The use of Knowledge Tools and Transition Tools for the transition to AWM and realisation of NbS

An assessment of water management practices in Co-Adapt catchments

CONSULTANCY REPORT

InCompany Milieuadvies

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Preface

Global warming and the related climate change redefine the challenges waterprofessionals are facing. Water management strategies that have been common practice for decades need a radical overhaul in order to anticipate changing climate conditions and increasing uncertainties. This climate adaptive management method requires among other things: a more participatory management and collaborative decision making, decentralized and more flexible management approaches, the incorporation of iterative learning cycles and the explicit inclusion of the environment in management goals. The EU Interreg 2 Seas Co-Adapt project seeks to improve the adaptive capacity of the 2Seas regions to water related effects of climate change. The project involves waterprofessionals from eight catchment areas and has a strong focus on co-creation of Nature based Solutions (NbS).

This research looks into the use of tooling in adaptive water management (AWM)in these 2 Seas Co-Adapt catchments. The main focus of this research is on both Knowledge Tools (KT), instruments for knowledge transfer and/or creation, and Transition Tools (TT), instruments that support the initiation and/or process of transition. The aim is to share the information about TT and KT between Co-Adapt waterprofessionals in order to support the transition to AWM and NbS within the 2 Seas Co-Adapt catchments and beyond. In 2020 Co-Adapt has already created a Guide to Co-Creation Tools (Co-Adapt, 2020); Co-Creation tools are not part of this research. This research has been achieved with support of Co-Adapt waterprofessionals and under the guidance of the commissioners from the Open Universiteit and the Province of Noord-Brabant.

Abstract

The full impact of global warming and climate change on catchments in Northwest Europe remains uncertain. Consequently, water management practices need a radical overhaul to anticipate changing climate conditions and its uncertainties. In the context of the complexity of Social-Ecological System (SES) - a system with its dynamics and interactions between its social-human and ecological part - these uncertainties require an innovative and adaptive water management (AWM) approach. AWM is essentially an experimental approach, characterized by iterative development cycles. However, institutional settings are in many cases too constraining and inflexible to allow continuous improvement of climate adaptivity.

This research is conducted within Co-Adapt, a collaboration of eight catchments in northwestern Europe. Co-Adapt professionals focus on the realisation of Nature-based Solutions (NbS) - actions based on nature as a solution to sustainability problems - in co-creation with key stakeholders. Tooling is deployed to support waterprofessionals in the transition towards AWM and in the process of realising NbS in co-creation with stakeholders. In this research two types of tools are assessed: Knowledge Tools (KT) and Transition Tools (TT). KT are instruments in which creation and/or transfer of knowledge is the central focus. TT support the initiation and/or process of transition.

It is unclear how tooling can best support waterprofessionals in AWM and the realisation of NbS. Therefore, KT and TT used within Co-Adapt are assessed on their contribution to AWM and NbS and their reusability. Data from Co-Adapt is collected through a survey, webinars and interviews with waterprofessionals. Four studies are conducted using this data. The first study is an assessment of AWM with respect to three institutional factors; adaptive governance, cooperation structures and adaptive policy development. The second study is an evaluation of the Panarchy-model for the assessment of tools and their effectiveness in delivering NbS. The Panarchy-model is an integrative sustainability tool analysis framework. The third study is an assessment of the role of SES in tool selection and use. It provides insights in the impact of tools on SES and the re-usability of tools in other catchments. The final study is an analysis of the contribution of TT to transition processes.

AWM in Co-Adapt primarily focusses on improving cooperation structures. KT and TT are mainly used in a Co-Adapt setting to develop cooperation structures and increase stakeholder involvement. The complexity of SES makes tool selection complicated. Tools can only be re-used in other catchments if they are adjusted to the specifics of the SES. To assess the effectivity of tools and increase their reusability more information should be collected over time (initial and final state) and regarding the contribution to three sustainability dimensions.

KT and TT collected from Co-Adapt catchments are bundled and published into guides. A Guide to Knowledge Tools (G2KT) and a Guide to Transition Tools (G2TT) are appended to this report. Also, Good Practices (GP) have been collected through the survey. The GP are not assessed in this research. Since the GP cannot be allocated to the G2KT or G2TT, they are bundled in a G2GP. The guides intent to provide information about tools and support the transition to AWM and NbS within Co-Adapt catchments and beyond.

Samenvatting

Er is veel onzekerheid over de exacte gevolgen van klimaatverandering voor beekstroomgebieden in Noordwest-Europa. Om hierop te anticiperen dienen waterprofessionals een transitie te bewerkstelligen van conventioneel naar Adaptief Water Management (AWM). Dit kan vormgegeven worden door het implementeren van Nature based Solutions (NbS); maatregelen gebaseerd op de natuur als oplossing voor duurzaamheidsproblemen. De transitie naar AWM en de implementatie van NbS kan worden versneld door stakeholders te betrekken. Dit kan worden gefaciliteerd door het gebruik van tooling. In dit onderzoek is gekeken naar twee type tools beschikbaar voor waterprofessionals: Knowledge Tools, gericht op creatie en overdracht van kennis en Transition Tools, gericht op initiatie en ondersteuning van een transitie. De vraag is hoe KT en TT bijdragen aan AWM en NbS en op welke manier de tools kunnen worden hergebruikt in andere stroomgebieden. Dit onderzoek is uitgevoerd binnen Co-Adapt, een samenwerkingsverband van acht stroomgebieden in Noordwest-Europa. Met een survey, Webinars en interviews zijn gegevens vanuit de stroomgebieden verzameld. Uit het onderzoek blijkt dat het verbeteren van samenwerkingsstructuren de belangrijkste focus is in de realisatie van AWM. De gebruikte tools zijn voornamelijk gericht op het informeren en betrekken van stakeholders. De verwachting is dat dit leidt tot acceptatie en ondersteuning van noodzakelijke maatregelen. Om tools te beoordelen op hun bijdrage aan NbS, is verder onderzoek nodig naar de bruikbaarheid van het Panarchy-model. Duurzaamheidsanalyses met dit model geven inzichten waarmee de herbruikbaarheid van tools wordt vergroot. Hiervoor moeten wel meer gegevens worden verzameld, zoals: begin- en eindtoestand en bijdrage aan duurzaamheid.

Résumé

Il y a beaucoup d'incertitude sur les conséquences exactes du changement climatique sur les bassins fluviaux du nord-ouest de l'Europe. Pour anticiper cela, les professionnels de l'eau doivent réaliser une transition de la gestion conventionnelle à la gestion adaptative de l'eau (GAE). Cela peut se faire en mettant en œuvre des solutions fondées sur la nature (SFN) comme solution aux problèmes de durabilité. La transition vers la GAE et la mise en œuvre de SFN peuvent être accélérées en impliquant les parties prenantes. Cela peut être facilité par l'utilisation d'outils. Cette recherche s'est penchée sur deux types d’outils à disposition des professionnels de l'eau: les outils de connaissance (OC), destinés à créer et transférer des connaissances, et les outils de transition (OT), destinés à initier et à accompagner une transition. La question est de savoir comment les OC et OT contribuent à la GAE et aux SFN, et comment les outils peuvent être réutilisés dans d'autres bassins fluviaux. Cette recherche a été menée au sein du projet « Co-Adapt », une collaboration à l’échelle de 8 bassins hydrographiques du nord-ouest de l'Europe. Les données ont été collectées dans les bassins hydrographiques au moyen d'une enquête, de webinaires et d'entretiens. La recherche montre que l'amélioration des structures de collaboration est l'objectif le plus important dans la réalisation de la GAE. Les outils utilisés visent principalement à informer et à impliquer les parties prenantes. Cela devrait conduire à l'acceptation et au soutien des mesures nécessaires. Pour évaluer les outils pour leur contribution aux SFN, des recherches supplémentaires sont nécessaires sur l'utilisation du modèle Panarchy. Les analyses de durabilité avec ce modèle fournissent des informations qui augmentent la réutilisation des outils. Pour cela, davantage de données doivent être collectées, telles que: les états initial et final et leur contribution aux 3 dimensions de la durabilité.

1. Problem analysis

1.1. Climate Change & Hydro-Meteorological Hazards

The impact of global warming and climate change is seen in all parts of the world. The Intergovernmental Panel on Climate Change (IPCC) has shown in the *Climate Change 2014: Synthesis Report* that the chances of extreme weather events are increasing as a result of global warming (IPCC, 2014). The IPCC expects global temperatures to increase further over the next few decades, which results in increasing Hydro-Meteorological Hazards (HMH) (Kumar et al., 2020). HMH are natural risks that arise from atmospheric and/or hydrological processes. Examples are floods, drought, landslides, storm surge and increased leaching of nutrients and sediment. The HMHs such as floods and drought have already caused significant loss of life and economic damage across the globe (Kumar et al, 2020). Floods and drought threaten the resilience of socio-ecological systems (Pahl-Wostl, 2020).

However, the effects of climate change are not the same across all regions globally. This research focusses primarily on catchments in Northwest Europe. To enhance the understanding of the impact of global warming at a regional scale, the national meteorological institutes of these Northwest European countries published climate impact projections for their specific countries. The UK Climate Projections 2018, a forecast up to 2100, is published by the Met Office (Met Office, 2020), the *Climat Futur en France* by MeteoFrance (Meteofrance, 2020), the Belgium climate overviews for 2100 by the *Koninklijk Meteorologisch Instituut* (KMI) (Meteo, 2020) and climate scenarios to 2085 for the Netherlands by the *Koninklijk Nederlands Meteorologisch Instituut* (KNMI) (KNMI, 2014). All scenarios run at least until 2050 and assume that the effects of global warming will continue to increase within each region. Winters are projected to become warmer and wetter. Summers will have longer warm periods and are more likely to become drier. While heavy rainfalls are more likely throughout the year, the number of rainy days during summer decreases. These climatic changes apply to a greater or lesser extent to all scenarios and to the entire region. However, the national reports on climate impact projections also stress the exact course of climate change remains uncertain.

1.2. Brook catchments

Local differences can be expected for catchments in Northwest Europe dependent on how climate change unfolds (European Environment Agency, 2017). The way climate change effects these areas remain uncertain (Pechlivanidis, Arheimer & Donnelly, 2017), but overall HMH are expected to increase (Huntjens, Pahl-Wostl, and Grin, 2010). Some catchments may experience intense rainfalls and increased heavy flood risks, while other areas may witness less rainfall, and longer periods of droughts (Huntjens et al., 2010). Furthermore, temperature increase can lead to enhanced evapotranspiration which eventually will result in an even more reduced streamflow (Ledesma et al., 2019).

Catchments will be tested to their limits by these probable effects of climate change. To create catchments that are climate adaptive, the uncertainties of the effects of climate change at regional and local scale have to be taken into account. This can be achieved by managing for increased resilience (Nesshöver et al. 2017). Waterprofessionals should make a transition from conventional water management, often based on technical solutions, towards Adaptive Water Management (AWM) (Huntjens et al. 2010). Nature-based Solutions (NbS) - actions based on nature - are seen as one way to achieve resilient development and advanced AWM (Interreg 2 Seas, 2020). From the perspective of the waterprofessional, there is a need for support to realise the transition to AWM and to implement NbS. Tooling supports waterprofessionals in shaping this transition to AWM and in the realisation process of NbS in co-creation with other stakeholders.

1.3. Socio-Ecological Systems

A catchment including its stakeholders and their activities affecting the catchment can be seen as a Socio-Ecological System (SES). Vulnerable SES, like catchments, have lost their resilience and with it their adaptability - the capacity to adjust responses - to changing external drivers like extreme climate events (Folke, 2006). By studying the connection between the socio-human and the ecological part of the SES, the reaction of a system to dangers and hazards can be researched (Young et al., 2006).
SES are very complex and exist of several subsystems and internal variables (Ostrom, 2009). Every SES has its own system dynamic. The challenge is to find ways to match the dynamics of institutions with the dynamics of ecosystems for mutual social-ecological resilience and improved performance (Berkes & Folke, 1998). Ecological knowledge and understanding are seen as a critical link between the social-human and ecological part of the SES (Fig. 1) (Colding & Barthel, 2019).

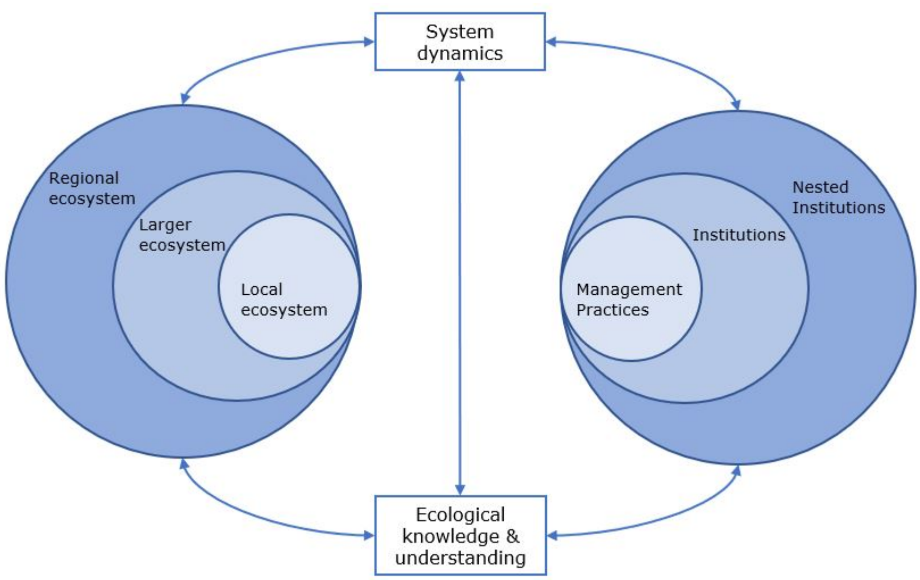

Fig. 1. A conceptual framework for the analysis of Socio-Ecological Systems. The circles on the right represent the scales within the socio-human part of the SES. The circles on the left represent the scales of the ecological part of the SES. The arrows represent the connection between both sides of the SES; the system dynamics and the ecological knowledge & understanding. Based on Colding & Barthel (2019) to Berkes & Folke (1998).

Catchments in this research can be classified as local ecosystems that are part of a larger and regional ecosystem. Local management practices are formed by institutions and regulations on a regional, national, and European level. Waterprofessionals working for these management practices are knowledge workers involved with water management. As a knowledge worker the waterprofessional is continuously innovating: learning and reflecting on their knowledge work (Drucker, 1999).

This research aims to support waterprofessionals and water management boards in their work within the SES. Waterprofessionals operate within the dynamics of the SES; they contribute to ecological knowledge and understanding, and they can initiate and support transition in the system dynamics. Tools can support waterprofessionals in their work within the complexity of the SES. The problem is that it is unknown how tools can support waterprofessionals in the transition of conventional to AWM and in realising NbS in: (a) the process of ecological knowledge and understanding; and (b) in transitions in the system dynamics (SES, fig 1).

1.4. Adaptive Water Management

Increasing the adaptive capacity of the SES is needed since climate-related extreme weather events (HMH) are expected to increase (Huntjens et al., 2010). However, the full impact of climate change on catchments in Northwest Europe remain uncertain (Pechlivanidis, Arheimer & Donnelly, 2017). Therefore, the measures to be taken can change over time. To become climate adaptive, climate uncertainties must be considered. This requires innovative and adaptive water management approaches. In literature there are different definitions of AWM. Huntjens et al. (2010) refer to AWM approaches as Adaptive and Integrated Water Management (AIWM). In their definition of AIWM they focus on the need of learning from the outcomes of implemented water management strategies. The insights gained must result in a continued process of improving policies and practices. According to Nesshöver et al. (2017), this continuous adaptation to changes facilitates the dealing with uncertainties and complexities of the future impact of climate change. They argue that water management practices should be considered as experiments, by ensuring that management treatments are replicated, and responses are carefully monitored (Nesshöver et al., 2017). Honkonen (2016) agrees with this view and concludes that adaptive management must be both anticipatory and reactive. Taken these definitions together, in this paper AWM is defined as an approach for water management, policies, and practices to deal with uncertainties and complexities of climate change, both in the present and future. The approach requires flexibility and focusses on ways to maximize learning opportunities by applying different strategies, seeking cooperation, and monitoring policies and processes already implemented.

Most water management agencies and professionals are aware of the climate tasks they face in their catchment, both today and in the future. Flexibility and continuous learning are keystones of adaptive management. How to operationalize this continuous learning and flexibility in the AWM practice is the task waterprofessionals have to fulfil.
AWM is often associated with field experimentation (Allan et al., 2013), it is essentially an experimental approach, characterized by iterative development cycles (Peat, et al, 2017). This in contrast to conventional water management methods, generally working towards predefined often technical solutions. The AWM approach therefore requires flexible decentralized management and policy processes, agile project methods, open information sharing and a core focus on the environment (Pahl-Wostl, 2020). Furthermore, AWM aims to find a suitable balance between measures and investments taken today and in the future (Roosjen et al., 2012). That is why AWM approach often starts with a strategic vision. Based on this vision short term actions will be determined, and a framework can be established to guide future actions (Haasnoot et al, 2013). This method enables policy makers to update

plans in case current policies can no longer meet the objectives due to changing (climate)conditions (Haasnoot et al., 2013).

Allan et al. (2013) concluded that conversion from conventional to adaptive management has been slow and problematic; there have been few fundamental structural changes within water managing institutions that could support the waterprofessionals in AWM. Allan et al. (2013) argue that without these changes it is almost impossible to address the complexity and uncertainty that make adaptive management necessary. The few advanced AWM practices assessed and documented are mainly large river basins and river deltas. For smaller brook catchments to support AWM and their climate adaptivity, literature does not explicitly mention what is required in terms of institutional arrangements and supporting processes. For this reason, an assessment is made of the AWM practices of small brook catchments. Relevant is to what degree processes, institutional arrangements and tooling could support continuous learning and flexibility in water management.

1.5. Nature-based Solutions

For realising the transition from conventional to AWM, NbS are researched. NbS is the key future vision for creating climate adaptive brook catchments. NbS are actions based on nature, using system's self-adapting capacity and resilience, for sustainable management of societal challenges. This definition is composed from the two most common used definitions by the European Commission (EC) and by the International Union of Conservation of Nature (IUNC) (Hanson et al., 2020).

From:	Definition
European Commission (EC)	"NbS aim to help societies address a variety of environmental, social and economic challenges in sustainable ways. They are actions inspired by, supported by or copied* from nature; both using and enhancing existing solutions to challenges, as well as exploring more novel solutions, for example, mimicking how non-human organisms and communities cope with environmental extremes".
International Union for Conservation of Nature (IUCN)	"...actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing well-being and biodiversity benefits"

Table 1: Most referred definitions of NBS based on Hanson, Wickenberg, and Alkan Olsson (2020)
* Since 2018 'copied from nature' has been removed from the definition because of no consensus.

Both definitions explicitly acknowledge that the benefits of NbS are related to Sustainability / Sustainable development (SD) (IUCN, 2020; Sartison & Artmann, 2020). Consequently, NbS can be an answer for SD-problems (IUCN, 2020).

NbS is considered an umbrella framework for ecosystem-based approaches in water management (Nesshöver et al., 2017; Cohen-Shacham et al., 2019). Occasionally, concepts under the NbS-umbrella are used as synonyms for NbS, which causes confusion about terms and concepts (Nesshöver et al., 2017; Cohen-Shacham et al., 2019). To avoid confusion and uncertainty, the meaning of NbS must always be analysed and appended in its context (Quinlan et al. 2016). Interacting and potential interacting terms as well as differences should also be acknowledged (Nesshöver et al., 2017). Consequently, to fully understand how to operationalise NbS, the context and parameters should be analysed and added (Nesshöver et al., 2017).

Key concept of NbS is resilience. The meaning of resilience depends on its context. In general terms, resilience is the capacity of an (ecologic) system to cope with disturbance, by absorbing shocks maintaining function as having the capability of renew and develop other functions (based on: Folke et al. (2010). Resilience explained on a higher level can be referred to as adaptive capacity (Holling, 2001).

Tooling supports the operationalisation of NbS. An analysis of tools and their contribution to the implementation of NbS should be done on the same origin as NbS; sustainability. Since sustainability includes three interdepend domains -ecological, social, economic-, all three domains should be included in an assessment (Sartison & Artmann, 2020). There is no conventional framework for analysing tools on their contribution to sustainability. The Panarchy-model seems a fitting model (Boyer, 2020; C. S. Holling, 2001). The problem is that not much is known about the potential of the Panarchy-model for tool analysis integrative on the sustainability domains.

Panarchy-model

The Panarchy-model describes complex human adaptive systems. Therefore, it can be used for analysing e.g.: societies, human-natural systems (Colding and Barthel 2019), economies (Slight, Adams and Sherren 2016), politics and policy (Garmestani, Allen and Cabezas, 2008). The key concepts of the Panarchy-model are: *resilience, connectivity*, and *wealth/potential* (textbox 1). These are the parameters with which the system state can be described. The Panarchy-model is a 'figure-8' in a three-dimensional box, with axis corresponding to those three parameters. Most often only two of the axes are shown (figure 2). In one Panarchy there are four characteristic phases (Ω, ☐, r, K) describing the system state according to the three parameters (textbox 1) (Holling, 2001). According to the Panarchy-model the system state can be disturbed by shocks, which can lead to uncertainties in the system. This can lead to adaptation by passing the phases and return to an (new) equilibrium. There is more than one equilibrium possible. A system can also move from one Panarchy to another Panarchy. This occurs when the shock has been very fast and high intense. The inter-Panarchy movements are called *Revolt* – upwards: associated with crisis - and *Remember* – downwards (textbox 3): associated with renewal after a catastrophe - (Slight et al., 2016).

Potential or wealth: this can be described as the inherent potential of a system available for change, the range of future possible options.

Controllability or connectivity: the degree of connectedness between internal controlling variables. Reflecting the degree of flexibility/rigidity and (in)sensitivity to perturbations. A measurement of control of system's own destiny (instead of getting caught by external influences).

Resilience / adaptive capacity of the system: A measure for the behavior of the system together with its vulnerability to withstand a shock.

Textbox 1: Panarchy's parameters, based on: (Gallopín, 2006; Holling, 2001)

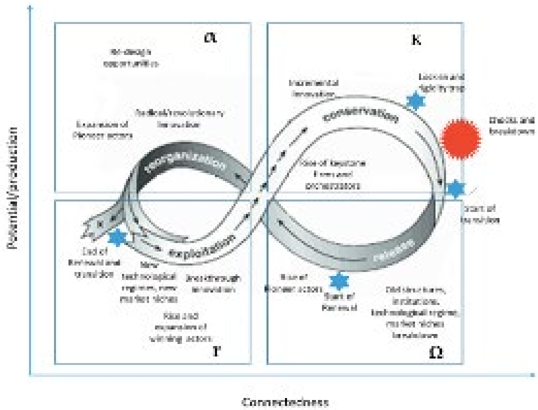

Figure 2: Panarchy's phases. Copied from: (Boyer 2020:1)

The back loop (Ω + α): This loop is typically characterized by rapid radical innovation leading to renewal. That are large unpredictable changes, with high risk of uncertain outcomes. Radical innovation adds additional components to the system and can, therefore, lead to the fundamental transformation of the system. the renewal phase is not market as separate phase; it goes from approximately halfway Ω to halfway α (Slight et al. 2016).

Decline/release phase (Ω): characterized by an interruption that disturbs the equilibrium or status quo, first step of the renewal. The impact of the disturbance depends on the conditions of the system. This phase is further characterized with low productiveness, low connectiveness (low trust, confidence and perhaps break down). Survival relies on adaptive capacity; therefore, resilience is high (Boyer 2020).

Reorganization phase (α): This is the end of the renewal phase. Pioneers (start-up, spin-offs) and some survivors are (re)starting. diversity is essential for this phase. There is low connectivity with the system but high influenced by external variability and in the end of this phase predictability grows. New relationships arise. After exploration, co-creation, regeneration a new balance will be found (Boyer 2020).

The front loop (r + K): This loop is typically characterized by incremental innovation and is also slower and more predictable than the back loop (Slight et al. 2016).

Rapid growth and exploitation (r): the more reliable state after the α-phase**:** with high growth rates for 'the winners'. A healthy state, with higher predictability, higher connectivity, competition, more complex relationships, more cooperation and overall, more symbiosis. The investments rate is high as the innovations, talents and investors are attracted; markets are growing. Over time competition will create new mono -or oligopoly situations, which harms the diversity. This will be the start of another Kgmail-phase(Boyer 2020).

Conservation (K): optimal performance (high population size, low growth rate. High connectivity, which makes the state rigid; increasing vulnerability, resilience is therefore not very high. Maturity or leadership(Boyer 2020).

Textbox 2: The four phases of a Panarchy, based on: (Boyer 2020; Slight et al. 2016)

The Panarchy-model describes complex adaptive systems. The transition from conventional to AWM, supported by tools, is a complex process seen against the background of the three SD-domains. Currently no tool analysis framework is available that assess three SD-domains all together. The absence of reliable information on the effectiveness of tools represents an obstacle to the re-use of tools and consequently the support for waterprofessionals in shaping this transition to AWM and the realisation of NbS. The Panarchy-model seems to be a potential fit.

Revolt (figure 2): The upwards movement from one faster adaptive cycle into a slower, larger cycle (Holling 2001): associated with negative impacts. This is when fast and small events overwhelm slow and large ones. Once triggered the effect can cascade to still higher, slower levels. This movement can be seen as a crisis. It is most likely to occur after Ω to a K-phase of a higher Panarchy (Slight et al. 2016:10). Examples (Ecologic domain): When a small ground fire spreads further to a crown of a tree and further to a whole stand of trees. Or when a collapse of a primary industry affects the economic success of its supply chain across an entire region (Economic domain) (Slight et al. 2016).

Remember (figure 2): The movement downwards after a catastrophe, from a larger to smaller and quicker Panarchy. The new system starts with a Renewal phase (halfway Ω to halfway α). For example: after a fire seeds start to grow, seeds that became left over from the earlier system state (after a crisis). Not only leftovers also wisdom and experience has been accumulated: that is why it is called remember. This movement is despite of the antecedent catastrophe associated with positive impacts (Slight et al. 2016:10)

Textbox 3: Movements between Panarchies, based on: (Allen et al. 2014; Slight et al. 2016)

1.6. Framework and Tooling

Currently, no comprehensive information is available on how waterprofessionals can be supported in the transition to AWM and in realising NbS. However, the problem analysis (fig 3) indicates waterprofessionals could use tools for the processes of 'continuous learning' and 'resilience-adaptive capacity'. Furthermore, tools can support stakeholder involvement and co-creation to contribute to AWM and NbS.

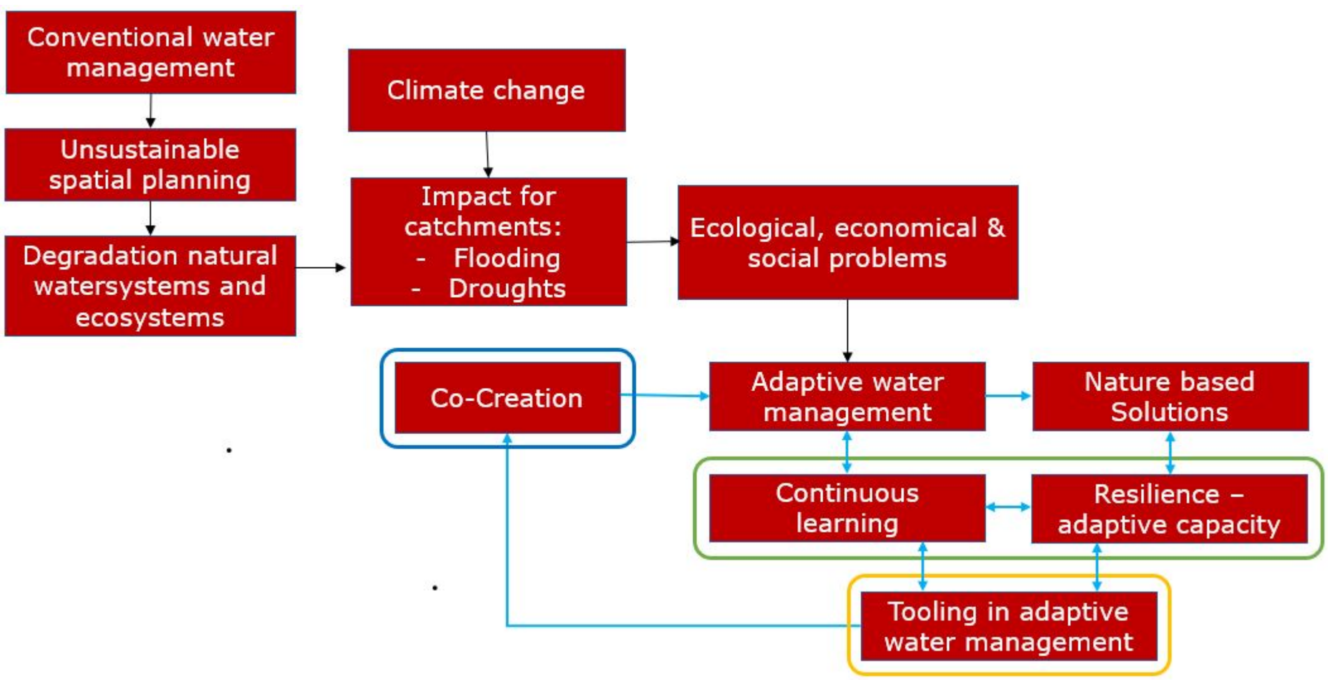

Fig 3. Problem analysis of tooling in AWM for supporting waterprofessionals in the transition towards AWM and for realising NbS in co-creation with stakeholders. The key terms (red boxes, and blue arrows for 'flexibility') reflect the relationships (black arrows) of the problem definition. The framework (green box) of AWM and NbS can be supported by tooling (yellow box), which can be used for co-creation (blue box)

Co-creation is used to involve stakeholder in AWM. Cooperation structures are an essential institutional factor of AWM to facilitate co-creation. Nesshöver et al. (2017) identify the following advantages for cooperation in the form of stakeholder involvement:

- 'substantive' benefits; stakeholders' perspectives, conditions and knowledge inform and improve planning of NbS.
- 'instrumental' benefits; the process becomes better understood and more acceptable to stakeholders, and hence better supported.
- 'normative' benefits; stakeholder involvement increases the legitimacy of the process, and generally supports democracy.

To make sure that these advantages contribute to the realisation of NbS it is important stakeholders have a meaningful involvement and empowerment during the entire process of this realization (Nesshöver et al., 2017).

According to Nesshöver et al. (2017) tools can support waterprofessionals in dealing with uncertainty, complexity, ambiguity, and possible conflicts that may arise during development and implementation of NbS. Tools may vary in form and content depending on the purpose, the type of process, the intended target audience and the demarcation of the content (Hamilton et al. 2015). In this research tooling is defined as all the methods, models and policy instruments that support waterprofessionals in the transition towards AWM and in the realisation of NbS.

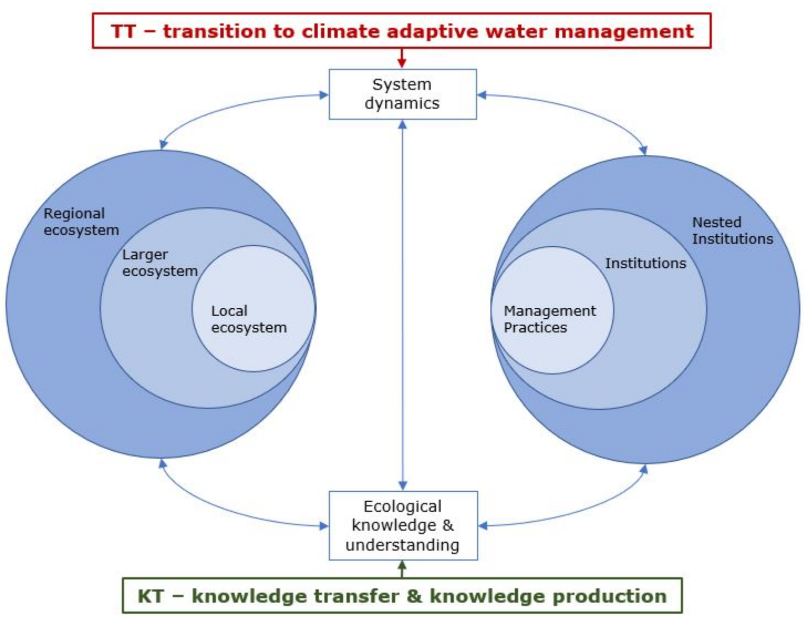

Fig. 4. KT and TT positioned in the SES framework. The green arrow shows the connection between KT and ecological knowledge & understanding. The red arrow shows the connection between TT and system dynamics.

Based on the problem analysis (fig 3) this research focusses on tooling connected to two key terms of the framework:

- 'Continuous leaning' (fig 3) aligns with 'knowledge and understanding' (SES, fig 4), which are supported by Knowledge Tools.
- 'Resilience-adaptive capacity' (fig 3) aligns with 'system dynamics' (SES, fig 4), which are supported by Transition Tools.

In this research the KT and TT available for waterprofessionals are assessed; how they are used and how they contribute to the transition towards AWM and in the realisation of NbS.

Knowledge Tools

KT support waterprofessionals in the processes of 'continuous learning' (fig 2) and 'ecological knowledge and understanding' (fig 3). KT can have one or multiple objectives (table 2). In this research KT are defined as instruments in which knowledge transfer and/or creation of knowledge is the central focus.

Knowledge tools intend to	o Improve system understanding o Identify indicators and criteria o Identify objectives, issues, preferences and management options o Communicate knowledge o Identify knowledge gaps o Obtain information from stakeholders

Table 2. An overview of the different goals of KT ((Hamilton et al., 2015)

Transition Tools

TT support waterprofessionals in the transition process towards AWM and NbS. TT can be policy instruments and measures that facilitate adaptation of complex system to changing internal and external circumstances (Loorbach, 2010). Transitions must be initiated within different sectors and at different levels, for example to make catchments climate adaptive (Kemp et al., 2007). According to Rauschmayer et al. (2015) a transition can be described as series of interconnected changes that reinforce each other but occur in different domains, such as economic sectors, behaviour, and ecology (Fig 5).

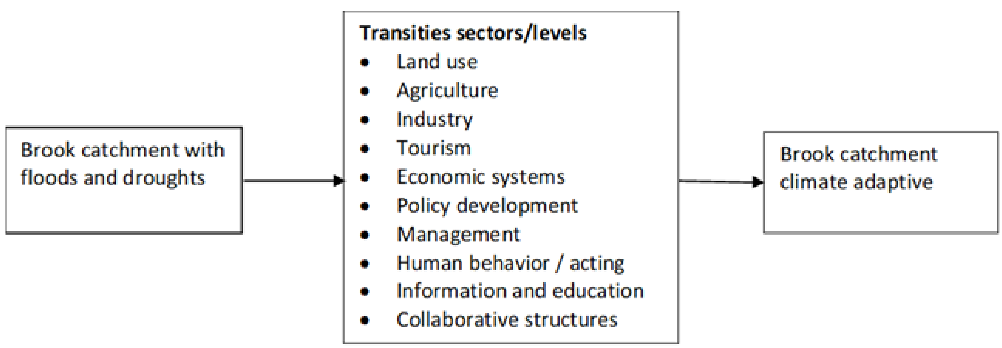

Fig. 5. Transitions within different sectors and levels. Kemp et al., 2007 & Rauschmayer et al.,2015

In this research a Transition Tool is defined as an instrument that supports the initiation and/or process of transition from the existing water management situation to a stable envisaged climate AWM practice. This could be the transition from highly productive grassland with a fixed groundwater level to 'wetland' with a natural groundwater level. The latter having an increased adaptive capacity to climate change.

1.7. Research area: Co-Adapt catchments

This research looks specifically at catchments affiliated with the EU Interreg 2 Seas Programme 'Co-Adapt: Climate adaptation through co-creation'. The eight catchments in Belgium, the Netherlands, France, and England involved in Co-Adapt all aim to become climate adaptive. Each catchment suffers from problems due to climate change, such as water shortages and flooding. The Co-Adapt project investigates NbS and their contribution to climate adaptation. Co-creation is central to Co-Adapt; sharing GP, insights, and experiences among the waterprofessionals should realise the move towards more AWM (Interreg 2 seas, 2020).

1.8. Research Question

The main question this research seeks to answer is:

How can KT and TT contribute to NbS and AWM within Co-Adapt brook catchments and how can tools be re-used in other catchments?

To come to an answer to the main question of this research, four studies are conducted (fig. 6):

RQ1. Adaptive Water Management
How do Co-Adapt brook catchments adjust their water management practice to address climate change and how can these small catchments further increase their institutional flexibility to enhance climate adaptation?

RQ2. Integrative sustainability analysis of tools
How can the Panarchy-model be used for an integrative sustainability analysis of tooling in the operationalization phase of NbS in brook catchments?

RQ3. Socio-Ecological System & Tools
What is the role of the Socio-Ecological System in KT and TT used by waterprofessionals in Co-Adapt?

RQ4. Transition Tools
In which project phase and with which (transition) goal can Transition Tools (identified from gray and scientific literature - and from Co-Adapt practice) be used in the transition to a resilient area development?

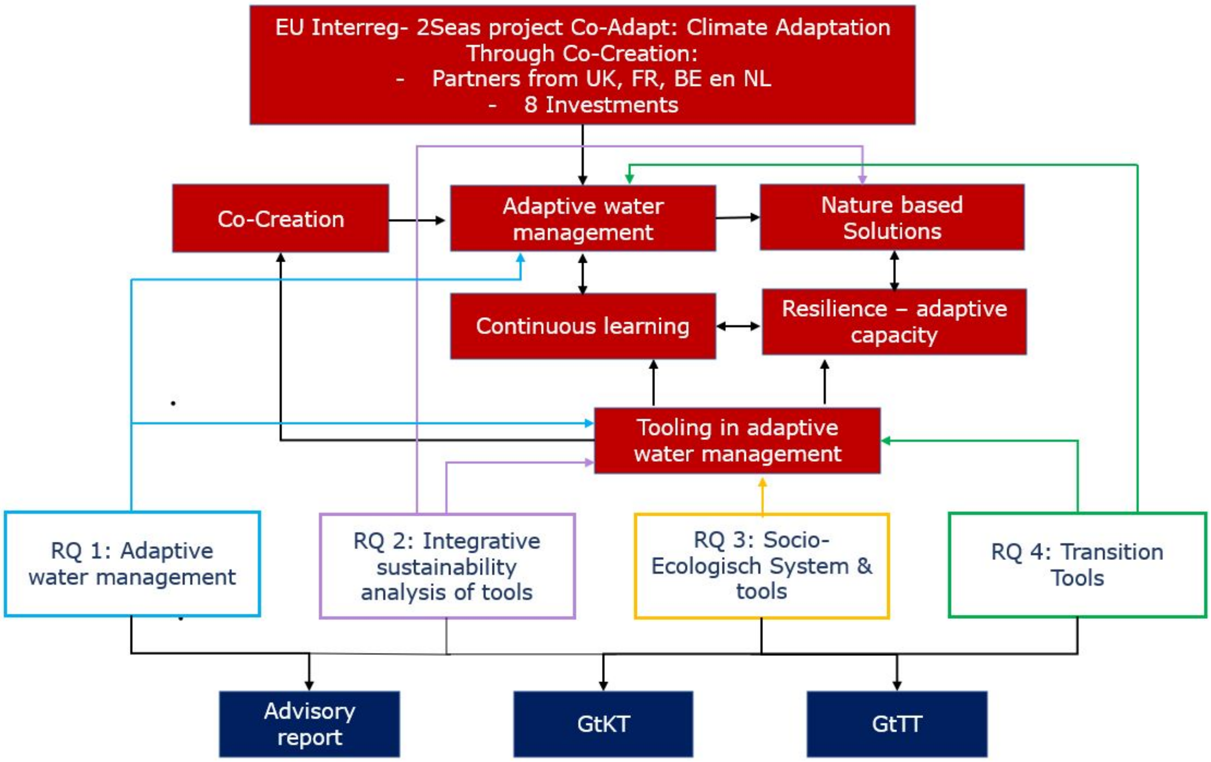

Fig. 6. Overview of the RQ's in relation to the problem analysis. The key terms (red boxes) reflect the relationships (black arrows) of the problem definition. The four RQ's (different coloured boxes) are connected (corresponding coloured arrows) to the key terms in the problem definition. The relationship of the RQ's with the products of this research (blue boxes) is also shown.

1.9. Objectives

Firstly, this report aims to contribute to the use of KT and TT in AWM and realising NbS by sharing findings obtained from literature research and studying tools submitted by Co-Adapt waterprofessionals.

Secondly, this research will contribute to the Co-Adapt objectives by creating a Guide to Knowledge Tools (G2KT) and a Guide to Transition Tools (G2TT) (Appendices A, B). These guides bundle tools received from catchments participating in Co-Adapt. Good practices (GP) that are collected are not assessed. The GP are collected in a Guide to Good Practices (G2GP) (Appendix C). The tools in the guides intend to inspire waterprofessionals within the Co-Adapt catchments and beyond. The guides aim to share experiences and to learn from each other's expertise.

The two objectives will result in conclusions and recommendations for waterprofessionals and water management boards to support their transition to AWM, to assess the effectiveness of tooling in realising NbS, to improve the guides and consequently increase the re-usability of the TT and KT.

2. Methods

To answer the main research question four studies are conducted. Each study has its own research question (RQ). For each RQ an analytic framework is developed based on literature study. The frameworks are used to assess information provided by Co-Adapt catchments.

2.1. Research Design

The generic research design is presented in figure 7. Data for the research is collected using a survey, webinars and interviews with the Co-Adapt waterprofessionals. The Tooling Guides (G2KT and G2TT) have been derived and created from the data collected with the survey. In the survey and guides catchments refer to all types of areas within Co-Adapt. In this research and in the four studies catchments refers to brook-catchments.

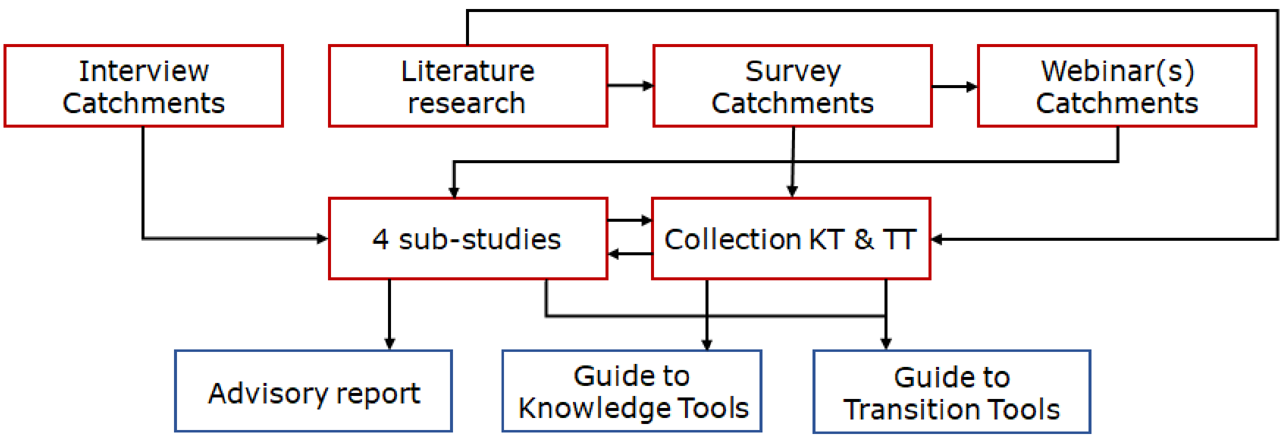

Fig. 7. A schematic view of the research design. The different steps in the research (red lined boxes) are connected (black arrows) to each other and to the products (blue lined boxes) as result of this research.

2.2. Data Collection

Tool Collection

The main objective of the assignment is to collect TT and KT from catchments involved in Co-Adapt and bundle these tools in the G2KT and G2TT. In order to complete this assignment, tools are collected with a survey that was sent to the Co-Adapt investments.

Survey to collect data

For this research a survey is drawn up to gather information about tools from the Co-Adapt catchments. The survey has three objectives:

1) The collection of KT and TT Co-Adapt catchments have used or are planning to use. The survey requested to share specific information about each tool:

- The type of tool;
- The objective of the tool;
- In what policy and project stages it can be used;
- To which ecological goals it contributes;
- The strengths and weaknesses of the tool;

- Some practical information.

The primarily aim of the first objective is to compile this specific information into a G2KT and a G2TT. The data is also used for assessments in the four studies.

2) The collection of GP of Co-Adapt Catchments. The GP could be tools that have been used or other good water management practices. It is requested to share specific information about each GP, such as:

- Description of GP.
- Contribution to climate adaptivity of catchment.
- Evaluation of GP: what worked well, what did not.
- To which ecological goals it contributed.

3) Obtain additional information. This information is used to identify the context in which the KT and TT can be deployed, but also to gather more in-depth data on the themes of the studies. The additional questions were on:

Adaptive water management: How is AWM defined in the context of the catchment? What are their objectives? Did the catchments make any adjustments to their governance practice, water management organization, policy and regulatory framework and project methodology to achieve these objectives?

Drivers and focus: The survey requested to share information about the (SES) drivers for selecting the TT and KT, and about the groups/sectors and the water management activities the tools are primary focusing on.

Literature and case study

A systematic literature study is conducted in each of the four studies. Literature data bases (web of sciences and Google Scholar) at the Open Universiteit library have been the main source for the scientific articles used. Based on the literature a theoretical framework is constructed to answer the main research question and to review the four themes of the studies. The literature study provides an in-depth understanding of how the four themes are perceived in an academic setting. This report aims to compare these academic views with real life cases from the catchments involved in Co-Adapt. For this reason, each study selected one or more cases from the tools and answers submitted in the surveys that could provide information about brook catchment practices regarding the theme of the study. These cases were discussed in interviews and in the webinars in order to deepen the understanding of the practice. Next, the cases were assessed in view of the theoretical framework and used to illustrate the findings of the literature research.

Webinar

In the research period three digital meeting were organised by the Co-Adapt Project. These webinars offered the opportunity to gather information used in this research and the guides.

- Pre-webinar (Oct 28th, 2020): Introduction survey and planning.
- Seminar (Nov 18th, 2020): Presentations on NbS in AWM.
- Post-webinar (Dec 9th, 2020): Share findings survey and presentation and discussions of GP submitted by catchments.

Interviews

For collecting additional information interviews have been conducted with waterprofessionals from the following Co-Adapt catchments:
- Aa of Weerijs, The Netherlands, Appendix D
- Province Antwerp, Belgium, Appendix E
- Laakbeek project, Belgium, Appendix F
- Somerset Levels and Moors, United Kingdom, Appendix G

Collection of Knowledge Tools and Transition Tools

TT and KT are collected from the Co-Adapt catchments using the survey. The tools received are bundled into two guides: the G2KT and G2TT (Appendices A and B). Also, Good Practices (GP) have been collected through the survey. The GP are not assessed in this research. The GP supplied by the waterprofessionals are both tools and other GP within AWM. The tools cannot be allocated to the G2KT or G2TT. Therefore, all submitted GP are bundled in a G2GP (Appendix C).

2.3. Data Analysis

The analytic framework developed for each RQ is used to assess information provided by the Co-Adapt catchments in the survey. Further in-depth information about some of the collected tools is derived from bilateral discussions with representatives of the catchments and from presentations during the post-webinar. In short, the studies developed the following frameworks to find an answer to the RQ:
RQ 1: The assessment of the degree of transition to AWM is based on three institutional factors: adaptive governance, cooperation structures and adaptive policy development.
RQ 2: The contribution of the tools and their effectiveness to realising NbS was assessed by using the Panarchy-model for each SD-domain: an integrative sustainability tool analysis framework.
RQ 3: To assess the effect of tools on the SES and the re-usability of tools two SES frameworks were combined.
RQ 4: The TT were analysed and defined on their contribution to the transition process based on a part of the extensive framework Adaptive Capacity Wheel (ACW).

3. Results

3.1. Adaptive Water Management in Co-Adapt catchments

To identify how KT and TT contribute to AWM, first an assessment is conducted to the AWM practices of waterprofessionals in Co-Adapt catchments. Relevant is to what degree institutional arrangements support continuous learning and flexibility in water management. For this study data is assessed received from Co-Adapt waterprofessionals.

Data analysis: compelling a normative framework

A normative framework is constructed to assess how Co-Adapt water management boards address the complexity and uncertainties of climate change in their water management practice and institutions. To enable water management agencies and thus societies to adapt to uncertainties, complexities, and the dynamics of climate change, water management institutions must become more flexible (Peat, et al, 2017). Consequently, the normative framework includes institutional factors that could increase the institutional flexibility and therefore support the movement towards AWM. Huntjens et al. (2010) defined an analytic framework consisting of nine institutional factors. These are: agency, awareness raising & education, type of governance, cooperation structures, policy development, information management & sharing, risk management and effectiveness of international regulation. For this study three core institutional factors from Huntjens et al. (2010) are selected to create the normative framework. These factors are adaptive governance, cooperation structures and adaptive policy development. Each factor and its indicators are presented in table 3. The factors are selected because they facilitate the transition from conventional to adaptive water management (fig. 8). Furthermore, these factors enable the other institutional factors identified by Huntjens et al. (2010). For example, cooperation structures enable information sharing and education. The assessment of the water management practices creates a view of the current state of transition to AWM in Co-Adapt catchments.

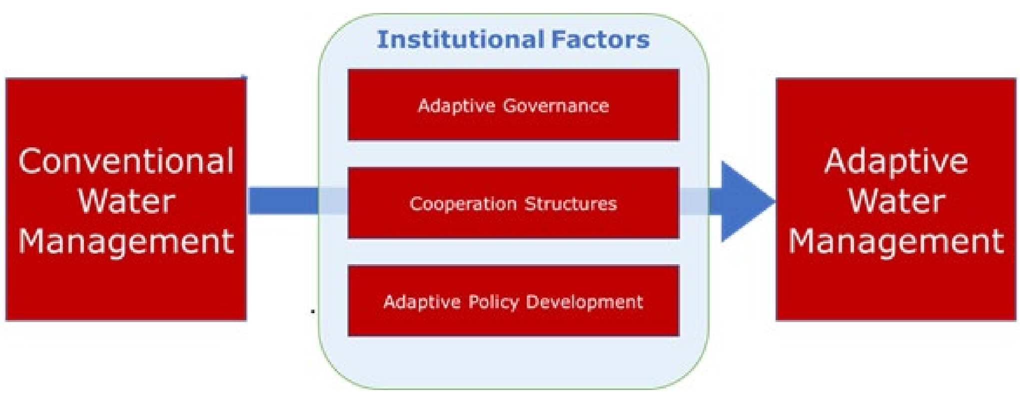

Figure 8: The transition from conventional to adaptive water management through flexible institutions

In this study the following definitions are used for the institutional factors:

- Adaptive Governance: the dynamic structures and processes by which societies share power, and shape, individual and collective actions regarding the management of natural resources (Paet et al., 2017). This study focusses on the degree to which power is shared between centralised and decentralised stakeholders.

- Cooperation Structures: both formal and informal actor networks. It includes the level of, or provisions for, stakeholder participation, cross-sectoral cooperation, and the cooperation between administration levels (Huntjens et al., 2010).
- Adaptive Policy Development: flexible policies which can be adjusted if needed based on conclusions from monitoring and evaluation. Flexibility is created by defining flexible measures, discussing alternative scenarios, and conducting small-scale policy experiments (Raadgever et al., 2008).

Factor	Indicator
Adaptive governance	Polycentric decision making
	Balance between decentralized and centralized control.
	Lower-level governments are involved in decision making by higher level governments
Cooperation structures	Cross-sectoral cooperation: active involvement of other government sectors (e.g., agriculture, environment, tourism, forestry, spatial planning)
	Level of or provisions for stakeholder participation, including non-governmental stakeholders (e.g., NGO's, user groups, citizen groups or private sector)
	Non-Government stakeholders actual contribute to the agenda setting, analysing problems, developing solutions, and taking decisions.
	Conflicts are dealt with constructively, resulting in inclusive agreements to which parties are committed
Adaptive policy development	Flexible measures, keeping option open
	Experimental small-scale policy experiments
	Alternatives and scenarios are discussed and included
	Monitoring and evaluation mechanisms are in place. Adjustments are made.

Table 3: Factors and indicators of Institutional flexibility (Huntjens et al., 2010)

Results: Assessment documented AWM practices River Basins

First the normative framework is used to assess documented advanced AWM practices from (scientific) literature. The catchments assessed represent river basins with a relatively advanced adaptive management practice: Lower Rhine or Rhine-Delta in the Netherlands, Upper Elbe in Germany, The Thames in the United Kingdom, Alentejo or lower Guadiama in Portugal and the Hutt River in New Zealand[1]. The normative framework has been applied to these practices. From the river basins the most advanced institutional factors and indicators were selected. The selection is based on the appraisal of the indicators of the framework in the research article. A summary of the information collected is presented in appendix D. The results of this assessment are illustrations of the normative framework with indicators for advanced AWM practices. These indicators could be an example for smaller catchments how to further increase their institutional flexibility in order to enhance climate adaptation.

Results: Assessment Survey data Co-Adapt catchments

The normative framework is used to assess data provided in the survey by six Co-Adapt catchments: Vlissingen (the Netherlands), River Culm (U.K.), Somerset Levels & Moors - Parrett / Tone & Axe / Brue (U.K.), Porlock (U.K.), Liane (France) and Laakbeek (Belgium). The waterprofessionals were asked to define AWM for their specific water management practice. As expected, it shows that the agencies primarily focus their approach to increase the resilience of the catchment in order to reduce the risks of flooding and in some cases droughts. Solutions are mainly technical, and nature based, aimed to restore natural processes of rivers and brooks and to increase ecosystem function. With regard to the

[1] References: Haasnoot et al. (2013), Huntjens et al. (2010), Huntjens et al. (2011), Lawrence et al. (2018), Pahl-Wostl (2009), Pahl-Wostl & Knieper (2014), Ranger et al. (2010).

institutional arrangements, all six catchments primarily focus on cooperation structures. That is the second institutional factor of the normative framework. The indicator most identified is the provisions for non-Government stakeholder's involvement in the development of solutions. The information provided about Co-Adapt water management practices show little evidence on developments with regards to the first and third institutional indicators of the normative framework: adaptive governance and adaptive policy development.

Results: Assessment Co-Adapt catchment Aa and Weerijs

The answers submitted in the survey with regard to AWM by catchment Aa and Weerijs (The Netherlands) are very similar to the responses of the other six Co-Adapt catchments. The primarily focus of the AWM approach of the province Noord-Brabant is to increase the resilience of the catchment in order to reduce the risks of flooding and in some cases droughts. The main objective is to develop cooperation structures, the second institutional factor of the normative framework. However, the waterprofessional from the province Noord-Brabant was asked to provide answers to additional questions with regard to the three institutional factors and related indicators of the normative framework. The additional information provided show efforts have been made to develop the first and third institutional factors of the normative framework: adaptive governance and adaptive policy development. Consequently, it must be considered that also other catchments could have made an effort with respect to these institutional factors, which did not come up in the survey. An overview of the additional information from Aa and Weerijs is presented in Appendix D.

3.2. A Panarchy-based sustainability analysis of tooling

The transition from CWM to AWM is a complex adaptive process. Tools can support that transition. In this section data about tools are assessed by using the Panarchy model for a sustainability analysis. The problem is that there is no tool analysis framework on the three SD-domains integrative. The Panarchy-model seems to fit that need, because it describes complex adaptive systems. This study tests the usability of the Panarchy-model in usage of an integrative sustainability analysis of tooling.

Data collection

This merged framework is used to assess data from one Co-Adapt case: Laakbeek project, Beerse Belgium. The tools are analysed by describing the system's change according to the Panarchy phase and parameters for each SD-domain (fig. 9). The choice for this project was made pragmatically. The information was collected through the survey and two interviews. The interviews were held with waterprofessionals from Co-Adapt (appendix E and F). The Laakbeek-project is about a small river in the city of Beerse, which has been flooded in 2014 and keeps threatening ever since. The collected tools are shown in text

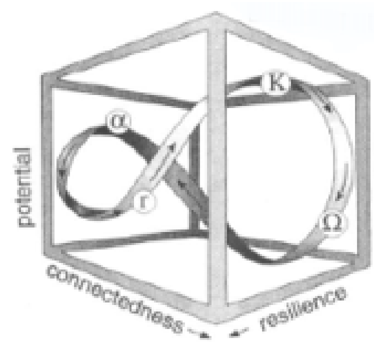

Figure 9:.Panarchy's parameters and phases. (Holling, 2001)

1. Models: hydrological, forecasts, statistical analysis: KT1
2. Citizen-call, September 2019. (Antwerpen 2020c)
3. Face to Face: KT2
4. Online Ideation: CT1
5. Survey: KT3
6. Participation-evenings (2x) Round table TT2; Public meeting CT 3
7. Landscape planning CT2/GP1 + video: GP2
8. Flyer: about the suggested solution (Antwerpen 2020b): TT1
9. Naming contest: 'Laakland'; Request for license for construction (1-2021)

Textbox 4: The selection of nine shared tools of the project of Laakbeek. The name of the KT/TT/CT correspond to the name of the tool in the Survey. Collected from (Antwerpen 2020a, b, c: Appendix).

Findings

System change

The collected data describes *the back loop - Decline phase (Ω) plus the Reorganization phase (α)* - of the Panarchy on the social domain (textbox 2). This phase is known as to be characterized as highly unpredictable, uncertain and have weak control mechanisms (Holling, 2001). The increase in *social connectivity* started by a natural event in the ecological domain, the flooding. Consequently, the *social connectivity* (belief, trust) came to decrease. As a result a decrease in local economic aspects were expected (damage, insurance claims and decreasing in market value e.g.). The risk and concerns of next floods keeps the *connectivity* low on social and economic domain. The ecologic domains seems not much disturbed at this moment: the flooding was not that heavy or long-lasting. Therefore, only individual adaptation of plants can be expected: that is moving through the phase of one Panarchy. In case of much heavier flooding, it is expected to act as a shock, which would move the system state into a *revolt-movement* (textbox s). A revolt can be seen as a system crisis. Nevertheless, the ecologic system is expected to go through a *revolt movement*, when the ecologic park – Laakland - will be constructed. Heavy machinery and digging will bring the ecologic balance in such disbalance that it destroys the ecologic system. Afterwards, the *Remember-phase* will follow and a new ecologic balance will be found. After a couple of years it is expected that the ecologic system has found a new kind of balance. When the area proofs itself in flood prevention and water retention, both *connectivity* in social domain and economical domain will increase.

The effects on the economic domain are hardly seen in the data. This could be expressed for example in less insurance claims, less water damage, increase in *the wealth* of living in Beerse and surroundings (*both social and economic wealth*). These are not seen in the collected data. The costs are covered for 60% by Co-Adapt, which can be seen as increasing *Economic Potential* on the level of water management. This made a different approach possible: more focus on NbS and co-creation. On project level there is seen some small movement in increasing *economic connectivity*: that is the belief that such approach (Co-Adapt: co-creation, NbS) has benefits (interview Appendix E and F).
The subsidy made movement over a threshold for economic decision-making possible. The K-level thresholds is high due to high economic *potential*. The threshold in the K-phase of the economic domain is high, partly because of the high economic *potential*. High *potential* is a risk for rigidity, increasing vulnerability/decreasing resilience (Slight et al. 2016).
If NbS-strategies in future actual turn out to be economical beneficial, this pathway - *Co-Adapt: NbS by co-creation* - can act as example for other projects and governances. If that is the case, the *economical connectivity* - the belief in these kinds of projects - increases, which makes the economic K-threshold relatively smaller.

Effects of tools

The Laakbeek project started citizen involvement from the beginning (tool 2-9, textbox 4; figure 10). The attributed effects can be described as a decrease in social *connectivity*. Because of that effect, a revolt-movement seems to be prevented on the social domain. That is: the flooding only resulted in a small dip in trust, not a deep social crisis. The citizens of Beerse are said to have high climate awareness (reason therefore unknown (Interview, Appendix E and F). This can be seen as a high *social potential*, which makes movement towards *renewal* (from Ω to α) easier. After tool 5, a lot of pioneering ideas for the project area arose (*Radical innovation)*. The predictability and *social connectivity* started rising.

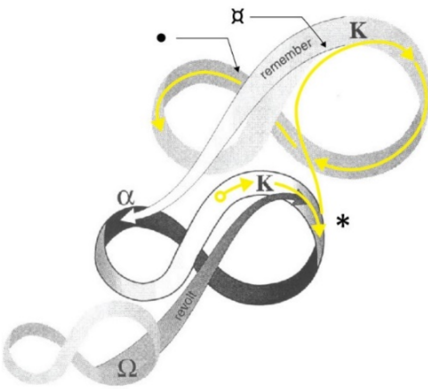

Figure 10. The movement in system state on the social domain illustrated by yellow arrows.
*****trigger: the actual flood (2014).
After the flood, a revolt-movement (upwards) was trigger; the system moved to a higher Panarchy. The influence of citizen involvement (tool 3, 4, 5, textbox 4) marked by **¤**, prevented a crisis and deflected the movement towards Ω-phase of the higher Panarchy. • marks the position of (tool 6; textbox4)

The economic aspects are covered by the Co-Adapt project. That is one explanation why not much social tumult has been seen. The influence of Co-Adapt made different decision making possible; expressed as relatively lowering the threshold on K-phase on economic domain (figure 11).

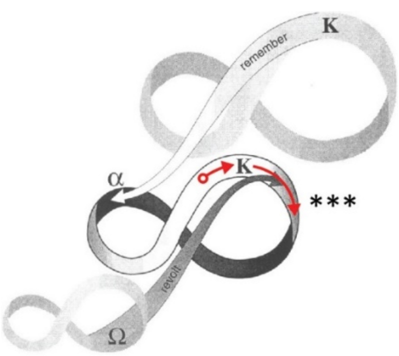

Figure 11. The movement in system state on the economic domain illustrated by red arrows. The levels are not specified. ******* marks the influence of the Co-Adapt project.

When the project plan came ready (tool 7 and 8) the social trust increases further. That can be seen as the start of the Front loop on the social domain - *exploitation-phase (r) plus the conservation-phase (K)* -. *Social connectivity* will further increase when the park is being made and citizens can see the progress and/or collaborated in the construction. The increase in *social connectivity* can have positive stimulating effects to similar other projects and /or to higher social levels. This can be translated as growth in *potential and connectivity* or even *social resilience*. It is normal to expect (in the r-phase) that the *social connectivity*, 'concern' will lower down, as also the *potential* (socially; idea's, capacity of collaboration) when the park has been made (Holling, 2001). That are normal effects due to decreasing need.

On ecologic domain adaptation is expected during the analysed period. That is passing the phases of one Panarchy. For the next period, next summer, it is expected the construction of the area will start. This will drastically disrupt the ecologic balance (necessary for creating a new system). This can be seen as a Revolt-movement, quickly followed by a Remember-movement to a lower Panarchy (blue arrows in figure 12): The Revolt-movement can be seen as system destruction. In this case it is expected that the system will not be able to reach the K-phase, because there is no high Connectivity nor high productivity; plants and balances are harmed due the construction by machines. Instead, the system state will tumble down to a lower Panarchy'α-phase a cascade downwards: The Remember-movement. Correspondingly the area will look damaged directly after the creation of the ecologic park. The seeds (the leftovers; remember-mechanism) and the planted plants will then soon start to grow start of the renewal /α-phase on a lower Panarchy.

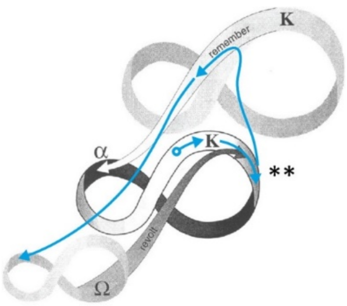

Figure 12: The hypothetic future movement in system state on the ecologic domain illustrated by blue arrows. From a not specified level of Panarchy, the system gets triggered by the construction of the Ecologic Park: Laakland. This is marked by ******. A Revolt-movement follows resulting (upwards) in a Remember-movement (downwards) ending at a α-phase of a lower Panarchy

Concluding results
The analysis shows that in different phases (of Panarchy) different contribution can be helpful. This information can be used to determine which parameter - potential, connectivity or resilience - should be dealt with first. And on which domain - ecology, economy, social - the focus should be on. The support function of tools can be explained tools by the change in system state. Water managers can use this analysis and could use it for a more desired system change or state. The analysis also shows the inter-dependence of the domains, which substantiated the recommendation for an integrative approach.

3.3. Socio-ecological systems and tools

For waterprofessionals to be able to re-use tools it is important to know if the tools are suitable for the SES the waterprofessional works in. According to Hamilton et al. (2015), for a successful application of tools for complex environmental problems, the purpose of the tool and the context for tool use should be taken into account. The SES provides the context in which a tool is used. The system dynamics and the ecological knowledge define the purpose of the tools. This section discusses the role of the SES in tools used by waterprofessionals in Co-Adapt; what were drivers for tool selection and how did the tools impact the SES?

Data analyses
For researching the influence of the SES on tool selection and usage, two SES frameworks were combined. Mc Ginnes and Ostrom (2014) created a SES framework that contains of four subsystems: *resource system, resource units, governance systems* and *actors*. These interact with each other and lead to SES outcomes (Barrett et al., 2019). Each subsystem is divided in multiple variables denoting its characteristics. In this study these variables are used to research the role of the SES in tool use. This framework is combined with the

framework from Colding and Barthel (2009) based on Berkes and Colding (1998), because of its clearly visualized relationship between the socio-human and the ecological part of the SES. The subsystems *resource system* and *resource unit* are placed within the ecological side and the subsystems *governance system* and *actors* are placed within the social side of the SES (Fig. 9).

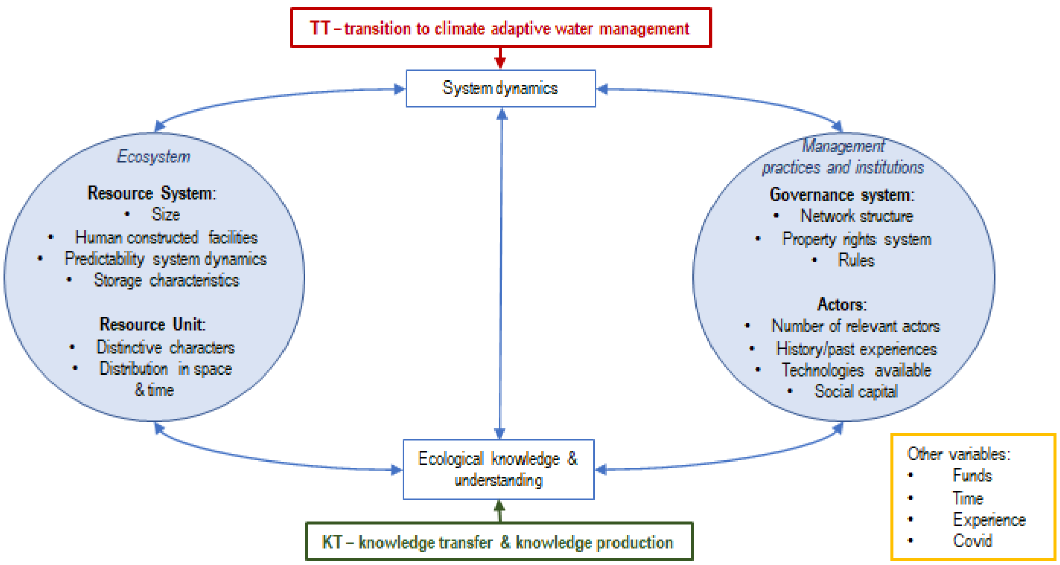

Fig. 9. The connection and interaction of KT (green arrow) and TT (red arrow) with the characteristics of the SES. The right circle shows characteristics of the social side of the SES, the left circle shows characteristics of ecological side of the SES. Other variable for tool selection are shown in the yellow box. Based on a combination of the conceptual framework for the analysis of SES taken from Colding & Barthel (2019) and of the framework for SES taken from McGinnis & Ostrom (2014).

Beside the variables of the SES, other possible drivers for tool selection have been assessed; funds, time, experience with tool (Hamilton et al., 2015) and Covid. Covid occurred during the period of this research and could have influenced waterprofessionals in tool selection and use considerably. The information for this study was collected through the survey, webinars and an interview with waterprofessionals from the U.K. catchment Somerset Levels & Moors (SLM) (appendix G and H).

For analysing the drivers for tool selection waterprofessionals were asked to select drivers from the variables of the SES from the SES-framework and the additional context variables funds, time, experience and Covid-19 (fig 9) for each separate TT and KT. There was also the possibility to select 'other' as driver for tool selection.

For researching the impact of tools on the SES, a selection of tools has been analysed. This selection is made on the criteria that the tool had actually been used and had been evaluated by a waterprofessional.

Results - Drivers for tool selection

The variables of the subsystem a*ctors* seem to be the most important driver for tool selection for Co-Adapt waterprofessionals (table 3). *Social capital* is most frequently chosen driver for both KT and TT.

For the waterprofessionals of SLM *social capital* plays a major role; e.g. tools were selected in order to address separation between stakeholder groups, to address general mistrust of the community in authority and to encourage farmers to work collectively.

Covid is of great influence on tool use; there has been a shift from live tools to online tools. The waterprofessionals from SLM indicate that in a pandemic-free world they would never use only online tools. After Covid they would like to do part of the process live and part

online. As they notice advantages – e.g. reaching a different audience – and disadvantages – harder to reach the community – in using online tools.
It is found Co-Adapt waterprofessionals select tools on the specifics of their SES, mainly on the characteristics within the sub-system *actors*. This aligns with the focus of Co-Adapt on co-creation; the stakeholders involved by waterprofessionals for co-creation belong to the sub-system *actors.* The information from SLM shows that waterprofessionals select tools fit for conditions that are very specific to the SES in which they work. Consequently, it is difficult to re-use tools in other catchments, because of the differences between the SES.

It is pointed out that tools waterprofessionals select and use, also depend on the level of the socio-human part of the SES. Waterprofessionals from organisation belonging to different SES-levels seek to address different actors. This leads to selecting different tools.

Variables		Transition Tools - Total 9			Knowledge Tools - Total 12		
		Number of times chosen	Times chosen - percentage	Average points (max 3)	Number of times chosen	Times chosen - percentage	Average points (max 3)
Resource Systems	*Size of resource system*	2	22%	2	6	50%	1,8
Resource Units	*Distribution space/time*	5	56%	2,2	6	50%	1,3
Actors	*Number of relevant actors*	4	44%	1,8	8	67%	2,4
	History/past experiences	5	56%	2,2	5	42%	2
	Social capital	6	67%	2,5	8	67%	1,9
	Technologies available	3	33%	2,7	4	33%	2
Other – additional context variables	*Costs*	1	11%	3	4	33%	1

Table 3. An overview of a selection of the variables chosen in the survey as drivers for tool selection by waterprofessionals. The waterprofessionals were asked to indicate for each separate KT and TT they submitted, which variables were drivers for selecting a specific tool and to give a value of 'little importance' - 1 point -, 'some importance' - 2 points -, or 'great importance' - 3 points - to this driver. The variables that were chosen most often (for ≥ 50% of the tools, yellow boxes) and/or got the highest point average ((≥ 2,5 points, blue boxes) are presented in this table.

Results - Role of the SES in tool use

It is found all tools were called successful by the waterprofessionals because of their direct impact within the subsystem *Actors (table 4);* this will be elucidated on the basis of a few examples. The *landscape & planning* tool provided clear preconditions for stakeholders about the measures possible by providing a virtual budget to spent. Hamilton et al. (2015) acknowledges that providing a clear context is important for system actors to adopt certain measures. The objective of the *creating safe space* tool - stimulate stakeholder who have difficulties expressing themselves - is in line with the research of Jakeman et al. (2006). This research warns for exclusively engaging the "usual suspects"; small but vocal groups of stakeholders who are already widely engaged in research and policy debates. The waterprofessionals from SLM found that the tools they used were very time consuming, but necessary to keep stakeholders involved. This is consistent with the research of Hegger and Dieperink (2014), that observed that for a project to be successful, it is important to acknowledge stakeholder involvement is a demanding process. The impact on the ecological side of the SES is seen as a result of the effect tool have on the involvement, understanding and/or behaviour of stakeholders. According to the waterprofessionals this will create acceptance, support and/or active involvement of stakeholders for the measures that have to be taken (table 4).

Concluding, the tools used within Co-Adapt focus on initiating change within the sub-system *actors* of the socio-human side of the SES, which results in creating opportunities for transitions in the ecological side of the SES.

Co-Adapt Catchment	Name Good Practice	Achievements within the sub-system *Actors*	Contribution to achieving ecological goals
Somerset Levels	Face to face meetings	Long term engagement; minimising disengagement stakeholders	Ensures knowledge transfer for duration of project; ensure long term project objectives
	Communicating feedback to community	Development of trust; creating insight in results from earlier events for community	Increasing engagement and willingness to undertake adaptive measures; enables the overall effectiveness of the project; social capital is a precondition for adaptive capacity
	Creating safe space	Stimulate stakeholders to express themselves for whom this is difficult, preventing people swaying opinion, bringing those with opposing views together	Ensure local communities understand and accept the investments we make through the project
Laabeek, municipality Beerse	Video to inform stakeholders	Creating transparency for stakeholders; engaging a wider community/broader network	
	Involving designers and politicians	Confidence to stakeholders that their ideas and concerns are listened to	Keeping an eye on the technical borders for the realisation of NbS
	Landscape and planning (sell and buy tool)	Create discussion and interaction among stakeholders; give clear preconditions to stakeholders (give virtual budget); get different opinions of stakeholders	Stakeholders are involved and collaborating for implementing measures
Porlock	Knowledge tool - Webinar	Bringing together expertise and convey this to easy-to-understand information for stakeholder.	Developing innovative NbS that restore natural process; adds to learning and understanding of NbS which are vital in developing ecological resilience

Table 4. An overview of all the GP in tool use submitted by waterprofessionals within Co-Adapt in the survey. The impact of the tool within the sub-system *Actors* and the contribution to achieving ecological goals is mentioned for each GP.

3.4. Transition Tools

Waterprofessionals are looking for tools to support the transition process to improve the resilience of the catchment to floods and drought (Interreg 2 Seas, 2020). This study assesses the contribution of TT to the transition towards a resilient area development. The insights and additional information this generates, must increase the reusability of the TT. Transition research aims to develop tools that take the complexity of ecological and social systems into account. The research route applied aims at assessing and describing tools that influence transitions that focus on actor-based processes (Rauschmayer et al., 2015).

Data collection

Twelve TT were submitted by the Co-Adapt waterprofessionals. In the survey it is asked to indicate in which project phase the TT have been applied. In table 5 the results are shown. A Systematic Literature Review (SLR) was carried out to compare the TT submitted with scientific knowledge. To assess whether the TT support the waterprofessionals in the transition process, part of the extensive framework Adaptive Capacity Wheel (ACW) prepared by Gupta et al. (2010) and expanded by Grothmann et al. (2013) was used. The ACW is used to assess whether institutions stimulate society's adaptability to respond to climate change. In this study only the ACW-dimensions have been used aimed at assessing social factors. These dimensions are: (1) variety; encourage the involvement of a variety of perspectives, actors and solutions, (2) learning capacity; enable social actors to continuously learn and improve their institutions (3) room for autonomous change; allow and motivate social actors to adjust their behaviour (Gupta et al., 2010), (4) adaptation motivation; refers to the motivation of decision makers and other actors to realise, support and/or promote adaptation to climate change and (5) adaptation belief, refers to the ability of actors and decision makers to adapt to climate change (Grothmann et al., 2013).

Results project phases

Most TT have been applied in the motivation phase and implementation phase. In the motivation phase actors are convinced to participate in the co-creation process. During the implementation phase agreements are made and the action plan is drafted. Table 5 shows in which project phase the TT have been applied.

Transition Tools	Evidence-based findings of method by waterprofessionals	Project phase
1. Schools and education materials and resources	Scientific knowledge corresponds to the definition of water professionals. In addition, literature indicates that the teaching material should be used from primary education to university level (Torres et al., 2020)	Implementation
2. Webbased survey - maptionnaire	Literature provides a broad description of the tool, but the scientific knowledge broadly corresponds to the definition of water professionals (García-Díez et al., 2020).	Problem definition
3. Citizen Science	Scientific knowledge corresponds to the definition of water professionals. (Bela et al., 2016)(Kullenberg & Kasperowski, 2016)	Implementation
4. Flyer	Scientific knowledge corresponds to the definition of water professionals. (Steuri et al.,2020)	Motivation
5. Round table	The water professionals indicate that the stakeholders are divided into small groups. This is not stated in the literature found. Scientific knowledge and the definition of water professionals are broadly similar (Pisarski & Ashworth, 2013)	Project definition
6. Permanent information plaques	Scientific knowledge corresponds to the definition of water professionals (Wikipedia)	Policy proces: formulation
7. Story map	Scientific knowledge corresponds to the definition of water professionals. (Torres et al., 2020)	Motivation
8. Travelguide climate robust river landscapes	Nothing specific has been found in literature about these tools. However, another way has been found to make people aware of climate adaptation, such as through serious games (Fleming et al., 2020)	Policy proces; Formulation
9. Design thinking – Embassy of water	According to literature, design thinking is people-oriented design. In terms of theory, this corresponds with the description of the water professionals depending on how design thinking is used (Gobble, 2014)	Motivation
10. Public Citizen Meeting	Literature provides a broad and general definition of public citizen meeting. Water professionals indicate how and with whom they organized the public citizen meeting. The manner of organizing falls under the definition of scientific knowledge (McComas, 2011)	Policyproces: decision-making
11. Capital invesment	Capital investment is a broad concept and can be used to realize small and large projects in the field of water management. Funding can be used from various sources. The ultimate goal is to tackle the effects of climate change. This applies to both the Co-Adapt catchments and the funding objective described in the literature	Motivation
12. Financial subsidy	Scientific knowledge corresponds to the definition of water professionals (Buelow & Cradock-Henry, 2018)	Implementation

Table 5. Evidence-based findings of method by waterprofessionals

Results Systematic Literature Review TT

From the survey data it could not be determined whether the TT are scientifically substantiated. SLR is performed to determine the scientific knowledge of TT. The evidence-based findings of methods used by waterprofessionals are shown in table 5. TT 1,2,3,4,6 and 7 correspond to scientific knowledge. Transition Tools 5,9,10 and 11 broadly correspond to scientific knowledge. TT 8 does not correspond to scientific knowledge. Scientific knowledge about some TT can provide additional support to the waterprofessionals in the transition process, such as; creating sense of place, framing discussions of complex and sensitive issues in an inclusive and non-threatening way and aligning people's needs to what is technologically feasible.

Results assessment TT
The scores of the assessment of the TT on the basis of the ACW framework are shown in table 6.

Transition Tools	Total score
1. Schools and education materials and resources	22
2. Webbased survey - maptionnaire	18
3. Citizen Science (collect water quality and environmental data)	22
4. Flyer	5
5. Round table	24
6. Permanent information plaques and accessibility of the project area	10
7. Story map	21
8. Travelguide climate robust river landscapes	22
9. Design thinking – Embassy of water	19
10. Public Citizen Meeting	23
11. Capital investment	24
12. Financial subsidy	21

High score	Medium score	Low score

Table 6. Results assessment Transition Tools

TT 1,3,5,7,8,10,11 and 12 have a high score on basis of the ACM framework. These tools stimulate the involvement of different actors (variety) by asking the community to participate in co-creation processes, sharing local knowledge and providing information in an engaging way.

In addition, there is a high score for "room for autonomous change" because there is easy access to (guided) information. There is an increased community awareness of the consequences of climate change and of the urgency of the measures to be taken.
TT 2 and 9 score medium. These tools support waterprofessionals in the transition process. Only data provided by citizens can give a distorted picture (tool 2) and tool 9 can appear artistic or abstract because citizens are not interested in the topic of climate change.
TT 4 and 6 score low. These tools do not explicitly support waterprofessionals in the transition process. These tools only provide information about participation in the co-creation process and share information about the implemented measures.

Concluding results
The TT are applied in different project phases to involve and inform the community about participation in the climate adaptation projects. Ten of twelve TT contribute to the transition process. Two TT contribute to information sharing. The transition goals of TT are; stimulate the involvement of different actors, share local knowledge and provide information in an engaging way, increase awareness about the consequences of climate change and the need for measures to be taken.

4. Discussion

This research is conducted within the practice of the Co-Adapt catchments. The information has been provided by waterprofessionals working for these catchments. A substantial part of the information is gathered through a survey. Some surveys were not filled in completely, resulting in less and often incomplete information. This can give a distorted picture and may have created gaps in the research results. The formulation of the questions in the survey might have influenced the answers given by the waterprofessionals, and therefore the results of this research. The survey has not been validated. If this research is repeated in the future and/or in other catchment, it could lead to different results.

This research is based on data provided in the survey by seven Co-Adapt catchments. Follow-up research in each of the studies is often done for only one of these catchments. The AWM study for Aa of Weerijs, the Netherlands, the NbS study for Laakbeek, municipality Beerse in Belgium, and the SES study for Somerset Levels & Moors, U.K. Because of the scope of the data collected for this research, it is likely the picture of the current water management practices is yielded. Additional research of the catchments concerned is required to complete the picture.

Co-Adapt partners are not representative for all waterprofessionals working in Northwest Europe. They are involved in the Co-Adapt program and therefore willing to implement NbS. Consequently, a bias is expected in their tool selection; they are all willing to cooperate and implement NbS through co-creation. By researching Co-Adapt catchments, conclusions can be drawn for tools and AWM within Co-Adapt. The information cannot be used as a reflection on common water management.

The AWM study aimed to understand how institutional flexibility can be created for water management agencies to improve the climate adaptability of brook catchments. The assessment performed is based on a normative framework first used by Raadgever et al. (2008) and Huntjens et al. (2010). Huntjens et al. (2008) identified nine dimensions of variables. However, the assessment in this study is limited to three dimensions.

Tools

For researching the purpose and context of tool use connected to the characteristics of the SES, a selection of these characteristics was made on forehand. Consequently, the information collected on the role of the SES in tool use might be incomplete and missing out on important drivers for tool selection and impacts of tool use within the SES.

There is no existing framework for analysing tooling for NbS. A merged framework has been tested in this study. It suggests determining the effectiveness of tools by looking at the impact on the SD-domains by using a Panarchy-approach. Often the assumption is that change is the result of using the tool. This is not necessarily the case: correlation does not necessary means causality. The causality has not thoroughly been validated but was checked on reasonability. Furthermore, both begin and end state measurements should be included in the assessment to be able to really measure the effects. Therefore, effects are now assumed, not objectively measured. The application of the Panarchy-model on the economic domain is not conventional and therefore a test-case. Further validation is needed.

As a result of the way survey questions are drafted and due to the incomplete answers, the information provided was static and informative. Consequently, it is not possible to draw conclusions on whether a TT contributed to the transition toward AWM and thereby contributed to implementing NbS.

From the survey data it could not be determined whether the TT were scientifically substantiated. Systematic Literature Review is performed to determine the scientific knowledge of the tools. Based on scientific knowledge, the TT should be re-defined as instruments that involve, inform, and raise awareness among actors. The initiated a shift in thinking about how to deal with climate change, and more specific climate adaptation.

5. Conclusion

The aim of this research is to find an answer to the question how KT and TT contribute to NbS and AWM within Co-Adapt catchments. Additionally, it aims to find how these tools can be re-used in other catchments. For answering these questions four studies are completed.

How KT and TT contribute to NbS and AWM
First, an assessment into the AWM practices in Co-Adapt catchments is conducted. It shows that the waterprofessionals primarily focus their approach to increase the resilience of the catchments in order to reduce the risks of flooding and in some cases droughts. Solutions are mainly technical and nature based. They aim to restore natural processes of rivers and brooks, and to increase ecosystem functions. Regarding the institutional arrangements, the catchments primarily focus on cooperation structures. More specific the structures in place to involve governmental and non-governmental stakeholders. Consequently, most KT and TT collected and gathered in the G2KT and G2TT support stakeholder involvement. The most frequently named driver for tool selection in Co-Adapt is the SES-subsystem *actors.* This indicates that stakeholders are important in tool use, and tools might be deployed to facilitate cooperation. According to the waterprofessionals, the tools contribute to achieving ecological goals by creating understanding, increased and continued engagement, acceptance and involvement of stakeholders for the measures that have to be taken to realise NbS.

However, it cannot be concluded if the TT and KT are effective and to what degree they contributed to the transition to AWM and the realisation of NbS. The transition from conventional to AWM supported by tools, is a complex process in time. Currently no tool analysis framework is available to assess tools and their effectiveness.

How can KT and TT be re-used
Tool selection is a complicated process. Waterprofessionals select tools based on the conditions specific for the SES they are deployed in. Consequently, to be reused tools should be adjusted to the specifics of the SES they will be used in. Beside the SES-specifics, successful implementation of tools is determined by the role of the responsible waterprofessional. Because of these complexities, adopting existing tools without adjustments is difficult, if not impossible. Additionally, obstacle to the re-use of the Co-

Adapt TT and KT collected, is the absence of information on the effectivity of the tools and condition in which they are deployed.

A comprehensive assessment of the effectivity of tools will increase their reusability. Therefore, more information should be collected over time (initial and final state), regarding the contribution to three sustainability dimensions and the phase the system is in. The Panarchy-model has potential for being used as an integrated sustainability tool analysis framework. The model includes the entire transition process, the three sustainability domains and the ecological, economic, and social impact. An integrated sustainability analysis could show if tools contribute to one or more of the Panarchy characteristics: potential, connectivity and/or resilience. These insights can indicate the usefulness of tools to support the objectives they are selected for in the context they will be deployed.

6. Recommendations

The G2KT and G2TT (Appendix A and B) are composed based on information received in the survey. The guides are in fact collections of tools without objective criteria and guidelines for usage. There are several recommendations to enhance the informative value of the guides and hence the re-usability of the tools. Also, some recommendation for tool use in general are added. Additionally, there are scientific recommendations, which show options for further research for evaluating and validating tools.

6.1. Recommendations for waterprofessionals & water management boards

1. Define effectivity of the tools.

Definitions of effectiveness contributes to the range of terminology on which tools can be arranged in the Guides. Options for defining effectiveness of tools:

- Effects described by a Panarchy-based sustainable tool analysis
  One way to determine the effects of tools is by looking at the effects they have had on the system state. When the influence of tools on the system state or system change is known, waterprofessionals can use this transformability -de ability to influence the system- in their own practice (Sediri, 2020). In study 2 a Panarchy-based sustainability tool analysis framework was tested: it shows potential for determining the effectiveness of tools. The effects are described as changes in connectivity, potential and / or resilience within the three SD-domains. Further development, research and validation is needed before this framework can be an useful addition for the guides as a tool selection grid (section Scientific Recommendations).

- Tool-effects determined by change in discourse
  The shared tools are generally used for creating acceptance, support and/or active involvement of stakeholders. The effectiveness of these tools depends on the question if the tools contributed to a change in thinking and behaviour of stakeholders as well as to the process of implementing NbS. This is partly causality, partly change in discourse. The change in discourse could be measured within the Panarchy-based sustainability tool analysis - by measuring change in social connectivity -. Or by analysing the effects on the level of stakeholders within SES. Either way both begin and end situation should be

measured: in this case a comparison of interviews from the begin and end- discourse could make the evaluation possible.

2. **Use uniform terminology in the guides & collect additional information on tools**.
When uniform terminology is used in de guides and effectiveness are defined, collecting additional information about the tools will be necessary. This will contribute to building a complete data set of the current and future tools. An uniform description of tools should at least include:

- Three levels of space and time on three domains: an analysis of tools in their contribution to sustainability should be done over at least three levels of space and time (dictated by resilience) and over the three sustainability domains integrative.
- Begin and end measurements: for determining the effectiveness of tools both begin and end measurements should be done. This enables tool evaluation.
- Add context and parameters: the meaning of NbS and resilience depends on the context and parameters. Consequently, the context and parameters should always be explained and added.

3. Ensure an adaptive design of projects.
The survey output shows the influence of external factors on tool selection and the water management practice. Covid-19 changed the context of tool use enormously. It made some tools unusable but also created new possibilities.

4. Use process phase for classification of tools.
Different tools are used in different project phases. Therefore, the project phase could be leading in the choice of tools. Further documentation is required.

5. Include scientific knowledge in the transition process.
Scientific knowledge about TT can provide additional support to the waterprofessionals in the transition process, such as: creating sense of place, framing discussions of complex and sensitive issues in an inclusive and non-threatening way and aligning people's needs to what is technologically feasible.

6.2. Scientific recommendations

The scientific recommendations show options for additional research to evaluate and validate tools.

1. Assess development of adaptive policy and governance in Co-Adapt.
The study shows that water management within Co-Adapt primarily focused on developing cooperation practices. The findings from advanced AWM practices in larger river basins might provide feasible and useful examples for the further improvement of the climate adaptivity within the context of brook catchments. Further research on this topic is recommended**.**

2. **Panarchy-based sustainability tool analysis framework**.
The merged Panarchy-based framework has been tested in this research. For further development and validation more research is needed. This should at least include:

- further conceptualisation of the Panarchy-model to the economic domain.
- further research about the behaviour of Panarchy applied to three domains integrative.
- research about tool causality.

3. Record and research new insights, tools, experiences from Covid related changes in project design.

To ensure that not all the new experiences, newly developed tools and new ways of working related to Covid is lost, further research is required. This research should be on how Covid influenced the use of tools for stakeholder involvement, what new insights and possibilities it has provided and how these can be used in the future.

4. Explore the use of tool in combination.

In order to support transition thinking of actors involved in the SES at the local level, transition tools could be used in combination. Further research is needed to confirm the effectiveness of combining tools. Also, further research is required on how people, communities and societies can be better stimulated to participate in the transition processes.

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Appendix A: Guide to Knowledge Tools – Extra PDF file

Appendix B: Guide to Transition Tools – Extra PDF file

Appendix C: Guide to Good Practices – Extra PDF file

Appendix D: Results AWM assessment

Adaptive governance	Literature Case Studies	Aa of Weerijs
Polycentric decision making	Polycentric governance regime is seen in many of the large European catchments, both with respect to cooperation and coordination as distribution of power. Examples: Lower Rhine (Netherlands), Upper Elbe (Germany) and Thames (United Kingdom) (Pahl-Wostl & Knieper, 2014)	In the Netherlands, this form of decision making relates to the so-called Huis van Thorbecke (national-regional-local government cascade of decision making, with an additional role for the waterboards). Especially in Brabant there is a long tradition of close cooperation between regional partners
Balance between decentralized and centralized control.	Institutional functions, responsibilities and powers are allocated to various levels. Both policy development and implementation are decentralized. Level of decentralization is in accordance with the available technical capacity and taken into account of economies of scale. Lower Rhine (Netherlands) and Thames (United Kingdom) (Pahl-Wostl & Knieper, 2014) Dutch Rhine and German Elbe seem to be characterized by a balance between top-down government dominated processes and bottom-up governance processes with strong stakeholder participation.) (Pahl-Wostl, 2009)	ONE front office for the three layers of government involved (province, waterboard, municipality) at the municipality of Zundert, taking care of questions from - and communication to - the people in the area. Challenge is to synchronize the large-scale vision (climate robust catchment according to the provincial spatial vision and provincial climate adaptation policy) and the local possibilities, policies and perspectives of stakeholders. Thus, the process ideally is a sort of top down meets bottom up.
Lower-level governments are involved in decision making by higher level governments	Local governments are involved in the creation of institutions at higher levels and participate in decision making. Cooperation and clear allocations of tasks is supported. : Lower Rhine (Netherlands) and Thames (United Kingdom) (Pahl-Wostl & Knieper, 2014)	Provincial policy making always incorporates consulting (and cooperation with) lower government levels (municipalities and waterboards). Apart form legally required advice (e.g. sanitation plans) the provincial government is not always involved in local decision making. Climate dialogues might be a suitable platform for better local/regional aligning of decision making on climate adaptation issues. For this purpose, the province assigned regional contact persons.

Cooperation structures	Literature Case Studies	Aa of Weerijs
Cross-sectoral cooperation: active involvement of other government sectors (e.g. agriculture, environment, tourism, forestry, spatial planning)	Co-operation structures are in place to involve other government sectors in Lower Rhine (Netherlands), Upper Elbe (Germany) (Huntjens et al. 2011)	We chose not to focus on climate adaptation only, but to link it to other pressing challenges in the Aa of Weerijs region (agricultural transition, nature development, recreation). Therefore, the Co-Adapt pilot is part of a larger project. What is needed for working on a catchment scale is upscaling the climate related planning to regions upstream (Flanders) and downstream (city of Breda). A cooperation structure is in place for the area of the municipality of Zundert. All parties involved have signed a cooperation plan that should lead to an implementation plan (and actual groundwork).
Level of or provisions for stakeholder participation, including non-governmental stakeholders (e.g. NGO's, user groups, citizen groups or private sector)	Legal provisions concerning access to information, participation in decision making+ access to courts Lower Rhine (Netherlands). Alentejo (lower Guadiama) Huntjens et al. 2010)	For the project, a dedicated coordinator is appointed who is working with the people and parties in the area on behalf of the public authorities involved. The coordinator is paid for by the province (project Klimaatrobuuste Beeklandschappen).
Non-Government stakeholders actual contribute to the agenda setting, analyzing problems, developing solutions and taking decisions.	Non-governmental stakeholders are involved in setting the requirements and are consulted Lower Rhine (Netherlands), (Huntjens et al. 2011)	Developing solutions: Co-created nature based solutions initiating the path towards this long term perspective. Regional communities and stakeholders must be willing and able to join action. This is done in a process of cocreation.
Conflicts are dealt with constructively, resulting in inclusive agreements to which the parties are committed.	Conflicts are dealt with constructively, resulting in inclusive agreements to which the parties are committed. Lower Rhine (Netherlands), (Huntjens et al. 2010)	

Adaptive policy development	Literature Case Studies	Aa of Weerijs
Flexible measures, keeping option open	A dynamic adaptive policy plan (DAPP) is conceptualized for proactive planning for flexible adaptation over time in response to how the future actually unfolds. (Hutt River, New Zealand) (Lawrence et al, 2018), (Rhine-Delta, the |Netherlands (Haasnoot et al. 2013) and (Thames, UK) (Ranger et al., 2010)	Our main policy is our Climate Adaptation Vision (Visie Klimaatadaptatie). This policy is to be integrated soon in our new Regional Water and Soil Management Policy (Regionaal Water en Bodem Plan). This is to be adopted by our political board (Gedeputeerde Staten) by the end of 2020 However, this system of planning follows a government cycle (often: new government – new plan). For climate adaptation actions this is a problem because climate effects and measures often have a horizon of 10-20 years or more. This is why in our regional climate adaptation projects we apply the adaptive pathway approach to make sure we are able to switch between strategies when necessary
Experimental small-scale policy experiments	Experimentationa used, e.g. impacts of lowering groynes near Beuningen) (Room for Rivers policies, the Netherlands) (Huntjens et al., 2011)	Experiments are an effective approach to challenges with a high degree of uncertainty (such as climate change). However, from a government point of view (subject to failure) experiments are not always popular. Branded as 'pilots' there are often acceptable. However, follow up of pilots often lacks (so called pilot paradox)
Alternatives and scenarios are discusses and included	Scenario-based approaches proved to be helpful in handling risks & uncertainties. E.g. Environmental impact asessment and costs-benefit analysis (Room for Rivers policies, the Netherlands) (Huntjens et al., 2011) Extensive testing of options to assumptions, particularly over future sea level rise projections, and so informally incorporated elements of a robustness-based approach. (Thames, UK) (Ranger et al., 2010).	This sort of assessment is mostly reserved for larger projects. Smaller projects often lack this kind of review. However, on a regional (or catchment) scale this could be helpful for planning a (cost)effective mix of measures in the region of NO Brabant we are working on such an approach, based on the NL2120 scenario's (WUR)
Monitoring and evaluation mechanisms are in place. Adjustments are made.	The policy plan incorporates a process to wait, monitor and learn to gain more information before taking a larger and irreversible investment decision to deal with long-term increases in extreme water levels. (Thames, UK) (Ranger et al., 2010).	Monitoring mostly focusses on policy implementation (did we take the steps we promised) or situational data (ground water level, river runoff etc.). Monitoring effects of measures is much more difficult because of the many different variables usually involved. Affiliated to the Co-Adapt project we are starting to work on monitoring using different sources of GEO data from European and other data sources (EIFFEL project). On a catchment scale, input-output monitoring of water flows gives an indication of the combined effect of measures.

Appendix E: Interview 1, water management Province Antwerp

Interview was held in Dutch and translated into English. Questions in black, answers in blue.

Interview with the project manager of the Flemish Land Agency, region West
About: general water policy in Flanders. (Multiple waters in portfolio)
Date: 1/12/2021

Purpose of the interview: Additional questions for a more complete understanding of the transition process towards implementation of NbS. In order to be able to analyze tooling by means of the chosen model, a project process / change process is considered. This analysis is used in my thesis. Conclusions and recommendations from this will flow into the joint recommendation report to Co-Adapt.

• How did the water problem arise; from whom (socially) did the initiation go? (Beerse residents, municipality, province, otherwise? Flooding was the actual 'drop'.

• Economic consequences of the 2014 floods:
o Did the threat and the actual flooding (2014) lead to a reduction in the value of homes / neighborhood? (plausible or also proven by reporting). Were many water damage claims submitted at the time, to insurance or the municipality? (more than usual for a village of that size) unknown
o Have calculations been made in the Laakland project showing that there is less risk of water-related nuisance and damage in the new situation? This is done; see interview 2: Laakbeek.

- What would the funding options have been in the absence of the Co-Adapt project?

In Belgium: Order in administration: government, Flemish government, province, municipality. The province is charged with jurisdiction over water courses. In a case without subsidization / financing in collaboration with the municipality, the province would be taxed on financing for the watercourse.

Ecology:
In general, there are few larger rivers in Flanders (compared to the Netherlands). In addition, there are also large agricultural areas in west Flanders, which is a high risk of drought in summer. In summer 2020, even drinking water supplies are at risk. Drinking water in Belgium depends on surface water and few sources.
Water buffering necessary; meandering, fens and other wet soils.
Examples of NbS used in projects in the province of Antwerp:
In Kemmelbeek project (near the city of Iep) as example; prevention of erosion upstream; buffer strips along a meandering river, create meanders, trees on banks for erosion prevention, excavate strips next to the river to enable overflow function (remove impenetrable layer).

- Choice for water overflow: based on? Motives? Alternatives?

Often a practical reason, which is the lowest point, natural place / seepage. Or simply no other options.
In the Kemmelbeek project and generally, the choice of location for water overflow, buffer location will be based on:
• Lowest point (natural place)

• Where possible, or least possible badly
• Determine with model-based scenarios

- planning:

Phases in planning: planning, then working out to implementation (1 year very intensive) then implementation (contractor and / or other more nature professional) then let it sink in for a year (with regard to nature development but also for use / social), 2 years in general before completion is. After that it changes even further: after 5 years new ecological changes can be expected (evolving).

Interview watermanagement Provincie Antwerpen

Gesprek met: de projectleider Vlaamse Landmaatschappij, regio West
Over: algemeen waterbeleid Vlaanderen. (Meerdere wateren in portefeuille)
Datum: 12-1-2021

Doel interview: Aanvullende vragen voor vollediger begrip van het transitieproces richting implementatie NbS. Om tooling te kunnen analyseren middels het gekozen model, wordt een project-proces/ veranderingsproces beschouwd. Deze analyse wordt gebruikt in mijn thesis. Conclusies en aanbevelingen hieruit zullen doorvloeien in het gezamenlijke aanbevelingsrapport aan Co-Adapt.

- Hoe kwam het waterprobleem aan het ligt; van wie (sociaal) ging de initiëring uit? (bewoners Beerse, gemeente, provincie, anders? Overstroming was de daadwerkelijke 'druppel'.

Economische gevolgen overstromingen 2014:

- Heeft de dreiging en de daadwerkelijke overstroming (2014) tot vermindering in waarde woningen/wijk geleid? (Aannemelijk of ook gebleken uit rapportage). Zijn er toen veel waterschadeclaims ingediend, bij verzekering of gemeente? (meer dan normaal voor een dorp van die grootte) onbekend
- Zijn er berekeningen gemaakt in het Laakland-project waaruit blijkt dat er minder risico is op watergerelateerde overlast en schade, in de nieuwe situatie? Dit wordt gedaan; zie interview 2: Laakbeek.
- Wat zouden de financieringsopties zijn geweest in afwezigheid van het Co-Adapt project?
    - In België: Volgorde in bestuur: overheid, Vlaamse overheid, provincie, gemeente. Provincie is belast met bevoegdheid inzake waterlopen. Provincie zou in geval zonder subsidiëring/financiering in samenwerking met gemeente financieringslast zijn voor de waterloop.

Ecologie:

In Vlaanderen in algemeen weinig groter rivieren. In west Vlaanderen daarnaast ook nog eens grote landbouwgebieden; veel risico op droogte in zomers. Zomer 2020 zelfs drinkwatervoorziening in gevaar. Drinkwater in België afhankelijk van oppervlaktewater en weinig bronnen.
Waterbuffering noodzakelijk; meanderen, vennetjes en andere natte gronden
Voorbeelden van gebruikte NbS in projecten in provincie Antwerpen:
In Kemmelbeek-project (als voorbeeld); erosie bovenstrooms voorkomen; bufferstroken langs meanderende rivier, meanders aanleggen, bomen op oevers als anti-erosie, afgraven van stroken naast de rivier om een overloopfunctie mogelijk te maken (de ondoordringbare laag verwijderen).

Keuze voor wateroverloop: op grond van? Drijfveren? Alternatieven?
Vaak praktische reden; dat het laagste punt is, natuurlijke plek/ kwel. Of gewoonweg geen andere opties.
In project Kemmelbeek bij stad Iep en meer algemeen keuze voor locatie wateroverloop, bufferplek:

- Laagste punt (natuurlijke plek)
- Waar het kan, of het minst slecht kan
- Met modelmatige scenario's bepalen

Fases in planning:
Planning, daarna uitwerken tot uitvoering (1jaar erg intensief) daarna uitvoering (aannemer en of andere meer natuur-professional) dan jaartje laten bezinken (m.b.t. natuurontwikkeling maar ook voor gebruik/sociaal), 2 jaar in algemeen voor het af is. Daarna verandert het nog verder door: na 5jaar al wel weer nieuw ecologisch veranderingen te verwachten (evolueren).

Appendix F: Interview 2, Laakbeek-project

Interview translated from Dutch. Questions in black; answers in blue.

Policy advisor, Integral Water Policy Service
Date: 18-01-2021

• I understand that the actual flooding of a district in Beerse in 2014 was the reason / made it clear the necessity for tackling this watercourse. Is this correct? Was this problem recognition in the first instance via the neighbor, municipality or otherwise?
Problems from before 2014. The Laakbeek is a flood-prone watercourse. In 2005, the province carried out a hydrological study of the catchment area in which two floodplains were then planned.
The most upstream flooding area (where the extension of the care center can now be found) was eventually scrapped because of the poor cost-benefit ratio. Expensive construction for little buffer capacity.
It was then stated that the other (= current) area certainly had to be realized. In 2012, a provincial spatial implementation plan was drawn up for this purpose and this area was designated by the Flemish government as a 'signal area' (= areas with a large water storage potential and a hard spatial destination (housing, industry, etc.) that has not yet been developed. therefore a policy aimed at retaining the water storage capacity.

Detail from a project area and waterway of the Laakbeek in Beerse; shared by the interviewed policy advisor, Province Antwerp

Economic consequences of the 2014 floods:
• Did the threat and the actual flooding (2014) lead to a decrease in the value of homes / neighborhood and / or have there been more damage claims? (plausible or also proven by reporting).
No, no knowledge of real insurance claims. The flood (2014) was mainly due to the size of water in streets and driveways.
• Have calculations been made in the Laakland project showing that there is less risk of water-related nuisance and damage in the new situation? Yes, model-based calculations were made (initially in the hydrological study and were subsequently updated). This showed that there would be a reduction in peak river flow after the investments, depending on the type of storm; T2: 70%; T5: 16%; T10: 10%; T20: 9%; T50: 9%; T100: 10%
In addition, a statistical analysis was performed on the hydrological model (regarding estimation of water levels). This was then combined with the economic risk map layer (Flemish Environment Agency - via *Waterinfo*). This is a layer that was drawn up under the Floods Directive and shows the cost price due to flooding in € / m² / year. These calculations showed that the construction of the flood basin reduced the impact of a T100 storm to that of a T15 storm.

- *What are the cost savings compared to traditional measures?* Our natural based solution costs €240.000 for the execution of it. If we would use traditional measures for holding up water (= buffer basin in concrete material with the same buffer capacity 14.000m3) than the costs would be € 4.000.000! The cost savings are thus €3.760.000. More than we expected but we calculated this thoroughly.
- *How many households have better protection?*
  There are 789 houses in the flood-sensitive area downstream area our project area (= area of direct intervention). After co-adapt they will be better protected.

The course of the Laakbeek can be seen on the *geoloket of the province of Antwerp*: http://geoloket.provrekenantwerpen.be/geoloketten/?viewer=extern&LayerTheme=2 or pdf added below.

- There is no relationship between Laakbeek and employment.
- Planning maintenance ecological park: once a year the province will do a big maintainance with machines. maintenance of the play zone by the municipality.
- Why was an overflow / area in the village center chosen? is this the lowest-lying area or for other reasons? The hydrological study has shown that this turned out to be the most effective for taking measures (+ unbuilt: If this were built on, the problem would only increase.).
  And it was the only landscape option left; another option was less financially favorable. A lot of area is covered with buildings: There are also not many options upstream, for example there is a lot of tunneling / the watercourse runs under the housing.

- Funding: Co-Adapt - subsidizes (Co-adapt subsidizes this project for 60%. Other funding is borne by the province).
- Without co-Adapt: The problem would have been tackled in any case, even without Co-adapt finalization, but co-adapt has changed the approach and contributed to the participatory aspect.
- In that case, less residents' participation might have been envisaged, or at least approached in a more traditional way in the form of plenary proposals. We have certainly learned from this process and filtered out elements that we will certainly include in other projects in the future.

- Land purchase process: Land was bought up for the realization of Laakland *(chosen new for the area*), how did that process go and who bought it from whom? Purchase process was difficult (acquisition of arable land). The province (with a contribution from the municipality) has bought this plot from a private owner.
- Was there understanding for this? (Social aspect) What has been sacrificed for it? Previously, it was arable land, but was designated by the Flemish government as a "signal area" in 2013, building was not done here since then. Ultimately there was understanding and participation of the owner in the participatory process, also to ensure that this would indeed be set up for water. Attempts have been made to deal respectfully with the sense of loss (of history) of the family.

Social: The course of the entire process (from flood to now; eve before construction "solution") seems to have gone very smoothly: What forms of resistance or conflicting interests have arisen?

- Privacy mainly comes from residents adjacent to the flooding area and as the flooding area would become accessible, fear to look into it, etc.
- Dirty water (risk of sewage water entering the overflow, in the absence of a section of sewer) problem rightly raised and clarified by residents during a participatory

process; solution was sought. Sewage treatment is included in the project (Similar problem in Kemmelbeek project)

- What is a possible explanation for the high climate awareness of the inhabitants of Beerse? Is there no possible bias here? that only interested parties participate? There is a chance, but it is difficult to prevent, hence broad and open communication via the provincial website, among other things, so that reactions are also possible via other platforms (then only on the participation evenings).
- Is this harmonious course of this project a lesson and can therefore be used as an example for administrators (province, municipality or to other provinces)? Certainly yes, hence the video to quickly and clearly portray the project to other parties or authorities.

Ecology:
Background information:
Planting plan: by Regional Landscape Kleine and Grote Nete and internally within the province, we were assisted by our Sustainable Environmental and Nature Policy Department to make choices regarding the planting plan. Layout plan: Antea Group: Antea made the design of the flood zone, the landscaping (trees, shrubs) was done by the regional landscape
Fluvius: disconnects sewage water
(Antwerp 2020)

- How long will nature creation continue to be controlled / supported / when is an ecological balance expected to be found? Management is expected to be more intense in the beginning, is monitored (management plan is still being drawn up).
- Ecological choices / NbS: o What is the target ecosystem? In the folder you can read that there will be a Dotterbloem grassland, for example these should be mown twice a year and fertilized once (ecopedia.be);> o Who is going to mow and fatten that? Or will there be animal input? (municipality?) 'rough' maintenance will be done once a year by the province, together with the maintenance of the watercourse, maintenance of the play area by the municipality. Adjustment can therefore easily be realized (A rough note has already been drawn up by RL for management).
- What kind of land was there before? It was leased as hay land if it was heavily fertilized soil; what is the planned approach with regard to high potassium and nitrogen values? (I read that they can be especially annoying when laying marsh marigold hay land)> is there any planning to cut sod? Specific management plan has yet to be drawn up.
- How will the drought be combated? (Due to water storage by placing a non-return valve in toe ditch or else) So there is clay soil or other impenetrable layers around it? If necessary, the basin can be used to drain water slowly during dry periods. This is a good idea, because if a summer storm is expected, the basin must be completely empty to buffer the storm.
- Which choices in plants, ground, NbS, have been made? No concrete container in any case;) Bee-friendly plants, Water-permeable pavement on paths (fully accessible (wheelchair accessible because of the adjacent care home), sandy paths not suitable), native plant species. Steerable water flow; overflow and buffer function. Measuring points (often digital, to be followed on the app).
- What is meant by a play zone of natural and ecological play elements? Natural play elements such as willow huts, tree trunks, steppingstones and the like: elements that are also resistant to being under water.
- • Ecological damage from flooding? Unknown
- The water overflow could theoretically have been created elsewhere (upstream or downstream) and why or not? Why in a village center, what are the motives for this choice?

lowest point (natural spot)
-where it is possible, or least bad
-determining scenarios with model; based on (which parameters)? A mix of model-based and where there is still enough space available in an "urbanized" (paved) region. In the center of the village, it now means added value for the local residents.

Interview: Project Laakbeek, Beerse

Beleidsadviseur, Dienst Integraal Waterbeleid
Datum: 18-01-2021

- Ik begrijp dat de daadwerkelijk overstroming van een wijk in Beerse in 2014 de aanleiding is geweest /noodzaak duidelijk heeft gemaakt voor het aanpakken van deze waterloop. Is dit correct? Verliep deze probleemerkenning in eerste instantie via omwonende, gemeente of anders?
  Problemen al van voor 2014. De Laakbeek is een overstromingsgevoelige waterloop. In 2005 werd door de provincie een hydrologische studie opgemaakt van het stroomgebied waarin toen nog twee overstromingsgebieden werden voorzien.
  Het meest stroomopwaarts overstromingsgebied (waar nu de uitbreiding van het zorgcentrum is terug te vinden) werd uiteindelijk geschrapt, omwille van de slechte kosten-batenverhouding. Dure aanleg voor weinig buffercapaciteit. Toen is wel gesteld dat het andere (=huidige) gebied zeker moest worden gerealiseerd. In 2012 werd hiervoor een provinciaal ruimtelijk uitvoeringsplan voor opgemaakt en werd dit gebied door de Vlaamse overheid aangeduid als 'signaalgebied' (= gebieden met een groot waterbergend potentieel en een harde ruimtelijke bestemming (wonen, industrie etc.) die nog niet ontwikkeld is, krijgen daarom een beleidsgericht op het behouden van het waterbergend vermogen.

Economische gevolgen overstromingen 2014:

- Heeft de dreiging en de daadwerkelijke overstroming (2014) tot vermindering in waarde woningen/wijk geleid en /of zijn er meer schadeclaims geweest? (Aannemelijk of ook gebleken uit rapportage).
  Nee, geen weet van echte schadeclaims. De overstroming (2014) was voornamelijk van de grootte van water in straten en opritten.
- Zijn er berekeningen gemaakt in het Laakland-project waaruit blijkt dat er minder risico is op water relateerde overlast en schade, in de nieuwe situatie? Ja, modelmatige doorrekeningen werden gemaakt (in eerste instantie in de hydrologische studie en werden nadien bijgewerkt). Hiermee werd aangetoond dat er na de investeringen een reductie in peak river flow zou zijn, afhankelijk van het type storm; T2: 70%; T5: 16%; T10:10%; T20: 9%; T50: 9%; T100: 10%
  Op het hydrologische model werd daarenboven een statistische analyse uitgevoerd (aangaande inschatting waterpeilen). Dit werd vervolgens gecombineerd met de kaartlaag economisch risico (Vlaamse Milieu maatschappij – via Waterinfo). Dit is een laag die werd opgemaakt in het kader van de overstromingsrichtlijn en die de kostprijs door overstromingen weergeeft in €/m²/jaar. Door deze berekeningen kon worden aangetoond dat de aanleg van het overstromingsbekken de impact van een T100-storm verlaagd naar die van een T15-storm.
- • Wat zijn de kostenbesparingen in vergelijking met traditionele maatregelen? Onze natuurlijke oplossing kost € 240.000 voor de uitvoering ervan. Als we traditionele maatregelen voor het vasthouden van water zouden gebruiken (= bufferbassin in beton met dezelfde buffercapaciteit 14.000m3) dan zouden de kosten € 4.000.000

zijn! De kostenbesparing bedraagt daarmee € 3.760.000. Meer dan we hadden verwacht, maar we hebben dit grondig doorgerekend.

- • Hoeveel huishoudens zijn beter beschermd?
- Er zijn 789 woningen in het overstromingsgevoelige gebied benedenstrooms ons projectgebied (= gebied van directe interventie). Na co-aanpassing zullen ze beter beschermd zijn.

- Het verloop van de Laakbeek is te zien op *geoloket* van de provincie Antwerpen: http://geoloket.provincieantwerpen.be/geoloketten/?viewer=extern&LayerTheme=2 of pdf hieronder toegevoegd.
- Er is geen verband tussen de Laakbeek en werkgelegenheid.
- Planning onderhoud ecologisch park, wanneer dit klaar is: 'Grove' onderhoud zal 1maal per jaar door provincie gebeuren, onderhoud speelzone door de gemeente.
- Waarom is er gekozen voor een overloop /gebied in de dorpskern; is dit het laagst gelegen gebied of om andere redenen? Het is uit de hydrologische studie gebleken dat dit het meest effectief bleek om maatregelen te nemen (+onbebouwd: Als dit bebouwd zou worden zou het probleem ook alleen maar nog groter worden.).
  En zo goed als de enigste landschappelijke mogelijkheid; andere optie was minder financieel gunstig. Voor de rest al veel volgebouwd. Bovenstrooms zijn er ook niet veel opties, daar is bijvoorbeeld veel in-getunneld/verloopt de waterloop onder behuizing door.

- Financiering: Co-Adapt –subsidieert (Co-adapt subsidieert dit project voor 60%. Overige financiering wordt door de provincie gedragen).
- Zonder co-Adapt: Het probleem was sowieso aangepakt, ook zonder Co-adapt-financiering, maar co-adapt heeft de insteek veranderd, een bijdrage geleverd naar het participatieve luik.
- Er was dan wellicht minder bewonersinspraak voorzien, of in ieder geval meer op een klassiekere manier aangepakt in de vorm van plenaire voorstellen. We hebben uit dit traject al zeker geleerd en elementen uitgefilterd die we zeker in de toekomst bij andere projecten zullen meenemen.

- Proces van land opkopen: Er is land opgekocht voor de realisering van Laakland, hoe is dat proces verlopen en wie heeft het gekocht van wie? Proces van aankoop is moeizaam verlopen (verwerven bouwland). Provincie (met bijdrage van gemeente) heeft dit perceel van een private eigenaar gekocht.

- Was daar begrip voor? (Sociale aspect) Wat is er voor opgeofferd? Voorheen was het bouwland, maar werd door de Vlaamse overheid in 2013 aangeduid als 'signaalgebied', bouwen was hier sinds dan 'not done'. Uiteindelijk was er wel begrip en een deelname van de eigenaar aan het participatieve proces, ook om te waken dat dit wel degelijk voor water zou worden ingericht.
  - Hierbij is er geprobeerd respectvol met het gevoel van verlies (van historie) van de familie om te gaan.

Sociaal: Het verloop van het hele proces (*van overstroming tot nu; vooravond voor aanleg 'oplossing')* lijkt heel gemoedelijk te zijn verlopen: Welke vormen van weerstand of conflicterende belangen hebben zich voor gedaan?

- Privacy komt voornamelijk vanuit bewoners grenzend aan het overstromingsgebied en daar het overstromingsgebied toegankelijk zou worden, vrees naar inkijk etc.
- Vies water (kans dat rioolwater in de overloop komt, bij afwezigheid van een stuk riool) probleem terecht aangekaart en verduidelijkt door bewoners tijdens

participatief proces; oplossing werd gezocht. Rioolwaterzuivering wordt meegenomen in het project (*In Kemmelbeek-project vergelijkbaar probleem)*

- Wat is een mogelijke verklaring van het hoge klimaatbewustzijn van de bewoners van Beerse? Zit er hier geen sprake van mogelijke bias; dat alleen de geïnteresseerden meedoen? Die kans bestaat, maar is moeilijk te voorkomen, vandaar ook brede en open communicatie via o.a. provinciale website zodoende dat ook via andere platformen (dan louter op de participatieavonden) nog reacties mogelijk zijn.
- Is dit harmonieuze verloop van dit project een lering en daarmee als voorbeeld te gebruiken voor bestuurders (provincie, gemeente of naar andere provincies)? Zeker wel, vandaar ook het filmpje om het project snel en duidelijk in beeld te brengen naar andere partijen of instanties.

Ecologie:
Achtergrondinformatie:
Beplantingsplan: door Regionaal Landschap Kleine en Grote Nete en intern binnen de provincie werden we bijgestaan door onze Dienst Duurzaam Milieu- en Natuurbeleid om keuzes te maken omtrent het beplantingsplan.
Inrichtingsplan: Antea Group: Antea heeft het ontwerp van het overstromingsgebied opgemaakt, de landschappelijke inrichting (bomen, struiken) werd gedaan door het regionaal landschap
Fluvius: ontkoppelt rioolwater
(Antwerpen 2020b)

- Hoelang blijft de natuurcreatie gestuurd/ondersteund worden/wanneer is de verwachting dat er een ecologisch evenwicht is gevonden? Beheer wordt verwacht in het begin intenser te zijn, wordt opgevolgd (beheerplan wordt nog opgemaakt).
- Ecologische keuzes/ NbS:
    - Wat is het streef-ecosysteem? *In de folder is te lezen dat er een Dotterbloemgrasland komt bijv. deze dienen 2x p.j. gemaaid en 1x bemest te worden (ecopedia.be);>*
    - Wie gaat dat maaien en mesten? Of komt er dierlijke inzet? (Gemeente?) 'Grove' onderhoud zal 1maal per jaar door provincie gebeuren, samen met het onderhoud van de waterloop, onderhoud speelzone door de gemeente. Bijsturing kan dus makkelijk worden verwezenlijkt (Er is al een grove nota opgemaakt door RL voor het beheer).
    - Wat voor land was er voorheen? Werd verpacht als hooiland als dit sterk bemeste grond was; hoe is de geplande aanpak dan ten aanzien van hoge kalium en stikstof waarden? (ik lees dat die vooral hinderlijk kunnen zijn bij aanleg van dotterbloemhooiland)>is er gepland om te plaggen? Specifiek beheerplan moet nog opgesteld worden.
    - Hoe gaat de droogte bestreden worden? (*Door waterberging door plaatsing terugslagklep in teengracht of nog anders)* dus daar kleigrond of andere ondoordringbare lagen omheen aanwezig? Indien nodig kan het bekken gebruikt worden om water vertraagd af te voeren in droge perioden. Goed over na te denken, want bij verwachting zomerstorm moet het bekken volledig leeg zijn om de storm te kunnen bufferen.
    - Welke inrichtingskeuzes zijn er gemaakt? Geen betonnen bak alleszins;) Bij-vriendelijke planten, Waterdoorlatende verharding op paden (integraal toegankelijk (rolstoel toegankelijk vanwege naastgelegen zorgtehuis) zandpaden niet geschikt), inheemse plantensoorten. Stuurbare watervloed; overloop en bufferfunctie. Meetpunten (vaak digitaal, op app te volgen).
    - Wat wordt verstaan onder speelzone van natuurlijke en ecologische speelelementen? Natuurlijke speelelementen zoals o.a. wilgenhutten,

boomstammen, stapstenen dat soort: elementen die ook bestand zijn om onder water te staan.

- Ecologische schade door overstroming? Onbekend
- Had de wateroverloop theoretisch ook elders gecreëerd kunnen worden (boven of benedenstrooms) en waarom wel of niet? Waarom in een dorpskern?! Drijfveren voor deze keuze?
  -laagste punt (natuurlijke plek)
  -waar het kan, of het minst slecht kan
  -met modelmatige scenario's bepalen; gebaseerd op (welke parameters)? Een mix van modelmatig en waar nog voldoende ruimte beschikbaar in een 'verstedelijkte' (verharde) regio. In de dorpskern betekent nu voor de buurtbewoners een meerwaarde.

Appendix G: Interview Somerset Levels and Moors

Interview with waterprofessionals from the investment Somerset Levels and Moors
Date interview: 12-1-21

Can you give a brief overview of your project?
Adapting the levels is a collaboration between Somerset County Council, Farming & Wildlife Advisory Group (FWAG) and Somerset Wildlife Trust. The wider partnership is Co-Adapt. Somerset Levels & Moors is a very large area of extremely vulnerable low-lying ground which flooded very badly in 2013 and 2014. This is the focus of our work. Locally everything has to change. Even without climate change there is already a high risk of flooding. There is political sensitivity in this area and mistrust in authorities. The flood events of recent years have been blamed on agencies who are operating water management locally. There is a lot of misconception on water management. We have to be very sensitive in our approach. For that reason, we have been operating on a two front approach; focus on the direct farmer-land owner engagement and in parallel on more public and community engagement. Those two things are informing each other and coming back together. But we have to be very careful that we don't draw our people away before they have seen what's this project is about.
We had a great momentum going before the lockdown last year. We had two extremely successful public events, public drop-ins. We had 330 people over two drop-ins. To put that in context; the environment agencies had done different outreach events in the same communities and reached just 20 people. We had started to build trust in the communities. The original plan was to have focus workshop with those members of the public who were interested in looking at adaptation pathways in more depth, but obviously this couldn't take place because of COVID-19.
We have produced a report with all the finding and feedback from the public events. We held a series of workshops with local government officials, parish councillors, district councillors and county councillors. We looked at different adaptation pathways, so not planned scenarios, for different issues in certain geographic areas.
At this point is the farmer-landowner engagement ahead of pace. That's very much focussed on encouraging them to work collaboratively. What we have is hydrological blocks, therefor the decision making for those areas, in an ideal world, would be made collectively. But farmers, historically, are independent, they don't necessarily work together in that way. Both farmers with farmers but also with the community. There is definitely a separation and a division between the communities and the farmer communities.
The local community doesn't always understand what the farmers are doing. The farmer community is not very good at communicating that. And the farmers also feel demonized, especially with the climate change and the vegan lobby. That's making the situation worse. This project that is working across both sides is important. The people do understand that on both sides. There is a comment from one of the local councillors: "Stop blaming farmers for problems we all created". This is now used as a mantra in this area. It made farmers locally feel more seen. And made them feel that there is the opportunity to have a conversation instead of being screamed at or demonized when they walk in a room.
One of the fundamental things we do is building trust in those communities. We have been very careful that we deliver what we promise. Being transparent is very important.

In what way does the history/background of the area you work in, influence your work today?
There is a strong narrative in the background of dredging the channels. In 2013, when a very large agricultural land was flooded, the narrative was that it happened because there had no longer been dredging going on as had been since the 60's. The local community was

extremely focal and effective of getting this message out there. The prime minister came down and said that money is not an object and that all the rivers would be dredged. Since then, all the rivers have been dredged, while all the modelling has said that dredging wouldn't have prevented the flooding, it would have made the duration slightly shorter – only a matter of hours, not even days.
This idea, that dredging is they answer to everything, is so embedded in the consciousness of the local community. Our work is building community literacy, helping people to build a more accurate picture of why flooding takes place in this area and how NbS can help take some of the pressure of the systems. Public events aim to raise awareness and challenging the misconceptions and myth.
The amount of work in dredging and bank management. The cost of the pumping station and their maintenance, which will soon reach their end of life. Every year they bring in Dutch pumps for a lot of money, which run on Diesel. None of what's going on now is sustainable. And that's just river flooding. That's before you get to the impact of drought and sea level rise.

The entire area is tidal marsh. The area did always used to flood, every single winter. After the 2nd world war there was a huge amount of investments in pumping stations and dredging. They created this situation where people forgot and this generation got used to not having any flooding. In the agricultural community there is now an expectation of pumping winter flooding off of their fields. This is not sustainable in its current form, let alone if you add the effects of climate change.
There's recognition that this has to change. We got to see a shift in expectations; especially in farm-landowner community.
Our project is the first one that has gone out and said, this isn't sustainable and this is what we're facing and we need to have this discussion and we need to start understanding that. What has changed, in relation to a few years ago, is that climate change is in the public psyche. When people think of climate change, they think of mitigation. They think of locking up carbon.
They don't realize what the effects of climate change are. We want to communicate that and broaden peoples understanding about what climate adaptation is and why it is necessary. It's been powerful for us to open up this conversation. People are shocked by it; it makes them realize we need to take action.

Is there support for your project from inside your organisations?
There is enough understanding and acceptance from our organisation for the project to be pulled together, but also nervousness because it is so political and so charged.
We've won the trust; we work very well together. We get an increased amount of support from within our organisations and organisations working alongside. It comes at a serendipity time.
In realising our goals, it helps that we're from three different organizations. We are very selective who does what presentations and attends meetings.
This project is overall improving relationships in this region.

How do you approach the realisation of NbS?
The way we are developing the NbS is all bottom up. The communities themselves have been giving an understanding and information about what we are facing and what the projections are. They come up with the options for NbS.
Our original plan, without COVID-19 would be:
We work with the councillors and make skeleton pathway, which we've done. Then we do these big events and we get a hype. We get all of the public along and we get everybody to a level of understanding. Feeding in and getting inspired and interested by NbS. And then pull the two together where we put it all together; the ideas and feedback from the

community and the skeleton pathways of the councillors. Now, working together, both community and councillors' ideas would be put onto this pathway. That would be the community build pathway which we would take to the county council and the environment agencies. We show the stakeholders who have that influence and see what they say about the pathway in terms of technical possibility and where do they agree with and where not. The next step would be to feed this back to the communities.

What are you working on at the moment?
Adaptation pathways is central to our work. We are creating pathways for different scales and for different environmental pressures. One is for flooding, one is for land management and agriculture use, and we can do one for drought. We are working on this locally, but all of this information is feeding into a broader one for the whole of the Somerset Levels.
At this moment everything has shifted online. We have our first pathway workshop online next week.
We have commissioned an online adaptation tool to be made. This tool makes it possible to feedback on pathways and have all of the general public and communities make their comments and changes to the pathways. They can also indicate what they like and what they don't like.
Trying out this new online tool with different demographics is not possible with the current lockdown. It's very difficult to reach people at the moment. The main attention has gone into making the tools accessible. This is in the way everything is written, not using jargon, keeping it simple and using videos to explain it.
Our next step is to identify areas where FWAG can invest on community land, parish council and district council land with NbS. We need more localized data before we can start building that larger level pathway. We're looking at working with the Avalon Marshes partnership who own quite a significant area of land. They're exploring how to restore and improve the peatlands, how climate change is going to impact the habitats and which areas of land should try to be bought or gain management power over in order to protect the wildlife. And how all of this can be used to improve tourism and bring an eco-tourism element in.
We're looking to work with them to develop an adaptation pathway. In the beginning we'll work with that partnership and then we'll work with the farmers and landowners surrounding that area. Also, with the peat diggers. This could be useful sides for flood prevention and it's highly beneficial to keep the peat in the ground.
We're also developing a walking app. When you come to certain points in your walk, a video, audio, text and photos come up. This tells you all about NbS and the need for climate adaptation about the place where you are actually standing. There is also a whole section for kids .
Once it's there you can make one for cyclist or school trips. The app will be called Somerset Trails and will be used in a Somerset wide collaboration. This will be a nice legacy for the project.

All of your tool aim to realize a transition in stakeholders, like building trust, understanding and commitment. Have you been able to evaluate if this transition took place?
It's very hard to say, because of COVID-19 happening in the middle of the process. One of our ethical considerations is "who is holding the power" and looking at that constantly. Usually what you end up with in these projects is that the project officers are holding the power. Because they say what gets fed back and when. We have been conscious to feedback. We've written a report in which all we did was group people's comments into themes, we don't discuss them, we don't pull them apart and we don't drew conclusions from them. It's just genuinely feeding it back. We also made all of the raw data available online, so they community has the ownership.

We've noticed an increase in the understanding of NbS with a tree planting event. Parish councils could plant free trees, and some of them, who had worked with us in workshops, changed their planting plans and put them somewhere, where they can help prevent flooding.

In the beginning of the interview, you told about the public events where you had many people dropping in. What did you do, to attract so many people?
We were very sensitive in the communication about the event. We weren't going out with predetermined set of proposals that we were looking to get a response to. Our message was: "look this is the issue we're all facing, what do you think we should do about it? Come and learn more about it and give us your ideas, knowledge and experience.". I think often when people see an consultation event, they have the perception that it's just a box ticking exercise. Just a way to say "we spoke to the public". That's quite off-putting to people. We have very genuinely wanted to go out there and sort of capture the knowledge and ideas from the communities and see what is feasible in that platter of different ideas. To see what we could essentially act on and push forward with. Using all of those different opinions and thought to inform the plan; the shared vision of Somerset Levels & Moors to climate adaptation.
The events were also well planned by the partners. We went out there, put posters on lamppost and used a social media push. It really became a calendar event in peoples mind because of the work on forehand.
Before the public events took place, we did a series of councillor's events with parish districts and county councillors. The second one was a month before the drop in. The local parish councillors are often farmers as well. They are usually quite active and vocal within their communities. These councillors were already inspired, interested and engaged with our project. This most definitely had an impact on the number of people.
Also, we provides free food and cake and we advertised that very well. And we advertised it as child friendly event. The posters were sweet, engaging and fun. We used simple language, not too technical and not overly branded. Not too serious, simple and fun.
We also really did make the event child friendly. By engaging the children on their level, we gave the parents space to stay and spent time to engage with it on their level.
It was not only a success because of the number of people that came, but also because of the quality of interaction the public had. They often stayed for the entire event.

How do think the experiences through COVID-19 will influence your way of working in the future?
Without COVID-19, we would never do all of this online. The online tools would be part of public events and face to face events. But it is valuable to have this sit alongside in the longer term. Face to face events tend to cut out people with young children, people who are working and are exhausted ánd people can't leave their house because of illness or injury. After COVID-19 we would like to do a part of the process live and then have the public online. Working online gives people time and space to really look at it and think about it. It's possible to get feedback in a way that is structured and standardized, rather than getting random thoughts in email and written on pieces of paper. For the online adaption tool, this contributes to drawing out more robust conclusions and back up some of the shifts and changes that are made to the pathways.

Appendix H: SES Somerset Levels and Moors

In this table the information obtained from the interview with the waterprofessionals from the catchment Somerset Levels and Moors is placed inside the framework of the SES.

Subsystem	**Variable**	**Context & Purpose within SES**
Resource system	Size	*Context:* 2500 ha (Bogatinoska 2020); part of wider area of Somerset ----- *Purpose:* Identify areas where they can invest on community land, parish council and district council land with NbS.
	Human constructed facilities	*Context:* Pumping stations and pumps running on diesel, bank management and dredging. None of this is sustainable or even a solutions to all the problems this area faces, and the maintenance is expensive. ----- *Purpose:* - They are the first ones that have gone out and made clear that the current situation isn't sustainable, and to point out the necessity of starting to understand and discuss about the problems the area is facing. - Transition to NbS
Resource unit	Distinctive characters	*Context:* Extremely vulnerable low-lying ground, the entire area is a tidal marsh and peat digging is still going on. Even without climate change there is a high risk of flooding. ----- *Purpose:* The whole area is extremely vulnerable. Locally everything has to change. Making people aware of that and involving the whole community.
	Distribution in space & time	*Context:* Flooding in 2013 & 2014, drought and sea level rise ------ *Purpose:* Creating adaptation pathways for different scales and for different environmental pressures is central in their work. They are working on this locally, but all of this information is feeding into a broader adaptation pathway for the whole of the Somerset Levels.
Governance system		*Context:* Influence of national politics.
		Context: Their ethical considerations is "who is holding the power". They want to prevent that the project ends up with project officers holding the power. Because they say what gets fed back and when. ----- *Purpose:* They try to lay the ownership of the project within the community.
	Network structure	*Context:* - Adapting the Levels is a collaboration between Somerset County Council, Farming & Wildlife Advisory Group and Somerset Wildlife Trust. There is an increased amount of support from within the collaborating organisations and organisations working alongside them. The collaboration of the three different organizations helps in establishing and improving relationships. They are very selective who does what presentations and attends what meetings. - Wider partnership of Co-Adapt
		Context: Local parish councillors are often farmers as well and are usually quite active and vocal within their communities. ----- *Purpose:* Using this structure for reaching people in the community (for public events). For this purpose a series of councillor events was planned just before a public event, to get the local parish councillors inspired, interested and engaged with the project.
Actors	Number of relevant actors	*Purpose:* Including all voices from the community in the project. They have made everything accessible the everything is written, not using jargon, keeping it simple, using video's to explain it.

		Purpose: Creating involvement by a great number of people from the community.
	History/past experiences	*Context:* Because of pumping and dredging the community forgot about the annual winter floods. This generation has the expectation of not having any flooding. ----- *Purpose:* Shifting this expectation, by building community literacy, helping people to build a more accurate picture of why flooding takes place in this area and how NbS can help take some of the pressure of the systems.
		Context: Often when people see an consultation event, they have the perception that it's just a box ticking exercise. Just a way to say 'we spoke to the public'. That's quite off-putting to people. ----- *Purpose:* They have very genuinely wanted to go out there and capture the knowledge and ideas from the communities and see what is feasible in that platter of different ideas. Using all those different opinions and thought to inform the plan.
	Social capital	*Context:* Misunderstanding, separation and division between local community and farmer communities ----- *Purpose:* Operating on a two front approach; focus on the direct farmer-land owner engagement and in parallel on more public and community engagement.
		Context: Mistrust in authority, misconception on water management and blaming recent flood events on local water management agencies. ----- *Purpose:* Building trust among both communities and being transparent in what they do.
		Context: Historically farmers are independent and don't work together with each other and the community ----- *Purpose:* Encouraging farmer/land-owners to work collaboratively, where in an ideal world decisions would be made collectively.
		Context: What has changed, in relation to a few years ago, is that climate change is in the public psyche. People think of climate change and they think of mitigation. They think of locking up carbon ----- *Purpose:* Broadening peoples understanding about climate change. Share knowledge about climate adaptation and why it is necessary.
Additional context variables	COVID-19	*Context:* They just had two successful public events and had a great momentum going before the first lockdown in 2020. After this everything has shifted online and new tools had to be designed.
		Context: It's more difficult to reach people and to try out online tools with different demographics. ----- *Purpose:* Making the online tools as accessible as possible, by keeping it simple, not using jargon and using video, audio and photo's to explain

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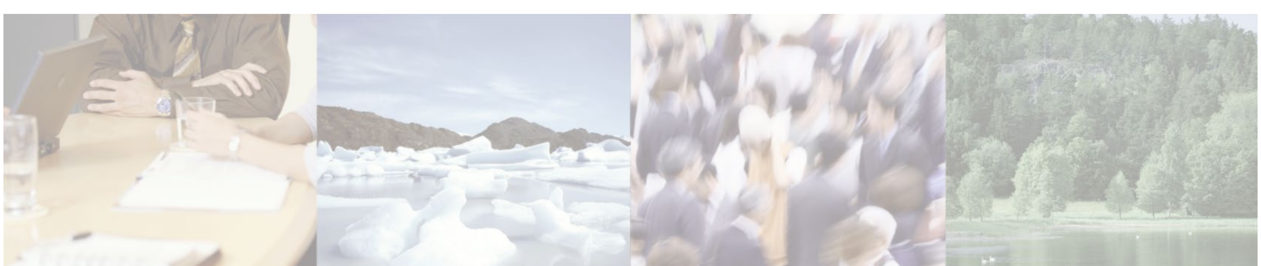

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