|---|---|
| Valid | Development/Humanitarian | 24 | 43.6 |
| | Safety/DRM | 12 | 21.8 |
| | Critical infrastructure/Utilities | 8 | 14.5 |
| | Social welfare | 4 | 7.3 |
| | Economic | 4 | 7.3 |
| | Environmental | 3 | 5.5 |
| | Total | 55 | 100.0 |

*Table 4. The identified organisational sectors and their frequencies (Miettinen, 2017).*

Considering the sector-actor type dichotomy, the most numerous group was DH NGOs/IOs[6] with the frequency of 17 and 30.9% prevalence (see table 5). The second most numerous was CI state bureaucracies with the frequency of 5 and 9.1% prevalence. The third position was divided between DH independent research organisations and SDRM state bureaucracies, both with the frequency of 4 and 7.3% prevalence. Moreover, it is very interesting that research organisations are contributing to

[6] NGO stands for a non-governmental organisation and IO stands for an international organisation.

**The type of actor/partnership * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The type of actor/partnership | Research | Count | 4 | 0 | 0 | 1 | 0 | 1 | 6 |
| | | % within The sector of the actor/partnership | 16.7% | 0.0% | 0.0% | 25.0% | 0.0% | 33.3% | 10.9% |
| | NGO/IO | Count | 17 | 3 | 2 | 1 | 1 | 0 | 24 |
| | | % within The sector of the actor/partnership | 70.8% | 25.0% | 25.0% | 25.0% | 25.0% | 0.0% | 43.6% |
| | State | Count | 0 | 4 | 5 | 0 | 0 | 0 | 9 |
| | | % within The sector of the actor/partnership | 0.0% | 33.3% | 62.5% | 0.0% | 0.0% | 0.0% | 16.4% |
| | Consultancy/corporate | Count | 1 | 2 | 0 | 0 | 3 | 0 | 6 |
| | | % within The sector of the actor/partnership | 4.2% | 16.7% | 0.0% | 0.0% | 75.0% | 0.0% | 10.9% |
| | Research-Professional Partnership | Count | 2 | 2 | 1 | 2 | 0 | 0 | 7 |
| | | % within The sector of the actor/partnership | 8.3% | 16.7% | 12.5% | 50.0% | 0.0% | 0.0% | 12.7% |
| | Multi-type Partnership | Count | 0 | 1 | 0 | 0 | 0 | 2 | 3 |
| | | % within The sector of the actor/partnership | 0.0% | 8.3% | 0.0% | 0.0% | 0.0% | 66.7% | 5.5% |
| Total | | Count | 24 | 12 | 8 | 4 | 4 | 3 | 55 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 5. The crosstabulation of sectors and types of organisations (Miettinen, 2017).*

professional resilience MMs through active partnering or independent publishing outside academic journals. Research organisations, research-professional partnerships and multi-type partnerships constituted 29.1% of the MM developers.

As the final observation, resilience MMs are fundamentally used in every income context. Table 6 shows MM target countries for each observation. The classification is based on World Bank Data income classes, which denote countries to low-income, middle-income and high-income groups. The classification was done based on completed MMs, cases presented in the MMs and regions mentioned in the text, but in the case of pure methodological documents the target region was derived from the pictures depicted in the respective methodological document.

**The targeted region**

| | | Frequency | Percent |
|---|---|---|---|
| Valid | LIC | 10 | 18.2 |
| | MIC | 4 | 7.3 |
| | HIC | 19 | 34.5 |
| | LIC-MIC | 9 | 16.4 |
| | MIC-HIC | 2 | 3.6 |
| | Any/Not specified | 11 | 20.0 |
| | Total | 55 | 100.0 |

*Table 6. The targeted economic areas by their income group (Miettinen, 2017). Low income (LIC), middle income (MIC) and high income (HIC) country categories were utilised.*

To answer the first research question, resilience MMs are utilised on the strategic level mainly for programmatic and M&E purposes. When it comes to the organisations authoring resilience MMs, they are diverse, but from clearly recognisable sectors. The most prominent authors of resilience MMs were DH NGOs/IOs (30.9%), CI state

bureaucracies (9.1%), DH research institutes (7.3%) and SDRM state bureaucracies (7.3%). Resilience MMs seem largely to remain in 'a pilot phase', but this is likely to change due to increasing trend in the development of professional resilience MMs.

## 6.2. Are Professional Resilience Measurement Methodologies Cohesive in Their Resilience Definitions and Operationalisations?

Within the 6.2 sub-chapter, the first sub-section (6.2.1) focuses on evaluating definitions and operationalisations of resilience of the scoped MMs. The next sub-section (6.2.2) assesses conceptual cohesion and collaborative potential across sectors.

### 6.2.1. Resilience Definitions and Operationalisations

Based on the fact that resilience MMs span a multitude of sectors and types of organisations, their collaboration is best analysed through the concept of *harmony of efforts*. According to Brehmer (2011), harmony of efforts is a collaborative relationship between organisations with varying goals and expertise. Harmony is considered the best approach against complex issues, where multiple needs exist simultaneously and where multiple organisations operate to fulfil these needs. Without a central authority, it is up to thr individual organisations to voluntarily agree for collaboration to achieve holism and optimal cumulation of limited resources. Cooperation is agreed upon through negotiations, where general sense-making is followed by practical planning of roles and responsibilities (Brehmer, 2011). As a social process, sense-making is fundamentally dependent on a common discursive perspective which is utilised to depict the operational environment for collaborative purposes. In other words, for collaboration to succeed in inter-organisational endeavours, these organisations need to borrow concepts, for instance from the Inter-agency Standing Committee (IASC), or negotiate a conceptual framework for collaborative objectives and processes. Thus, to analyse cohesion, resilience defitions and operationalisations need to be analysed in relation to their compatability.

Based on the content analysis, resilience is mainly defined through the capacity to absorb and the capacity to adapt (see tables 7a-d; see also Annex 1 table 1; Annex 1 table 2). It is very important to note that the four capacities are not mutually exclusive, meaning that a resilience MM can include any number of them. Absorptive capacity seems to be fundamental to resilience, as it is included by 87.8% of the resilience MMs (table 7a). Adaptive capacity is also highly regarded with the prevalence of 61. 2% (table 7b), expect for the economic and environmental sectors, which largely ignore it (see Annex 1 table 2). However, transformative capacity is largely ignored, with 81.6% prominence (table 7c), aside from eight MMs from the DH sector (in-sector prevalence of 38.1%) and one MM from the SDRM sector (in-sector prevalence of 8.3%) (table 8). When it comes to the capacity to recover, mainly critical infrastructure MMs include this in their definition (see Annex 1 table 3). Recovery gains interest from all the sectors with the overall prevalence of 49.0% (table 7d). The social welfare sector completely omits it (Annex 1 table 3). Six MMs (10.9 %) failed to provide a clear definition for resilience and overall only two methodologies across all the scoped MMs shared the same definition; both of which were from the same organisation.

**The capacity to absorb in the resilience definitions**

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | No | 6 | 10.9 | 12.2 |
| | Yes | 43 | 78.2 | 87.8 |
| | Total | 49 | 89.1 | 100.0 |
| Missing | System | 6 | 10.9 | |
| Total | | 55 | 100.0 | |

**The capacity to adapt in the resilience definitions**

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | No | 19 | 34.5 | 38.8 |
| | Yes | 30 | 54.5 | 61.2 |
| | Total | 49 | 89.1 | 100.0 |
| Missing | System | 6 | 10.9 | |
| Total | | 55 | 100.0 | |

**The capacity to transform in the resilience definitions**

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | No | 40 | 72.7 | 81.6 |
| | Yes | 9 | 16.4 | 18.4 |
| | Total | 49 | 89.1 | 100.0 |
| Missing | System | 6 | 10.9 | |
| Total | | 55 | 100.0 | |

**The capacity to recover in the resilience definitions**

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | No | 25 | 45.5 | 51.0 |
| | Yes | 24 | 43.6 | 49.0 |
| | Total | 49 | 89.1 | 100.0 |
| Missing | System | 6 | 10.9 | |
| Total | | 55 | 100.0 | |

*Tables 7a-d. The frequencies for absorptive, adaptive, transformative and recovery capacities as the definitions of resilience, all mutually non-exclusive (Miettinen 2017).*

**The capacity to transform in the resilience definitions * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The capacity to transform in the resilience definitions | No | Count | 13 | 11 | 7 | 3 | 3 | 3 | 40 |
| | | % within The sector of the actor/partnership | 61.9% | 91.7% | 100.0% | 100.0% | 100.0% | 100.0% | 81.6% |
| | Yes | Count | 8 | 1 | 0 | 0 | 0 | 0 | 9 |
| | | % within The sector of the actor/partnership | 38.1% | 8.3% | 0.0% | 0.0% | 0.0% | 0.0% | 18.4% |
| Total | | Count | 21 | 12 | 7 | 3 | 3 | 3 | 49 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 8. The capacity to transform in resilience definitions by organisational sector (Miettinen, 2017).*

In comparison to resilience definitions, resilience operationalisations are very diverse and complicated. They are complicated by the fact that the clear majority of resilience MMs did not construe resilience operationalisations in relation to the defined capacities, but created higher and lower level indicators to measure resilience directly itself (cf. tables 7a-d and Annex 2). In other words, resilience MMs mostly ignore their definition concepts, the capacities to absorb, adapt, transform and recover, in their measurement frameworks. Hence, when it comes to evaluating cohesiveness and harmony of efforts, resilience definitions are not relevant and the focus needs to be on the resilience operationalisations.

Conceptual lists showing higher and lower level operationalisations (measurement indicators) can be found in the Annex 2 of this thesis, but short descriptions of the most common indicators categories within each professional sector is given in the forthcoming sub-sections. Before that however, a finding related to the indicator operationalisations is discussed. The resilience MMs divided the operationalisations to various levels. MMs were often very specific about the level they chose. These levels included: household (29.1%), community (25.5%), city (12.7%), national/regional (5.5%), multi-scale/context-dependent (16.4%) and single system (5.5%) (see table 9). Three MMs (5.5%) were unclear about their scale of application. While most of the levels are very clear, it needs be specified that the multiple/context-dependent class was constituted by MMs that accepted the cross-scale nature of resilience or those MMs that contextually operationalised resilience to the measured levels. Overall, these levels are mostly self-defined, as such, it can be argued that the organisations have internal

comprehension regarding the various levels upon which resilience applied to and of which measurements are derived of.

**The specified level of the MM * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The specified level of the MM | Household | Count | 15 | 0 | 0 | 0 | 1 | 0 | 16 |
| | | % within The sector of the actor/partnership | 62.5% | 0.0% | 0.0% | 0.0% | 25.0% | 0.0% | 29.1% |
| | Community | Count | 2 | 6 | 0 | 4 | 1 | 1 | 14 |
| | | % within The sector of the actor/partnership | 8.3% | 50.0% | 0.0% | 100.0% | 25.0% | 33.3% | 25.5% |
| | City | Count | 0 | 5 | 1 | 0 | 1 | 0 | 7 |
| | | % within The sector of the actor/partnership | 0.0% | 41.7% | 12.5% | 0.0% | 25.0% | 0.0% | 12.7% |
| | National/Regional | Count | 2 | 0 | 0 | 0 | 1 | 0 | 3 |
| | | % within The sector of the actor/partnership | 8.3% | 0.0% | 0.0% | 0.0% | 25.0% | 0.0% | 5.5% |
| | Multiple/Context-dependent | Count | 5 | 1 | 3 | 0 | 0 | 0 | 9 |
| | | % within The sector of the actor/partnership | 20.8% | 8.3% | 37.5% | 0.0% | 0.0% | 0.0% | 16.4% |
| | Single system: infrastructure/ecological | Count | 0 | 0 | 1 | 0 | 0 | 2 | 3 |
| | | % within The sector of the actor/partnership | 0.0% | 0.0% | 12.5% | 0.0% | 0.0% | 66.7% | 5.5% |
| | Unclear/Not specified | Count | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| | | % within The sector of the actor/partnership | 0.0% | 0.0% | 37.5% | 0.0% | 0.0% | 0.0% | 5.5% |
| Total | | Count | 24 | 12 | 8 | 4 | 4 | 3 | 55 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 9. The crosstabulation of resilience measurement levels and organisational sectors (Miettinen, 2017).*

**The type of used indicators * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The type of used indicators | Unclear | Count | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| | | % within The sector of the actor/partnership | 0.0% | 0.0% | 25.0% | 0.0% | 0.0% | 0.0% | 3.6% |
| | Pre-defined | Count | 14 | 10 | 5 | 0 | 4 | 3 | 36 |
| | | % within The sector of the actor/partnership | 58.3% | 83.3% | 62.5% | 0.0% | 100.0% | 100.0% | 65.5% |
| | Context-dependent | Count | 10 | 2 | 1 | 4 | 0 | 0 | 17 |
| | | % within The sector of the actor/partnership | 41.7% | 16.7% | 12.5% | 100.0% | 0.0% | 0.0% | 30.9% |
| Total | | Count | 24 | 12 | 8 | 4 | 4 | 3 | 55 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 10. The crosstabulation of measurement indicator types and organisational sectors (Miettinen, 2017).*

When it comes to the resilience operationalisations, the resilience MMs were divided to approaches, which consider resilience as universal (pre-defined) or as context-dependent. The universal approach assumed that one methodology with its pre-defined indicator sets could be applied to multiple cases and thus resilience measurements are seen as comparable across cases. On the other hand, some MMs adapt resilience indicators to each case and see resilience as a context-specific property, which renounces the comparability of measurements. Overall, 65.5% of the MMs opted for a

pre-defined indicator framework and 30.9% chose a contextually defined framework, while two MMs or 3.6% were unclear about their framework (see table 10). Differences between the two frameworks creates potential problems in collaborative terms. First of all, it could be argued that organisations with a pre-defined resilience measurement framework have fundamentally defined their organisational goals before a spatially bounded resilience measurement is conducted and thus are limiting their resilience MM to their organisational expertise and functional areas. As such, they are capable of negotiating their place for harmony of efforts. On the other hand, while organisations utilising a context-dependent MM might be more tuned for distinguishing locally important issues, they are likely to operationalise resilience outside their operational capabilities and deriving multiple potentially mutually exclusive goals. This limits their ability in collaboration to being a provider of information about local priorities in sense-making processes. Furthermore, as such, these organisations are likely to be unable to negotiate their roles and alignment of goals before deployment to a previously unknown area. Next, sectoral indicator trends are assessed.

#### 6.2.1.1. Development/Humanitarian Sector

Development/humanitarian (DH) MMs seem to focus on the contextual state of a livelihood. This is done by operationalising and measuring resilience in relation to the common development goals and outcomes, such as those presented in the Sustainable Development Goals (SDGs). In a comparison, 12 out of the 17 SDGs[7] are present in the conceptual list presented in the Annex 2. Resilience operationalisations were mostly used to measure household level resilience. The indicators included household assets and income, access to basic services and food, access to education, gender equality and participation in institutions. While some MMs try to operationalise, absorptive, adaptive and transformative capacities, fundamentally these approaches merely include the

[7] SDGs: No poverty (1), Zero hunger (2), Good health and well-being (3), Quality education (4), Gender equality (5), Clean water and sanitation (6), Decent work and economic growth (8), Industry, innovation and infrastructure (9), Reduced inequalities (10), Life on land (15), Peace, justice and strong institutions (16) and partnerships (17).

previously mentioned categories under these capacities. Some leadership and planning elements are suggested and they are measured in a qualitative manner mainly. There are only few MMs that include DRM functions (see Annex 2). For DH, resilience measurements are very similar to traditional context analysis, where factors relevant to a project are evaluated for project priorities and potential risks (see IGAD, 2015). Most interestingly, the concept of vulnerability is omitted even though contextual state is often associated with the susceptibility to hazards, especially in the disaster literature (Wamsler, 2014). This could indicate that DRM is largely ignored by the DH sector for other priorities.

Discursively, DH relate being resilient with being developed. The rationale can be depicted as such that having for instance access to basic services increases one's resilience against generic shocks and stressors (see IGAD, 2015; FAO, 2016). In a sense, 'resilience-building' here refers to improving the indicators of resilience, which function as the overall development indicators as well. Hence, development is defined in relation to 'shocks' and 'stressors'.

Although there are various approaches to operationalising resilience, they are all fundamentally applicable and harmonisable under the SDG. It can thus be argued that the sector is conceptually cohesive. Within the DH, sector harmony is dependent on the performance of the negotiation process and the capacity of the organisations.

#### 6.2.1.2. Safety /Disaster Risk Management Sector

The SDRM resilience MMs have conceptual interest in linking resilience to proactive and reactive disaster risk management capacities (see Annex 2). Expect for two MMs, all other MMs measure risk management capacities, such as disaster recovery, emergency, response, risk assessing and public engagement about risk. The two MMs that ignore capacities are focused on social and structural vulnerabilities and exposure, such as climatic conditions, infrastructure, sense of community and diversity (see Annex 2).

There seems to be an interesting disparity between the DH and the SDRM MMs. While DH focuses mainly on the contextual state, the SDRM MMs tend to make a distinction between contextual state, which in some cases is named vulnerability, and capacities, which in this case are those of disaster prevention, mitigation, preparedness, recovery and response. Discursively the SDRM MMs seem to be focused on achieving resilience to decrease fatalities and consequences, or the risk, of disasters (see Khazai, Bendimerad, Cardona, Carreño, Barbat, & Burton, 2015). This is somewhat different from the DH in a sense that it enables defining societal development outcomes outside the DRM, and the role of DRM is therefore providing safety so the 'the optimal development pathway' can be followed (see Becker, 2014). In other words, achieving safety through resilience enables attaining more definitive societal goals.

Overall, cohesiveness of the sector is very strongly based on the fact that general DRM functions are utilised across the sector and there seems to be a universal understanding of their operationalised meanings (see Annex 2). Also, there seems to be a clear idea about how the concept of vulnerability is used for depicting susceptibility to risk. No conceptual limitations to achieving harmony of efforts within the sector can conclusively be presented. Harmony of efforts is therefore dependent on the performance of negotiations between organisations.

#### 6.2.1.3. Critical infrastructure Sector

Critical infrastructure MMs were somewhat diverse in their operationalisations. One MM proposed analysing critical infrastructure as a component of societal resilience. Resilience however was predominantly associated with a single (engineered) facility or a system. Resilience was mainly operationalised to characteristics determining the stability (robustness), the capacity to recover and the organisational management of the system (resourcefulness). In relation to utilities, profitability was mentioned (see Annex 2). Discursively, critical infrastructure resilience seems to be focused on enabling optimal up-time and maximising performance of a facility. Capacities, both system and management specific, play a vital role. Contextual state descriptions seem to be limited to system interdependencies, which were mentioned by only one MM, and to the

operational risk environment. In general, there seems to be clear understanding regarding robustness, recovery and resourcefulness. Thus, cohesiveness and collaborative potential exist.

#### 6.2.1.4. Social welfare Sector

Social welfare focused solely on the social elements of communities. These included factors, such as demographics, community engagement, cohesion and crime rates. Some MMs also included factors, such as health, household resources and the physical infrastructure (Annex 2). Discursively, the main focus is on the community characteristics which ensure the stability of the social fabric. It is worth noting that some of the scoped social welfare MMs are similar to the Cutter et al. (2003) social vulnerability index in their attempt to compare communities based on their social characteristics (cf. Cutter et al., 2003 and Mguni & Bacon, 2010). Overall, demographics and community dynamics were accounted by all of the social welfare MMs and thus they are cohesive and conceptually capable to achieving harmony of effort if needed. Due to the limited number of sectoral observations, these results are sensitive to change.

#### 6.2.1.5. Economic Sector

Based on discursive analysis of economic MM resilience operationalisations, there seems to be a major focus on stability. The reference point for stability is economic well-being. One MM focuses on the readiness and ability to respond, recover and learn, but most of the MMs are focused on factors associated with 'healthy' economy. On the macro-economic level, there is focus on the indicators, such as productivity, recovery, exposure, gross domestic product and quality of risk management. Also, supply chain stability is indicated as a part of resilience. MMs considering lower societal levels, there seems to be focus on community cohesion, stability of well-being, i.e. basic services and risk sharing (see Annex 2). For economic MMs, the discursive assumption on resilience is stability and the general goal is economic well-being. Overall, the discursive perspective remains a cohesive factor, but the approaches to account resilience are

diverse. Due to the limited number of sectoral observations, these results are sensitive to change.

#### 6.2.1.6. Environmental Sector

Environmental MMs only included three observations, all of which operationalised resilience completely differently. The first MM assessed resilience in reef ecosystems by assessing the ecosystem's characteristics mainly in relation to biodiversity and ecological diversity of the reef itself. These were then compared with risk factors potentially pushing the reef to a bleached state (International Union for Conservation of Nature , 2011). Here, resilience constituted in sense the threshold preventing a reef from moving to an alternative state. The second MM operationalised resilience as a spatial ecosystem characteristic. Here, resilience was also constituted by the ecological characteristics of the system and the anthropogenic pressure on the system, which was proxied through the capacity to natural resource management (Anderson, Barnett, Clark, Ferree, Sheldon, & Prince, 2014). The third environmental MM focused on agro-ecological sustainability by operationalising resilience as the ecological state of the ecosystem and socio-ecological relations, which were proxied with environmental knowledge and practices and the state of livelihood (Bergamini, 2014). The discursive goal of resilience for environmental MMs is conservation of ecological diversity. Due to the limited number of sectoral observations, these results are sensitive to change.

### 6.2.2. Cross-sectoral Cohesiveness

To conclude, the in-sector cohesiveness and collaborative potential were good within the DH, SDRM, CI and social welfare sectors. The economic and environmental sectors did not have enough observations for definitive conclusions. This thesis set also to evaluate the cross-sector cohesiveness and ability to collaborate, but the analysis of operationalisations itself does not provide a comprehensive way to do this. Thus, inclusion of complexity, DRM and CCA frameworks within sectors was taken as a proxy

for cross-sectoral collaboration. The fundamental idea is that organisations can utilise these conceptual frameworks as 'bridges' in negotiations for the harmony of effort.

Inclusion of complexity was determined 'yes' if the respective resilience MM included at least one complexity concept in its conceptual framework (table 11). Simply mentioning something as complex or holistic did not count, but the respective term had to be discussed in relation to resilience or other concepts within the MM's conceptual framework. Overall, there was a general lack of complexity within sectors. The environmental and DH sectors were the most prominent with the inclusion rates of 66.7% and 41.7%, respectively. When it comes to other sectors, 16.7% of SDRM, 25.0% of CI, 25.0% of social welfare, 25.0% of economic MMs included complexity (see table 11). Taking a simple Boolean approach, where complex sectors (with >=50%) cannot discuss with non-complex sectors (with <50%), only the environmental sector is excluded from harmonised efforts.

**The presence of a complexity framework in the MM * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The presence of a complexity framework in the MM | No complexity concepts/Unclear | Count | 14 | 10 | 6 | 3 | 3 | 1 | 37 |
| | | % within The sector of the actor/partnership | 58.3% | 83.3% | 75.0% | 75.0% | 75.0% | 33.3% | 67.3% |
| | Atleast one complexity concept | Count | 10 | 2 | 2 | 1 | 1 | 2 | 18 |
| | | % within The sector of the actor/partnership | 41.7% | 16.7% | 25.0% | 25.0% | 25.0% | 66.7% | 32.7% |
| Total | | Count | 24 | 12 | 8 | 4 | 4 | 3 | 55 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 11. The inclusion of complexity within resilience measurement frameworks by sector (Miettinen, 2017).*

When it comes DRM and CCA, both the conceptual framework section and the indicator section were reviewed in each MM for the presence of framework inclusion. A classification was made to depict if the MM included only a DRM or a CCA framework, both, or neither. In the case of DRM, functions of disaster prevention, mitigation, preparedness, response and recovery were accounted for. On the other hand, CCA was considered present if the respective MM related resilience to climatic factors or mentioned adaptation to climatic disturbances or stressors. General discussion about climatic factors or hazards was not interpreted as a part of DRM or CCA, but specific conceptual reference had to be made.

Surprisingly, around one third (32.1%) or 17 MMs ignored both DRM and CCA conceptually. When it comes to 'understanding' CCA, the rates were as follows: 70.8% of the DH, 66.6% of the SDRM, 12.5% of the CI, 25.0% of the social welfare sector, 25.0 % of the economic sector and 100 % of the environmental sector (see table 12). Assuming the same Boolean cut-off point on the 50th per cent point, The DH, SDRM and environmental sectors are capable of achieving harmony of efforts in regard to CCA, expect the environmental sector is likely to utilise 'too complex' language based on previous analysis and it is thus rejected from the collaboration. When it comes to 'understanding' DRM, the rates are as follows: 20.8% of the DH, 66.6 % of the SDRM, 75.0% of the CI, 0.0% of the social welfare sector, 25.0% of the economic sectors and 0.0% of the environmental sector (see table 12). The SDRM and CI sectors are capable of achieving harmony of efforts in DRM.

**The presence of DRM and CCA frameworks in the MM * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The presence of DRM and CCA frameworks in the MM | Neither | Count | 7 | 3 | 2 | 3 | 2 | 0 | 17 |
| | | % within The sector of the actor/partnership | 29.2% | 25.0% | 25.0% | 75.0% | 50.0% | 0.0% | 32.1% |
| | DRM | Count | 0 | 1 | 5 | 0 | 1 | 0 | 7 |
| | | % within The sector of the actor/partnership | 0.0% | 8.3% | 62.5% | 0.0% | 25.0% | 0.0% | 13.2% |
| | CCA | Count | 12 | 1 | 0 | 1 | 1 | 0 | 15 |
| | | % within The sector of the actor/partnership | 50.0% | 8.3% | 0.0% | 25.0% | 25.0% | 0.0% | 28.3% |
| | DRM & CCA | Count | 5 | 7 | 1 | 0 | 0 | 1 | 14 |
| | | % within The sector of the actor/partnership | 20.8% | 58.3% | 12.5% | 0.0% | 0.0% | 100.0% | 26.4% |
| Total | | Count | 24 | 12 | 8 | 4 | 4 | 1 | 53 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 12.The inclusion of DRM and CCA frameworks within resilience measurement frameworks by sector (Miettinen, 2017).*

To conclude, based on the resilience MM framework analysis, DH and SDRM sectors are capable of collaborating and achieving harmony of efforts in issues regarding CCA. On the other hand, SDRM and CI sectors are capable of collaborating and achieving harmony of efforts in issues regarding DRM.

When it comes to the analysis of resilience definitions and operationalisations, it was concluded that resilience definitions are mostly ignored in the resilience

operationalisations. Therefore, in the light off harmony of efforts, only the cohesiveness of resilience operationalisations is relevant. Furthermore, it was pointed out that different measurement levels and the distinction to universal and context-specific indicators can be used to explain differences in resilience operationalisations. When it comes to the in-sector cohesiveness, common outcome reference points and shared concepts were present within each sector. On the other hand, the sectors were isolated among each other in their outcome references points and used concepts.

## 6.3. How Are Professional Resilience Measures Designed and Used?

In order to answer the third research question, this sub-chapter presents how the professional resilience measurement frameworks are designed and used in the light of data inputs, measurement types and the inclusion of risk assessing.

### 6.3.1. Data Inputs

A general overview of data shows that there was a multitude of utilised data input types. Primary data inputs included surveys, interviews, focus groups, field observations, workshop exercises and mixtures of all the previous (see Annex 1 table 4). Secondary data inputs included specified public domain data sets and 'generic literature review' (see Annex 1 table 5). Overall, 29.1 % of resilience MMs did not state their utilised data or suggested generic data collection options in case of guidance manuals (see Annex 1, table 20). In classification, if the indicator operationalisations did not regard secondary data sources, it was assumed that the main method for data was primary collection. In-depth analysis of sectoral differences in the utilisation of primary and secondary data collection methods provides no clear results (see Annex 1 table 6). However, depicting the collection methods in relation to the specified level of analysis without 'unclear' and 'context-dependent' observations results in an interesting insight. Almost all of the household level MMs utilised only primary data sources (84.6% prevalence) (see table 13). Also, a number of MMs on other levels rely similarly on primary data only: 42.9% of community level, 25.0% of city level and 66.7% of single system MMs. Overall, the

reliance on secondary data seems to increase when the scale of resilience MM increases. While only 15.4 % of household level MMs use secondary data sets, 57.1% of community level MMs, 75.0% of city level, 100% of national/regional level MMs and 100 % of multi-level MMs rely on some type of secondary data set (see table 13).

**The data input types, excluding unclear observations * The specified level of the MM**

| | | | The specified level of the MM | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Household | Community | City | National/Regional | Multiple/Context-dependent | Single system: infrastructure/ ecological | Total |
| The data input types, excluding unclear observations | Primary data only | Count | 11 | 6 | 1 | 0 | 0 | 2 | 20 |
| | | % within The specified level of the MM | 84.6% | 42.9% | 25.0% | 0.0% | 0.0% | 66.7% | 51.3% |
| | Secondary data only | Count | 1 | 5 | 2 | 0 | 4 | 1 | 13 |
| | | % within The specified level of the MM | 7.7% | 35.7% | 50.0% | 0.0% | 100.0% | 33.3% | 33.3% |
| | Mixed | Count | 1 | 3 | 1 | 1 | 0 | 0 | 6 |
| | | % within The specified level of the MM | 7.7% | 21.4% | 25.0% | 100.0% | 0.0% | 0.0% | 15.4% |
| Total | | Count | 13 | 14 | 4 | 1 | 4 | 3 | 39 |
| | | % within The specified level of the MM | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 13. The data input types by resilience measurement level (Miettinen, 2017).*

### 6.3.2. Measurements

Most of the resilience MMs (40.0 %) opted to utilise interval type of measurements (table 14), depicting differences between the current system state and the target system state, or chose to simply represent the current state in a format, against which differences in the future can be compared to. The second most utilised type was nominal measurement (36.4% prevalence). Ordinal measurements were used by some (16.4%) (table 14). Ratio scales were used only by two MMs (3.6%) and only two MMs (3.6%) discussed or suggested using multiple methods (table 14). Qualitative approaches, i.e. nominal and ordinal measures, accounted for 52.8% of the MMs and quantitative approaches, i.e. interval and ratio measures, construed 43.6% of the MMs.

**The resilience measurement type * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The resilience measurement type | Nominal | Count | 12 | 2 | 4 | 2 | 0 | 0 | 20 |
| | | % within The sector of the actor/partnership | 50.0% | 16.7% | 50.0% | 50.0% | 0.0% | 0.0% | 36.4% |
| | Ordinal | Count | 1 | 4 | 0 | 1 | 1 | 2 | 9 |
| | | % within The sector of the actor/partnership | 4.2% | 33.3% | 0.0% | 25.0% | 25.0% | 66.7% | 16.4% |
| | Interval | Count | 8 | 6 | 3 | 1 | 3 | 1 | 22 |
| | | % within The sector of the actor/partnership | 33.3% | 50.0% | 37.5% | 25.0% | 75.0% | 33.3% | 40.0% |
| | Ratio | Count | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | % within The sector of the actor/partnership | 8.3% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 3.6% |
| | Multiple | Count | 1 | 0 | 1 | 0 | 0 | 0 | 2 |
| | | % within The sector of the actor/partnership | 4.2% | 0.0% | 12.5% | 0.0% | 0.0% | 0.0% | 3.6% |
| Total | | Count | 24 | 12 | 8 | 4 | 4 | 3 | 55 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 14. The measurement types by sector (Miettinen, 2017).*

### 6.3.3. Risk Assessment

The content analysis included extraction of information related to risk assessing to determine which risk concepts are measured in the resilience MMs. Interestingly, resilience measurements generally seem to be separated from risk. It is striking that 45.5% of the MMs did not include any considerations for understanding risks in any form (see table 15). 18.2% of the MMs suggested some type of risk assessment to be made, but did not include it in the resilience MM itself. 10.9 %, i.e. six MMs within the DH, described previous disasters qualitatively or depicted maps showing hazard exposure areas. 9.1% of the MMs analysed risks solely providing their historic frequencies for various magnitudes of events. 5.5 % of the MMs focused on portraying historic or potential losses related to events, without mentioning frequencies or other characteristics of risk. Only 10.9 % of MMs included, or suggested the inclusion of, a full risk assessment calculating frequencies/probabilities for events or scenarios (table 15). To conclude, resilience MMs are seen separate from the assessment and analysis of risks. Generally, 63.7% of the resilience MMs ignored risk completely or failed to provide a clear method for accounting risk.

**The type of risk assessment * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The type of risk assessment | No/Not specified | Count | 11 | 4 | 2 | 3 | 3 | 2 | 25 |
| | | % within The sector of the actor/partnership | 45.8% | 33.3% | 25.0% | 75.0% | 75.0% | 66.7% | 45.5% |
| | Yes, contextually defined | Count | 2 | 5 | 3 | 0 | 0 | 0 | 10 |
| | | % within The sector of the actor/partnership | 8.3% | 41.7% | 37.5% | 0.0% | 0.0% | 0.0% | 18.2% |
| | Contextual description/Hazard map | Count | 6 | 0 | 0 | 0 | 0 | 0 | 6 |
| | | % within The sector of the actor/partnership | 25.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 10.9% |
| | Frequencies/Probability/Exposure Scenarios | Count | 1 | 2 | 0 | 1 | 1 | 0 | 5 |
| | | % within The sector of the actor/partnership | 4.2% | 16.7% | 0.0% | 25.0% | 25.0% | 0.0% | 9.1% |
| | Consequences | Count | 2 | 0 | 0 | 0 | 0 | 1 | 3 |
| | | % within The sector of the actor/partnership | 8.3% | 0.0% | 0.0% | 0.0% | 0.0% | 33.3% | 5.5% |
| | Risk calculation/Scenarios | Count | 2 | 1 | 3 | 0 | 0 | 0 | 6 |
| | | % within The sector of the actor/partnership | 8.3% | 8.3% | 37.5% | 0.0% | 0.0% | 0.0% | 10.9% |
| Total | | Count | 24 | 12 | 8 | 4 | 4 | 3 | 55 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 15. The types of risk assessing within resilience measurement frameworks by sector (Miettinen, 2017).*

# 7. Discussion

## 7.1. Limitations of the Research

The scoped material and the analysis have several critical limitations that affect the validity of the results. These include temporal validity, completeness validity and limited number of observations. Temporal validity is related to the explanatory power of the results. The conceptual nature of resilience should be considered constantly changing in relation to time. Further discussions of the concept and its measurement change the discourses that constitute the resilience definitions and operationalisations (see Batra et al., 2017). In other words, the concept of resilience and how it is measured should not be expected to remain the same in the future MMs. Hence, the results of this thesis are only valid when explaining the used research material. Future studies can however use this thesis as a reference point in order to track temporal changes. The systematic nature of scoping and content analysis ensure the potential for replicating this thesis in the future in order to provide temporally distinct results. In the future, it will be interesting see if resilience is utilised as a defining characteristic of development instead of the traditional indicators, such as the gross domestic product (GDP) or the human development index (HDI).

The completeness validity relates to the extent this thesis was able to capture all available and relevant material with the used scoping method. While the scoping framework was followed rigorously, it is still possible that some material was not captured. The main reason is that only publicly available documents could be extracted by the method. It is likely that especially CI MMs and related reports are considered confidential due to security concerns and are therefore for not publicly accessible. Moreover, it is possible that the using the Google Search tool for scoping introduced unobservable biasness. It is very difficult to evaluate the completeness of the sub-setting of Google Search results (see chapter 5 for full description). It is thus possible that some relevant material was missed, which could have impacted the final results.

Due to the small number of MMs especially within the identified social welfare, economic and environmental sectors, the conclusions regarding these sectors remain uncertain. Whilst the conclusions are valid for the scoped material, the results from social welfare, economic and environmental sectors are not robust in relation to potentially missed grey literature during the scoping process. Even if one MM observation would be added to these sectors, in such a case that it was missed during the scoping process, the results for these sectors could look completely different. Regarding the social welfare, economic and environmental sector results, the used percentage format for most of the results is very sensitive to drastic changes if a small number of additional observations were obtained.

## 7.2. The Results and the Research Aim

The fundamental aim of this thesis has been to contribute to the knowledge on how resilience is operationalised by professional organisations. The research aim was fulfilled well. It was established that six sectors were clearly present in the research material. The resilience MMs were then categorised in accordance to the established sectors. The analysis of resilience operationalisations for common goals and use of concepts revealed that resilience is operationalised cohesively within each sector. These results provide a

sectoral framework for understanding resilience operationalisations, as the derived sectors can be used as a basis for future research. The 'knowledge' regarding the resilience operationalisations is that resilience is used in a somewhat isolated manner. While in-sector conceptual cohesion exists, the goals and used concepts vary between sectors. Furthermore, it was noted that different sectors tend to measure resilience of different level systems which arguably impacts the choice of indicators. This knowledge is relevant for the professional organisations which are partnering with organisations from a different sector for resilience-building projects. Decision makers need to assume that the resilience operationalisations between the two or more organisations are likely to be incompatible and time should be dedicated for the staff to develop common understanding of organisations' resilience frameworks. If the concept of resilience is used without discussing its operationalisations explicitly, it is likely that harmony of efforts is not achieved.

When it comes to fulfilling the research goal, this thesis' targeted determining if conceptual heterogeneity exists among the professional resilience measurement methodologies. While the analysis of operationalisations showed that there is heterogeneity, determining the extent of heterogeneity and the related ability to collaborate was not so successful. Proxying heterogeneity and the potential for harmony of efforts through the prevalence of DRM, CCA and complexity within sectors did not provide an explanatory answer. Regarding the DRM, it was concluded that SDRM and CI are likely to be able to collaborate. Regarding the CCA, it was concluded that DH and SDRM are likely to collaborate. The results to seem somewhat arbitrary without any additional analysis of practical collaboration experiences. The chapter 7.3 explains additional approaches to the study of resilience which can be used provide more fulfilling answers. Overall, the analysis of the operationalisations and the prevalence of DRM, CCA and complexity provided a proper answer for the 'if'-focused goal. Conceptual heterogeneity exists among most of the identified sectors.

While the content analysis of data inputs, measurement types and risk assessing were somewhat external to the research aim and goal, they provided contextual information about the nature of resilience MMs. Furthermore, they also provide a reference point

for future studies which can track temporal changes in the use of resilience measurements.

## 7.3. Recommendations: Improving the Cohesiveness of Resilience MMs

### 7.3.1. Improving Data Quality and Availability as an Entry Point for Cohesion

As the scoping results show, there seems to be a reliance on public domain databases, especially in the community level measurements (see Annex 1 table 5). Furthermore, household and other level MMs also indicated problems with quantitative data, which arguably has an impact on the selection of indicators. For instance, Intergovernmental Authority on Development–Resilience Analysis Unit (IGAD) (2015) notes that they had several issues when utilising public data in their measurement. They mention that spatial and temporal issues in data sets and general problems with the standardisation of data collection prevented them performing a trend analysis on the household level. Furthermore, they state inefficiencies in the metadata of the used public domain data sets. IGAD (2015) asserts that, due to these issues, they had to supplement the public domain data with primary data in order complete their household resilience measurement. On the other hand, Platts-Fowler & Robinson (2013) state a lack of relevant data in relation to their resilience indicators and scale. More specifically, they indicate that census data was not suitable for community level resilience measurements due sampling constraints. Their data problem was further aggravated as local public domain data was difficult to obtain. While data problems are not directly related to cohesiveness and collaborative potential, their relevance as an entry point for cross-sector and in-sector cohesiveness should be considered.

To establish a basic understanding of data requirements, data is often divided into geographical, temporal and domain (field of study) conditions. A census is the most rigorous nationally collected socio-economic survey which is done once a decade (United Nations Statistics Division, 2001-08-06). The purpose is to provide an evidence-base for policies and the private sector with statistically significant sampling to the

lowest national administrative level or even lower ones depending on the sampling (Pratesi, 2016). In addition to censuses, national registers include data about population, health, business, property, school and land (Ibid.). However, many regions, especially the Sub-Saharan Africa, suffer from 'data poorness' due to problems related to funding, conflicting interests and a general lack of data standards resulting in the inability to integrate data set (United Nations Statistics Division, 2001-08-06; The Economist, 2014-11-13; Sustainable Development Solutions Network, 2015). Furthermore, national statistical agencies are affected by political interference which impacts the agencies' data collection activities but also the possibility to cooperate across ministries. The sharing of project related surveys and other 'microdata' is lacking due to disincentives, which are related to possible backlashes if accuracy or quality problems are detected in the shared data (CGDAHRC, 2014). Overall, issues with the quality of data and its availability are rooted in the same problems. However, the problem is fundamentally complex in nature and issues related to funding, political power and cooperation are likely interlinked.

Solutions to the availability of public domain data can be found through public-private partnerships. The commercial world has started a data revolution where enterprise giants, such as Amazon, have created and utilised data infrastructures for optimising pricing and business plans according to consumer behaviour (Weigend, 2009-05-20). It is not uncommon to see rankings of companies' analytical capabilities as a proxy of their future success (see Syrett & Devine, 2012). The data revolution is a consequence of improvements in the ability to collect data and in the capacity to analyse vast amounts of data effectively (ibid.; Alpaydin, 2016; The Economist, 2016-12-03). There is a great potential if and when private-public partnerships are actualised in relation to data availability (see Sui, 2014). For instance, M-PESA, which provides mobile banking services in Kenya, has changed how individuals consume and save. Now earned income from work in cities can be sent to relatives in rural areas where no bank branches or automated teller machines exist (Mbiti & Weil, 2013). While the commercial benefits are clear, in theory M-PESA enables the collection of economic transaction data on a finer scale compared to national statistics, which focuses on variables such as employment, inflation, exports, imports and aggregated consumption (Uganda Bureau

of Statistics, 2016). M-PESA could be used to make distinctions between health care, food and other expenditures, and thus provide resilience MMs with a multitude of temporally constant and spatially disaggregated economic data.

Inter-organisational open data regime would be beneficial for data availability, but additionally for data quality, due to improved data-related cooperation and interaction. For instance, United Nations World Food Programme (WFP) has launched a 'Beneficiary Information Management' system called SCOPE which records mobile and electronic cash-based transfers and the purchases made by beneficiaries on the local markets (United Nations World Food Programme, 2014). For instance, when recognising deviations, such as purchase shifts towards 'inferior' foods and goods, i.e. those culturally non-preferred, can depict a worsening socio-economic situation. Sharing data from organisational initiatives, such as SCOPE, could contribute to better measurements. Data sharing initiatives should be seen as a platform for discussions about resilience operationalisations and their underlying data needs. Overall, the argument here is that enabling collaboration on technical aspects of resilience MMs can result in more cohesive operationalisations through dialogue.

### *7.3.2.* Developing *an International Framework on Resilience*

This thesis started with a quote from the Guardian questioning the usefulness of resilience. Now the argument is deconstructed with the support of this thesis' results. According to the Guardian (2013-03-05), the fact that the existence of a wide variation of DH organisations, which define their own methodologies for resilience with very different operationalisations, is causing resilience to loss its potential usefulness. It is further argued that this contributes to unaccountable and unmeasurable development outcomes. In other words, the argument is that if resilience is not defined and utilised cohesively, resilience loses its meaning in strategic and operational terms. The Guardian thus suggests that the resilience measurements should be standardised in order to make them compelling (Guardian, 2013-03-05).

While the argument of non-cohesion within sectors has been now proven wrong by this thesis, the article presents an intriguing premise; resilience must have a universal definition and operationalisation to provide a useful framework for measuring outcomes and achieving the harmony of efforts. In sense, the argument concurs with the anarchic notion assumed by the framework of realism in the international relations. Hence, the argument goes that resilience can only be universal if the concept, its definition, operationalisation and measurement indicators are all governed by an overarching international body, a regime.

According to Carter (2007), a regime is: *"[t]he principles, norms, rules and decision-making procedures which form the basis of co-operation on a particular issue in international relations*". Under this insight, regimes are systems of soft governance, which provide institutional forms around international issues. They are often construed of multiple treaties or summits that eventually produce a set of rules, compliance mechanisms, concepts and actors around the specified issue (Breitmeier, Young, & Zürn, 2006; Carter, 2007). In the case of DRM, the Sendai Framework is the latest institutional form around the issues of natural and technological hazards (UNISDR, 2015). The administrative work and the conceptual development in the DRM regime has been devoted to the UNISDR, while the implementing role is given to national states (ibid.). On the other hand, when it comes to climate change, its regime is fundamentally tied around the conference of parties, where nation states agree upon the climate regime (UNFCCC, 2015). This regime also includes mechanisms, such as the green climate fund, and implementers, such as the United Nations Framework Convention on Climate Change (UNFCCC), and research organisations, such as the Intergovernmental Panel on Climate Change (IPCC) (ibid.; IPCC; 2014). Additionally, a major regime is constituted by the SDGs, which establish principles and a basis for collaboration in the field of development (United Nations General Assembly, 2015).

As it was established in the results chapter, many of the resilience operationalisations and measurement frameworks are fundamentally linked to the existing frameworks on SDGs, DRM functions and climate change. As the mentioned disaster risk, climate change and development regimes have arguably gathered great international interest,

it is unlikely to see a specific regime around resilience. However, linking resilience under the previously mentioned regimes can create a more universal comprehension of the concept.

## 7.4. Recommendations for Future Research: From Macro to Meso and Micro

This chapter shortly suggests new research approaches which have the potential for providing additional information about the relevance of resilience frameworks for the professional organisations. In general, the approach taken by this thesis provided a macro perspective on resilience. The macro-level approach enabled making interpretations regarding the cohesiveness of resilience operationalisations within and cross sectors, and showing why and how organisations measure resilience. For instance, the impacts on an organisation's performance and outcomes, when utilising a resilience MM, are fundamentally unobservable with the taken macro-approach. Moreover, modern organisations are fundamentally networked. For instance, much of the humanitarian world employ strategic and operational networks within their cluster approach (see IASC, 2015). The conceptual utility and cohesiveness of resilience within networks was ignored by this thesis. Focusing on networks could provide a focused approach on researching resilience and produce implementable suggestions for the professional organisations. In the light of the approach taken by this thesis, the individual organisation level and network levels could be named micro and meso levels, respectively, for the purpose of making comparisons.

On the micro level, resilience research should take an integrated approach by accounting how changes in outcome reference points and used concepts impact organisations when a resilience-building and measurement framework is enforced. The idea is that introducing a resilience framework shifts the organisational roles, interests and processes. Recording these changes can contribute to the organisational change theories. Recording lessons learned could also contribute to making resilience

frameworks cohesive, as organisations would be incentivized to utilise existing and well-proven methodologies.

The world is fundamentally networked, which demands novel approaches from the research of resilience. As previously stated, the humanitarian world has established a cluster system, where a division into global clusters, i.e. those responsible of strategic harmonisation, policy, expertise and resource support, and into local clusters, i.e. those responsible of preparedness, response and recovery roles on the ground, is made (see IASC, 2015). Moreover, the development sector divides itself thematically according to the Sustainable Development Goals (see Sustainable Development Solutions Network, 2015 p. 15). Similarly to organisations, networks can change and re-organise (see Newman, 2010). It is therefore important to understand if and how strategic and operational harmony in a network is changed when resilience MMs and underlying frameworks are implemented by the network nodes, i.e. organisations. Network-oriented resilience research not only provides 'lessons learned' for forthcoming implementers of resilience, but also produces understanding of network dynamics, discursive shifts and strategic and operational changes. For instance, determining conditions which increase cross-functional cooperation might result in better cluster system performance and outcomes.

# 8. Conclusions

The main conclusions are listed here. Firstly, the analysis of organisations and their stated purposes clearly identified that resilience measurements are used on the strategic level mainly for programming and monitoring and evaluation (M&E) purposes. Of all the organisations, 65.5% mentioned programming and 25.5% mentioned M&E, both mutually non-exclusive. The identified organisational sectors included development/humanitarian (DH), safety/disaster risk management (SDRM), critical infrastructure/utilities (CI), social welfare, economic and environmental sectors. The four most prominent developers of resilience measurement methodologies were DH

NGOs/IOs (30.9%), CI state bureaucracies (9.1%), DH independent research institutes (7.3%) and SDRM state bureaucracies (7.3%).

Secondly, it was concluded that there is in-sector cohesiveness in the operationalisations of resilience, which provide a potential framework for collaboration. DH sector associated resilience indicators with contextual states and their relation to development goals, such as the SDGs. SDRM sector focused on evaluating disaster risk management capacities and vulnerabilities with common conceptualisations. CI sector in general operationalised resilience in relation to system stability (robustness), capacity to recover and organisational management (resourcefulness) with some variation. Social welfare sector focused its operationalisations on demographics and social fabric. Economic sector associated resilience with economic stability. Environmental sector associated resilience to ecologic system states or human-ecologic interactions.

Thirdly, cross-sectoral collaboration potential was established in relation to the inclusion of DRM, CCA and complexity frameworks within the resilience measurement frameworks. It was concluded that DH and SDRM sectors are prospectively capable of collaborating in issues related to CCA, as both sectors integrated CCA across sectoral methodologies on 70.8% and 66.6% proportions, respectively. On the other hand, it was established that SDRM and CI sectors are prospectively capable of collaborating in issues related to DRM, as both sectors integrated DRM across the sectoral methodologies on 66.6% and 75.0 % proportions, respectively.

Fourthly, in regard to measurement designs, household level measurements were mostly focused on primary data sources on 84.6% prevalence. Overall, there was an increase in the use of secondary data sets when 'moving' to analyse higher levels. Secondary data sets were identified as data sources at the household level in 15.4% of MMs, on the community level in 57.1% of MMs, on the city level in 75.0% of MMs, on the national/regional level in 100% of MMs and the on multi-level in 100% of MMs. Additionally, it was concluded that qualitative (nominal and ordinal) measurement approaches were taken by 52.8% of all methodologies and quantitative (interval and ration) measurement approaches by 43.8% of all methodologies. Regarding risk

assessments, it was concluded that risk and resilience are likely to be conceptually separated as 63.7% of all methodologies ignored risk completely or failed to provide a clear way for measuring risk.

Fifthly, it was concluded that focusing on improving technical aspects related to data availability and quality can provide an entry point improving mutual comprehension of different conceptual needs and uses for resilience measurements. Furthermore, the argument concerning the need for an international regime on resilience was deconstructed and rejected since resilience conceptually overlaps with the existing regimes on DRM, climate change and development.

Regarding the first research question, it was concluded that the main purposes of resilience MMs are strategic programming and monitoring and evaluation. Moreover, the identified sectors were the DH, SDRM, CI, social welfare, economic and environmental sector. Regarding the second research question, it was established that within the identified sectors no heterogeneity exists to the extent that could diminish collaborative potential. However, inter-sectoral cohesion remains limited based on the used proxies, i.e. the sectoral prevalence of DRM, CCA and complexity frameworks. Regarding the third research question, it was concluded that risk assessments are generally not a part of resilience measurements, and both qualitative and quantitative resilience measurements are common. Additionally, it was noted that the reliance on secondary data increases when higher level systems are targeted with the measurements.

Overall, research aim and the goal were fulfilled. When it comes to contributing on knowledge about resilience operationalisations, several factors were identified. It was noted that resilience definitions are mostly ignored in the resilience operationalisations, and therefore only operationalisations matter when it comes to conceptually achieving harmony of efforts. Additionally, it was concluded that different measurement levels and the distinction to universal and context-specific indicators can be used to explain differences in resilience operationalisations. When it comes to the in-sector cohesiveness, common outcome reference points and shared concepts were present

within each sector. Between sectors, resilience operationalisations, their outcome reference points and shared concepts seemed to be used in a somewhat isolated manner. Also, it was noted that among operationalised indicators both qualitative and quantitative approaches were common.

When it comes to determining if conceptual heterogeneity exists among the professional resilience measurement methodologies, this thesis analysed both intra-sectoral and inter-sectoral conceptual cohesiveness. Intra-sectoral cohesiveness was based on the shared outcome reference points and used concepts within sectors. On the other hand, the inter-sectoral results did not provide a well-founded answer. It was concluded that SDRM and CI sectors are capable of collaborating in DRM, while DH and SDRM sectors are capable of collaborating in CCA. Overall, conceptual heterogeneity exists among most of the identified sectors. The prevalence based conclusion seems somewhat arbitrary and further studies are needed regarding resilience frameworks.

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# Annex 1: Tables

**The capacity to absorb in the resilience definitions * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The capacity to absorb in the resilience definitions | No | Count | 4 | 1 | 0 | 0 | 0 | 1 | 6 |
| | | % within The sector of the actor/partnership | 19.0% | 8.3% | 0.0% | 0.0% | 0.0% | 33.3% | 12.2% |
| | Yes | Count | 17 | 11 | 7 | 3 | 3 | 2 | 43 |
| | | % within The sector of the actor/partnership | 81.0% | 91.7% | 100.0% | 100.0% | 100.0% | 66.7% | 87.8% |
| Total | | Count | 21 | 12 | 7 | 3 | 3 | 3 | 49 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 1. The capacity to in resilience definitions by sectors (Miettinen, 2017).*

**The capacity to adapt in the resilience definitions * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The capacity to adapt in the resilience definitions | No | Count | 8 | 4 | 2 | 0 | 3 | 2 | 19 |
| | | % within The sector of the actor/partnership | 38.1% | 33.3% | 28.6% | 0.0% | 100.0% | 66.7% | 38.8% |
| | Yes | Count | 13 | 8 | 5 | 3 | 0 | 1 | 30 |
| | | % within The sector of the actor/partnership | 61.9% | 66.7% | 71.4% | 100.0% | 0.0% | 33.3% | 61.2% |
| Total | | Count | 21 | 12 | 7 | 3 | 3 | 3 | 49 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 2. The capacity to adapt in resilience definitions by sectors (Miettinen, 2017).*

**The capacity to recover in the resilience definitions * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The capacity to recover in the resilience definitions | No | Count | 10 | 6 | 2 | 3 | 2 | 2 | 25 |
| | | % within The sector of the actor/partnership | 47.6% | 50.0% | 28.6% | 100.0% | 66.7% | 66.7% | 51.0% |
| | Yes | Count | 11 | 6 | 5 | 0 | 1 | 1 | 24 |
| | | % within The sector of the actor/partnership | 52.4% | 50.0% | 71.4% | 0.0% | 33.3% | 33.3% | 49.0% |
| Total | | Count | 21 | 12 | 7 | 3 | 3 | 3 | 49 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 3. The capacity to recover in resilience definitions by sectors (Miettinen, 2017).*

**The inputted primariy data * The specified level of the MM**

| | | | The specified level of the MM | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Household | Community | City | National/Regional | Multiple/Context-dependent | Single system: infrastructure/ ecological | Unclear/Not specified | Total |
| The inputted primariy data | Not specified/No primary data source | Count | 4 | 5 | 4 | 2 | 5 | 1 | 2 | 23 |
| | | % within The specified level of the MM | 25.0% | 35.7% | 57.1% | 66.7% | 55.6% | 33.3% | 66.7% | 41.8% |
| | Survey | Count | 4 | 1 | 0 | 1 | 0 | 1 | 0 | 7 |
| | | % within The specified level of the MM | 25.0% | 7.1% | 0.0% | 33.3% | 0.0% | 33.3% | 0.0% | 12.7% |
| | Interview/Focus group | Count | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 4 |
| | | % within The specified level of the MM | 18.8% | 7.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 7.3% |
| | Survey + Key informant interview/focus group | Count | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 6 |
| | | % within The specified level of the MM | 25.0% | 14.3% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 10.9% |
| | Field observations/Workshop exercise | Count | 0 | 3 | 1 | 0 | 0 | 1 | 0 | 5 |
| | | % within The specified level of the MM | 0.0% | 21.4% | 14.3% | 0.0% | 0.0% | 33.3% | 0.0% | 9.1% |
| | Survey+Interview/FGD+Field/Workshop | Count | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 4 |
| | | % within The specified level of the MM | 6.3% | 14.3% | 14.3% | 0.0% | 0.0% | 0.0% | 0.0% | 7.3% |
| | Contextually-specified/Multiple options listed | Count | 0 | 0 | 1 | 0 | 4 | 0 | 1 | 6 |
| | | % within The specified level of the MM | 0.0% | 0.0% | 14.3% | 0.0% | 44.4% | 0.0% | 33.3% | 10.9% |
| Total | | Count | 16 | 14 | 7 | 3 | 9 | 3 | 3 | 55 |
| | | % within The specified level of the MM | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 4. The inputted primary data types by specified level (Miettinen, 2017).*

**The inputted secondary data * The specified level of the MM**

| | | | The specified level of the MM | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Household | Community | City | National/Regional | Multiple/Context-dependent | Single system: infrastructure/ ecological | Unclear/Not specified | Total |
| The inputted secondary data | Not Specified/Unclear/No data sec data | Count | 9 | 4 | 2 | 2 | 2 | 1 | 3 | 23 |
| | | % within The specified level of the MM | 56.3% | 28.6% | 28.6% | 66.7% | 22.2% | 33.3% | 100.0% | 41.8% |
| | Public domain database/Census | Count | 2 | 7 | 2 | 1 | 1 | 1 | 0 | 14 |
| | | % within The specified level of the MM | 12.5% | 50.0% | 28.6% | 33.3% | 11.1% | 33.3% | 0.0% | 25.5% |
| | Generic data review | Count | 5 | 2 | 0 | 0 | 3 | 1 | 0 | 11 |
| | | % within The specified level of the MM | 31.3% | 14.3% | 0.0% | 0.0% | 33.3% | 33.3% | 0.0% | 20.0% |
| | Public domain + Generic data review | Count | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| | | % within The specified level of the MM | 0.0% | 7.1% | 14.3% | 0.0% | 0.0% | 0.0% | 0.0% | 3.6% |
| | Contextually-specified/Multiple options listed | Count | 0 | 0 | 2 | 0 | 3 | 0 | 0 | 5 |
| | | % within The specified level of the MM | 0.0% | 0.0% | 28.6% | 0.0% | 33.3% | 0.0% | 0.0% | 9.1% |
| Total | | Count | 16 | 14 | 7 | 3 | 9 | 3 | 3 | 55 |
| | | % within The specified level of the MM | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 5. The inputted secondary data types by specified level (Miettinen, 2017).*

**The prevalence of primary and secondary data inputs * The sector of the actor/partnership**

| | | | The sector of the actor/partnership | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Development/ Humanitarian | Safety/DRM | Critical infrastructure/ Utilities | Social welfare | Economic | Environmental | Total |
| The prevalence of primary and secondary data inputs | Context-dependent/Not specified | Count | 6 | 3 | 6 | 0 | 1 | 0 | 16 |
| | | % within The sector of the actor/partnership | 25.0% | 25.0% | 75.0% | 0.0% | 25.0% | 0.0% | 29.1% |
| | Mainly primary (with generic literature review) | Count | 13 | 3 | 1 | 1 | 0 | 2 | 20 |
| | | % within The sector of the actor/partnership | 54.2% | 25.0% | 12.5% | 25.0% | 0.0% | 66.7% | 36.4% |
| | Only secondary data | Count | 3 | 3 | 1 | 2 | 3 | 1 | 13 |
| | | % within The sector of the actor/partnership | 12.5% | 25.0% | 12.5% | 50.0% | 75.0% | 33.3% | 23.6% |
| | Mixed | Count | 2 | 3 | 0 | 1 | 0 | 0 | 6 |
| | | % within The sector of the actor/partnership | 8.3% | 25.0% | 0.0% | 25.0% | 0.0% | 0.0% | 10.9% |
| Total | | Count | 24 | 12 | 8 | 4 | 4 | 3 | 55 |
| | | % within The sector of the actor/partnership | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

*Table 6. The primary and secondary data inputs by sector; 'unclear' data types included (Miettinen, 2017).*

# Annex 2: Conceptual list of resilience operationalisations

## Development/humanitarian indicators

| | |
|---|---|
| Adaptive capacity | Livestock ownership<br>Asset ownership<br>Food expenditure<br>Coping strategies<br>Informal safety nets<br>Psychological strength<br>Household cohesion<br>Savings and financial safety nets<br>Substitutable and diverse assets/resources<br>Social safety nets |
| Social safety nets | Cash transfers/in-kind transfers/support from relatives<br>Loans<br>Transfers<br>Support networks and social capital, relationship with spouse |
| Adaptive capacity | Livelihood diversification<br>Access to land<br>Labour capacity<br>Food preservation and storage<br>Assets and income<br>Climate information |

| | |
|---|---|
| | Basic services<br>Participation, coping strategy index |
| Transformative capacity | Access to basic services: water and sanitation, education, health, productive<br>Local social protection systems<br>Access to credit and savings<br>Early warning systems<br>Women's and youth empowerment<br>Community leadership, cohesion and peace building<br>Leadership/decision-making & empowerment<br>Innovation<br>Strategy, policy & planning |
| Economic | Trends/state<br>Assets<br>Connectivity (financial assets & economic diversity)<br>Access to economic resources (income)<br>Income diversification, investment on farmland production, propensity to save, good work ethic, joint decision-making with spouse, contingency funds<br>Income, savings and debt |

| | |
|---|---|
| | Income, savings and debt<br>Abstract |
| Ecology | Abstract<br>Abstract |
| Governance | Abstract<br>Community leadership & Rights awareness and advocacy & Integration with development planning<br>Access to funding and partnerships & Accountability & Inclusion of vulnerable groups & Women's participation |
| Urban growth | Abstract |
| Anticipatory capacity | Preparedness & planning<br>Anticipatory capacity & Coordination & mobilisation<br>Risk information |
| Social | Social networks & information (civil society participation)<br>Household structure (family size)<br>Gender & social equality<br>Drinking, openness to change, engaging community, family planning, reliance on remittances to make strategic investments |

| | |
|---|---|
| | Abstract<br>Abstract<br>Aspirations for better life<br>Child inclusion in decision-making, gender equality, psychological resilience<br>Access to and participation in networks and institutions<br>Peace and security & political relationships |
| Shocks & stressors | Trends<br>Interactions<br>Exposure and resilience to shocks<br>Climate change adaptation<br>Illness score<br>Sensitivity<br>Psychological resilience, gender-based violence, risk awareness and mitigation, physical abuse prevention |
| System | Interactions |
| Access to basic services | Electricity sanitation, proximity to services<br>Domestic water supply<br>Sanitation and hygiene<br>Housing, clothing and energy<br>Health and health care |

| | |
|---|---|
| | Telecommunications, electric power, distance to water, distance to work, school drop-out<br>Sanitation, water, lighting & electricity, cooking energy, water disposal, education, distance to services<br>WASH, housing<br>Social safety nets |
| Assets | Wealth index<br>Agricultural land area<br>Livestock<br>Harvested crops<br>Agricultural asset index<br>Agricultural assets & technology<br>Non-agricultural assets<br>Farm assets<br>Non-farm assets<br>Value of productive assets, net debt, income<br>Income, agricultural wealth, plot size, agricultural assets, wealth index, tropical livestock |
| Human capital | Education & skills<br>Education<br>Education & skills |

| | |
|---|---|
| Food security | Food & nutrition access<br>Food security level and access<br>Coping strategies index<br>Food consumption score<br>Access to food year around<br>Food security level<br>Food security & nutrition level<br>Food consumption score, household dietary diversity, household food insecurity access scale |
| Physical | Abstract<br>Abstract<br>Infrastructure (water, road, railway, telecommunication) |
| Institutional | Abstract |
| Political | Abstract |
| Natural (capital) | Abstract<br>Natural resources and associated services (farming, fishing & erosion protection, storm protection) |
| Financial | Abstract<br>Income, pension, remittances<br>Productive goods and services |

| | |
|---|---|
| Human (capital) | Abstract<br>Skills & knowledge<br>Health |
| Risk assessment | Hazard assessment<br>Vulnerability and capacity assessment<br>Local and scientific methods for risk awareness |
| Knowledge and education | Public awareness & knowledge & Dissemination of DRR knowledge & Cultural attitudes and values |
| Risk management and vulnerability reduction | Sustainable environmental management & Access to health care in emergencies & Health access and awareness in normal times & Food and water supplies & Hazard-resistant livelihoods & Access to market & Social protection, Access to financial services, Income and Asset protection, Infrastructure and basic services, & Land-use and planning & Education in emergencies |
| Peace building | Abstract |
| Social-ecological system interactions | Abstract |

## Safety/Disaster Risk Management

| | |
|---|---|
| Adaptive capacity | Governance<br>Institutions<br>Technical and learning<br>Planning systems<br>Funding structures |
| Vulnerability | Climate<br>Environment capacity<br>Resource capacity<br>Infrastructure<br>Community<br>Demographic<br>Social capital<br>Economic<br>Government<br>Environment |
| Community | Housing<br>Health & social services<br>Economic recovery<br>Community planning<br>Social connectedness<br>Infrastructure systems<br>Natural and cultural resources<br>Threats and hazard identification<br>Risk and disaster resilience assessment (Risk awareness and preparedness)<br>Collaborative networks |

| | |
|---|---|
| | Civic capacity<br>Long-term vulnerability reduction (building codes, higher standards, mitigation investment) |
| Legal and institutional | Effectiveness of legislative framework & effectiveness of institutional arrangements |
| Awareness and capacity building | Training and capacity building & advocacy<br>Communication<br>Education and public awareness |
| Critical services and infrastructure | Abstract 'resiliency' |
| Planning | Emergency preparedness, response and recovery<br>Development planning and regulation<br>Risk mitigation |
| Social vulnerability | Personal disruption<br>Population composition<br>Poverty<br>Labour force structure<br>Housing characteristics<br>Housing disruptions |
| Gentrification vulnerability | Retiree migration<br>Urban sprawl |

| | |
|---|---|
| | Natural amenities |
| Coastal management | Land-use & structural design<br>Coastal resource management |
| Community development | Governance<br>Society & economy |
| Disaster management | Risk knowledge<br>Warning & evacuation<br>Emergency response<br>Disaster recovery |
| Personal | Critical awareness<br>Action coping<br>Positive/Negative outcome expectancy<br>Self-efficiacy<br>Intentions |
| Community | Sense of community<br>Community participation<br>Cognitive empowerment<br>Social support<br>Diversity<br>Articulating problems/Leadership |
| Institutional | Empowerment<br>Trust |
| Governance and financial issues | Organization and coordination |

| | |
|---|---|
| | Learning: capture, publish and share data<br>Mainstreaming of disaster resilience<br>Risk assessment<br>Update process<br>Financial plan and budget<br>Contingency fund<br>Incentives and financing for business<br>Community organizations and citizens<br>Financing or resilience expenditures |
| Planning and disaster preparation | Land-use effectiveness and use zoning in preventing exposure build-up<br>Building codes<br>New development (built environment and ecosystem service integration)<br>Ecosystem services (awareness, health and policies)<br>Skills and experience<br>Public education and awareness &<br>Learning from others<br>Training delivery<br>Languages (cohesion)<br>Protective infrastructure |

| | |
|---|---|
| | Grass roots organizations &<br>private sector/employers &<br>Systems of engagement<br>Communication<br>Electricity, water and sanitation, gas, transportation<br>Law and order, First responders<br>Structural facility safety: education, health care, administrative operations, computer systems & data |
| Disaster response and post-event recovery | Recovery planning<br>Early warning<br>Event management plans<br>Staffing/responder needs<br>Equipment and relief supply needs<br>Food, shelter, staple goods and fuel supply<br>Interoperability and inter-agency compatibility<br>Drills |
| Disaster risk management | Risk and vulnerability<br>Public engagement<br>Planning integration<br>Disaster preparedness and recovery<br>Hazard mitigation implementation |
| Health & wellbeing | Minimal human vulnerability |

| | |
|---|---|
| | Diverse livelihoods & employment<br>Effective safeguards to human life & health |
| Leadership & strategy | Effective leadership & management<br>Empowered stakeholders<br>Integrated development planning |
| Infrastructure & ecosystems | Reliable mobility & communications<br>Effective provision of critical services<br>Reduced exposure & fragility |
| Economy & society | Sustainable economy<br>Comprehensive security & rule of law<br>Collective identity & community support |

## Critical Infrastructure/Utilities

| | |
|---|---|
| Organisational | Clear recovery priorities<br>Proactive posture<br>Change readiness<br>Communication and warning<br>Information and technology |

| | |
|---|---|
| | Insurance<br>Planning strategies<br>Drills and response exercises<br>Internal resources & funding<br>Adaptation |
| Infrastructure | Reduced exposure & fragility |
| Governance | Abstract |
| Robustness | Redundancy<br>Prevention/Mitigation<br>Maintaining key functions<br>Structural & procedural & interdependencies<br>Indicator under development |
| Recovery | Restoration & coordination<br>Abstract<br>Disturbance duration |
| Resourcefulness | Training/Exercises<br>Awareness<br>Protective measures<br>Stockpiles<br>Response<br>New resources<br>Alternative sites |
| Redundancy | Structural & Procedural & Interdependencies |

| | |
|---|---|
| Safe-to-fail | Structural & Procedural |
| Networks | Breaking silos<br>Leveraging knowledge<br>Effective Partnerships<br>Connectivity |
| Leadership | Situation awareness<br>Leadership<br>Staff engagement and involvement<br>Decision making authority<br>Innovation and creativity<br>Effective leadership & management<br>Empowered stakeholders<br>Integrated development planning |
| Economy/society | Abstract<br>Abstract<br>Sustainable economy<br>Comprehensive security & rule of law<br>Collective identity & community support |
| Risks | Flood risk (exposure and consequences)<br>Threat, likelihood, consequence |
| Prepare | Abstract |

| | |
|---|---|
| Withstand | Abstract |
| Adapt | Abstract |
| Predictive capacity | Abstract |
| Absorptative capacity | Abstract |
| Reactive capacity | Abstract |
| Restorative | Abstract |
| Civil society | Abstract |
| Critical infrastructure | Abstract |
| Supply chain/Dependencies | Abstract |
| Buffering capacity | Abstract |
| Social capital | Abstract |
| Environmental capital | Abstract |
| Financial capital | Abstract |
| Profitability | Abstract |
| Diversity | Abstract |

| | |
|---|---|
| Information & learning | Abstract |
| Self-organization | Abstract |
| Transformability | Abstract |
| Equitability | Abstract |

## Social welfare

| | |
|---|---|
| Self-efficacy | Education<br>Health<br>Material wellbeing |
| Social capital | Strong & stable families<br>Community networks<br>Active citizenship<br>Media and communications<br>Crime and anti-social behaviour |
| Enabling environment | Local economy<br>Public services<br>Crime and anti-social behaviour<br>Infrastructure<br>Belonging |
| Health and safety | Personal health and wellbeing<br>Community connectedness<br>Lifelong learning<br>Service availability |

| | |
|---|---|
| Local economy | Economic activity<br>Employment<br>Income and wealth<br>Skills<br>Diverse and innovative economy |
| Built and natural environment | Disaster vulnerability<br>Housing<br>Transport accessibility |
| Culture | Arts and cultural activities<br>Cultural diversity<br>Values |
| Democratic and engaged community | Citizen engagement<br>Shared notions of belonging and identity<br>Inclusive communities |
| Demography | Population size & structure<br>Population stability<br>Diversity<br>Income support and concessions |
| Population | Individual resources<br>Age profile<br>Capacity to engage<br>Population stability<br>Diversity and difference |

| | |
|---|---|
| Physical context | Physical environment<br>Facilities and amenities<br>Service provision<br>Links to power and influence<br>Housing<br>Community infrastructure (services and facilities) |
| Human | Knowledge, skills and learning |
| Community dynamics and stability and contextual state | Abstract |
| Governance | Engaged governance |

## Economic

| | |
|---|---|
| Preparation | Readiness and response |
| Performance | Recovery<br>Taking advantage and learning |
| Economic | GDP per Capita<br>Political risk<br>Oil intensity<br>Diversity<br>Workforce capacities<br>Business presence<br>Labour market state<br>Assets and infrastructure |

| | |
|---|---|
| | Scale and proximity<br>(interconnectedness) |
| Risk | Exposure to natural hazard<br>Quality of natural hazard risk management<br>Quality of fire risk management |
| Supply chain | Control of corruption<br>Infrastructure<br>Local supplier quality |
| Macro-economy | Productivity<br>Reconstruction rate |
| Micro-economy (household) | Income (economic state)<br>Inequality<br>Risk inequality<br>Basic services (smoothing effect)<br>Risk sharing |

## Environmental

| | |
|---|---|
| Land diversity | Landform variety<br>Landform and species relationships<br>Elevation range<br>Wetland score<br>Soil diversity |

| | |
|---|---|
| Land permeability | Local connectedness<br>Water permeability |
| Reef ecology | Coral associates<br>Fish functional groups<br>Connectivity<br>Anthropogenic factors<br>Benthic state<br>Substrate and reef morphology<br>Cooling and flushing<br>Shadowing and screening<br>Extreme conditions and acclimatization<br>Coral population structure |
| Landscape/seascape diversity and ecosystem protection | Diversity<br>Ecosystem protection<br>Ecological interactions |
| Biodiversity | Level of general and agricultural biodiversity |
| Knowledge and innovation | Innovation in agriculture and conservation practices<br>Traditional knowledge<br>Documentation of biodiversity-associated knowledge<br>Women's knowledge<br>Social equity |

| | |
|---|---|
| Governance and social equity | Rights in relation to land/water & other natural resources management capacity<br>Community-based land/seascape governance platform<br>Coordination capital |
| Livelihoods and well-being | Socio-economic infrastructure<br>Human health and environmental conditions<br>Income diversity<br>Biodiversity-based livelihoods<br>Socio-ecological mobility |

# Annex 3: Self-made supplemental list of NGOs and IOs

African Union

CARE International

Catholic Relief Services

European Union

Food and Agriculture Organization of the United Nations

International Committee of The Red Cross

International Federation of Red Cross and Red Crescent Societies

Plan International

Swedish Civil Contingencies Agency

United Nations Children's Fund

United Nations Office for Disaster Risk Reduction

United Nations World Food Programme

World Bank

World Health Organization

World Vision