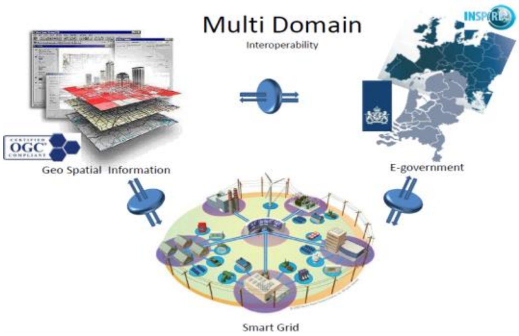

CERISE

Combining Energy and Spatial Information Standards as Enabler for Smart Grids

TKI Smart Grid Project: TKISG01010

D2.2 *Use case* Crisis management

Work package – 20

Lead partner: TNO

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Contents

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Summary

The CERISE-SG project (Combining Energy and Geo-information standards as enabler for Smart Grids) focuses on improving interoperability between the geo-, utility-, and e-government domain by connecting sector-specific data definitions and by providing sector-overarching standards for information exchange.

This document describes the Crisis Management scenario that was used in the CERISE project to work out a data sharing solution based on Linked Data concepts. The primary target group for this deliverable is the CERISE project team.

During crisis management sharing of data becomes important when electrical (smart) grids are hit by a power cut. As the electrical grid is important for many parties and societal activities, such as healthcare, schooling, and transport, lots of stakeholders from different sectors are involved in crisis management. For instance electrical grid operators, water boards, and safety regions. To understand the relevant information and their interlinks between these different stakeholders, a crisis management use case has been set-up. It provides a thinking framework for the CERISE project team to work out the information model and harmonize data sharing.
The use case scenario describes the effects of a flooding on electrical and flood-protective assets, e.g. transformers and water pumping stations. The main focus of this crisis is a power cut, caused by the breakdown of electrical assets due to increased water levels.

Data sharing is limited to two main stakeholders. Alliander, the largest utility company of the Netherlands[1], as well as HHNK, the water board of Hollands Noorderkwartier, which manages flood-protective assets. Data sharing in this scenario is supposed to serve two main operations: Re-ensurance of power supply and flood reduction. They are broken down into a chain of sub-processes each assigned to a stakeholder and based on a data concept. The relations between these data concepts are then defined in a conceptual model.

This exchange of data and the creation of awareness is of explicit importance in the region that HHNK is active in as this region is below sea-level. This creates all kinds of issues in case of flood, which are not taken into account when developing the area. It might therefore be the case that the emergency power systems of hospitals are located on the ground level and will therefore be below water in case of a flood (or the fuel tanks cannot be reached in case of a flood). Next to that assets for the electricity network might also not be set high enough to resist a flood.

This use case description lays the foundation for further interoperability research within crisis management. Based on this scenario specific data sharing platforms can be developed and other crisis processes can be examined in the same way.

[1] Tasks of interest regard the operation of the electrical grid and the management of electrical assets. These are executed by Liander, a sub-part of Alliander. Since Alliander is the official project partner within the CERISE project their name will be used in this report and relevant responsibilities of sub-companies will be left out for means of simplicity.

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1 Introduction

The project CERISE-SG (Combining Energy and Spatial Information Standards as Enabler for Smart Grids) focuses on interoperability between the geo-, utility and e-government domains, by establishing information links between smart grids and their environment (CERISE, 2015). Obtaining reliable information from various sources is invaluable in order to account for the increasing distributed and dynamic structure of energy management (Book, Bastiaans & Bruinenberg, 2014).

However, data sharing is complicated since parties use different definitions supported by different standards for their data. For example, HHNK, a regional Dutch water authority, uses the term "kunstwerken" when referring to infrastructural engineering constructions, such as bridges (de Landmeter & van Giessel, 2015). A flood-management novice, however, rather uses terms like "bridge" or "road" to refer to the same concept. In order to help parties share and use this information, the CERISE project seeks to analyze currently used standards, identify as well as overcome gaps, overlaps, and inconsistencies, and finally link proven standards to create a coherent data sharing environment.

This endeavor first requires a clear picture of the targeted information and the scenarios in which it is supposed to be shared. For this reason, the CERISE project is based on use cases which provide a conceptual framework for developing information models, determining relevant standards, and establishing linkages between them.

This report represents deliverable D2.2, an elaboration of use case 3 dealing with data sharing within crisis management. This use case deals with a flood-caused crisis, a permanent risk for the Netherlands in general and for her power supply in particular. By damaging electrical assets increased water levels may cause a power cut that threatens various vital societal activities such as healthcare, schooling and transport (van Dongen et al., 2013). Due to these sector-interdependencies many different stakeholders are involved in crisis management, e.g. grid operators, water boards and safety regions. They depend on each other's sector-specific information, making data sharing essential.

This use case presents a small extract of these sector-interdependencies by describing information exchange between two stakeholders: Alliander, the grid operator and manager of electrical assets and HHNK, the water board of Noord Holland's Noorderkwartier which manages flood-protective assets such as dams and sluices, and water pumping stations.

At the moment, cross-sector data sharing systems are rare within crisis management in the Netherlands, since standards are mainly developed within one sector and cannot communicate with each other (Kalcheva, 2015; ACIR, 2005). Stakeholders mainly use traditional channels, like email, phone, or database merges to exchange information during a crisis (Book, Bastiaans & Bruinenberg, 2014). For example, Alliander and HHNK currently exchange data with a USB stick. This makes data sharing slow and error prone since no common conceptualization of the data exist between the stakeholders. Misunderstandings regarding the correct interpretation of the data occur often and are tediously solved on an individual basis.

The target audience of this document is the CERISE team itself and associated committees such as the steering group and the sounding board. Moreover, all stakeholders of this use case who share and provide data, as well as parties involved

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and/or interested in crisis management in general are addressed. This document is subsequently used for further detailing the data exchange between Alliander and HHNK, as well as for generalizing information exchange to other tasks and parties within crisis management.

This report includes six chapters. Chapter 2 presents the context and scope of crisis management in general and of the specific use case scenario in particular. Chapter 3 describes the stakeholders and operations within this crisis scenario. Chapter 4 presents the conceptual model for information exchange and chapter 5 includes a concluding statement. The references can be found in chapter 6.

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2 Context and scope

2.1 Context of crisis management

Floodings put the energy network at risk, since power assets can break down if the water level exceeds a critical threshold, thus, increasing the probability for a power cut (Book, Bastiaans & Bruinenberg, 2014). This will affect a great variety of electricity users like schools, hospitals, and electrical water pumping stations, the main user of interest within this study. In case of a power cut they will stop running and therefore cannot combat the flood by draining the crisis area (de Landmeter & van Giessel, 2015). Moreover, just like power assets, these pumping stations are also directly vulnerable to high water levels.

The development of the crisis is described in Figure 1. As a result of a flooding, power station 1 breaks down and therefore can no longer supply electricity to the users in its supply area. Thus, the affected electrical supply area of that flooded power station and the electricity users within it have to be identified. Electrical water pumping station 3 is located in the affected supply area and consequently breaks down, too. Now, counter-measures against the flooding have to be taken, for example by replacing the broken with a functioning pumping station, which involves a reconfiguration of the pumping station grid. Electrical water pumping station 4 is located in a non-affected supply area. If it is close by, it can be used to drain the flooded area, otherwise, a battery or a generator can be used for temporary power supply. In the long run, the electricity grid has to be reconfigured in order to supply electricity to the most vulnerable users (e.g. hospitals, electrical water pumping stations). Once the flood is gone, damaged power assets and pumping stations have to be repaired in order to be put back on the grid.

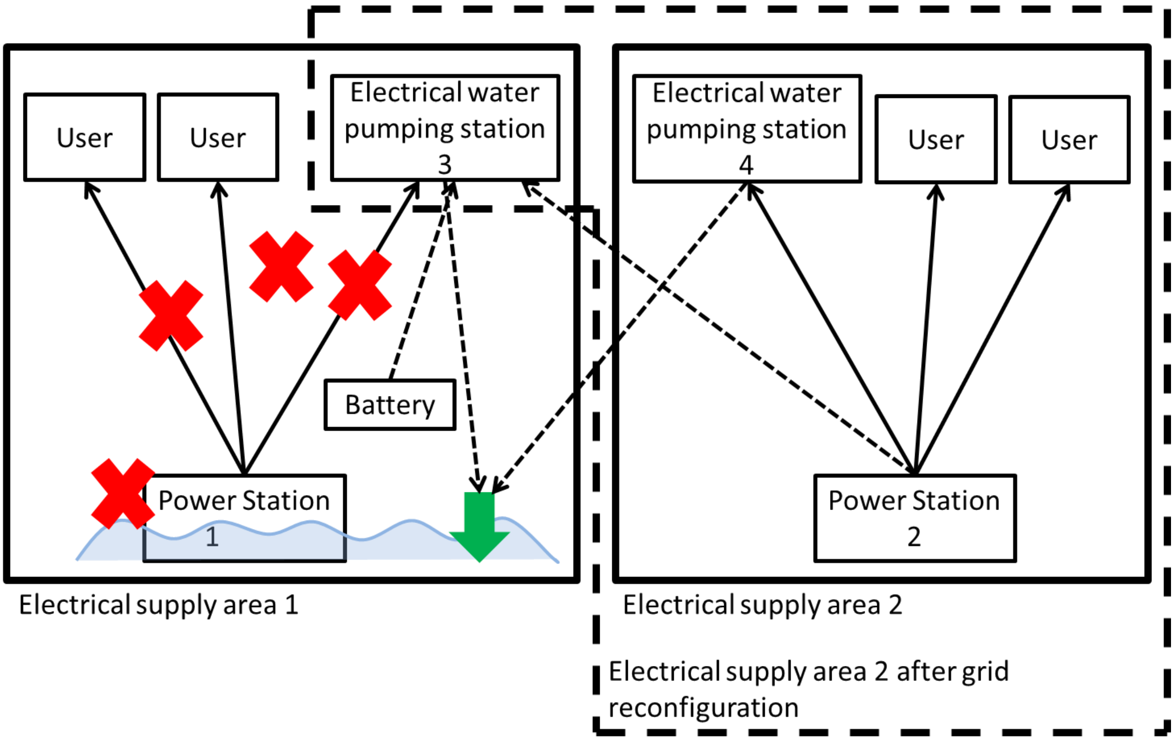

Figure 1. Concepts and processes within crisis scenario of flood-caused power cut

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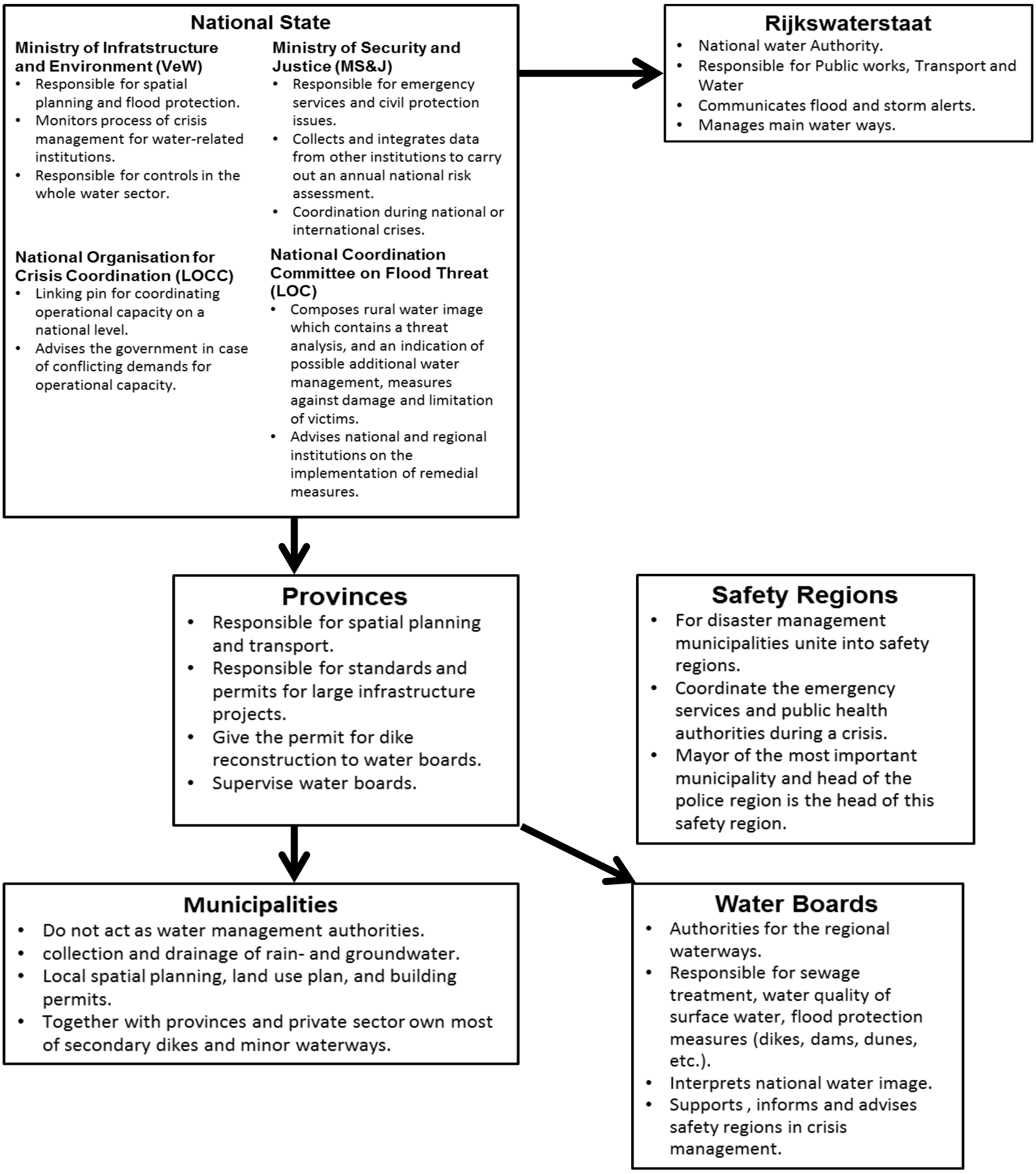
2.2 Scope of crisis management and of use case scenario

Roles and responsibilities are clearly defined for the parties involved in crisis management in the Netherlands as shown in Figure 2 (MTPWW[2], 2012, 2010; PHN[3], 2012). However, where to get relevant information from, how to share and use it, is neither standardized nor very clear.



→ Flow of command

Figure 2. Roles and responsibilities of water and crisis management during floodings (adapted from MTPWW, 2012)

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[2] Ministry of Transport, Public Works and Watermanagement
[3] Province of North Holland

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The scope of data sharing during the crisis scenario defined in this report is based on stakeholders' requirements as well as organizational constraints, such as the availability of time (Table 3). This provides a clearly defined, but also highly limited scenario. However, for this exploratory pilot study it provides a sufficient thinking framework.

Scope of data sharing scenario
Functionality purpose - Identify assets at risk and damaged ones. - Localize affected supply area. - Deal with real-time water level heights.
Durability purpose - Provide future-proof data sharing solution. - Generalize data sharing solution to other domains (e.g. gas). - Data sharing solution should be adopted by more stakeholders.
Small user community Only Alliander and HHNK use data sharing solution. It is therefore easier to adjust it to the stakeholders' IT landscape than the other way round.
Closed application environment Alliander and HHNK only share data with each other. No open data wanted.
Economical purpose Data sharing solution should impose little extra costs on the stakeholders.
Limited time available - Data sharing process has not been running for a sufficiently long period. - Implementation does not exist. - Assessment process must not be too time consuming.
User-centered development Development of data sharing solution is done in close cooperation with Alliander and HHNK and based on their explicit requirements.

Table 1. Scope of crisis scenario

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3 Stakeholders and operations

3.1 Stakeholders

The two primary data sharing stakeholders in this study are Alliander, the electrical grid operator and manager of electrical assets and HHNK, the water board of Noord Holland's Noorderkwartier, which manages flood-protective assets. They exchange information about water levels and their respective assets (e.g. power stations and water pumping stations) in case of a flooding. By doing this they want to localize the affected assets, determine which supply areas are hit by a power cut, and reconfigure the power grid accordingly (Figure 3). Their aims are to re-ensure power supply and reduce the flooding.

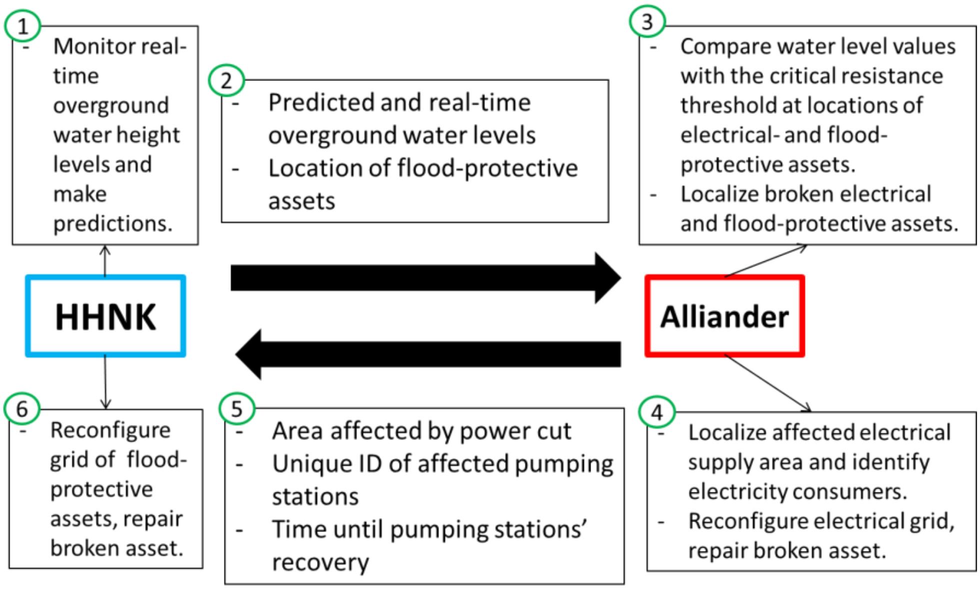

Figure 3. Information exchange between Alliander and HHNK during a flood-caused power cut

In addition, there are many secondary stakeholders who hold relevant data, prepare them for the main stakeholders and have other responsibilities within crisis management not directly related to flood control and electrical grid management. It is important to be aware of all stakeholders in order to get a full picture of crisis management. Table 2 gives an overview of the stakeholders, including a description of the different roles that they play.

Stakeholder	Description
Alliander https://www.alliander.com/en	Public utility company that distributes energy to one third of the Netherlands. It consists of the four sub-parts, Liander, Liandon, Endinet, and Ziut, of which Liander is responsible for grid operation and asset management in the responsibility area of HHNK.
HHNK https://www.hhnk.nl/	Hoogheemraadschap Hollands Noorderkwartier is one of the 24 Dutch water boards (Waterschappen, 2015). Responsible for regions north of the North Rhine canal in the province of North Holland. Manages water ways as well as the sewage system, and maintains flood protection measures (dikes, sluices, etc.).

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Deltares https://www.deltares.nl/en/	Independent institute for applied research in the field of water, subsurface and infrastructure. Main focus is on river dealtas, coast regions, river banks and offshore areas.
Hospitals	Take care of people that have injuries caused by the flooding and/or power cut.
Kadaster http://www.kadaster.nl/	Netherlands' Cadastre, Land Registry and Mapping Agency collects and registers administrative and spatial data on property and the rights involved. Maintains the Key Registers Cadastre and Topography which include geo-data on locations of buildings and ground surface heights.
KNMI http://www.knmi.nl/	Koninklijk Nederlands Meteorologisch Instituut, the Royal Netherlands Meteorological Institute is the Dutch national weather forecasting service. Contributes to the calculation of over ground water levels by providing data on precipitation and river levels.
KPN http://www.kpn.com	Dutch landline and mobile telecommunications company. Provides voice and data communication for the parties involved. If the communication fails it becomes very difficult for the parties to perform their tasks as communication is difficult.
Municipality	Administrative division and subdivisions of their respective provinces. - Informs the water authorities about developments in the municipality which are important for actions of the water boards. - Agrees, where applicable, with the water board and regional services of Rijkswaterstaat on crisis management.
National crisis coordination centers and General Directorates E.g. General Directorate for water, inspection of traffic and water management, part of Ministry of Transport, Public Work, and Water management; National Organization for Crisis Coordination (LOCC), part of Ministry of Interior and Kingdom Relations or General Affaires	Part of the ministries, central nods in the web of national information, monitor the overall crisis management process, advise responsible ministers, and other national bodies.
Network operators: Cogas Infra & Beheer B.V. Delta netwerkbedrijf Endinet Enexis Liander Rendo Stedin Westland Infra	Regional operators of middle- and low voltage networks. Each region has only one responsible network operator.

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Province	Administrative layer between the national government and the local municipalities, having the responsibility for matters of regional importance. - oversees the water authorities with a view to the safety of the dams - receives rural water picture of LCO - receives information on tides of RWS messaging services
Rijkswaterstaat http://www.rijkswaterstaat.nl/en/	Part of the Dutch Ministry of Infrastructure and the Environment (VeN), and responsible for the design, construction, management and maintenance of the main transport infrastructure facilities in the Netherlands, including the main road and waterway networks, as well as the main water systems.
Safety region (nl.: veiligheidsregio)	Organization coordinating disaster management. In a crisis, affected municipalities form a safety region which then coordinates emergency response services (fire brigades, hospitals, and police forces) - Receives information on tides from Rijkswaterstaat and liaises on interpretation of water image. - Liaises with regional water board and with Rijkswaterstaat about the crisis.
TenneT http://www.tennet.eu/de/en/home.html	National operator of the high-voltage network.
Water boards http://www.waterschappen.nl/: 1. Waterschap Noorderzijlvest 2. Wetterskip Fryslân 3. Waterschap Hunze en Aa's 4. Waterschap Reest en Wieden 5. Waterschap Vechtstromen 6. Waterschap Groot Salland 7. Waterschap Vallei en Veluwe 8. Waterschap Rijn en Ijssel 9. Hoogheemraadschap De Stichtse Rijnlanden 10. Hoogheemraadschap Amstel, Gooi en Vecht 11. Hoogheemraadschap van Rijnland 12. Hoogheemraadschap van Delfland 13. Hoogheemraadschap van Schieland en de Krimpenerwaard 14. Waterschap Rivierenland 15. Waterschap Hollandse Delta 16. Waterschap Scheldestromen 17. Waterschap Brabantse Delta 18. Waterschap De Dommel 19. Waterschap Aa en Maas 20. Waterschap Peel en Maasvallei 21. Waterschap Roer en Overmaas 22. Waterschap Zuiderzeeland 23. Waterschap Blija Buitendijks	Regional water management authorities charged with managing water barriers, waterways, water levels, water quality and sewage treatment in their respective regions.

Table 2. Stakeholders and their responsibilities

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3.2 Operations

Within the crisis management use case data sharing is supposed to serve two main operations: reinsure of power supply and flood reduction. These operations depend on several sub-processes which are presented in Table 3 and the activity diagrams below (Figure 4, Figure 5).

Re-ensure of power supply (Figure 4)	**Reduce flooding** (Figure 5)
Calculate over ground water level.	
Monitor real-time over ground water levels and make predictions.	
Compare water level values with the critical resistance threshold at locations of electrical assets and electrical water pumping stations.	
Switch off threatened substations in a controlled way.	Switch off threatened electrical water pumping stations in a controlled way.
Localize broken electrical assets damaged by flooding.	Localize broken electrical water pumping stations affected by power cut or damaged by flooding.
Identify affected supply area of broken electrical asset.	Localize functioning electrical water pumping stations in the vicinity of the broken ones.
Localize and identify electricity users within supply area.	Replace broken pumping stations with functioning ones or power them with batteries.
Reconfigure grid to ensure power supply to most vulnerable users first and to all affected users as fast as possible.	Repair broken electrical water pumping station.
Repair broken electrical asset.	Put broken pumping station back on the grid.
Put broken power asset back on the grid.	

Table 3. Sub-processes of main operations during crisis management

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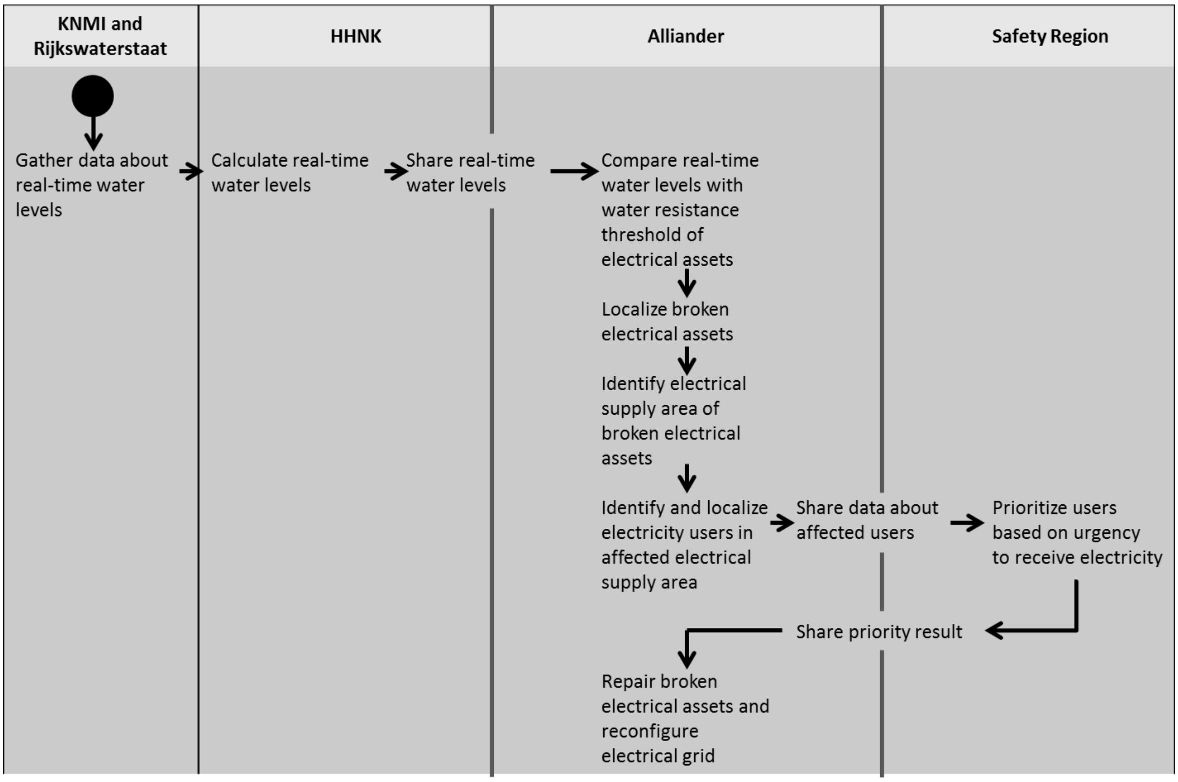

Figure 4. Re-ensuring power supply during a crisis.

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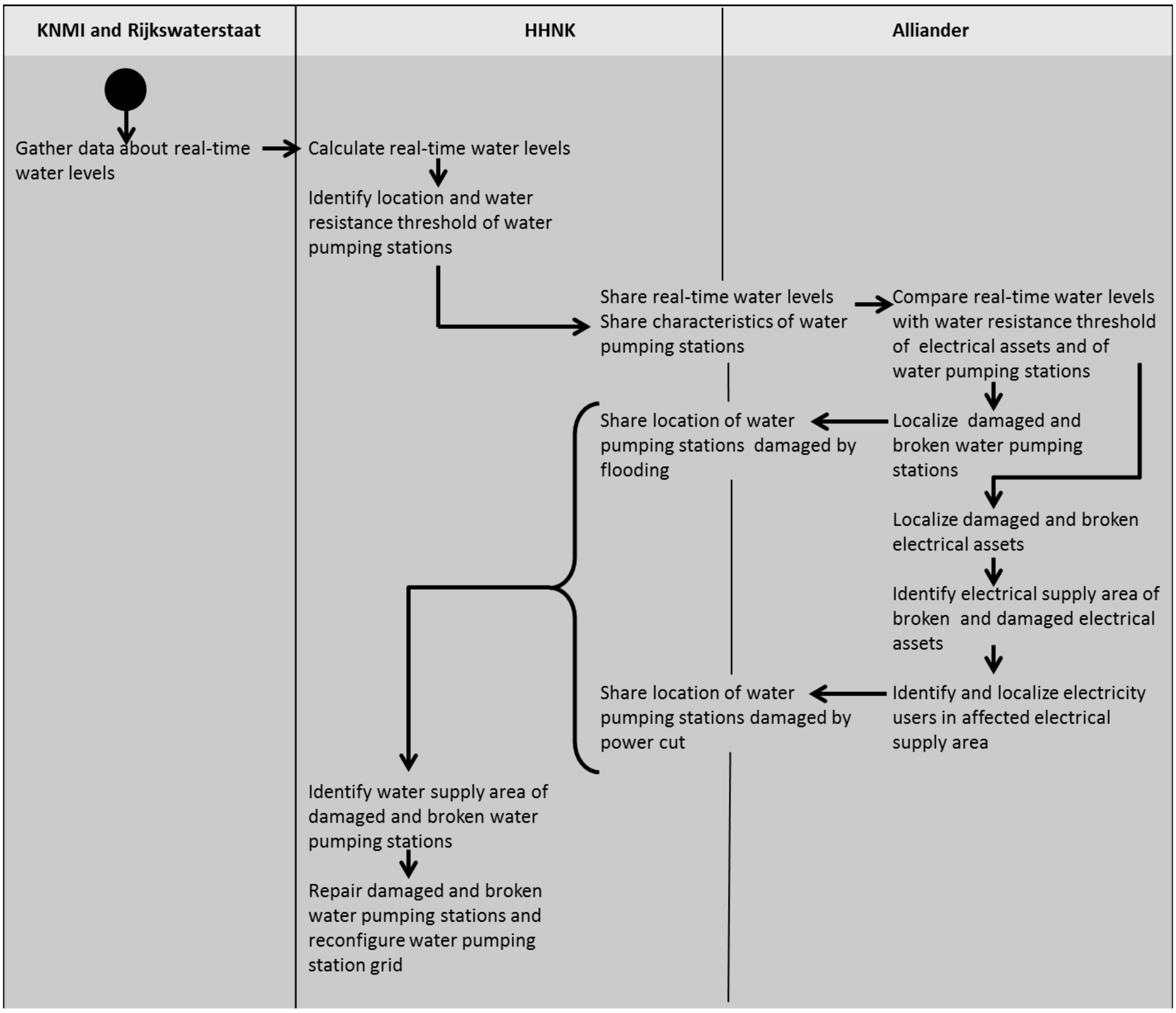

Figure 5. Re-ensuring functioning pumping stations during a crisis to combat flooding

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4 Conceptual model for information exchange

Domain concepts are data categories that are relevant for information exchange in a specific scenario. Stakeholders exchange data from these domains. Table 4 describes the domain concepts relevant for the current crisis scenario and Figure 6 shows the relationships between those. Finally, Figure 7 presents a summary of the information preparation and exchange as well as responsibilities of and interrelations between the stakeholders.

Concept	Description
Water Level	Overground water height measured in meters which result from a combination of various factors, such as precipitation, dike breakages, meltwater of rivers, decreased absorption ability of the soil, etc. **Real-time** values provide data on the actual water height at the current moment whereas **predicted** values represent assumptions on future water levels.
Electricity component	All components of the electricity grid, such as cables, power stations, transformers, etc. Managed by Alliander.
Electrical asset	Devices responsible for power generation and transduction to suitable voltage levels. These include power stations, sub-stations, transformers, etc. Sub-class of “Electricity component”.
Cable	Devices responsible for power transmission to the users. Sub-class of “Electricity component”.
Water resistance threshold	Maximum water level that an electricity component can resist in order not to break down.
Electrical supply area	Geographical area of responsibility of an electrical asset. All users in this area receive electricity from this power asset.
User	Electricity consuming objects located in the supply area of a power asset. E.g. water pumping stations, hospitals, schools, private households.
Electrical flood-protective asset	All electrically powered assets that serve flood protection or combat. Subclass of “User” and managed by HHNK. E.g. Water pumping stations, sluices
Water pumping station	Drain flooded area in their water supply area in case of a flooding. Sub-class of “Electrical flood-protective asset”. Break down in case of a power cut.
Other users	Sub-class of “User” and include all electricity consuming objects that are NOT “Electrical flood-protective assets”. E.g. hospitals, schools.
Water supply area	Geographical area of responsibility of a water pumping station. In case of a flooding, the pumping station will attempt to drain this area. All “Other users” are located in this area.

Table 4. Domain concepts

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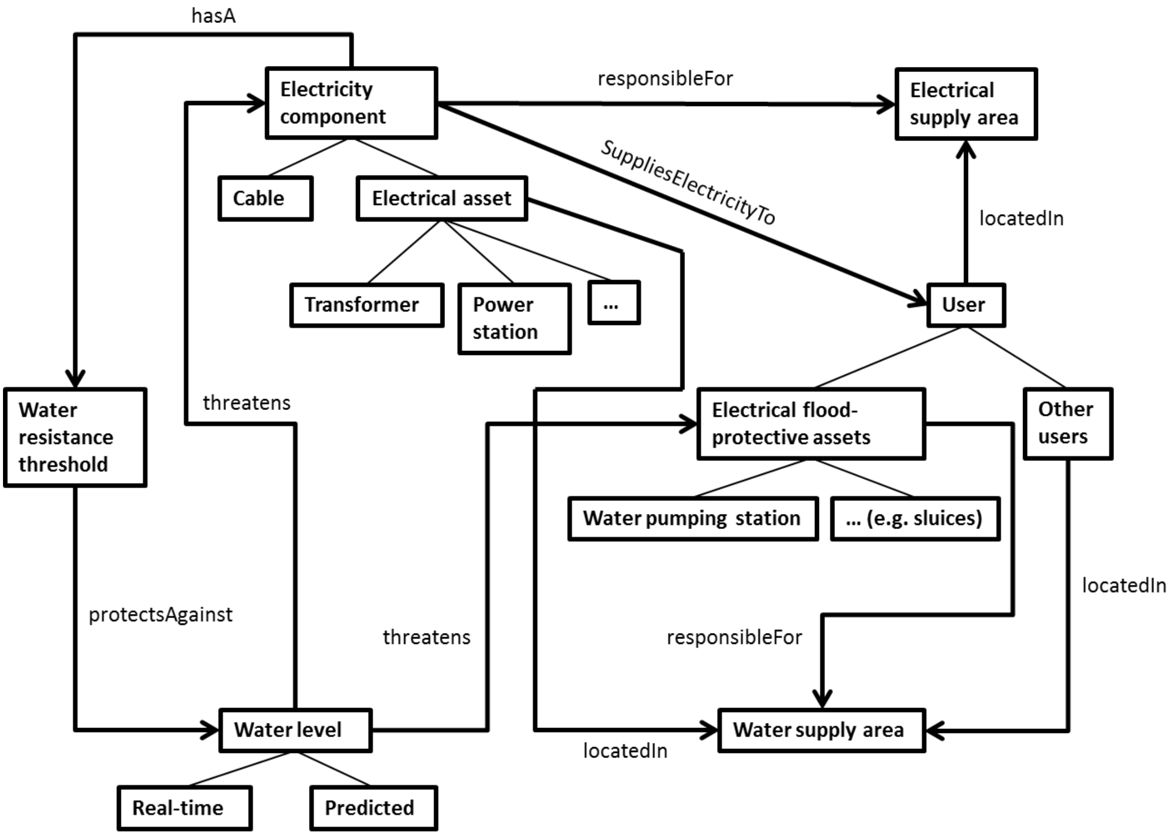

□ Domain concept

⟶ Interaction between domain concepts

− Subclass of

Figure 6. Conceptual model visualizing relationships between domain concepts

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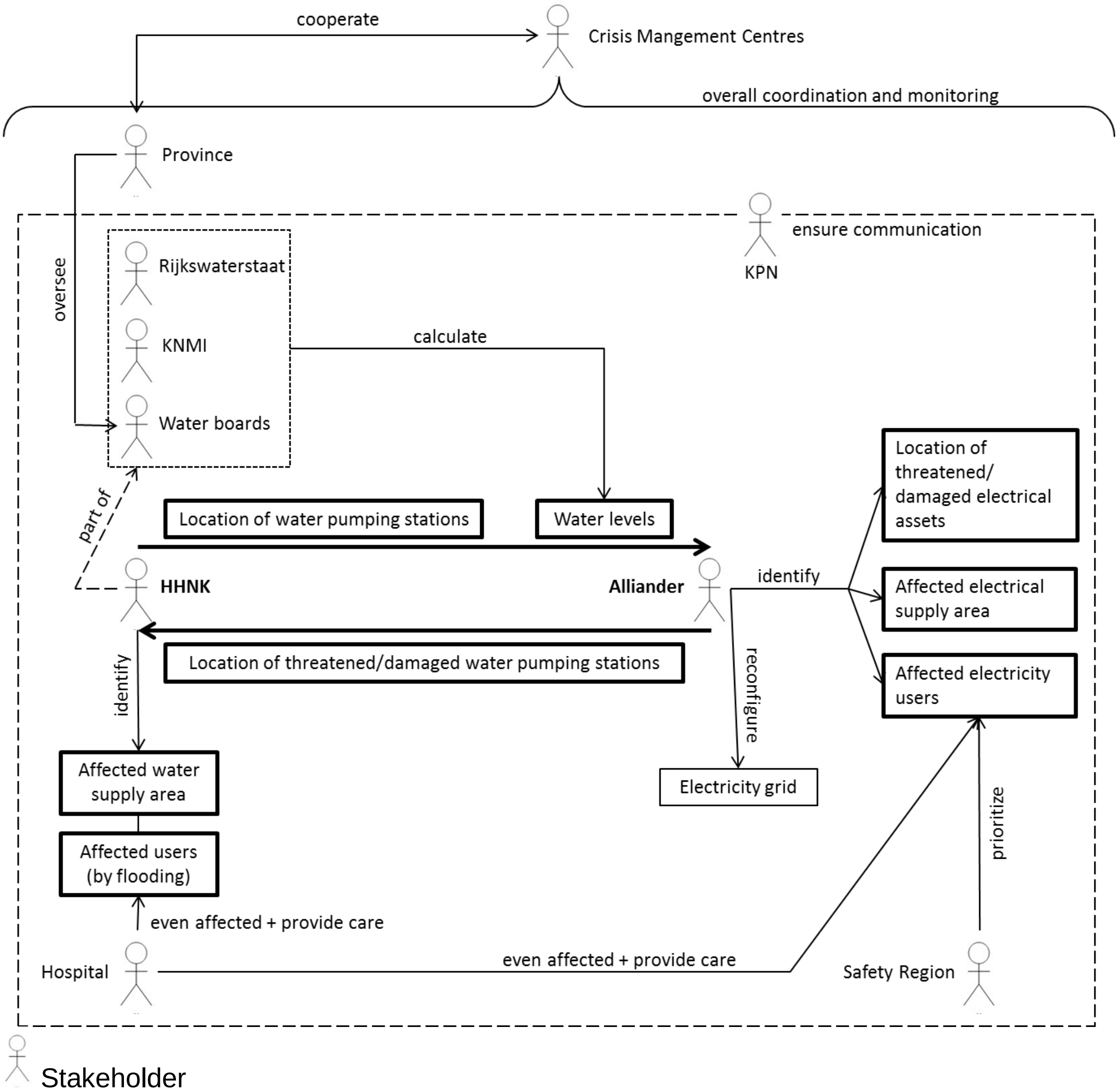

Stakeholder

□ Domain concept

⟶ Interaction

Bold: Activities and Domain concepts related to the primary stakeholders

Figure 7. Stakeholders and their relationships during the data sharing process

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5 Conclusion

The main goal of this deliverable is to present use case 3: Information exchange within a crisis management scenario dealing with the effects of a flood on the power grid. Due to sector-interdependent effects during this disaster data sharing is essential for successful crisis management. However, it is also difficult since stakeholders have their own ways of describing and maintaining their data. The two primary stakeholders, Alliander and HHNK, share data on their assets in case these are threatened by a flood and/or by a power cut. Other secondary stakeholders prepare this relevant information and coordinate other aspects of crisis management. The purpose of this information exchange is to improve crisis management by optimizing the reinsurance of power supply and the reduction of flooding. Based on this use case description a technology for an actual data sharing solution can be chosen, such as merges of relational databases or Linked Data. Moreover, this scenario can support research in other parts of crisis management such as domino effects and emergency response modeling.

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