An SDI assessment framework for emergency response data provision readiness

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Abstract

Well-established information flows are vital for the disaster management cycle. Thanks to spatial data infrastructures (SDIs), the facilitation and coordination of the exchange and sharing of spatial data between stakeholders in the spatial data community can be efficiently sustained. In Turkey, there is a continuing effort for the establishment of a national SDI and a national emergency response system (ERS). The Turkish ERS, AYDES has been gathering data from various sources. This situation causes problems with the interoperability of data and organizations. On the other side, there is an already established SDI developed specifically for the nation-wide ERS of the Netherlands, and a previous study shows that the users of this system are mainly content with its benefits. However, before directly linking the Turkish NSDI to ERS, its data provision readiness should be assessed to detect the points that need improvement before further possible linking efforts.

The main purpose of this study is to design an assessment framework to measure emergency response data provision situations of SDIs and see to what extent can an SDI assessment framework be used to determine and improve the capabilities of an NSDI. For this, first of all, literature research was conducted and the relationship between the SDI framework and data provision during the emergency response was examined. The emergency response approaches of Turkey and the Netherlands were investigated and the data provision needs of emergency response information managers were determined. These determinations were then used to finalize the assessment framework. With the created framework, the Netherlands' emergency response SDI, Geo4OOV, and Turkey's NSDI, TUCBS, which is still in the process of being completed, were assessed and compared in terms of emergency response data provision readiness. The results are expected to benefit the further development efforts for the emergency response data provision of both countries.

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AFAD	Afet ve Acil Durum Yönetimi Başkanlığı
AYDES	Afet Yönetimi ve Karar Destek Sistemi
ERS	Emergency Response System
GI	Geographical Information
GIS	Geographic Information System
GPS	Global Positioning System
ICT	Information and Communication Technology
IFV	Instituut Fysieke Veiligheid
INSPIRE	Infrastructure for Spatial Information in the European Community
LCMS	Landelijk Crisis Management Systeem
NSDI	National Spatial Data Infrastructure
OGC	Open Geospatial Consortium
SDI	Spatial Data Infrastructure
TAMP	Türkiye Afet Müdahale Planı
TUCBS	Türkiye Ulusal Coğrafi Bilgi Sistemi
UN	United Nations
VSM	Viable System Model
WFS	Web Feature Service
WMS	Web Map Service
WMTS	Web Map Tile Service

CHAPTER 1: Research Introduction

1.1. Introduction

According to the United Nations (UN), the effects of disasters are growing year by year while their number is also increasing. Especially after the 1980s, dealing with the disasters globally has got a whole new level of significance with the revealing climate change effects (UNISDR, 2015). The disasters are hampering sustainable growth and development globally, causing deaths, hazards, economic losses and environmental changes. To guide member states in building up resilience against the disasters, Sendai Framework outlines main targets, priorities and relevant actions. Among many, two issues Sendai Framework emphasizes are: (1) the importance of the information management and (2) the use of geographic information systems (GIS) (UNISDR, 2015). The importance of GIS in disaster management is already accepted because geographic information is vital for all phases of the disaster management process, not just during the response stage. All disaster and emergency events are attached to geographic information by their nature (Manfré et al., 2012; Zlatanova & Fabbri, 2009). GIS is a valuable tool to utilize this information for search, detection, analysis and management activities. However, there are numerous effects for the management of emergencies and disasters requiring various input data and effective use of them in a limited time.

An efficient way to sustainably manage spatial information is spatial data infrastructures (SDI). SDIs are the concepts and related setups to facilitate and coordinate the exchange of spatial data among the stakeholder groups (Rajabifard, Feeney, & Williamson, 2002). From local to continental, SDIs are varying in scales, capabilities and they can be specified according to their establishment aims. Countries are establishing and using these infrastructures for disaster management because this concept facilitates a base for integrating different applications and tools along with their supervised data, accessible through authorized network services. The decision-makers can have the advantage of using timely, accurate and current data thanks to these systems.

As a UN member state and a country dealing with various disasters, Turkey is liable for the Sendai Framework and, thus, responsible for taking action to reach disaster management and resilience goals. There is already a national plan encouraging the organizations to implement information technologies including GIS (AFAD, 2013). Based on that plan, a nation-wide emergency response system (ERS) called AYDES has been developing in the last decade (Keskin et al., 2018). In parallel, The Directorate of Geographic Information Systems has been working on the set up a national spatial data infrastructure (NSDI) to gather data from various sources, supervise them and share them under dataset themes in accordance with the needs of user groups. However, the developing Turkish ERS collects the data directly from various organizations by relying on their data management capabilities. At this point, the advantage of using the Turkish NSDI becomes prominent because an SDI can provide the data supervision mechanism for unified quality, interoperability, usage, gathering and sharing purposes. An ERS can benefit the SDI platform for gathering nation-wide quality data. The readiness of SDI for such a mission should be assessed before implementing an affiliation between SDI and ERS.

1.2. Context and Problem Statement

Spatial information has become vital in all phases of emergency management, including the response phase because it helps decision-makers to determine the location of the emergency situations, as well as their scale and effects. There are a handful of data providers that could regularly gather and share data such as satellite images, topography, road networks, residential areas, etc. However, without governance and the coordination of the providers and the data they have, the efficiency would reduce significantly.

Turkey has to cope with natural disasters and other emergency situations every year. These incidents vary from forest fires to floods, earthquakes to terrorist attacks. The authorities seek more effective approaches that would help them to be ready before the incidents, to respond appropriately during them, and to recover quickly thereafter. There is a national action plan for disaster response named Disaster Response Plan of Turkey (TAMP, Türkiye Afet Müdahale Planı) and formally accepted in January 2014, aiming to provide instructions to all related organizations before, during and after different types of emergency situations (AFAD, 2013). The action plan provides content about responsible organizations, their missions and coordination between these organizations. It also encourages the use of technology and digital data that would help the effective response but it does not provide concrete directives for it. With this content, the plan leaves the options about the usage of these kinds of tools and data to the organizations.

During emergencies, information managers have to deal with massive amounts of information, which may sometimes incomplete or misleading, usually within limited time periods (Kowalski-Trakofler, Vaught, & Scharf, 2003). Emergency response systems (ERS) facilities diverse technological tools for helping authorities and civilians to overcome emergency and disaster situations with minimum harm. ERSs also let them be prepared before these situations and recover aftermath. Such systems need various up to date, detailed, and reliable datasets which can be retrieved in a timely and appropriate manner (Jennex, 2007; Mansourian et al., 2004). Clear communication and organization, integration of knowledge and its management along with a dynamic infrastructure are base components of properly working ERSs (Jennex, 2007). These components and requirements point out a system that can facilitate the relations between people and data.

Continuous data sharing with the emergency management community would help them to be affiliated with the data, its content, features, and even quality. In disaster situations, that would also implicitly create comfort for the actors who already have become acquainted with the data. In addition to that, it may cause the community to detect the errors beforehand, improve the data content, facilitate actuality and accuracy according to their needs (Snoeren et al., 2007).

A spatial data infrastructure (SDI) is an environment facilitating the organization of spatial data circulation, standards, access networks and related policies, along with the stakeholders (Rajabifard, Feeney, & Williamson, 2002). The main aim is the efficient use of resources, time and effort (Mansourian et al., 2004). Figure 1.1 shows a basic model consisting of five main components.

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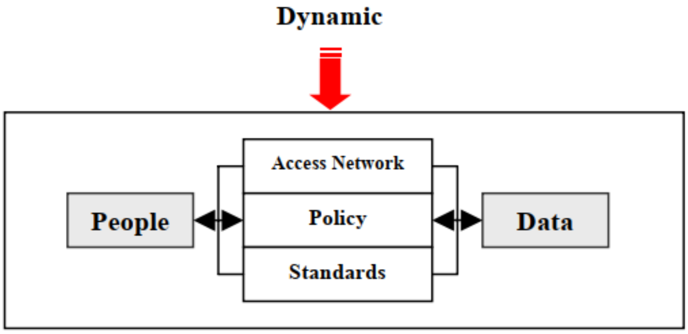

Figure 1.1: SDI components (Rajabifard et al., 2002)

According to the model, facilitation of the relationship between people (data gatherers, data sharers, decision-makers) and data relies on the appropriate access network, policies and standards. The development of an SDI concept requires the establishment of these core components in relation to each other. In this way, availability, access and usage of data can serve for various purposes, including emergency response. The disasters and emergency events are mostly unpredictable and the management of these situations brings the requirement for diverse and real-time datasets at very short notice. Therefore, multiple organizations should work together to collect and update the required data before, during and after emergency situations (Mansourian et al., 2006).

The initial development period of Turkish national spatial data infrastructure (TUCBS, Türkiye Ulusal Coğrafi Bilgi Sistemi) has reached its final phases recently. It has become official with the enactment of the related laws in 2018, 2019, 2020 and 2021. Based on these laws, the documents about organization coordination, data needs, access networks, metadata, datasets are also published for the first time by the Turkish Ministry of Environment and Urbanism, the organization responsible for the development of the national spatial data infrastructure (NSDI). Considering the recent developments in NSDI establishment and the constant search for better emergency response capabilities, an affiliation between NSDI and nation-wide emergency response system can be fruitful to the efforts of improving both the emergency response capabilities and NSDI maturity in Turkey.

Concurrently, there is continuous work for the development of a nation-wide ERS to assist Disaster and Emergency Management Presidency (AFAD, Afet ve Acil Durum Yönetimi Başkanlığı) in the management of disaster and emergency mitigation, preparation, response and recovery phases. Disaster Management and Decision Support System (AYDES, Afet Yönetim ve Karar Destek Sistemi) is a software integrating internal and external services for current and accurate data provision, analysis, reporting and organization. For AYDES components, various data are gathered from diverse sources and these data are shared under themes set up in accordance with their purpose of use. The governmental organizations are the main contributors to the thematic datasets of AYDES. However, unlike the ERS of The Netherlands, these organizations supply the data separately from each other rather than through an SDI or NSDI (Keating, 2016; Keskin et al., 2018).

As discussed before, an ERS can efficiently work at the national scale through continuous and unified data provision may be what the countries need for future emergency response actions. Therefore, the main problem of this study is specified as *lack of unified data provision for a national emergency response system*. Deriving from the main problem, the focus area of this study is designing an SDI assessment framework to evaluate the readiness of an SDI in terms of data provision to nation-wide ERS for effective emergency response and disaster management. This research will be carried out as a contribution to the NSDI and ERS works of the Turkish Ministry of Environment and Urbanism as well as academic literature. Therefore, the background research on current situations of NSDI and ERS in Turkey will mostly be focused on the works of the ministry and Disaster and Emergency Management Presidency (AFAD).

1.3. Research Objectives

The main objective of this study is to design an SDI assessment framework to evaluate Turkish NSDI in terms of data provision for national ERS. To reach the ultimate goal of the thesis, researching the relation between ERS and SDI, investigating current ERS usage in Turkey and in the Netherlands in order to learn from each country's experiences, determining the user needs of the emergency response information managers, designing the assessment framework based on these user needs and previous studies, measuring the relevant SDI capabilities in terms of data provision for ERS are the steps that will be taken. These steps can be translated to the research objectives of the study as below:

- Examining the relationship between the SDI framework and data provision during emergency response.
- Examining the national emergency response approaches in the Netherlands and Turkey; investigating current nation-wide ERSs to make a further comparison between the approaches of both countries.
- Examining recent SDI assessment researches on emergency response.
- Determining the needs of emergency response information managers in Turkey in terms of spatial data provision.
- Developing an emergency response SDI assessment framework based on recent assessment studies and needs of Turkish emergency response information managers.
- Examining the Turkish NSDI in terms of data provision capabilities for ERS.

Based on these objectives, the main research question of the study is:

To what extent can an SDI assessment framework be used to determine and improve the capabilities of an NSDI in terms of data provision for an emergency response system?

The research goals can be turned into sub-questions under the main research question, to focus on substantial and particular kinds of data within the study (Agee, 2009). To answer this question extensively and to reach the goals of the study, the following research sub-questions are formulated:

1. How may an SDI be assessed in terms of emergency response data provision according to the academic literature? (Chapter 2)
2. What are the SDI and data needs of the emergency response information managers in Turkey and the Netherlands for nation-wide ERS and how do these needs translate into performance indicators in the SDI assessment framework? (Chapter 3)
3. How does the Turkish NSDI perform according to the developed SDI assessment framework? (Chapter 4)
4. How does the Dutch ERS SDI perform according to the developed SDI assessment framework? (Chapter 5)
5. In the context of the assessment framework, what may these countries learn from each other? (Chapter 6)

1.4. Research Scope and Inputs

The main beneficiary of this study is The General Directorate of Geographic Information Systems (CBSGM, Coğrafi Bilgi Sistemleri Genel Müdürlüğü) because of their intention to improve the capacity of Turkish NSDI. Also, Turkey's Disaster and Emergency Management Authority (AFAD) would benefit from the outcomes of this research for the development process of the emergency response system they are working on. For this reason, this study focuses on the needs of these two governmental organizations and aims to serve the improvement efforts for both Turkish NSDI and ERS.

This research aims to present an assessment framework resulting from literature and qualitative researches. The main aim of the assessment is to measure the capabilities of SDI in terms of information facilitating. However, the technical and the economic details are out of the context of the thesis. Additionally, the SDI concept mostly concerns the sharing of rather static data, while in emergency response, real-time data is also very important. In this study, the data provision refers to both static and dynamic data provision. The main data sources of the project are literature research on ERS and SDI, a review of Turkish and Dutch ERSs, research on Turkish NSDI features, and context information gathered from the interviews. The expected outcomes of the research are the presentation of the current ERS approaches of both countries, ERS assessment principles translated from the user needs of the interviewees and recent studies, and analysis of Turkish NSDI in terms of emergency response capabilities. This study could be helpful for a nation-wide ERS establishment in Turkey, interesting both emergency managers and system developers.

1.5. Methodology

The main research question of the study is deconstructed into research sub-questions according to the sub-objectives that would lead to reaching the main objective of the study eventually. Each following chapter of the study is allocated to these objectives and associated research questions (see Figure 1.2). The study starts with gathering information through literature research and interviews (Chapters 2 and 3), continues with processing the collected information to build a framework (Chapter 3) and concludes with the application of the framework (Chapter 4 and 5) and evaluation of the SDIs (Chapter 6). The aims of the interviews are to gather background information about the NSDI and ERS, their current development stage, data capabilities, current use, information management within the systems, and relevant activities of the interviewees. The content per chapter, employed research methodologies and relation to the research sub-questions are summarized as follows:

Chapter 2 (Q1) – Theoretical Background on SDI and ERS: The theoretical background on SDI-ERS association and the SDI assessment studies from the literature will be investigated in this chapter. The recent studies on emergency response-related SDI assessment will be examined and synthesized to create a base for this research.

Chapter 3 (Q2) – Exploring the User Needs: Through one-on-one semi-structured interviews and surveys with (three each) Turkish and Dutch information managers, the needs of emergency response information managers in Turkey and the Netherlands in terms of data will be investigated and translated to SDI assessment indicators. Based on the principles translated from examined recent studies and user needs, an SDI assessment framework will be proposed to measure the capabilities of an SDI in terms of data provision during an emergency or disaster situation.

In addition, to learn from the two countries, the current approaches of both countries on emergency response and use of ERSs, on large scales rather than local applications, will be reviewed. In addition to research of documentation, the interviews with Turkish and Dutch emergency response information managers will provide input for this chapter.

Chapter 4 (Q3) – Assessment of Turkish NSDI: The built assessment framework will be applied to Turkish NSDI (TUCBS). This will be carried out by interviewing the same information managers who were interviewed for user needs, and an NSDI employee from the ministry. This application of the assessment framework will provide an assessment of the capabilities of the NSDI for emergency response data provision, from the viewpoint of both information managers (who would be the potential users of the developing ERS) and the data provider.

Chapter 5 (Q4) – Assessment of Dutch Emergency Response SDI: The built assessment framework will be applied to Dutch ERS SDI (Geo4OOV). This will be carried out by interviewing the same information managers who were interviewed for user needs, in order to assess the capabilities of SDI for emergency response data provision and user satisfaction.

Chapter 6 (Q5) – Evaluation of the Dutch ERS SDI and Turkish NSDI: The application results of the framework of the previous two chapters will be evaluated in this chapter. In this way, the current states of both countries' SDI network in terms of emergency response data provision readiness and the capabilities of meeting the needs of emergency response information managers can be seen and the lessons can be derived. The derivations can provide feedback for further initiatives to improve the SDIs.

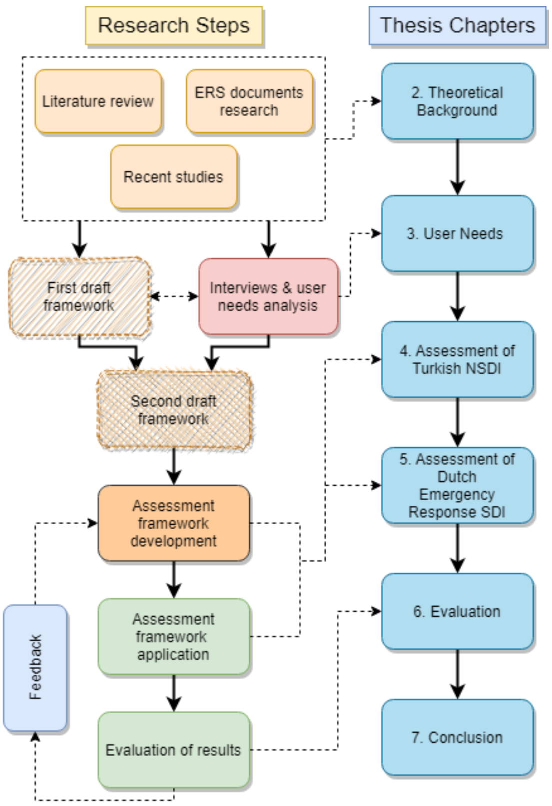

Figure 1.2: Study process diagram

1.5.1. User Definition and User Needs

'User' is one of the five main components of the SDI framework defined by Rajabifard et al. (2002) (see Figure 1.1). At the second phase of development, exploring the user needs has an important role to shape the framework for accurately serving the needs it is set up for. The user needs are the user's description of the features, functions, and characteristics for the product to be developed. Determining these needs make the developers able to understand the user groups and requirements of the system (Snoeren et al., 2007).

While talking about users, it is important to acknowledge different types of user groups relevant to SDI (van Loenen, 2009). The users can be defined and grouped according to their activities, needs, and settings of the system. Van Loenen (2009) distinguishes four different user groups and defines them as follows:

- Primary users: Regular collectors of information. They are generally members of the organizations which collect and process information.
- Secondary users: They are similar to primary users but not heavily focused on continuous data collection.
- Tertiary users: They add value to the framework by providing integrated datasets, access to them, or help information resources through their purposes. Value-added use or re-use can be referred to the tertiary use.
- End-users: They use end products of geographic information. This group typically includes average citizens, decision-makers and other groups using the products provided by tertiary users.

These user groups can be members and employees of various organizations, such as government and administrations, utility and public services, private companies, NGOs, research institutions, and non-profit organizations (van Loenen, 2009).

Charvat et al. (2013) recognize five user groups and list their activities for the development process of the EU HABITATS Project that includes a participatory process to design and validate data, metadata and services. End-users comprise both registered and non-registered ones using free data and services. Registered users can personalize their preferences, share their content with others, and use exclusive services through their accounts. Expert users have more authorization within the portal than end-users, as they can connect data and servers to manage context, define analysis and prepare to report. Content provider user groups are the collectors, publishers and editors of the data provided by them. They have a continuous responsibility to carry on these missions within the system. Lastly, Administrators are simply administrating the whole system with full access to the portal (Charvat et al., 2013). The activities of each group are listed in Table 1.1.

Table 1.1: User groups and activities (Charvat et al., 2013)

User Groups	Activities
Non-registered users	○ Search for data ○ Search for information ○ Personal content composition ○ Visualize information ○ Download free information ○ Use free services
Registered users	In addition to non-registered user activities, ○ Publish metadata ○ Personalized profile ○ Publish information ○ Share content with others ○ Use advanced services
Expert users	In addition to registered user activities, ○ Manage content among servers ○ Define analysis ○ Prepare reporting
Content providers	In addition to expert user activities, ○ Provide data on the web ○ Produce metadata ○ Assure quality of data and metadata ○ Define policies and license agreements
Administrators	Technically managing the system

This study particularly seeks to propose a link between ERS and NSDI at the governmental level. Therefore, the main governmental organizations managing the nation-wide ERS and NSDI, are the subjects of user needs and ideas detection. The users who will be interviewed to shape the proposed framework will be the people who have the responsibility of managing spatial/geographic information flow during crisis situations from the office. Three of them are from a Turkish provincial directorate and Turkish Disaster and Emergency Management Authority (AFAD), while three other participants are the employees of a Dutch safety region and Institute for Safety (IFV). These interviewees can be defined as secondary or tertiary users according to the user groups defined by van Loenen (2009) or a combination of registered and expert user groups defined by Charvat et al. (2013) as they are or they will be using the end products of geographic information for strategic and tactical decision-making, crisis management and communication.

The aims of the interviews are gathering background information about the NSDI and ERS, their current development stage, data capabilities, current usage, information management within the systems, relevant activities of the interviewees and their ideas along with their needs to establish a geographic information flow for effective emergency response.

1.5.2. Framework Development

This research is partially following the assessment development works of Keating (2016) and Visser (2020). As studies from Geographic Information Management and Applications (GIMA) program, both theses focus on creating assessment framework for crisis management or emergency response SDIs.

In his MSc thesis, Keating (2016) focuses on the Dutch emergency response system capabilities and its evaluation within the SDI framework through the principles of the Viable System Model (VSM). The study examines the current state of the information infrastructure and governance of the emergency response SDI network by seeking the user opinions and needs through emergency response employees from safety regions such as information manager/coordinator, safety region director, head of communications, and calamity coordinator. A maturity model for the evaluation of the current system is developed based on VMS's five subsystems: operations, coordination, management, future/planning, and system policy. Thereafter, the information governance in the Dutch emergency response network is evaluated with relevant authority (e.g. information manager at safety region, as the research indicates). The evaluation points out the bottlenecks and requirements of the current system and provides a path for further initiatives.

Visser (2020) developed a user-centric assessment framework for SDIs to be established for large-scale disaster events. The elements of the framework are derived through four different studies from geographic information literature: the works of Hennig and Belgiu (2011), Kleijn et al., (2014), Welle Donker and van Loenen (2017), and Zwirowicz-Rutkowska (2017). The interviews with relevant academic experts provided more ingredients for the assessment framework that the research presents.

In Visser's thesis, the indicators on data provision and related components are mainly adapted from these two researches above and the first draft of the assessment framework emerged. In addition, more indicators will be identified through the user needs analysis of interviews with Dutch and Turkish emergency response information managers as both referred researches recognize that the conventional SDI assessment approaches are inadequate without the involvement of user needs and user-related elements (Keating, 2016; Visser, 2020). The user analysis will hand in joining indicators translated directly from the emergency response decision-makers who are using the ERSs and the data within these systems. From the synthesis of these drafts, the final assessment framework will be developed.

1.5.3. Evaluation of the SDIs

The relevant SDIs of both countries will be evaluated by analyzing the second interviews and surveys with information managers using the final version of the developed assessment framework. These relevant SDIs are Geo4OOV of the Netherlands because it is basically the SDI project for security regions for security reasons, including emergency response; and TUCBS which is the NSDI of Turkey. Turkish NSDI is chosen for this assessment because Turkish ERS, AYDES, does not work with an established SDI specifically for disaster management or emergency response. Thus, Turkish NSDI is assessed instead, to see if the NSDI has the capabilities of data provision for Turkish ERS. The evaluation will be focused on data supply and interoperability within a short period of time, considering the activities during the response phase. Therefore, the sub-activities of relevant actors and needed datasets in that scenario will be identified. Then the SDIs will be assessed and evaluated through proposed data supply, interoperability and quality indicators by the interviewees. The results will provide the information about each SDI's readiness for emergency response and at what extent these systems are capable of meeting the needs of emergency response decision-makers.

CHAPTER 2: Emergency Response and SDI Affiliation

2.1. Introduction

This chapter aims to address the SDI and emergency response affiliation by examining the studies from literature and seeks to answer how the SDI framework would be helpful for effective data provision for emergency or disaster response. The chapter starts with the definition of emergency and disaster, referring to emergency and disaster management. Then, the historical progress of SDIs summarized and the importance of assessing the SDIs is descripted. Finally, two MSc theses are investigated to derive the initial metrics for data provision readiness.

2.2. Emergency and Response

Before mentioning the response or management of emergencies, it should be noted that the emergency and disaster terms are sometimes used interchangeably. However, the United Nations (UN) defines emergency and disaster terms as distinct from each other. According to the UN, an emergency is a disruptive situation which causes damages to society and the environment but could be handled by the affected societies and their local resources. As a more serious disruption, however, disasters cause more damage and wide-scale effects that surpass the coping abilities of the affected societies and would lead them to seek higher or external assistance (UN General Assembly, 2016). Both emergencies and disasters may claim lives and may cause physical, social, economic and mental damage to the people and the environment. Just in 2019, natural disasters affected nearly 95 million people, caused 11755 fatalities and cost 130 billion US dollars damage around the world (CRED, 2020). Apart from natural disasters such as earthquakes, tsunamis, bushfires, and cyclones, etc., disasters resulted from man-made, technological sources are also an issue (such as rapid climate change, nuclear accidents, fires caused by electronic tools, etc.).

Heatwaves in Europe claiming more than 2,500 lives in France, Belgium and the Netherlands is recorded as the deadliest global event of 2019. It is followed by the flood in India that lasted from July to October, killing nearly 2,000 people (CRED, 2020). Turkey also had to deal with remarkable disasters and emergencies in 2019. The number of the responded emergency situations was 3,724 and this record is significantly higher than the ones in 2017 (1465 situations), and 2018 (1788 situations). The floods are reported as the biggest disasters overall for Turkey in 2019 (AFAD, 2020). During the writing of this thesis, an earthquake of at least 6.6 magnitude struck the Turkish province İzmir on the 30th of October 2020, claiming 114 lives, and causing the destruction of many structures (Euronews, 2020). Even in one year, these events would change daily life dramatically and leave big impacts, hurting society, economy and environment.

Disasters and accidents cannot be fully stopped due to the dynamic nature of the environment and inevitability of human errors but could be partially prevented or their possible impacts could be mitigated (Lee & Bui, 2000). Disaster prevention and mitigation activities aim to be prepared before a disaster, responding quickly during the events and recovering aftermath. All these activities can be conceptualized as a continuous framework comprising the phases of mitigation, preparedness, response and recovery (see Figure 2.1). These phases constituting the so-called integrated disaster management cycle can be defined as follows (Simonovic, 2011):

Mitigation: Risk assessment and long-term planning to prevent or reduce the possible negative impacts before an emergency occurs. It involves stakeholders from the government and military, as well as local emergency services.

Preparedness: To acknowledge the possible problems beforehand, exercising the emergency plans and informing the related organs. Citizens also can be involved in this phase in addition to the previous.

Response: After the disaster or emergency occurs, the first activities such as search and rescue, first aid, and hazard assessment are included in this phase. The responders and managers have to deal with coordination, communication and information to get rid of the first impact as efficiently as possible. In this study, emergency response term will be referring to the response after disasters, rather than the response to small emergent occurrences.

Recovery: All activities aiming to rehabilitate the affected society and helping them to return their daily life.

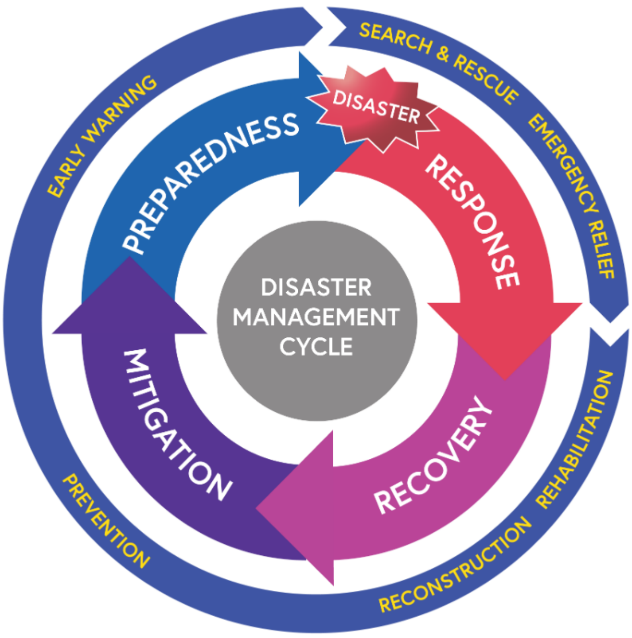

Figure 2.1: Disaster management cycle (FutureLearn.com)

In an emergency or disaster situation, multiple organizations form a network to respond to the situation, communicate, share data, and operational collaboration. As the situation advances, the settings, participants and other elements would evolve and change. Accordingly, the need for information will also change (Janssen et al., 2010). Figure 2.2 shows the life cycle of a crisis situation (such as a disaster). According to the figure, the crisis life cycle starts with prevention. Early signals of the situation should be paid attention to form a common operational picture beforehand. The biggest impact of the crisis will be observed in the response phase, needing timely and proper intervention (Janssen et al., 2010).

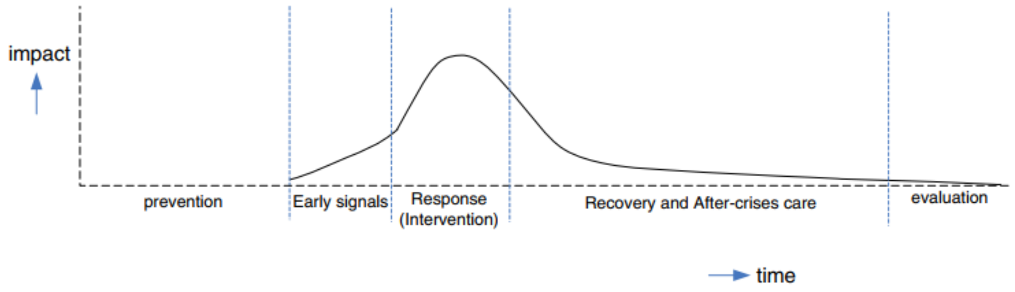

Figure 2.2: Life cycle of a crisis situation (Janssen et al., 2010)

After the recovery, the society, especially the authorities, may take lessons from the related happenings to boost themselves in terms of disaster and emergency resilience. The issues derived from past events could be addressed during the preparation of the new plans or reviewing the previous ones. This act points out to the mitigation phase again, creating a cycle. During all phases, various actions are taken involving many stakeholders. Cooperation of the organizations, coordination of the responsible people, documentation of the information, data gathering and dissemination, developing tools, research and more actions need to be carried continuously. There will be a constant information flow to be managed for effective emergency response.

2.3. Spatial Data Infrastructure (SDI)

The importance of geographic data in emergency and disaster management is undeniable. Location of the events, their impact areas, allocation of resources and services, affected people and environment are all vital information for the managers and decision-makers. Thanks to advancing technology, information and communication technologies are in favor of the management of emergencies and disasters, more than ever. Remote sensing, Global Positioning Systems (GPS), Geographic Information Systems (GIS), early warning systems, and the Internet are such well-known technologies to be used for data gathering, processing, analyzing and distributing. Having alternative ways to gather data could be an advantage but at the same time, handling masses of data would become an issue to address.

Spatial data infrastructures are the environments that enable users to facilitate and coordinate the exchange and sharing of spatial data between stakeholders in the spatial data community. They can be constituted varying in different sizes and scales. An SDI could service the specific missions for a municipality or can be used internationally as long as it is structured accordingly.

The importance of data infrastructures and correspondingly SDI had been recognized by international organizations through the end of the 1990s (Rajabifard, Feeney, & Williamson, 2002). All around the world, countries have been establishing and developing their SDIs at different levels and the SDI framework is dynamically improving because of this. Through their development journey, the SDI initiatives around the world accumulated through the identification of some key linkages and phases. The first generation of SDIs were the product-based platforms that were created with limited knowledge on SDI issues and dimensions. They were designed and developed as far as the countries' specific characteristics, requirements and priorities. Therefore, the general approach during their creation was a top-down and normative point of view. Thanks to the experiences of the practitioners and the related documentation of the first generation SDIs, the knowledge on related issues started to spread internationally (Rajabifard, Binns, Masser, & Williamson, 2006). The transition to the second generation of SDIs has come with the change of strategies and update of the SDI conceptual model but the biggest role belongs to the development of the modern internet which opened opportunities in terms of cost-effective data dissemination and sharing for nations (Masser, 2005). The focus was to facilitate the management of information assets through communication among the actors. Hence, SDIs within this generation were developed according to the so-called process-based development model. With the technological improvements and evolving political interests, the SDIs have become crucial instruments to handle the spatial data and application requirements of various users from both private and public organizations. That makes the late SDI development concepts more user-driven than they have ever been. It can be said that there is a new shift from the process-based second generation to user-centric third-generation SDI models (Hennig & Belgiu, 2011). To reveal its full potential, SDIs are started to be developed as user-centric because the main factor which makes an SDI successful is its users (Rajabifard et al., 2002). Recently, the SDI approach has been evolving and becoming more "open" by welcoming unusual stakeholders such as businesses, citizens and other non-governmental actors. The latest approach enables a transparent SDI structure, bringing more data sources and challenges along with it. impact of open SDI would compel the governments to review and improve their protocols and mechanisms (Vancauwenberghe & van Loenen, 2017).

2.4. Emergency Response and Data Sharing

Information flows have a tremendous role in the disaster management cycle. Thanks to advances in technologies such as remote sensing and GIS, there are many ways to gather, process and analyze spatial data. Being able to generate big amounts of information could be an advantage, but it is not very useful without efficient and effective coordination of stakeholders and organization of data dissemination. Sharing correct data with the correct actors in a timely manner without being hampered by technological barriers is a challenge for effective decision making during all phases of disaster management. At that point, the SDI framework provides an environment to overcome these challenges through effective and efficient data sharing.

A disaster is a continuously advancing situation; changes in urgency, impact, needed stakeholders, and people's needs for information and communication are expected. The dynamic nature of the disasters causes complexity and uncertainty of information management (Janssen et al., 2010). To answer the requirement of information management and data provision for disasters, various technologies have been developing. However, these technologies remain isolated from each other and even overlooked for any kind of emergency or disaster action (Janssen et al., 2010). If these technologies become integrated and used together, they would help to improve society's ability to effectively respond to complex and unpredictable events, Janssen et al. (2010) suggest.

Sharing already gathered data with other relevant organizations may help saving time, money and effort to gather those data again by another organization (Snoeren et al., 2007). Late delivered information would cause happening of unwanted damages or losses while too early information might be neglected or forgotten by the decision-makers (Janssen et al., 2010). During the disaster response phase, the timing would become even more important as the focus of the organizations would heavily be on the response activities such as taking care of affected people, seek and rescue, firefighting, etc. Hence, saving time would mean saving lives in such situations. Secondly, the data supplied by another organization may help the efforts of decision-makers for a better judgment in a crisis situation (Snoeren et al., 2007). (Janssen et al., 2010)(Janssen et al., 2010)(Janssen et al., 2010)

Continuous data sharing with the emergency management community would help them to be affiliated with the data, its content, features, and even data quality. In disaster situations, that also would implicitly create comfort for the actors who already get acquainted with the data. In addition to that, it may cause the community to detect the errors beforehand, improve the data content, facilitate actuality and accuracy according to their needs. Not just in the response phase, but also in the preparation phase, shared data would help the policy makers to prepare for crisis situations even better thanks to provided excessive information (Snoeren et al., 2007).

Having various datasets would help organizations to create their overviews of the disaster situation and share them with the citizens easily resulting in the development of mutual trust between these organizations and the citizens so the benefits of data sharing would go beyond the emergency response community (Snoeren et al., 2007).

From the mentioned benefits, Snoeren et al. (2007) draw two conclusions from data sharing among disaster response actors: 1) increases the efficiency of work and 2) improves the communication and collaboration among stakeholders.

In case of an emergency or a disaster, the initial outputs of spatial information (eg. impact analysis) would normally be cartographic products. To be able to extract meaningful, value-added information from these products, the availability of precise and accurately referenced geographic datasets is essential. The implementation of SDI generally provides user tools for data search, evaluation, acquisition and application, together with international level representation rules (Ajmar et al., 2010).

2.5. SDI Assessment

The world has been establishing SDIs for various reasons and on various scales. Many countries have already established their national SDIs (NSDIs) for reducing the spatial data collection time or prevent the duplication of performances for it, creating a central platform of accessing and sharing spatial data, enabling users to utilize better the spatial data and related services (Grus, 2010). At first, the main concerns were on the collection of data. What data will be collected and how were the main questions. With the advancement of the SDIs, their components and definitions become richer, causing the SDI-relevant issues to become more political. The concerns about access and use rights or prices started to be discussed along with this process (Kok & van Loenen, 2005).

De Man (2006) describes SDIs as a common-pool of resources including stakeholders along with technical components. Multiple actors come together to share, manage and interact with resources. However, only coming together for these purposes may not be successful sometimes (De Man, 2006). SDI coordinators have an important role in the success of SDI initiatives through their ability to comprehend, analyze and report on the performance of their initiatives (Giff & Lunn, 2008). This is why the assessment efforts become prominent and why the performance of SDIs are assessed, measured, evaluated and reported. In this way, the organizations, funders and authorities can evaluate the effectiveness and efficiency of their efforts and expenditures.

One of the metrics for evaluating the SDI is generally called performance indicator (PI). Performance indicators, or simply indicators, are quantifiable measures that help people to see whether the objectives of an initiative are being achieved (Giff & Lunn, 2008). However, SDIs are complex structures including both technological and human resources. They are dynamically changing, having multi-faceted nature and sometimes vaguely defined objectives. Evaluating these resources may not be possible with quantitative metrics, instead, qualitative methods may be needed. The same assessment methods may give different results in different environments. Therefore, defining indicators to assess SDIs comprehensively is a complex issue and constituting uniform criteria for assessment studies are not feasible (Craglia & Nowak, 2006; Crompvoets, Rajabifard, van Loenen, & Fernandez, 2008; Giff & Lunn, 2008; Grus, 2010)

SDI assessment is actively drawing the attention of authorities and SDI coordinators who want to utilize their resources provided for SDI initiatives and see the success degree of their operations. In this study, SDI assessment will be within the context of data provision readiness for emergency response. The indicators will be mainly adapted from the literature, especially the SDI assessment works of Eelderink et al. (2008) and Visser (2020).

2.6. SDI Assessment for Emergency Response

This study follows two previous GIMA MSc theses by Keating (2016) and Visser (2020). Both focused on the emergency response and SDI relation, and assessment of SDIs in the domain of emergency response.

Keating (2016) aimed to explore the geographic information governance within the Dutch emergency response system, which is LCMS, in terms of communication among the relevant actors and organization of geographic information and management. The Viable Systems Model (VSM) is used to map out the structure of SDI, geographic information governance and key actors. VSM allows exploring the purpose of the system (the SDI) from the perspective of involved actors (Beer, 1979; Keating, 2016). According to this model, the whole system can be subdivided as follows:

System 1 – Operations: The actors within this part are responsible for carrying out the basic operations. These actors can be defines as end-users in an SDI.

System 2 – Coordination: This part is responsible for monitoring System 1 and connecting the basic operations to the meta-management.

System 3 – Internal management: This system manages the resources such as staff, budget, and efficiency assessment of operations. It follows the guidelines and strategy for System 1 activities, at the same time, supervises the infrastructure components.

System 4 – Future/planning: Research and development part of the whole system. User needs assessments, data requirement derivations can be performed within this part.

System 5 – Guidelines/policy: Takes input from System 3 and 4 to provide policy and guidelines for the whole system considering both short-term and long needs.

Emergency response SDI of the Dutch Safety Regions, named Geo4OOV, is assessed according to the structure composed of these five sub-systems and their components. To structure the SDI network within the organization, and to identify associated bottlenecks, the user needs analysis was performed through interviews with relevant actors. The participants of the study rated the performance of geographic information in terms of three processes: checking, using and sharing. There are seven indicators within these processes, defined by van de Walle, van den Eede, and Muhren (2009). The interviewees commented on the existing performance of the geographic information governance through these seven indicators, which are reliability, accountability, semantics, accessibility, sustainability, timeliness, and relevance.

The qualitative derivations from the interviews are then validated through an SDI network maturity model adapted from the information technology (IT) alignment maturity model by Luftman (2000) and SDI stages of development maturity model by van Loenen and van Rij (2008). The IT alignment maturity model aims to assess mutual alignment between functional organizations and IT. There are six criteria within the IT alignment model, and all of them are adapted to the SDI network maturity model by Keating (2016). These are communications, competency/value measurement, governance, partnership, architectıre, and skills. The SDI assessment was performed through these six criteria under every five sub-systems coming from VSM.

While Keating (2016) discovered geographic information governance in Dutch emergency system, Visser (2020) focused on creating a user-centric SDI assessment framework combining elements of four assessment framework studies from the literature and the interviews for the chosen case study, the SDI of the World Food Programme (WFP). The adapted elements contain, for instance, methodology steps (such as performing a requirement analysis); user group definitions, activities and their components (such as objectives or GI literacy); templates or ideas for the survey to be used in interviews; and various indicators and criteria (data supply, data governance, data usability).

The user-centric SDI assessment framework for emergency response by Visser (2020) is completed in two steps. The first step was the derivation of the relevant indicators from the literature, and the second step was the finetuning of the framework according to its application area. This was managed by intervieweing experts. The core of the framework is composed of the elements from the literature research and referenced studies. The elements adopted from these studies are listed below:

From Hennig and Belgiu (2011):

- SDI value measurement by usability criteria
- Inputs for user needs analysis
- Inputs for survey and interviews

From Welle Donker and van Loenen (2017):

- Usability criteria/ indicators
- Data supply indicators
- Data governance indicators
- Inputs for survey and interviews

From Kleijn et al. (2014):

- Users and user objectives
- GI-literacy of users

From Zwirowicz-Rutkowska (2017):

- Usability indicators/criteria and other indicators
- User groups definitions
- Inputs for survey and interviews

Through the indicators and the basic SDI schema, the general framework emerged. Afterward, the framework is finetuned according to the interviewed experts' opinions and ideas derived from user needs analysis about, the SDI of the WFP.

The context and methodology of this thesis benefit from both Keating's (2016) and Visser's (2020) studies. Keating's exploration of data governance and user satisfaction becomes an input while generating the interview structure and the surveys. Visser's interviews with relevant experts are also taken into account. Additionally, the indicators chosen for the emergency response SDI assessment framework are reviewed and adapted.

In addition to these two theses, the indicators taken from Eelderink, Crompvoets, and de Man (2008) are also reviewed and adapted. Eelderink et al. (2008) define a set of measurable key variables to assess NSDIs in developing countries. The final framework indicators are gradually filtered from 94 initial variables through feasibility analysis and the consultation to a selected group of SDI experts. Resulting from the filtering, a set of 14 variables are selected as key variables (Eelderink et al., 2008). These variables correspond to the vital features of any SDI, and this is why they are included in this study.

Among the indicators suggested by Eelderink et al. (2008) and Visser (2020), indicators deemed to be applicable are selected and adapted to the framework of this thesis. It is aimed to select the complemental indicators for technical details as well as usage and organizational aspects of SDI assessment. The indicators which are out of interest and responsibilities of the emergency response information managers are excluded from the framework. The indicators related to finances, leadership, decision making quality, and socio-political stability can be counted as excluded indicators. While choosing the indicators, the factors affecting decision making in emergencies are also taken into account while choosing the relevant indicators. Kapucu and Garayev (2011) identified five impact factors composed of four negative and one positive:

- **Uncertainty** caused by limited situations and chaotic atmosphere (negative).
- **Time pressure** resulting from urgency to make immediate decisions (negative).
- **Stress** caused by the severity and complexity of the situation, and the urgency to make the consequential decision (negative).
- **Risk** needed to be taken to decide on critical and high-stake issues (negative).
- **Previous experience** concerning the case at hand (positive).

In conclusion, the indicators for the assessment framework are chosen in parallel to the remarks of Snoeren et al. (2007), Janssen et al. (2010) about the data sharing for emergency response regarding the issues such as integration of technologies; preparedness for emergencies; communication, collaboration and efficiency in terms of organization; data quality, correctness, actuality, continuity, and usability. The factors affecting decision making in emergencies infleunced In the light of these, the emergency response data provision readiness assessment indicators are adapted from the studies of Eelderink et al. (2008) and the literature reviewed by Visser (2020) are listed in Table 2.1.

Table 2.1: Adapted Indicators to measure emergency response data provision readiness

Source	Indicator group	Indicator	Description	Reasons (Kapucu and Garayev, 2011)
Welle Donker & van Loenen (2017)	Known	Recognizable	The dataset is recognizable (thanks to metadata availability)	Time pressure
	Known	Findable	The dataset is findable	Time pressure, Stress
	Attainable	Practically available	The dataset is practically available	Uncertainty, Time pressure
	Attainable	Affordable	The dataset is affordable	Stress
	Attainable	Delivery time	The dataset can be acquired/delivered in time	Time pressure
	Attainable	Legal transparency & interoperability	The dataset does not have any legal restrictions (and there is legal transparency)	Uncertainty, Time pressure
	Attainable	Service level / format	The dataset is distributed in a sufficient format or service	Uncertainty, Time pressure
	Usable	Manageable	The dataset is manageable	Uncertainty
	Usable	Reliable	The dataset is reliable	Uncertainty, Risk
	Usable	Sustainability / long term availability	The dataset has long-term availability / is sustainable	Uncertainty, Stress, Risk
	Usable	Up-to-date	The dataset is up-to-date	Uncertainty, Time pressure, Stress, Risk
	Usable	Communication of data supplier to the user	There are active communication channels from the data supplier to the data user	Uncertainty
	Usable	Clear / support	The metadata and support are clear	Uncertainty, Time pressure,
	Governance	Stimulation of SDI use	The SDI organization stimulates SDI use	Uncertainty
Zwirowicz-Rutkowska (2017)	Usable	Spatial data quality*	The dataset has sufficient spatial data quality	Uncertainty, Risk
	Use process	Access to more sources of information	The SDI increases access to sources of information	Stress
	Use process	Data management*	The SDI improves data management	Previous experience
	Use process	Decision making time*	The SDI shortens decision-making time	Time pressure, Stress

Source	Indicator group	Indicator	Description	Reasons (Kapucu and Garayev, 2011)
Zwirowicz-Rutkowska (2017)	Use process	More independent of suppliers, superiors, other employees	The SDI creates independence for suppliers, superior, other employees in decision making	Stress, Previous experience
	Use process	Use of spatial data (frequency)*	The SDI increases the use of spatial data	Previous experience
	Use process	Workflow*	The SDI improves the workflow	Time pressure, Stress, Previous experience
	Governance	Clear / support*	The communication and support regarding the SDI use are sufficient/clear	Uncertainty
	Governance	Communication of data supplier to user*	The SDI stimulates and supports communication from the data supplier to the data user	Uncertainty
Eelderink, Crompvoets & de Man, (2008)	-	Availability of digital datasets	The digital dataset is practically available	Uncertainty, Time pressure
	-	Metadata availability	The metadata of the digital dataset is practically available	Uncertainty, Time pressure
	-	Communication channels	There are communication channels among the developers, users and other partners of the SDI	Uncertainty
	-	Access network reliability	The access network of the SDI is established and enable coordinators to manage access rights of different user groups	Stress
	-	Interoperability	Ability to understand and share various data and relevant technology across organizations and users	Uncertainty, Time pressure
	-	Data delivery mechanism	The data delivery mechanism is reliable in different situations (such as no-internet)	Time pressure, Stress
	-	Willingness to share	Relevant organizations are willing to share their data	Previous experience
	-	SDI directive	The existence of SDI directive (legalization of unified definitions and frameworks)	Uncertainty, Previous experience
	-	Institutional arrangements	Institutional arrangements for intended objectives are made or in progress	Previous experience

*These indicators are combined and suggested by Visser (2020). Original indicators can be found in Appendix A.

2.7. Summary

Information management is essential for dealing with emergencies and disasters in all phases of the disaster management cycle. Spatial data is of prime importance as location and related information is one of the first things to look up following an emergency. Today's technology enables communities to gather and exchange information easily. However, without proper governance of information and information flows, the potentials of the technology would not be efficient and effective as intended. Following this, modern emergency and disaster management approaches emphasize the importance of information management. SDI framework gives a base to those looking for a versatile and dynamic environment to establish their comprehensive information system. The assessment framework of this study will help the authorities and developers to picture their system's readiness and to address the issues related to emergency response data provision. From different parts of the world, the initiatives have been encouraging, implementing and utilizing the SDI and ERS affiliation. As a country of frequent disasters, Turkey can benefit from such an approach by implementing coordination between ERS and Turkish NSDI for efficient governance of information and supporting effective decision-making during emergency situations.

CHAPTER 3: User Needs

3.1. Introduction

This chapter aims to give a general overview of the user ideas and needs on ERS and data provision, thanks to one-on-one semi-structured interviews with Turkish and Dutch information managers, the people who have the responsibility of managing geographic information flow during crisis situations from the office. The reflections from these interviews are used to shape the assessment framework for the next step. Before giving the overviews from the interviews of each country, their emergency response systems are introduced.

3.2. Differences Between Two Countries

Before exploring the nation-wide ERSs, it is important to look at the geographic features and disaster vulnerability of the two countries because these two systems have been developed according to the countries' priorities, requirements and legal frameworks.

Firstly, Turkey suffers from various disasters and emergencies such as earthquakes, wildfires, floods, landslides and more. These are all impactful events which can affect broad areas, the natural environment and many people. It is not uncommon that surrounding cities are also affected by the disaster when a city is hit. The natural characteristic of this region pushes the authorities to think about many aspects of emergency response.

As a Western European country residing near the North Sea, the Netherlands has been dealing with heavy rainfalls. Due to the country's geographic features, controlling sea and water levels has been an important issue historically (Spaling et al., 2018). Apart from that, firefighting is another priority for disaster management and emergency response authorities. Currently, there is a development process of a nation-wide information model for the distribution of fire brigade building information across all the 25 safety regions (IFV, 2020b).

The size difference between the two countries is also something to mention. Turkey's total land area (769,630 km^2) is almost 23 times bigger than the mainland Netherlands (33,670 km^2), as of 2020 (The World Bank, 2020a). For the same year, the population of Turkey is nearly 84.34 million while the population of the Netherlands is 17.44 million (The World Bank, 2020b). Accordingly, the jurisdictional organizations are different. Disaster management and emergency response approach in Turkey dictates vertical hierarchy from district to provincial, then to national level. All provinces are responsible for prepare their own action plan in parallel to TAMP. For horizontal hierarchical interaction, 81 provinces are grouped into 15 logistic regions to assist each other in large scale emergency events (AFAD, 2013).

3.3. Exploring the User Needs

The target user group of the interviews are the people from emergency response organizations, who are managing the spatial information flow for disaster management. Three participants per country are interviewed for this part. The identities of the participants are confidential and kept anonymous. All user needs interviews are held in May 2021.

While creating the assessment framework, the indicators are grouped through their measurement purpose. The indicators adapted from Welle Donker and van Loenen (2017) are mostly focused on data and data supply. Originally developed by Backx (2003), the concentric shell model illustrates the steps to be taken to reach the required data. Van Loenen and Grothe (2014) indicate that a user can reach the needed information if the following three conditions of the model are met:

Known: The user must know where can the needed information be obtained.

Attainable: The user must be able to obtain the data under particular conditions.

Usable: The user must be able to use the data for the intended purpose.

The first of the remaining two indicator groups covers the indicators related to the usage of the data and the SDI. It is adapted from the SDI effectiveness assessment study by Zwirowicz-Rutkowska (2017) and most of the indicators adapted from this study fall under this category.

Use process: Indicates that the actions and features to utilize the data for the intended purposes.

The last indicator group is about the organizational administration of the SDI. The indicators of this group seek legal procedures, organizational functionality and the relations among the relevant organizations.

Governance: The indicators to look up how well the internal and external organizational functionalities and relations to administer the SDI are established.

In brief, while grouping the indicators it is looked at that if the indicator:

- Measures whether the data is reachable: is the data known, attainable and usable?

- Measures whether the SDI provides a sufficient use process for the user.

- Measures whether the SDI is governed sufficiently,

The structure of interviews starts with a brief introduction of the study and getting acknowledged with the participant's role, experience, daily tasks and use of the SDI. The main body of the interview focuses on the data provision by the SDI, the data usage and the governance of the SDI. The thoughts of the participants on the current situation of their SDI, their data usage and the organizational functioning within their and other organizations they are working with, are discussed using the assessment framework as a guideline. The indicators from the first version of the assessment framework lay the foundation of the interviews. Mainly, data features such as reachability, quality, and format are followed by the data and SDI utilization, namely the usage during the occasions, accessibility, and the benefits of the spatial data usage for emergency response. Then the governance of SDI, internal and external institutional arrangements, and how these are reflected to the participants are retraced. Finally, the content of the assessment framework that this study generates and its place within SDI development are briefly discussed. The interview structure can be found in Appendix B.

3.3.1. Turkish Emergency Response System

Turkey frequently suffers from disasters such as floods, wildfires, landslides and earthquakes. These disasters can happen in various regions of the country. To help the relevant organizations to overcome the disaster and emergency situations, Turkey's Disaster and Emergency Management Authority (AFAD, Afet ve Acil Durum Yönetimi Başkanlığı) prepared and published the Disaster Response Plan of Turkey (TAMP, Türkiye Afet Müdahale Planı) in 2013.

The National Disaster Response Plan provides a strategic guide for the authorities at national, provincial and district levels. It also contains detailed vision for disaster risk mitigation and recovery. Every local extension of AFAD, which are provincial or district disaster and emergency directorates, is responsible for creating their own management and response action plans covering their jurisdictions, collaboratively with the relevant stakeholders and in line with the national plan. Disaster response and management activities are managed by the directorates and field related actions are carried out by service groups composed of operations and logistics units. When it is needed, any support can be provided by external disaster and emergency directorates or other responsible organizations, by the means of information, equipment, search and rescue, volunteers, etc. (AFAD, 2013). Figure 3.1 shows the map of the logistic regions for the provinces which to provide support to each other during emergencies.

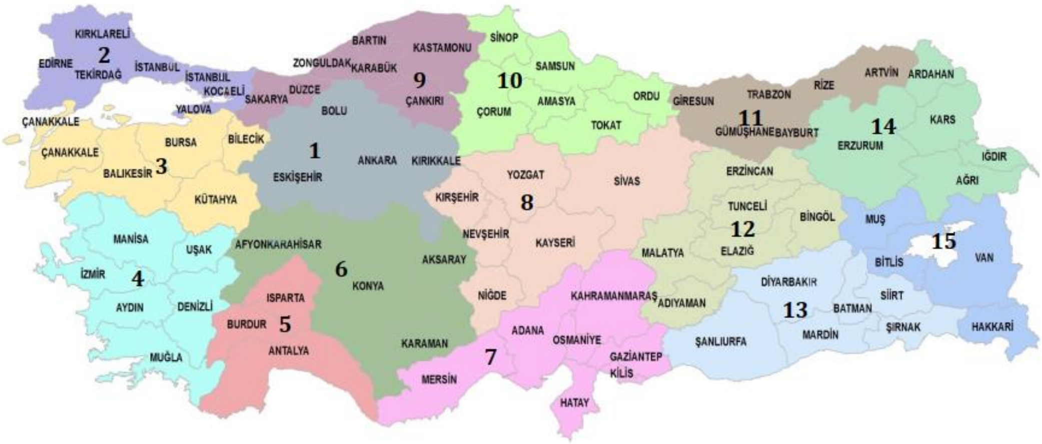

Figure 3.1: Emergency logistic regions map of Turkey (AFAD, 2013)

Currently, there is continuous work carried out for the development of a nation-wide ERS to assist AFAD in the management of disaster and emergency mitigation, preparation, response and recovery phases. Disaster Management and Decision Support System (AYDES, Afet Yönetim ve Karar Destek Sistemi) is a software integrating internal and external services for current and accurate data provision, analysis, reporting and organization. These integrated services, comprising of desktop, mobile and web-based applications, are grouped under three core components having different functionalities (Keskin et al., 2018). Figure 3.2 shows the components of AYDES.

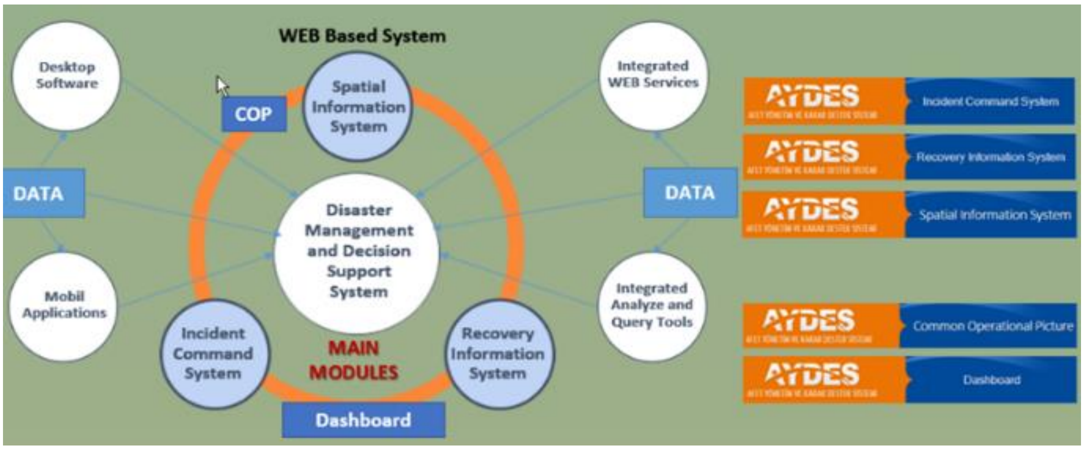

Figure 3.2: AYDES components (Keskin et al., 2018)

Incident Command System (ICS) is a holistic management module developed according to the directives of TAMP. Information gathering and dissemination among the stakeholders, resources allocation, and demands management are available through this module. It is supposed to be used actively during all phases of the disaster management cycle at local to national levels. The service groups can exchange information through the data pool and data analysis framework of ICS. It also enables to send quick event notifications among the stakeholders and service groups via e-mail or SMS. *Recovery Information System (RIS)* utilizes GIS technology for disaster recovery management. Damage determination, geological hazard surveys, ownership and debiting, resettlement site selection, national emergency assistance and tracking are some of the important functions of this module. On the field, near real-time data gathered by integrated mobile applications can provide input for decision-makers and other stakeholders. *Spatial Information System (SIS)* has the role of supplementary environment to carry out disaster management and decision support in an effective and sustainable way. Basic and useful GIS tools are present in this system. Such tools include spatial data displaying, querying, editing and analysis features that would be useful during not only an emergency response but also other phases of the disaster management process. The aim of this component is to assist decision-making processes through the provision of quick and accurate data, planning tools, and GIS features. *Common Operational Picture (COP)* comes prominent as a submodule under SIS, specifically developed for emergency response. It has almost the same features as SIS (Keskin et al., 2018). Besides these three core components, remote sensing (AYDES-RS) and crowdsourcing (AYDES-CS) modules were developed for supportive data gathering and analysis. Figure 3.3 is a screenshot from the SIS module user interface.

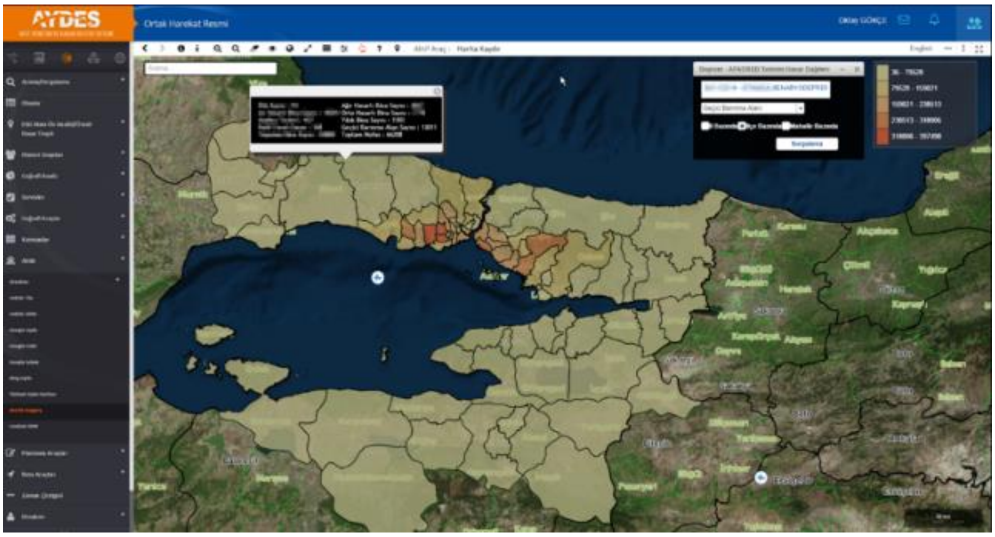

Figure 3.3: A screenshot from the user interface of the SIS module (Keskin et al., 2018)

For AYDES components, various data are gathered from diverse sources and these data are shared under themes set up in accordance with their purpose of use. Table 3.1 lists the datasets used within AYDES and their sources. According to the Table 3.1, governmental organizations are the main contributors to the thematic datasets of AYDES. However, unlike the ERS of the Netherlands, these organizations supply the data separately from each other rather than through an SDI or NSDI.

Table 3.1: AYDES datasets and their sources (Adapted from Keskin et al., 2018)

Type	Source	Dataset
Base maps	General Directorate of Registry and Cadaster, RASAT, Landsat, Google, Bing	Satellite images, orthophotos
Core records	General Directorate of Registry and Cadaster, Turkish statistical institute, National Address Database	Population statistics, cadaster, postcodes, admin-boundaries
Risk maps, emergency areas, gathering and tent areas, disaster affected zones	AFAD	Hazardous materials, flooding, vulnerable objects, emergency management infrastructure
Infrastructure	General Directorate of Roads, General Directorate of Railways, Private sector	Traffic, road/highways, railways, energy, etc.
Meteorology	General Directorate of Meteorology, Yahoo, EUMETSAT	Weather forecast

With various features under three core components, integration with desktop, mobile and web-based applications utilizing GIS and remote sensing technologies, AYDES has been developed to answer almost all needs of disaster and emergency management decision-makers, considering the variety and regularity of the disasters occurring in Turkey. Namely, it is defined as an all-in-one solution for disaster management by Keskin et al. (2018).

3.3.2. Exploring the User Needs from Turkey

From Turkey, Disaster and Emergency Management Presidency (AFAD) and the provincial directorates are the primary organizations investigated in this study. The roles of the participants are as follows:

Participant 1: Engineer in the AFAD's Department of GIS

Participant 2: Manager in Earthquake Working Group of AFAD

Participant 3: Director in a provincial directorate

First of all, all three participants state that the currently developed version of AYDES is actually the second version of the system, and known as AYDES 2.0. The first version included functions for disaster preparedness, response, recovery and risk reduction. Besides AFAD itself, several other organizations working with AFAD had their own interfaces in the portal. However, the first version was not an ideal system for the users. The interface was not user-friendly and mostly addressing the GIS specialists, rather than all the relevant users. Additionally, some organizations were not using the system as they were supposed to, even though they have their own menu or interface in the portal. The interest in the system waned due to such problems. Therefore, a new version has been planned and developing with the aim to a user-friendly, easy-to-use, faster and richer system. Although the development stage of the system has not been fully completed, AYDES 2.0 is actively used by AFAD and the government institutions they are working with.

Data

AYDES has two environments, the live environment and the practice environment. In the live environment, including earthquakes, all disaster-related tasks are carried out by the provincial directorate in the region where the disaster occurred. The occurrences are entered into the live environment. There is also a practice environment. The drills that provinces should do at national, regional and local levels at certain periods are carried out through the practice environment.

The base maps and other needed data for AYDES are all defined within the system. There are maps and services for different uses, such as topography or Google Earth integration. AFAD collects data such as population, address, cadaster, parcel inquiry, roads, highways, and traffic from various organizations. They also create their own data. Datasets related to disasters, gathering areas, debris dump areas, cold storage areas, and more are determined and entered into AYDES with spatial features. Along with coordinates, their size, capacity, type, and land use are a few of these features. Locations of family health centers, hospitals, dental health centers, and dispensaries are parts of the health dataset which already exists in AYDES.

The data gathered from multiple resources are supervised by the GIS team of AFAD. The GIS team is responsible for the arrangement of the data by assuring their quality and interoperability. These data are generally requested directly from the organizations who generate the relevant data. These organizations are mostly the government institutions such as ministries, state companies, observatories and universities. The participant from the department of GIS states that they mostly want the raw data from the organizations, instead of requesting edited or processed data. The reason is that these organizations sometimes answer by stating that they do not have the requested type of (processed) data when they are asked because they actually do not want to spend their time to edit the data for AYDES. This situation reduces the interoperability of the gathered data because these organizations usually generate data according to their own needs. The file formats and coordinate systems may vary. Some of the partner organizations stick to their own ways while data gathering and generating. Those who transmit the data do not have to produce it according to a common AYDES standard because there is no obligation for it. Therefore, the GIS department sometimes rearranges or transforms these data and makes them suitable for AYDES. To reduce this inconvenience and time spent for such effort, a participant suggests, the organizations need to arrange the data in conformity with a common system (in the case of this study, an SDI), or they need to create automated mechanisms that would reduce the need for manual drawing or visualization during the data generation so that the data interoperability problems among the relevant organizations can be reduced.

The participant from the provincial directorate indicated that they did not encounter such problems of interoperability between various data. The reason is that their employees are being the tertiary or end users of the AYDES and they use the data already supervised and managed by the expert users or system administrators. The only data they generate and manage are the disaster and emergencies within that particular province.

It seems that the often suggested addition to the current datasets would be more information on building stock. Two participants stated that, at the moment, the information on building stock is very limited in some areas. Some buildings have only coordinate information. They do not have information such as the number of floors, year of construction, the usage purpose of the building, and the type of building. A participant indicates that it is important to enter the residential areas into AYDES with their ownership and damage histories of the at least last 50-60 years, along with the information stated above. These data would be useful for various purposes including urban renovation works or preventing the illegal sale of damaged properties.

AFAD do not openly share the data they gathered from other sources. The exception is earthquake data. Both raw data from earthquake monitoring stations and processed data about their effects are all open and accessible through their website.

Use Process

After its first version, AYDES has been transforming to a more practical, more flexible, more user-friendly and faster system that can work on different platforms. For the last 5 years, base maps and GIS have been integrated. In the first version, the primary users realized that INSPIRE-like layer names or AFAD layer names mean nothing to the end-users. To perform their tasks sufficiently, it was not obvious for the end-users to easily notice and select particular datasets, and find needed data layers under them. Therefore, an attempt is made to create a less complex, an open-sourced system in AYDES 2.0. The searching functionality improved and at the same time designed to be easier to use. An elastic search engine has been established to make users able to search layers, tables, and even menus. They had to create their own Atlas (the portal of TUCBS) before the actual Atlas was created, as stated by one participant. The gathered data are stored and made suitable for various usage purposes within the system. Data rearrangement work was a lot during development.

After all these efforts, the system became more established and user-friendly. The people who manage the information flow during emergency situations can coordinate and monitor them through AYDES. The participants agree that the system is more useful now and started to be used actively in AFAD and by some of the relevant organizations.

Governance

The Disaster Response Plan of Turkey (TAMP) steps in when there is a disaster. There are 28 emergency and disaster working groups specialized in their responsibilities. These people use AYDES more actively after a disaster. For example, when an earthquake occurs, the earthquake working group enters all incoming data (tent, aid, search and rescue, vehicles, personnel, where the teams come from, etc.) to AYDES in detail. There is also a practice part of this. They are conducting regular drills exercises on different scales. Almost every working group (could be from either a provincial directorate or a ministry) actively uses AYDES in this respect. According to TAMP, the ministries should have a data service group and representatives. All of them have the competence to use AYDES, thanks to the drills and training programs.

For example, the citizen calls the emergency call center. The center informs the relevant institution about the occurrence. In terms of disasters and emergencies, the center directs the matter to AFAD. In AFAD, an entry is made into the AYDES. Through the management process of the occurrence, other information such as the size and type of the team, sent vehicles and number of the personnel, their leaving times are also entered into the system.

AFAD has both an earthquake observation center and an intervention monitoring room. They also have a system that works 24/7 to monitor disasters and emergencies from every part of Turkey. Supervisors, administrators, local municipalities, governorship, or district governorships are reached by their provincial directorates and provided the necessary information about disaster management, in line with the information received through AYDES.

There is an indicated problem with the active use of the AYDES. The only institution that needs to enter data into AYDES every day is AFAD. Other institutions enter data when necessary or when a disaster occurs. Naturally, some of the responsible people forget how to use it. Also, sometimes people from different institutions see the data arrangement for AYDES as extra work besides their main job. Some people use it only once a year. Not all of these people are accustomed to GIS-based programs. AFAD has educational materials and a live hotline for these people. Still, these people should be more competent in terms of use.

A participant suggests that each data generating organization, or at least the government institutions, need to establish GIS departments, establish core teams and never disintegrate them. In this way, the organizations can work in harmony in terms of spatial data generation and exchange. There is a need for more GIS teams to realize the government's data-driven aspirations for the future.

Another interesting point is the data exchange among government institutions. In the previous years, the data exchange between government institutions was not free. Any institution requesting data from another institution had to pay its fee. However, AFAD quickly became exempt from this practice as this practice and following procedures would harm the disaster management processes. Now, AFAD can gather data from these institutions for free.

3.3.3. Dutch Emergency Response System

In the Netherlands, disaster management is handled as a part of crisis management among the 25 zones covering the whole country (see Figure 3.4). These zones are called the safety regions and they are extended versions of the local municipalities in terms of legal and geographical, to intervene in the crisis situations at the tactical level. Each safety region has its own local organizations, trained personnel and emergency services such as fire brigades and medical assistance. The management boards of safety regions are also responsible for and ready to work together in greater cases (Government of the Netherlands, 2013).

Figure 3.4: Safety regions of the Netherlands (Government of the Netherlands, 2013)

The Institute for Safety (IFV, Instituut Fysieke Veiligheid) is responsible for public crisis management and post-disaster recovery through the safety regions and other crisis partners including all 25 safety regions, the National Crisis Center (NCC), the National Operational Coordination Center (LOCC) and many organizations from sectors such as public order, safety, water, healthcare, ICT, energy, transport, and finance (IFV, 2020b). In the last decade, the institute and the relevant partners have been adopted the network-centric way of working.

Network-centric (or net-centric) working is establishing a network within which the stakeholders can share information. This way of working aims to quick information sharing among diverse partners to inform them timely, to picture any situation in a fast, collaborative and information-rich process, and by doing this, to leave more room for decision-making. It is implemented through four dimensions: internal and external information process, organization set up, people and culture, technological resources (IFV, 2020b). The collaboration of the relevant partners is managed by the IFV, through a Dutch nation-wide crisis management system called LCMS.

National Crisis Management System (LCMS, Landelijk Crisis Management Systeem) is the national crisis management system of the Netherlands, connecting most of the relevant security and crisis management stakeholders: safety regions, the majority of the water boards, some of the drinking water providers, emergency health care organizations, the Royal Military Police organization, and General Directorate for Public Works and Water Management. The system supports net-centric working. According to IFV, it is seen as important to have a consistent, current and jointly prepared operational image during any crisis situations. This situational picture is maintained centrally and accepted as the heart of the system (IFV, 2020b). Figure 3.5 shows a generic system concept for a stakeholder.

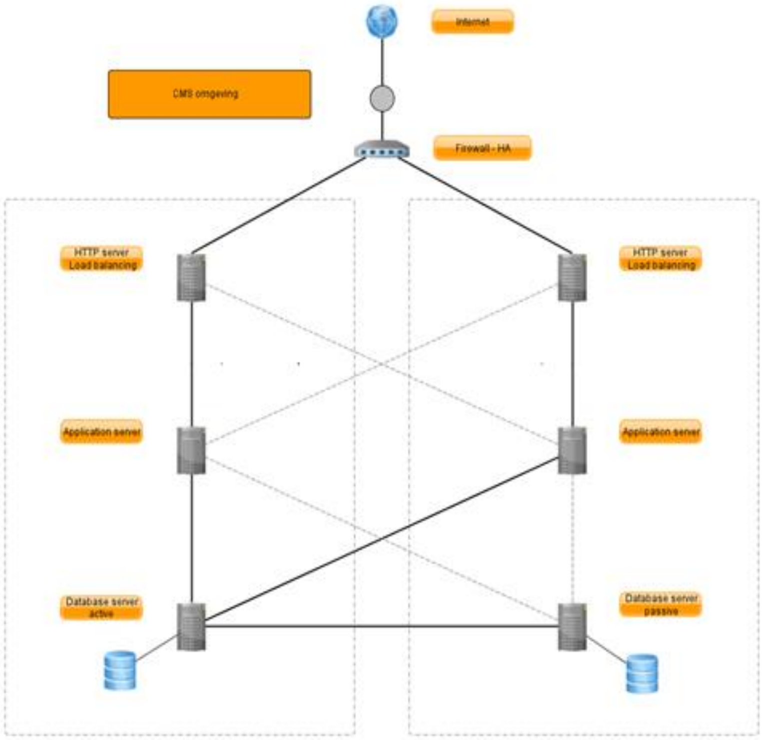

Figure 3.5: A generic technical set up of LCMS for an organization (LCMS.nl)

LCMS provides an environment to exchange information as text, document or geographic, either within and between the organizations through three main functionalities. *LCMS Text* is used to compose textual documents about an event. For the information managers, the default templates include themes related to crisis management such as meteorology, safety of emergency workers and victim overview. *LCMS Plot* is a function to make drawings and create a geographic image of the crisis situation. Participators of the events can create their own layer on the event map. LCMS Text also has a web-based geographical viewer used to demonstrate maps and plot layers. *LCMS Mobile* makes it possible to connect the system through mobile devices, mainly for the coordination of extensive response to wildfires. Locations of the incidents can be seen through this feature, as well as firefighting situations, fire control lines, unit control and command, and service resources. The actual vehicle locations, deployments and logistics can be tracked thanks to GPS. The Ad-Hoc Routers provide connection security among the central LCMS servers and the internet. Also, they create a local network for the vehicles on the field (IFV, 2020b). Figure 3.6 shows a situation display from the interface of LCMS.

Figure 3.6: A situation picture from LCMS interface (LCMS.nl)

According to Keating's research (2016) aiming to assess the geographic information governance for emergency response in The Netherlands, both net-centric working and the information sharing within LCMS are helping the facilitating of emergency response activities at the utmost level of efficiency than they have ever been before (Keating, 2016).

3.3.4. Exploring the User Needs from The Netherlands

The Institute for Safety (IFV, Instituut Fysieke Veiligheid) and the safety regions (veiligheidsregio's) are the Dutch organizations approached in this study. The participants of the interviews were:

Participant 4: Functional manager at IFV / plotter at a safety region

Participant 5: Information provision coordinator & information manager at a safety region

Participant 6: Functional manager at a safety region

It can be said that the net-centric way of working was the desired goal in the first place rather than LCMS itself. A system that makes different groups able to see and track a common picture of an occasion was the primary idea. Later, LCMS and Geo4OOV were developed around this idea. The system is now legally required to be used by all safety regions. Also, the organizations such as the water board, energy suppliers, the military are using this system. LCMS has menus for different organizations specifically developed for their use. These organizations can access the system and perform their tasks through their menus. They can track the situation of the occasions or the real-time information shared by other organizations.

There are plans for expanding the use of the system with more content. Also, more organizations will get acquainted with the system in a few years. It will be mandatory for all companies and institutions related to crisis situations to use this program. A few examples to those are the organizations of railways, some engineering companies, or nuclear energy companies.

Data

When there is a confirmed emergency, LCMS comes into play, except for minor situations. The control room of the safety region enters the information about the incident through the LCMS.

Event location, description, status, and the informer are some of the information entered into the system. The system provides its users various data for disaster management purposes: base maps, object points, areas, transportation networks and more. PDOK, the NSDI of the Netherlands, is not only but a major data provider for Geo4OOV. IFV, as the maintainer organization of Geo4OOV, acquires many datasets from PDOK. In addition, there is Risicokaart (Risk Map) as another major data provider, a platform that provides (potential) risk situations that can lead to various disaster and crisis situations such as earthquakes, forest fires, hazardous material accidents, floods, etc. Open Geospatial Consortium (OGC) standards are used within the LCMS, such as Web Map Service (WMS), Web Map Tile Service (WMTS), and Web Feature Service (WFS). While creating LCMS, it has planned to be complying with these standards so that LCMS and PDOK could work with each other. Today, the system works as intended. The data are mostly interoperable.

During the planning phase, IFV was not the organization directly appointing the datasets. Instead, the safety regions tailored the data themes according to their own needs. All of them came together in a series of meetings, investigated their needs, and stated the most necessary and requested data. Then these were requested from relevant organizations. The organizations generated and edited these data according to the used standards. Then IFV supervised these data and created datasets for the system. Similar meetings among the safety regions are still held periodically. The safety regions themselves are also responsible to prepare some particular data or maps and transfer them to the LCMS but these cover a small part of the whole database. For the emergency response, the spatial data needs of the users, including the safety regions, are supplied through the LCMS and seldom other municipalities, provinces and companies. When a dataset is found insufficient, it can be returned to Geo4OOV for feedback. Geo4OOV website now functions as the catalog of the SDI. The list of the datasets and relevant information can be reached through the catalog but the spatial data cannot be downloaded. A participant stated that he/she would prefer publicly open data as a manager of information flow, and he/she thinks that it will be beneficial for the development of the data awareness of the society. Some data providers such as PDOK and Risicokaart have their own portals to publicly share their data.

Although the system was established more than five years ago, the organizational differences and lack of interoperability between partner organizations may still cause inconveniences in some situations. A participant gives an example of the differences among the organizations. Two years ago, the safety region where the participant works contacted the local municipality and requested all types of maps and data for the security preparations of a popular event within the boundaries of that municipality. The municipality shared the requested data. However, the format of the data was a problem for the safety region. The maps coming from the municipality were AutoCAD files and were not compatible with the other data in LCMS so they did not match the needs of the safety region. Eventually, the safety region employees had worked to translate these files into LCMS or GIS-compatible spatial data, taking a few weeks.

About the needed datasets, a participant indicates that the detection of these datasets are disaster-driven, meaning that the types of local disasters and crisis situations reveal the needs or increase the importance of some particular datasets. In parallel to that, all participants mentioned that the furtherly added datasets will be mostly water-related datasets, such as the depth of the canals or the real-time locations of the water vehicles. Additionally, a participant suggested that the real-time data of the open and closed bridges would be useful to make real-time trip planning. That is currently implementing by IFV but not operational yet. The real-time weather information is also mentioned as important for various crises and incidents.

Use Process

LCMS is defined as mostly text-based but there are some spatial features. When there is an incident, the field of occasion and its effect area are drawn in LCMS. For example, if there is an explosion in a factory, there will be smoke, the roads nearby may be closed. These will be drawn and shown on the map to all relevant actors. Also, there may be injured people, and ambulances would go there, the injured people will be transferred to health institutions, and the factory workers will be evacuated. These can be planned through LCMS. Different institutions can be involved and track the situation by using LCMS depending on the emergency or disaster situation. Each institution has its own menu in the system. They use the services for their own tasks. For example, one for the military, one for utility companies, one for health. However, when necessary, they can add other data themes to their parts. It is called net-centric working. Every operating organization can see what is happening in the occasion area in real-time. In the past, a participant indicates, there was hierarchy among institutions and actors so it was taking longer times for information to reach decision-makers and to make decisions.

Other than the emergency and disaster situations, the safety regions are responsible for ex ante or ex post-analysis of both the situations and the responses shown. The analyzers of the safety regions may use different spatial data viewers other than LCMS for such purposes. These applications are developed specifically for the safety region employees.

Some precautions have been taken for inconvenient situations which would prevent users to access and use LCMS sufficiently. The IFV has measures against these inconvenient situations (e.g. power outage or the internet outage), such as providing data via satellite and even providing satellite dishes for emergency response units or relevant organizations. In addition, a certain percentage of 5G data usage capacity has been allocated to specific institutions for crisis situations because when there is an emergency, people would probably use the internet intensely, and 4G may get blocked due to data traffic density.

A participant remarked that especially in the recent coronavirus pandemic, they have seen that some of the important information cannot be plotted on a map because visualizing some of the related information would not mean anything to some emergency response professionals, e.g. to the health workers. Instead, they need more ways to present information within the system such as various dashboards, or a graph drawing application. These are now under development, the same participant indicates.

Governance

LCMS is constantly developing with the needs and requests of relevant actors. In the past, Geo4OOV and LCMS were one body but later they were separated to make Geo4OOV able to be utilized in both the crisis and the analysis parts.

As governmental institutions, the safety regions do not request a fee for data exchange between partner organizations. They also do not regularly distribute their data to other organizations. For some of the required data, the technical details are not a big difficulty, the participants stress. These can easily be gathered and managed through technological tools. However, the organizational differences among the partner institutions make it harder to obtain the required data in its needed form. Some organizations gather the data according to their needs, instead of considering LCMS. All participants mentioned that organizational differences and insufficient communication are what makes it difficult to prepare and share the data for intended purposes. Also, the capacity of the IFV data team responsible for Geo4OOV is considered rather small to handle the development or data requests timely. All 25 safety regions hold regular meetings and vote for the most needed data to be added to the SDI because the Geo4OOV team is small and has limited capacity.

As the managers of information flows for disaster management, the participants state that their main goal is coordination. To facilitate coordination, they need the cooperation of relevant organizations. They sometimes need to contact people who have geographic information literacy (GI-literacy) from these organizations but they cannot find such people in some of the organizations. Therefore, more geographic information specialists from the relevant organizations are needed, according to the participants. These organizations also should be more cooperative and willing to work together for disaster preparation, instead of seeing policy-making for disaster management as extra work. Also, they should be more active in terms of data gathering, correcting the data errors, extending their geographic information capacity and exchanging data. Disaster preparation should be a common concern because disasters can affect everyone. Having good communication and explanation would help to overcome these barriers.

A participant stated that the awareness of the importance of spatial data is often neglected and its place in disaster management is not even well described in the scenarios created by safety region policymakers. The policy workers do not think about how to utilize spatial data for efficient and effective disaster management. The data and technical abilities are beyond the currently developing scenarios but the people who create these scenarios do not think to incorporate the spatial data usage into the scenarios. A participant defines this circumstance by indicating that the distribution of spatial data is not really an issue, it is more about the interpretation of data and its use. The policy workers prepare various disaster and emergency scenarios. These scenarios are prepared by considering almost all aspects but the spatial data. The policy workers of the safety regions can work with geo-specialists to incorporate spatial data in these scenarios. That would bring quality and fitness of spatial data and more time for disaster preparation. This kind of incorporation should be more but the request should come from both sides instead of just one side pushing it, the participant suggests. The data is a part of the solution. Having good spatial data for emergencies and disasters means that these organizations are probably more efficient. If they would be more efficient, other actors of the crisis will be more effective and the impacts of the unwanted situations will be smaller.

According to the safety region directives, they are obligated to have proper crisis management organization. Also, after a crisis, they need to evaluate the situation and their operations properly. Therefore, those incidents are carefully archived. While archiving, the safety regions also include those generated data within the LCMS so that they can scroll through backward when needed. That feature was recently built in the new LCMS plot so they can see what was put when onto the map.

All interviewees are on the same page in terms of awareness about the importance of spatial data for disaster management. According to one of the participants, the realization or the awareness about what could be done with data is the most important thing to focus on for future improvement of the safety regions in terms of spatial data. Technical limitations do not matter anymore: technically everything is already possible. Now, what needs to be done is increasing the realization or the awareness. People need to realize that whatever they think about the data is already possible.

3.4. Implications from the Interviews

It can be derived that both countries use their ERSs actively, both for small-scale emergencies and big-scaled disastrous situations. The information managers from both countries have active roles before, during and after these situations. In general, they are able to have an active ERS and they think that the ERSs help countries to perform disaster management more efficiently and effectively.

On the Turkish side, data incompatibility stands out as one of the issues hindering data flow and effective management for emergency response. Because the data provider organizations follow their own ways to gather and generate data, and do not arrange these data according to an obligatory standard so AYDES data managers have to rearrange all incoming data to make them compatible with each other. In addition to setting standards for data provision, having more GIS teams or GI-literate people in each relevant organization may help to solve this issue.

In addition, the competent people who can use AYDES from some of the emergency or data provider partner organizations do not use the system as regularly as users from AFAD. This results in losing competency with time. AYDES has a practice environment for local and inter-organizations drills. These drills can help all users to stay acquainted with the system.

On the other hand, the participants define AYDES 2.0 as a highly developed system, answering many needs of the users. A participant compares it with the web portal of Turkish NSDI, namely Atlas, in terms of data variety, use process and visualization.

The organizational differences, insufficient communication and unwillingness for more cooperation in terms of data provision and emergency/disaster management among the relevant organizations are the main problems making the emergency response more complicating for the Dutch participants.

The lack of a sufficient number of GIS teams or GI-literate people is also mentioned by the Dutch interviewees. This causes organizations to fail to be proactive in integrating spatial data into emergency management. Integration of spatial data to emergency management is also related to awareness of what could be done with the spatial data. A participant pointed out that without the awareness, the benefits of spatial data for emergency response will be limited.

The participants from both countries mention that sufficient communication and increasing the awareness of the importance of (spatial) data are the most needed improvements for better data provision and information management for emergency and disaster management.

During the interviews, two indicators are found not applicable for the assessment by the participant user group. The first was *Manageable* indicator. For assessment, the Manageable indicator was about if the obtained data is manageable according to the participants. However, most of them indicated that they have no authorization to manage the data and other colleagues are responsible for this. For this reason, the indicator is removed from the assessment framework.

Secondly, the knowledge about the existence of SDI directives is found ambiguous from the answers that the participants gave. Actually, both countries have relevant SDI directives to provide a legal framework for the establishment of SDIs, in our case TUCBS and Geo4OOV. These directives specify the scope, the purpose of establishment and technical details about the relevant SDIs, including data standards and engagement of partner organizations (Government of the Netherlands, 2013; Government of Turkey, 2021). Because the survey including the assessment framework is a subjective questionnaire, asking both knowledge and opinions of the participants, the indicator *SDI directive* is found out not well known by some of the participants and removed for disambiguation of the assessment.

The points derived from the interviews to seek about the efficiency and effectiveness of the current data provision and information management for emergency response are:

- The GIS teams or GI-literate employees within the partner data supplier organizations
- The communication among the data supplier organizations
- The awareness of the importance of spatial data

These points are found to be assessable for purpose of this study and translated into indicators for the final assessment framework.

3.5. Final Assessment Framework

The second version of the assessment framework is obtained by removing the duplicated indicators and non-applicable indicators (see Appendix B). Because the first version includes the indicators suggested by three different academic studies, there was a need for examination of each indicator one by one. As a result of the examination, the overlapping indicators are identified and merged. Then, the indicators found not applicable during the initial and second interviews, as explained in the previous section, are removed.

The final assessment framework includes the remaining indicators from the previous two versions and the newly added four indicators. The framework is separated into two tables comprising dataset indicators (Table 3.2) and SDI indicators (Table 3.3).

The participants found dataset indicators highly relevant to the purpose of the framework. To be able to reach data, to recognize it, to use it, to ensure its quality and actuality, and to be able to do all of this in a timely manner are accepted as the utmost important features for emergency response and management. While dataset indicators directly assess data provision, the SDI indicators of the assessment framework seek the factors that reside in the background to realize the goals of the SDI. Even though some participants think these are not the first criteria that come into mind when aiming to assess data provision of SDI, they accept that it would be beneficial to assess these factors (use process and governance) too because the SDI definition includes multiple aspects, namely, people, policy, standards, data and access network.

Table 3.2: The dataset indicators to measure emergency response data provision readiness

Indicator group	Indicator	Description
Known	Recognizable	The dataset is recognizable (thanks to metadata availability)
Known	Findable	The dataset is findable
Attainable	Practically available	The dataset is practically available
Attainable	Affordable	The dataset is affordable
Attainable	Delivery time	The dataset can be acquired/delivered in time
Attainable	Legal transparency & interoperability	The dataset does not have any legal restrictions (and there is legal transparency)
Attainable	Service level / format	The dataset is distributed in a sufficient format or service
Usable	Reliable	The dataset is reliable
Usable	Sustainability / long term availability	The dataset has long-term availability / is sustainable
Usable	Up-to-date	The dataset is up-to-date
Usable	Spatial data quality	The dataset has sufficient spatial data quality
Usable	Communication of data supplier to the user (data)	There is sufficient communication from the data supplier to the data user
Usable	Clear / support (metadata)	The metadata and relevant support are clear

Table 3.3: The SDI indicators to measure emergency response data provision readiness

Indicator group	Indicator	Description
Use process	Access to more sources of information	The SDI increases access to sources of information
Use process	Data management	The SDI improves data management
Use process	Decision making time	The SDI shortens decision-making time
Use process	More independent of suppliers, superiors, other employees	The SDI creates independence for suppliers, superior, other employees in decision making
Use process	Use of spatial data (frequency)	The SDI increases the use of spatial data
Use process	Workflow	The SDI improves the workflow
Use process	Data delivery mechanism	The data delivery mechanism is reliable in different situations (such as no-internet)
Governance	Stimulation of SDI use	The SDI organization stimulates SDI use
Governance	Clear / support (governance)	The communication and support regarding the SDI use are sufficient/clear
Governance	Communication of data supplier to user	The SDI stimulates and supports communication from the data supplier to the data user
Governance	Access network reliability	The access network of the SDI is established and enable coordinators to manage access rights of different user groups
Governance	Interoperability	Ability to understand and share various data and relevant technology across organizations and users
Governance	Willingness to share	Relevant organizations are willing to share their data
Governance	Institutional arrangements	Institutional arrangements for intended objectives are made or in progress
Governance	GIS / GI-literate employees	Partner data supplier organizations have GIS teams (or employees who have GI-literacy)
Governance	Communication among data suppliers	There is sufficient communication among the data supplier organizations in terms of governance
Governance	Spatial data awareness among data suppliers	The awareness of the importance of spatial data is high among the data supplier organizations
Governance	Spatial data awareness among user organizations	The awareness of the importance of spatial data is high among the user organizations (e.g. safety regions)

The three points derived from the user needs are translated into indicators and added to the final version of the framework. These indicators are *GIS/GI-literate employees*, *Communication among data suppliers*, *Spatial data awareness among data suppliers*, and *Spatial data awareness among user organizations*. This framework is shaped through the ideas and needs of the interviewed user groups. Therefore, it is important to consider these users as the target group of the assessment. As discussed in Chapter 1, their responsibilities include reaching data, visualizing information, sharing value-added information with others, using various relevant services, defining analysis and preparing reports. The assessment results would reflect the situation according to the emergency management information managers. If it would be aimed to assess the relevant SDIs from the point of view of other user groups, the framework should be fine-tuned accordingly.

3.6. Summary

This chapter was all about reflecting the thoughts of the emergency response employees on their current national ERSs and the designed emergency response SDI assessment framework. For this, three participants per country are interviewed and answered the questions about their responsibilities, ERS usage, spatial data usage and the assessment framework that this study suggests. Their answers are grouped as Data, Use Process and Governance, concerning the indicator groups of the framework. The derivations made from these answers are to be able to fine-tune the content of the framework. These derivations are turned into indicators for the assessment. Also, there are indicators that were detected as inapplicable and removed. In total, four indicators are added to the final version while two other indicators from the first version are removed. The final version of the assessment is applied to the Turkish NSDI (TUCBS) and the Dutch emergency response SDI (Geo4OOV) in the following two chapters. For this, the second round of the interviews is held with the same participants.

CHAPTER 4: Assessment of Turkish NSDI

4.1. Introduction

The assessment of Turkish NSDI is performed through the final assessment framework proposed in the previous chapter. The participants are surveyed through the second interview which includes the questions on actions for emergency response, needed data, the data provision and the current performance features of the relevant SDI. The user profiles of the participants are identified and assessment predictions are made according to their usage of the NSDI and their needs. As mentioned in Chapter 1.5.1, the interviewees are categorized according to the definitions of both van Loenen (2009) and Charvat et al. (2013). All assessment interviews are completed by June 2021.

The assessment answers are presented as tables showing Yes, No, or Insufficient/Not enough choices along with the reasoning for each indicator from the viewpoint of the participants. The reflections are mostly focused on these answers to the indicators of the assessment.

4.2. Turkish NSDI: TUCBS

The first steps of the establishment of NSDI for Turkey have been taken in 2003 with the introduction of the E-transformation of Turkey Project. Along with the project, an action plan for the preparation studies for a national geographical information system was published in 2005. At that time, the General Directorate of Land Registry and Cadaster was the responsible institution. Through the years, the project has been evolved to the efforts for Turkish National Spatial Data Infrastructure establishment. Today, the General Directorate of Geographic Information Systems (CBSGM) is the responsible institution for conducting relevant actions to establish and develop Turkish NSDI (CBSGM, 2021).

The development and establishment works of the NSDI of Turkey, TUCBS (Türkiye Ulusal Coğrafi Bilgi Sistemi), aim to determine, plan and meet the requirements for the existence, sharing and use of geographical data, geographical datasets, geographical data services and metadata belonging to public institutions, special provincial administrations, provincial municipalities, and water and other infrastructure organizations. Currently, the efforts continue to increase awareness among all stakeholders through training and workshop organizations (CBSGM, 2021). Among many, some of these stakeholders or partner organizations are ministries, local administrations and universities (see Figure 4.1).

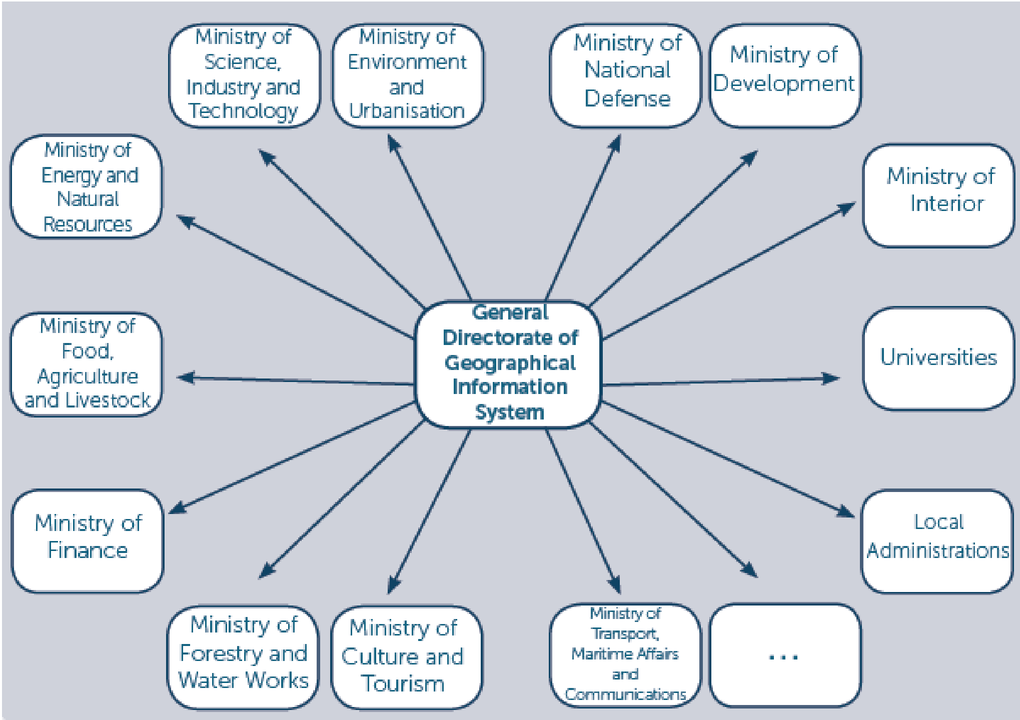

Figure 4.1: Partner organizations of TUCBS (CBSGM, 2021).

The process of data integration for the NSDI started in 2018 with 32 geographic data producer public institutions/organizations and 30 metropolitan municipalities. in 2020, 20 public institutions and organizations, 5 general directorates of water and sewerage administration, 5 mayorships, 5 special provincial administrations were responsible for the standardization of their geographic data according to the TUCBS data standards. Capacity building and data integration studies are still continuing for the purpose of harmonization with the data standards and integration with TUCBS. Geographical data services and metadata of institutions whose integration studies have been completed will be made available to the users through the National Geographic Information Platform, called Atlas (CBSGM, 2021).

The geographic data themes of TUCBS are determined and updated in accordance with national and international standards, in line with the needs of public institutions and organizations. Commonly used standards, such as INSPIRE or ISO, are studied but eventually a local standard is created in comply with the standards suggested by the UN (CBSGM, 2021). There are 32 dataset themes defined for TUCBS through the workshops held with partner organizations. The data provider organizations are responsible to arrange their data according to the NSDI standards (see Table 4.1).

Table 4.1: TUCBS dataset themes (CBSGM, 2021)

Dataset Themes	Dataset Themes
Reference Systems and Geo Grids	Conservation areas
Administrative Units	Disaster risk areas
Place Names	Infrastructure (Water, electricity, natural gas, etc.)
Cadaster	Energy sources
Buildings	Mines
Addresses	Demography
Elevation	Industrial plants
Orto photos	Agriculture areas
Transportation network	Environmental monitoring facilities
Hydrography	Habitat areas
Sea and water bodies	Species distribution
Land cover	Biogeographical areas
Land use	Geology
Soil types	Atmosphere
Human health and safety	Meteorology
Public administration zones	Statistical reporting areas

Most of these dataset themes are basic environmental datasets, and could be used for various purposes, including disaster management because disasters and their effects cannot be taught without their environment.

The initial development period of TUCBS has reached its final phases recently. It has become official with the enactment of the related laws in 2018, 2019, 2020 and 2021. Based on these laws, the documents about organization coordination, data needs, access networks, metadata, datasets are also published for the first time by the Turkish Ministry of Environment and Urbanism, the organization responsible for the development of the national spatial data infrastructure. Considering the recent developments in NSDI establishment and the constant search for better emergency response capabilities, an affiliation between NSDI and the nation-wide emergency response system can be significantly helpful to the efforts of improving both the emergency response system and the NSDI.

4.3. Assessment of TUCBS

The user groups of the three participants who joined the study from the Turkish institutions AFAD and a general directorate are identified according to their positions, responsibilities and needs. The positions of the participants are as follows:

Participant 1: Engineer in the department of GIS of AFAD

Participant 2: Manager in Earthquake Working Group of AFAD

Participant 3: Director in a provincial directorate

Table 4.2 shows that the user groups defined by both van Loenen (2009) and Charvat et al. (2013), and which participant belongs to which user group. While choosing the groups they belong to, their responsibilities within the Turkish ERS are considered. According to the table, Participant 1 (P1), who is an engineer in the department of GIS of AFAD can be defined as an expert user by Charvat et al. (2013), while can be defined as a secondary user by Loenen (2009). The reason is that P1 works for the GIS department and he/she is responsible for the data arrangement of the Turkish ERS, AYDES. He/she has the right to access collected data, edit and arrange it before the lower-level user groups see and use it. This is the most defining liability of this user, among others. An employee in this position can see the raw data before arranging and integrating it into the ERS.

Participant 2 (P2) is the manager of the earthquake working group and regularly uses the ERS for earthquake-related tasks such as examining the earthquakes, their effects, locations and response to them. Even though the users from this working group enter information about the earthquakes into the system, as the manager of the earthquake working group, P2 mostly benefits from the system as a tertiary user (van Loenen, 2009) or a registered user (Charvat et al., 2013). His/her responsibilities over ERS include managing scenario maps for drills, tracking earthquake data and reaching risk or disaster information when it is needed.

Participant 3 (P3) is a director from a Turkish provincial directorate. Similar to P2, P3 is also responsible for entering some relevant data about the emergency situations into the system but rights of both P2 and P3 for editing or arranging the data are limited.

Table 4.2: User profiles of Turkish participants

van Loenen (2009)		Charvat et al. (2013)	
Secondary users	Tertiary users	Expert users	Registered users
P1		P1	
	P2, P3		P2, P3

The assessment results of Turkish NSDI are presented in Table 4.3 and Table 4.4 below. The tables include the Yes, No, or Insufficient/Not enough answers and the overall remarks of the participants from the Turkish side (P1, P2 and P3) for each indicator of the assessment framework. The green color symbolizes positive answers (Yes) and reds are showing negative answers (No). The yellows are for the answers which stand in between, reflecting the insufficiency of that particular indicator for the assessed SDI. For the second interview structure which include assessment, see Appendix C.

Table 4.3 shows the dataset indicators assessment results. These are focused on measuring if the needed datasets are known, attainable and usable as these three aspects are key to reach needed information (van Loenen & Grothe, 2014; Welle Donker & van Loenen, 2017).

Table 4.3: The survey results of the Turkish NSDI's assessment with dataset indicators (Green: Yes, Red: No, Yellow: Insufficient/Not enough)

Indicator group	Indicator	Participants P1	P2	P3	Remarks by Participants
Known	Recognizable				Some of the needed datasets are not findable and recognizable.
Known	Findable				Some of the needed datasets are not findable and recognizable.
Attainable	Practically available				Only some of the needed datasets are available.
Attainable	Affordable				Mostly free of charge.
Attainable	Delivery time				Reasonable delivery time if the dataset exists.
Attainable	Legal transparency & interoperability				Some datasets have legal restrictions due to privacy and security reasons.
Attainable	Service level/format				Not all of them have proper standards. Not ready to use for an emergency response without pre-editing.
Usable	Reliable				Mostly provided by governmental organizations.
Usable	Sustainability / long term availability				The datasets are usable for a long time.
Usable	Up-to-date				The ones existing are up-to-date.
Usable	Spatial data quality				- Some of the data do not have sufficient quality. Some of them do not exist. - Periodic data updates would help to increase the quality in terms of completing the missing datasets and finding out the required ones.
Usable	Communication of data supplier to the user (data)				The communication channels are limited. More communication options would increase the spread of the use of the system.
Usable	Clear / support (metadata)				Metadata is not sufficient for some of the datasets.

Table 4.4 is the results table of assessment with SDI indicators. These indicators are chosen for assessment of the use process and governance status of the Turkish NSDI.

Table 4.4: The survey results of the Turkish NSDI's assessment with SDI indicators (Green: Yes, Red: No, Yellow: Insufficient/Not enough)

Indicator group	Indicator	Participants P1	P2	P3	Remarks by Participants
Use process	Access to more sources of information	Green	Green	Green	Combinations of various datasets can be seen through the portal.
Use process	Data management	Green	Green	Green	Guide/direct stakeholders to arrange, edit and use the data.
Use process	Decision making time	Green	Green	Green	Easy visualization of the situation.
Use process	More independent of suppliers, superiors, other employees	Yellow	Green	Yellow	- There is still a hierarchy so it is only partially true. - The usage of spatial data and related tools is limited with a group of people. Other people are dependent on those who can use the system and spatial data.
Use process	Use of spatial data (frequency)	Red	Green	Yellow	Not surely because the data may be used when only it is needed. The SDI may not increase its usage frequency.
Use process	Workflow	Green	Green	Green	Would help more efficient disaster management.
Use process	Data delivery mechanism	Red	Yellow	Red	Data are mainly delivered through the internet. Internet must be stable. Also, the portal itself is not working sometimes. There is no alternative delivery mechanism.
Governance	Stimulation of SDI use	Green	Green	Green	With the shift to the use of the system, more users will learn its use.
Governance	Clear / support (governance)	Red	Red	Green	SDI is still establishing so it is not possible to reach the support team every time.
Governance	Communication of data supplier to user	Yellow	Green	Green	There are ways to reach data suppliers.
Governance	Access network reliability	Red	Green	Yellow	The portal is not working well sometimes and some data cannot be found. This brings doubt about access rights and reliability.
Governance	Interoperability	Red	Green	Green	Some data are not interoperable and SDI is not helpful for users to understand and use the system.
Governance	Willingness to share	Red	Red	Green	The organizations' unwillingness to share their data has been a significant problem.
Governance	Institutional arrangements	Green	Green	Green	Legal arrangements have been made. The stakeholders are active.
Governance	GIS / GI-literate	Yellow	Yellow	Green	The organizations have GI-literate employees but their number may not be enough.
Governance	Communication among data suppliers	Red	Yellow	Yellow	For data provision, there is almost no communication at all.
Governance	Spatial data awareness among data suppliers	Green	Green	Green	Most of them are already gathering data for their needs. These data are found easy to visualize and present.
Governance	Spatial data awareness among user organizations	Yellow	Green	Yellow	Its importance is started to be accepted but some of the old ways of working still continue.

4.4. Reflections

The first thing catching interest is the difference between all three participants' points of view. The answers of participants are not parallel to each other. While P1 is stricter in terms of his/her answers, P3 thinks more positively about the NSDI. P2 stays between these two. Another interesting derivation is that the points found by negative or insufficient by P2 is also answered similarly but more negatively by P1, even though they are from different user groups and they have different needs.

In this chapter, the sufficiency of an indicator means that the relevant description (see Table 3.2 and Table 3.3) is valid for that particular indicator.

Data

Before seeking the reflections from the assessments, it would be helpful to see which datasets are needed for emergency response actions according to the participants, in terms of interpreting the reasons behind their answers to the assessment indicators. Presented in Table 4.5, the listed datasets are the ones that TUCBS currently includes. According to the table, all of the participants are mostly on the same page regarding the needed datasets. P1 states only three more needed datasets than the other two participants (soil types, energy resources, agricultural areas). P3 does not mark these three datasets as needed, as well as the geology dataset. Unlike P3, P2 agrees with P1 that the geology dataset is needed for emergency and disaster response.

Table 4.5: Emergency response data needs of the Turkish participants

Dataset Themes	P1	P2	P3	Dataset Themes	P1	P2	P3
Ref. Systems and Geo Grids	✓	✓	✓	Conservation areas			
Administrative Units	✓	✓	✓	Disaster risk areas	✓	✓	✓
Place Names	✓	✓	✓	Infrastructure (Water, electricity, natural gas, etc.)	✓	✓	✓
Cadaster	✓	✓	✓	Energy sources	✓		
Buildings	✓	✓	✓	Mines			
Addresses	✓	✓	✓	Demography			
Elevation	✓	✓	✓	Industrial plants	✓	✓	✓
Orto photos	✓	✓	✓	Agriculture areas	✓		
Transportation network	✓	✓	✓	Environmental monitoring facilities			
Hydrography	✓	✓	✓	Habitat areas			
Sea and water bodies	✓	✓	✓	Species distribution			
Land cover	✓	✓	✓	Biogeographical areas			
Land use	✓	✓	✓	Geology	✓	✓	
Soil types	✓			Atmosphere			
Human health and safety	✓	✓	✓	Meteorology	✓	✓	✓
Public administration zones	✓	✓	✓	Statistical reporting areas			

As answered by P1, TUCBS fails to meet nearly half of the obtaining information needs of the users as P1 stated six out of thirteen indicators as negative (No) and found the other two insufficient. Especially, the NSDI fails to meet the known aspect of reachable information completely and the Usable aspect mostly, according to P1. This makes P1 stricter than the other two participants for these indicators.

P2 partially agrees with P1 on *Known* aspect. The known aspect is not completely *No* but insufficient for P2. In total, there are two No and four Insufficient/Not enough answers given by P2.

Interestingly, the NSDI has perfect features for P3 in terms of dataset indicators as all of the answers given by P3 are Yes to this part. P3 states that the needed datasets for their department are fully known, attainable and usable for an emergency or disaster situation. It should be noted that P3 is a provincial directorate and the needed datasets may be found for that particular province. However, P1 and P2 stated that the datasets are not complete for the whole country. The possible needed information for some provinces is still missing or in the completion process during the time of the interviews.

P1 and P2 state that some of the datasets are not standardized to be worked interoperable. P1 emphasizes that most of the datasets are still needed to be pre-edited or rearranged for the ERS because these two systems, TUCBS and AYDES, are working independently from each other and have their own separate standards. Also, the standards for TUCBS are recently enacted and the establishment of the full database may take time.

Another problem stated by the participants is metadata insufficiency. According to participants P1 and P2, metadata for some of the datasets are not complete or do not even exist.

The indicators answered as No or Insufficient/Not enough by at least two participants are (6 out of 13 dataset indicators):

- Recognizable
- Findable
- Practically available
- Service level/format
- Communication of data supplier to the user
- Clear/support (metadata)

Use Process

There are seven indicators for the use process. Although the approach of the participants to this part seems more positive than to other parts, there are still indicators that needed to be focused on and improved. Four indicators out of seven are answered as Yes by all three participants. One indicator, independence, is found only partially true because there is still a hierarchy within the institutions so the users cannot be count as more independent. Among the remaining indicators, the frequency of the spatial data use is found negative by P1 and not enough by P3 in terms of possible use for emergency response because these participants think that the existence of the SDI will not change the use frequency of the spatial data. The needed data will only be used when there is a need. There are already needed spatial data in AYDES so data provision by TUCBS may not change the use frequency significantly.

The least favored indicator is the data delivery mechanism. P1 and P3 think that the data delivery mechanism of TUCBS is not reliable in different situations. P2 also found the mechanism insufficient. The main delivery mechanism of the TUCBS is through the internet. The participants state that there is no alternative to obtain the needed data quickly if a problem emerges relevant to the internet connection. During the interviews, the spatial data portal and the data viewing tools were relatively slow.

The indicators answered as No or Insufficient/Not enough by at least two participants are (3 out of 7 use process indicators):

- More independent of suppliers, superiors, other employees
- Use of spatial data (frequency)
- Data delivery mechanism

Governance

Governance is the part that TUCBS needs to be developed most for a possible emergency response data provision, according to P1, because only three out of eleven indicators are answered as Yes by this participant. P1 states that the establishment of TUCBS should be finished first, then more development can take part but TUCBS is not ready to provide data for AYDES at the moment. The approach to the usage of spatial data, to its importance for TUCBS and AYDES, should be elaborated, P1 remarks. The thoughts of P2 and P3 are more positive on governance as P2 gives only two No answers (clear support and communication provided by the NSDI; and the data provider institutions' willingness to share data) and two Insufficient/Not enough answers (sufficient number of GI-literate employees and communication among data suppliers) while P3 gives three Insufficient/Not enough answers (access network reliability, communication among data suppliers, and spatial data awareness among user organizations).

Access network reliability is one of the issues that the participants mentioned. To reach the needed data and services, the participants must login to the system. However, they have doubts about the user rights reliability as they cannot reach the data or even the portal itself. As mentioned during the user needs interviews as well, the organizations are not willing to share their data, they do not have enough communication among them, and they have limited numbers of GI-literate employees.

For the user institutions or their user departments, their spatial data awareness is low because they may not fully get used to new technologies.

The governance stands out as the part to be focused on most. All three participants meet on the common ground that the main aspect that needs to be handled carefully is the governance aspect of TUCBS. The participants think that if the management of the NSDI can be maintained well, other aspects that the framework measures will be improved in parallel. To do this, both internal (within the ministry) and external (among the data providers) organizational problems relevant to the NSDI should be addressed.

The indicators answered as No or Insufficient/Not enough by at least two participants are (6 out of 11 governance indicators):

- Clear/support (governance)
- Access network reliability
- Willingness to share
- GIS/GI-literate
- Communication among data suppliers

- Spatial data awareness among user organizations

4.5. Summary

In this chapter, the assessment framework is applied to TUCBS, the Turkish NSDI. TUCBS is chosen for the assessment in terms of data provision readiness for Turkish ERS because it is the most comprehensive SDI that may have capabilities regarding such data provision for ERS in the future. Also, as a counterpart of the Turkish side in this study, the Dutch emergency response SDI is also gathering a handful of datasets from the Dutch NDSI, PDOK.

At the start of the chapter, TUCBS is introduced. Then, the user groups to which each participant belongs are interpreted, considering the definitions of van Loenen (2009) and Charvat et al. (2013). Thus, it is aimed to derive how their tasks and needs affect their answers. The participants' answers of Yes, No, and Insufficient/Not enough for each indicator are presented as tables and these answers are summarized under the assessment framework main parts of data, use process, and governance. The same framework is applied to the Dutch emergency response SDI, Geo4OOV in the next chapter.

CHAPTER 5: Assessment of Dutch Emergency Response SDI

5.1. Introduction

The Turkish SDI is assessed in the previous chapter through the final assessment framework. To make a comparison, the assessment of Dutch emergency response SDI, Geo4OOV is performed through the same final assessment framework during the second interviews with the Dutch participants and the results are presented in this chapter. As in the previous chapter, the user groups of the participants are defined. The assessment answers are shown as Yes, No, or Insufficient/Not enough choices along with short remarks reflecting the general thoughts of the participants. The assessment interviews are completed by June 2021.

5.2. Dutch Emergency Response System SDI: Geo4OOV

The data need of Dutch ERS, LCMS is met by the Dutch emergency response SDI, called Geo4OOV, which is established and managed by IFV. It has developed as a part of the Information Provision for Safety Regions 2015-2020 program which is covering the joint actions to be taken by safety regions for information provision. Geo4OOV is responsible for obtaining geo-information from various sources, organizing them and disseminating them to related emergency stakeholders through connected ERS, in compliance with the doctrine of net-centric working. It assures the most recent data with the standardized quality for any related GIS applications. The GIS clients are served map layers and object information with commonly known service standards WMS, WFS, and WMTS, making them compatible with common GIS applications. The users of LCMS can access datasets in varying themes and scales, such as aerial photos, water depth maps, or building locations, through Geo4OOV infrastructure.

Features of the crisis management system make use of these data for risk analysis, decision making support, operational plan drawing, medical care directing and more (IFV, 2020a; Keating, 2016). Table 5.1 presents the datasets within Geo4OOV and their sources. As the table indicates, Geo4OOV gathers data from different sources including PDOK (Publieke Dienstverlening Op de Kaart, Public Services on the Map), the Dutch NSDI. It has been established through a collaboration among government organs and a private company, intending to provide reliable and up-to-date data from both the public and private sectors. PDOK provides its services and geo-information openly so that they are available for anyone and for free (PDOK, 2020).

Table 5.1: Geo4OOV datasets and their sources (Keating, 2016)

Type	Source	Dataset
Base maps	PDOK	BAG, BRT, BGT
Core records	PDOK	Population statistics, postcodes, admin-boundaries
Risk maps	Risicokaart, Dataland (municipal knowledge and data hub org.)	Hazardous materials, flooding, vulnerable objects
Objects (Points of Interest)	Emergency services, Imergis (an open data initiative)	Fire, police, and ambulance stations. Government services and emergency management infrastructure
Infrastructure	Multiple partners	Waterways, road/highways, Railways, Energy, etc.

Geo4OOV offers a metadata list of thematic datasets data through its geocatalog webpage. This webpage is supposed to inform the users about the owner and the manager of the data, reference, theme, scale, last update and the foreseen next update. The SDI avoids the sharing of personal and confidential data, protected by regulations, due to privacy and security reasons (IFV, 2020a).

5.3. Assessment of Geo4OOV

The participants from The Netherlands have similar user profiles to the Turkish participants as they are working for IFV or Dutch safety regions.

Participant 4: Functional manager at IFV / plotter at a safety region

Participant 5: Information provision coordinator & information manager at a safety region

Participant 6: Functional manager at a safety region

Among the Dutch participants, Participant 4 (P4) works as a national functional manager in IFV. His/her job is to maintain the functioning and further development of LCMS, and the supporting the functional managers of the multiple departments. The access and user rights of P4 make him/her be able to reach out to the content Geo4OOV provides, manage them, and make analyses. Even though the user hierarchy of P4 is higher than many other users, this hierarchy is not at the point of neither content provider nor administrator because the P4 does not gather data or provide data for the SDI; in addition he/she does not technically administrate the infrastructure. With this situation, P4 can be defined as a secondary user by van Loenen (2009) or an expert user by Charvat et al. (2013). In addition to this, it should be noticed that P4 also works as a plotter in a Dutch safety region. When there is an incident alarming the safety region, as a plotter, P4 has the responsibility of making digital drawings related to the incident. The types of these drawings may vary from affected areas to closed roads; from smoke direction to assembling points for the incident victims. These drawings are shared within the LCMS and other relevant actors can see them simultaneously thanks to the system created for net-centric way of working. As a plotter, the user rights of P4 within LCMS are more limited, making him/her also a tertiary user (van Loenen, 2009) or registered user (Charvat et al., 2013). Being a member of different user groups thanks to having a secondary job would provide more insights about all aspects of the SDI. Although knowing this, P4 is asked to answer the questions as a national functional manager during the SDI assessment survey of the second interview, for the sake of catching the parallelism between the Turkish and Dutch participant types.

Participant 5 (P5) is an information provision coordinator and information manager at a different safety region than the safety regions where P4 or P6 works at. P5 defines his/her job as an information provision coordinator as analyzing and improving the systems and processes of the safety region to make people work efficiently. Examining the LCMS for the safety region with this aim is within the responsibilities of P5. In addition to that, P5 indicates that he/she uses the LCMS as an information manager during the incidents. This means that during an emergency situation, P5 gathers the information from the relevant emergency response teams (such as police or fire department) and shares the needed information (such as the smoke, affected areas and vulnerable buildings) with the other relevant stakeholders through LCMS by the means of text or maps. Thanks to net-centric working, the relevant actors can immediately have this shared information about the situation. All these responsibilities make P5 a frequent user of the LCMS, thereby, the Geo4OOV. P5 has specific user rights in the LCMS due to his/her position in the safety region.

However, these rights do not exceed the tertiary and registered user levels because P5 still works for the safety region only. For example, P5 has no right to manage content among the servers of Geo4OOV. For these reasons, P5 can be counted within the tertiary users (van Loenen, 2009) or registered users (Charvat et al., 2013).

Participant 6 (P6) is also a functional manager but on the safety region level. The job of P6 can be described as acting as an intermediary between the user organization and the IT organization (including application managers) of the safety region and maintaining the functional management of such domains: GIS, crisis organization (including LCMS), information management, and others. Being on the safety region level makes the user rights of P6 more limited in comparison to the user rights of P4. Thus, the user group which P6 belongs to is also different: tertiary users (van Loenen, 2009) or registered users (Charvat et al., 2013).

Table 5.2: User profiles of Dutch participants

van Loenen (2009)		Charvat et al. (2013)	
Secondary users	Tertiary users	Expert users	Registered users
P4	P4 *	P4	P4 *
	P5, P6		P5, P6

* P4 can be defined as both secondary and tertiary user by van Loenen (2009); and an expert and registered user by Charvat et al. (2013) due to the responsibilities of two different jobs. However, only the primary position of P4, national functional manager, will be taken into consideration during the SDI assessment.

The assessment results of Dutch emergency response SDI are presented in Table 5.3 and Table 5.4 below. As in Chapter 4, the results tables include the Yes, No, or Insufficient/Not enough answers along with the overall remarks of the participants from the Dutch side (P4, P5 and P6) for each indicator of the assessment framework. The green color is for positive answers (Yes) and reds are for negative answers (No). The yellows show the answers which stand in between, reflecting the insufficiency of that particular indicator.

Table 5.3 shows the results of assessment results with dataset indicators. These indicators aim to measure if the needed datasets are known, attainable and usable.

The assessment results with SDI indicators are shown in Table 5.4. The SDI indicators are for the assessment of the use process and governance status of the Dutch emergency response SDI, according to the perspectives of users.

Table 5.3: The survey results of the Dutch emergency response SDI's assessment with dataset indicators (Green: Yes, Red: No, Yellow: Insufficient/Not enough)

Indicator group	Indicator	Participants			Remarks by Participants
		P4	P5	P6	
Known	Recognizable				Geo4OOV has a Geocatalog and the datasets can be recognized through it.
Known	Findable				- Via LCMS or Geoserver of Geo4OOV. - Datasets can be searched through the search module. - Some data are still missing or not detailed (grid and building stocks).
Attainable	Practically available				Easily reachable through LCMS.
Attainable	Affordable				All datasets via LCMS or Geo4OOV are already paid on forehand collective.
Attainable	Delivery time				- For so long, the datasets are available. New datasets sometimes take some time because of legal restrictions or the pricing of the datasets. - Local cache of the datasets is possible.
Attainable	Legal transparency & interoperability				Some datasets have legal restrictions but that is mentioned in the metadata. Restrictions can be applied via authorization.
Attainable	Service level / format				European Union's INSPIRE standards and OGC services (WMS, WFS, WMTS) are used.
Usable	Reliable				There are inaccuracies in the buildings dataset.
Usable	Sustainability / long term availability				Gathered and provided data are mostly sustainable and re-usable.
Usable	Up-to-date				The datasets are refreshed periodically; depending on the dataset.
Usable	Spatial data quality				Spatial data quality should be reflected in the metadata.
Usable	Communication of data supplier to the user (data)				Not always because Geo4OOV acts as an intermediate and can also be a filter of information.
Usable	Clear / support (metadata)				Some datasets are missing metadata. The content of metadata could be improved.

Table 5.4: The survey results of the Dutch emergency response SDI's assessment with SDI indicators (Green: Yes, Red: No, Yellow: Insufficient/Not enough)

Indicator group	Indicator	Participants P4	P5	P6	Remarks by Participants
Use process	Access to more sources of information	Green	Green	Green	In general, yes, but the access rights should be adjusted properly.
Use process	Data management	Green	Green	Green	It forces standardization so it improves data management.
Use process	Decision making time	Green	Green	Green	It is easier to gather the data. Although more data /insights result in more questions of decision-makers.
Use process	More independent of suppliers, superiors, other employees	Green	Green	Green	It provides the independence to geospecialists. Although there is still need a specialist to clarify the data and information for decision-makers.
Use process	Use of spatial data (frequency)	Green	Green	Green	LCMS is regularly used, and spatial data as well.
Use process	Workflow	Green	Green	Green	It is a useful technology so it improves the workflow.
Use process	Data delivery mechanism	Green	Green	Red	Internet connection is needed. Caching mechanism is not for everyone.
Governance	Stimulation of SDI use	Green	Green	Green	Its usefulness is acknowledged widely among different institutions.
Governance	Clear / support (governance)	Green	Green	Green	There are ways to reach the SDI administrating team if anything is needed.
Governance	Communication of data supplier to user	Green	Yellow	Green	Could be improved, e specially around metadata.
Governance	Access network reliability	Green	Green	Green	The user rights and access are managed well.
Governance	Interoperability	Green	Yellow	Green	Relevant data suppliers work or gather their data in their own ways.
Governance	Willingness to share	Green	Green	Green	Most of the time. Sometimes there are legal or pricing restrictions.
Governance	Institutional arrangements	Green	Green	Green	Already established arrangements. More institutions will get involved.
Governance	GIS / GI-literate	Green	Green	Yellow	Most of the organizations have big GIS asset teams although their objective is not to prepare the data, especially for the SDI.
Governance	Communication among data suppliers	Green	Red	Red	- Communication lacks between the organizations. Organizations collect data for their own process and standardization seems to be a long process. - On the other side, the partner data supplier organizations meet regularly.
Governance	Spatial data awareness among data suppliers	Green	Green	Yellow	Generally yes but a few organizations think in their own process.
Governance	Spatial data awareness among user organizations	Green	Red	Red	Only a small part of the potential is used. There is no good system/process to increase the use and quality of spatial data.

5.4. Reflections

As a general reflection, it appears that the thoughts of Dutch participants on Geo4OOV in terms of the emergency management data provision are remarkably positive: the number of Yes answers to the indicators is explicitly more than the No or Insufficient/Not enough answers. The dataset indicators are answered positively in general, except a few. More interestingly, there is not a single indicator that was answered as No or Insufficient/Not enough by two different participants in the indicator group of Use Process. The only indicator group that is found relatively insufficient is Governance and mainly the indicators that derived from the user needs interviews, rather than the indicators proposed in the first version of the assessment framework. Again, the sufficiency of an indicator stands for the validity of the description for that particular indicator.

Data

To be able to interpret the relation between their point of view and the assessment indicators, examining the dataset needs of the participants could be helpful. Table 5.5 shows the needed datasets for emergency response actions, according to the Dutch participants.

Table 5.5: Emergency response data needs of the Dutch participants

Dataset Themes	P4	P5	P6	Dataset Themes	P4	P5	P6
Ref. Systems and Geo Grids	✓	✓	✓	Conservation areas			✓
Administrative Units	✓	✓	✓	Disaster risk areas	✓		✓
Place Names		✓	✓	Infrastructure (Water, electricity, natural gas, etc.)	✓		✓
Cadaster			✓	Energy sources	✓		✓
Buildings	✓	✓	✓	Mines			✓
Addresses			✓	Demography	✓		✓
Elevation	✓	✓	✓	Industrial plants	✓		✓
Orto photos			✓	Agriculture areas			
Transportation network	✓	✓	✓	Environmental monitoring facilities			
Hydrography	✓	✓	✓	Habitat areas			✓
Sea and water bodies				Species distribution			
Land cover	✓		✓	Biogeographical areas			
Land use	✓		✓	Geology			✓
Soil types	✓	✓	✓	Atmosphere			✓
Human health and safety	✓	✓	✓	Meteorology	✓	✓	✓
Public administration zones	✓	✓	✓	Statistical reporting areas			

According to the table, P5 draws attention as the least demanding participant in terms of needed datasets. He/she chose only nine proposed datasets out of twenty-eight as needed. This seems to contradict the multiple responsibilities and usages coming from his/her two positions in the safety region. The needed datasets choices indicated by the other two participants seem similar to each other. P4 checked fifteen datasets in the proposed list, while P6 checked six more in addition to the same fifteen datasets.

Within the dataset indicators group, there is no Known or Attainable indicator answered negatively or found insufficient by two different participants. The only negative answer is for the data delivery mechanism by P6, while the only Insufficient/Not enough answer is for the dataset indicator named reliable. Among the whole dataset indicators group, only one indicator was marked as No (by P5 and P6) and only one as Insufficient/Not enough (by P4 and P5) by two different participants. These are, respectively (2 out of 13 dataset indicators):

- Communication of data supplier to the user
- Clear/support (metadata)

Communication is mentioned by all of the participants during the second interviews and pointed out as one of the aspects that should be improved for both better emergency response management and relevant data provision. The participants mentioned that some organizations remain slow to answer the feedbacks coming from LCMS users. These feedbacks actually go to the Geo4OOV administration first, and then to the data provider organization, if the feedbacks are transmitted to them. It should be noted that the Geo4OOV administration has the right to set priorities among these feedbacks and system maintenance.

Apart from the communication, the participants indicated that the metadata of some datasets are found out to be incomplete, insufficient, or consist only basic information. It is regardless of the data's gathering time or how up-to-date they are. For a relatively established SDI, it is another important indicator that requires attention.

Use Process

The Use Process group is the most positively answered indicator group. According to the Dutch participants, there is almost no flaw in the use process aspect of Geo4OOV. There is only one indicator (Data delivery mechanism) answered as No by only one participant (P6). This means zero out of seven use process indicators are found insufficient by two different participants.

Governance

Governance is the most criticized aspect of Geo4OOV but still with low rates; the No and Insufficient/Not enough answers show only a slightly higher proportion than the dataset indicators group. While P4 answered all the indicators as Yes, P5 and P6 found a few governance features partially or fully insufficient. Communication of data supplier to user is the only indicator found insufficient by P5 while the other two participants see this indicator positively. P5 also pointed out two other indicators as No (communication among data suppliers; and spatial data awareness among user organizations), similar to what P6 thinks of these two indicators. Apart from these, P6 founds two others as Insufficient/Not enough (GIS/GI-literate; and spatial data awareness among data suppliers).

Again, the communication is found insufficient once more just like found insufficient in the dataset indicators group. For the governance aspect, the communication between the data supplier organizations is found lacking. The way of working of some of the partner organizations is not interoperable sometimes and with the lack of communication, the tackles for better emergency management or data provision are deepening. For instance, in some situations, they gather data that overlap the data provided by other data suppliers, or on the contrary, they gather insufficient data due to thinking these parts are within the responsibilities of other organizations. Therefore, the data provided by these organizations are needed to be arranged to be able to work interoperable with the rest of the datasets within the system. These regularly happen due to lack of sufficient communication among the partner data suppliers, the participants mark.

Interestingly, this problem still exists although the data supplier partner organizations or safety regions regularly meet.

Awareness of spatial data is the second indicator that needed to be improved according to the assessment results. The participants believe that the spatial data awareness is not high enough among the data supplier organizations to interpret the other utilization possibilities than what just the current system brings.

The indicators answered as No or Insufficient/Not enough by at least two participants are (2 out of 11 governance indicators):

- Communication among data suppliers
- Spatial data awareness among user organizations

5.5. Summary

The results show how Geo4OOV is established through the years regarding the data provision readiness for emergency response. The answers of the Dutch participants show low negativity for all aspects of the SDI assessment. Only four indicators among thirty one are answered as No or Insufficient/Not enough by at least two participants. It is also interesting that two indicators related to communication from two different indicator groups are found to require improvement.

CHAPTER 6: Evaluation

6.1. Introduction

This chapter examines the SDI assessment results of TUCBS and Geo4OOV. The indicators that were found insufficient by at least two participants of each side are compared. Through that, the similarities, the differences, and the inferences are discussed. In addition, another assessment completed by an administrator of TUCBS, from the General Directorate of GIS of the Turkish Ministry of Environment and Urbanism is presented in this chapter. The aim is to have a glimpse of the administrator sides perception of the Turkish NSDI and its establishment process.

In this chapter, the insufficient term is used for the indicators assessed as No or Insufficient/Not enough by at least two participants from Chapter 4 or Chapter 5.

6.2. Evaluation of the Results

The results show that TUCBS is remaining behind its counterpart in terms of emergency response data provision. As an SDI specifically created for emergency response and a net-centric way of working, Geo4OOV maintains data provision better. There are four indicators commonly insufficient for both SDIs. For Geo4OOV, the Dutch participants did not find any insufficient indicators different than the Turkish participants chose for their NSDI. There is also no significant parallelism between the answers and the user groups of the two sides. While P1, who is defined as a secondary or expert user, found more indicators insufficient than any other participants found for Turkish NSDI, while the tertiary or registered user P6 is the participant who gives the most negative answers for Geo4OOV. The reason might be related to the maturity levels of the two SDIs. P1 thinks more critically about TUCBS because as an expert user and a data editor of Turkish ERS, he/she thinks more comprehensively in terms of data provision needs. On the other side, the expert user of Dutch ERS, P4 is not a regular data editor for the SDI and thinks that both LCMS and Geo4OOV are working well in general terms because they are already established a time ago and, since, they have been used as intended. Another reason might be the difference between the awareness levels of the two countries. As a registered user from a Dutch safety region, P6 emphasized that the potential of data utilization is not considered by many stakeholders. P5, a user from the same user group, also mentioned this issue by stating the geographical data should be taken into consideration during policy making for various emergency management actions. This awareness emphasis shows why P6 is more critical than expert user P4. P3, the Turkish counterpart of P6, is mostly content with the current readiness of TUCBS because he/she only thinks of a limited number of datasets in parallel to his/her data needs for emergency response in that particular province.

Data

In terms of dataset indicators, Turkish participants found six indicators insufficient. Among these, two indicators are also evaluated insufficient by the Dutch participants. Table 6.1 shows these insufficient indicators. The indicators pointed out only by the Turkish participants are about the being known, findability and availability of data. Turkish participants are on the same page that some of the datasets in TUCBS are not complete for the whole country. However, they do not know exactly which datasets or layers are incomplete: there is no open information about this. In addition, the Turkish participants mention that the incompatibility of the layers with each other even though it is a rare issue. That could be a problem for an emergency situation that needs highly accurate and compatible data. In addition to the datasets themselves, the metadata of datasets in TUCBS is pointed out as requiring attention as some of the metadata do not include all of the needed information. The Dutch participants state that some of their datasets do not even have metadata, while some others are insufficient. While entering the datasets to TUCBS to publish them, it is compulsory to generate standard metadata. Therefore, missing metadata is not an issue for the Turkish NSDI.

The comments on the communication of data suppliers to the user about data obtaining and its use in Geo4OOV is because of this SDI being the only communication channel for the users. When the users need change, arrangement of some particular data, or when they have a complaint, they reach out to Geo4OOV. The relevant Geo4OOV employees prioritize these feedbacks and put them on the line. This process sometimes works slow for specific situations and it needs to be fastened, according to the Dutch participants. The Turkish participants also have similar thoughts. The communication between the data suppliers and the users should be augmented in the TUCBS environment.

AFAD employees P1 and P2 state that there is a need for an infrastructure that provides the needed datasets for Turkish ERS AYDES because requesting data from multiple sources may not be an efficient way of data gathering. Currently, the Department of GIS is responsible for arranging the incoming data for AYDES. The Dutch participants already state that the existence of Geo4OOV as an emergency response SDI, enhanced their control on information, increasing their efficiency in emergency response tasks.

Table 6.1: Dataset assessment indicators found insufficient by the participants (X: No or Insufficient by at least two participants)

Indicator group	Indicator	Participants		Remarks by Participants
		Turkish ERS	Dutch ERS	
Known	Recognizable	X		Some of the needed datasets are findable and recognizable but not all of them.
Known	Findable	X		Some of the needed datasets are findable and recognizable but not all of them.
Attainable	Practically available	X		Only some of the needed datasets are available.
Attainable	Service level / format	X		Not all of them have standards. Not ready to use for an emergency response without pre-editing.
Usable	Communication of data supplier to the user (data)	X	X	**T:** The communication channels are limited. More communication options would increase the spread of the use of the system. **D:** Not always because Geo4OOV acts as an intermediate and can also be a filter of information.
Usable	Clear / support (metadata)	X	X	**T:** Metadata is not sufficient for some of the datasets. **D:** Some datasets are missing metadata. The content of the metadata could be improved.

Use Process

The Dutch participants are content in terms of the use process of Geo4OOV. The only indicators chosen insufficient are coming from Turkish participants, as shown in Table 6.2. Starting from the indicator about independence, the participants state that they are still liable to the hierarchy and bureaucracy within the organizations because both they and the organizations they are in contact with in terms of data use process are governmental organizations. Additionally, they are in doubt that TUCBS will increase their spatial data usage as they are already using spatial data for their emergency response tasks. The main difference would only be the data source.

The delivery mechanism is also found insufficient as there is no alternative way to get data through the portal (Atlas) for now, and the portal is not well established to answer their quick data needs. This digital channel is dependent on the internet connection so if there would be a problem with the connection, the data delivery will be disrupted.

Table 6.2: Use process assessment indicators found insufficient by the participants (X: No or Insufficient by at least two participants)

Indicator group	Indicator	Participants		Remarks by Participants
		Turkish ERS	Dutch ERS	
Use process	More independent of suppliers, superior, other employees	X		- There is still a hierarchy so independency is only partial. - The usage of spatial data and related tools is limited to a group of people. Other people are dependent on those who can use the system and spatial data.
Use process	Use of spatial data (frequency)	X		Not sure because the data may be used when only it is needed. The SDI may not increase its usage frequency.
Use process	Data delivery mechanism	X		Data are mainly delivered through the internet. Internet must be stable. Also, the portal itself is not working sometimes. There is no alternative delivery mechanism.

Governance

The governance is remarked as the part that needs to be improved most by both sides. Especially, the communication and awareness related indicators are underlined by almost all participants. The Turkish participants evaluated six indicators for the governance of TUCBS as insufficient, and the Dutch participants found two for the governance of Geo4OOV. Table 6.3 presents the indicators evaluated by Turkish and Dutch participants as insufficient.

The participants from AFAD state that it is not possible to have enough support in terms of coordination and informing, probably because TUCBS is still in the establishment process and the General Directorate of GIS has numerous tasks going on at the same time. Other partner organizations also require support, communication and coordination from the department.

As mentioned for dataset indicators, the Turkish participants are not able to reach some of the data as these data are not in the system yet. In addition, the portal does not work from time to time. They experience these circumstances although they have explicit access rights within the system.

It has been a well-known issue that the data supplier organizations of TUCBS were not willing to share their data in the previous years. Before working together for TUCBS, the organizations were not sharing their data openly and were not easily sharing their data with other organizations or people. There were regulations on data exchange among the organizations with money so buying was a way to officially gather the data. With the TUCBS project, the data sharing approach and ways are aimed to change. They are now liable to the regulations in respect of sharing their data according to the legal guidelines. Although it was a bigger problem in the past, the partner organizations are still not very active to share data with other organizations. It should be noted that, as the national emergency response organization, AFAD is an exception for data buying from other governmental institutions by having the right of gathering needed data from the relevant organizations without paying for it.

The Turkish participants underline that all current and potential partner organizations should have enough GI-literate employees. These employees could either constitute one department or be employees of several departments, one of the participants states. However, these GI-literate employees should be temporary and be effectively involved in spatial data related tasks. All relevant organizations are suffering from the lack of a sufficient number of GI-literate or GIS-competent employees. This slows the current processes and prevents the utilization of spatial data with full potential.

For Turkish data supplier organizations, there is almost no communication between them, the Turkish participants believe. They mostly work independently in the matter of data provision as well as data gathering. They are not proactive in terms of communicating with others to gather or provide interoperable data. This is also a problem stated by the Dutch participants who assess Geo4OOV. They give similar comments about how the data suppliers of Geo4OOV work and gather data. There are similar remarks for both SDIs even though their data providers meet in periodically organized meetings and workshops. Although it is pointed out by both sides, the lack of communication between organizations could be a perception inherent to the type of people working in disaster management. There is a need for further examinations for clearer indications.

The other issue stressed by the participants from both sides is spatial data awareness among user organizations. The user organizations are the organizations that need particular spatial data provided by the Turkish NSDI for their own tasks. AFAD, energy institutions, safety regions, police, etc. are examples of these organizations. They use the spatial data if only their systems or workflows officially require it. The old ways are still dominating the processes within the organizations of both sides. Of course, the Dutch organizations are more be accustomed to using spatial data as they have been partners of the emergency response SDI for more than five years. Still, the Dutch participants think that it is not at a high level. Without sufficient awareness among these organizations, reaching the full potential of the spatial data in terms of possible benefits is impossible, a Dutch participant implies.

Table 6.3: Governance assessment indicators found insufficient by the participants (X: No or Insufficient by at least two participants)

Indicator group	Indicator	Participants		Remarks by Participants
		Turkish ERS	Dutch ERS	
Governance	Clear / support (governance)	X		SDI is still establishing so it is not possible to reach the support team every time.
Governance	Access network reliability	X		The portal is not working well sometimes and some data cannot be found. This brings doubt about access rights and reliability.
Governance	Willingness to share	X		It has been a significant problem that the organizations' unwillingness to share their data.
Governance	GIS / GI-literate	X		It results in the independence of GEO specialists. Although you need a specialist to clarify the data to decision-makers.
Governance	Communication among data suppliers	X	X	**T:** For data provision, there is almost no communication at all. **D:** - Communication lacks between the organizations. Organizations collect data for their own process and standardization seems to be a long process. - On the other side, the partner data supplier organizations meet regularly.
Governance	Spatial data awareness among user organizations	X	X	**T:** Its importance is started to be accepted but some of the old ways of working still continue. **D:** Only a small part of the potential is used. There is no good system/process to increase the use and the quality of spatial data.

6.3. Perspective of TUCBS Administration

Before this part, the assessment results of TUCBS and Geo4OOV are compared and evaluated. The SDI features that require improvement are explained along with their reasons and relevant remarks. In this part, the thoughts and ideas from the viewpoint of the TUCBS administration are explored. Participant 7 (P7) is a manager from the General Directorate of GIS who is responsible for the coordination of the development and establishment processes of TUCBS since the start of the project. The aim of involving P7 in this study is to review and, if possible, verify the TUCBS assessments of emergency response information managers and to see if the perspectives of the administration and the users are similar.

P7 is the manager of the Geographic Information Infrastructure and Coordination Department in the General Directorate of GIS. As the coordinator from the ministry, P7 provides communication and collaboration among the partners of TUCBS regarding the geographic information dataset themes, preparation of legislation, committee meetings, organization of working groups, geographic information strategy formulation, the spread of the strategy, and its application. To be able to perform these tasks, he/she has the highest user and administration rights in the system. Therefore, P7 fits the definitions and tasks of a primary user (van Loenen, 2009) or an administrator (Charvat et al., 2013).

Table 6.4 presents the comparison of dataset indicators assessment results of the participants from AFAD and a provincial directorate (P1, P2 and P3), with the assessment answers of P7. The first thing that catches interest in the table is the difference between the answers given by the users and the administrator. The insufficiencies pointed out by these two sides are different than each other, except for two indicators. This situation reflects how the viewpoint of a higher level user differs from the thoughts of other user groups. The reason could be the top-down approach of P7 to the assessment due to his/her higher position within the system.

According to P7, the problems of TUCBS in the data aspect are about the delivery time, quality, currency, and thus, the reliability of data, instead of recognizability, findability and availability of it. P7 states that the users can easily find the data and its information through the portal. However, they may not find every data they search because the integration of datasets and layers is not finished yet. The reason why P7 states delivery time, quality, currency, and the reliability of data as insufficient is this continuing establishment process. Currently, they can provide qualified data in a short time but only the ones integrated into TUCBS. Not all provinces or not all layers of datasets are entered into the system. The data gathering by the data suppliers and the arrangement of gathered data are still in the process. However, this situation will not take much longer, P7 indicates. The data provision and arrangement of all datasets will be finished around one year. After that, they can timely provide all datasets with the intended quality, reliability, and actuality, the manager believes.

The General Directorate of GIS gathers the feedback from the users and other organs of the system and directs them to the relevant organizations. The directorate does this often because a system being able to be used by all partner organizations is a goal. The directorate defined the datasets and their standards with the workshops and meetings organized with partner organizations and their geographic information systems working groups. Because of this effort, P7 thinks that the communication between the data suppliers and the users is sufficient. It should be kept in mind that the establishment process continues intensely and they may not answer all requests or at least, cannot quickly answer. They also have manuals within the system to help the data providers arrange and integrate their data into TUCBS.

With this kind of approach to the dataset indicators, it can be said that the concerns of P7 are mostly about the completion of the establishment process.

Table 6.4: The dataset indicators assessment of TUCBS by the users from AFAD and Participant 7 (Green: Yes, Red: No, Yellow: Insufficient/Not enough, X: No or Insufficient by at least two participants)

Indicator group	Indicator	Tr ERS	P7	Remarks
Known	Recognizable	X		The data can be recognized through searching it and thanks to metadata in web portal (Atlas).
Known	Findable	X		The existing datasets can be found through the portal (Atlas).
Attainable	Practically available	X		650 layers out of approximately 700 are completed and in process of integration into the system.
Attainable	Affordable			The data shared by SDI is free.
Attainable	Delivery time			Some data are still under arrangement. And for some data, there are uncertainties about sharing priorities among the organizations.
Attainable	Legal transparency & interoperability			Not all data are shared due to privacy and security reasons.
Attainable	Service level / format	X		These are legalized and standardized last year.
Usable	Reliable			Not all data is reliable because their arrangement is not finished. Some of the datasets are incomplete.
Usable	Sustainability / long term availability			The shared data will be in the system as long as the system remains
Usable	Up-to-date			Some of the datasets are not current, data supplier organizations should gather up-to-date data.
Usable	Spatial data quality			Some of the data gathered by some data providers do not have the intended quality.
Usable	Communication of data supplier to the user (data)	X		The General Directorate of GIS gathers the feedbacks and directs them to the relevant organizations. They also have manuals within the system.
Usable	Clear / support (metadata)	X		The data entered into the system should also have sufficient metadata that is prepared according to standards.

Table 6.5: The SDI indicators assessment of TUCBS by the users from AFAD and Participant 7 (Green: Yes, Red: No, Yellow: Insufficient/Not enough)

Indicator group	Indicator	Tr ERS	P7	Remarks
Use process	Access to more sources of information			This is one of the main goals of the NSDI establishment.
Use process	Data management			A common source for many and interoperable data would provide better data management.
Use process	Decision making time			It will decrease the time spent on data gathering and arranging, boosting the decision making progress.
Use process	More independent of suppliers, superior, other employees	X		This is one of the goals. If the use of the NSDI, the spatial data spreads, people can work more independently because there will be a big source of data and information under their hands.
Use process	Use of spatial data (frequency)	X		Definitely. There should be also more users than currently exist.
Use process	Workflow			Similar to other information systems used in different sectors, SDI will also provide a better workflow for its users if they can integrate it into their tasks.
Use process	Data delivery mechanism	X		There is a working mechanism that applies to all data suppliers and users. The priority is to gather data from the suppliers to TUCBS.
Governance	Stimulation of SDI use			It will be a national source for many datasets and their layers.
Governance	Clear / support (governance)	X		The directorate is responsible to coordinate the related organizations. Therefore, they should give sufficient support in terms of governance.
Governance	Communication of data supplier to user			The legislation and processes are transparent to the partner organizations. The users can follow these and reach out to the general directorate.
Governance	Access network reliability	X		The users can reach out to the portal and shared data through it, in accordance with their user rights.
Governance	Interoperability			Making the data, technologies and way of working interoperable is one of the goals.
Governance	Willingness to share	X		Many organizations have not been willing to share their data for years. It started to change with the establishment of NSDI and relevant regulations.
Governance	Institutional arrangements			Both legal and institutional arrangements are completed in recent years.
Governance	GIS / GI-literate	X		There is a need for more GI-literate people. There are training programs going on.
Governance	Communication among data suppliers	X		TUCBS provides a platform for partner organizations to communicate with each other and with the general directorate.
Governance	Spatial data awareness among data suppliers			Similar to the willingness to share, even though data suppliers are aware of importance of their own data, some of them are not well aware of the importance of spatial data, interoperability and quality in general.
Governance	Spatial data awareness among user organizations	X		Users are well aware of spatial data in terms of current usage, quality, and their own data needs.

The perceptions of the users and P7 also differ on the use process of TUCBS. While the users find three indicators out of seven are insufficient, P7 does not think any feature of the use process is lacking. The thought of P7 on the independence indicator, for example, indicates that if the use of the NSDI and the spatial data spreads, people can work more independently because there will be a big source of data and information under their hands, even though the other participants stated that there will be bureaucracy still in their workflows. When it comes to governmental organizations, the existence of bureaucracy is inevitable but the importance is on how the bureaucracy enhances and secures the working of the governmental organs. Additionally, there will be more NSDI users with the spread of the TUCBS use and more people will start to integrate their tasks with TUCBS when the system is established, according to P7. About the criticisms on the data delivery mechanism, P7 admits that their priority is the data gathering and completing the datasets for now but states that their data delivery mechanism is not insufficient at all. There is a standardized data delivery mechanism for the users, which could be useful in accordance with the availability of current datasets and the access rights of the users. Table 6.5 includes both the use process and governance indicators assessment results comparison of the Turkish participants from AFAD and the Directorate of GIS.

Table 6.5 also shows that there are two common indicators for all of the Turkish participants in terms of governance. Six governance indicators out of eleven are found insufficient by other participants while P7 thinks that three indicators are the points that need to be improved for governance. Among these, two of the indicators are common for both sides.

The governance support by the NSDI is provided by the General Directorate of GIS. The directorate maintains the organizational tasks between the partners for many issues related to SDI establishment. The organizations work together according to a national geographic information strategy. The directorate has to deal with numerous organizations and their relevant people. In recent years, the establishment of the TUCBS progressed constantly, so P7 thinks that the governance support provided by them is sufficient. There is also no issue with the reliability of the access network within the system as the user rights and their access are all defined in the system and the portal works with no problem in terms of access rights. About the communication between the data suppliers, P7 emphasizes that the general directorate organizes regular meetings and workshops among these organizations, and provides training programs for their data teams. The communication is held at the maximum level possible for the sake of interoperability of not just the stakeholders but also the data they provide. Lastly, P7 remarks that the users of NSDI, as the demanders of data, are aware of their data needs and how to utilize them.

One of the main problems at the starting phase of the project was the organizations' unwillingness to share their data, with either the NSDI or other organizations, P7 highlights that this was a last longing issue for years and it was not easy to persuade the organizations to share their data, especially for free, mostly until the relevant legislation came into force. Their reluctant attitude waned in the last couple of years, P7 indicates, and their viewpoint will change more in the following years when these organizations start to see the benefits of data sharing through TUCBS.

The lack of a sufficient number of GI-literate or GIS-competent people is specified by both sides. Participants 1 and 2 mentioned that there are not enough GI-literate people within the data supplier organizations, causing the decrease in data quality and interoperability. P1 suggested the constitution of GIS departments under these organizations. During the interview, P7 was also thinking similarly and agreed with those comments stating that the lack of trained people in respect of geographic information in the organizations is their biggest deficiency in the TUCBS project right now. To fulfill the qualified employee needs of the organizations, the general directorate has been organizing training programs and capacity building projects for various organizations.

P7 states that, in fact, the situation of TUCBS until June 2020 was somewhat closer to the assessment by the participants from AFAD. The departments which collaborate under the NSDI project are under separate governmental institutions and they do not have the power to impose sanctions on each other because of insufficient data exchange and contribution to the project. However, after the national GIS committee meeting held in June 2020, with the inclusion of the Vice President from the government, the process gained speed. Having the Vice President on the TUCBS committee meant that the project was now being followed by a higher authority. When there is an investigation, for example, the deputy ministers of the ministries have to answer to the committee.

One of the main goals of the General Directorate of GIS in terms of TUCBS establishment is the spread of the NSDI usage. For this, there have been dissemination projects going on since June 2020. To determine the situations and follow the improvements of the partners and other relevant organizations, a maturity model proposed in the Integrated Spatial Information Framework (IGIF) by the United Nations, is used. It consists of nine assessment aspects (governance and institutions, policy and legal, financial, data, innovation, standards, partnerships, capacity and education, communication and engagement) under three main titles which are governance, technology, and people (UNSD, 2018).

There are two responsibility matrixes created for the national spatial data infrastructure: the national geographic data responsibility matrix and the national data sharing matrix. Responsible institutions have been identified 32 data themes for the Turkish NSDI through their geographic information working groups. The data exchange regulations are defined on the legal background. Which data can be shared with whom is apparent for nearly 700 layers. In addition, the dataset information cards have been created for each dataset regarding the subjects such as which parts of a particular data should or should not be shared, which services should be used, whether it will be downloading or just viewing, and the degree of confidentiality. Until now, approximately 650 layers out of planned approximately 700 are completed in the system and are currently being integrated into the portal.

Another goal is the spread of open data sharing. This has been highlighted by the general directorate at the committee meetings. Currently, the data shared openly from the portal is around 50% of all completed layers.

P7 also mentions that data sharing with AFAD is one of the issues the general directorate would like to focus on in the future. Currently, AYDES gathers its datasets from various sources and even TUCBS obtains some of these data (mainly emergency and disaster related) from AFAD as they are already arranged for AYDES and they are mostly interoperable with the TUCBS standards. However, P1 previously stated that the data standards of AYDES are not defined in the legislation. Therefore, interoperability between datasets of two systems is not dictated officially. Apart from that, there are priority questions among the Turkish NSDI and ERS partner organizations in terms of data obtaining. The data provision during normal times and during emergency situations are different circumstances and require different measures.

Similar to AFAD, some of the other partners also use their own systems for spatial data utilization within their assignments. TUCBS would link to these systems in time after the establishment and thanks to the capacity building projects, P7 indicates.

6.4. Summary

Judging by the results, Dutch users generally find Geo4OOV sufficient and useful. The most important part they pointed out as inadequate is governance. They emphasize that if communication and awareness within the SDI would increase, their spatial data utilization could rise to a new level.

Although the governance is also considered to be an aspect that needs development by the Turkish users, it is not the only aspect described as such. Turkish participants also found deficiencies among datasets and use process indicators. The deficiencies in the dataset aspect are related to difficulties in reaching the needed data, and the communication between users and data suppliers. For the use process, user independence, data use frequency and data delivery are the ones pointed out as insufficient or negative. In addition to these, the results show how the thoughts of the system administrator alter from the opinions of the other users who have lower access and use rights within the TUCBS system. While users are not satisfied with fifteen indicators, the administrator finds seven indicators insufficient for now, and only two of these indicators are the same for both administrator and users. The administrator stated that a significant part of insufficiencies will be fixed in about a year.

The insufficiencies relevant to technical features of TUCBS are due to the NSDI's being in the establishment process. These complaints would probably decrease once the establishment is properly completed. Because of this, the things that can be learned from each other for the two countries are mainly organizational and governance approaches. Namely, the metadata problems of the Dutch side can be reduced by implementing obligations for currently arranging data, and conducting a metadata completion project for older data. The lack of communication between the users and data supplier organizations is a common problem for both SDIs and there is a need for better means of communication. Both countries have similar approaches for communication and they need to improve those. To spread spatial data awareness and develop its beneficial effect on daily tasks, there is a need for richer educational efforts. These efforts should not be limited to short seminars or courses but also be supported by the drills and actual integration of daily tasks. Interdisciplinary education is also a requirement for more qualified GI-literate human resources. Finally, the positive results of willingness to share data in the Netherlands should set an example to the Turkish stakeholders.

Generally, being established about a half decade ago gave Geo4OOV the advantage of being more mature than TUCBS, which is still in the process of establishment. There are still shortcomings within the Geo4OOV system, but it is recognized that the benefits are beyond that. The Dutch users mentioned in Chapter 3 that the use of this system will spread further and many new organizations will be using Geo4OOV with time. P7, who is the TUCBS administrator, states that their long-term aim is to make TUCBS a system that many organizations will integrate their own work to it, like a version of Geo4OOV, with respect to the information obtained within the scope of this study.

CHAPTER 7: Conclusions

7.1. Introduction

The conclusion chapter is where the results are evaluated and conclusions are presented through the remarks derived from the assessments by all participants. The research questions of the study are answered and the main conclusion is explained. Lastly, limitations of the study are mentioned and further research subjects are discussed.

7.2. Conclusion and Answers to Research Questions

The aim of this qualitative study was to create an assessment framework that could measure how adequate the relevant SDIs are in terms of data provision to their countries' ERSs for emergency response activities, and by applying the created assessment framework, to evaluate the results and compare them with each other in order to make inferences that could be useful for both countries. In this context, the main research question of the study stated below can be answered:

To what extent can an SDI assessment framework be used to determine and improve the capabilities of an NSDI in terms of data provision for an emergency response system?

First of all, literature research will provide a background into SDIs, the necessity and importance of data sharing for emergency response, and the SDI assessment approaches. With this information, the next step can be examining the frameworks in the literature and selecting the indicators relevant to the information stated as important for emergency response data provision.

In addition to these, examining the needs of the users who are involved in emergency response activities by undertaking information management provides a more applicable and useful assessment framework. The requests and needs of the users can be transformed into new indicators and added to the framework, while the indicators that turn out to be unnecessary or non-applicable can be removed from it. During the assessment, participants measure whether each indicator is sufficient or insufficient for the relevant SDI. In this study, the sufficient term is used to identify the indicators which would be integral parts of the functioning system if the assessed SDI would be the data provider infrastructure for the ERS of that particular country.

Application of this assessment framework should not remain as a one-off effort, instead, should be performed periodically. Thus, the change and development of both SDIs can be followed through time. In the case of TUCBS, the completion process and its readiness for emergency response data provision after completion can be measured. If the establishment will be completed on time, as stated by the administrator from the General Directorate of GIS, this assessment can be performed again one year after this study.

For TUCBS, the capabilities that need to be improved are data content and reachability, metadata support, communication among stakeholders, spatial data awareness and GI-literate human resource capacity. Some of these are also pointed out for Geo4OOV: metadata support, data awareness and communication are the common problems that need to be focused on, according to the assessment results. The authorities of both SDIs should take these issues into consideration while establishing or developing their system for the sake of a sustainable data infrastructure.

The relevant findings for each sub-research question of the study are explained below.

1. How may an SDI be assessed in terms of emergency response data provision according to the academic literature?

The role of spatial data is undeniable for emergency response practices. To be able to benefit from the spatial data, efficient and effective coordination of stakeholders and organization of data dissemination is needed. The stakeholders have to obtain correct data promptly without being hampered by technical or organizational issues during emergency situations. In the literature, these issues are linked with the topics such as integration of technologies; preparedness for emergencies; organization of communication, collaboration, and efficiency; data quality, correctness, actuality, continuity, and usability. These issues should be the main frame of any emergency response data dissemination system assessment. The proposed assessment framework should be fine-tuned according to the purpose of the assessment and the guidance of the relevant experts. In this study, these mentioned topics are proper for the purpose of the assessment, and expert guidance is provided through the previous studies. Additionally, determining the needs of the SDI user groups has a remarkable role in the creation of the assessment framework and its application. When the evolution of SDI over time is considered, it can be seen that the structure and establishment of SDIs shifted from top-down and product-based systems to user-centric and even open data dissemination focused systems. In other words, the needs and wishes of the users are taken into account more than ever during the establishment of SDIs. The recent objective is to create more cost-effective, more useful and more sustainable infrastructures. Investigating user needs is a necessity to identify associated technical and organizational bottlenecks within the SDI network.

2. What are the SDI and data needs of the emergency response information managers in Turkey and the Netherlands for nation-wide ERS and how do these needs translate into performance indicators in the SDI assessment framework?

In conversations with participants about their nation-wide ERS, both of the two sides actually seem complacent in terms of their currently used systems. It is observed that their systems function and be maintained without any serious flaws. Still, both groups have their own comments and complaints about their ERS. These include issues related to much more data collection and the insufficient number of GI-literate employees within partner organizations for the Turkish ERS, while organizational and spatial data awareness subjects for Dutch ERS.

The complaints and requests of the participants from AFAD on AYDES are primarily about obtaining accurate and interoperable data. Two of the users mention that it is not easy to collect interoperable data for the current ERS because the datasets are gathered from different institutions. Generally, these institutions collect and organize the data according to their own needs. Just like these needs, the standards of the data also differ among the organizations. These data are required to be arranged before integrating into AYDES.

In the interviews held for LCMS and Geo4OOV, the subjects emphasized by the participants are mainly about organizational difficulties and how these reflect negatively on their own work. The low level of communication and cooperation between various institutions, and the lack of proactivity in resolving these problems are among the issues that the participants complained about. In addition, there are participants who think that the insufficient level of spatial data awareness and only superficial integration of data into their work prevents them from using spatial data in more useful ways.

The first version of the assessment framework, developed after the literature research, has changed with the effect of discovering the user needs. After the interviews with the participants, the current indicators that meet the needs were determined and left within the framework while indicators that are not applicable or non-measurable were removed. The issues that have an impact on the SDI data provision process were converted to indicators and added under the relevant indicator groups.

3. How does the Turkish NSDI perform according to the developed SDI assessment framework?

Although the Turkish NSDI, TUCBS is welcomed by the participants and thought to be beneficial in general terms, it does not seem to have enough capabilities for emergency response data provision in its current form. There are indicators that users find insufficient for emergency response data provision within all assessment aspects gathered under the topics of data, use process and governance. These are about, for instance, the reachability of data and its appropriate service level and format. Two of the participants stated that they could not find all the data they were looking for, and they also pointed out the existence of situations such as not being able to reach the portal from time to time. As users, the participants think that they are not able to easily reach every relevant data supplier organization, either through TUCBS or in a way that is provided by the TUCBS administration. In addition, although the existing datasets have metadata, the information of datasets or layers is not complete for all of them. In terms of use process. they think that the impact of TUCBS regarding the independence of employees and frequency of spatial data use will be minor. For governance, it seems that a lot of improvement is still needed. Even the managers of the TUCBS project cannot provide clearance and support in terms of organization, cooperation and collaboration among organizations, the participants remark. Access reliability, the data sharing willingness of organizations, communication among the partner data suppliers and their spatial data awareness are still unsettled.

It is difficult to derive that the Turkish NSDI is currently ready for emergency response data provision to Turkish ERS. Considering both the assessment results and the comments of the participants, it can be clearly seen that obtaining the necessary data for the ERS will not be easy for now. However, once the establishment process is completed as desired and if the process is well managed by addressing the problems pointed out by users and partners, this situation may change in the future.

4. How does the Dutch ERS SDI perform according to the developed SDI assessment framework?

Considering that Geo4OOV has more than half decade of usage history, it can be said that this SDI is a much more established infrastructure that can meet the emergency response data needs of users. Data and use process indicator measurements of users also point to this result. One of the two technical issues mentioned is the lack of communication between users and data supplier organizations, similar to the situation in TUCBS. The second issue is the metadata support which is missing or does not exist for some layers. While technical issues are not a serious problem for Dutch ERS SDI, there are still two organizational features that the information managers want to be improved. The first is the lack of communication among data supplier organizations, which causes slowness of work, reduced quality of data and reduced interoperability. Another issue is the lack of users' awareness in terms of utilizing the data. That is if users become more conscious of spatial data: know what they need, where to find it, and what they can do with that data, the increase in spatial data utilization can boost the works of the organizations related to Geo4OOV.

Based on these, the conclusion is that Geo4OOV is working sufficiently in terms of emergency response data provision. Generally, positive opinions and assessment answers of the users also show parallelism with Keating's assessment results in 2016. To focus on improving the governance of the SDI would affect the system and related actors positively.

5. In the context of the assessment framework, what may these countries learn from each other?

Although Dutch emergency response information managers seemed to be more satisfied with their SDI during the interviews, there were significant issues that were found insufficient for both countries' SDIs. The first of these is metadata support. The approach of TUCBS in this regard is an obligation to generate metadata for the dataset that will be integrated into the system from the very beginning. Of course, not every metadata information is available for every layer, especially for old data. Therefore, among the missing information of these data, the most necessary ones can be determined and, if possible, studies can be carried out to complete them. Concurrently, the metadata generation obligation can be maintained for new dataset integrations. A similar approach can be implemented to Geo4OOV.

For both countries, the lack of communication between the users and data supplier organizations can be solved by the constitution of new platforms and channels of communication, where the interaction between these organizations and the users will increase. For example, seminars, panels and trainings can be organized, digital information and communication portals can be created for datasets of the relevant SDI and the institutions providing these datasets. Similar communication channels and activities can also be implemented among data suppliers.

Although it is not directly related to the awareness issue for both SDIs, the scarcity of GI-literate people naturally causes low awareness already. The awareness of the users who do not have extensive GI-literacy but regularly work with spatial data in their day-to-day tasks needs to be increased through capacity building projects. In addition to that, the importance of interdisciplinary education should not be overlooked. The quality and quantity of educational activities and trainings should be increased while the relevant SDIs are integrated into daily tasks. As pointed out by a Dutch participant, awareness will not be able to reach a high level unless the policy makers consider the utilization of spatial data for their work and include it in their policies.

Currently, Turkish NSDI seems to have a lot of aspects that need improvement and Dutch ERS SDI has a few. The assessment results show that fifteen indicators are chosen as insufficient by Turkish emergency response managers and four indicators are chosen by their Dutch counterparts. One of the main reasons why TUCBS remains behind Geo4OOV in terms of the emergency response data provision is current dataset features and the barriers related to data exchange. The reason for this was mostly reflected in the interviews as the fact that the SDI establishment project is not completed yet. If this is the case in reality, it can be said that these problems will be resolved after a period of about one year, as the administrator from TUCBS stated. Of course, this would be the case only if the project advances and be completed as idealized. Elimination of problems related to data content and provision would also improve the use process and ensure that users' experiences are more positive.

Although with fifth sub-question, the original intention was to analyze what the two countries could learn from each other, in practice, this question cannot be easily answered. It should be noticed that it is unreasonable to expect that the two countries can set a comprehensive example for each other in terms of emergency response governance or the policies they implement. The populations, geographical features, disasters and disaster management approaches of the two countries are different. The main reason for comparing these two countries with each other in this study was to compare an SDI (TUCBS), which is still in the completion phase and likely to provide data for the emergency response in the future, with another SDI (Geo4OOV) that is already in progress, and to draw conclusions from this comparison that can be useful for both countries. Again, from a governance perspective, carrying out sufficient administration and providing enough organizational support to the stakeholders is a must for a well-working SDI platform.

The sharing of qualified data with other organizations brings both efficiency and effectiveness to Dutch emergency response agencies. Sharing their data with other organizations and people also benefits the data supplier organizations in return, increasing their willingness to share data. Lastly, the existence of more GI-literate employees would boost decision making process by delivering the correct and enough information to the stakeholders on time.

Among the main benefits of this study, the following take part: the composition of an assessment framework designed for emergency response data provision, the application of the framework to the relevant SDIs of two countries, and thus showing the current status of these SDIs. Considering these measurement results and derived conclusions while determining the future strategies and paths of the relevant SDIs will be useful in terms of the development of these infrastructures for the benefit of all stakeholders.

7.3. Limitations and Further Research

Due to time limitation concerns, only seven people could be interviewed for this study. Even though the interviews provided a relatively in-depth look into the current issues within the context of this study, the sample size was not big enough to bring comprehensive results. Additionally, the core information for this research was obtained from qualitative analysis of interviews, reflecting the subjective thoughts of the participants. Therefore, expanding the sample size is recommended to be able to derive more objective and detailed information coming from multiple perspectives.

The relevance of many Insufficient/Not answers implies that there is a need for a more detailed measurement approach to each aspect of the SDIs. Some indicators seem not comprehensive enough to assess if a particular feature is really sufficient or insufficient. Creating quantifiable indicators would help to gather more accurate results for further studies. Good quantifiable indicators should be complied with some definitive characteristics, altogether named SMART (specific, measurable, attainable/feasible, relevant, timely and bias-free) characteristics.

The extended utilization of the assessment framework proposed by this study could grant a basis for a quantitative assessment or a mixed method approach. However, such assessments should also be tailored to the purpose of the SDI and the needs of user groups. Considering that the requirements and thoughts of the users reflect only a cross-section from the short time period in which this study was carried out, the regular application of the assessment would help the authorities and experts from AFAD and IFV to keep track of the SDI's working progress and to observe whether the defined problems persist or be addressed through time. Especially regarding the dynamic nature of emergencies and disasters, regular assessments will provide a clearer perception in the long term.

Finally, as mentioned by the administrator from TUCBS, data obtaining priorities among the emergency response stakeholders, especially during emergency situations, and its implementation to the SDI concept could be a subject for further research.

REFERENCES

AFAD. (2013). *Türkiye Afet Müdahale Planı (TAMP)*. TC Başbakanlık Afet ve Acil Durum Yönetimi Başkanlığı Yayınları. https://www.afad.gov.tr/kurumlar/afad.gov.tr/2419/files/Afet_Mud_Pl_ResmiG_20122013.pdf

AFAD. (2020). *Afet Yönetimi Kapsamında 2019 Yılına Bakış Ve Doğa Kaynaklı Olay İstatistikleri Raporu*. https://www.afad.gov.tr/afet-istatistikleri

Agee, J. (2009). Developing qualitative research questions: A reflective process. *International Journal of Qualitative Studies in Education*, *22*(4), 431–447. https://doi.org/10.1080/09518390902736512

Ajmar, A., Boccardo, O., & Terzo, O. (2010). UN WFP Spatial Data Infrastructure. *Core Spatial Databases –Updating, Maintenance and Services – from Theory to Practice*.

Backx, M. (2003). *Gebouwen Redden Levens. Toegankelijkheidseisen van Gebouwgegevens in Het Kader van de Openbare Orde en Veiligheid. [Buildings Save Lives. Accessibility Requirements for Buildings in the Context of the Public Order and Safety]*. Delft University of Technology.

Beer, S. (1979). *The heart of enterprise (Vol. 2)*. John Wiley & Sons.

CBSGM. (2021). *TUCBS*. cbs.csb.gov.tr

Charvat, K., Osorio, G. U., Maurer, L., Bruns, P., Ikaunice, A., O'Flaherty, J., Scianna, A., Hajek, F., Mlcousek, M., & Bojko, J. (2013). User centric design for SDI architecture. *SDI, Communities and Social Media*, *1*, 97. http://www.researchgate.net/profile/Otakar_Cerba/publication/234838617_SDI_Communities_and_Social_Media/links/0fcfd51014bc9b4052000000.pdf#page=98

Craglia, M., & Nowak, J. (2006). *Report of International Workshop on Spatial Data Infrastructures: Cost-Benefit/Return on Investment: Assessing the Impacts of Spatial Data Infrastructures* (Issue January). https://op.europa.eu/en/publication-detail/-/publication/39b96518-21d6-4159-8fce-1b880c2e121b

CRED. (2020). Disaster Year in Review 2019. *CRED Crunch*, *58*, 1–2. https://www.emdat.be/publications?field_publication_type_tid=All

Crompvoets, J., Rajabifard, A., Van Loenen, B., & Fernandez, T. D. (2008). *A Multi-View Framework to Assess SDIs* (Issue January). Space for Geo-Information (RGI), Wageningen University and Centre for SDIs and Land Administration, Department of Geomatics, The University of Melbourne.

De Man, W. H. E. (2006). Understanding SDI; complexity and institutionalization. *International Journal of Geographical Information Science*, *20*(3), 329–343. https://doi.org/10.1080/13658810500399688

Eelderink, L., Crompvoets, J., & de Man, E. (2008). Towards key variables to assess National Spatial Data Infrastructures (NSDIs) in developing countries. *A Multi-View Framework to Assess SDIs*, *October 2015*, 307–325.

Euronews. (2020). *İzmir depremi: Can kaybı 114'e yükseldi, 137 kişinin tedavisi sürüyor*. https://tr.euronews.com/2020/11/04/izmir-deki-depremde-y-k-lan-binalara-iliskin-9-kisi-gozalt-na-al-nd

Giff, G., & Lunn, R. (2008). Designing performance indicators for local SDI assessment: A city of Fredericton case study. *International Journal of Spatial Data Infrastructures Research*, *August*, 25–29. http://www.gsdi.org/gsdiconf/gsdi10/papers/TS22.2paper.pdf

Government of the Netherlands. (2013). *Safety Regions Act*. https://www.government.nl/documents/decrees/2010/12/17/dutch-security-regions-act-part-i

Government of Turkey. (2021). CBS Mevzuat Kitabı (in English: GIS Legislation Book). *General Directorate of Geographic Information Systems*. https://cbs.csb.gov.tr/cografi-bilgi-sistemleri-mevzuat-kitabi-i-102099

Grus, Ł. (2010). *Assessing Spatial Data Infrastructures*. 170.

Hennig, S., & Belgiu, M. (2011). User-centric SDI: Addressing Users Requirements in Third-Generation SDI. The Example of Nature-SDIplus. *Geoforum Perspektiv*, *10*(20), 29–42. https://doi.org/10.5278/ojs.persk..v10i20.448

IFV. (2020a). *Geo4OOV*. geo4oov.nl

IFV. (2020b). *LCMS*. lcms.nl

Janssen, M., Lee, J., Bharosa, N., & Cresswell, A. (2010). Advances in multi-agency disaster management: Key elements in disaster research. *Information Systems Frontiers*, *12*(1), 1–7. https://doi.org/10.1007/s10796-009-9176-x

Jennex, M. E. (2007). Modeling emergency response systems. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 1–8. https://doi.org/10.1109/HICSS.2007.386

Keating, E. (2016). *Governance of Geo-Information Flow & Coordination in Emergency Response*. Utrecht University.

Keskin, I., Karacameydan, N., Tosun, M., Tüfekci, M. K., Bulut, D., Avci, F., & Gökce, O. (2018). AYDES: An All-in-One Solution for Geospatial Information Technology Based Disaster Management and Decision Support. *GeoInformation for Disaster Management Conference*, 61–86. https://doi.org/10.1007/978-3-030-05330-7_3

Kleijn, M. De, Manen, N. van, Kolen, J., & Scholten, H. (2014). Towards a User-centric SDI Framework for Historical and Heritage European Landscape Research. *International Journal of Spatial Data Infrastructures Research*, *9*, 1–35. https://doi.org/10.2902/

Kok, B., & van Loenen, B. (2005). How to assess the success of National Spatial Data Infrastructures? *Computers, Environment and Urban Systems*, *29*(6 SPEC. ISS.), 699–717. https://doi.org/10.1016/j.compenvurbsys.2004.02.001

Lee, J., & Bui, T. (2000). A Template-based Methodology for Disaster Management Information Systems. *Proceedings of the Annual Hawaii International Conference on System Sciences*, *2000-Janua*(c), 1–7. https://doi.org/10.1109/hicss.2000.926635

Loenen, Bastiaan van, & Grothe, M. (2014). INSPIRE Empowers Re-Use of Public Sector Information. *International Journal of Spatial Data Infrastructures Research*, *9*, 96–106. https://doi.org/10.2902/

Luftman, J. (2000). Assessing Business-IT Alignment Maturity. *Communications of the Association for Information Systems*, *4*(14), 9–15.

Manfré, L. A., Hirata, E., Silva, J. B., Shinohara, E. J., Giannotti, M. A., Larocca, A. P. C., & Quintanilha, J. A. (2012). An Analysis of geospatial technologies for risk and natural disaster management. *ISPRS International Journal of Geo-Information*, *1*(2), 166–185. https://doi.org/10.3390/ijgi1020166

Mansourian, A., Rajabifard, A., Valadan Zoej, M. J., & Williamson, I. (2006). Using SDI and web-based system to facilitate disaster management. *Computers and Geosciences*, *32*(3), 303–315. https://doi.org/10.1016/j.cageo.2005.06.017

Mansourian, Ali, Rajabifard, A., Valadan Zoej, M. J., & Williamson, I. (2004). SDI for disaster management to support sustainable development. *Map Asia*.

Masser, I. (2005). *GIS worlds: creating spatial data infrastructures*. ESRI Press. https://doi.org/10.13140/RG.2.1.3358.2565

PDOK. (2020). *About PDOK*. pdok.nl

Rajabifard, A., Binns, A., Masser, I., & Williamson, I. (2006). The role of sub-national government and the private sector in future spatial data infrastructures. *International Journal of Geographical Information Science*, *20*(7), 727–741. https://doi.org/10.1080/13658810500432224

Rajabifard, Abbas, Feeney, M. E. F., & Williamson, I. P. (2002). Future directions for SDI development. *International Journal of Applied Earth Observation and Geoinformation*, *4*(1), 11–22. https://doi.org/10.1016/S0303-2434(02)00002-8

Simonovic, S. P. (2011). *Systems Approach to Management of Disasters*. John Wiley & Sons, Inc. https://doi.org/10.1016/0016-3287(72)90060-2

Snoeren, G., Zlatanova, S., Crompvoets, J., & Scholten, H. (2007). Spatial Data Infrastructure for emergency management: the view of the users. *Proceedings of the 3rd International Symposium on Gi4DM*, 22–25. http://www.researchgate.net/publication/40106306_Spatial_Data_Infrastructure_for_emergency_management_the_view_of_the_users/file/9c96051b77f02f2c06.pdf

Spaling, G., Peters, R., & Wilson, F. (2018). Improving Crisis Response by Interconnecting Data Worlds. *Electronic Journal of Electronic Government*, *16*(2), 119–126.

The World Bank. (2020a). *Land area (sq. km)*. https://data.worldbank.org/indicator/AG.LND.TOTL.K2

The World Bank. (2020b). *Population, total*. https://data.worldbank.org/indicator/SP.POP.TOTL

UN General Assembly. (2016). *Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction*. *21184*(December), 1–41.

UNISDR. (2015). *Sendai framework for disaster risk reduction 2015-2030*.

UNSD. (2018). *Integrated Geospatial Information Framework (IGIF) - UN-GGIM*.

van de Walle, B., van den Eede, G., & Muhren, W. (2009). Humanitarian Information Management and Systems. In *Lecture Notes in Computer Science* (pp. 12–21).

van Loenen, B. (2009). Developing geographic information infrastructures: The role of access policies. *International Journal of Geographical Information Science*, *23*(2), 195–212. https://doi.org/10.1080/13658810701851412

van Loenen, Bastiaan, & van Rij, E. (2008). Assessment of spatial data infrastructures from an organisational perspective. In Joep Crompvoets, A. Rajabifard, B. van Loenen, & T. D. Fernández (Eds.), *A multi-view framework to assess spatial data infrastructures* (pp. 173–192). The University of Melbourne.

Vancauwenberghe, G., & van Loenen, B. (2017). Governance of open spatial data infrastructures in Europe. In *The social dynamics of open data* (pp. 63–84). African Minds.

Visser, M. (2020). *Creating a user-centric assessment framework to assess Spatial Data Infrastructures for Crisis Management* (Issue November). Utrecht University.

Welle Donker, F., & van Loenen, B. (2017). How to assess the success of the open data ecosystem? *International Journal of Digital Earth*, *10*(3), 284–306.

https://doi.org/10.1080/17538947.2016.1224938

Zlatanova, S., & Fabbri, A. G. (2009). Geo-ICT for Risk and Disaster Management. In *Geospatial Technology and the Role of location in Science* (pp. 239–266). Springer. https://doi.org/10.1007/978-90-481-2620-0_13

Zwirowicz-Rutkowska, A. (2017). A multi-criteria method for assessment of spatial data infrastructure effectiveness. *Earth Science Informatics*, *10*(3), 369–382. https://doi.org/10.1007/s12145-017-0292-8

APPENDIX A: Original Indicators from Previous Studies

The following table shows the proposed indicators used in this study and their originals used by Welle Donker and van Loenen (2017), and Zwirowicz-Rutkowska (2017).

Original indicator group	Original indicator	Proposed indicator by Visser (2020)
Data supply - attainable	Service level	Service level / format
Data supply - usable	Clear	Clear / support
Governance	Communication S2U	Communication of data supplier to the user
Information and support provided - data	Thematic accuracy	Spatial data quality
	Completeness	Spatial data quality
	Spatial resolution	Spatial data quality
	Temporal validity	Spatial data quality
	Positional accuracy	Spatial data quality
	Lineage	Spatial data quality
	Distribution format	Service level / format
Information and support provided - support	Help menu - FAQ	Clear / support
	Help menu - video tutorial	Clear / support
	Email contact	Clear / support
	Tel contact	Clear / support
	Forum menu	Clear / support
	User's manual	Clear / support
	Other materials	Clear / support
Use process - Decision making process	Faster access to information	Decision making time
	Length of time to make decisions	Decision making time
	Length of time to acquire data	Decision making time
	Length of time to analyze data	Decision making time
	Better data management	Data management
User organizational Performance	Duration of procedure	Decision making time
	Change of attitude towards some procedures/tasks	Workflow
	Improved procedures	Workflow
	More executed plans, decisions, studies	Use of geodata (frequency)*
	Automates manual calculation, analysis, tasks, realization	Decision making time
	The prompt completion of work	Decision making time
	Automates data acquisition and collection	Data management

Original indicator group	Original indicator	Proposed indicator by Visser (2020)
Strategic alignment and business impact	Enhances linkages with customers and data suppliers	Communication of data supplier to user
	Optimalization of workflow	Workflow
	Increase of tasks/procedures/work supported by ICT	Use of geodata (frequency)*
	Possibility of ICT inclusion in tasks	Use of geodata (frequency)*
	ICT impact on efficiency increase of the employees and the whole company	Workflow

* This indicator changed to *use of spatial data (frequency)* in the assessment framework of this study.

APPENDIX B: User Needs Interview Structure

The aim of the interviews is the exploration of emergency response needs of decision-makers in terms of data provision and investigating opinions of the participants on SDI.

Introduction:

- Objectives and methodology of the research, information about the interview and the upcoming survey.

Defining the users:

- Department and responsibilities of the participant; expertise on emergency response/disaster management; general routines/activities during an emergency.
- The recent emergency situations they have faced.

Emergency response and data use:

- The system/software they use for their activities.
- Kinds of information they need, use, share.
- The spatial dataset themes they generally need, use, share.
- The standards, quality, actuality, and interoperability of these spatial data.
- The time they spend during emergency response and decision-making processes.
- The actors they generally work with.
- The cooperation and data share with those actors.
- Knowledge about legal aspects of the data they use.

SDI and the assessment framework:

- Knowledge about the existence, definition and capabilities of SDI.
- Characteristics of SDIs for emergency response.
- If exists, SDI; If not exists, data acquisition policy of the organization that they are working for
- Content of the assessment framework that this study generates and its place within SDI development.
- Their opinions in terms of data provision.
- Their needs and suggestions in terms of data provision.

APPENDIX C: Second Version of the Assessment Framework

The indicators and decision actions to create the second version of the assessment framework are shown in the table below.

Source	Indicator group	Indicator	Description	Action & Reason
Welle Donker & van Loenen (2017)	Known	Recognizable	The dataset is recognizable (thanks to metadata availability)*	Keep: Relevant
	Known	Findable	The dataset is findable	Keep: Relevant
	Attainable	Practically available	The dataset is practically available	Keep: Relevant
	Attainable	Affordable	The dataset is affordable	Keep: Relevant
	Attainable	Delivery time	The dataset can be acquired/delivered in time	Keep: Relevant
	Attainable	Legal transparency & interoperability	The dataset does not have any legal restrictions (and there is legal transparency)	Keep: Relevant
	Attainable	Service level / format	The dataset is distributed in a sufficient format or service	Keep: Relevant
	Usable	Manageable	The dataset is manageable	Remove: Not applicable
	Usable	Reliable	The dataset is reliable	Keep: Relevant
	Usable	Sustainability / long term availability	The dataset has long-term availability / is sustainable	Keep: Relevant
	Usable	Up-to-date	The dataset is up-to-date	Keep: Relevant
	Usable	Communication of data supplier to the user	There is sufficient communication from the data supplier to the data user	Keep: Relevant
	Usable	Clear / support	The metadata and support are clear	Keep: Relevant
	Governance	Stimulation of SDI use	The SDI organization stimulates SDI use	Keep: Relevant
Zwirowicz-Rutkowska (2017)	Usable	Spatial data quality	The dataset has sufficient spatial data quality	Keep: Relevant
	Use process	Access to more sources of information	The SDI increases access to sources of information	Keep: Relevant
	Use process	Data management	The SDI improves data management	Keep: Relevant
	Use process	Decision making time	The SDI shortens decision-making time	Keep: Relevant
	Use process	More independent of suppliers,	The SDI creates independence for suppliers, superior, other employees in decision making	Keep: Relevant

Source	Indicator group	Indicator	Description	Action & Reason
Zwirowicz-Rutkowska (2017)		superior, other employees		
	Use process	Use of spatial data (frequency)	The SDI increases the use of spatial data	Keep: Relevant
	Use process	Workflow	The SDI improves the workflow	Keep: Relevant
	Governance	Clear / support	The communication and support regarding the SDI use are sufficient/clear	Keep: Relevant
	Governance	Communication supplier to user	The SDI stimulates and supports communication from the data supplier to the data user	Keep: Relevant
Eelderink, Crompvoets & de Man, (2008)	-	Availability of digital datasets	The digital dataset is practically available	Remove: Duplication
	-	Metadata availability	The metadata of the digital dataset is practically available	Remove: Duplication
	-	Communication channels	There are communication channels among the developers, users and other partners of the SDI	Remove: Duplication
	Add: Governance	Access network reliability	The access network of the SDI is established and enable coordinators to manage access rights of different user groups	Keep: Relevant
	Add: Governance	Interoperability	Ability to understand and share various data, relevant technology	Keep: Relevant
	Add: Governance	Data delivery mechanism	The data delivery mechanism is reliable in different situations (such as no-internet)	Keep: Relevant
	Add: Governance	Willingness to share	Relevant organizations are willing to share their data	Keep: Relevant
	-	SDI directive	The existence of SDI directive (legalization of unified definitions and frameworks)	Remove: Not known by the participants
	Add: Governance	Institutional arrangements	Institutional arrangements for intended objectives are made or in progress	Keep: Relevant

After the changes, the second version of the assessment framework is obtained as follows.

Data-specific indicators

Indicator group	Indicator	Description
Known	Recognizable	The dataset is recognizable (thanks to metadata availability)
Known	Findable	The dataset is findable
Attainable	Practically available	The dataset is practically available
Attainable	Affordable	The dataset is affordable
Attainable	Delivery time	The dataset can be acquired/delivered in time
Attainable	Legal transparency & interoperability	The dataset does not have any legal restrictions (and there is legal transparency)
Attainable	Service level / format	The dataset is distributed in a sufficient format or service
Usable	Reliable	The dataset is reliable
Usable	Sustainability / long term availability	The dataset has long-term availability / is sustainable
Usable	Up-to-date	The dataset is up-to-date
Usable	Spatial data quality	The dataset has sufficient spatial data quality
Usable	Communication of data supplier to the user	There is sufficient communication from the data supplier to the data user
Usable	Clear / support	The metadata and support are clear

SDI-specific indicators

Indicator group	Indicator	Description
Use process	Access to more sources of information	The SDI increases access to sources of information
Use process	Data management	The SDI improves data management
Use process	Decision making time	The SDI shortens decision-making time
Use process	More independent of suppliers, superior, other employees	The SDI creates independence for suppliers, superior, other employees in decision making
Use process	Use of spatial data (frequency)	The SDI increases the use of spatial data
Use process	Workflow	The SDI improves the workflow
Use process	Data delivery mechanism	The data delivery mechanism is reliable in different situations (such as no-internet)
Governance	Stimulation of SDI use	The SDI organization stimulates SDI use
Governance	Clear / support	The communication and support regarding the SDI use are sufficient/clear
Governance	Communication of data supplier to user	The SDI stimulates and supports communication from the data supplier to the data user
Governance	Access network reliability	The access network of the SDI is established and enable coordinators to manage access rights of different user groups
Governance	Interoperability	Ability to understand and share various data, relevant technology
Governance	Willingness to share	Relevant organizations are willing to share their data
Governance	Institutional arrangements	Institutional arrangements for intended objectives are made or in progress

APPENDIX D: Assessment Survey Structure

This purpose of this survey to assess the data provision readiness of the SDIs for emergency response systems. It comprises four main questions related to, respectively, disaster response activities, needed datasets for these activities, assessment of relevant SDI and indicator suggestion.

1. Please think of a disaster situation and response activities to interfere the situation. For example, Aydinoglu and Bilgin (2015) defined emergency response activities for a landslide as follows:

- Determining disaster effect area
- Defining disaster location
- Disaster effect analysis
- Determining affected buildings
- Determining affected infrastructures
- Directing response units
- Directing police response units
- Directing fire response units
- Directing health response units
- Directing civil defence units
- Directing emergency management units
- Evacuations works
- Identifying buildings for evacuation
- Routing evacuation
- Delivery of help resources
- Delivery of base and health supplies

Do you agree on the activities above? What is unnecessary or what is missing?

2. Then, check the dataset themes that would be needed during decision making for various emergency situations (landslide, flood, earthquake, fire, etc.) and needed activities. What would be the other needed datasets?

✓	Dataset Themes		✓	Dataset Themes
	Reference Systems and Geo Grids			Conservation areas
	Administrative Units			Disaster risk areas
	Place Names			Infrastructure (Water, electricity, natural gas, etc.)
	Cadaster			Energy sources
	Buildings			Mines
	Addresses			Demography
	Elevation			Industrial plants
	Orto photos			Agriculture areas
	Transportation network			Environmental monitoring facilities
	Hydrography			Habitat areas
	Sea and water bodies			Species distribution
	Land cover			Biogeographical areas
	Land use			Geology
	Soil types			Atmosphere
	Human health and safety			Meteorology
	Public administration zones			Statistical reporting areas

3. Please go to the webpage of the relevant SDI portal of your country (LCMS/Atlas). Please try searching a few important data relevant to the actions you stated in the previous question.

3a. Please evaluate the dataset-related statements below and pick an answer (yes or no). A reason or comment for your answer is also needed. You can leave empty rows if you do not have any idea. Otherwise, try to fill all rows.

Statement	Yes	No	Reason / Comments
The dataset is recognizable (thanks to metadata availability)			
The dataset is findable			
The dataset is practically available			
The dataset is affordable			
The dataset can be acquired/delivered in time			
The dataset does not have any legal restrictions (and there is legal transparency)			
The dataset is distributed in a sufficient format or service			
The dataset is reliable			
The dataset has long-term availability / is sustainable			
The dataset is up-to-date			
The dataset has sufficient spatial data quality			
There is sufficient communication from the data supplier to the data user			
The metadata and support are clear			

3b. Please evaluate the SDI-related statements below and pick an answer (yes or no). A reason or comment for your answer is also needed. You can leave empty rows if you do not have any idea. Otherwise, try to fill all rows.

Statement	Yes	No	Reason / Comments
The SDI increases access to sources of information			
The SDI improves data management			
The SDI shortens decision-making time			
The SDI creates independence for suppliers, superior, other employees in decision making			
The SDI increases the use of spatial data			
The SDI improves the workflow			
The data delivery mechanism is reliable in different situations (such as no-internet)			
The SDI organization stimulates SDI use			
The communication and support regarding the SDI use are sufficient/clear			
The SDI stimulates and supports communication from the data supplier to the data user			
The access network of the SDI is established and enable coordinators to manage access rights of different user groups			
Ability to understand and share various data, relevant technology			
Relevant organizations are willing to share their data			
Institutional arrangements for intended objectives are made or in progress			
Partner data supplier organizations have GIS teams (or employees who have GI-literacy)			
There is sufficient communication among the data supplier organizations			
The awareness of the importance of spatial data is high among the data supplier organizations			
The awareness of the importance of spatial data is high among the user organizations (e.g. safety regions)			

4. If you think more measures (indicators) to assess SDIs in terms of emergency response data provision, please suggest along with reason.

Indicator Suggestion	Reason / Comments