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VEILIGHEIDSREGIO UTRECHT

Design of a participatory approach to assess the climate resilience of the “Utrechtse Heuvelrug” region

Master Thesis

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Summary

Due to its characteristics, the Utrechtse Heuvelrug region is vulnerable to wildfires. This existing risk is exacerbated by multiple developments, most notably climate change. To reduce the vulnerability of the region, there is an urge to strengthen its climate resilience. As safety region Utrecht lacks authority to impose or take resilience improvement measures, it is dependent on stakeholders with implementation power. However, a common awareness among stakeholders on wildfire risks currently lacks and results in a limited interest to take interventions that improve resilience. To add, before targeted interventions can take place the stakeholder must be familiar with the features of an area under consideration that are vulnerable to the wildfires. Hence, assessing the current state of resilience by means of a climate resilience assessment is an essential first step. Especially because of the normative nature of resilience on what constitute desirable area features that should be maintained to consider an area resilient, stakeholder engagement is key. Furthermore, involving stakeholders in a resilience assessment creates a common understanding on the hazard risks that is desired by safety region Utrecht. Creating a common understanding already contributes to the disaster-preparedness of stakeholders and hence enhances the resilience of the area by itself. Next, the participation of stakeholders with implementation power brings about other benefits related to the actual implementation of measures for resilience enhancement in the future. Against this background, the aim of this research is to design a participatory approach that safety region Utrecht can use to assess climate resilience in the context of the Utrechtse Heuvelrug region.

The structure of this design-oriented research is based on the design cycle. Accordingly, it constitutes of a problem investigation, and a design and validation phase. The problem is investigated by means of a data collection that constitute an analysis of relevant policy documents and a field visit. To take into account the perspective of the end users, data collection is complemented with weekly unstructured interviews with employees of safety region Utrecht and two semi-structured interviews with pre-identified stakeholders. These pre-identified end users are, respectively, safety region Utrecht and the municipality Utrechtse Heuvelrug. Moreover, a literately study on resilience assessment and stakeholder analysis is conducted. The approach is designed iteratively in the design and validation phase on the basis of initial assumptions of the research and the problem investigation phase. The prototype design approach is adjusted based on new insights and a validation session in which the design is applied to the Henschotermeer pilot area. The Henschotermeer is a subarea illustrative for the considered vulnerability issues of the Utrechtse Heuvelrug region.

In the problem investigation phase, no hands-on approach that combines resilience assessment and stakeholder analysis consistent with the purpose of this research is found. Specifically for stakeholder analysis, the contents of the approach should be tailored to the exact purpose of the participatory process. Moreover, stakeholder analysis approaches are often not straightforward applicable or require substantive foreknowledge of the applicators. In participatory resilience assessment approaches, the self-evidence of stakeholders is often assumed and the approaches used to select and engage stakeholders are therefore often not explicit. This imposes the need to design a tailor-made approach that ingrates stakeholder analysis and resilience assessment. Although literature streams on stakeholder analysis and resilience assessment do not offer a complete approach, they contribute to the design approach as characteristics and methodologies of existing approaches are deployed. To make design choices based on the perspectives of end users, two pre-identified stakeholders are interviewed based on their perspective on resilience assessment and participation.

Existing approaches, stakeholder perspectives and initial assumptions of this research are used to compile the design brief. The design brief consists of requirements concerning the outcome, process, implementation criteria, flexibility and scope of the approach. On the basis of these design requirements, the prototype approach is designed. Because of the iterative research method adopted, design requirements and the prototype design are adapted multiple times on the basis of new insights.

To validate the final prototype design, it applied to a workshop in the Henschotermeer pilot area. In this workshop, a selection of relevant stakeholders resulting from the stakeholder analysis part of the approach are engaged. Validation here constitutes verification of the consistency between design requirements and design. Second, it comprises the evaluation of the perceived usability of the approach according to stakeholders. From the results of this session, the compliance of the design approach with the design requirements is verified. From feedback of the stakeholders after the application of the design approach, it is evaluated that it is perceived as sufficiently usable. Despite this, points improvements constituting recommendations for future application comprise scheduling more time and adding a field visit to the workshop and devise potential measures plenary.

The research method adopted fits the purpose of this research and led to fruitful results in the form of a participatory approach that safety region Utrecht can use to assess the climate resilience of the Utrechtse Heuvelrug region. For future application, it is recommended to consider the points of improvement of the prototype. In order to achieve its ultimate aim, it is recommended to safety region Utrecht to extend this participatory approach to actually design and implement measures to strengthen climate resilience.

Preface

In front of you lies the thesis “Design of a participatory approach to assess the climate resilience of the “Utrechtse Heuvelrug” region”. The research presented in this thesis constitutes the last phase to obtain a master’s degree in Construction Management and Engineering at the University of Twente.

The subject of this research originates from a practical problem perceived by the problem owner, safety region Utrecht. This problem constitutes the vulnerability to wildfires of the Utrechtse Heuvelrug, a region situated in the service area of the safety region. The ultimate aim of the safety region is to improve the safety of this region by reducing the existing and future vulnerability. The approach designed in this research project is intended to contribute to this aim.

During the course this research, I gratefully benefited from the supervision of Joanne Vinke – De Kruijf. I also want to thank Deger Ozkaramanli – Leerkes for her valuable contributions. Finally, I would like to thank Andreas Hartmann for being the chair of the graduation committee. Next to the supervision of the University of Twente, I want to express my gratitude to the employees of safety region Utrecht involved with this research. This particularly applies to Roelof Willemze, Michiel Rhoen and Marcel Geluk. I would like to thank them for their input on this research, as well as for the fun experiences during my time at safety region Utrecht.

I hope you enjoy reading.

Menno Domhof

Utrecht, 16 September 2022

Table of contents

List of tables

List of figures

1 Introduction

1.1 Background

As the climate continues to change, the intensity, frequency and duration of extreme weather events are expected to increase (Poo et al., 2021). The exact consequences of climate change, however, are uncertain. To cope with this uncertainty, a resilience approach can be embraced to adapt an area to climate-induced hazard risks (Wardekker et al., 2010). Namely, as disasters cannot always be prevented the notion of resilience emphasizes the need to have mechanisms in place to keep the impact of threats to a minimum (Renschler et al., 2010). A resilient area maintains their essential function in the face of hazardous events (Kim & Lim, 2016). Climate resilience can therefore be regarded as a property of an area that describes the capacity of key area features to continue performing services through climate-induced disasters (Fox-Lent et al., 2015).

A region particularly vulnerable to climate-induced hazards in the Netherlands is the Utrechtse Heuvelrug region (Veiligheidsregio Utrecht, 2019). Accordingly, there is an urge to enhance the climate resilience of this area. The current desire to strengthen the resilience of the Heuvelrug region arises from the regional risk profile drawn by safety region Utrecht (Veiligheidsregio Utrecht, 2019). Based on the Safety Regions Act, safety region Utrecht is obliged to draw a regional risk profile that provides an overview of high-risk areas and elaborates upon the hazards present in each of those areas (Ministerie van Justitie en Veiligheid, 2022). On the basis of this overview, the safety region is expected to promote action in each vulnerable area to reduce prevailing safety risks. In this regard, promoting action mainly entails the assistance of municipalities to enhance the climate resilience of the Utrechtse Heuvelrug. As stated in the risk profile, the Utrechtse Heuvelrug is currently vulnerable to climate-induced stressors, respectively prolonged periods of drought and heat, and therefore prone to shocks, especially wildfires (Veiligheidsregio Utrecht, 2019). This vulnerability particularly results from pine forests on sandy soils, abundantly present in the region. As the safety region lacks authority to take or impose actual measures themselves, it is dependent on other parties with this implementation power to take resilience improvement measures. Consequently, the ultimate aim of the safety region is to incite those other parties to take measures that aim at the reduction of wildfire hazard risks at the Heuvelrug area.

The Utrechtse Heuvelrug region is characterized by many different land use functions and hence accommodates a wide variety of individuals, groups and organizations that have goals and interests related to the area. These individuals, groups and organizations that might be affected by or might affect the objectives of the safety region concerning climate resilience improvement of the Utrechtse Heuvelrug are called stakeholders (Freeman, 1984). As the safety region depends on those stakeholders with authorities and relevant resources to improve resilience, in this research context relevant stakeholders comprise those with implementation power. The wide variety of land use functions and stakeholders are often concentrated on relatively small subareas of the Utrechtse Heuvelrug region. According to safety region Utrecht, stakeholders generally have diverging and often conflicting perspectives, interests and goals related to the area. For instance, campsite owners have an interest in surrounding forests with a low flammability, while forest managers are more concerned on the forest's natural value and ecology. Safety region Utrecht further states that there is no common perspective on the prevailing wildfire risk among stakeholders and between most stakeholders and the safety region. Therefore, there is no common understanding on the current vulnerabilities of an area. Besides, an earlier participatory initiative of a local municipality to reduce hazards risks in the area did not lead to fruitful results because of a lacking risk perception among stakeholders (municipality Utrechtse Heuvelrug, personal communication, 23 March 2022). Consequently, there is a need to address the affected climate resilience of the area while taking into account the different perspectives of stakeholders.

1.2 State-of-the-art literature

Before measures to enhance resilience can be taken, it is essential to determine the current degree of resilience of the area, in particular to identify its weaknesses (Cutter, 2016; Tong, 2021). The meaning of resilience in the area, metrics to assess the notion and priorities regarding key area features, however, differ per stakeholder (Morelli et al., 2021). As interventions to improve resilience ultimately depends on stakeholders, awareness and mutual consensus on these aspects is key. To establish the required common understanding regarding prevailing risks among relevant stakeholders, it is key to operationalize the notion of resilience in the context of the Utrechtse Heuvelrug area by conducting a participatory resilience assessment (Morelli et al., 2021). To add, Sharifi (2016) states that resilience assessment tools can be used as ex-ante decision tools by identifying vulnerable area features and by determining potential leverage points for intervention. In this context, a participatory resilience assessment is understood to be the collaborative transformation of climate resilience into a measurable and more tangible notion. This results in an understanding of what it entails, according to the perspectives of relevant stakeholders (Sharifi, 2016). Hence, this research draws on combining literature streams regarding resilience assessment, and stakeholder participation and analysis.

The necessity for stakeholder involvement particularly arises from the normative nature of resilience as what is considered to be desirable and what not is different per stakeholder (Helfgott, 2018). Resulting weaknesses of the area provide directions among those who take measures to enhance the area's current degree of resilience. Additional advantages of performing a resilience assessment together with stakeholders include the improvement of the accuracy and the context-specificity of an assessment methodology (Sharifi, 2016). This author adds that a participatory assessment also enables the reflection of perceptions and goals of the relevant stakeholders in assessment criteria. As concerns advantages regarding the participatory process directly, the resulting awareness on prevailing risks among stakeholders resulting from the participatory resilience assessment eventually increases their support and acceptance for the implementation of measures to reduce the area's vulnerability (Coenen, 2009). The level of conflict during subsequent implementation processes will thus also be reduced (Krywkow, 2009). Finally, since resilience assessment together with stakeholders increases the public awareness on hazard risks it enhances their disaster preparedness. A participatory resilience assessment therefore contributes to the strengthening of the resilience of an area in itself.

1.3 Problem statement

Ultimately, safety region Utrecht aspires to restore the balance between nature, recreation and safety at the increasingly vulnerable Utrechtse Heuvelrug area. From their experience, the safety region has identified multiple subareas of the Utrechtse Heuvelrug region accommodating a wide range of stakeholders that are especially vulnerable to wildfires. Promoting the implementation of risk mitigation measures to enhance climate resilience at those locations is ultimately desired. Though, the current state regarding resilience at those areas has not yet been assessed and weak area aspects affected by the wildfire risk therefore remain unidentified. As a consequence, vulnerable area features and potential leverage points for solutions to strengthen resilience are unknown (Sharifi, 2016).

As the safety region depends on relevant stakeholders to actually intervene and stakeholder involvement is associated with a multitude of benefits, engaging relevant stakeholders is key. However, the wide range of stakeholders of the region, including their perspectives and goals related to the area, is not yet well understood. Although the safety region has meetings on different themes with some of the parties in the area from time to time, intensive relationships have generally not been maintained. Additionally, the safety region lacks experience and hence an approach to engage stakeholders in a participatory exercise. Also, safety region Utrecht has never applied to concept of resilience before and hence lacks an approach for resilience assessment. Currently, the degree of climate resilience at vulnerable areas, especially according to stakeholders' priorities, remains rather

vague. Additionally, the lacking common risk perception prevents stakeholder from being truly engaged in the problem (municipality Utrechtse Heuvelrug, personal communication, 23 March 2022). Accordingly, the vulnerability of the Utrechtse Heuvelrug region cannot be addressed properly. As a consequence, there is a need for a tailor-made participatory climate resilience assessment approach.

The problem addressed in this research project is hence the absence of a necessitated participatory approach for assessing climate resilience. Developing this approach is considered to be an intermediate step for the aspired strengthening of resilience at the Utrechtse Heuvelrug region. Concretely, there is a need for an approach to identify and engage relevant stakeholders in the assessment of climate resilience. This approach must consider the perspectives of stakeholders in order to develop a mutual problem perception. Next, it should result in leverage points to find solutions to strengthen climate resilience.

1.4 Research aim, goals and approach

This research project arises from the ultimate aim of safety region Utrecht to promote climate resilience improvement interventions at the Utrechtse Heuvelrug region by means of stakeholder participation. It contributes to this aim as it develops the necessitated participatory resilience assessment process. Therefore, this research aims to:

"Design a participatory climate resilience assessment approach that safety region Utrecht can use in the "Utrechtse Heuvelrug" region"

This research aims to design an approach that contributes to successful interventions in the known practical problem context of the Utrechtse Heuvelrug region and is hence design-oriented (Verschuren & Doorewaard, 2010). This design science project is conducted on the basis of the steps of the design cycle (Wieringa, 2014). This cycle consists of three iterative steps, namely problem investigation, design and validation. Because of this, the design cycle steps are reflected in the sub goals that guide the achievement of the research aim. The sub goals are as follows:

- Investigate the practical and theoretical problem context
- Investigate existing approaches for resilience assessment and stakeholder analysis
- Investigate stakeholder perspectives on resilience assessment and participation
- Design an approach for participatory climate resilience assessment
- Verify compliance with design requirements and evaluate the usability of the design by applying it to a pilot area

As reflected in the research aim, the research intends to deliver an approach for participatory climate resilience assessment. This aim comprises terminology that should be elaborated upon to avoid confusion. As stated Krywkow (2009), a participatory approach entails "the interaction of experts (…) with lay people [stakeholders] throughout a planning procedure with the aim of including the perspectives and views of these lay people to support a decision making process" (p. 45). A participatory process is hence referred to as a bottom-up decision-making process in which safety region Utrecht deploys instruments to interact with stakeholders (Bayley & French, 2008). These instruments to interact with stakeholders in a multi-actor setting are referred to as participatory methods (Krywkow, 2009). As the appropriateness of those instruments is contextual, the safety region needs an approach that can be used in the context of the Utrechtse Heuvelrug region. The participatory process to be developed is intended to engage the relevant stakeholders in resilience assessment. As argued, relevant stakeholders are those parties affecting and affected by the issue that have implementation power. That is, relevant stakeholders possess resources potentially required to take measures to strengthen resilience. Resilience assessment is recognized as a first step to reduce the area's vulnerability for climate-induced hazards (Cutter, 2016; Tong, 2021). Resilience assessment is

regarded as a process to transform resilience into a more tangible and therefore measurable concept, thereby identifying vulnerable area features that provide directions for intervention (Sharifi, 2016).

1.5 Start assumptions and scope

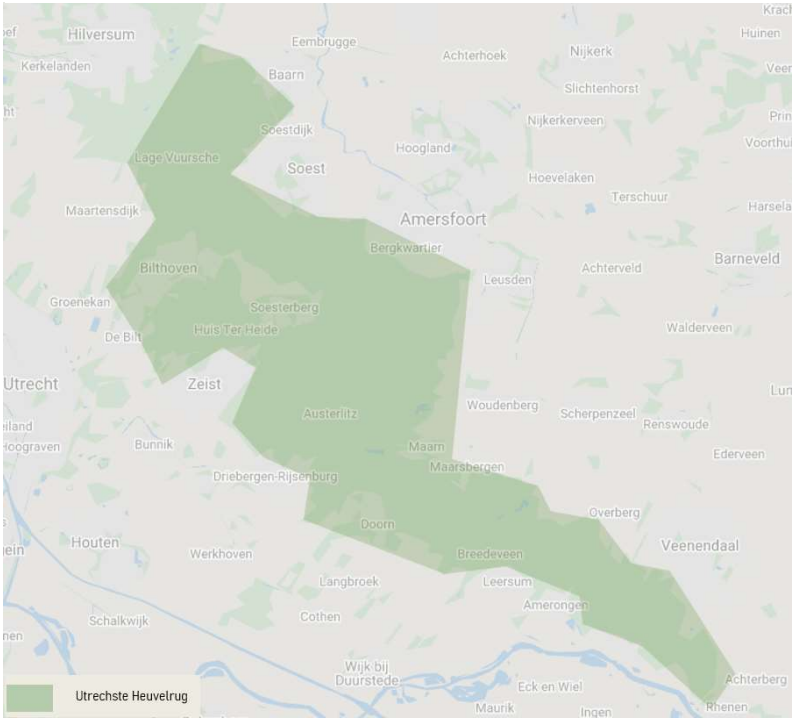
This research project is design-oriented, implying that the general problem at hand has already been identified and defined. For that reason, it rests on a couple of start assumptions. These reflect the underlying assertions of this research and are derived from the background, state-of-the-art literature and the problem statement. The initial design requirements are as follows:

a. There is a need to improve the climate resilience of the Utrechtse Heuvelrug region
b. Resilience assessment is an essential intermediate step prior to resilience improvement
c. The meaning of climate resilience in the context of this research must be established prior to assessing resilience
d. The engagement of relevant stakeholders in the process of resilience assessment is beneficial
e. Stakeholders have to be analysed to identify the relevant ones for engagement

Based on scientific literature (e.g. Leichenko, 2011), it is assumed that climate change will increase the number of occurrences and the intensity of the considered hazards. The verification of the occurrence of this trend at the Heuvelrug region is therefore not part of the research. In addition, it is assumed that a participatory resilience assessment is a beneficial intermediate step in addressing current vulnerability issues. Namely, stakeholders engaged in this approach for resilience assessment are those with powers, either or both because of physical and intangible resources, to eventually take resilience improvement measures. According to safety region Utrecht, an understanding on relevant stakeholders is missing, leading to the assumed need to analyse them.

The design contributes to the ultimate aim of the safety region, respectively resilience improvement against climate-induced stressors and shocks at the Utrechtse Heuvelrug together with relevant stakeholders. This contribution consists of a participatory approach for climate resilience assessment. Given the time available for this thesis, developing an approach for designing and implementing measures together with stakeholders to actually improve climate resilience at the Utrechtse Heuvelrug area does not fall within its scope. This research therefore not aims to fulfil the ultimate goal of safety region Utrecht. Furthermore, in the resilience assessment only the hazard risks associated with the stressors and shocks described in the regional risk profile are considered (Veiligheidsregio Utrecht, 2019). These are prolonged periods of heat and drought resulting in forest fires. Other stressors and shocks may prevail but do not fall within the scope as the risk profile has not prioritized them.

Figure 1 Geographical scope



The Utrechtse Heuvelrug area is geographically demarcated as depicted in Figure 1. Roughly, the area stretches between the

Rhine near Rhenen in the southeast and the provincial borderline near Hilversum in the northwest. In this demarcated region, a number of vulnerable subareas are already known by safety region Utrecht. Identifying the subareas to which the research problem specifically applies is hence out of scope. According to the safety region, the Henschotermeer pilot area is one of the subareas to which the problem context particularly applies. The Henschotermeer area is hence considered as a subsystem representative for the resilience issues of the Utrechtse Heuvelrug. In this area context, the design approach is applied in order to validate it. Validation involves the verification of the consistency between design and design requirements, as well as the evaluation of the usability of the approach according to relevant stakeholders. The application to the pilot area results in a guideline to conduct the design approach in other subareas as well.

1.6 Relevance

1.6.1 Practical relevance

To start with, the outcome of this research is relevant to safety region Utrecht as it ultimately contributes to the enhancement of climate resilience at the Utrechtse Heuvelrug, an area where this organization is expected to promote action to limit hazardous risks. As reasoned, identifying and engaging relevant stakeholders to conduct a participatory climate resilience assessment is an essential first step for achieving this aim. However, methodologies for this currently lack in this organisation. Also, an appropriate hands-on methodology that meets the specific objectives of safety region Utrecht is not available in scientific literature. On a practical level, this research therefore fulfils an essential step. The research's impact on society therefore comprises of offering an approach that contributes to the improvement of safety of vulnerable areas within the Utrechtse Heuvelrug region. To add, the resulting design approach is in principle also applicable to areas with a similar problem context outside this region. Specifically for adopting a participatory approach, it adds to this as the viability to actually take measures is strongly magnified as this approach aims to engage stakeholders with implementation power. Global and regional developments, most importantly climate change, lead to additional vulnerability and stress the societal relevance of resilience improvement and hence this research even more.

1.6.2 Scientific relevance

Literature on climate resilience often expresses that different definitions of this concept are diverging (Wardekker, 2021). This author states that the definition of resilience is inherently vague, resulting in different framings of the notion. Consequently, if it is not made specific different problem perceptions among stakeholders on the definition arise and therefore targeted measures for resilience enhancement remain impossible. The research responses to this statement as it establishes a contextual meaning of climate resilience as a starting point for addressing the problem of this research.

Moreover, measuring resilience is recognized as an essential initial step to reduce vulnerability to disasters in resilience assessment literature (e.g. Sharifi, 2016; Tong, 2021). However, this literature also indicates that indicators to assess resilience are context-specific. This research adds to this as the design approach allows for context-specific resilience metrics. Additionally, Sharifi (2016) mentions the challenge to design assessment approaches that are applicable to multiple locations. According to this author, customization of resilience indicators based on local needs and priorities must be allowed. This research project complies with this finding as it allows for subarea-specific metrics. Indicators are local stakeholder-informed and therefore not fixed. This makes the assessment approach flexible and therefore relatively easily applicable to locations other than the Henschotermeer pilot area.

Also, this research is relevant as it combines literature on stakeholder analysis and resilience assessment, enabling the engagement of relevant stakeholders in the resilience assessment process. This combination of stakeholder analysis and resilience assessment often lacks in scientific literature. Combing the literature streams is relevant since literature usually takes the engagement of relevant

stakeholders in participatory processes for granted despite of the vitality of decent stakeholder selection (Reed et al., 2009). Not properly considering the inclusion of stakeholders affects the usefulness of the outcome of the participatory process, for instance regarding the necessitated support among stakeholders. Reed et al. (2009) additionally argue that there is a need for methodologies that streamline stakeholder analysis as practitioners usually lack time to investigate the best way to identify relevant stakeholders themselves. This research addresses this finding as it provides a hands-on approach for the selection and involvement of relevant stakeholders in a participatory process. This prevents a time-consuming investigation on stakeholder analysis methods for safety region Utrecht. This research therefore complements to literature streams related to both resilience assessment and stakeholder analysis.

1.7 Outline

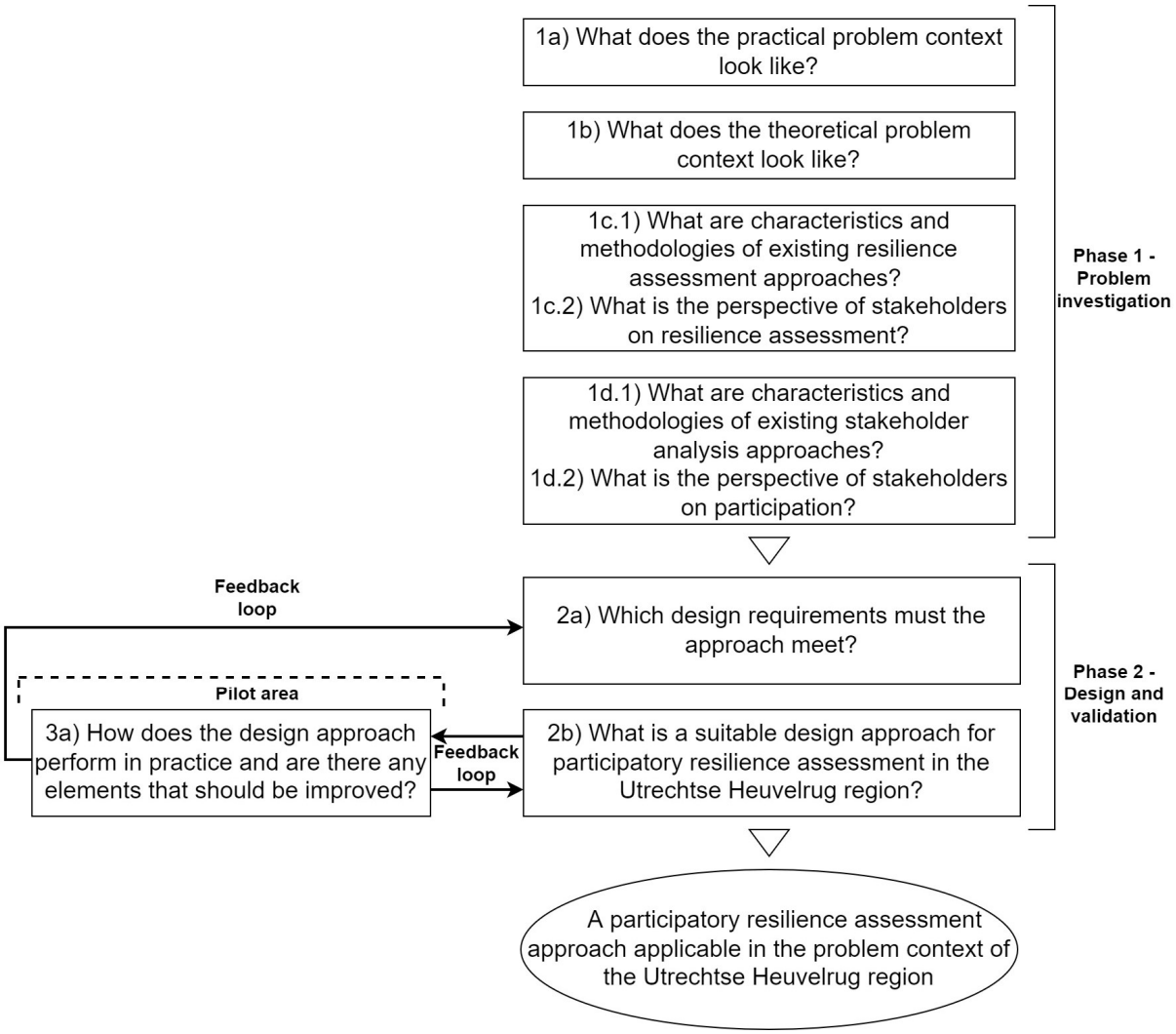
The structure of this research is as follows. **Chapter 1** covers the introduction, which encompasses the background of the research, state-of-the-art literature related to this background and the problem statement. Next, it encompasses the aim, goals and scope of the research as well as its practical and scientific relevance. In **Chapter 2**, the methodology is provided in the research design. Roughly, the research design is split in a problem investigation, and a design and validation part. **Chapter 3**, accordingly, presents the results of the problem investigation phase. This chapter first investigates both the practical and theoretical problem considered in this research. Subsequently, it establishes a meaning of climate resilience in the context of the Utrechtse Heuvelrug region. Furthermore, this chapter investigates the contents of existing approaches for stakeholder analysis and resilience assessment. Relevant characteristics and methodologies found from these approaches are intended to contribute to the design of the tailor-made approach. Moreover, this chapter focusses on the perspectives of relevant stakeholders on these subjects by investigating their experiences, demands and wishes. As this research has adopted an iterative design process, the design and validation stages are intertwined. **Chapter 4,** accordingly, presents the design and validation of the participatory approach for climate resilience assessment in the context of the Utrechtse Heuvelrug region. Designing this approach takes place on the basis of the flexible design requirements, as compiled as a first step of this chapter and possibly adapted as a result of the iterative design and validation process. Insights from the problem investigation phase are also deployed to design the approach. Validation of the design approach takes place at a workshop in the context of the pilot area and occurs on the perceived usability of the design and its compliance with the design requirements. Grounded on this, designing and validating components of the developed approach might be iterative. Ultimately, this fourth chapter provides a validated approach that the safety region can use as an example to conduct a participatory resilience assessment at vulnerable locations of the Utrechtse Heuvelrug area. **Chapter 5** reflects upon the results and methods of the thesis and presents its limitations. Finally, the main conclusions are presented in **Chapter 6**. This chapter also provides recommendations for future research.

2 Methodology

This project encompasses practical research as it is meant to contribute to successful interventions at the Utrechtse Heuvelrug area in order to improve the existing situation (Verschuren & Doorewaard, 2010). Since the research aims to design a participatory approach for climate resilience assessment, it is specified as design-oriented research. As this entails a design problem, a design science approach is adopted (Wieringa, 2014). Therefore, the development of the approach is divided in three iterative steps in accordance with the design cycle. In sequential order, these steps are problem investigation, design and validation (Wieringa, 2014).

Accordingly, the problem is thoroughly investigated first. Based on this problem exploration and the compiled design requirements, a participatory resilience assessment approach is designed. Designing the approach is incremental and iterative (Wieringa, 2014). That is, it is designed and tested intermediately and adapted based on detected deficiencies. In the research design (Figure 2), this is depicted by means of feedback loops between the design and validation phases of the design cycle. Ultimately, the final design approach is validated based on a verified compliance with the design requirements and an evaluated usability. Validating the design occurs by applying it to a workshop with stakeholders in the context of the pilot area. The Henschotermeer area is selected as a pilot area as it is illustrative for the affected climate resilience of the entire Utrechtse Heuvelrug region. Guiding questions structure the research design which is depicted in Figure 2.

Figure 2 The research design as adapted from the design cycle (Wieringa, 2014)



2.1 Problem investigation

The first phase constitutes investigating the problem context and is structured based on multiple activities. These activities belonging to the problem investigation phase are elaborated below on the basis of six guiding questions.

1a) What does the practical problem context look like?
This guiding question focusses on the problem context as experienced in practice. For this, the causes and effects leading to the existing vulnerability that result in the need to strengthen the resilience of the physical system is investigated. This investigation complements the start assumptions. Additionally, the governance system is explored in order to gain insight in the division of roles and responsibilities regarding the practical problem. To answer this guiding question, document analysis, interviews and field observations are combined. The document analysis focusses on policy documents of the national government, the province of Utrecht and the safety region Utrecht. Weekly unstructured interviews are conducted with employees of the safety region to define the practical problem. To gain a better understanding on the hazards in the Utrechtse Heuvelrug region and specifically in the Henschotermeer pilot area, observations are made during a field trip.

1b) What does the theoretical problem context look like?
As a point of departure to design the approach, this step combines the practical problem and existing definitions of climate resilience to define the problem in the theoretical context. Hence, this activity adds to the start assumptions of this research. A literature study is conducted to find definitions of climate resilience that reflect the practical problem. The scientific database Scopus is used to find relevant literature using the search terms "(climate) resilience", complemented with "definition".

1c.1) What are characteristics and methodologies of existing resilience assessment approaches?
Existing approaches to assess resilience are investigated to answer this guiding question. Existing methodologies are considered as potential components of the tailor-made design whereas identified key characteristics contribute to complement the formation of design requirements. Existing methodologies are potentially usable if they align with the objectives of resilience assessment adopted in this research. A literature study is conducted to study existing resilience assessment approaches. Existing approaches are found using the Scopus database. Search terms used comprise "(climate) resilience assessment" and "(climate) resilience operationalization", complemented with "(stakeholder) participation" or "participatory". Literature reviews on this subject are considered in particular to obtain a more generally valid image. Hands-on resilience assessment approaches are studied as well to identify the potentially useful methodologies.

1c.2) What is the perspective of stakeholders on resilience assessment?
The findings on existing approaches are complemented with the view of relevant stakeholders on the desired contents of resilience assessment. The first of these stakeholders is safety region Utrecht as the approach is specifically designed to be used by this organization. The second is the municipality Utrechtse Heuvelrug as the safety region recognizes this stakeholder as committed to the problem context. Stakeholders are questioned on their past experience, demands and wishes regarding climate resilience assessment. Together with the initially developed design requirements and identified characterises of resilience assessment, this adds to the development of the design requirements. To answer this guiding question, two semi-structured interviews with safety region Utrecht and the municipality Utrechtse Heuvelrug were conducted.

1d.1) What are characteristics and methodologies of existing stakeholder analysis approaches?
From literature studied in early phases of this research, a standardized approach to analyse stakeholders for involvement in a participatory approach could not be determined. Nevertheless, it was found that the importance of selecting the right stakeholders for engagement is widely recognized

(Prell et al., 2009; Uittenbroek et al., 2019; Walker & Salt, 2012). Hence, in this step existing stakeholder analysis approaches are consulted to identify their main characteristics and methodologies. To investigate relevant existing stakeholder analysis approaches, only those related to the scope of this research are considered. Stakeholder analysis in the context of this research are approaches that have the purpose to identify stakeholders and prioritize them for engagement in the process (Prell et al., 2009). Characteristics of stakeholder analysis identified add to the development of design requirements and existing methodologies potentially provide the component parts of the tailor-made design. Existing methodologies are potentially usable if they are consistent with the objectives adopted for this research related to the engagement of stakeholders in resilience assessment. For this literature study the search terms "stakeholder analysis", "stakeholder engagement/involvement" and "(stakeholder) participation" are applied in the Scopus database. Literature reviews on this subject are considered in particular to obtain a more generally valid image of stakeholder analysis. To add, hands-on approaches to analyse stakeholders are studied as well to identify potentially useful methodologies.

1d.2) What is the perspective of stakeholders on participation?
Findings from relevant literature on participation is complemented with the perspective of stakeholders. Stakeholders are asked about their past experience, demands and wishes with regard to stakeholder participation. Stakeholder perspectives add together with the initial design requirements and characteristics identified in literature to the formation of design requirements. To question relevant stakeholders, the same semi-structured interviews as step 1c.2 with representatives of safety region Utrecht and the municipality Utrechtse Heuvelrug are used.

Table 1 Guiding questions and methodologies to answer them - Phase 1

Phase 1 – Problem investigation	
Guiding question	*Methodology*
1a) What does the practical problem context look like?	• Document analysis on policy documents of the national government, province of Utrecht and safety region Utrecht • Weekly unstructured interviews with safety region Utrecht • Field visit to the Utrechtse Heuvelrug region
1b) What does the theoretical problem context look like	Literature study on the definition of climate resilience
1c.1) What are characteristics and methodologies of existing resilience assessment approaches?	Literature study on (participatory) climate resilience assessment and operationalization
1c.2) What is the perspective of stakeholders on resilience assessment?	Two semi-structured interviews with safety region Utrecht and municipality Utrechtse Heuvelrug
1d.1) What are characteristics and methodologies of existing stakeholder analysis approaches?	Literature study on stakeholder analysis and participation
1d.2) What is the perspective of stakeholders on participation?	Two semi-structured interviews with safety region Utrecht and municipality Utrechtse Heuvelrug

2.2 Design and validation

The second phase of this research encompasses the iterative design and validation of the design approach (Wieringa, 2014). This phase is structured on the basis of three guiding questions.

2a) Which design requirements must the approach meet?
The design brief is developed to answer this guiding question. The design brief consists of the context of application and the design requirements. The context of application describes the specific situation to which the approach is applicable as well as the target group that can use the design approach. The context of application is based on weekly unstructured interviews or discussions with employees of safety region Utrecht familiar with the problem context. The flexible design requirements form the basis on which the prototype approach is designed. As this research has adopted an iterative design approach, design requirements are tentative. Later, validation includes the verification of the compliance of the design with the requirements. The design requirements are based on the investigation of existing approaches for resilience assessment and stakeholder analysis and the interviews with the safety region and municipality Utrechtse Heuvelrug on these approaches. Furthermore, they are based on the start assumptions these are all reflected in the set of design requirements.

2b) What is a suitable design approach for participatory resilience assessment in the Utrechtse Heuvelrug region?
As a next step, the participatory resilience assessment approach is designed. The design requirements, and findings from literature and perspectives of the end users on resilience assessment and stakeholder analysis constitute the point of departure of designing. It is intended that the contents of the approach are always in accordance with the design requirements. As an iterative research approach is adopted, additional literature study on either or both stakeholder analysis and resilience assessment is conducted to complement to the findings of the problem investigation phase when deemed necessary. Related to this, changes to the design are made as new design requirements or insights arise. After the application to the pilot area as described in the next guiding question, a validated participatory resilience assessment approach in the context of the Utrechtse Heuvelrug region arises.

3a) How does the design approach perform in practice and are there any elements that should be improved?
The prototype design is applied to the pilot area to verify compliance with the design requirements and to evaluate the usability from a stakeholder perspective. Eventually, this determines the validation of the design. Compliance with the design requirements is verified by comparing the requirements with the application of the approach design. The perceived usability is derived from evaluation forms filled in by the participating stakeholders at the end of the workshop. To determine the compliance to design requirements and perceived usability, a workshop is organized in the context of the Henschotermeer pilot area to apply the approach in practice. For this, a selection of relevant stakeholders as identified in the stakeholder analysis part of the approach participate. On the basis of the results of this application, the design or design requirements may be adjusted. Namely, a lacking consistency of design requirements with a design considered as usable is dealt with by adjusting the requirements. A lacking usability resulting from the stakeholder evaluation is addressed by adjusting the design or design requirements, dependent on the nature of the perceived deficiencies of the design. Verification of the design requirements and an evaluated usability from a stakeholder perspective of the approach ultimately validate the design approach. The resulting design is applicable to areas facing the same issues as the pilot area. The application of the approach may be used for illustrative purposes to apply the design elsewhere. To enable a straightforward application of the approach by safety region Utrecht, a guideline to conduct the approach is provided.

Table 2 Guiding questions and methodologies to answer them - Phase 2

Phase 2 – Design and validation	
Guiding question	*Methodology*
2a) Which design requirements must the approach meet?	• Based on initial design requirements, and insights and stakeholder perspectives on existing approaches for resilience assessment and stakeholder analysis • Modified based on the application workshop
2b) What is a suitable design approach for participatory resilience assessment in the Utrechtse Heuvelrug region?	• Based on the design requirements and characteristics and methodologies of existing approaches for resilience assessment and stakeholder analysis • Modified based on the application workshop
3a) How does the design approach perform in practice and are there any elements that should be improved?	• Application of the prototype design to the Henschotermeer pilot area • Validation based on verification of design and design requirements and usability derived from stakeholder evaluation

3 Problem investigation

This chapter provides an overview of the problem context. It aims to extensively elaborate upon the practical and theoretical problem context, while it also investigates potential solutions to address this problem. The sections of this chapter are based on the guiding questions that structure the problem investigation phase. Accordingly, the chapter first explores the practical problem context related to the physical system by looking into the causes and effects of the affected climate resilience of the Utrechtse Heuvelrug region. Moreover, it elaborates on this problem and its background from a governance perspective by focussing on the division of roles and responsibilities among stakeholders. Based on this examination of the practical problem context and existing definitions of climate resilience, it is attempted to define the problem in theory that serves as a point of departure for designing the participatory approach. Moreover, the chapter is devoted to gaining insights on solutions for this design problem by investigating existing approaches for climate resilience assessment and stakeholder analysis. Next, the perspective of the end users on resilience assessment and stakeholder analysis is explored. While gained insights on existing approaches provide key characteristics and methodologies for the tailor-made approach, the investigation of the physical and governance system specifically aim to add to the development of the design requirements.

3.1 The practical problem context

This section starts with investigating the physical problem context by elaborating on the causes and effects of the issues as perceived by safety region Utrecht. Secondly, it focusses on the area's governance context by considering the division of roles and responsibilities among stakeholders. It is intended that these activities together with the activities of the subsequent section result in the formation of additional design requirements.

3.1.1 The physical system

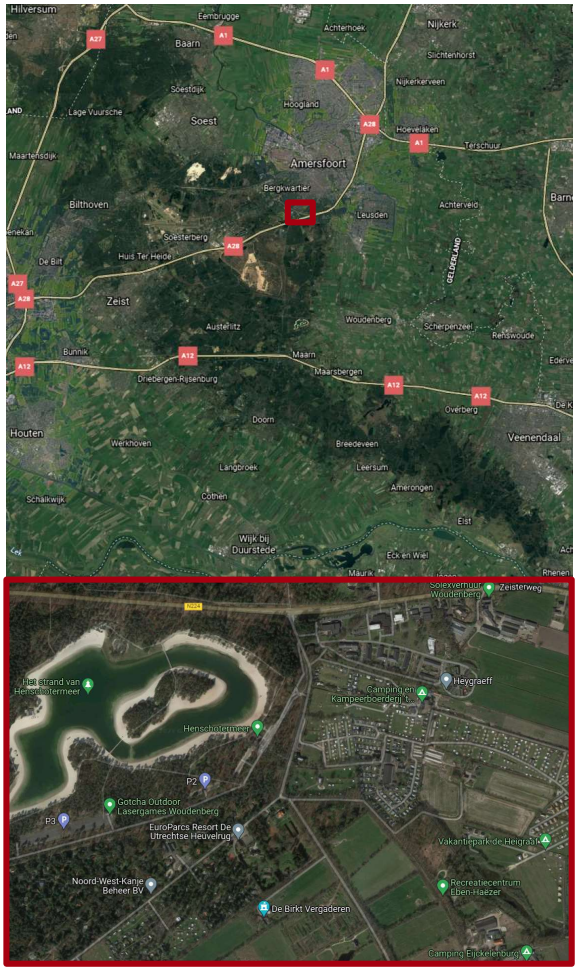
Vulnerability in this research is defined as the degree to which a system is incapable of dealing with the adverse effects of climate change (Poo et al., 2021). According to an analysis of the safety region on their high-risk areas, the vulnerability of the Utrechtse Heuvelrug primarily results from the prevailing wildfires risk (Veiligheidsregio Utrecht, 2019). This hazard risk primarily arises from the fact that the larger part of the Utrechtse Heuvelrug consists of forests, where the main stressors that cause wildfires are long periods of drought and enduring heat waves. Specifically for the sandy soils accommodating pine forests that are typical for the Utrechtse Heuvelrug, drought is exacerbated by the quick infiltration of rainwater in combination with extensive evaporation characteristic of these kinds of forests (safety region Utrecht, personal communication, 2021). The hazards associated with this wildfire risks are exacerbated by multiple factors that are elaborated in the remaining of this section.

One of the factors magnifying the bushfire hazard is the intensive use of this fostered area (Veiligheidsregio Utrecht, 2019). This decreases the region's climate resilience since it reduces the acceptability of the occurrence of a wildfire. To start with, the region accommodates various networks of vital infrastructure. Wildfire hazards threat vital infrastructure, thereby increasing the risk of social disruption by potentially disrupting important processes and cascading effects (Rinaldi et al., 2001; Veiligheidsregio Utrecht, 2019). Examples of networks of vital infrastructure accommodated by the Heuvelrug are high-voltage cables, gas pipelines and cell phone towers. Next to these networks, the region accommodates a wide range of other vulnerable objects contributing to the intensive use of land. In the first place, a large number of health care institutions are located in the Utrechtse Heuvelrug region. These institutions mainly affect the climate resilience of the area as the evacuation possibilities of their inhabitants are rather limited, thereby further reducing the acceptability of wildfires (Veiligheidsregio Utrecht, 2019). Also, a number of vast recreation areas negatively influence the region's resilience.

Another factor exacerbating the vulnerability to bushfires of the Utrechtse Heuvelrug region is associated with recreation pressure, which is fairly high and increasing (Veiligheidsregio Utrecht, 2019). Namely, next to the noticed increasing daytime recreation, permits for new recreation locations are issued regularly (safety region Utrecht, personal communication, 2021). This is associated with the resilience-affecting factor of intensive land use. That is to say, the increasing recreation pressure intensifies the land use of the Utrechtse Heuvelrug, contributing to the region's vulnerability. Next to the increasing risks associated with bushfires affect the region's safety, this societal development reportedly disrupts the balance between recreation and nature values (Province of Utrecht, personal communication, 2021).

The third factor aggravating wildfire hazards is climate change. Due to climate change, weather extremes are increasingly likely to occur in the service area of safety region Utrecht (Veiligheidsregio Utrecht, 2019). These extreme weather events concern heavy rains and prolonged periods of heat and drought. As discussed earlier, these climate-induced stressors of prolonged periods of drought and heat lead to increasing wildfire hazard risks. Although the precise consequences of climate change, caused by the exacerbated emission of greenhouse gasses, remain uncertain, it is assumed that it either way increases the vulnerability of the Utrechtse Heuvelrug (Poo et al., 2021).

Figure 3 The Henschotermeer area and its location on the Utrechtse Heuvelrug



In addition to these factors, the vulnerability of the Utrechtse Heuvelrug area is reinforced because their effects are predominantly concentrated on small subareas. An example of a subarea illustrative for the problem context is the Henschotermeer area (safety region Utrecht, personal communication, 2021). To start with, this piece of land of approximately one squared kilometre accommodates a wide variety of land use functions. That is, a multiplicity of campsites, cottage parks and other recreation firms are situated in the middle of the forest. Also, there is a health care institution that accommodates vulnerable people. Furthermore, the beaches of the lake attract many recreational visitors. Adding to this are poor evacuation possibilities and a limited accessibility for approaching emergency vehicles. This is a result of the limited capacity of adjacent roads and a consequence of fences surrounding the area (Veiligheidsregio Utrecht, 2019). Obviously, these beaches and surrounding recreation facilities attract most visitors in dry and heat periods, just when wildfires risks are at their highest. As a result of climate change, it is likely that those periods will occur more often. Moreover, a number of recently issued permits will lead to an increased recreation pressure (safety region Utrecht, personal communication, 2021). The Henschotermeer is thus one of the areas that represent the prevailing issues at the Utrechtse Heuvelrug and is therefore selected as pilot area to validate the approach for participatory resilience assessment.

The practical problem associated with the physical system of the Heuvelrug area can hence be summarized as an increasing risk of wildfires caused by long periods of heat and drought. This

hazardous risk is exacerbated by multiple factors, respectively intensive land use, increasing recreation pressure, climate change and the facts that these risk-increasing factors are often concentrated on small subareas such as the Henschotermeer area.

3.1.2 The governance system

Safety region Utrecht is responsible for preventing fires and preparing for disasters by, for instance, giving advice to municipalities and companies (Ministerie van Justitie en Veiligheid, 2022). As an extension of this, a safety region is obliged to draw a regional risk profile that brings forth high-risk areas and elaborates upon the hazard risks present in each. Since the safety region has determined that the Utrechtse Heuvelrug is one of those high-risk areas, the safety region has an advisory role to advice authorities that have jurisdiction and other relevant parties concerned on prevailing hazard risks. The role of safety region Utrecht remains advisory as safety regions do not have authorities to take measures themselves or impose them on others. Consequently, the safety region needs cooperation of local governmental authorities and other parties affected by the current vulnerability issues that have the potential to take preventive measures themselves (safety region Utrecht, personal communication, 2021). As mentioned earlier, in this research those parties are referred to as stakeholders with implementation power, or relevant stakeholders.

Since the safety region does not possess authorities to impose measures on others, stakeholders need to get activated before they are willing to cooperate in taking any preventive measure. According to safety region Utrecht, the perceptions of stakeholders do often not align with each other, nor with the safety region. Besides, genuine interest of non-governmental stakeholders for the greater part lacks (municipality Utrechtse Heuvelrug, personal communication, 23 March 2022). Safety region Utrecht assumes that aligning those diverging perceptions in order to create a common risk perception is required prior to taking measures with stakeholders. This assumption is shared by the municipality Utrechtse Heuvelrug, even though local governmental stakeholders already share a common understanding on safety risks (municipality Utrechtse Heuvelrug, personal communication, 23 March 2022). Correspondingly, this municipality also feels obliged to address this threat, but only in collaboration with a wide range of other stakeholders. The need for collaboration partly arises from the fact that the Heuvelrug region comprises nine municipalities that often lack aligned objectives in the problem context of the Utrechtse Heuvelrug (municipality Utrechtse Heuvelrug, personal communication, 23 March 2022). However, the urge for collaboration is not solely stemming from this fragmentation. The municipality's lack of knowledge and expertise regarding the resilience issue is an important incentive for collaboration as well. According to the municipality Utrechtse Heuvelrug, there is a potential role for the safety region to form a connecting link between them and the other stakeholders in terms of support, facilitation, knowledge and expertise on the problem. To establish the required common risk perception among relevant non-governmental stakeholders as well, respectively those with implementation power, climate resilience must be operationalized in the local context and according to what is meaningful for stakeholders by conducting a participatory resilience assessment (Morelli et al., 2021). As a result, a supportive attitude to taking measure for resilience enhancement may be expected (Coenen, 2009). In alignment with this, the municipality Utrechtse Heuvelrug already shares the risk perception with the safety region and is therefore willing to design and implement actual measures targeted at vulnerability reduction (municipality Utrechtse Heuvelrug, personal communication, 23 March 2022).

Based on the investigation of the practical problem context, new assumptions regarding this research are added to the pre-established start assumptions:

a. The participatory process should raise the awareness levels concerning the wildfire risk among stakeholders
b. A common understanding on the problem should be established among stakeholders

3.2 The theoretical problem context

By comparing existing definitions of the notion of climate resilience with the practical problem context, this section aims to theoretically define climate resilience contextually. This definition serves as a point of departure to design the participatory resilience assessment approach.

Resilience is used on many occasions and is therefore a non-specific concept (Wardekker, 2018). Different framings of climate resilience eventually result in different directions for improvement as a definition serves as a starting point for assessment (Wardekker, 2021). The multidisciplinary origins of the concept of resilience present a challenge to understand and operationalize it in a specific context (Johannessen & Wamsler, 2017). As aforementioned, the safety region is not familiar with applying the notion of resilience in their activities. Before initiating the operationalization of the notion of climate resilience, a meaning should thus be assigned to the concept. Because this meaning, as well as metrics to assess resilience and priorities associated with it are subject to different interpretations, the initial definition of climate resilience established in this section is tentative (Morelli et al., 2021). Nevertheless, it serves as a point of departure to identify initial priorities for assessing climate resilience together with stakeholders based on the practical problem context.

Many definitions of resilience exist (Wardekker, 2021). Helfgott (2018) has identified a common thread in these definitions, as well as in the manner to operationalize resilience. The author emphasizes that resilience always refers to the response of a system to a disturbance or change, whether that disturbance is shocking or more gradual. There are multiple possible outcomes of such a response (Helfgott, 2018). A system is considered resilient if it maintains its specified features of interest, does not maintain them but recovers them within an acceptable timeframe, or does not maintain or recover them but changes in a beneficial way. A system is not resilient if it does not preserve or recover the specified features of interest when exposed to a disturbance, but instead changes in an undesirable way. This implies that defining desirable features of an area that may not change in the face of a shock is essential to assess the degree of resilience. Desirable area features and what constitutes desirable change therefore constitute resilience metrics. As the judgement of what are desirable and what are undesirable area features is observer dependent, climate resilience metrics are per definition based on stakeholders' perceptions (Helfgott, 2018). Tentative desirable area features could not be determined in consultation with the safety region and all features must therefore be derived from other relevant stakeholders (safety region Utrecht, personal communication, 18 February 2022). Furthermore, Helfgott (2018) adds that in order to make the notion of resilience practically applicable, it has to be determined to what disturbances an area must be resilient and which developments are considered. Finally, system boundaries have to be set and it has to be defined which area components are considered. To summarize, the definition of climate resilience must prescribe the response of a demarcated system to a particular disturbance from the perspective of specified observers, considering future trends of the area (Helfgott, 2018).

This specific content of climate resilience is taken into consideration as climate resilience in this research is referred to as a property of an area that describes the capacity of key area features to continue performing services through climate-induced disasters (Fox-Lent et al., 2015). In the concept of climate resilience, climate refers to future changes related to an increase in hazard risks (Kim & Lim, 2016). However, to enable the operationalization of climate resilience in the context of a certain system, the definition has to be more specific. As specifying the definition depends on, among others, desirable area features and system boundaries, a definition of climate resilience for the purpose of assessment is contextual and depends on the subsystem under consideration (Morelli et al., 2021). To obtain such a contextual definition, resilience framing questions derived from Helfgott (2018) and Walker & Salt (2012) are used to specify this definition (Table 3). Because of the normative nature of resilience, answering the framing questions requires the engagement of stakeholders, for example in order to determine desirable area features (Helfgott, 2018). Hence, this theoretical approach to

operationalize resilience does not suffice as it does not consciously consider stakeholder engagement. Accordingly, in the next section it is explored whether existing approaches on either stakeholder analysis or resilience assessment can be used to assess resilience in the context of this research. However, to guide the operationalization of the resilience concept in the area context under consideration, the resilience framing questions are recognized to be useful (Helfgott, 2018; Walker & Salt, 2012).

Table 3 The resilience framing questions as adapted from Helfgott (2018) and Walker & Salt (2012)

Framing question	Description
Resilience of what?	Determine the boundaries of the system under consideration and the components that are included in the analysis
Resilience to what?	Determine which disturbances are included in the analysis
Resilience for whom?	Determine the features of interest, the features that must be preserved, which may change and what constitutes desirable change
Resilience for when?	Determine the drivers and trends of the area

On the basis of this section on the theoretical problem, additional start assumptions are compiled. These are:

c. The degree of resilience is considered to be higher if an area better maintains the specified features of interest
d. Desirable area features should be determined from the perspective of relevant stakeholders because of the normative nature of resilience

The sections on the practical and theoretical problem context defined the problem and the emerging insights provide additional start assumptions used to design the approach. In essence, the design should allow for the climate resilience assessment of vulnerable subareas on the basis of their desirable attributes according to the perspectives of relevant stakeholders. In order to find methodologies that can potentially contribute to this aim, existing approaches for climate resilience assessment and stakeholder analysis are examined.

3.3 Existing approaches for climate resilience assessment

To operationalize the concept of climate resilience in accordance with the initially established design requirements, a participatory resilience assessment methodology that complies to them ought to be developed. To operationalize resilience, resilience assessment methodologies can be deployed (Sharifi, 2016). To find these potential suitable methodologies for the tailor-made design, as well as relevant characteristics that may contribute to the design requirements, relevant insights on existing approaches for climate resilience assessment are explored in this section. To reflect the insights of stakeholders, results of interviews on the desired contents of climate resilience assessment complement these findings.

To start with, measuring resilience is a crucial first step for the reduction of disaster risks by being better prepared to, or being better able to withstand the impact of disasters (Poo et al., 2021; Sharifi, 2016). Assessment tools enable the measurement of resilience of the considered components of an area, thereby enabling the identification of vulnerable area features. This provides directions for climate resilience improvement and enables the search for solutions. Conducting a participatory resilience assessment, in particular, enables the required reflection of the perceptions, interests and goals in assessment criteria (Sharifi, 2016). The to be expected resulting consensus among relevant stakeholders on prevailing risks increases their support and acceptance concerning future resilience enhancement measures. Assessing resilience together with stakeholders also increases the overall

public awareness on hazard risks, which enhances their disaster preparedness and is therefore resilience-enhancing in itself (Krywkow, 2009).

In the resilience assessment literature, there is lack of consistency in methodologies integrated in assessment approaches (Tong, 2021). From reviews on resilience assessment approaches, a vast number as well as a significant diversity of methodologies is observed (Poo et al., 2021; Schipper & Langston, 2015; Sharifi, 2016, 2019). Nevertheless, these review articles provide several similarities of resilience assessment methodologies as well. To start with, the definition of resilience should always be framed and defining the disturbances to which an area should be resilient is in any case needed. Also, the area under consideration should be physically demarcated. This framing and conceptual defining of resilience is referred to as the first step of resilience assessment by, among others, Fox-Lent et al. (2015), Helfgott (2018) and Walker & Salt (2012).

As resilience is contextual, the characteristics of resilience assessment depend on which impacts on which components of the system are considered (Walker & Salt, 2012). From an extensive collection of resilience assessment methods, Poo et al. (2021) found that components of a system considered may include environmental resources, the society, the economy, the built environment and infrastructure, and governance. In consultation with safety region Utrecht, it is decided that the tailor-made approach should at least assess the vulnerability of all physical area components (safety region Utrecht, personal communication, 18 February 2022). Here, the physical components refer to the nature and infrastructure of the system under consideration. Adding area domains that should be considered may result of stakeholder interaction. Essentially, resilience is about whether a disturbance pushes the desirable features of an area over a perceived threshold, so that their services are affected. Defining system's important features that have to be maintained therefore often constitute the second step of existing resilience assessment approaches (e.g. Fox-Lent et al., 2015). Desirable area features entail functions, facilities, infrastructure and physical conditions (Wardekker et al., 2010).

From reviewing an extensive set of resilience assessment approaches, Sharifi (2016) has distinguished five groups of methods to measure resilience. According to this author, resilience is assessed against baseline conditions, against thresholds that reflect objectives, against resilience principles, against peers by benchmarking or based on the speed of recovery. Most group of methods do either or both not comply with the purpose of this research or are considered unfeasible because of their characteristics. The group of methods that assess the vulnerability of system components against climate-induced shocks on the basis of resilience principles, in turn, is potentially applicable to the problem context (Sharifi, 2016; Wardekker, 2018). Resilience principles comprise mechanisms that enable the assessment and improvement of a system. Hence, resilience principles can either be used to assess the compliance of an area component with each resilience principle or as a handhold to find solutions to improve resilience. Either way, these methods require determining the attributes of the area that should be maintained to get a resilient area. To reflect stakeholder perceptions, desirable area features are obtained by consulting local experts (Sharifi, 2016). This research specifically aims to find solutions to strengthen the resilience of desirable attributes of an area instead of scoring the resilience of each. Hence, the possibility to deploy these group of methods constitutes of devising potential measures to improve resilience based on standardized resilience principles (Cutter, 2016; Fox-Lent et al., 2015).

Resilience principles differ but are often along the lines of homeostasis, omnivory, high flux, flatness, buffering and redundancy (Wardekker, 2018). Homeostasis refers to feedback mechanisms that counteract external disturbances and may involve, among others, setting up an early warning system. Omnivory, in turn, involves diversifying the means where a function depends on. An example of this includes the availability of both a shelter and an evacuation route that can be used in case of a wildfire. High flux refers to a smooth flow of resources, such as rescue services, to cope well with disturbances. Flatness relates to a flat and non-hierarchical system, for example informing area users on hazards.

The resilience principle of buffering involves over-dimensioning components of a system able to counteract disturbances, for example fire stop lines to absorb wildfires. Finally, redundancy involves the availability of multiple components that fulfil the same function, such as multiple evacuation routes, so that if one fails the other can take over.

As already emphasized, resilience assessment is always contextual. Next to stakeholders' interests, the established definition of resilience therefore always determines the area features that are selected (Schipper & Langston, 2015). The suitability of area features to improve the resilience of the system depends on the prioritization of those area components, resulting from the interests and objectives of stakeholders (Cutter, 2016). Assessing the area based on these stakeholder-informed metrics has a big advantage in the sense that they define the assessment of the area according to local needs. Fox-Lent et al. (2015) add that, since it is not possible to externally validate contextual metrics, their appropriateness must be approved by judgements of stakeholders. The resilience of prioritized area features are hence qualitative, immeasurable metrics to assess resilience (Fox-Lent et al., 2015). Accordingly, assessing the prioritized area features results in an overview of weaknesses of an area regarding climate resilience that can be strengthened based on the resilience principles.

From literature, a multiplicity of resilience assessment methodologies is found. Due to the start assumption of this research, however, many of them are excluded for the tailor-made design. Despite this, especially the need to identify desirable attributes of a demarcated area and the option to find solutions to address their vulnerability in the context of this research are found. As resilience is normative, each stakeholder may have a different perspective on what resilience entails (Helfgott, 2018; Morelli et al., 2021). Hence, value-laden choices inherent to resilience assessment make that stakeholder participation is an essential part of resilience assessment. Resilience assessment methodologies must hence cover the identification and engagement of stakeholders. Yet, literature on resilience assessment that makes use of the engagement of stakeholders often neglect the approach used to select stakeholders for the sake of involvement (Reed et al., 2009). That is, literature often speaks about stakeholder engagement but does not prescribe an approach to involve them. Because of the relevance of selecting the right stakeholders for any participatory session, methodologies and characteristics identified in this section are complemented by literature and stakeholder perspectives on stakeholder analysis (Uittenbroek et al., 2019; Walker & Salt, 2012).

3.4 Existing approaches for stakeholder analysis

In scientific literature on resilience assessment studied in section 3.3, methodologies to engage stakeholders generally lack and safety region Utrecht has limited experience with stakeholder participation (Interview D.1). Furthermore, engaging the right stakeholders is recognized to be both challenging and important (Prell et al., 2009; Reed et al., 2009). Therefore, existing approaches for stakeholder analysis are explored in order to identify potentially useful methodologies and characteristics. These contribute to the design as potential methodologies and to the formation of design requirements. To reflect the stakeholder perspectives, results of interviews with safety region Utrecht and the municipality Utrechtse Heuvelrug on stakeholder analysis add to this.

In literature, an extensive selection of stakeholder analysis methodologies are observed. By means of stakeholder analysis, the interests and objectives of stakeholders that possess means to solve the problem are considered by engaging them (Enserink et al., 2010). Engaging stakeholders in decision-making is referred to as stakeholder participation and can be defined as the redistribution of power when decisions are being made (Bjørgen et al., 2021). From reviewing scientific literature on stakeholder participation, Sarzynski (2015) determined five characteristics structuring stakeholder engagement. The first to determine is who participates. Secondly, it is determined at what moment in the process stakeholders participate. The third aspect characterizing stakeholder engagement is what happens when stakeholders participate. This refers to the degree of involvement such as information

provision only or co-decision making (Krywkow, 2009). Fourthly, it is commonly defined how much engagement takes place. Lastly, the purpose of stakeholder participation has to be determined. These objectives that can be achieved with participation are diverse (e.g. Coenen, 2009; Enserink et al., 2010; Prell et al., 2009; Reed et al., 2009). As recognized in the review of Sarzynski (2015) the purpose determines, for the larger part, what happens during participation. Moreover, the purpose of participation also determines the contents or steps of stakeholder analysis (Reed et al., 2009). Literature on participation often distinguishes between a normative or instrumental objective of stakeholder analysis approaches. When stakeholders are engaged on a normative rationale, participation is considered intrinsically valuable whereas instrumental stakeholder involvement is valued for what is brings to governance (Sarzynski, 2015). Examples of instrumental objectives may include knowledge, resources and the acceptability of outcomes of the decision-making. The success of stakeholder participation depends on the achievement of the objectives. As the specific objectives set determine the contents of stakeholder analysis, an effective stakeholder analysis approach is context-specific and hence tailor-made. Therefore, it can be concluded that the characteristics of an appropriate stakeholder analysis depend on the objective of participation that has to be achieved.

In order to obtain potential methodologies for this tailor-made stakeholder analysis approach, existing approaches in different fields of literature are studied. From this literature, it is determined that many existing approaches for stakeholder analysis are not hands-on. Two approaches that explicitly describe the activities of stakeholder analysis, however, are developed by Enserink et al. (2010) and Prell et al. (2009). The approach of Enserink et al. (2010) is rooted in policy analysis and focusses on stakeholders taking part in multi-actor policy process. Because of this, the approach assumes that cooperation between stakeholders is required as no party is able to impose their solutions onto others. Especially because of the safety region's lack of authority to impose measures on others, this multi-actor environment has close similarities with the context of this research. The approach of Reed et al. (2009), in turn, is rooted in literature on environmental management and focusses specifically on the difference between instrumental and normative approaches for stakeholder analysis. Relevant insights on both approaches are highlighted in this section.

As reflected in both stakeholder analyses, defining the problem under investigation is always the first step (Enserink et al., 2010; Reed et al., 2009). Next, it is already determined that participation in this resilience assessment takes place in the pre-planning phase of measures to strengthen climate resilience and involves a participatory workshop. This involves a high degree of collaboration (Sarzynski, 2015). Finally, the purpose of participation is defined based on the grounds for adopting a participatory approach in this research. Because of the urge to include stakeholders with implementation power in this context, it is determined that an instrumental approach to engage stakeholders applies here. Then, stakeholders must be identified on the basis of this instrumental goal of the participatory process. The instrumentality of stakeholders refers to their implementation power of resilience enhancement measures. This is also in compliance with the desire of the safety region to identify powerful stakeholders (safety region Utrecht, personal communication, 18 February 2022). Both the approaches of Enserink et al. (2010) and Reed et al. (2009) mention a wide variety of stakeholder analysis methodologies and stress the importance of using complementary techniques to avoid accidently neglecting stakeholders. To subsequently categorize stakeholders, also reflected in many existing stakeholder analysis approaches, a reconstructive or bottom-up categorization is preferable over an analytical method as it considers stakeholder perspectives (Enserink et al., 2010; Krywkow, 2009; Reed et al., 2009). The perspective to categorize stakeholders in a constructive manner is shared by the safety region, and hence grouping occurs on the basis of the pre-existing categorization of safety region Utrecht as depicted in Table 4 (safety region Utrecht, personal communication, 18 February 2022).

Table 4 Stakeholder categories

Category	Stakeholder	Category	Stakeholder
Land management organizations	Nature management organizations		Day care activity centres
	Private land managers	*Living and working*	Citizens
	Ministry of Defence		Other companies
Infrastructure managers	Road authorities • Water boards • Municipalities • Utrecht province Rijkswaterstaat	*Legislators*	State of the Netherlands E.g. Nature Conservation Act
	Vital infrastructure managers • Utility providers Telecom and ICT providers		Province of Utrecht E.g. Strategic forest policy, subsidies
Recreation businesses	Stay-over recreation companies • Campsites • Cottage parks Hotels		Municipalities E.g. permits
	Daytime recreation companies		Water boards E.g. permits
Health institutions	Residential care institutions	*Client*	Safety Region Utrecht

The studied literature reviews and separate approaches to analyse stakeholders provide considerable insights on the methodologies and characteristics of stakeholder analysis. However, many studied approaches on stakeholder analysis are not straightforward applicable. To add, the limited experience of the client regarding stakeholder analysis is taken into account by excluding overly difficult approaches in advance. The steps of stakeholder analysis are not fixed but should be tailored based on the reasons to engage stakeholders (Sarzynski, 2015). Gained knowledge on resilience assessment and stakeholder analysis, already reflected to the objectives of this research when possible in this section, hence determine the contents of the participatory approach. The insights are thus useful to design the approach. However, existing participatory approaches tend to assume that stakeholders are self-evident (Reed et al., 2009). In accordance with this finding, resilience assessment methodologies do often not prescribe a methodology to consciously engage stakeholders. Because of the relevance of appropriate stakeholder selection in this research, there is a need to design an approach that integrates stakeholder analysis and climate resilience assessment. Although scientific literature does not provide a ready-made solution, it does contribute to the development of design requirements and delivers useful components for the design approach. In accordance with this, it is already determined that under all conditions desirable area features must be determined to assess resilience and that the subjectivity of this requires stakeholder engagement. Furthermore, it is found that in this research context resilience principles can be used to find solutions to address the vulnerability of affected desirable area features. Also, the need to identify stakeholders on the basis of the purpose of the participatory process and the methods to do this are found. The insights on stakeholder analysis and resilience assessment gained in this section are therefore used in the next chapter on designing the participatory resilience assessment approach.

4 Design and validation

This chapter presents the tailor-made design for the participatory climate resilience assessment approach. The design is validated in the context of the Henschotermeer pilot area. The guiding questions on the design and validation phase guide the structure of this chapter.

The chapter starts with the development of the design brief, consisting of the context of application and design requirements. Based on the design requirements and insights obtained during the problem investigation phase, the prototype design of the participatory resilience assessment approach is presented in the subsequent section. In a workshop, the approach is applied together with relevant stakeholders in the context of the Henschotermeer pilot area. This application to the pilot area is discussed and resulting lessons learned are highlighted in the third section. Because of the iterative design method approach adopted, design requirements and the design of the approach are adapted according to the deficiencies detected and suggestions for improvement mooted by stakeholders. Deficiencies may comprise of failure to meet the design requirements or a lack of perceived usability by the stakeholders. This verification of the compliance with the design requirements and the evaluation on usability from a stakeholder perspective comprise the validation of the approach and is discussed as a final section of the chapter.

4.1 Design brief

The design brief forms the basis of the design of the participatory resilience assessment approach. The design brief consists of the context of application and design requirements. The context of application, describing who should be able to conduct the approach and in which context, is provided first.

4.1.1 Context of application

The design problem this approach addresses constitute integrating stakeholder analysis and resilience assessment in order to assess resilience in collaboration with relevant stakeholders. This new integrated approach is especially applicable in the context of vulnerable subareas of the Utrechtse Heuvelrug. These areas have already been identified and are therefore known by safety region Utrecht. An example of them is the Henschotermeer area, which is selected as pilot area to apply and subsequently validate the design approach. Area contexts to which the approach is applicable all have the issues as described in the section on the practical problem context in common. That is, they are increasingly vulnerable to wildfires and its consequences, resulting from climate change and because of the intensive use of the areas by multiple land use functions.

The target group of the designed approach are employees of safety region Utrecht working on enhancing the safety of high-risk region Utrechtse Heuvelrug. These employees are intended to use the approach as an initial step towards the actual improvement of climate resilience at a specific vulnerable subarea of the Heuvelrug region. To add, employees of municipalities and other safety regions can also apply the approach in other contexts similar to the Utrechtse Heuvelrug area. The approach is meant to identify and involve stakeholders in the problem, create an overview of vulnerabilities regarding climate resilience and provide directions for solutions to address the vulnerabilities. This functions as a stepping-stone to take actual resilience enhancement measures together with stakeholders.

4.1.2 Design requirements

From the introduction and practical problem context, start assumptions for this research have already been compiled. These assumptions are reflected in the design requirements, as underpinned in Table 12 of Appendix C. Moreover, insights gathered from the problem investigation phase add to the formation of the other design requirements.

After designing, validating includes verifying that the approach complies with all design requirements. As the validation phase also comprises of evaluating that the designed approach complies with the user expectations regarding usability, requirements are added until the validation is finished. Design requirements are therefore flexible.

Table 5 provides an overview of the established design requirements. To structure these requirements, they are grouped based on the following classification: outcome, process, implementation criteria, flexibility and scope. The rationale to add each requirement, as well of the source(s) of each requirement is also provided in the table.

Table 5 Design requirements

	#	Design requirement	Rationale	Source
Outcome	1	The participatory approach should contribute to climate resilience improvement of the Utrechtse Heuvelrug area	There is an urge to enhance the climate resilience of the Utrechtse Heuvelrug	Initial design requirements a and c, based on Veiligheidsregio Utrecht (2019)
	2	Conducting the participatory resilience assessment should result in an overview of an area's current state regarding climate resilience	The identification of vulnerable area features by means of resilience assessment is a first step to reduce the area's vulnerability for climate-induced hazards	Initial design requirement b, based on Sharifi (2016) and Tong (2021)
Process	3	The wildfire hazard should be clearly introduced to engage stakeholders	The perceived urgency of stakeholders concerning the wildfire hazard and therefore their willingness to engage in a participatory process is limited	Interviewee of the municipality Utrechtse Heuvelrug (interview D.2) and initial design requirement f
	4	The design approach should allow for the inclusion of the perceptions of all relevant professional stakeholders	Stakeholder participation is considered as an essential instrumental part of eventually enhancing resilience	Initial design requirements d, e and g, based on input from safety region Utrecht

Implementation	5	Safety region Utrecht and other stakeholders should be able to jointly conduct the participatory assessment in half a day	Intended participants have limited time available to be engaged in the process	Input from safety region Utrecht, based on Prell et al. (2009)
	6	Employees of the safety region with a limited experience on stakeholder analysis and resilience assessment should be able to conduct the designed approach	The experience of employees of the safety region in both subjects is rather limited	Input from safety region Utrecht (i.a. expressed in interview D.1)
Flexibility	7	Adapting the assessment approach to local circumstances should be possible	There is an urge to increase the resilience of multiple subareas of the Utrechtse Heuvelrug area	Input from safety region
	8	Modification of the assessment approach should be possible based on changing circumstances or new insights	Future scenarios are uncertain and the risk profile, in which this problem context is rooted, is updated regularly	Based on uncertainty associated with climate change (e.g. Leichenko, 2011) and the changing nature of the risk profile (Veiligheidsregio Utrecht, 2019)
Scope	9	The metrics to assess climate resilience should at least refer to desirable area features related to the physical area components	It is agreed upon to consider the physical area components. Stakeholders, however, may add to this dimension	Interviewees of safety region Utrecht (interview D.1) and based on initial design requirement h and I

4.2 The prototype design

Based on the practical and theoretical background provided in the chapter on the problem investigation phase, as well as grounded on the design brief established in the previous paragraph, the participatory resilience assessment approach is set to be designed. As the design and validation phases are intertwined, designing the approach is an incremental and iterative process. Ultimately, this chapter brings about the validated approach, meaning that the design resulting from this approach both meets the design requirements and complies to the perceived usability of the stakeholders. This section presents the prototype of the design that is applied to the pilot area and validated in the subsequent paragraphs of this chapter.

The prototype design presented below is developed by means of multiple iterations on the basis of new insights gained during the course of this research. Namely, the initial prototype design constituted a separate stakeholder analysis and resilience assessment approach. As argued, the insight that integration of resilience assessment and stakeholder analysis is necessary arose. The subsequently developed integrated approaches intended to derive desirable area features from literature that should be complemented by stakeholders. Later, the need to fully base desirable area features on stakeholder input came to light and the approach was redesigned accordingly. Furthermore, these

former prototypes intended to devise indicators that would measure the degree of resilience for each desirable area feature on the basis of literature. Later, awareness on the limited usefulness for the purpose of this research resulted in the replacement of this activity. Also, initial designed approaches were meant to result in weak desirable area features that would constitute the basis to devise solutions to improve resilience. They lacked the actual development of potential solutions that provide the basis to actually design and implement measures. In later designs, this gap was therefore complemented by another activity in the final prototype. The emerging structure of the final protype design is based on the steps and related guiding questions as depicted in Table 6.

Table 6 Steps, guiding questions and task allocation

Steps and related guiding questions	Task allocation
1. Formulate the problem at stake: What is the problem at stake?	Performed by analyst before the workshop
2. Identify the relevant stakeholders: Who are the relevant stakeholders?	Performed by analyst before the workshop
3. Determine the desirable area features: What are the desirable area features of the system?	Performed by stakeholders in the workshop
4. Determine the vulnerability of the desirable area features: Which desirable area features are vulnerable to wildfires?	Performed by stakeholders in the workshop
5. Determine directions to improve the resilience of vulnerable, desirable area features: What are possible solutions to improve the resilience of vulnerable, desirable area features?	Performed by stakeholders in the workshop

1. *Formulate the problem at stake: What is the problem at stake?*

As recognized earlier, the exact meaning of resilience depends on the context to which the concept is applied (e.g. Fox-Lent et al., 2015; Wardekker, 2018). Furthermore, the resilience guiding questions dictate the urge to characterize the problem under consideration as a first step of resilience assessment (Helfgott, 2018; Walker & Salt, 2012). Additionally, a participatory approach in particular urges for the formulation of the issues under consideration as an early activity (Prell et al., 2009).

As part of the problem investigation phase, the general problem at stake has already been defined as the affected climate resilience of the Utrechtse Heuvelrug resulting from wildfire hazards, caused by the stressors heat and drought, and exacerbated by intensive land use, the increasing recreation pressure and climate change. However, this general definition lacks context specificity regarding the specific subarea under consideration. Like establishing the general problem of the Utrechtse Heuvelrug region, context-specificity to the problem under consideration is added by applying the resilience framing questions to the specific subarea under consideration. Accordingly, the boundaries of the subsystem under study, considered disturbances, desirable area features, and trends of the area are defined (Helfgott, 2018; Walker & Salt, 2012). From the general definition, it is deduced that wildfires are the disturbances considered in this research. Parts of this operationalization of resilience, respectively defining features of interest and observed trends of the subarea, are normative. In alignment with design requirements and findings on the advantages of stakeholder participation, these activities require stakeholder involvement. Consequently, defining desirable area features and trends comprise sequential steps of the prototype design. Physically demarcating the subsystem under examination is hence the activity conducted in defining the problem at stake. Also, identifying stakeholders is merely possible after demarcating the area under consideration (Prell et al., 2009). The application of the general problem to the subarea serves as an explanation for the rationale of the workshop in the invitation of stakeholders. As the most vulnerable areas within the Utrechtse Heuvelrug region have already been identified by the safety region, boundaries are set by the analysist

conducting the approach and familiar with the problem context. Setting physical boundaries around an area contributes as an initial activity to the operationalization and hence to the assessment of resilience.

2. *Identification of the relevant stakeholders: Who are the relevant stakeholders?*

Stakeholder involvement in resilience assessment is prescribed in the context of this research. Hence, a stakeholder analysis is conducted to identify the relevant stakeholders (Enserink et al., 2010; Reed et al., 2009). This step might be iterative as additional stakeholders can be considered as either relevant or irrelevant during the course of preparing the workshop. As reasoned, the purpose of the participatory process is instrumental and demands the inclusion of stakeholders with implementation power only (Cornwall, 2008). Despite this, this stakeholder analysis step starts with the identification of every individual, group and organization that are affected by the phenomenon, or those who can affect it (Freeman, 1984). The rationale to initially identify every stakeholder present is to avoid accidently not considering and thereby omitting a relevant stakeholder.

The identification of relevant stakeholders hence starts with drawing a list of all parties present in the demarcated subarea. The set boundaries therefore determine this selection (Reed et al., 2009). Accordingly, the first step of stakeholder identification comprises of listing stakeholders by looking at the map of the demarcated area. In accordance with Reed et al. (2009), stakeholders identified are categorized based on the pre-existing stakeholder categorization of safety region Utrecht (Table 4). This specific categorization is used because the premise of this research is that the concerns of safety region Utrecht are leading. As stakeholders present in the area are not always directly visible, which is for example applicable to governmental bodies, stakeholder identification is complemented by the positional approach (Enserink et al., 2010). This approach complements to the list of stakeholders by identifying parties with a formal position in policy making structures. To perform the positional approach, policy pieces and existing procedures are consulted (Enserink et al., 2010).

The objective of stakeholder participation in this research is instrumental (Reed et al., 2009). This implies here that only stakeholders with implementation power are engaged. This prioritization of stakeholders is based on the extent to which safety region Utrecht depends on the implementation power of each stakeholder. Dependencies hence encompass relevant resources that stakeholders possess that are potentially necessary to take resilience-improvement measures. Potentially instrumental resources for climate resilience enhancement are therefore inventoried. In addition, whether or not those resources are replaceable is indicated (Enserink et al., 2010). The degree to which resources of stakeholders are important and replaceable determines their power to activate the implementation of resilience-enhancing measures or implementation power. The degree to which stakeholders possess important, irreplaceable resources is referred to as the criticality of stakeholders (Enserink et al., 2010). The results from the process of determining critical stakeholders are documented in Table 7. These results result from findings of the analyst knowledgeable with the area context. Stakeholders that turn out to be critical are perceived as relevant and hence prioritized to get engaged in the sequential steps.

Table 7 Overview-table to determine critical or relevant stakeholders, adapted from (Enserink et al., 2010)

Stakeholders	**Relevant resources**	**Replicability of resources**	**Dependency on resources**	**Criticality of stakeholder**
Stakeholder 1				
Stakeholder 2				
Stakeholder N				

3. *Determine the desirable area features: What are the desirable area features of the system?*

A crucial step of resilience assessment entails determining the desirable area features as resilience is recognized as the degree to which key attributes of a system continue to provide services in the face of disruptive events (Fox-Lent et al., 2015; Wardekker et al., 2016). In other words, whether or not a system is resilient depends on the degree to which desirable area features maintain functioning in the face of wildfires. In alignment with findings in literature and design requirements related to the advantages of stakeholder participation, area features of interest are always subjective and hence stakeholder-informed (Fox-Lent et al., 2015; Wardekker et al., 2016).

Consequently, in order to characterize the subarea a system description is developed together with the local stakeholders by means of a participatory workshop. The system description encompasses desirable area features and observed trends in the area. As adopted from Wardekker et al. (2010), desirable area features may constitute different types of components. These are, respectively, functions, facilities, infrastructure and physical conditions. Stakeholders can write down those desirable system components on a post-it and put them on the relevant location of a printed map of the area concerned. If a desirable area feature is present on multiple locations or on a wider area, the post-it is put at a random location.

In order to enable more anticipatory adaptation on the basis of the outcome of this resilience assessment approach, the trends of the area are determined as well in the workshop (Wardekker et al., 2010). Determining the trends in the area constitute the last resilience framing question and hence enables the operationalization of climate resilience in the context of the area under study (Helfgott, 2018; Walker & Salt, 2012). Stakeholders can write down visible and expected area developments on a post-it with a different colour in order to distinguish them from desirable area features. Moreover, positive and negative area developments can be written down on different colours of post-its. That is because positive developments are, in spite of being prospective, considered as desirable area features that hence need to be maintained to strengthen the area's resilience. Negative area developments, on the contrary, do not need to be maintained. Nevertheless, negative area developments are still written down by stakeholders as they provide insight in the area's risk evolvement, resulting in public awareness raising on potential hazards and thereby contributing to enhanced resilience (Krywkow, 2009). To approve the completeness of the devised desirable area features and positive and negative developments among stakeholders, they are discussed and approved plenary.

4. *Determine the vulnerability of the desirable area features: Which desirable area features are vulnerable to wildfires?*

To determine the need of devising solutions in order to strengthen the resilience of desirable area components and developments, their vulnerability to wildfires is determined. Future expressions of wildfires are associated with significant uncertainty, related to for example their location, magnitude and prevailing weather conditions. Consequently, plausible future expressions of wildfires are demonstrated by developing scenarios to determine the vulnerability of area features that should be maintained (Sharifi, 2019; Wardekker et al., 2010). To make sure the resilient system can cope with a certain degree of scenario uncertainty, two diverging scenarios are developed in this step.

In the participatory workshop, one scenario is presented first, after which stakeholders mark the desirable area features and developments that they consider to be vulnerable in this scenario with stickers. To approve the completeness of the features marked as vulnerable, they are plenary discussed among the facilitator and the stakeholders engaged in the workshop. Thereafter, this activity is repeated for the second scenario, resulting in an overview of vulnerable, desirable area features with the uncertainty regarding the exact consequences of wildfires taken into account.

This activity might result in many desirable and vulnerable area features, decreasing the reasonability of actually strengthen their climate resilience (Fox-Lent et al., 2015). To address this issue, these

desirable area features vulnerable to the wildfire scenarios are prioritized. Prioritization occurs based on the perceptions of local stakeholders regarding which selection of area features can be improved to achieve maximum resilience enhancement. As a guideline, the maximum number of prioritized area features to keep a reasonable scope in the subsequent step is set as five (Fox-Lent et al., 2015). The prioritization is discussed plenary to ensure the inclusion of the perceptions of all stakeholders.

5. *Determine directions to improve the resilience of vulnerable, desirable area features: What are possible solutions to improve the resilience of vulnerable, desirable area features?*

To devise potentially usable solutions to address the prioritized vulnerable area attributes, specific mechanisms that enable the improvement of resilience are used. Those so-called resilience principles are redundancy, omnivory, buffering, flatness, homeostasis and high flux (Wardekker, 2018). The resilience principles are translated in easily understandable language and presented to the local stakeholders in the workshop as stated in Appendix B.1. Principles make explicit to the participations how climate resilience can be improved and are used to devise a set of possible measures to strengthen the resilience of the subarea under examination (Wardekker, 2018).

Stakeholders are asked to imagine as many resilience-improving measures per principle of the prioritized area features as possible and to write them down on the provided ruled paper. To make sure that stakeholders can apply the presented resilience principles, the sheet with the simplified explanation of resilience principles as presented in Appendix B.1 is provided to each of them. Practical examples are deliberately not given to prevent guidance, thereby securing the reflection of stakeholder perceptions in the devised solutions. To create more consensus and a more shared perception of appropriate hazard risk-reduction measures, they are plenary discussed with the stakeholders. Next to this, this interaction may result in other measures to strengthen the areas resilience that can also be incorporated in the eventual overview of possible measures.

4.3 Application to the pilot area

In order to validate the design, it is verified that the prototype design complies with the design requirements and it is evaluated that the stakeholders perceive the approach as sufficiently usable. Validation is conducted by testing the prototype by applying it to the Henschotermeer pilot area. This section describes the observations made and insights gained while testing the approach in practice. The complete report of the application workshop is provided in Appendix A.

1. *Formulate the problem at stake: What is the problem at stake?*

The Henschotermeer area is labelled as one of the subareas of the Utrechtse Heuvelrug whose climate resilience is particularly affected because of its area specifics (safety region Utrecht, personal communication, 2021). As the first step of the approach, the area's boundaries were drawn on the basis of input from employees of safety region Utrecht familiar with the local context. The Henschotermeer area was physically demarcated as depicted in Figure 3. The predefined rationale for the problem at stake, and hence the reason of the workshop was presented as an introduction to the participating stakeholders in accordance with the results of section 3.1.1.

2. *Identification of the relevant stakeholders: Who are the relevant stakeholders?*

The map of the demarcated Henschotermeer area (Figure 3) was used to pick all directly visible stakeholders that meet the broad definition of a stakeholder of Freeman (1984). Together with the results of the positional approach to identify additional invisible stakeholders, a long list of parties that meet the broad definition of a stakeholder was drawn (left column of Table 9 in Appendix A). Whereas most parties were identified by looking at the map of the area, conducting the positional approach led to additional stakeholders, respectively governmental and nature management organizations. Their presence in the area was derived from policy documents on the Henschotermeer area and input of the safety region on parties that might have a stake (safety region Utrecht, personal communication,

2022). All parties were then categorized according to the pre-existing categorization of safety region Utrecht as also presented in Appendix A.

To determine whether the parties meeting the broad definition of a stakeholder were considered relevant for engagement, their implementation power was determined based on the steps depicted in the upper columns of Table 9 in Appendix A. This started with inventorying relevant resources, which were, in according with discussions with the safety region, mainly considered to be plots of land, infrastructure, and authorities and knowledge to impose measures. It was per stakeholder possessing resources also indicated whether their resources are easily replaceable and whether the degree the safety region dependents on them is limited or high. This was defined based on the perception of employees of safety region Utrecht familiar with the problem context. Stakeholders that possess non-replaceable relevant resources upon which the safety region is likely to be dependent when taking resilience enhancement measures, those with implementation power, are normally invited to engage in the workshop. As the application of the prototype serves a verification and evaluation purpose only, merely one relevant stakeholder per category was involved in this workshop. The rationale for this is that there are mutual tensions between multiple relevant stakeholders, which was considered to be a limited factor for the validation session. Additionally, engaging all relevant stakeholders for this validation workshop is seen as unnecessary and the safety region is reluctant for including to many as this might reduce their willingness to participate in future participatory exercises.

The selected participations received an invitation for the workshop via email, complemented with a problem description on the wildfire hazard that gave rise to the session. A link to a website where invitees were supposed to indicate their availability on a set of dates was included as well. Furthermore, contact details were provided to the invitees for questions which led to a phone call between a stakeholder and facilitator on the question a stakeholder had. All participants were in principle willing to participate. However, one of them was not available on the final date of the workshop.

3. *Determine the desirable area features: What are the desirable area features of the system?*

Stakeholders were asked to think of desirable area features from their perspective, respectively functions, facilities, infrastructure and physical conditions. This resulted in the collection of desirable features as depicted on the yellow post-its in Figure 6. During the plenary discussion on the completeness of the initial collection of desirable area features, stakeholders came up with several additional desirable area features which were written down and put on the map as well. The groups of desirable area features stakeholders came up with can roughly be divided in the forest system, recreation, health care and accessibility of the area. It was noted that some of the desirable area features the participants came up with were not covered by the definitions of functions, facilities, infrastructure or physical conditions. As these did not fit the scope of the assessment, they were left out by the facilitator and should be noticed and omitted as well by the facilitator of subsequent applications of the approach.

Second, current and expected trends of the area were asked to the participants. Stakeholders wrote down the negative developments on pink post-its, whereas positive trends were written down on the green versions (Figure 6). While discussing the devised developments with stakeholders, no new positive or negative developments arose. It was noted that more negative than positive developments were mentioned by stakeholders. New insights among stakeholders, however, emerged as a stakeholder that regarded an area feature or development as positive explained his perspective to a stakeholder that viewed the development as negative. This multiparty interaction hence changed the understandings of individuals on the nature of an area feature or development. The new shared perspectives that emerged went beyond the existing perspectives of individuals and thus created a common understanding among stakeholders, referred to as social learning (Reed et al., 2010). According to Johannessen & Wamsler (2017), social learning builds a perception among stakeholders

about disaster risks that potentially have an impact on the area. Additionally, the occurrence of social learning is especially advantageous in order to eventually collaboratively improve resilience, as the created common understanding for instance enhances trust among stakeholders (Johannessen & Wamsler, 2017; Pahl-Wostl et al., 2007). Although social learning often occurs naturally when stakeholders with different perceptions interact, more complex cases require professional facilitation of stakeholder interactions which was, albeit to a certain extent, provided in this workshop (Mostert et al., 2007).

4. *Determine the vulnerability of the desirable area features: Which desirable area features area vulnerable to wildfires?*

Stakeholders were asked to determine which desirable area features are vulnerable to wildfires in order to determine which of them should be improved to strengthen the area's resilience. The first wildfire scenario (Figure 5) was presented, after which stakeholders marked the vulnerable area attributes with stickers. Then, the second (Figure 4) was presented and it was asked to the participants to mark additional features that would be vulnerable to wildfires if this scenario occurred. A more extreme scenario than the first should be presented in order to enable the identification of additional vulnerable area features. An overview of desirable, vulnerable area features emerged (Figure 6). As presented in this figure in Appendix A, stakeholders marked a lot of area attributes as vulnerable. The plenary discussion of the desirable area features marked as vulnerable did not lead to the identification of additional vulnerabilities.

As the stakeholders identified a lot of desirable, but vulnerable area features, it was decided to determine the most crucial ones. The criteria used to determine this had been left open and it was thus the task of the stakeholders to determine this, according to their perspectives. The prioritized key area attributes are fully derived from the perceived important by the stakeholders. Stakeholders prioritized the desirable area feature related to the forest system as maintaining this is perceived to be a precondition of all area features stakeholder desire. Next, stakeholder prioritized the function evacuation of the Henschotermeer area. The reason for this function should be maintained in the face of wildfires considering the high number of visitors in the summer. Finally, the building of the health care institution in the area is prioritized as a facility that should be maintained when a wildfire occurs. The reason for this is the vulnerable inhabitants of this institution are most likely not evacuated in time. As stakeholders did not write the prioritization down individually, the facilitator ensured that every stakeholder provided their input. The resulting prioritization was approved by all participations after the plenary discussion.

5. *Determine directions to improve the resilience of vulnerable, desirable area features: What are possible solutions to improve the resilience of vulnerable, desirable area features?*

Stakeholders devised potential solutions that could strengthen the resilience of the area using the resilience principles adopted from Wardekker (2018). Stakeholders were asked to find as many solutions using as many resilience principles as possible and write them down on lined paper. Sheets with a concise explanation and simplification of the theoretical principles were provided to the stakeholders as they were unfamiliar with them (Appendix B.1). Potential solutions stakeholders devised are depicted in Figure 8 of Appendix A. Every stakeholder came up with multiple solutions, albeit there was quite some overlap between the solutions they devised. In principle, this was not considered to be a bad thing as this might be a sign of a more common understanding of the problem, which is one of the intended outcomes of the workshop.

Plenary discussing the diverging potential solutions stakeholders came up with did result in the generation of additional possible solutions. Hence, on the basis of this application is was noted that plenary devising appropriate solutions per resilience principle would possibly have been better in order to create a more diverse list of solutions, using more resilience principles. Namely, the discussion of the ideas of that the stakeholders wrote down led quickly to the emergent of some additional

solutions, but it is assumed this could have been done better if more time were reserved for this activity. Moreover, during the course of applying the resilience principles to devise solutions it seemed that stakeholders found some principles difficult to apply and hence needed more guidance. That is, solutions stakeholders came up with were already discussed before each stakeholder successfully applied each of the six principles in their suggested potential measures.

4.4 Verification and evaluation

In this section, the verification regarding compliance of the approach with the design requirements and evaluation concerning the usability from the perspective of stakeholders is treated. As a result of new insights during the problem investigation phase, the flexible design requirements were adjusted multiple times during the course of this research. Next, the application of the design approach to the Henschotermeer pilot area led to minor alterations in the design requirements as well. Eventually, it is verified that the final design requirements comply with the design approach as indicated in Table 8.

Table 8 Verification of the design approach and design requirements

	#	Design requirement	Rationale
Outcome	1	The participatory approach should contribute to climate resilience improvement of the Utrechtse Heuvelrug area	The participatory approach constitutes a resilience assessment, which is regarded as an initial crucial activity to improve climate resilience (e.g. Tong, 2021).
	2	Conducting the participatory resilience assessment should result in an overview of an area's current state regarding climate resilience	During evaluation, stakeholders agreed that the outcome of the session shows a sufficient image regarding the degree of climate resilience of the pilot area.
Process	3	The wildfire hazard should be clearly introduced to engage stakeholders	The invitation was accompanied by a concise explanation of the wildfire hazard. Based on the invitation, all stakeholders invited were in principle willing to participate.
	4	The design approach should allow for the inclusion of the perceptions of all relevant professional stakeholders	All parties in a demarcated subarea are considered to identify all relevant stakeholders. To add, the activities of the approach to assess whether a subarea is resilient are based entirely on the subjective input of these stakeholders.
Implementation criteria	5	Safety region Utrecht and other stakeholders should be able to jointly conduct the participatory assessment in half a day	From the prototype, the two hours initially scheduled to conduct the approach appeared to be too short. In consultation with safety region Utrecht, conducting it in half a day is considered to be feasible. This is noted by the facilitator in the session on the application of the prototype and therefore adjusted in the final guideline to conduct the approach (Appendix G).
	6	Employees of the safety region with a limited experience on stakeholder analysis and resilience assessment should be able to conduct the designed approach	From the evaluation it turned out that the activities of the approach were straightforward to the stakeholders. However, some noticed that the

			explanation of theoretical concepts deserves more time. This is noted by the facilitator in the session on the application of the prototype and therefore adjusted in the final guideline to conduct the approach (Appendix G).
Flexibility	7	Adapting the assessment approach to local circumstances should be possible	Determining desirable area features and their prioritization based on which measures to strengthen resilience are devised depends on the area specifics and stakeholder input. Therefore, they are not proposed or fixed but defined in collaboration with local stakeholders.
	8	Modification of the assessment approach should be possible based on changing circumstances or new insights	A resilience approach can deal with uncertainty associated with the future (Wardekker et al., 2010). Since desirable area features, their prioritization and related possible solutions are not fixed but emergent in the workshop, a new workshop could change the outcome of the previous one. This makes the design approach flexible.
Scope	9	The metrics to assess climate resilience should at least refer to desirable area features related to the physical area components	The climate resilience of the area is assessed based on (among others) physical desirable area features. Other area dimensions are added on the basis of stakeholder input on desirable area features.

Evaluation forms that were filled out by the participants of the workshop showed that the design approach is perceived as sufficiently usable from the perspective of stakeholders. the full record of this evaluation is provided in Appendix A.

Generally, stakeholders reported that the developed approach provided a complete overview of the current state of climate resilience, enabled the reflection of their organization's perspective on climate resilience, was straightforward, provided a complete image on the wildfire risk and can be an initial step to eventually take measures to improve climate resilience. However, some points of improvement were mentioned by the stakeholders. Points of improvement regarding usability suggested by the participants particularly constitute a more elaborate introduction, particularly on theoretical concepts, as well as the inclusion of all relevant stakeholders instead of a selection. To include this stakeholder feedback regarding usability in future applications, it is incorporated in the guideline to conduct the approach (Appendix B).

In addition to the evaluation form filled in by stakeholders, additional lessons that should be accounted for in future application are presented in the remaining of this section. Generally, the two hours scheduled for this workshop were too short, resulting in a bit of rush to finish the steps. This especially applies when all relevant stakeholders are engaged instead of the selection used in this application. To gain a useful outcome of the approach, engaging all relevant stakeholders is observed to be essential because most results of the workshop are based on stakeholders' perceptions. The outcome is thus per definition subjective and should hence be based on all relevant perceptions to get valid results that the safety region desires from stakeholder participation. Also, not all desirable area features met a

prescribed definition, respectively a function, facility, infrastructure or physical condition and should hence be discarded. Furthermore, interaction between stakeholders during the discussion of desirable area features, developments, vulnerability and possible solutions changed the understandings of individuals to a more common understanding. This brings about benefits associated with social learning (Mostert et al., 2007). Ensuring sufficient time to plenary discuss the outcomes per step of the approach is hence important. Next, during prioritizing the desirable and vulnerable area features stakeholders do not write down their perspective individually. Because of the subjectivity involved with prioritizing it is however necessary to fairly balance all stakeholder interests (Prell et al., 2009). This requires a complete ask around and approval of all stakeholders by the facilitator. Lastly, stakeholders were not able to use every resilience principle when drawing potential solutions while new solutions arose during the plenary discussing the solutions. This combination of observations manifests a benefit and preference to devise potential resilience enhancement measures collaboratively while considering one principle at the time instead of individually writing down as many as possible.

Because of the verification that the design complies with the design requirements in combination with the stakeholder evaluation that the design is usable, the design approach is validated.

5 Discussion

5.1 Reflection on the results

In this section, it is highlighted what the most important findings of this research add to literature. The key findings constitute the need to integrate resilience assessment and stakeholders, the necessity to define resilience contextually and the development of the tailor-made approach. The first hence constitutes the need to integrate an approach for resilience assessment and stakeholder analysis. The activities embedded in the design of this approach ensure that either involving or omitting a potential stakeholder in the participatory process is well-balanced. This contrasts to existing literature on participatory resilience assessments, where stakeholders are often selected and subsequently engaged inconsiderate (Reed et al., 2009; Sharifi, 2019). The developed method for stakeholder selection contributes to, among others, the acceptance and ownership regarding the outcome of the resilience assessment, as well as benefits associated with learning among all relevant stakeholders. Moreover, the designed approach prescribes an easy accessible method to effectively select stakeholders for practitioners, thereby enabling the application by those without foreknowledge or previous experience about stakeholder selection (Reed et al., 2009).

Secondly, in accordance with the finding of Wardekker (2018) that resilience is a vague concept if not defined in a certain context, it is found that the concept should be defined in the research context. Accordingly, defining climate resilience in the context of the Utrechtse Heuvelrug enables designing and conducting the assessment approach and hence the possibility to find solutions that tackle the right challenge (Walker & Salt, 2012). Furthermore, making the concept specifically applicable to the problem context aligned the understandings of stakeholders on the meaning of the problem which is essential to start the participatory process (Wardekker, 2018).

The development of assessment approaches prior to taking efforts to strengthen resilience is considered important in literature (Cutter, 2016). The contribution of the designed approach as an intermediate step to intervene in order to strengthen climate resilience constitute the third contribution to existing literature. A resilience assessment approach applicable to vulnerable areas is namely an essential intermediate step before actual measures can be taken (Sharifi, 2016; Tong, 2021). To add, conducting the designed approach already results in possible solutions to strengthen resilience that can function as a stepping-stone to actually planning and taking measures. Despite the context-specificity of the approach developed, its flexibility ensures the customization of resilience metrics in other subareas than the pilot area, thereby contributing to tackling the affected resilience at all affected subareas of the Utrechtse Heuvelrug region.

5.2 Recommendations for application

The design approach is used to assess the climate resilience of an area with stakeholders as an initial step towards taking measures to collaboratively strengthen resilience. It is recommended to apply the design approach in accordance with the guideline of the approach provided in Appendix B.

The design constitute a participatory resilience assessment approach that is customizable to other subareas than the pilot area, particularly since the metrics for assessment are derived from local stakeholder input and hence not fixed. Moreover, stakeholder analysis methodologies are integrated in the resilience assessment approach, enabling the selection and involvement of relevant stakeholders in any subarea. Consequently, the approach can in principle also be used by safety regions other than safety Region Utrecht as long as it is applied to a problem context similar to that of the Utrechtse Heuvelrug region. To conduct the approach, practitioners conducting the approach in subareas other than the Henschotermeer area may refer to the application of the design approach to this pilot area as an illustrative case. Specific matters manifested themselves during the application of

the prototype design to the pilot area. These matters comprise recommendations for application and should be accounted for in future applications.

Firstly, assessment occurs on the basis of stakeholder perspectives and is hence highly subjective. Therefore, every identified relevant stakeholder should be invited in the subsequent application of this approach in order to obtain a valid and supported outcome. Next, the time scheduled for the workshop should be extended to allow more time for an introduction, explanation of theory and plenary discussions. In consultation with safety region Utrecht, a half-day is considered to be sufficient time to give the workshop. To add to the introduction, a brief field visit prior to the workshop is recommended. To allow for a fair balancing of stakeholder interests, an objective facilitator should be appointed by the safety region to guide the workshop. Also, it is advisable to consider for all desirable area features suggested by participants whether they fit the definition of a function, facility, infrastructure or physical condition of the area under consideration. As other attributes of an area are not meant to be considered in the remaining of the workshop, the facilitator should timely notice and discard these. During the plenary prioritization of vulnerable desirable area features, it is recommended that the facilitator structures the discussion to make sure that the input of all stakeholders is equally taken into account. Finally, it is recommended to devise potential measures to strengthen the climate resilience of prioritized area attributes plenary by considering one resilience principle at the time. As argued before, in contrast to letting stakeholders write down measures individually this is likely to ensure potential solutions related to each of the six principles.

5.3 Reflections on the method

The adopted research method based on the design cycle method is intended to be used to develop a solution that contributes to solving the already identified problem in practice (Verschuren & Doorewaard, 2010; Wieringa, 2014). As argued, the methodology adopted hence fits the goal of the research as it contributes to the vulnerability reduction of the Utrechtse Heuvelrug region. Eventually, this research resulted in a validated design approach in the sense that it complies with the design requirements and is evaluated as usable to those that are intended to use it.

Though, the limited testing of the external validity of the design is a limitation of this research. Data to design the approach is especially based on the Henschotermeer pilot area. Although assumed to be true, it is not tested whether the application of the design to other subareas of the Utrechtse Heuvelrug area actually leads to fruitful results. Furthermore, because of the one-time application of the design, it is not determined whether the involvement of other stakeholders would result in an useful application as well. In addition, there was only a limited amount of information available for this research topic as no approach to engage stakeholders or assess climate resilience existed in safety region Utrecht. Hence, the entire approach is designed from scratch in the limited amount of time available for this research. Another limitation of this research is the limited scope of discussion. The limited experience of the researcher with the topics addressed likely limits the depth of results and discussions in comparison to an experienced scholar.

6 Conclusion and recommendations

6.1 Conclusion

This research aimed to design a participatory approach that safety region Utrecht can use to assess the climate resilience of the "Utrechtse Heuvelrug" region. This objective has been achieved by means of five subgoals. The problem context is defined as the vulnerability of multiple subareas of the Utrechtse Heuvelrug to wildfires resulting in the need to collaboratively strengthen the climate resilience with stakeholders. It is found that existing literature on resilience assessment provides a set of potential usable methodologies for the tailor-made design. Yet, existing resilience assessment approaches often lack a conscious approach to engage stakeholders. Because of the identified relevance of appropriate stakeholder selection in participatory resilience assessment, the necessity to integrate stakeholder analysis and climate resilience assessment approaches arises. Literature on stakeholder participation provides potentially relevant methodologies to that could contribute to the integrated tailor-made design.

The design brief is compiled on the basis of the start assumptions and the problem investigation. Five types of design requirements are formulated, respectively related to the outcome, process, implementation criteria, flexibility and scope of the design approach. These guide the iterative design of the prototype design approach. On the basis of the application to the Henschotermeer pilot area, it is verified that the design approach complies with the final design requirements. Also, it is found that the design approach is sufficiently usable from the perspective of the participating stakeholders. To enhance the usability of the approach, recommendations for future use of the design are made and integrated in guideline to apply the approach on the basis of the evaluation.

The research aim is achieved as a validated participatory climate resilience assessment approach is presented. Points of improvement that are identified from the evaluation are integrated in the guideline for safety region Utrecht to apply the approach again in the vulnerable subareas of the Utrechtse Heuvelrug region (Appendix B).

6.2 Recommendations for future research

To obtain additional external validity of the designed approach, it is recommended to apply it to other subareas and address potential deficiencies arising from those future applications. In line with the eventual objective that gave rise to this research, it is also recommended to extend this participatory approach to take actual measures for strengthening climate resilience in a subsequent research project. Extending the approach would directly draw on the possible solutions stakeholders come up with during the last activity of the current participatory approach. As a specific result when implementing actual measures while having already engaged stakeholders in the assessment phase, an increased public support and a reduced level of conflict may be expected (Coenen, 2009). Specifically concerning the application of the participatory resilience assessment approach to the Henschotermeer pilot area, it is advisable to conduct it again while including all stakeholders that were identified as relevant. Drawing on the results of the application of the approach to the Henschotermeer pilot area is strongly discouraged because low levels of acceptance regarding the outcome and a lack of common understanding on the problem among stakeholders that were not engaged is expected (Sharifi, 2019).

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Appendices

Appendix A – Application to pilot area

Deze bijlage bestaat uit het observatieverslag van de workshop om de ontworpen aanpak voor het participatief toetsen van de veerkracht van gebieden op de Utrechtse Heuvelrug te valideren. Hiervoor zijn de stappen van de aanpak doorlopen samen met een selectie van relevante stakeholders uit het Henschotermeer gebied. Zoals beargumenteerd in dit rapport is het Henschotermeer gekozen om als pilot gebied te dienen aangezien het representatief is voor kwetsbare gebieden in de Utrechtse Heuvelrug wat betreft het natuurbrandrisico. De sessie vond plaats op vrijdag 24 juni van 13:00 tot 15:00 uur in een vergaderzaal van de brandweerkazerne te Woudenberg.

Het probleem wat aanleiding heeft gegeven tot het houden van deze workshop is vooraf geformuleerd om gepresenteerd te worden aan de stakeholders. In overstemming met het Regionaal Risicoprofiel (Veiligheidsregio Utrecht, 2019), uitgangspunt van dit onderzoek, betreft de probleemcontext de toenemende mate van kwetsbaarheid voor natuurbrand van de Utrechtse Heuvelrug. In overeenstemming met de ontwerpeisen tracht deze participatieve ontwerpaanpak daarom bij te dragen aan de veerkracht verbetering van de Utrechtse Heuvelrug. Voor deze pilotsessie zijn stakeholders geselecteerd met het potentiële vermogen om fysieke maatregelen ter verbetering van de veerkracht van het gebied te implementeren, de zogenaamde professionele stakeholders. Aangezien het formuleren van de probleemcontext en de identificatie van relevante stakeholders stappen voorafgaand aan de participatieve workshop betreffen, zijn deze niet behandeld in de workshop. De stakeholderanalyse die heeft geresulteerd in de relevante stakeholders van deze workshop is afgebeeld in Table 9.

Table 9 Stakeholder analyse en resulterende relevante stakeholders (Enserink et al., 2010)

#	Stakeholder	Relevante bronnen	Vervangbaar (Ja/Nee)	Afhankelijkheid (Hoog/Laag)	Relevant (Ja/Nee)
1	Staatsbosbeheer	- Land - Kennis	Nee	Hoog	**Ja**
2	Landgoed Den Treek-Henschoten	Land	Nee	Laag (land wordt uitgebaat door stakeholder #3)	Nee
3	Vakantiepark De Heigraaf	Land	Nee	Hoog	**Ja**
	EuroParcs Resort De Utrechtse Heuvelrug	Land	Nee	Hoog	**Ja**
4	Recreatiepark Noord West Kanje	Land	Nee	Hoog	**Ja**
5	Camping en Kampeerboerderij 't Boerenerf	Land	Nee	Hoog	**Ja**
6	Camping Eijckelenburg	Land	Nee	Hoog	**Ja**
7	Camping YMCA Henschotermeer	Land	Nee	Hoog	**Ja**
8	Ruitersportcentrum Henschoten	Geen	N.v.t.	N.v.t.	N.v.t
9	Recreatiecentrum Eben-Haëzer	Geen	N.v.t.	N.v.t.	N.v.t

10	Gotcha Outdoor Lasergames Woudenberg	Geen	N.v.t.	N.v.t	N.v.t
11	De Birkt vergaderen	Geen	N.v.t.	N.v.t	N.v.t.
12	Solexverhuur Woudenberg	Geen	N.v.t.	N.v.t	N.v.t
13	Bewoners	Geen	N.v.t.	N.v.t.	N.v.t.
14	Reinaerde De Heygraeff	Land	Nee	Hoog	**Ja**
15	Gemeente Utrechtse Heuvelrug	- Land - Infra - Autoriteiten (b.v. vergunningen bestemmingsplannen	Nee	Hoog	**Ja**
16	Gemeente Woudenberg	- Land - Infra - Autoriteiten (b.v. vergunningen, bestemmingsplannen	Nee	Hoog	**Ja**
17	Provincie Utrecht	- Infra - Autoriteiten (b.v. strategisch bosbeleid)	Nee	Beperkt (strategisch bosbeleid is meer een kader)	Nee
18	Veiligheidsregio Utrecht	Kennis	Nee	Hoog	**Ja**

Table 10 Stakeholder categorieën van relevante stakeholders

#	**Stakeholder categorieën**
	Natuurbeheerders
	Verblijfsrecreatie
	Dagrecreatie
	Wonen en werken
	Zorginstellingen
	Infrastructuurbeheerders
	Wetgevers
	Overige

Deze workshop voor het toetsen van de huidige mate van veerkracht van het Henschotermeer gebied betreft de validatiesessie voor de ontworpen aanpak voor veerkrachttoetsing van andere kwetsbare gebieden op de Utrechtse Heuvelrug. Door verschillende ontwikkelingen zijn de relaties tussen meerdere professionele stakeholders rondom het Henschotermeer verstoort. Hierdoor is er besloten

om de geïdentificeerde stakeholders te groeperen en voor iedere groep belanghebbenden binnen het gebied één stakeholder uit te nodigen. Iedere deelnemende stakeholder representeert daarom een gebruikersfunctie of overheidsdienst in het gebied. De deelnemende functies/overheidsdiensten en aanwezige personen in het gebied zijn weergegeven in onderstaande tabel.

Table 11 Deelnemers van de workshop

Gebruikersfunctie/overheidsdienst	Aanwezige stakeholder
Recreatie	TBVA Vastgoedadvies (vertegenwoordigt camping YMCA en kan camping de Heigraaf vertegenwoordigen) Functie aanwezige: Vastgoedadviseur
Natuur	Staatsbosbeheer Functie aanwezige: Operationeel beheerder Utrecht Oost
Zorg	Reinaerde De Heygraeff Functie aanwezige – Fictief vertegenwoordiger
Gemeente	Gemeente Woudenberg Functie aanwezige: Adviseur crisisbeheersing en veiligheid
Veiligheidsregio	Veiligheidsregio Utrecht Functie aanwezige 1 - Coördinator risicofocusgebied Henschotermeer Functie aanwezige 2 – Medewerker operationele voorbereiding crisisbeheersing

De sessie begon met een welkomstwoord en een introductie van de probleemcontext die aanleiding heeft gegeven tot het organiseren van deze workshop door de procesbegeleider. Vermeld is dat het geformuleerde probleem zijn oorsprong heeft in het Regionaal Risicoprofiel, waarin Veiligheidsregio Utrecht de Utrechtse Heuvelrug aanmerkt als risicofocusgebied door het aanwezige natuurbrandrisico. Klimaatverandering, recreatiedruk en intensief landgebruik op gebieden binnen de Heuvelrug zijn besproken als ontwikkelingen die het natuurbrandrisico vergroten. Daarop is het begrip veerkracht door de procesbegeleider aan de deelnemers gepresenteerd als een door de veiligheidsregio wenselijke oplossingsrichting om de kwetsbaarheid van de Utrechtse Heuvelrug te verlagen. Veerkracht is gepresenteerd als de capaciteit van de beschouwde eigenschappen van een gebied om natuurbrand beter te kunnen weerstaan. In navolging hierop is de inhoud en het nu van deze workshop, een participatieve veerkrachttoetsing, geïntroduceerd.

Vervolgens is door de procesbegeleider aan iedere deelnemer gevraagd zichzelf te introduceren. Dit heeft geresulteerd in Table 11 met een overzicht van de deelnemers en hun functies. Een bijzonderheid om hier te vermelden is dat een medewerker van veiligheidsregio Utrecht de rol van vertegenwoordiger van zorginstelling Reinaerde inneemt. Deze rol is door hem ingenomen aangezien de daadwerkelijk aangewezen persoon binnen Reinaerde niet beschikbaar was tijdens de sessie.

Na de introductieronde is door de procesbegeleider het doel van deze sessie geïntroduceerd als het inzichtelijk krijgen van de huidige stand omtrent veerkracht in het Henschotermeer gebied en oplossingsrichtingen vinden voor het verbeteren van de veerkracht. Aan de deelnemers is gepresenteerd dat er om dit doel te bereiken vier subdoelen of agendapunten doorlopen moeten worden. Het eerste gepresenteerde subdoel betreft het karakteriseren van het Henschotermeer gebied om de belangrijke gebiedseigenschappen te bepalen. Belangrijke gebiedseigenschappen vanuit de perceptie van deelnemende stakeholders dienen bepaald te worden omdat de veerkracht van deze

eigenschappen bepaalt of het gebied wel of niet veerkrachtig is. Het tweede gepresenteerde subdoel betreft het bepalen van de kwetsbaarheid van belangrijke gebiedsfuncties aan de hand van twee scenario's. Het derde betreft het prioriteren van deze kwetsbare, belangrijke gebiedseigenschappen met als doel te bepalen welke gebiedseigenschappen het meest cruciaal zijn om de veerkracht van het gebied te verbeteren. Het laatste subdoel dat is voorgelegd aan de stakeholders betreft het zoeken naar oplossingsrichtingen om de veerkracht van de meest cruciale gebiedseigenschappen te vergroten.

Participatieve ronde 1: Het gebied karakteriseren
De eerste participatieve ronde betrof dus het karakteriseren van het Henschotermeer gebied. Aan de stakeholders van het Henschotermeer gebied werd gevraagd welke gebiedseigenschappen vanuit het perspectief belangrijk zijn, of welke erg gewaardeerd worden. Door de procesbegeleider is toegelicht dat gebiedseigenschappen zowel functies, faciliteiten, infrastructuur en fysieke condities van het gebied kunnen betreffen. Aan de stakeholders is gevraagd deze belangrijke functies, faciliteiten, infrastructuur en fysieke condities op gele post-its te schrijven. Vervolgens is het aan de stakeholders gevraagd om deze papiertjes met belangrijke gebiedseigenschappen op de A0-poster van het Henschotermeer gebied te plakken. Wanneer een belangrijke gebiedseigenschap op een bepaalde plaats in het gebied is geaccommodeerd plakten de stakeholders de gele post-it daar, anders werd gevraagd of ze het aan de rand van de poster konden plakken. Aan de stakeholders is gevraagd hun initialen aan de beschrijving van de belangrijke gebiedseigenschap toe te voegen zodat naar hen gerefereerd kon worden in het geval van onduidelijkheden.

Door de zes deelnemende stakeholders zijn in totaal 26 gebiedseigenschappen aangedragen die naar het perspectief van hun organisatie belangrijk zijn. De meeste gebiedseigenschappen zijn aan het begin van deze ronde opgeschreven, enkele zijn tijdens het plenair bespreken van de eigenschappen ontstaan en toegevoegd aan het overzicht. Daarbij is opgemerkt dat meerdere functies overlappen. Daarnaast vielen enkele aangedragen gebiedseigenschappen niet binnen de definitie van functies, faciliteiten, infrastructuur en fysieke condities. Vanuit de veiligheidsregio werden namelijk twee gewaardeerde sociale aspecten aangedragen, respectievelijk de bereidwilligheid van civiele partijen en ambtelijke bestuurlijke afstemming. Bij navraag aan de betreffende stakeholder is de waardering van deze sociale aspecten verduidelijkt, maar bleef het moeilijk om ze als fysieke eigenschap te definiëren. Deze twee aspecten zijn daarom buiten beschouwing gelaten. De 24 overig aangedragen belangrijke gebiedseigenschappen zijn met instemming van de deelnemende stakeholders geclassificeerd in vier groepen. De eerste groep gebiedseigenschappen is gerelateerd aan het natuur/bossysteem. Voorbeelden van aangedragen gebiedseigenschappen binnen deze groep betreffen een functionerend bossysteem, de luchtkwaliteit, groen en schaduw en de randwerking van het gebied met aanliggende natuurgebieden. De tweede groep heeft betrekking tot recreatieve gebiedseigenschappen zoals evenementen, sport en recreatie en toerisme als algemene functies. De derde groep van gewaardeerde gebiedseigenschappen betreft de bereikbaarheid van het gebied voor gasten, leveranciers en hulpdiensten en drukteregulering om piekbelasting te voorkomen. Als laatst is er een onderscheid gemaakt in een groep met overige functies, vooral bestaand uit de functie en de opvang van Oekraïense vluchtelingen. De genoemde gebiedseigenschappen die zoveel mogelijk service moeten blijven verlenen in het geval van natuurbrand om het gebied als veerkrachtig aan te merken zijn met de stakeholders besproken en zij gaven aan tevreden te zijn met het overzicht.

Als tweede stap wat betreft het karakteriseren van het gebied rondom het Henschotermeer is aan de stakeholders gevraagd welke ontwikkelingen zij of de organisatie die zij representeren momenteel zien gebeuren of in de toekomst verwachten. De procesbegeleider heeft aan de stakeholders gevraagd de om positieve gebiedsontwikkelingen die naar hun perspectief kwaliteit toevoegen aan het gebied op te schrijven op de groene post-its. Betreffende de ontwikkelingen die stakeholders als negatief en problematisch beschouwen is aan hen gevraagd deze op de roze post-its te noteren. De procesbegeleider heeft uitgelegd dat deze positieve, kwaliteit-verbeterende ontwikkelingen

toevoegen aan gebiedseigenschappen die, hoewel ze toekomstig zijn, zoveel mogelijk behouden moeten blijven.

Direct viel op dat de stakeholders meer negatieve dan positieve ontwikkelingen opmerkten; er werden 15 problematische tegen acht positieve ontwikkelingen genoteerd. Daarbij was het opvallend dat dezelfde ontwikkeling door de ene stakeholder als positief werd beschouwd terwijl het volgens de perceptie van een ander negatief was. Een voorbeeld hiervan is het verbeteren van de natuurwaarden door middel van ecologisch beheer dat door TBVA en Staatsbosbeheer werd gewaardeerd, terwijl de veiligheidsregio het als een risico verhogende factor voor natuurbrand zag. Het probleem van de veiligheidsregio met ecologisch beheer betrof met name het laten liggen van omgevallen boomstammen omdat het zou zorgen voor meer brandbaar materiaal op de bosbodem. De vertegenwoordiger van Staatsbosbeheer reageerde hierop dat het laten liggen van omgevallen bomen juist kan bijdragen aan een reductie van het natuurbrandrisico omdat dit hout nog veel vocht bevat. Het beschrijven en vervolgens discussiëren over gebiedsontwikkelingen heeft naast het creëren van een compleet gezamenlijk overzicht geleid naar 'social learning' waarin individuele inzichten door middel van sociale interactie veranderen tot gemeenschappelijke inzichten. Er wordt onderling dus kennis verworven.

Genoemde negatieve ontwikkelingen omvatten politieke spanningen met betrekking tot het Henschotermeer gebied, onderlinge spanningen tussen recreatieondernemers, aantasting van de natuur door diverse oorzaken (bv. droogte, stikstof, vercommercialisering) en toenemende drukte in het gebied en op omliggende wegen. Positieve ontwikkelingen aangedragen door de stakeholders omvatten het verbeteren van natuurwaarden, aanpassingen ten behoeve van ontruiming, vervang van bestaande voorzieningen, meer mogelijkheden voor recreatie, drukteregulering, aandacht voor klimaatadaptatie en meer samenwerking tussen stakeholders.

Participatieve ronde 2: De kwetsbaarheid van de belangrijke gebiedseigenschappen bepalen
Zoals uitgelegd zijn het de functies, faciliteiten, infrastructuur, fysieke condities en positieve ontwikkelingen, opgeschreven op de gele en groene post-its, die zoveel mogelijk behouden moeten blijven om het Henschotermeer als veerkrachtig te bestempelen. Om te bepalen voor welke functies de veerkracht verhoogd dient te worden, werd in de tweede participatieve ronde de kwetsbaarheid van deze belangrijke gebiedseigenschappen bepaald. Om te kunnen bepalen of een bepaalde gebiedseigenschap kwetsbaar is voor natuurbrand heeft de procesbegeleider een scenario gepresenteerd. Het aanvankelijk gepresenteerde scenario is afgebeeld op Figure 5. Dit betreft een scenario waarin een bosbrand in het noordwesten van het gebied ontstaat die onder invloed van een matige noordwestenwind onder invloed van warme en droge weersomstandigheden uitbreidt richting het zuidoosten. Na het voorleggen van het eerste scenario is de stakeholders is gevraagd om met dit scenario in hun achterhoofd te bedenken welke van de door hen bedachte gebiedseigenschappen en positieve ontwikkelingen kwetsbaar zijn voor natuurbrand. Door middel van rode stickers werd stakeholders gevraagd dit te per kwetsbare gebiedseigenschap op de A0-poster aan te geven.

Gezamenlijk met de eerste participatieve ronde leverde deze stap het resultaat op als afgebeeld in Figure 6. Te zien is dat een aanzienlijk deel van de belangrijke gebiedseigenschappen door de stakeholders als kwetsbaar is aangemerkt. Als kwetsbaar aangemerkte gebiedseigenschappen zijn samen te vatten als het natuursysteem, de gebiedsontsluiting, luchtkwaliteit, toerisme en de vluchtelingenopvang.

Omdat bosbranden in allerlei vormen kunnen voorkomen is er voor de volledigheid een tweede scenario gepresenteerd. Dit betreft een heftiger scenario dan het eerder gepresenteerde scenario. Deze is afgebeeld in Figure 4. Naar aanleiding van dit scenario heeft de procesbegeleider aan de deelnemende stakeholders gevraagd of zij nog steeds achter hun keuze staan om belangrijke gebiedseigenschappen wel of niet als kwetsbaar te markeren. Op grond hiervan zijn door de

stakeholders aanvullende functies als kwetsbaar aangemerkt. Deze betreffen de verbinding en ontsluiting van de zorginstelling en het YMCA-campingterrein, als mede een verminderde toegang tot Woudenberg voor bijvoorbeeld hulpdiensten, omdat de bosbrand over de N224 slaat.

Figure 5 Bosbrand scenario 1

Figure 4 Bosbrand scenario 2

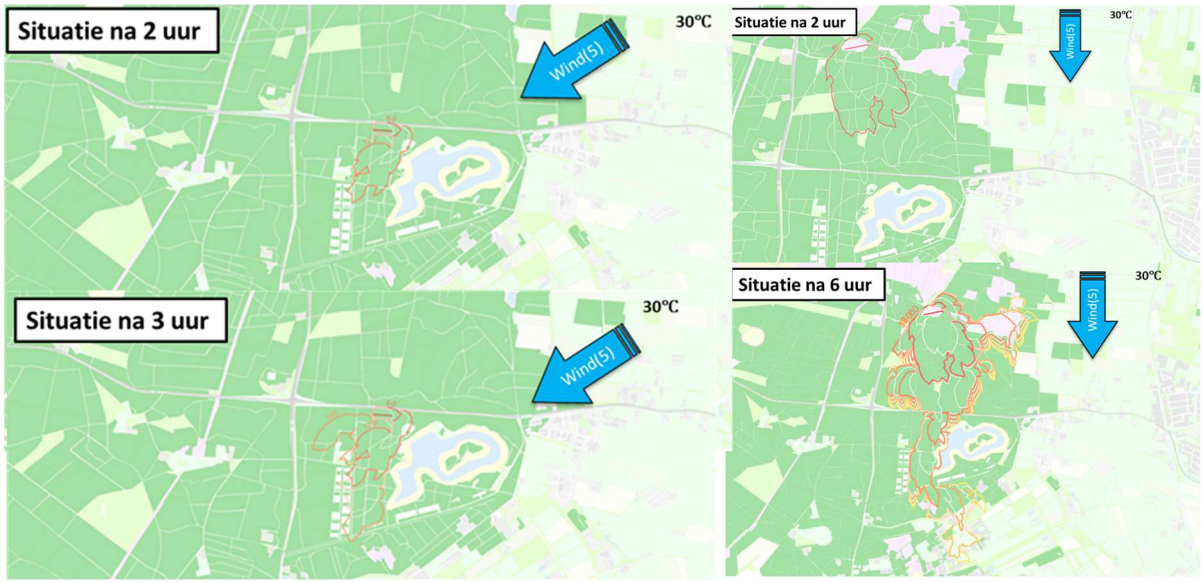
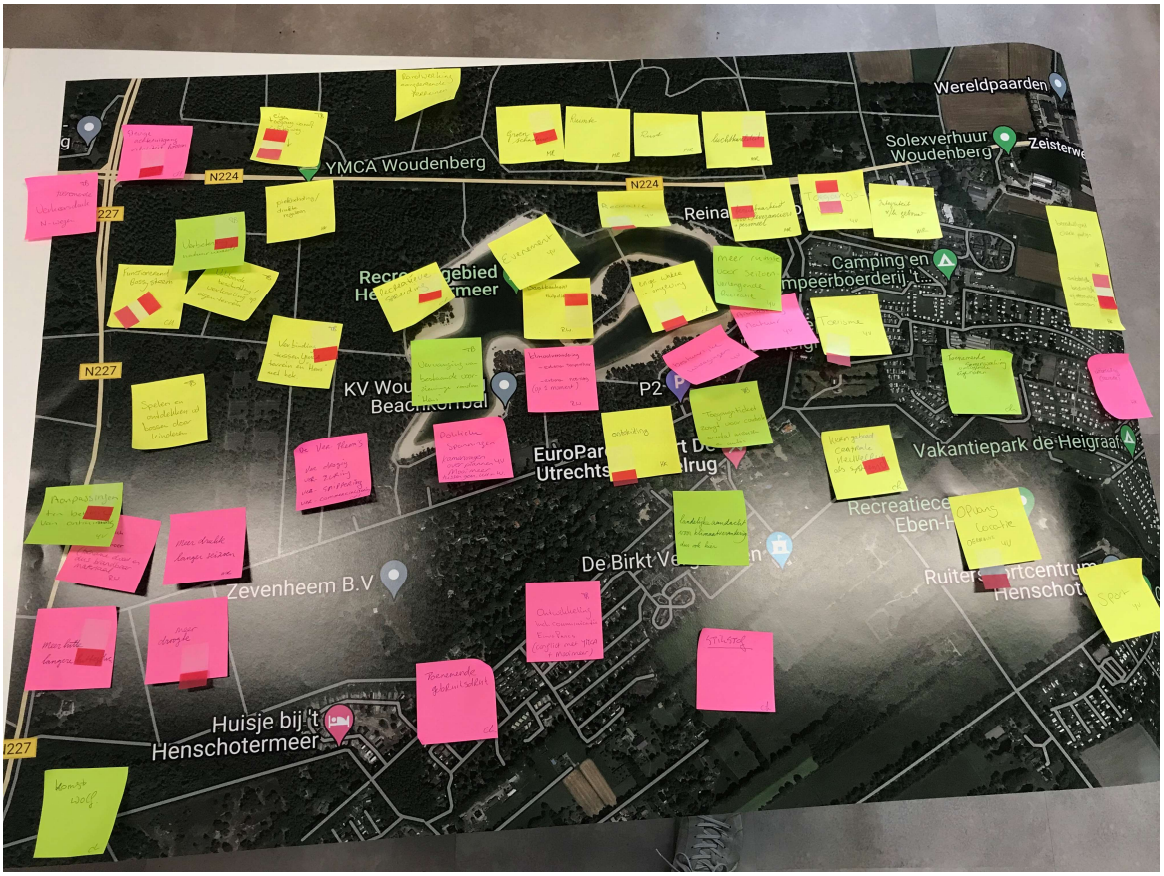


Figure 6 Important area features and developments as resulting from the participatory session

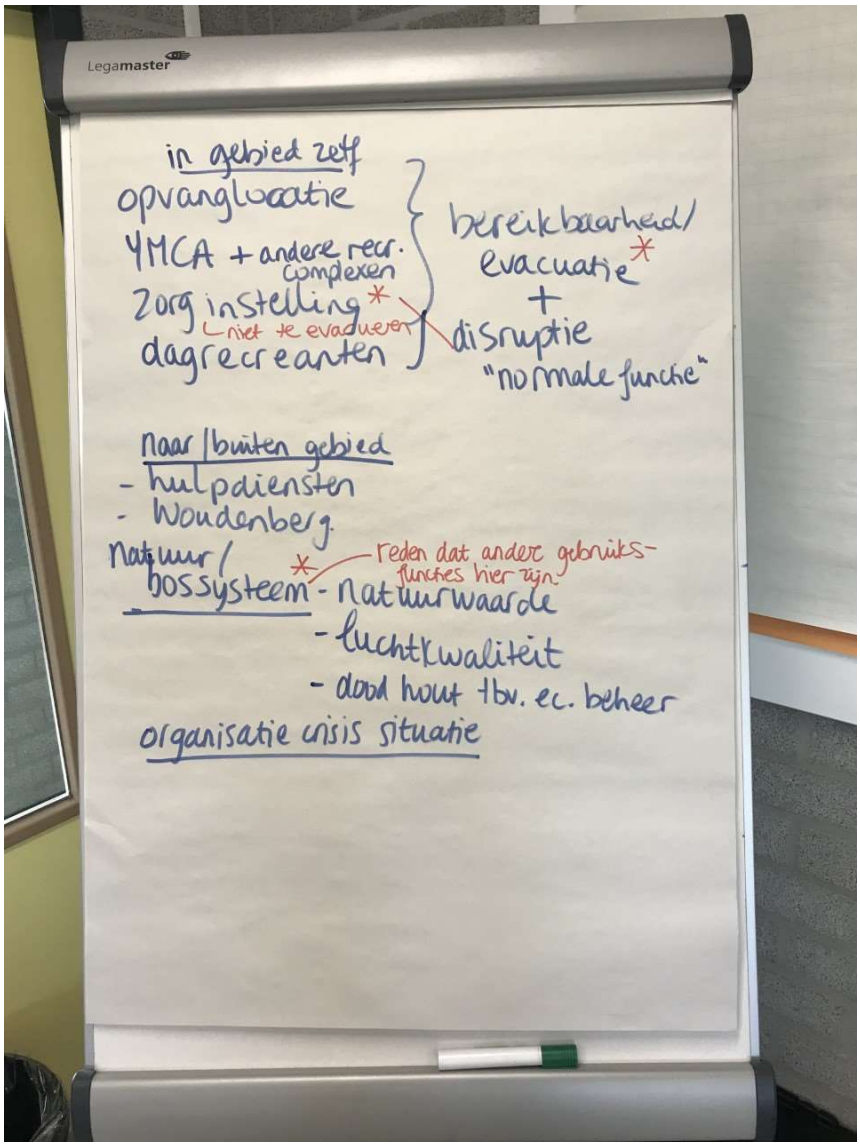


Na deze activiteit is 10 minuten pauze gehouden zodat de procesbegeleider de kwetsbare gebiedseigenschappen kon samenvatten en op kon schrijven ten behoeve van de volgende ronde. Na

de pauze is de manier van samenvatten van de kwetsbare functies met de stakeholders besproken en hebben zij er mee ingestemd.

Participatieve ronde 3: Prioriteren van cruciale gebiedseigenschappen
Aangezien het niet haalbaar zal zijn ter verbetering van de veerkracht voor iedere kwetsbare gebiedseigenschap maatregelen te treffen worden ze geprioriteerd. Hiervoor wordt bepaald welke functies het meest belangrijk om de veerkracht van het Henschotermeer gebied te vergroten. Voor de geprioriteerde functies zal uiteindelijk over oplossingsrichtingen voor het vergroten van de veerkracht nagedacht worden. Voor de kwetsbare functies is bepaald welke het meest cruciaal zijn door middel van een plenaire discussie met de stakeholders. De cruciale gebiedseigenschappen zijn aangeduid met een rode ster in Figure 7.

Figure 7 Crucial area features



Aanvankelijk leek er onder de stakeholders consensus te ontstaan dat het natuur-/bossysteem de meest cruciale gebiedseigenschap is om de veerkracht van te verhogen. De reden hiervoor die door verschillende stakeholders werd aangedragen is dat de natuur rondom het Henschotermeer de reden is dat alle andere functies in dit gebied gesitueerd zijn. Het bossysteem is dus cruciaal omdat het een voorwaarde is voor de accommodatie van verscheidene functies zoals recreatie. Daarnaast komt het

natuurbrandrisico ook voort uit de aanwezigheid van de bosrijke omgeving in het Henschotermeer gebied. Bij verdere navraag bij andere stakeholders kwamen echter nog een cruciale gebiedseigenschap naar voren. Dit betreft het de functie evacuatie van het Henschotermeer gebied zelf. De redenen die de stakeholders hiervoor hebben aangedragen liggen voornamelijk in het gegeven dat er toereikende ontvluchtingswegen aanwezig moeten zijn om het grote aantal bezoekers tijdig te evacueren. Ten derde en als laatste werd consensus bereikt dat het gebouw van de zorginstelling, in tegenstelling tot die van andere functies, veerkrachtig moet zijn aangezien de niet-zelfredzame bewoners ervan in deze scenario's niet tijdig geëvacueerd kunnen worden. De drie geprioriteerde functies waarover onderling consensus is bereikt door de stakeholders vormen het uitgangspunt om potentiële oplossingsrichtingen te vinden voor het verhogen van de veerkracht van het Henschotermeer gebied.

Participatieve ronde 4: Oplossingsrichtingen voor het verbeteren van de veerkracht
De laatste participatieve ronde bestaat uit het bedenken van potentiële maatregelen of oplossingsrichtingen om de veerkracht van de geprioriteerde gebiedseigenschappen, en daarmee van het Henschotermeer gebied, te verbeteren. Om richting te geven aan deze maatregelen worden de zes veerkrachtprincipes gepresenteerd als de stakeholders. De stakeholders krijgen deze principes ook op papier uitgereikt zodat ze deze na kunnen lezen tijdens het bedenken van oplossingsrichtingen. De veerkracht principes zijn door de procesbegeleider als volgt toegelicht:

1. Stabiliserende feedback: Stabiliserende terugkoppelingen die een natuurbrand afremmen zijn aanwezig.
2. Variatie: Kwetsbaarheid voor natuurbranden wordt verminderd doordat belangrijke gebiedseigenschappen op verschillende manier vervuld worden.
3. Omloopsnelheid: Middelen om natuurbranden tegen te gaan kunnen snel gemobiliseerd worden.
4. Platte organisatiestructuur: In geval van natuurbrand kan er snel lokaal en flexibel worden gereageerd omdat competenties hiervoor (bv. verantwoordelijkheden, middelen of kennis) op lokaal niveau aanwezig zijn.
5. Buffercapaciteit: Eigenschappen die ervoor zorgen dat natuurbranden kunnen worden opgevangen zijn over gedimensioneerd.
6. Overlap: Functies overlappen zodat wanneer één (bv. infrastructuur of een voorziening) faalt tijdens een natuurbrand een andere functie het kan overnemen.

Vervolgens is door de procesbegeleider aan de stakeholders gevraagd om voor elk van de drie geprioriteerde gebiedseigenschappen zoveel mogelijk oplossingsrichtingen met de veerkracht principes als uitgangspunt op te schrijven. Vervolgens is per stakeholder gevraagd welke oplossingsrichting hij heeft opgeschreven. Wanneer een bedachte maatregel onduidelijk was is door de procesbegeleider om toelichting gevraagd. Het viel op dat meerdere stakeholders overlappende oplossingsrichtingen aandroegen. Desondanks heeft elke stakeholder wel meerdere unieke oplossingsrichtingen opgeschreven en plenair besproken. Deze bedachte oplossingsrichtingen zijn per geprioriteerde gebiedseigenschap opgeschreven (zie Figure 8).

Voor de cruciale gebiedseigenschap het natuur-/bossysteem zijn de volgende oplossingsrichtingen aangedragen:

- Stabiliserende feedback:
    - De herplant van niet-brandbare vegetatie zodat er een gevarieerde houtopstand ontstaat
    - Het aanleggen van een blusvijver en/of een bluswaterriool

    - Het laten liggen van omgevallen bomen zodat zij door het vocht dat ze bevatten brandvertragend werken (ecologisch beheer)
- Omloopsnelheid
    - Het oefenen op de snelle inzet van de juiste brandweervoertuigen
    - Het ontwikkelen van een plaatsgebonden early-warning systeem zoals een lokale vorm van NL-alert
    - Het nog sneller alarmen van brandweer en Staatsbosbeheer in geval van natuurbrand
- Platte organisatiestructuur
    - Het vooraf informeren van gasten van de recreatieparken over wat te doen indien een natuurbrand zich voordoet
    - Het snel en flexibel opschalen in crisisstructuur en het direct alarmeren van de adviseur crisisbeheersing door te oefenen
    - Het onderling afstemmen van de planvorming in het gebied
    - Het mandateren van Staatsbosbeheer om op particuliere terreinen in te grijpen in het geval een bosbrand zich voordoet
- Buffercapaciteit
    - Het rooien van bomen om buffercapaciteit te creëren, bijvoorbeeld door vakken in het bos te maken
- Overlap
    - Het inzetten van reguliere blusvoertuigen als aanvulling op natuurbrandvoertuigen in het geval van natuurbrand

Voor de cruciale gebiedseigenschap de zorginstelling zijn de volgende oplossingsrichtingen aangedragen:

- Stabiliserende feedback:
    - Het koelen van de gevel van de zorginstelling koelen door bijvoorbeeld sprinklers in geval een natuurbrand zich voordoet
    - Het in beschouwing nemen van het natuurbrandrisico bij nieuwbouw of renovatie door bijvoorbeeld een schuilkelder te bouwen
    - Het herplanten van vegetatie op het terrein van de zorginstelling met meer brandbestendige struiken en bomen
- Omloopsnelheid:
    - Het sneller alarmeren en inzetten van BHV
- Buffercapaciteit:
    - Het inrichten van een buffercapaciteit in het gebouw van de zorginstelling waardoor cliënten binnen het gebouw in veiligheid kunnen worden gebracht
    - Het creëren van een vegetatievrije buffer tussen het bos en de zorginstelling

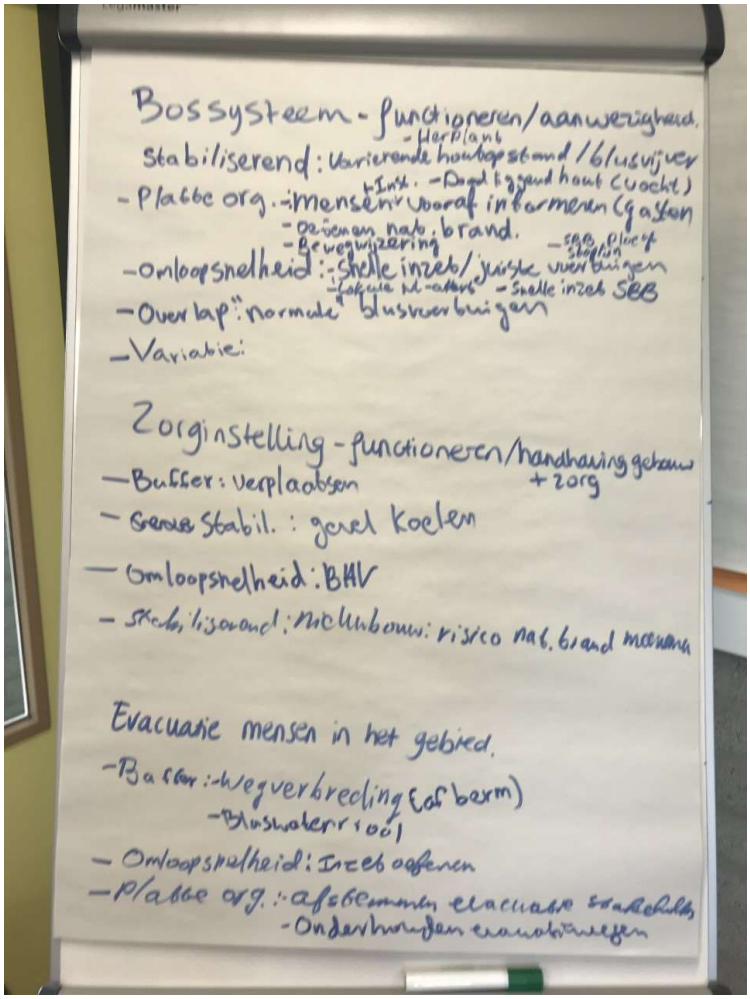
Voor de cruciale gebiedseigenschap bereikbaarheid en evacuatie zijn de volgende oplossingsrichtingen aangedragen:

- Stabiliserende feedback:
    - Het aanbrengen van bewegwijzering zodat mensen in geval van natuurbrand zelfstandig de weg uit het gebied kunnen vinden
- Omloopsnelheid:
    - Het realistisch oefenen van een evacuatie met stakeholders en brandweer
- Platte organisatiestructuur:
    - Het gezamenlijk onderhouden en optimaliseren van vlucht- en aanrijroutes
- Buffercapaciteit:
    - Het verbreden van wegen en/of bermen om bosbranden te onderbreken

- Door middel van een bluswaterriool een stoplijn creëren om de uitbreiding van een natuurbrand te onderbreken

Gedurende de bespreking van de oplossingsrichtingen die de stakeholders opgeschreven hebben viel op dat er nog meer ideeën ontstonden. Wellicht waren er meer ideeën ontstaan als de plenaire bespreking langer had voortgeduurd.

Figure 8 Examples of possible solutions to improve the resilience of crucial area features



Evaluatie

Na het participatief aandragen van belangrijke gebiedseigenschappen en ontwikkelingen, het bepalen van hun kwetsbaarheid, het prioriteren van de kwetsbare en belangrijke gebiedseigenschappen en het ontwikkelen van oplossingsrichtingen met behulp van de veerkrachtprincipes is het proces afgerond. Ten behoeve van de validatie van dit proces is als laatste activiteit de stakeholders gevraagd het evaluatieformulier in te vullen. Gegeven antwoorden op de vijf gestelde vragen zijn hieronder toegelicht.

1. *Bent u van mening dat het doorlopen van deze aanpak heeft geresulteerd in een toereikend beeld omtrent de huidige veerkracht van het Henschotermeer gebied met betrekking tot natuurbrand? Waarom wel of waarom niet?*

De meeste stakeholders gaven aan dat ze het wel met deze vraag eens zijn. Redenen voor hun tevredenheid omvatten dat het duidelijkheid schept omtrent onderlinge belangen en dat verschillende inzichten samen werden gevoegd. Eén stakeholders is het er gedeeltelijk mee eens en denkt dat

veldbezoek of bredere sessie mogelijk tot aanvullende invalshoeken heeft geleid. Een andere stakeholder gaf aan dat hij deze vraag moeilijk heeft kunnen beoordelen door gebrek aan kennis over de samenhang van de gebiedskenmerken.

2. *Heeft u het gevoel dat u het perspectief van uw organisatie voldoende heeft kunnen uiten? Waarom wel of waarom niet?*

Op één deelnemer na was elke stakeholder volledig positief over het voldoende kunnen uiten van hun perceptie. Redenen die hiervoor genoemd zijn omvatten dat er veel uitwisseling tussen partijen heeft plaatsgevonden en een relatief kleine groep. Eén stakeholder antwoordde met "redelijk" en heeft het gevoel dat het zijn perspectief vanuit een andere rol minder goed heeft kunnen toelichten. Dit betrof een persoon van veiligheidsregio Utrecht die zowel vanuit zijn rol bij deze organisatie, als zijn fictieve rol als afgevaardigde van zorginstelling Reinaerde aanwezig was.

3. *Vond u de doorlopen activiteiten van deze methode eenvoudig te begrijpen? Waarom wel of niet?*

De stakeholders hebben tijdens de evaluatie aangegeven dat de doorlopen activiteiten van deze methode stappen over het algemeen goed te begrijpen waren. Redenen hiervoor omvatten de gegeven uitleg door de procesbegeleider, maar ook hun expertise omtrent dit onderwerp. Enkele verbeterpunten die stakeholders aandroegen omvatten het uitgebreider toelichten van theoretische begrippen, zoals de definitie van veerkracht zelf en de veerkracht principes.

4. *Wat zijn uw gedachten over het natuurbrandrisico? Zijn deze veranderd door deze werksessie?*

Vooral vanwege hun dagelijkse werk en expertise gaven de meeste stakeholders aan dat hun perceptie over het natuurbrandrisico op en rond het Henschotermeer gebied niet veranderd zijn. De stakeholders waren zich vooraf namelijk al bewust van dit relatief hoge risico. Desondanks gaven twee stakeholders in hun evaluatieformulier aan dat ze nu een completer beeld van dit risico hebben.

5. *Denkt u dat deze werksessie een opstap kan zijn naar het uiteindelijk gezamenlijk treffen van maatregelen om de veerkracht van het Henschotermeer gebied te verhogen? Waarom wel of niet?*

Alle stakeholders gaven aan het ermee eens te zijn dat de gehouden werksessie een opstap kan zijn naar het gezamenlijk treffen van risico mitigerende maatregelen, bijvoorbeeld doordat het inzicht geeft in tegenstrijdige belangen en perspectieven van stakeholders. Enkele stakeholders noemen wel voorwaarden die volgens hen van toepassing zijn op het succesvol gebruiken van deze methode om tot interventies te komen. Zo is opgeschreven dat alle eigenaren dan moeten aanhaken, dat het moet aansluiten bij een bestaande projectgroep omtrent de veiligheid van het gebied, en dat er nog stappen tussen kunnen zitten voordat het daadwerkelijk tot maatregelen komt.

Als laatste wordt vanuit de veiligheidsregio opgemerkt dat het goed zou zijn geweest als er in de huidige projectgroep rondom het verbeteren van de veiligheid van het Henschotermeer gebied was begonnen met het doorlopen van dit proces. Dit geldt vooral wanneer de stakeholders rondom het Henschotermeer beter door een deur hadden gekund. Dit zou de veiligheidsregio inzicht hebben gegeven over wat er moet gebeuren en welke partijen daarvoor nodig zouden zijn geweest. Andere stakeholders beamen het nut van dit proces, vooral als dit in een nog breder overleg met meer stakeholders wordt toegepast.

Appendix B – Guideline of the design approach

Deze bijlage bevat de handreiking voor Veiligheidsregio Utrecht om de ontworpen aanpak voor het participatief toetsen van de veerkracht van kwetsbare locaties op de Utrechtse Heuvelrug toe te passen. Het identificeren van deze kwetsbare locaties is niet voorgeschreven in deze aanpak. Of de ontworpen aanpak toepasbaar is in een specifieke locatie moet daarom worden bepaald door de veiligheidsregio. De aanpak is specifiek toepasbaar op relatief kleine gebieden kwetsbaar voor natuurbrand die veel verschillende stakeholders accommoderen. Deze handreiking is gebaseerd op het prototype ontwerp en de aanbevelingen voor toekomstig gebruik resulterend van de toepassing op het Henschotermeer pilot gebied. De aanpak is per stap beschreven.

Algemene aandachtspunten:

- Voor de workshop moet een tijdspanne van vier uur worden gereserveerd.
- De workshop moet geleid worden door een objectieve facilitator.
- Voor de workshop is een locatie met beamer en projectiescherm nodig.
- Overige benodigdheden omvatten een A0-poster van het gebied, gelinieerd papier, gele, groene en roze post-its, rode stickers, pennen en een whiteboard en markers.

1. Formuleer het op te lossen probleem: Wat is het probleem dat moet worden opgelost?
   Het algemene probleem dat aanleiding geeft tot de workshop wordt in deze stap toegespitst op de locatie.
   a. Beschrijf het generieke probleem omtrent de veerkracht van de Utrechtse Heuvelrug en pas het toe op de specifieke locatie. Dit vormt een bijlage in de uitnodiging voor stakeholders.
   b. Begrens het gebied fysiek om te bepalen welke potentiële stakeholders en gebiedscomponenten in beschouwing worden genomen.

2. Identificatie van relevante stakeholders: Wie zijn de relevante stakeholders?
   Deze stap resulteert in een overzicht van relevante stakeholders die betrokken dienen te worden in het participatieve proces.
   a. Maak een lijst met alle partijen van het gebied op basis van:
      i. De kaart van het afgebakende gebied.
      ii. Het beschouwen van niet-direct zichtbare stakeholders, zoals natuur- en overheidsorganisaties.
   b. Categoriseer de stakeholders op basis van onderstaande categorisatie van stakeholders.

Landbeheersorganisaties	Infrastructuurbeheerders
Recreatiebedrijven	Zorginstellingen
Wonen en werken	Wetgevers

   c. Bepaal stakeholders met het potentiële vermogen maatregelen ten behoeve van de versterking van de veerkracht te treffen (relevante stakeholders).
      i. Inventariseer potentieel relevante middelen van stakeholders (bv. land, infrastructuur, autoriteit en kennis).
      ii. Bepalen of deze middelen worden beschouwd als vervangbaar door andere aanwezige middelen.
      iii. Bepalen in welke mate de middelen worden beschouwd als belangrijk voor het verhogen van de veerkracht.

iv. Bepalen of stakeholders relevant zijn. Dit is het geval wanneer zij relevante middelen hebben die moeilijk vervangbaar zijn en waarop het kunnen treffen van maatregelen afhankelijk is.

Stakeholders	Relevante middelen	Vervangbaarheid van middelen	Afhankelijkheid van middelen	Relevantie van stakeholder
Stakeholder 1	…	Ja/nee	Hoog/laag	Ja/nee
Stakeholder 2	…	Ja/nee	Hoog/laag	Ja/nee
Stakeholder N	…	Ja/nee	Hoog/laag	Ja/nee

v. Nodig de relevante stakeholders uit
Voeg de gebiedsspecifieke probleemomschrijving toe aan de uitnodiging. Voor de validiteit van het participatieve proces is het van belang alle relevant stakeholders te betrekken.

3. Bepaal de gewaardeerde gebiedseigenschappen
Deze stap resulteert in het overzicht van gebiedseigenschappen die vanuit het perspectief van stakeholders belangrijk zijn. Of deze gewaardeerde gebiedseigenschappen kwetsbaar zijn voor natuurbrand bepaalt uiteindelijk of een gebied veerkracht is.
    a. Laat stakeholders gebiedseigenschappen bepalen die vanuit het perspectief van hun organisatie gewaardeerd worden.
        i. Leg uit dat gebiedseigenschappen bestaan uit functies, faciliteiten, infrastructuur en fysieke condities. Leg verder uit dat positieve ontwikkelingen, zij het in de toekomst, bijdragen aan gewaardeerde gebiedseigenschappen.
    b. Laat de stakeholders de gebiedseigenschappen op gele post-its schrijven en op de betreffende locatie op de A0-gebiedskaart plakken. Let erop dat gebiedseigenschappen slechts bestaan uit functies, faciliteiten, infrastructuur en fysieke condities. Overig geopperde eigenschappen worden buiten beschouwing gelaten.
    c. Laat stakeholders de negatieve ontwikkelingen op roze post-its en positieve ontwikkelingen op de groene post-its schrijven en deze op de betreffende locatie op de A0-gebiedskaart plakken.
    d. Bespreek de geopperde gebiedseigenschappen en ontwikkelingen plenair om de compleetheid ervan te valideren. Deze stap kan leiden tot aanvullende gebiedseigenschappen en ontwikkelingen.

4. Bepaal de kwetsbaarheid van de gewaardeerde gebiedseigenschappen: Welke gewaardeerde gebiedseigenschappen zijn kwetsbaar voor natuurbrand?
In deze stap wordt bepaald voor welke gebiedseigenschappen en positieve ontwikkelingen de veerkracht moet worden verbeterd. Dit gebeurt door het bepalen van hun kwetsbaarheid. Negatieve ontwikkelingen dragen slechts bij aan de beeldvorming van stakeholders en worden daarom niet meegenomen in deze stap. De kwetsbare gebiedseigenschappen worden ook geprioriteerd aan de hand van hun geschatte potentiële bijdragen aan het versterken van hun veerkracht.
    a. Presenteer een bosbrandscenario van het gebied.

b. Vraag stakeholders de gebiedseigenschappen die zij op basis van dit scenario als kwetsbaar beschouwen te markeren met rode stickers.
c. Presenteer een tweede bosbrandscenario die andere karakteristieken heeft als het eerder gepresenteerde scenario.
d. Vraag stakeholders de gebiedseigenschappen die zij op basis van het tweede scenario als aanvullend kwetsbaar beschouwen te markeren met rode stickers.
e. Bespreek de kwetsbare gebiedseigenschappen plenair om de compleetheid ervan te valideren. Deze stap kan leiden tot de markering van aanvullende kwetsbare gebiedseigenschappen.
f. Leg stakeholders uit dat het niet haalbaar zal zijn om voor alle kwetsbare gebiedseigenschappen oplossingsrichtingen te bedenken. Daarom moeten ze worden geprioriteerd op basis van waar de meeste veerkrachtwinst te behalen valt volgens stakeholders.
g. Discussieer gezamenlijk over welke gebiedseigenschappen moeten worden geprioriteerd. Hou hierbij rekening dat de belangen van alle stakeholders gelijkmatig worden afgewogen.

5. Bepaal oplossingsrichtingen om de veerkracht van kwetsbare, gewaarde eigenschappen te bepalen: Wat zijn mogelijke oplossingsrichtingen voor het verhogen van de veerkracht van kwetsbare, gewaardeerde eigenschappen?
   In deze stap wordt per geprioriteerde gebiedseigenschap bepaald welke maatregelen kunnen bijdragen aan het verhogen van de veerkracht van het gebied.
   a. Leg stakeholders uit dat oplossingen worden gezocht aan de hand van de veerkrachtprincipes en presenteer deze. Voorzie stakeholders ook van de hand-out van deze aanpak met een bondige uitleg over veerkrachtprincipes.
   b. Bedenk gezamenlijk zoveel mogelijk oplossingsrichtingen per veerkrachtprincipe. Om maatregelen te bedenken voor elk principe is het van belang om de veerkrachtprincipes één voor één te behandelen.
   c. Discussieer plenair over de compleetheid van de bedachte maatregelen. Deze activiteit kan leiden tot aanvullende oplossingen om de veerkracht van de geprioriteerde functies te verhogen.

De uitkomst van deze aanpak is een overzicht van mogelijke oplossingsrichtingen voor de kwetsbare gebiedseigenschappen waarop volgens het perspectief van stakeholders de meeste winst valt te behalen. Deze mogelijke oplossingsrichtingen kunnen worden gebruikt als een opstap naar het uiteindelijke doel van veiligheidsregio Utrecht om samen met stakeholders maatregelen te treffen om de veerkracht van het gebied te verhogen.

Appendix B.1 Accompanying explanation on resilience principles

1. Stabiliserende feedback: Stabiliserende terugkoppelingen die een natuurbrand afremmen zijn aanwezig.

2. Variatie: Kwetsbaarheid voor natuurbranden wordt verminderd doordat belangrijke gebiedseigenschappen op verschillende manier vervuld worden.

3. Omloopsnelheid: Middelen om natuurbranden tegen te gaan kunnen snel gemobiliseerd worden.

4. Platte organisatiestructuur: In geval van natuurbrand kan er snel lokaal en flexibel worden gereageerd omdat competenties hiervoor (bv. verantwoordelijkheden, middelen of kennis) op lokaal niveau aanwezig zijn.

5. Buffercapaciteit: Eigenschappen die ervoor zorgen dat natuurbranden kunnen worden opgevangen zijn over gedimensioneerd.

6. Overlap: Functies overlappen zodat wanneer één (bv. infrastructuur of een voorziening) faalt tijdens een natuurbrand een andere functie het kan overnemen.

Appendix C – Reflection of start assumptions in design requirements

Table 12 The reflection of the start assumptions in the design requirements

Start assumptions	a	There is a need to improve the climate resilience of the Utrechtse Heuvelrug
	b	Resilience assessment is an essential intermediate step prior to resilience improvement
	c	The meaning of climate resilience in the context of this research must be established prior assessing resilience
	d	The engagement of relevant stakeholders in the process of resilience assessment is beneficial
	e	Stakeholders should be analysed to identify the relevant ones for engagement
	f	The participatory process should raise the awareness levels concerning the wildfire risk among stakeholders
	g	A common understanding on the problem should be established among stakeholders
	h	The degree of resilience is considered to be higher if an area better maintains the specified features of interest
	i	Desirable area features should be determined from the perspective of relevant stakeholders because of the normative nature of resilience
Design requirements (Letters indicate the reflection of the assumptions)	a, c	The participatory approach should contribute to climate resilience improvement of the Utrechtse Heuvelrug area
	b	Conducting the participatory resilience assessment should result in an overview of an area's current state regarding climate resilience
	f	The wildfire hazard should be clearly introduced to engage stakeholders
	d, e, g	The design approach should allow for the inclusion of the perceptions of all relevant professional stakeholders
		Safety region Utrecht and other stakeholders should be able to jointly conduct the participatory assessment in half a day
		Employees of the safety region with a limited experience on stakeholder analysis and resilience assessment should be able to conduct the designed approach
		Adapting the assessment approach to local circumstances should be possible
		Modification of the assessment approach should be possible based on changing circumstances or new insights
	h, i	The metrics to assess climate resilience should at least refer to desirable area features related to the physical area components