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INTEGRATION OF SOCIAL-ECOLIGICAL SYSTEMS APPROACH IN URBAN GREEN INFRASTRUCTURE PLANNING

Case study of Hunze river corridor in Groningen

MASTER THESIS

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ABSTRACT

City can be seen as multifunction organism, which is able to function due to both internal recourses of the urban ecosystem and is even more dependent on external recourses. Nevertheless rising population numbers and pressure on the nature areas and cultural heritage sites is constantly increasing. Urban management and administration is based on rigid legislation instruments and technical engineering solutions. Consequently cities become rigorous and human-controlled systems that lose the ability to adopt to unpredictable external factors. The loss of city's cultural and historical face leaves an undesirable mark on place identity and well - being issues.

This research focuses on urban green infrastructure restoration and integration in the surrounding landscape, taking into consideration social and cultural heritage issues. Additionally, this work will research various case studies that could serve as an additional source of data not only to complement theoretical background overview but also integrate practical examples into research results by providing recommendations for urban green infrastructure planning.

Each anthropogenic intervention leaves a stamp on the landscape that makes it almost impossible to reverse system to the previous system state. For this reason the research is based on social-ecological system sustainability (resilience) assessment which examines the issues of the particular system, its key components, system dynamic in various scales and also governance and social network characteristics.

This work will look for solutions how to combine social and ecological values in historical Hunze river area located in the city of Groningen. Considering social-ecological system assessment, it is possible to highlight the strengths and weaknesses of the system and therefore adjusting governance and decision - making accordingly to the relevant circumstances.

Key words: urban, green infrastructure, planning, socio-ecological system, sustainability, resilience.

ANOTĀCIJA

Pilsētu var uzskatīt par daudzšķautņainu organismu, kas pastāv pateicoties gan pilsētas ekosistēmas iekšējiem, gan arī ārējiem resursiem, taču pieaugot iedzīvotāju skaitam, noslogojums uz pilsētā pastāvošajām dabas teritorijām un kultūrmantojumu nemitīgi pieaug. Pilsētvide veidošanā tiek izmantoti stingri noteikti pārvaldības instrumenti, kā arī pilsētvides apsaimniekošanā tiek izmantoti tehniski pārvaldības risinājumi. Līdz ar to pilsētas kļūs par neelastīgām un izteikti cilvēku kontrolētām sistēmām, kuras zaudē spēju pielāgoties neprognozētu ārējo faktoru iedarbībai. Arī pilsētas kultūrvēsturiskās sejas zaudēšana atstāj nospiedumu uz vietas identitātes un labklājības jautājumiem.

Tā iemesla dēļ šajā pētījumā galvenā uzmanība tiek pievērsta pilsētas zaļās infrastruktūras atjaunošanai un integrēšanai apkārtējā ainavā, ņemot vērā sociālos un kultūras mantojuma jautājumus. Papildus šajā darbā tiks pētīti gadījumu piemēri, kas kalpo kā papildus informācijas avots ne tikai teorētisko zināšu papildināšanai, bet arī praktisku piemēru integrēšanai šī pētījuma rezultātos, piedāvājot ieteikumus pilsētvides zaļās infrastruktūras plānošanā.

Katra antropogēna iejaukšanās atstāj nospiedumu, kuru nevar tik viegli mainīt vai atgriezt iepriekšējā sistēmas stāvoklī, tāpēc šajā darbā tiks izmantota sociāl - ekoloģiskas sistēmas ilgtspējas (noturības) novērtējums, kurš apskata konkrētas sistēmas problēmas, tās elementus, dinamisko attīstību dažādos mērogos, kā arī pārvaldības un sociālā tikla īpašības.

Šis darbs meklēs risinājumus, kā apvienot sociālo un ekoloģisko vērtības vēsturiskajā Hunzes upes teritorijā. Pateicoties socio-ekoloģiskajam novērtējuma ir iespējams izcelt sistēmas stiprās un vājās puses, laicīgi piemērojot pilsētvides pārvaldību attiecīgajiem apstākļiem.

Atslēgvārdi: pilsētvide, zaļā infrastruktūra, plānošana, sociāl - ekoloģiskā sistēma, ilgtspēja, noturība.

CONTENT

INTRODUCTION

Urban ecosystems more often are perceived as unsteady and non-persistent environment; however most of the human population choses live in such a surrounding (Li et al. 2017). These concerns accord with IPCC (IPCC 2014) report that present facts about increasing risks of freshwater shortage and accelerating river floods due to heavy rainfalls. Besides highly altered urban ecosystems are negatively affecting human well-being and livelihood (IPCC 2014). Heat stress, air and water pollution are only some of the consequences that appear in excessively human managed cities. These climate extremes and issues related to human health are the main drivers why there is a need for climate responsive cities that are able to create favourable microclimate for its inhabitants and at the same time adapt to the foreseen extreme climate fluctuations (Alexandra 2017).

Cities considerably depend on the natural ecosystems within it (Folke 2006). Nevertheless this statement very often stays in the background when decision-making process is related to development plans and economic prosperity. Perfect description of such short-minded decisions is presented by Eden and Tunstall (Eden and Tunstall 2006, 662) when they talk about loss of urban riparian ecosystems "…bury them, turn them into canals, line them with concrete and build upon the (now protected) floodplains".

Urban environment is dynamic and constantly changing ecosystem, that embodies varies functions and resources for its diverse inhabitants, in this case talking about both humans and also various species that has adjusted to the human-dominated environment (Resilience Alliance 2010; Alberti et al. 2013). Because of the various involved stakeholders, multi-functionality and frequent political and economic influences urban environment presents both, considerable challenges and at the same time favourable conditions for sustainable and adaptive ecosystem management (Dennis et al. 2016).

While rigid engineering approaches and grey infrastructure dominant management methods are not capable to address frequently changing environment, scholars have come up with more effective and adoptive urban management practices as "green infrastructure planning" and "urban green corridors" (Alexandra 2017; Fabos 1995; Li et al. 2017; Peng et al. 2017). These practices not only mitigate urban drought and flooding issues, but also offer complementary urban problem solutions, like, reduction of heat stress, increase of biodiversity and also provide recreational possibilities (Alexandra 2017).

Nevertheless there is an information gap regarding social aspects in green infrastructure planning. Considerable focus is on the ecological and safety factors, but very often social factors are left out (Eden and Tunstall 2006). Even if social dimension is mentioned, very

often it is generalized as a green infrastructure for recreation purposes which frequently leads to the opposite effect - over-utilization (Baschak et al. 1995).

For better balance of social and ecological dimension author will base its research on social-ecological system sustainability (resilience) assessment which examines the issues of the particular system, its key components, system dynamic in various scales and also governance and social network characteristics (Resilience Alliance 2010).

As research focal system was chosen severely altered Hunze river in city of Groningen, which nowadays can only be indicated as urban canal or ditch system. Hunze river remaining parts encompass potential of ecological, cultural, social and economic values, although currently these characteristics are insufficiently implemented in urban surrounding. This can be explained by various site and management obstacles. In order to obtain data about main issues, valuable qualities, system dynamics, thresholds and influences from internal and external factors author will conduct semi-structured and open interviews with involved stakeholders not only within the focal system but also outside of the focal system borders. Such an overview of theoretical framework and focal system assessment will allow to draw conclusions about historical Hunze river area and site management sustainability as well as offer possible improvement for both green infrastructure planning and management.

Research goal: provide sustainable urban green infrastructure planning and management suggestions for historical Hunze river area.

Research tasks:

- Develop theoretical framework about urban green infrastructure planning and adoptive governance concept;
- Conduct case study research in order to compliment theoretical framework with practical examples;
- Carry out semi-structured and open interviews with professionals from formal and inform institutions as well as experts, practitioners and local community members;
- Complete context analysis by planning document, report and cartographic material studies;
- Using the framework of social-ecological system assessment, evaluate sustainability of historical Hunze river area as such, its planning and management practices;
- Apply carried research and assessment into urban green infrastructure planning and management proposal for historical Hunze river area.

Mater thesis consists of four main chapters. **First chapter** reviews theoretical literature about urban green infrastructure concept, place - based and adoptive governance, composition of social-ecological system assessment and provide practical information gained from case studies. **Second chapter** describes material and methodology used to carry out master thesis. **Third chapter** describes main characteristics of historical Hunze river area and presents results from conducted social-ecological system sustainability assessment. **Fourth chapter** discusses project "Stad aan de Hunze" sustainability proposed by "Het Groninger Landschap" foundation and compares positions and attitude of involved stakeholders regarding future development scenarios of historical Hunze river area.

Master thesis consists of 72 pages. Research provided 14 figures and 4 tables.

1 THEORETICAL FRAMEWORK

1.1 URBAN GREEN INFRASTRUCTURE CONCEPT

1.1.1 PROBLEM DESCRIPTION

Cities are the most appropriate example of human dominated ecosystem - a large area where natural land was transformed to impervious surface, where human population density has reached the caring capacity of available resources within the city, where the flow of energy, water, nutrients and species have been interrupted from its natural circulation. No wonder these huge interventions have left extensive ecological consequences to the urban ecosystem and those residing in it (Baschak et al. 1995). To mention some - water level rise during the peak rainfall events, water quality deterioration due to the urban air pollutants and overload of the sewage systems, urban heat-island effect, and decrease of significantly valuable ecological urban landscapes (Findlay et al. 2006; Peng et al. 2017). Baschak et al. (1995) mentions the main **reasons** that supports depletion of ecological values: rapidly expanding urban development that disconnects and limits natural areas encapsulating them in remnant patches and corridors, previously functioning ecosystem are kept apart from the supporting structures, natural areas are overloaded with recreational and facility development that is suitable mainly for human use.

1.1.2 CONCEPT DEVELOPMENT

"Green infrastructure" is a very broad concept that has various interpretations (Benedict, McMahon 2006). In this research most appropriate explanation is summarized in this definition: "connected networks of multifunctional, predominately unbuilt, space that supports both ecological and social activities and processes (Kambites, Owen 2006, quoted in Scott Shafer et al. 2013, 478)".

Formation of this concept is related urbanisation, growth of population density and to climate adaptation concerns (Austin 2014). With arising problems of urban ecosystem liability, green infrastructure is presented as "a systematic, holistic approach, involving transdisciplinary cooperation, green infrastructure addresses pollution, habitat, recreation, open space and urban form (Austin 2014, 3)". There is a need for comprehensive solutions that could balance the economic prosperity with amenity and liability requirements.

Even more alarming are weather extremes in form of intensive storm events and more intensive droughts (Alexandra 2017). It is clear that rigid engineering approach or so called grey infrastructure is not capable to adapt to these frequent changes because it was designed

with a certain expectation of normality (Li et al. 2017; Alexandra 2017). Overall there is a need for extensive supplies of potable water but at the same time there is a need to mitigate surplus water from possible flooding events (Alexandra 2017).

Green infrastructure can be designed to both drought and flood phases. Additionally it also provides complementary outcomes, for example, reduction of urban heat-islands, improvements of biodiversity and provision of recreational possibilities (Alexandra 2017).

1.2 METHODOLOGICAL SOLUTIONS (CRITICAL ANALYSIS) OF GREEN INFRASTRUCTURES PLANNING

1.2.1 URBAN GREEN CORRIDORS

Above mentioned issues are the main reasons why spatial planners are looking into possibilities to balance out economic development with ecological protection. Scholars have come up with an effective construction and management practices that is named as "urban green corridor" (Fabos 1995; Peng et al. 2017). Although must be mentioned that there is not a consistent terminology for this term. Peng et al. (2017) mentions that a lot of scholars use also terms like greenway, green belt, ecological corridor, habitat/ecological network and ecological infrastructure etc. The closest definition of the term related to this research is definition of the term "greenway".

The term "greenway" is mostly used in the United States, where Ahern (1995) proposes a comprehensive definition for it: "Greenways are networks of land containing linear elements that are planned, designed and managed for multiple purposes including ecological, recreational, cultural, aesthetic, or other purposes compatible with the concept of sustainable land use". As to the term "urban green corridor" Fabos (1995) mentions in his paper that this term is used as an alternative name for "greenways" in European countries. In addition he point out that the term "corridor" encompasses a broader meaning of space linkages that has a huge impact on the surrounding areas and serves a multifunctional space. In case of heterogeneous urban environment it is substantial to make the research form many-sided perspective in order to overlook all the opportunities in a limited space. Because of that further in this research will be used the term "urban green corridor".

Green urban corridors as part of the urban matrix preforms essential functions of the urban ecosystem. It is a heterogeneous entity that firs of all create migration route network for species that are representing flora and fauna. It serves as a foundation for enhancement of

biological diversity. Must be noted that a high priority should be given to the growth and expansion of indigenous species (Baschak et al.1995).

Green urban corridors are instruments that can be used to tackle climate adoption issues, more specifically high temperature rises and as a consequence of that “urban heat islands”. Vegetation surface mitigates the heat and regulates the local climate (Baschak et al.1995).

Urban green corridors can serve for utilitarian proposes. As for example, its permeable surface and vegetation recycle storm water and sewage effluent through natural filter systems. Mechanical purification occurs already at the top soil layer where nutrients catch on to sand grains. Further the accumulated nutrients serves as a resource for plants to evolve. In this case it is a win-win situation, where polluted and undesirable water for people perspective can be an important energy supply for plants. Additionally, besides urban storm water management it enhances wildlife habitat because nutrients enriches the soil (Fabos 1995). Erosion control, noise abatement, economic benefits (Baschak et al.1995).

Urban green corridors can be classified into four primary **types**: urban river corridors, urban green corridors with high ecological significance, recreational urban green corridors and urban green corridors with heritage and cultural characteristics (Fabos 1995).

- Regarding **urban river corridors** and their adjacent wetlands it is possible to observe significant changes in the main function they used to provide in the past and what is the main role of the urban river nowadays. If we look back in the past it is possible to witness significant value rivers used to provide to the cities. Staring with water and food supply, concluding with transportation and industrial functions (Everard et al. 2011). Due to mentioned river services a lot of dwellings concentrated along the rivers (Fabos 1995). But that was only the beginning of the striking alterations of the ecosystem that are still present and threatens to escalate even further. Nowadays floodplains of freshwater ecosystems are replaced with impervious surfaces and disconnected from the rivers; natural river flows are culverted and even buried in subterranean pipes and due to urban pollutants river systems carry contaminated water even further leaving a footprint on surrounding areas and the entire water cycle (Everard et al. 2011; Eden, Tunstall 2006).

Alterations made by humans cause sequential changes in ecosystems. By changing only one function of the system it creates successive reaction of other elements involved. For example, the increase of impervious surfaces and urban drainage reduces infiltrations which consequently increase surface runoff. In urban environment hard surface and drainage system is a common practice, that’s why it is not surprising that during peak rainfalls cities are vulnerable to flooding and during periods of drought vulnerability is visible as insufficient water supply. Furthermore interference in infiltration and flow of the water reduces the

chances for water to recharge to groundwater system (Findlay, Taylor 2006; Everard et al. 2011). This example shows that it is enough to change water flow and infiltration processes to cause huge effects on "geomorphology, water quality and habitat value of urban streams (Findlay,Taylor 2006, 314)."

Regarding water quality deterioration there are also other external factors that can reinforce the negative impact - total pollution of greenhouse gasses, metals, suspended solids, waste water etc. High impact can be caused by overloaded sewerage systems that during peak hours can overflow and end up in open water streams (Paul and Meyer 2001; Findlay, Taylor 2006; Everard et al. 2011).

Most direct changes are caused by physical modifications like "navigation and/or flood protection, including channel straightening and reinforcement", due to urban development, rivers are culverted and diverted or even buried (Everard et al. 2011).

- In **ecological green corridor** development the main aim is to maintain and increase biodiversity. A significant aspect regarding biodiversity is the composition of the species, more precisely - a preference should be given to indigenous, rare and endangered species. As to ecological green corridor functions it serves as a connector between habitats creating the most favourable conditions for specie migration and dispersal (Baschak et al. 1995; Fabos 1995).

Nevertheless formation of connectivity is not enough. Decisive role is played by the structure and content of the corridor. To support the re-colonization of indigenous species, it is essential to connect nature areas with source points of ecologically valuable patches and very often especially riparian zones are the most favourable places in urban environment for species to exist and migrate (Findly, Taylor 2006). Noss and Harris (1986) proposed a multiple-use-modules (MUM) where the most essential part of the habitat core is sheltered from external influences. Although it doesn't mean that the core habitat is completely isolated because there is also a need for a wider exchange of elements between larger systems. An important structural feature is the distribution of valuable nature patches and the overall structure of the patch itself. Baschak et al. (1995) summarizes these suggestions as follows: "dispersion of the patches should be distributed gradually, starting from species source pool where the patches are smaller and closer together continuing with steadily increased distance between them. He also mentions that "Patches are also frequently located at junctions of corridors and function as nodes".

Certainly preservation of ecologically significant areas are important, however it should be taken into consideration that in an urban environment there are a lot of undesirable disturbances from the adjacent neighbourhoods. Therefore protection and conservation should

be followed by rehabilitation of impacted areas (Findly, Taylor 2006). Accordingly there are certain planning and design principles that can help to improve ecological quality of the place. Regarding the structure of the patch Diamond (1975) came up with configurations for nature preserve design:

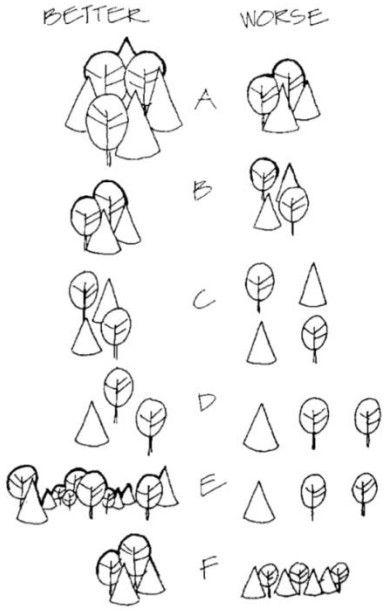

Fig. 1.1. Schematic representatives of comparative shapes and configurations for nature preserve design. (Baschak et al. 1995, adapted from Diamond 1975)

"A, a large reserve will hold more species than a small reserve because of species-area relationships; B, for the same reason, a single large reserve is preferable to several small reserves of equal total area, assuming that all represent the same habitat type; C, if it is necessary to have multiple small reserves, they should be grouped as closely as possible to minimize isolation; D, arranging small reserves in a cluster, as opposed to a linear fashion, will also facilitate movement among the reserves; E, connecting the reserves with corridors will make dispersal easier for many species; F, by making reserves as circular as possible, dispersal within the reserve will be enhanced and the negative effects of edges will be minimized (see Fig. 1.1) (Baschak et al. 1995, 216, adapted from Diamond 1975)."

- Urban environment requires versatility. City is a place where large number of people concentrates around multifunctional urban nodes. In order to meet countless demands and needs regarding living conditions of inhabitants an important urban function is **recreation.** Recreational urban green corridors include pedestrian and cycling pathway web, infrastructure for leisure activities, access to the water, walking places with scenic landscapes etc. But then there is a question concerning enjoyable and pleasant living environment - can recreation sites serve for the same purpose without ecological quality of the place? Would people want to spend time in unpleasant microclimate suffering from air and sound pollution, next to

contaminated water bodies? Fabos (1995) proposes to approach urban green corridor planning with mixed approach by connecting recreational needs with nature protection.

Significant changes have occurred in the urban structure as well. Population growth that has caused urban sprawl and decentralisation of population has also affected recreation planning structure. If previously the focus was on park planning in the central part of the city where planners determined a particular range of green space that should be assigned per person than now it has shifted to landscape approach. Attention is drawn to the assessment of the landscape characteristics, elements and network (Fabos 1995; Baschak et al. 1995). In summary, outskirt of the city has a bigger potential to preserve the existing values of the landscape. After this step it is possible to shape the development direction into more comprehensive practice where recreational urban green corridor functions as central axis - a foundation to connect city neighbourhoods and deliver recreation opportunities for larger number of city inhabitants.

- Most of the time urban green corridors with **heritage and cultural** characteristics can emerge because of the historical functions that adjacent river could provide. For example, water supply, fishing possibilities, trading, transportation etc. are the functions that could support village and later on also urban development (Fabos 1995). Aside from that, cultural legislation cannot be viewed as one single unit. It must be integrated in a rapidly developing city with its various needs without losing "authentic face" of the place. For instance Fabos (1995) proposes that in lines with urban green corridors it is possible to create heritage trails that can reinforce recreational opportunities and tourist attraction places.

1.2.2 MULTI-FUNCTIONALITY

Already in the previous paragraphs it was evident that urban green corridors have a potential to become a comprehensive urban area where all of the three types can be merged together. Urban green corridors are evolving in into multipurpose systems that can meet not only ecological requirements but also recreational and cultural functions (Fabos 1995).

Most important part of comprehensive planning is that each function is complementing one another. To harmonize theses three dimensions together it is crucial to assess the elements of the area and its overall structure. Assessment of the area will not only help to evaluate ecological quality of the place but also cultural elements and potential recreational areas. Significant natural patches should be preserved (followed by any necessary plant community restoration) and places with lower ecological value can be left for other development purposes like, for example, recreational purpose (Baschak et al. 1995).

1.2.3 SCALES

Most of the time the conservation practices has been applied on discrete ecologically valuable places but a lot of scholars have emphasized the need to merge these activities into more comprehensive land-use planning process (Peng et al. 2017; Ahern 1995; Baschak et al. 1995; Fabos 1995).

Fabos (1995) compares green corridor systems to highway and railway **network**. He envisions that the green corridor network should take the same evolution pattern as human-made grey infrastructure: "After building dozens of railway and highway segments incrementally, planners stared to envision regional, state-wide and national networks (Fabos 1995, 4)". Here he shows how important it is to protect and manage each separate territory as a valuable steeping point and foundation to create wider linkages: "…we think of greenways as corridors of various widths, linked together in a network in much the same way as our networks of highways and rail- roads have been linked (Fabos 1995, 5)."

Nevertheless there is a considerable difference between these two networks. Green areas have already been there beforehand - not made by humans but nature itself, therefore the most important thing is to preserve them and protect from anthropogenic interventions (Fabos 1995). Regarding these irreplaceable nature formations Fabos (1995) cites landscape architecture teacher Stanley White: "…the form is there, we just have to respect it and fit our human activities around those forms (Fabos 1995, 8)".

Network consists of various scales. Baschak et al. (1995) suggests applying three scales for plan, design and managing urban green infrastructure: site, local and regional. Considering the urban green expansion opportunities and the interaction between various scales it shows us how yet important is the **site scale** from both perspectives - physical and mental. Physical - because protection of valuable core areas is a starting point for connectivity development. Although first concern is to search for any natural landscape fragments that are still present and have withstood urbanisation processes at a smaller scale and only then it is possible to talk about the protection of these places and further expansion around the habitat nods (Baschak et al. 1995). And mentally - because by giving high value to these areas, it creates a foundation for change in the attitude.

Usually site scale landscapes, especially in an urban environment, have limited space; therefore they are not capable to protect themselves from the impact of the urban environment and human disturbances. For this reason these areas are still considered to be managed ecosystems. But despite of that "management and/or maintenance can be minimized by

landscape design in concert with biological and physical environment (Baschak et al. 1995, 222)".At this scale it is important to increase structural complexity within habitat

Looking from a wider perspective where previously mentioned site scale nature areas and binding elements can be perceived as one entity leads to **local scale** ecosystem. In this scale that consists of specific nature areas and adjacent urban matrix is essential to scatter different habitat types throughout the ecosystem to create suitable conditions for element flows. Thus at this level it is not only about the structural design but also about the landscape planning taking into consideration numerous interactions among habitats, sites and urban structures (Baschak et al. 1995). At this scale it is important to make sure that nature area functions as a resilient ecosystem which is able to protect itself from surrounding disturbances. This can be achieved by surrounding ecological buffer zones and purification systems (Li et al. 2017).

Regarding **regional level** the goal is to preserve extensive and spacious areas that consist of considerable amount of linked local habitats which in turn are abiding "heaven" for indigenous species. This is the point where we go back to the complexity of network structure. We can see that structure of network is present in each scale and that each element is part of the system. Despite the fact that even the smallest scale of network is important, genuine impact on the ecological wellbeing will be significant when the regional level is reached (Baschak et al. 1995). Also Peng et al. (2017) emphasizes that large-scale green corridors are more favourable for biodiversity increase.

1.2.4 MANAGEMENT

Significant disturbance in an urban environment is caused by excessive maintenance of so called urban green living space. People are striving for organised and regulated environment which creates a sense of perfection, but in such an environment limits the possibilities for the nature to take over and restore natural habitats. There is no possibility to create heterogeneous environment where one ecosystem crosses to another creating different levels of development.

In order to overcome human caused disturbances Baschak et al. (1995) propose to reduce management actives, such as mowing and trampling. Findlay and Taylor (2006) also confirms this statement: "in urban situations a balance exists between minimizing anthropogenic disturbance whilst maintaining natural disturbance patterns (Findlay and Taylor 2006, 316)".

Yet again there is a need for thoughtful planning and management towards human flow planning to reduce human access to valuable nature areas and environmental planning to clearly distinguish patches that are left for free nature progression and places for more rigid management manner, that makes the green areas accessible for recreational and development purposes. Fabos (1995) mentions that areas next to the rivers and streams like "steep escarpments along the streams or stream banks, related wetlands and some unique areas with mature vegetation and north facing slopes" create inconvenient conditions for development which on the other hand is very beneficial environment for nature protection and recreational needs.

Amplifying instruments can be connected with **social** interference within community. First of all public education can play an important role for nature conservation. People are more understanding and understand the reasons behind management changes. Another instrument is management agreements with neighbourhood administration (Baschak et al. 1995).

1.2.5 ECOSYSTEM SERVICES

While listing various anthropogenic influences on urban river ecosystems and urban green corridors there still remains a question: why we should rehabilitate urban river systems and its surrounding floodplains? One good reason is mentioned by Everard et al. (2011) who draws attention to the fact that civilizations has already faced situations when natural system is altered and resources are overexploited to the extent when viability is no longer possible because of ecosystem collapse.

Wetland and riparian as well as freshwater ecosystems are considered to be among vastly diverse ecosystems (Fabos 1995; Everard et al. 2011). Due to this reason the loss of **ecosystem services** is even more significant. To deal with the loss of biodiversity and down grade of urban livability conditions scholars, decision makers and spatial planners have established significant toll to increase recognition of ecosystem benefits or services that society requires (Everard et al. 2011).

There can be mentioned a wide spectrum of **benefits** that river rehabilitation projects can provide. With comprehensive planning practices river and floodplain rehabilitation projects can decrease flooding probabilities, improve biodiversity, increase recreational benefits with leisure and amenity accessibility. The range of possible benefits can expand even further (Everard et al. 2011). It mostly depends on the existing problems in the specific area that are needed to be confronted.

There is a need for scientifically robust and practical tools. In connection with the previous context a useful instrument in planning and other decision making processes is ecosystem service framework. It highlights various benefits that society is relying on. UN Millennium Ecosystem Assessment (2005) categorises them into four general groups: "provision services", like food, fresh water, fiber and medical resources, "regulatory services", like air quality regulation, water regulation and purification etc., "cultural services", like aesthetic values, recreation, tourism etc. and "supporting services", services that support the function of other ecosystem services, for example, photosynthesis, nutrient cycling etc.

Although this method could be a helpful instrument to create well-considered and balanced development plans, there is lack of conventional methodology for evaluation of ecosystem services. However, Everard et al. (2011) provides some examples from real practices. First approach presents monetisation of services that can serve as justification for investments. It is a persuasive approach that can help to clarify the benefits behind the contribution. In addition, it is not only reflection of financial benefits but also serves as an education process for the local society. Second approach can help to simplify the evaluation process. It is a based on judgement of stakeholders or experts that helps to identify preferences and takes into account unique characteristics of the case. And the last one but not the least, is presented as a practical tool for everyday management decisions. In this case ecosystem service evaluation is made for certain areas and serves as representative of ecosystem carrying capacity. This overview can serve as a manual for everyday decision making processes.

However there are also some flows in ecosystem service evaluation system. Calculations can be inaccurate because in some cases it is impossible to foresee the relationship between the degree of rehabilitation and the amount of ecosystem services it can deliver in return. Another thing is that in time ecosystem services can change and deliver completely different benefits. Most of the time ecosystem service framework is criticized for inconsistent approaches used to evaluate the benefits; therefore evaluation can become a subjective matter. It can also be judged for ethical reasons, when nature is transformed into "human-centred product" instead of appreciating its intrinsic value (Everard et al. 2011; Findlay, Taylor 2006).

Nevertheless, ecosystem services can serve as cognitive process that helps to determine the relationship between causes from ecosystem intervention processes and consequences that manifest as loss of vast ecosystem services important to people well-being. This link is indefinite and therefore difficult to distinguish. There is a need to popularise ecosystem approach in mainstream planning and environmental management practices. It would not only

allow decision makers to foresee the actual situation from various aspects but also gives an opportunity to transfer this information to broader community in an simple and understandable way.

Often urban river corridors are associated as part of water runoff and flood mitigation system but very often it is forgotten what wide range of benefits it can bring. To mention some: it can provide "contribute to aesthetic quality, enhance economic values, provide wildlife habitat and diversify recreational opportunities through activities such as boating and fishing (Scott Shafer et al. 2013, 481)".

Shafer et al. (2013) introduce the main characteristics which usually encourages people to visit stream corridors in urban areas. Most often people use urban river corridors for recreational amenity, most of the time it incorporates possibilities of walking, running and cycling. They also mention that proximity of the open space is closely related to the frequency of visitors. It is important that the place is located in a distance that is accessible by walking. Urban river corridors are beneficial with its linear characteristic not only because it can provide green open space to several neighbourhoods but it also connects people to different places. It is important that the green area provide its residents with wide set of choices, like various length of walking trails, scenic beauty, dog exercising areas, fitness, fishing etc.

1.3 PLACE BASED AND ADOPTIVE GOVERNACE

1.3.1 PUBLIC ENGAGEMENT

Very often river restoration is described as win-win situation, where three most important pillars are addressed: economic, ecological and safety aspects. However, society doesn't always agree with this statement. For example, ecological restoration may affect cultural values of the place, leading to denial and resistance from the society. People fear to lose the attachment to the place due to planned changes, although is possible to assemble both aspect and in time when getting acquainted with the multiple benefits of the place, there would be room for new narrative values (Buijs 2009).

Public support for landscape change is based on the perception of an individual or society group (Buijs 2009). Perspective and attitude toward various solutions might differ significantly, therefore could result in conflicts or disagreements between involved stakeholders. Nevertheless, political methods of performance and communication can influence the why people see environment around them. Regarding attachment to the place and protection of cultural landscape values, it is important to introduce and educate people

about the improvements, simultaneously marking the importance of existing values. There is a need to communicate comprehensive planning approach in a simple and understandable way.

The main problem why people are indolent to participation process can be explained by the choice of typical and fixed interaction approach. Most of the time public engagement manifests as consultative approach, where people are informed about the future plans and specifically justified implemented measures (Petts 2007). This approach may lead to public resistance, indifference and narrow-minded vision of the specific place.

In order to enhance public participation Petts (2007) emphasises the importance of collaborative learning as well as process of learning itself. He suggests public engaging procedure already at the beginning. At this phase involved inhabitants are trying to gather information about the present issues and constrains, afterwards highlighting the main priorities. These actions can be supported by **discussion workshops** where small groups of people can interact with experts and decision makers. Experts are also assisting with background information on essential topics. This type of approach encourages empowerment and gives authority to the public (Petts 2007).

Afterwards theoretical base is supported by **practical site visit** that helps to illustrate previously highlighted problems and also allows participants to interact and have an open discussion in more informal environment (Petts 2007).

It is helpful to create **story based discussions**, because sometimes personal experiences of the place can tiger common values and comprehension of community. Real practices and examples can serve as a better argument that a description of technical solutions (Petts 2007).

Very often after participation procedure, interaction among communities and decision makers disrupts. There is a need to communicate and give feedback about communities input. It is one of the ways how people can feel satisfaction for their input and gain a motivation for further engagement. Most common information sharing instruments can be divided into two types: face-to-face and virtual/written form strategies. For example, contribution of outcomes through additional workshops and meetings can help to reflect on interaction process and see whether it was useful, or maybe there is a room for improvements. As to the second strategy, it includes: project website, where local communities have possibilities to gain information and also express their opinion; local press and distribution of questionnaires (George, Reed 2017; Petts 2007).

In summary, above mentioned approaches can boost-up the feeling of “local” ownership which can serve as an additional incentive of inters and sense of pride. Participants see that they can make a difference and therefore are more attached to the developed solutions. A

citation from an expert after public engagement project summarises this idea as follows: “if we had designed the scheme and then consulted on it, we would not have got the community buy in to the solution – they would not have owned the scheme like they seem to do now (Petts 2007, 309).”

1.3.2 BUTTOM-UP INNITIATIVES

Since climate issues have provoked concerns in global political arena it also has triggered movement of non-governmental environmental organisations (NGO’s). These organisations are taking a role of catalysts that are setting up interdisciplinary and multi-approach programmes in order to deal with environmental issues. They are also working in close cooperation with involved stakeholders and are making sore that their voices are heard during the decision making process (Findlay, Taylor 2006).

Although, very often the primary concerns of the local people are related to recreation, aesthetic and more utilitarian features of the place, enhanced work with educational activities, can raise people’s awareness about environmental questions as well. Involvement of community in environmental management process can enhance project results because of three main reasons. First, local knowledge, impressions and necessities give additional dimension of the place and its issues, resulting in more comprehensive developing and management options. Second, local people can be additional human recourses in implementation and management stages. Which leads to the third reason - people trust the adjusted measures and understands the main goals behind them (Findlay, Taylor 2006).

Because of the dens population urban areas are very convenient places for grassroots movements. Predominance of community voice and proactive movement can achieve a significant influence in decision making process concerning their surrounding living area. Fabos (1995) concludes that “nearly all greenway planning takes the form of grassroots projects” which shows that collective actions is a form of adaptability that can result in fundamental system transformations (Folke 2006).

1.4 ASSESSMENT OF SOCIAL-ECOLOGICAL SYSTEM

1.4.1 SOCIAL-ECOLOGICAL SYSTEM

Previous paragraphs where related to the overall understanding why urban rivers and its floodplains are important for both - living species and their habitats and also for the city dwellers and their environment. Nevertheless urban environment is more complex than that.

Nowadays the historical Hunze river territory is fragmented and consists of a various different ecosystems whose structures are very distinctive, for example there is an extensive difference between the elements in a build-up area and a meadow zone next to it or a canal ecosystem in contrast with industrial park area. In a place like city these areas are really close to each other, practically without any transition or buffer zone to separate these remarkably opposite systems. Generally natural areas are more vulnerable to human build environment because it limits its abilities to function in viable way, but human build environment is fully controlled by people and therefore nature around it is controlled as well (Alberti et al. 2013). But on the other hand if we approach this statement from a different perspective and look at the systems in a bigger scale, it can be seen that lately more often natural phenomenon is going to extremes that not only breaks human-made infrastructure but also affects human well-being and health (IPCC 2014).

In order to understand this continuous interaction better and make the future urban development more sustainable it is crustal to explore this system with in-depth research method. In literature there are various ways authors approach complex urban system exploration but social-ecological system approach stands out with its comprehensive and broad view of systems performance and interaction among other systems. One of the best descriptions can be found in Resilience Alliance (Resilience Alliance 2010, 4) created workbooks for assessing resilience in social-ecological systems: "… an approach to manage natural resource systems that takes into account social and ecological influences at multiple scales, incorporates multiple change, and acknowledges a level of uncertainty has the potential to increase systems resilience to disturbance and its capacity to adapt to change." …

Historical Hunze river area is a perfect example of various anthropogenic disturbances that changed the previous river ecosystem into a fragmented canal system. Nowadays the remains of Hunze river are surrounded by controlled landscape and build-up areas - a human force that has destroyed the previous ecosystem advantaging practical infrastructure and economic benefits over nature values, ecosystem services and historical heritage. Nevertheless economy and wellbeing of the city considerably depends on the natural ecosystems (Folke 2006). That is one of the reasons why it is important to keep the natural systems resilient and secure its capacity. **Resilience** concept "…refers to the magnitude of change or disturbance that a system can experience without shifting in to an alternate state that has different structural and functional properties and supplies different bundles of the ecosystem services that benefit people (Resilience Alliance 2010, 5)." Although historically this shift to an alternate state has already happened, this concept is still significant, because nowhere else than in a city it is both manageable to quickly alter the surrounding and on the

other hand there are more obstacles because of the dense build-up areas and involved stakeholders that has various different needs and perspectives of the world.

1.4.2 RESILIENCE ASSESSMENT FRAMEWORK

Resilience assessment can be described as an instrument that helps to understand the change dynamics of integrated social-ecological systems where numerous elements interact with one another. The overall comprehension of a system and its function creates an opportunity to improve management options under uncertain and changing environment. A positive feature of this framework is that it has a holistic approach without emphasizing detailed understanding of every element but the main objective is to understand **how fundamental units contribute to the dynamics of the whole system** (Resilience Alliance 2010).

Framework consists of four main key concepts: integrated social-ecological system, multiple system states and critical thresholds, adaptive cycle and panarchy and adaptive governance. The concept of **social-ecological system** is the key concept of this master thesis. It emphasizes the importance of comprehensive view of social and ecological systems where components from both fields interact at multiple levels (Resilience Alliance 2010; Ostrom 2009; Butler et al. 2017). It is important to understand how this synergy influences ecological resilience in urban ecosystem because human services in urban areas are reliant on ecosystem functions provided by biophysical forces. It will pinpoint the thresholds which will help to balance social and ecological aspects in urban ecosystem (Alberti et al. 2013). Previous overview of literature showed that urban ecosystems are viewed in two separate pillars either from ecological or social perspective but separation of these two entities might lead to narrow and short-minded solutions (Folke 2006). This is one of the reasons why it was chosen to merge this two separate entities with social-ecological approach.

Because of the complexity of urban ecosystem that comprise diverse components and is accessible for external influences, it can be described as dynamic system that is constantly changing. As a result there is a possibility that system can transfer to different **system states.** Resilience Alliance (2010) outlines that after this modification the system can form "…either stabilizing feedback that keeps the system in a particular state or ampliphying feedback that push the system towards a new configuration and system state." In a controlled environment as city these changes can develop gradually but can also be abrupt. In both cases a shift of system state can cause undesirable consequences and that is why it is crucial to be aware of critical thresholds.

Because of the previously discussed system dynamics social-ecological system can be analysed through **adaptive cycle of development and panarchy** proposed by Gunderson and Holling (2002). Ecosystem changes can be described in four phases of development: periods of exponential change which is described as rapid growth or **r phase**, periods of growing stasis and rigidity - conservation of resources or **k phase**, periods of readjustment and collapse - release of resources or **Ω phase** and periods of re-organisation and renewal - **α phase** (see Fig. 1.2.). The understanding of system as adaptive cycle gives an opportunity to oversee systems vulnerability to disruptions and its ability to react as it shifts through different phases of change. These analyses and awareness of possible shifts can provide additional information about the type and timing of management interventions (Folke 2006; Resilience Alliance 2010).

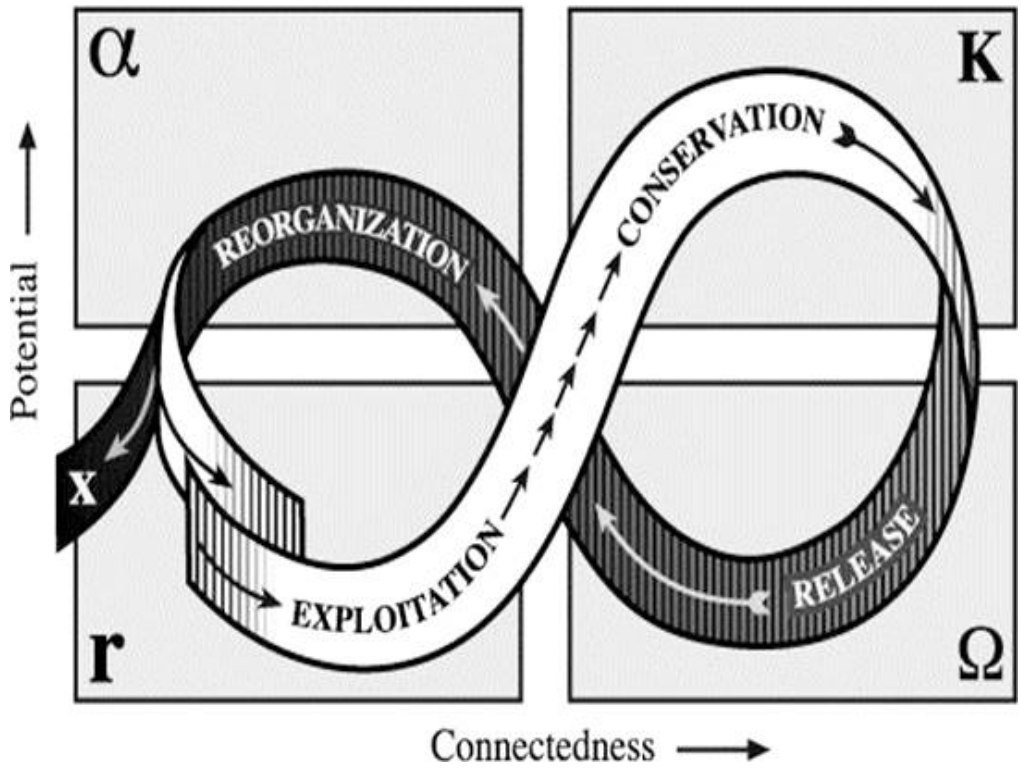

Fig. 1.2. Adaptive cycle (Gunderson and Holling 2002)

Despite the fact that adaptive cycle gives an insight to the changes of a system over extensive period of time, Resilience Alliance (2010) also considers different "dimensions of systems connected hierarchically across scales (Resilience Alliance 2010, 8)". The concept of **panarchy** shows how the focal system reacts to forces set from larger scale systems or to alteration from smaller embedded scales (Resilience Alliance 2010; Folke 2006).

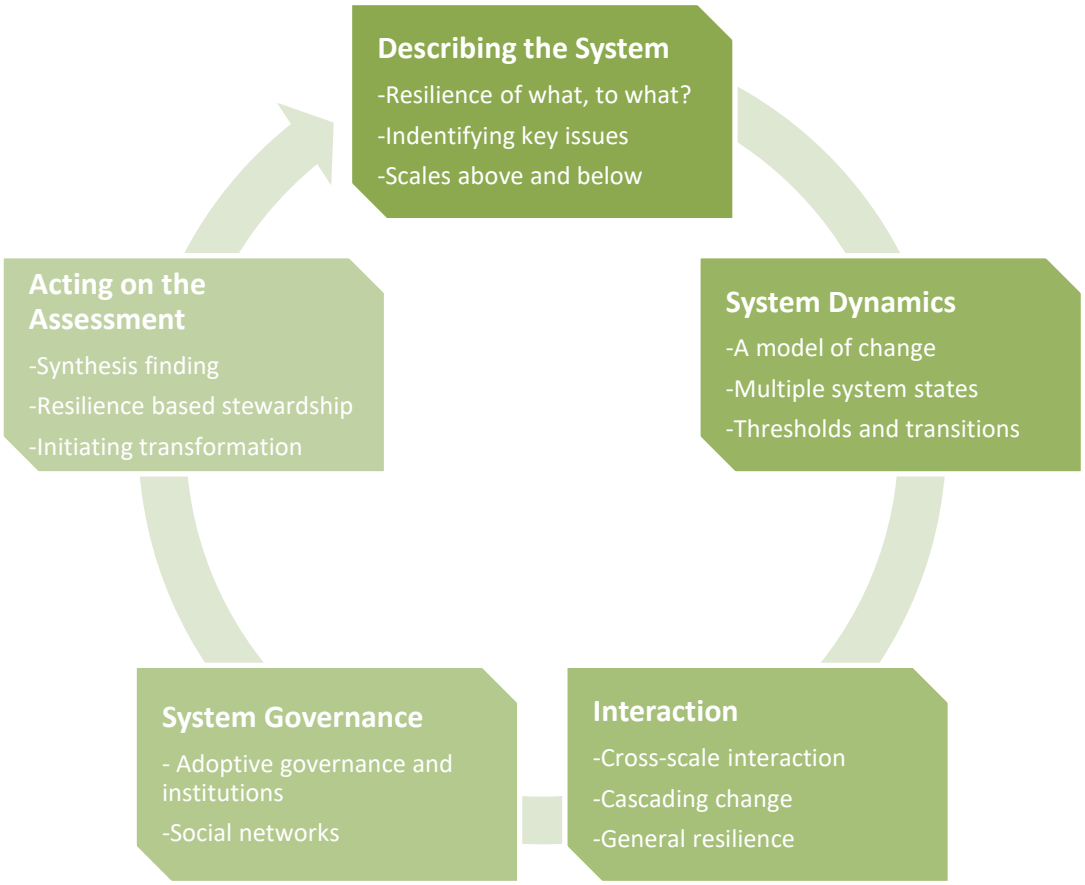

Fig. 1.3. Resilience assessment framework (Resilience Alliance 2010).

Finally governance system is a control mechanism that models how society operates and makes choices in their surrounding environment. Such responsibility and stewardship over available resources and involved representatives requires changes in the governance style to more flexible, comprehensive and innovative application such as **adoptive governance.** It requires experimentation, redesigned policies and arrangements, original approaches of cooperation, which can be achieved by applying both formal and informal institutions. So it means not only focusing on systematized and rigid regulations but also taking into consideration collective values and vision of involved citizens (Resilience Alliance 2010; Ramolini et al. 2016; Folke 2006).

In order to integrate these previously mentioned key concepts within one system, Resilience Alliance (2010) created five main stages of assessment: "beginning with describing the system, then understanding system dynamics, probing system interactions, and evaluating governance, and finally acting on the assessment (Resilience Alliance 2010, 5)" (see Fig. 1.3.).

Stewardship Mapping and Assessment Projects (STEW-MAP) conducted by Ramolini et al. (2016) offers a framework for examining and understanding urban stewardship network. This framework consists of five major components or lenses that studies characteristics of

social and ecological questions, variables and analyses. Population and ecosystem can be understood as series of ecological lenses - organismal, population, community, ecosystem and landscape lens - that consequently can be extended and adjusted also to social phenomenon (see Fig. 1.4.). This is a useful complementary tool for incorporating and combining different data types for social-ecological understanding of urban stewardship networks. This approach can help to identify social network that is one of the research stages in "Resilience Assessment Framework" (see Fig. 1.3.).

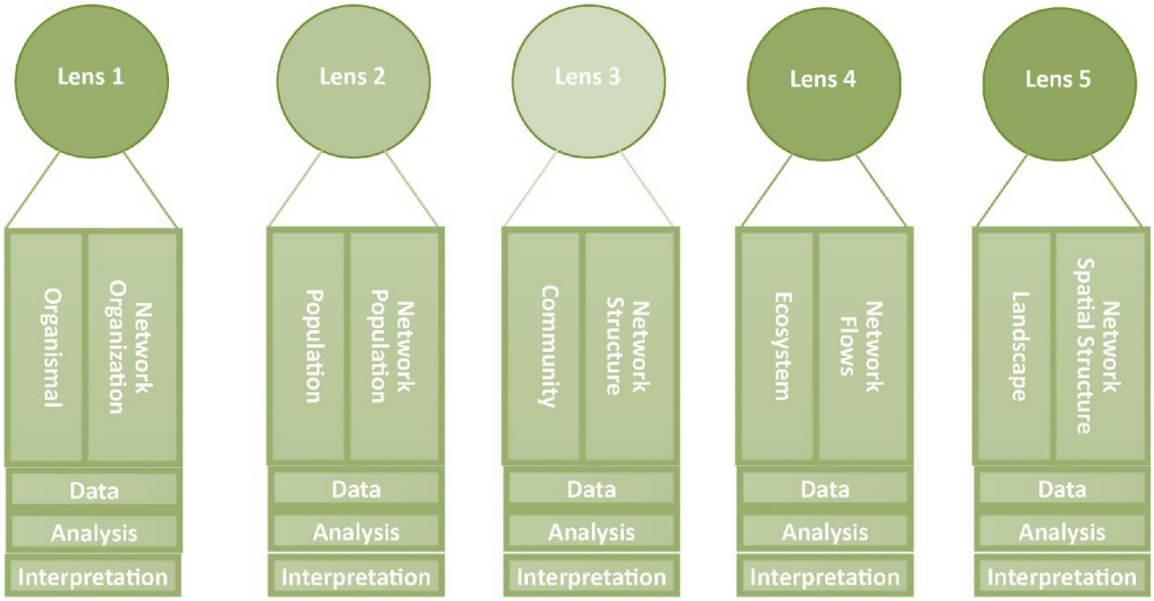

Fig. 1.4. The five lenses (Ramolini et al. 2016)

1.5 CASE STUDIES

1.5.1 CASE STUDY 1 - BINNENDIEZE RIVER PROJECT IN S-HERTOGENBOSCH

Genareal information

In the center of s-Hertogenbosch (Den Bosch) the Dommel, Aa and ZuidWillemsvaart streams come together and continue their flow as De Dieze stream. Through the Crevecoever sluices De Dieze flows into the Meuse river. Dieze river is completely surrounded by urban area. Due to city interventions it has been channelled and navigated. More specifically the streams and creeks where modified, there has been morphological alterations that completely changed the profile of the river and the catchment area has been completely urbanized. Nevertheless De Dieze in not an artificial water body, it can be characterized as highly modified but slowly flowing river (Waterschap 2014; Oosterveld et al. 2019).

Restoration

For centuries economic life of Den Bosch was supported with Binnendieze river that served as transportation route and trading place. But the situation changed when river lost its economic significance and when preference was given to the urban expansion. City was surrounded with fortification walls which made the expansion very concentrated and limited. In time these two components resulted in a very poor water quality and in some parts even disappearance of the river. The Binnendieze river had become a "stink ditch". First of all household sewage system was connected to the river and second, people couldn't care less, they continued to dump their household waste straight into the water. This was the point when city council decided to close up the river that followed with an unexpected reaction from the local people. People even created a political party to convince municipality that river and historical heritage around it should be restored (Luijten S.a.; Crijns 2019).

Involvement and activity from the local citizens changed the decision of government and it was decided not to close the river. After that, municipality began to work on the restoration project. The restoration of Binnendieze was long and expensive restoration project. In fact he restoration lasted 25 years and cost where around 20 million Euros (Crijns 2019). First restoration project started already in 1973 and lasted until 1998 but already few years after the first restoration approach it turned out that more extensive maintenance was needed to restore inner city walls than formerly estimated. Accordingly the municipality of Den Bosch adjusted the existing maintenance plan and in 2004 came up with a new Project Plan "Projectplan Reparatie Voegenwerk Binnendieze" to repair the walls and tunnels that connect the Binnendieze river flow. The project was divided into three parts that lasted from 2004 till 2006 (Hupkens 2009).

In order to start the renovation works there were considerable obstacles that had to been taken in account. In order to connect buildings to the sewer system, the floors in historical monuments had to be turn up. Another complication was the fact that the walls and enclosures in many cases are privately owned while the municipality of Den Bosch owns only a small number of properties around the Binnendieze. Nevertheless, municipality took the decision to bear the costs of major repairs. The involved homeowners were contacted so that they could sign an agreement which gave permission for the municipality to carry out maintenance works (Hupkens 2006).

In general this project enclosed various functions: hydraulic engineering and water quality improvement, preservation and enhancement of ecological values and restoration of cultural heritage. Binnedieze unique character hides in its contrast of closed an open space. In a lot of

places the water flow was restored underneath the buildings that now gives visitor a chance to see beauty of restored building, arches and bridges from the 19th and 20th century (Hupkens 2007).

Stakeholders

As mentioned above the most serious negotiations where with homeowners. A lot of obstacles where overcome because of the privacy legislation and restrictions for cultural monuments. It took nearly 25 years to deal with all negations and involved people.

In project development stage there was a collaboration with water board about ecological values, water quality and quantity, flood preventions; with national government, more specifically Ministry of Education, Culture and Science in order to discuss renovation works of cultural monuments and also non-governmental organisation (NGO) The Kring Vrienden van 's - Hertogenbosch association was interested in this project. In fact this NGO is the one who started boat trips through Binnendieze river (Crijns 2019).

Governance and legislation

Private Law was the most important legislation they had to deal with, as they had to negotiate with several thousands of private owners of houses on top or along the river. In changing the sewage system they had to collaborate with the water board, responsible for the cleaning of sewage water. The water directive would be the legislation on that matter. And thirdly most propriety along the river is enlisted monument. The Dutch National law on Monuments is very strict on what can be changed (almost nothing) in order to give way to the water, to open up closed parts of the river all the (mostly stone pavement) floors of the monuments had to be taken out, to change all the sewage pipes from the river side (at the back side) to the street side (in front). Finally legislation on nature values (protected plants and animals) were at stakle (Crijns 2019).

Financial support

They are writing project to get the funding from provincial and national government. For example, small project regarding climate resilience - water irrigation. And also takes advantage of small subsidising from municipality - for example supporting green roofing (Crijns 2019).

Municipality gets 25% of the income from boat trip tourist attraction. This money is used for maintenance works (Crijns 2019).

Future

In the future there are ideas to open up Bennendieze project even more, especially in the park area, where river used to flow. But these are huge expenses. It involves buying plots of land and houses. Than the project overall coast can go up to 25 million or even more. It should be considered whether it is worth it or not (Crijns 2019).

The most important part of the project was already done in 2003 when there was to make a connection with Binnedieze river and the surrounding water canal system, to offer a round tour around the city instead of going from point A to B (Crijns 2019).

Lessons learned

Binnedieze river was restored in a very "traditional" way. They wouldn't do it in the same manner today. Previously they demolished the remaining part and build upon a new construction. Now they are trying to keep the original constructions as much as possible intervening only with restoration works. Restoration measures were changed not only because of its cultural value but also because of ecological preservation. He mentions that there are a lot of species living in the cavities of the old walls. They are also trying to use more nature friendly materials.

Previously he mentioned that there were a lot of negotiations between the municipality and the private owners of the houses. But still it wasn't enough. There should have been more interaction with the people, like group meetings, education about the values and purpose of the project.

1.5.2 CASE STUDY 2 - LOVE YOUR RIVER TELFORD

General information

The main reason why this project was chosen is because it serves as a good example of collaborative governance and involvement of various stakeholders. And also demonstrates well developed and comprehensive monitoring practices.

Project

The main goal of the project was to "improve water quality and aquatic habitat around the watercourses of Telford while at the same time improving protection of downstream potable drinking water supply (SWM 2017, 1)".

Initially after a surveying the watercourse of Telford river it was found that the water quality was affected with urban pollution from sewer misconnections, trading estate runoff and all sorts of litter.

To cope with discovered pollution a team from Environmental Agency began the work on project called "Love Your River Telford". Already at the beginning they approached various partners and local groups to combine the efforts together. There was "a relatively large and very active network of volunteer groups that focused on environmental issues. After many discussions, some very innovative ideas and lots of unique suggestions about how to approach the challenges we faced, Love Your River Telford was born" (Pluckwell 2015; Puckwell 2019).

Stakeholders and public engagement

The project was carried out in collaboration with various involved stakeholders: four government organisations, two non-government organisations (NGO's), one water company, one university, sixteen community groups and an industry lead environmental groups.

There must be highlighted **three** important movements that have engaged local community:

1) They made a programme of training sessions to teach volunteer groups how to monitor water quality and what actions should be taken afterword;
2) A Clean Stream Team was formed whose main task is to provide training and advice to the local volunteer groups;
3) Created the River Ranger programme for schools - to raise awareness about the environment and water quality amongst schoolchildren and build a mini sustainable drainage system (SUDS) with the pupils in participating schools (Pluckwell 2015).

Funding

The main support to this project was from DEFRA (Department of Environment, Food and Rural Affairs) Grant in Aid funding.

1.5.3 CASE STUDY 3 - MAYES BROOK PARK

General information

Mayes Brook park is located London Borough of Barking and Dagenham in east London. It is also known as the UK's first "Climate Change Park", which was a successful "showcase of how public greenspace can help a community to cope with the risks from climate change; such as increased flooding and higher summer temperatures (ECRR 2019)". This case study shows how green infrastructure approach is a powerful alternative to traditional hard engineering (Natura England 2013).

Before the remarkable changes Mayes Brook was “realigned to the west side of the park and sunk into a deep concrete channel essentially limiting the river’s functions to acting as a road drain and flood water channel. Two lakes, created by extracting aggregate used to build the houses surrounding the park, once proved popular for boating and angling, but suffered from pollution as water from the river was diverted for flood management” (Natura England, 2013).

Restoration

The first phase of the project was dedicated to the renewal of rivers “natural” flow. More precisely river was released from the concrete channel and formed in a winding pattern. Besides that there was created a floodplain storage area, numerous sustainable urban drainage areas (SUDs) and a backwater in the middle part of the park. A very meaningful step towards better water quality was the identification of misconnected domestic water pipes which had led to pollution flowing into the brook (ECRR 2019). After all this project resulted with various advantages: it created an attractive place for recreation by creating new footpaths, sports facilities and information signs; it improved wildlife and biodiversity, but most importantly it implemented flood-safety measures with alternative biotechnologies.

Stakeholder and public engagement

This project demonstrates partnership of public, private and voluntary organisations. Certainly must be highlighted, that local interest in this project was very high. That could be observed from the high proportion of 2,000 questionnaires returned. There were carried out project meetings and public consolations to observe concerns of local people.

In order to reinforce community reconnection three primary schools where invited to participate with their artwork that where based their perception of the park. Later these artworks where presented to the local community as a consultation exercise. The ongoing work with schools and local communities gave people an opportunity to understand the new project better and therefor care for it maintain the prosperity of the park even further (Natural England 2013).

A good reflection and transparency about the process of project was achieved through information sharing in local newspapers and social media.

Ecosystem services

As already mentioned above park restoration brings various benefits but in order to show to a wider audience, there has been done an ecosystem service assessment. It is estimated the restoration of park “will bring benefits worth up to seven times the cost of the whole

regeneration scheme, according to an assessment by the Environment Agency and Queen Mary College" (Environmental Agency 2011).

The assessment was carried out by classifying identified benefits into four categories that are based on UN's 2005 Millennium Ecosystem Assessment definitions of 1. provision of food, water, fuel, 2. regulation of flood risk, air and water quality, 3. recreation, education and tourism, (cultural services) and 4. soil formation, nutrient cycling and habitats for wildlife (support services) (Environmental Agency 2011).

Report revealed that more than 88% of the total ecosystem services where beneficial to health, risk and cultural values. Furthermore the overall improvement of ecosystem functioning helped to boost or maintain all ecosystem service categories (Environmental Agency 2011).

Monitoring

This project is also a great example because of its monitoring strategy. Monitoring strategy was coordinated by River Restoration Centre and the London Borough of Barking and Dagenham. Strategy was prepared already at the conception stage of the project. "The "SMART" framework was used to set targets that were Specific, Measurable, Achievable, Relevant and Time based. These targets were agreed by the project Steering Group and were designed to incorporate the River Restoration Centre's monitoring guidance document (PRAGMO) where appropriate (ECRR 2019)". It resulted in "a range of targets across four thematic areas to assess the success of the project in a clear, scientific and transparent way. The four themes were:

- Climate change;
- Natural environment (aquatic);
- Natural environment (terrestrial);
- People (ECRR 2019)."

Strategy document helped to identify the overall aims for each theme of cost, achievability and relevance (ECRR 2019).

Different individuals and organisations of the Mayesbrook partnership where involved to collect the needed monitoring data. Council even employed a full-time ranger to organise events for local people, coordinate volunteers and collect monitoring data (ECRR 2019).

Funding

RSA (Royal & Sun Alliance), an insurance company, increased the funding by donating £ 300,000 through "Themes River Trust" as a research contribution. Additional funding was secured in 2008 through Mayor of London's 'Help a London Park' campaign acquiring £

400,000 and from the support from Natural England's "Access to Nature" fund £ 150,000 (ECRR 2019).

Future

In future The Mayes brook partnership is looking forward for the second phase of the project where they planning to create a café that would simultaneously serve as cognitive centre for public education about climate adaptation measures. They are planning to surround the cafe with climate change garden that would demonstrate drought resistant plants. The second phase also includes a clean-up of two polluted lakes in the park. After that it is planned to integrate this lakes as part of the park system by creating wildlife surrounding around them and introducing recreational possibilities like boating and angling. Although for this phase partnership is still seeking for the funding (ECRR 2019).

2 RESEARCH MATERIAL AND METHODS

Considering that urban ecosystems are heterogeneous units that consist of various entities, it was important to gain in-depth understanding from each significant pillar - which where ecology, culture and society. Most important data source point was knowledge of experts and decision makers who were directly related to the research area. Their expertise, knowledge and good orientation in local scale helped to get quick access to the information about the area, involved people and governmental approaches; and the last one but not the least also future plans that are not accessible elsewhere (Clifford 2010).

The following methods and materials were used in the research:

- **Semi-structures interviews** with experts from local, regional governance institutions and nature foundation. Indicated people in the list below where chosen because they are important actors that are influencing spatial planning and decision making process. In order to conduct resilience assessment of social-ecological system there were prepared questions beforehand. Semi-structures interview approach provided certain guidelines for the conversation and also helped to fill in information gaps about focal system issues, its components, system dynamics in multilevel scale, governance and social network characteristics (Clifford 2010; Resilience Alliance 2010). There were conducted 7 interviews from different governance levels and with different expertise spheres:
  - Quartermaster in Het Groninger Landschap foundation - Rob Reintsema (Reintsema 2019);
  - Spatial Planner from municipality of Groningen - Martijn Schuit (Schuit 2019);
  - Hydrologist from the municipality of Groningen - Anne Martin Helbig (Helbig 2019);
  - Ecologist from the municipality of Groningen - Janneke van Goethem (van Gothem 2019);
  - Policy advisor on sustainability, energy and innovation from water board "Noorderzijlvest" - Tjitse Mollema (Mollema 2019);
  - Ecologists from the provincial government of Groningen - Alco van Klinken (van Klinken 2019);
  - Advisor on spatial quality from provincial government of Groningen - Francien van Soest (van Soest 2019).

- **Open interviews** with experts, practitioners and community members:

  Consultation where carried out in order to get additional information about historical and cultural values of the place. This information was important not only because of specific information that was provided but also because it gave much broader viewpoint of the context around it. Several stakeholder where interviewed in order to gain understanding from different perspectives. There were conducted two interviews that were previously chosen as cases studies. Overall, there were 8 open interviews with experts, practitioners and community members:

  - City archaeologist - Dhr. drs. G.L.G.A. Kortekaas (Kortekaas 2019);
  - Archaeologist - prof. dr. H.A. (Henny) Groenendijk (Groenendijk 2019);
  - Professor of landscape history - prof. dr. ir. M. (Theo) Spek (Spek 2019);
  - Manager of Business association Zuidoost - Nico Borgman (Borgman 2019);
  - Resident Association of De Hunze / Van Starkenborgh, meber of the board - Marjan Boonstra (Boonstra 2019);
  - External funding officer of Heritage department (municipality of 's-Hertogenbosch) - Huibert Crijns (Crijns 2019);
  - Catchment Co-ordinator from Environmental agency (England) - Guy Pluckwell (Pluckwell 2019);
  - Activist from Essen community and also manager of klooster Yesse visitors centre - Annemiek Bos (Bos 2019).

- **Analysis of cartographic material** - cartographic material was the main instrument to trace land-use changes and fix anthropogenic disturbances that has affected Hunze river historical flow. There were analysed historical maps (Tijdreis S.a.) and historical cadastre maps (Kadaster 1832). To address actual environmental issues in Groningen there were analysed infrastructure maps (Jenldata 2019), open data map - Cultural-historical value map from municipality Geo-portal (Gemeente Groningen 2019), elevation map "Het Actueel Hoogtebestand Nederland "(AHN 2014-2019), University of Groningen Geodienst database (Geodienst 2019). To assess current situation of historical Hunze river area there were analysed municipality zoning plans (Ruimtelijkeplannen 2019).

- **Planning document analysis** - planning document where used for three purposes. First of all they provide general information about population, economic position, planning structure and values. Second, they were used to understand position of the municipality

towards environmental concerns. And final, analysis gave understanding how governance institutions intend to include environmental issues in their everyday planning practices. There where overviewed two planning documents: structural vision document "Groningen, Stad op Scherp, Structuurvisie 2008-2020" (Gemeente Groningen 2009) and recently released environmental vision document "Omgevingsvisie 'The Next City': de Groningse leefkwaliteit voorop" (Gemeente Groningen 2018).

- **Analysis of project reports -** similarly like planning document analyse gave an insight in actual situation of the place; project reports provide general and more place-specific information. "Stad straks geen belemmering meer voor het stromen van de Hunze" (Oosterveld et al. 2019) report was acquired in order to understand ecological significance of historical Hunze river area. In turn OECD (OECD 2015; OECD 2017) report gave a general insight in overall planning system and assessment of environmental policy.

- **Case study lesson drawing -** There were chosen 3 case studies from Europe: one from the Netherlands and two case studies from the United Kingdom. These cases are internationally recognized examples of good practices. First case study was chosen from the Netherlands because of its wide approach toward water quality improvement and renewal of cultural heritage. Other two cases from the United Kingdom are good examples of public engagement practices, ecosystem service assessment and afterwards broad monitoring strategies.

- **Resilience assessment** of historical Hunze river area - Resilience assessment framework is the main backbone of this research. It is a guided workbook for practitioners, who want to assess resilience of a certain focal system (Resilience Alliance 2010).

3 RESULTS

3.1 CHARACTERISTICS OF HISTORICAL HUNZE RIVER AREA

3.1.1 CONTEXT ANALYSIS

Groningen

Groningen is a city that is located in the northern part of the Netherlands. Besides, Groningen is not only a municipality but also a capital city of the province that is also named after the same name - the province of Groningen. It is also known as thriving university town with one of the youngest populations in Europe with an average number of 36 years. It also means that nearly 30% of the population are at the working age. In total city has 250,000 inhabitants and its density is 2137/km^2 (Gemeente Groningen 2018; CBS 2018). In percentage most of the territory to be precise, nearly 44% is occupied with build-up areas, while only 2% of the total area are forest and nature terrain and 9% recreation areas (Groningen 2019; CBS 2015).

Over the past 10 - 15 years Groningen has grown considerably, only in the past quarter the number of inhabitants has increased from 202,810 to around 250,000. That is one of the reasons why it is so important to find good balance between different functions, interests and the quality of the living environment in a limited and scares space (Gemeente Groningen 2018; CBS 2018).

Despite the fact that the population of Groningen is growing, the city administration is still holds on to the "Compact city" policy. "Compact city" policy is a concept that was accepted at the national level around 50 years ago, mostly applicable to the Ranstad area, "…a distinctive polynucleated pattern of urban centres in the western part of the Netherlands (including the major cities of Amsterdam, Rotterdam, The Hague and Utrecht and a substantial number of smaller cities (Geurs, van Wee 2006, 40)". The main aim of this concept was to fight against city expansion and suburban sprawl that goes hand in hand with demand for road infrastructure and environmental pollution (Geurs, van Wee 2006). What applies to the city of Groningen, it already historically developed as a compact and inclusive city because of the longstanding fortification walls, that where demolished in 1874 (Mens 2012). Only after that the city began to expand but nowadays Groningen still can be called as a compact city where everything is within half-hour bike-ride, in a distance of 5 to 7 km from Grote Markt (Gemeente Groningen 2009).

Returning to the previous fact of rapid population grow, city of Groningen emphasizes that it is important to absorb most of this growth within the (inner) urban area. Municipality

highlights the opportunities of new development in areas like development zones, business parks, neighbourhood centres, and urban nodes This task might be challenging because nearly 20,000 new houses are needed. Consequently the growing land demand for residential development might lead to the pressure on the available green areas and living environment (Gemeente Groningen 2018).

Due to climate change also Groningen will have to face more and more frequently appearing extremes such as high temperature, harsh storms and extreme rainfalls. In order to prepare for the alarming forecasts city is trying to create climate adaptive environment. As one of the approaches they mention the strengthening of the existing green areas and creating connectivity between them, not only in the municipality scale but also in regional. In relation to climate change city is striving to become energy neutral in a near future. It will be achieved by construction of windmill parks, solar battery fields, supporting gas-free policy and sustainable heating etc. (Gemeente Groningen 2018).

Planning policy

In the Netherlands there are three levels of governance: the national level, 12 provinces and 390 municipalities (OECD 2017). There is a certain hierarchy in responsibilities. Central government can be described as the main core of the overall goals and policy that creates a legal framework for spatial planning. National government is responsible for water safety and preservation of natural and cultural heritage of national importance (OECD 2017). Due to revision of the Law on Spatial Planning in 2006 there were done some changes in power distribution which resulted as a shift of responsibilities from the national to regional government and municipalities (Gerrits et al. 2012). In OECD Environmental Performance Reviews (2015) explains that "Netherlands decentralised many environmental competencies, including environmental permitting and supervision, spatial planning and nature policy. The reforms sought to provide more discretion and authority to provinces and municipalities to allow for more tailored policies and experimentation with various approaches (OECD 2015, 26)".

Provincial authorities are responsible for spatial planning issues of provincial importance. Overall, provinces are in charge of the rural areas, their development and management. They also serve as link between national and local legislation. Provinces are actively cooperating with water boards and sometimes are supervising spatial policies of municipalities. They are also assigned to administer public engagement, coordinate and subsidise projects (OECD 2017; van Soest 2019).

As to the local level, municipalities have the power to determine land-use policies. Municipalities can be described as proactive and the most decisive actors that can freely plan the development within the borders of the municipality. Even despite the fact that national and provincial government has the right to override the decisions of the municipality, they use this power very rarely. Other important legislative bodies are water boards who manage water infrastructure and they also have powerful vetoes, but specifically related to the water issues and planning (OECD 2017; Mollema 2019).

Public participation

Groningen wants to focus specifically on physical measures that encourage participation, meeting, social contact and healthy behaviour in the neighbourhood. Furthermore, municipality sees their weak points regarding enhancement of people engagement in spatial planning projects. Up to now the council lacks guidance and a clear assessment framework that determines whether the participation in a certain spatial project went well (Gemeente Groningen, 2018). To address this issue municipality in its Environmental vision "The Next City" (Gemeente Groningen, 2018) comes up with a Citizen Participation framework. Framework carries out four different forms of participation:

1) participative thinking, which results as an ideas, visons, concepts, agendas or design;
2) participative decisions, which results as legitimate decisions or regulations;
3) participative actions, which results as concrete outcomes in community surrounding and
4) participative learning, which results as an insights, feedbacks, suggestions etc.

Cultural remains

Remaining parts of the Hunze river already themselves can be considered as cultural and historical heritage. Consequently these places have been mapped as protected areas carrying a name - Hunzezone. Nevertheless a lot of archaeological research has been done. As already observed in historical land-use analyses most of the development occurred right next to the Hunze river. As a consequence other valuable artefacts and cultural heritage sites have been found besides the river.

From archaeological excavation it has been discovered that on the north-east side of Groningen, where nowadays Den Hunze neighbourhood is located, used to be a former castle "Elba" but it burned down at the end of the 14th or early 15th. Unfortunately there are no archaeological remnants left, but there is a wonderful idea to highlight the foundation shape in the pavement (Kortekaas 2019).

Next to the river where located brick kilns that worked in the Late Middle ages. It was very beneficial location for brick production because clay could be mined from the surrounding areas. In the fifties of the last century where found two stone ovens that belonged to Jacobijnerklooster (van den Broek 2011);

Already highlighted country estate "Zorgwijk" that is located in Hunzeboord is a great example of historical architecture and also surrounding pastures that used to be a familiar landscape back them but nowadays it is important pace not only because of its cultural values but also because of its recreational and ecological potential.

Similar place but with much greater cultural and ecological significance is Hunzezone located between Eemspoort and Euvelgunne business parks. First of all this place is special because of its story. The previous owner Thies Dijkhuis (who sadly past away this year), better known as the last farmer of Euvelgunne, despite the surrounding pressure from expanding business-parks has preserved an important landscape of Hunzezone. He even received Medal of Honor from the municipality of Groningen. Second of all it is noteworthy ecological and recreational site with well-preserved historic farmhouse with yard, five lindens and remains of an orchard in. In 1990s he sold most of his land to the municipality with a condition that it would be preserved as a natural reserve (RTV 2017; Kortekaas 2019).

3.1.2 HISTORY

Hunze river historically played an important role in the development of Groningen. First of all it determined location of the city itself. It was developed at the highest point between two rivers - Hunze river and river Aa. In the northern part of Groningen both rivers merged together and continued their flow forwards until the Wadden Sea. Due to this advantageous location economy of Groningen was flourishing. Surrounding areas were used for peat extraction while rivers where significant transportation routes (Spek 2019).

Historical landscape structure

Research territory historically can be characterized as tidal landscape of Hunze that was located within old stream valley of river. They can be characterized as wide and long meander bends that are located at greater distances from each other and have only a small number of successors towards the downstream area, briefly, the northern clay area therefore can be characterized with relatively large-scale meander patterns. These tendencies can be explained with the powerful influence from the sea that gave additional dynamics of flow velocity from the tidal changes (Deterd Oude Weme 2015).

Hunze probably flow in natural way until Late Middle Ages. From the latter time onwards larger scale anthropogenic influences impacted the natural river flow. River has been affected by land reclamations, water management interventions and later on also urbanisation processes. To promote peat navigation the construction of Drents diep in the 13th century and the Schuitendiep at the beginning of the 15th century initiated the canalization of the Hunze river. Additionally, from 1878 urban explanation sites moved outside of the old city fortress and construction intensity increases. In recent centuries Hunze river, previously known as wide watercourse, has been degraded to a small stream, whose bed in most places has been filled and can no longer be seen in the landscape without suitable technologies. However, there are still a larger number of open and visible current channel relics in the current landscape (Deterd Oude Weme 2015).

Land-use changes

To obtain information about land-use changes the main output data were acquired through analysis of cartographic material and conducted interviews. It must be noted that in the analysed maps Hunze river has already been modified to a canal and also bears a different name - **Selwerdiep**.

Fig. 3.3. Groningen 1788-1792 (Gemeente Groningen 2019)

Land-use changes can be perceived as main alterations that affected historical flow of the river. The oldest available map, where Hunze river appears, dates back to the period from **1788 till 1792** (see Fig. 3.3.). Already this map shows human disturbances to a quite big extend which is not surprising because as previously mentioned in Historical analysis Hunze river flow naturally only until Late Middle Ages. Later on due to intensive shipping that required faster and shorter trajectories, Hunze river was influenced with artificial shortcats. About disappearance of some meanders it is still not clear if it was because of human intervention or hydrological and geomorphological changes of the river that intensified the sedimentation of river began to silt up (Groenendijk 2019; Deterd Oude Weme 2015).

In this map we can see river flow in the Sothern part of Groningen is fragmented by **Schuiten diep** canal which nowadays is named as Oude (eng. Old) Winschoterdiep. Also on the Eastern part of Groningen we can see that two canals **Boterd diep** more to the north and **Damsterdiep canal**, that connects with water around city fortification wall, disrupts the flow of the river. Despite the fact that river is mainly used for water drainage function there are small villages are distributed along the river. Although, one plot of land stands out the most. The place is called "Zorgwijk" which was a country estate. Surrounding areas are mainly meadow land used for grazing. In the northern part of Groningen there are small elevations next to the river. After the interview with Theo Spek (2019) and Gert Kortekaas (2019) it is still not clear if these elevations formed from river sedimentations and later on where constructed as a dike construction or these where remnants of "koog" or groden (type of polder along the rivers used for land reclamation) that where constructed to drain the water from marshy lands. In places that are more inhabited developed also different land-use types, like garden and orchard areas.

Next significant changes can be observed in the map of **1871** where **Scheepvaart canal** appears (nowadays called as Eemskanaal) right next to the Damsterdiep canal. As mentioned before fortification walls where demolished in **1874** which now gave the city possibilities to expand. First evidence of expansion to the East side from Groningen, therefore also toward Selwerdiep, appeared in **1908**. Genuine development appears in **1934**, when city continues to expend toward east and digging works of **Van Starkenborghkanaal** (nowadays Winschoterdiep) has already started. Due to the construction of the new channel Selwerdiep loses one of its remaining meanders. Further urban expansion starts to accelerate. In the map of **1962** appear the first signs of build-up zones on the Eastern edge of Van Starkenborghkanaal, which means it is just a matter of time when Selwerdiep catchment area

will be developed. Rapid development of neighbourhoods and industrial areas is taking place which washes away Selwerdiep step by step (see Fig. 3.4.; 3.5.; 3.6.; 3.7.; 3.8.).

Nowadays next to remains of Hunze river there are few tips of land-use areas. These are residential areas, industrial or business park areas, green areas, social areas, one sport area (tennis courts) and only two remaining nature areas where river landscape and adjacent floodplains are more or less preserved.

Figure 3.4. Groningen 1871 (Tijdreis S.a.)

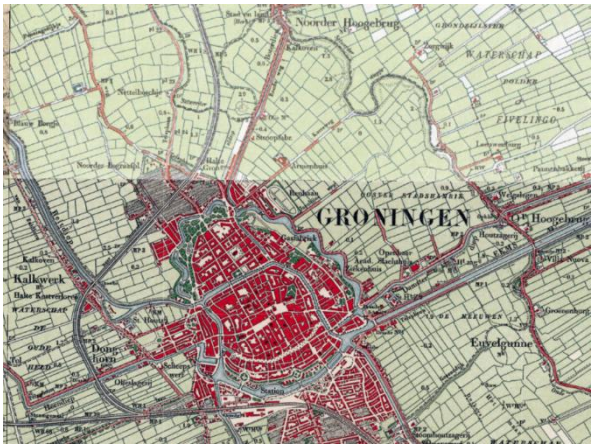

Fig. 3.5. Groningen 1908 (Tijdreis S.a.)

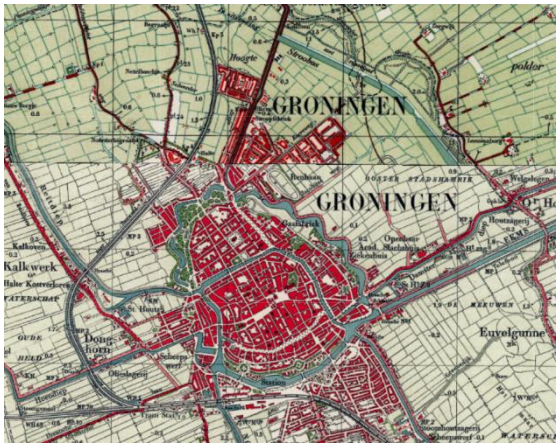

Fig.3.6. Groningen 1934 (Tijdreis S.a.)

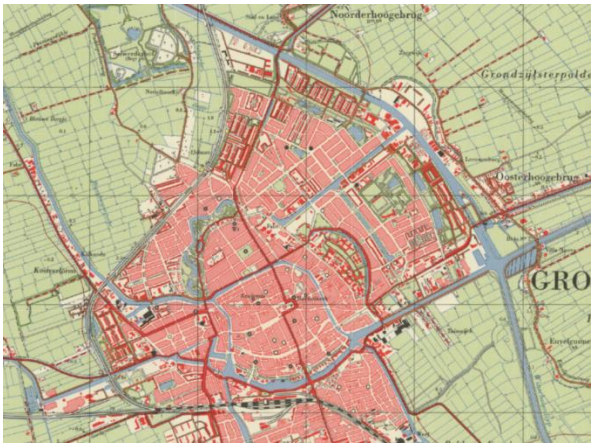

Fig.3.7. Groningen 1962 (Tijdreis S.a.)

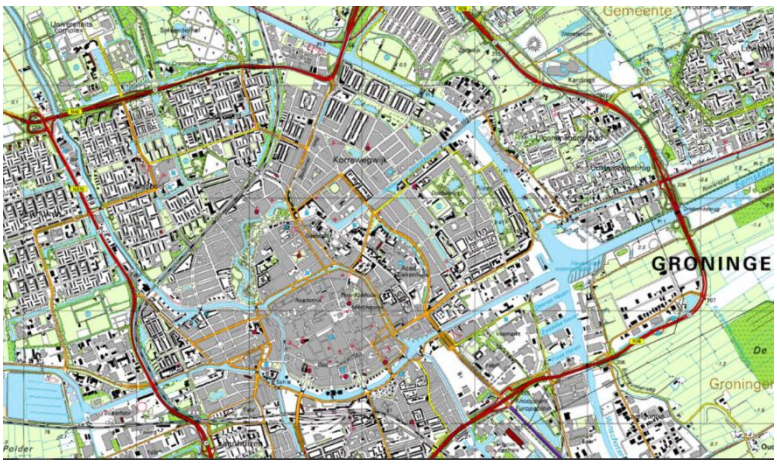

Fig. 3.8. Groningen 1995 (Tijdreis S.a.)

3.1.3 PROJECT “GRONINGEN: STAD AAN DE HUNZE”

The vision of rehabilitated Hunze river began already in 1995 when three organisations, World Wildlife Fund, Stichting Het Groninger Landschap and Stichting Drentse Landschap, joined forces together to develop new concept of nature area in predominantly agriculture-orientated river valley of the Hunze. During a period of nearly 20 years 3000 ha of nature areas along the river banks has been rehabilitated in the province of Drenthe and Groningen Zuidlaardermeer area (Southern part) (Deterd Oude Weme 2015).

In 2014 this project gained a second breath when previously mentioned organisations and this time also the Nature and Environmental Federation of Groningen and Drenthe (Natuur en milieu federatie Groningen and Natuur en milieu federatie Drenthe) launched a new vision document where the targets were even more ambitious - to restore the entire river valley from the source area in Drenthe to the embouchure at the Wadden Sea (Figure x) (Deterd Oude Weme 2015).

In the new vision document “Hunzevisie 2030: Wereldnatuur binnen handbereik” (Stichting Het Drentse..2014) the intention is to connect the missing links between the river and the nature areas. Important point is that the vision is not only focusing on ecological connectivity and quality but also on the cultural landscape elements, high-quality water management, sustainable agriculture and tourism (Reintsema 2019).

However reconstruction of the former course of the Hunze river is not that straightforward as the ambitions of “Hunzevisie 2030” because there are a lot of obstacles along the way. One of the most significant obstructions is the city of Groningen where river has been largely channelled and has even disappeared within the spatial fabric of the city (Deterd Oude Weme 2015).

For this reason a new project “Groningen: Stad aan de Hunze” (Het Groninger Landschap 2019) has been created. The main focus of the project is on the connection between the Drents Diep and the Reitdiep near Wierumerschouw. However, reconstruction should be made as close as possible to the original river flow. It means that river flow that nowadays has become a part of channel system (more specifically has been interrupted with historical construction of Winschoterdiep channel and forced to flow through Winschoterdiep, Eemskanaal, other city channels and only then ends up in Reitdiep) should regain the original flow through the historical meanders on the eastern outskirt of Groningen (Het Groninger Landschap 2019).

Omroep Organisatie Groningen (Omroep..2018), a local public multimedia institution, published an article and video with an enthusiastic title "City will no longer be an obstacle to

the Hunze river flow" where Rob Reintsema, quartermaster in Het Groninger Landschap organisation, explains the main idea behind the project. He mentions that organisation has envisioned three possible **scenarios**. In the first scenario he mentions that the main characteristics of the Hunzeloop areas would be similar to the current situation, more precisely, Hunzeloop areas wouldn't be connected. In the second scenario areas would be connected as much as possible, although Eemskanaal would be an obstacle to rehabilitate the river to its full length. The third scenario he describes as a dream vision where Hunze river flows through the city of Groningen and the water level differences within the city are resolved with the help of technological solutions, as for example, waterpump installations, fish ladders etc. (Oosterveld et al. 2019).

The aim of the project within the city is not only ecological connection and renewal of the water flow but also improvement of heritage, spatial quality and landscape (Het Groninger Landschap 2019).

In the Northern region digital newspaper "Dagblad van het Noorden" interview Rob Reintsema comments that a complete reconstruction of the river is not the main goal; most important part of this project is to adjust to the circumstances with contemporary interpretations. With this project "Het Groninger Landschap" organisation wants to emphasize the importance of the natural values. It would help to enrich natural areas within the city and create connections for animal migration pathways. In addition running water instead of a stationary ditch can improve quality of life for the inhabitants. This project is also connected to the climate adaptation measures. Due to the predictions of heavier rainfalls and higher temperatures Hunze river catchment areas can serve as water storage places (Brandsma 2018).

Renewal of the Hunze river is seen as part of specific development projects within the city. It means that any urban changes, construction works and development plans are an opportunity to rehabilitate parts of the historical river valley (Schuit 2019).

Water quality

Water quality of Huzne river especially during summer periods can be affected by connected canals like Eemskanal. Hence water quality in Hunze river doesn't meet the desired level. Much better indicators can be observed in Hunzeloop area. This can be explained by limited urban influences within the catchment area. It is the wides floodplain area compared to other Hunze river remaining parts in the city (Reintsma 2019).

According to WFD water in the Drentsche Diep on average meets good ecological conditions. It is characterized as slowly flowing lowland stream. The Drentsche Diep has

much better water quality if compared to the Van Starkenborgh canal and Hunze river area with the old meanders at the norther part of the city. For creating inundations and currents in the northern meanders, transit of the Hunzewater from the Drentsche Diep is therefore preferable than the water from the Van Starkenborgh canal (Oosterveld et al. 2019).

3.2 ASSESSMENT OF HISTORICAL HUNZE RIVER AREA

Previously described research gave an inside in the main components of the context where the urban system is located, gave an overview of historical events that has impacted the system and also introduced to the vision of "Groningen: Stad aan de Hunze" project - its objectives and possible implementations. In order to answer the main research question about sustainability of "Groningen: Stad aan de Hunze" project and contributed Hunze river flow restoration scenarios, it is necessary to carry out a research from much wider perspective. That includes analyses of territory itself, identifying most important external influences and taking into consideration knowledge and viewpoint of involved stakeholders.

With regards to further research there was used "Resilience Assessment Framework" that in more detail was described in chapter 1.4.2 - Resilience Assessment Framework. This framework was chosen because of its comprehensive approach and emphasis on system dynamics considering future influences.

Output data for this assessment where acquired from conducted interviews, research of planning documents and project reports and from cartographic material analysis.

3.2.1 DEFINING THE FOCAL SYSTEM

As a starting point of this assessment is the overall understanding of the focal system. It means - defining systems spatial and temporal boundaries, highlighting the main issues, key components and also key variables that have caused certain changes in the system.

- RESEARCH AREA - HUNZE RIVER

For in-depth research of green infrastructure planning there has been chosen a project "Groningen: Stad aan de Hunze" (Het Groninger Landschap 2019) area which focuses on the rehabilitation of previous Hunze river flow and meadow landscape integration within the city. This project has derived from a much broader vision called "Hunzevisie 2030: Wereldnatuur binnen handbereik" (Stichting Het Drentse..2014) whose main aim is to restore the entire river valley from the source area in Drenthe to the embouchure at the Wadden Sea simultaneously

integrating nature, landscape and recreation values and functions within it. In Fig. 3.1. the red line shows which are the places that can be considered as obstacles and creates ruptures in Hunze river flow. It can be observed that city of Groningen is one of the biggest obstacles but on the other hand city itself is still in development phase and it might be an opportunity not only to rehabilitate the river by connection the missing parts but it also might be an opportunity for the city to increase ecological values and the liability of the city.

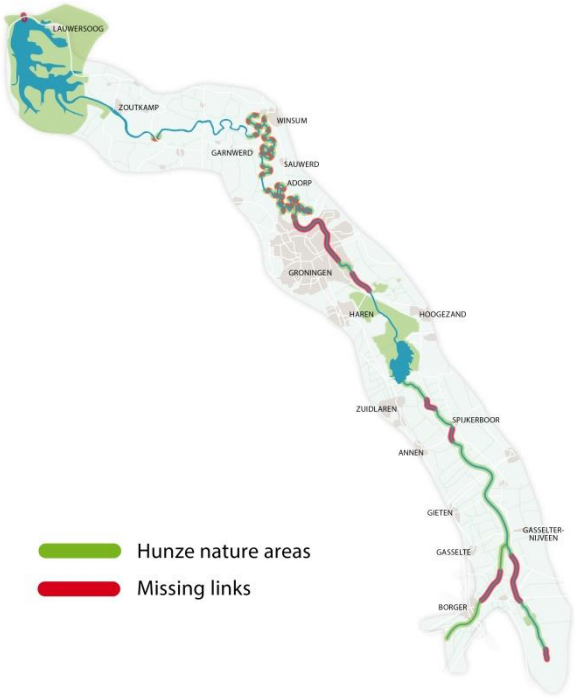

Fig. 3.1. Hunze river stream valley. Information about the natural areas and missing parts of the river (constructed by author, adopted from Stichting Het Drentse..2014)

Using this as a starting point of the research, consequently boundaries of the study area are set within the city. Nowadays the remaining parts of the Huzne river are located in the eastern part of Groningen. If we would place historical stream of the river on nowadays city map, we could see that the river crosses various neighbourhoods outskirts of the city centre (see Fig. 3.2.). To set more specific boundaries of the study area the starting point is set next to the Winschoterweg road which is also the beginning of the Hunze river canal system inside the city boarders. From this point onwards the planned river would flow between Stainkoel'n and Roodehaan neighborhood, further between Euvelgunne and Eemsporrt neighbourhood and later on through Driesbond, Woonschepenhaven, Oosterhoogebru, Ulgersmaborg, Hunzeboord De hunze and Van Starkenborgh neighborhoods. As the ending point of the study area is Beijumerweg road and Boterdiep channel. Due to urban environment limitations whole

area of each neighbourhood won’t be included within the boundaries. Only areas adjacent to the previous Hunze river flow will be examined more closely.

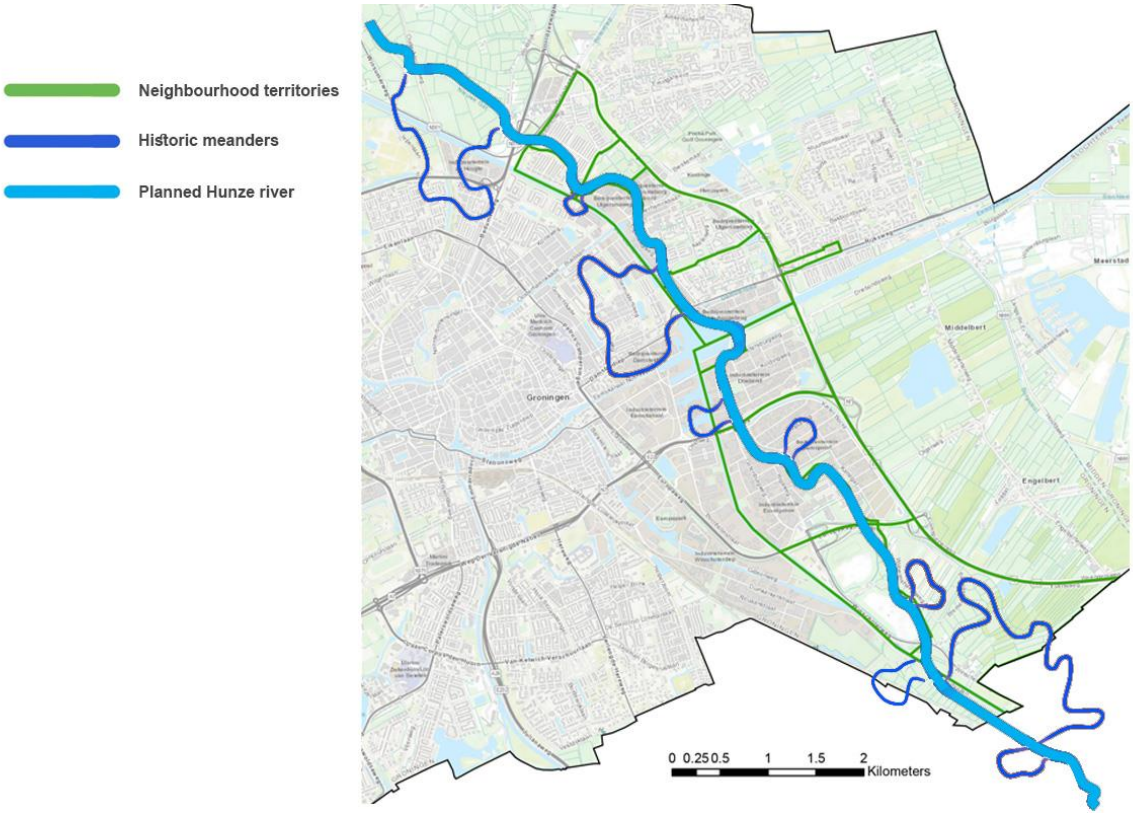

Fig. 3.2. De Hunze in 2030 (constructed by author, adopted from Het Groninger Landschap 2019)

Using this as a starting point of the research, consequently boundaries of the study area are set within the city. Nowadays the remaining parts of the Huzne river are located in the eastern part of Groningen. If we would place historical stream of the river on nowadays city map, we could see that the river crosses various neighbourhoods outskirts of the city centre (see Fig. 3.2.). To set more specific boundaries of the study area the starting point is set next to the Winschoterweg road which is also the beginning of the Hunze river canal system inside the city boarders. From this point onwards the planned river would flow between Stainkoel'n and Roodehaan neighborhood, further between Euvelgunne and Eemsporrt neighbourhood and later on through Driesbond, Woonschepenhaven, Oosterhoogebru, Ulgersmaborg, Hunzeboord De hunze and Van Starkenborgh neighborhoods. As the ending point of the study area is Beijumerweg road and Boterdiep channel. Due to urban environment limitations whole area of each neighbourhood won’t be included within the boundaries. Only areas adjacent to the previous Hunze river flow will be examined more closely.

An important point when choosing previously determined research site, was to choice neighbourhoods with includes wider build-up areas. Other parts of the historical meanders where not included in this study area because according to the "Groningen: Stad aan de Hunze" project Hunze renewal in the exact historical pattern is not possible due to existing build-up areas. They have suggested the most possible version for river rehabilitation places (Reintsema 2019).

As to the temporal boundaries, it much harder to identify them because this research focuses on comprehensive planning practises which includes a lot of variables that has changes due to past disturbances and can change in the nearest future as well. Because of that this research will focus on historical events and influences as far as possible but as to the period from this moment further on the time span is adjusted to the related larger scale vision Hunzevisie 2030 which means that the focal system will be assessed over ten year period.

- IDENTIFYING THE MAIN ISSUES

After in-depth interviews with involved stakeholders and specialists and comprehensive research of the focal system using project reports, spatial planning documents and historical analysis, it was possible to identify nine main **issues** of the focal system that are demonstrated in the Table 3.1.

Some of the mentioned issues can be described as complementary issues. Due to chain of events, one issue can serve as a catalyst leading to evolvement of further concerns. For example the issue high percentage of impervious surfaces in the catchment area can also lead to microclimate issues that are related to urban-heat island (Helbig 2019). Additionally it is also possible to link sewage system capacity characteristics to impervious surfaces. Nevertheless in order to define the focal system it is important to oversee all the possible obstacles and components of the social-ecological system.

Relating to the management of these issues, some of the issues are already addressed, for example, Water Board "Noorderzijlvest" has already created certain water storage sites outside the focal system in case of extreme droughts (Mollema 2019). They are also prepared for high rainfalls by allocating spacious territories for flooding outside the borders of the city, although Tjitse Mollema (Mollema 2019) mentions that any additional water storage areas even in a smaller scale are highly desirable.

Despite the fact that in the city of Groningen it is possible to observe practices of alternative green infrastructure management solutions (for example, limitation of human management in green areas that creates a fruitful ground to increase species richness), in the

focal system adoptive practices are lacking. For example, water quality and quantity issues are addressed through technological sewage system solutions (Helbig 2019; van Goethem 2019). However should be highlighted that there are new project emerging where planning and management is intended to be in more alternative and adaptive manner (Mollema 2019).

Table 3.1. Summary of main issues of concern for the assessment and of valued attributes of the system

Issues	Mains issue(s) of concern for the assessment		Valued attributes of the system
Issue 1	Ecological:	Ecological fragmentation (loss of biodiversity)	Small scale landscape with wildflowers and meadows
Issue 2		Impervious surfaces in catchment areas - water cycle	Preserved open grazing landscapes (part of Ecological Structure of the city)
Issue 3		Water quality and quantity	
Issue 4		Contamination from adjacent business parks, roads, household	
Issue 5	Social:	Loss of historically significant landscapes	Well researched potential of cultural heritage and historical identity
Issue 6		Livability and recreational issues (accessibility)	Have neighbourhood community initiatives
Issue 7		Urban-heat islands	Peaceful and quiet neighbourhoods, good location
Issue 8		Overloaded sewage systems - vulnerability to flooding during heavy rainfalls	Industrial development concentration in one specific area
Issue 9		Lack of collaborative public engagement	Bicycle roads

As to ecological fragmentation and also cultural heritage issues, must be said that a lot of opportunities for the focal system to develop as a green and culturally significant area where impressed already in the past, when rapid urban expansion occurred during the middle of 20th century (see paragraph 3.1.2 History). It can be described as a consequence of the previous planning approach that was addressing specific sectors of planning without taking into account inter-sectoral development possibilities (Helbig 2019).

Despite the fact that in the zoning plan of municipality (Ruimtelijkeplannen 2019) most of the focal system is described as green or nature area, the accessibility of recreation and provided well-being aspects are lacking. In many places green areas are inaccessible or preference is given only to the bicycle infrastructure (Schuit 2019).

After conducted interviews with “Het Groninger Landschap” foundation and specialists from the municipality of Groningen it seemed that Dutch governance has conducted good practices for public engagement (Reintsema 2019; Schuit 2019). Although after theoretical

description of public participation and case study research (see Chapter 1.5 Case studies) where were mentioned international practices, it showed that there is a room for even better participation enhancement.

Regarding **valued attributes** interviews showed that various stakeholders with different backgrounds had similar values and attitude towards importance of historical and ecological values that are still present (Reintsema 2019; Schuit 2019; van Goethem 2019; Mollema 2019; van Klinken 2019; Korterkaas 2019; Borgman 2019; Boonstra 2019). However, ecological values where mainly highlighted by ecologists (Reintsema 2019; van Goethem 2019; van Klinken 2019) and historical values by historians and archaeologists (Korterkaas 2019; Spek 2019). Accordingly, recreational and infrastructure aspects where pinpointed by local inhabitants and other local stakeholder (Borgman 2019; Boonstra 2019). This phenomenon shows that importance of focal system values is very much dependent on people background and education level.

- KEY COMPONENTS OF THE SOCIAL-ECOLOGICAL SYSTEM

Table 3.2 shows the relationship between involved stakeholders and natural resources present in the area. Next to the list of natural recourse uses there is a row that shows how many stakeholders are using a specific nature resource. This study shows that there is a high demand for many ecosystem services that are present in historical Hunze river area.

Nevertheless it is no enough to know that the resources exist in the focal system, most important if they are accessible for the stakeholders (Resilience Alliance 2010). Although there are a lot of private properties in the focal system, historical Hunze river area itself, more precisely, ditch with adjacent slopes and bicycle routes are publicly assessable. However accessibility can be considered as convenient only with the bicycle.

Resource conflict might occur only in the Hunzeboord area which is an open grazing landscape, but the accessibility is limited due to horse pen.

Despite the fact that province of Groningen (letter “J”) can’t really benefit from local resources, province could be a significant stakeholder in case of ecological corridor expansion in the future. Especially, if we look from larger scale perspective, as for example “Hunzevisie 2030” project (Stichting Het Drentse..2014).

Table 3.2. Direct and indirect uses of key natural resources supplied by the system and the stakeholder that rely on them.

Natural resource use					
Direct uses			**Indirect uses**		
1	Livestock	**A,B,K**	**7**	Air quality regulation	**A, B, C, D, E, L**
2	Crops for grazing	**A,B**	**8**	Water purification	**A, B, C, D, E, G, H, L**
3	Surface water runoff	**A, B, C, F, G, H, I**	**9**	Erosion regulation	**A, B, G, H, I**
4	Water storage area	**A, B, C, F, G, H, I, L**	**10**	Wildlife habitat	**A,B, G, H, L**
5	Historical landscape values - identity	**A,B, D, I, K, L**	**11**	Local climate regulation	**A,B,C,D, E, I, L**
6	Recreation	**A,B,C,D, E, F, I, K, L**			
Stakeholders					
Inside focal system			**Outside focal system**		
A	Neighbourhood communities/residents		**G**	Water Board «Noorderzijlvest»	
B	Hunzeboord area residents		**H**	Water Board «Hunze & Aa»	
C	VBZO and VBNO business parks		**I**	Housing associations	
D	Schools/Regional Training Centre		**J**	Province of Groningen	
E	Tennis club «Starkenborgh»		**K**	Marketing Groningen / VVV Groningen	
F	Municipality of Groningen		**L**	Groningen nature organisation/ foundations	

RESILIENCE TO WHAT? DISTURBANCES, DISRUPTIONS, & UNCERTAINTY

Whereas a lot of disturbances have happened in the past the previous system state is completely changes (see Table 3.3 and Fig.3.9.). There is no need to manage land reclamation or irrigation of agricultural lands, because the land-use has shifted to completely different functions. However, after this review we can see that urban sprawl, water level rise and extensive dry periods can intensify even more.

Urban sprawl in the city of Groningen is managed already from around 20th century sixties with the “Compact city” policy. However past few years population numbers have increased significantly and government has to provide accommodation (Geurs, van Wee 2006).

In Netherlands they practice very defensive flood protecting measures, which can be seen with highly technological dike systems. But lately the approach has shifted to mitigation measures that focus on more natural defence system, like for example, during high rainfalls giving space for the water to expand in a certain area (Mollema 2019).

Table 3.3. Summary of focal system disturbances and their attributes

Disturbance (past or present)	Pulse or Press	Frequency of occurrence	Time for recovery between occurrences	Components most affected (e.g., soil, markets)	Magnitude of impact (minor to severe)	Any change in past years or decades? (none, less frequent, more intense, etc.)
Land reclamation	Press	Used to be common	Historically focal system was considered to be a tidal river. Due to human intervene-tions and river sedimen-tation historical system was not able to recover. Present - recovery managed by people.	Ground-water level, altitude of the surface	Severe	None
Flooding	Pulse	In the past frequent, nowadays strong defence system		Agricultural lands, stock	Severe	Less
Irrigation	Press	Frequent		Soil, vegetation, vulner-ability to contaminati on	Severe	-
Resource extraction (peat, clay)	Press	In the past, nowadays only due to develop-ment (soil etc.)		Land-use	Severe	None/less
Artificial canals	Press	Frequent in the past		River flow	Severe	None
Urban sprawl	Press	Frequent		Land-use, loss of ecologically significant areas	Severe	Intense
High rainfalls	Press	Frequent		Water level, financial loss	Minor	Intense
Future disturbances	**Pulse or Press**	**Frequency of occurrence**	**Time for recovery between occurrences**	**Components most affected (e.g., soil, markets)**	**Magnitude of impact (minor to severe)**	**Any change in past years or decades? (none, less frequent, more intense, etc.)**
Urban sprawl	Press	Might occur more often	People manage-ment capacity might not be enough	-	Severe	Intense
Flooding	Pulse			-	Severe	Intense
High rainfalls				-	Severe	Intense
Drought	Press			Habitats	Severe	Intense

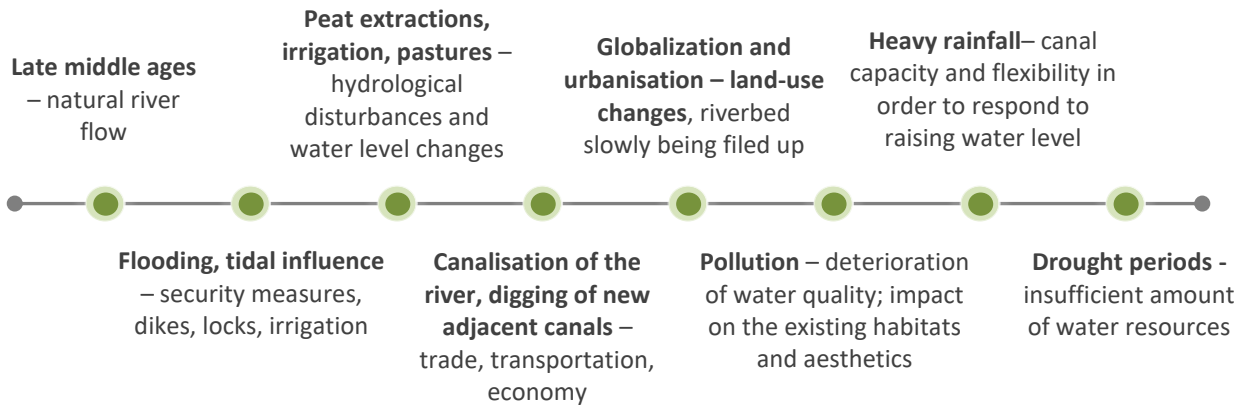

Fig.3.9. Chronological timeline of Hunze river disturbances

The beginning of the chronological timeline is described in chapter 3.1.2 History under paragraph Historical landscape structure and Land-use changes.

3.2.2 SYSTEM DYNAMICS

In a system like urbanised city changes are occurring very rapidly and often. Because urban ecosystem cannot function without human intervention, there is a need for constant management and issue resolving. In such a constantly changing and dynamic environment it is important to make decisions in a far-sighted. With system dynamic analysis it is possible to notice weather system is cyclical or for example distinguish key variables that lead the system to a certain change. These analyses also help to identify vulnerable or weak parts of the system that can prepare and warn about future system transitions (Resilience Alliance 2010).

- **Adaptive cycle**

One of the approaches used for system dynamic analysis is adaptive cycle framework (Gunderson and Holling 2002) that is described in more detail under chapter 1.4.2 - Resilience Assessment Framework (p.19). Taking into consideration presented four phases of system development, adaptive cycle framework was adapted to historical Hunze river area. Reference point of the focal system can be defined as river formation process, when river valley was carved out by the melting ice sheets and water (Spek 2019). This process can be linked to **r phase** that is characterised as phase of exponential change and rapid growth. According to the adaptive cycle next phase of the system is **k phase** where river ecosystem components are rigid and at the same time flexible enough to hold against natural disturbances like tidal phenomenon of the sea, it is able to recover from flooding and anthropogenic influences (Spek 2019). Previously described phases where occurring very

gradually over a long period of time, but further human intervention in the system provoke rapid changes that led to the **Ω phase**, which can be described as collapse of the previous system. State of collapse or release of resources was supported with profound urban development and interventions in the previous water system cycle, when river was canalised and later on even fragmented that completely interrupted the flow of the river (Spek 2019).

Since tidal river system had collapsed due to excessive human interference, a new re-organisation phase took place. **Phase α** or system renewal can be marked with the new function that Hunze river remains had obtained - which is drainage of water from the adjacent land. Due to urban development and land occupancy and rapid growth of households in the surrounding area promptly **phase α** evolved to **r phase** which can be described as human - managed canal system or system of ditches. Eventually canal system up to now has stabilised its evolvement to **k phase** where ditched are used as a surface waste water collectors and also for recreational purposes (Spek 2019; Helbig 2019).

Adaptive cycle framework clearly shows that previous natural river system has changed to completely human managed system that is much more limited and vulnerable to any kind of disturbances. Even connection of ditches may cause water level raise that consequently my affect the surrounding households' well-being (Mollema 2019)**.** Nevertheless historical Hunze river area still has a lot of potential regarding recreational and ecological purposes (Schuit 2019), which may lead to more sustainable and ecologically valuable system.

- **Thresholds, transitions and alternative systems states**

As from the analysis of the adaptive cycle it was possible to distinguish three historical systems states that the focal system has gone through: from tidal Hunze river to a Selwerdiep canal and from a canal to a canal or ditch system surrounded by urban areas.

After in-depth interviews with experts from local and regional institutions there were distinguished **five alternative system states** that might cause current system state to collapse or shift to **Ω phase** in the near future:

1. As mentioned in chapter 3.1.3 Project "Groningen: Stad aan de Hunze" the initial idea of foundation "Het Groninger Landschap" is to restore the river flow by connecting the remaining parts of the river (Reintsema 2019). Renewed river flow would improve water quality and therefore enhance well-being of the local people (Brandsma 2018). By giving space to the river and creating wetlands in the bordering green territories it would be possible to improve the ecological value of the project area and additionally increase the possibility to create urban green corridor in the eastern part of the city (van Goethem 2019). However in

order to achieve this system state there are political, economic, social and ecological obstacles to be addressed. Renewal of the river flow and the bordering nature areas might compete with the highly requested land from development investors that could benefit the city with economic growth (Schuit 2019). Existing obstacles like crossing canals and highways, as well as water level differences in the area would require technical and costly solutions (van Klinken 2019). Remaining parts of the Hunze river are not only protected cultural sites but also existing habitats for various species. Any kind of interventions might lead to loss of existing values (Kortekaas 2019).

In order to renew river flow by connecting the fragmented parts of historical river there are several thresholds that could start the transition process. First of all it depends on the decision making process, second it hinge upon the possibilities to obtain additional funding and the last one - there is a need for successful integration of stakeholders in decision making process.

2. Whereas municipality of Groningen has envisioned renewal of the Hunze river through new development projects that can result in two possible scenarios:

2.1. as connected canal system with adjacent floodplain areas for recreational purposes that could become an urban green corridor (Schuit 2019);

2.2. development areas for new residential buildings and business areas, that could threaten the existing parts of the ditch and potential floodplain areas (Schuit 2019).

From above mentioned scenarios 2.1. scenario would be the desired system state. It could serve as an example of comprehensive project, creating space for multifunctional territories that consist of residential areas, industrial or service areas and also integrated nature areas. Nature areas in turn would include both recreational areas and also valuable ecological patches. Although this kind of classification would require detailed inventory of existing system elements and its values (Baschak et al. 1995). In-depth research of the area would help to balance the preservation of the most important environmental and cultural values with economic development plans. Conversely, 2.2. scenario can be seen as undesirable system state. This scenario focuses on short term gains by giving preference to economic development, leaving behind great amount of ecosystem services that are required by local inhabitants (Everard et al. 2011).

In scenario 2.1. the main thresholds are comparable to 1. alternative system state which are decision making process, funding and integration of stakeholders in decision making process. As to scenario 2.2. an additional threshold must be added. It is possible that different

position and values of investors and housing associations might change the development plans of decision - makers.

3. Contamination from the sewage system overflow and other nutrients that affect the water quality of the ditch may result as a loss of habitat and biodiversity of the species and deterioration of neighbourhood well-being. This undesirable system state is mainly caused by rigid and traditional waste water collection solutions or misconnections in the sewage system that might lead to direct discharge of pollution into the water (Helbig 2019; Gothem 2019). For example in "Zuidoost business park" manager of the business park Nick Borgman (Borgman 2019) mentions that household and surface water sewage systems are not separated. In order not to dig up the roads sewage system is equipped with sensors that determine whether water quality is good or bad. If water if clean enough it is discharges straight into the ditch, but if the seniors show that the water is contaminated than it is sent to water treatment installations. Additionally must be taken into consideration that there is a possibility of diffuse pollution from local inhabitants that may discharge their litter or household wastewater strait into the ditch/canal system. Either point or diffuse pollution the main thresholds of this system state are decision-making process where governance decides how waste water is managed and additionally indifference from certain groups of local inhabitants. Attitude of local inhabitants and consequently contamination of the ditch can be highlighted as slow changing variable which is often very difficult to notice in the daily planning and management process.

4. Regarding the existing form of the ditch and its insufficient capacity, it is possible that due to frequently changing weather conditions canal system and its current functions might fall apart. It can result in higher chances of flooding or opposite - insufficient amount of water storage places that can appear as drought, therefore causing initial system collapse (Mollema 2019).

This system varies from the previously mentioned system states because this transition may occur very suddenly and unpredictably. Only viable way is to mitigate the flooding or drought occurrence by creating room for the water in case of flooding and water storage places in case of drought periods. Thresholds for this system state can be mentioned both climate change and also decision-making in order to adjust to the possible changes and disturbances.

In general transitions of the system are affected by four main **drivers or variables:** *economical dimension* that dictates land-use changes and consequently also *hydrological interference, climate change* that changes adaptability to extreme climate conditions, and also

pollution that is linked to population density, greenhouse gasses and load from the sewage system.

After analysing existing thresholds and possible transitions to alternative system states, it is possible to see how interdependent social and ecological dimensions are within the city. Nevertheless, should be taken into account that in human - dominated ecosystem as city, ecological dimension is highly exposed by human intervention and very often ecological values are not always distinguish by decision makers therefor are vulnerable to disappearance. Therefore as the most critical threshold can be mentioned decision-making process that has to be the main steward for adaptive, place - based and comprehensive decision - making process (George, Reed 2017).

3.2.3 CROSS-SCALE INTERACTIONS

Social-ecological system sustainability is influenced by larger scale systems as an external influence as well as smaller scale systems or internal influence (Resilience Alliance 2010). This phenomenon was already observed in the system dynamic assessment (see chapter 3.2.2.) when adaptive cycle pattern showed how external and inner influences have pushed the system towards certain system states. This assessment will analyse cross-scale interactions in more detailed way.

- **The panarchy and threshold interaction**

As described in social-ecological system resilience assessment workbook (Resilience Alliance 2010, 29) "Panarchy is a term used to describe a model of hierarchically linked systems represented as adaptive cycles that interact across scales.". In order to conduct this model to historical Hunze river area there was created table (see Table 3.4.) that shows larger -scale and smaller - scale systems within social and ecological dimension.

Referring to the **social dimension** both larger - scale and smaller - scale systems are allocated in conservation or k phase, because in general both scales can be described as stabile entities. Yet there can be observed constant changes and readjustments. In governance form it manifests as policy adaption to the changing circumstances while structure of communities are in a constantly changing state which can be explained by regular population composition changes (van Soest 2019; Schuit 2019). Provincial government and Northern Region of Netherlands mainly can have a very small impact on the focal system. To illustrate the reason behind it, there can be drawn parallels with Dutch decentralised planning policy where local level (focal system scale) has the most decisive role (van Soest 2019; OECD 2017). Although larger - scale system governance has the right to dispute decisions made by local government

(municipality of Groningen), this power is used very rarely. Most significant influence from provincial and regional governance levels can be provided by finical support, but then the investment should be related to provincial and regional development (van Soest 2019). Unlike larger - scale governmental institutions, two water boards, investors and housing associations (although in very specific topic) can significantly influence decision making process within the municipality (Mollema 2019; Schuit 2019). This influence can be seen as positive only if both sides are sharing the same values and viewpoints. Through mutual cooperation it would be possible to achieve sustainable solutions (Horlings 2015).

Table 3.4. Social and ecological dimensions of systems at larger and smaller scales that interact with the focal system

	Social dimensions that influence the focal system	**Ecological dimensions that influence the focal system**
Larger - scale systems	• Provincial government; • Northern Region of Netherlands; • two water boards; • Investors and housing associations	• Hunze river valley - regional level river and green corridor
Focal System		
Smaller - scale systems	• Neighbourhood communities	• Site scale meadow patches

As **to smaller - scale system** or neighbourhood communities, they can also achieve significant impact. Local communities can be described as driving force that can put pressure on the focal system (Fabos 1995). Although should be recognised that created pressures can be both positive and negative. Positive in a way that proactive community can achieve favourable changes in their living area by pressuring changes in decision making process and negative by damaging environmental quality though polluting and indifferent attitude towards their surrounding environment.

Concerning ecological dimension, Hunze river valley or more precisely “Hunzevisie 2030: Wereldnatuur binnen handbereik” project whose aim is to renew Hunze river flow through two provinces can be referred as larger - scale system (Reintsema 2019). This project has originated green infrastructure planning within the focal system thereby I can be perceived as main catalyst for ecological and cultural improvements with the city (Reintsema 2019). Just as important role is played by smaller - scale system that can be described as site scale meadow patches (van Goethem 2019) that perform as valuable core areas. These

ecologically significant site scale nature patches can be beneficial staring point and impact further ecological corridor development (Baschak et al. 1995).

3.2.4 GOVERNANCE SYSTEMS

From previously conducted assessments it can be observed that adopted governance practices within the focal system is the main key variable which can influence decision making process, power distribution and conflict resolving (Resilience Alliance 2010). Identification of governance and social network characteristics can help to identify whether or not management practices and collective cooperation can be seen as adaptive and sustainable.

- ADAPTIVE GOVERNANCE AND INSTITUTIONS

Informal and formal governance institutions are the main driving force that guides management of resource systems, their units and resource users or stakeholders (Ostrom 2009). Formal institutions use such instruments as planning documents, rules, laws and also adjust market conditions. Regarding informal institutions - they largely dictate social and behavioural norms of society (Resilience Alliance 2010).

According to Resilience Alliance (Resilience Alliance 2010, 37) flexible and responsive decision-making process can enhance "…interaction across organizational levels, experimentation, new policies for ecosystem management, novelty in cooperation and relationships among agencies and stakeholders, new ways to promote flexibility, and new institutional and organizational arrangements". Adoptive governance practices give an opportunity to use the full potential of the focal system and create fruitful ground for place - bases initiatives (Horlings 2018).

In order to evaluate sustainability and flexibility of formal and informal institutions within and outside the focal system, there were conducted interviews with stakeholders from local, regional governmental institutions, foundations and local neighbourhoods.

As key formal institutions participating in decision making process are municipality of Groningen, two Water Boards "Noorderzijlvest" and "Hunze & Aa" and occasionally provincial governance of Groningen (Helbig 2019; Schuit 2019; Mollema 2019; van Klinken 2019). As for example municipality of Groningen can be characterised as partly flexible formal institution. Such an assessment follows from conducted interviews where institution can be indicated as cross-sectoral entity that includes specialists from various sectors in one department. It is also mentioned that municipality tries to experiment with alternative green infrastructure management approaches, although specifically in focal system such solutions

are not yet implemented (Helbig 2019; Schuit 2019). In general municipality can be identified as strong formal power that is the main leader regarding conflict resolution among stakeholders.

Water boards hold similar power as municipalities but in a specific sphere related to water quality, quantity and safety contribution (Mollema 2019). Since water boards are responsible for water safety measure, there is a little room for flexibility and experimental policies, although large-scale areas outside city boarders have already been allocated in order to provide room for the water in case of overload of water-management system capacity during flooding events. It is also mentioned that the focal system is managed by two different water boards that might lead to conflict. Such situation may emerge due to different approaches of water management but in order to resolve these disagreements policy advisor from "Noordzijlvest" water board Tijtse Mollema (Mollema 2019) argues that any conflict resulting from mutual cooperation can be resolved through negotiation.

Informal institutions can be indicated as flexible provincial and also local decision making institutions with intermediate power. For instance foundation "Het Groninger Landschap" is one of the leading informal provincial institutions that address environmental issues in the province of Groningen. Foundation is the initiator of historical Hunze river area enhancement and renewal (Reintsema 2019). However municipality perspective of Hunze river historical area development slightly differs from foundation vision. Municipality sees Hunze river historical area as part of the ecological structure of the city and tries to integrate ecological renewal and recreational amenities simultaneously with development projects related to residential and industrial project construction (van Goethem 2019; Schuit 2019). Nevertheless "Het Groninger Landschap" foundation is an important motivating power that is capable to alter typical decision making pattern.

- SOCIAL NETWORK AMONG STAKEHOLDERS

Sustainable social network outlines the need for collaborative network building, stakeholder engagement, collective learning and information sharing (George and Reed 2017). Reciprocal collaboration and unified movement towards common objectives can strengthen focal system adaptability towards unexpected changes (Resilience Alliance 2010).

Stakeholder network of historical Hunze river area can be related to scheme "D" (see Fig. 3.10.) There can be distinguished two active groups that sustain this project. First of all, it is the initiator of the project "Het Groninger Landschap" and planning group from the

municipality that consist of specialists from different fields. Both of these groups are interconnected with most of the stakeholders.

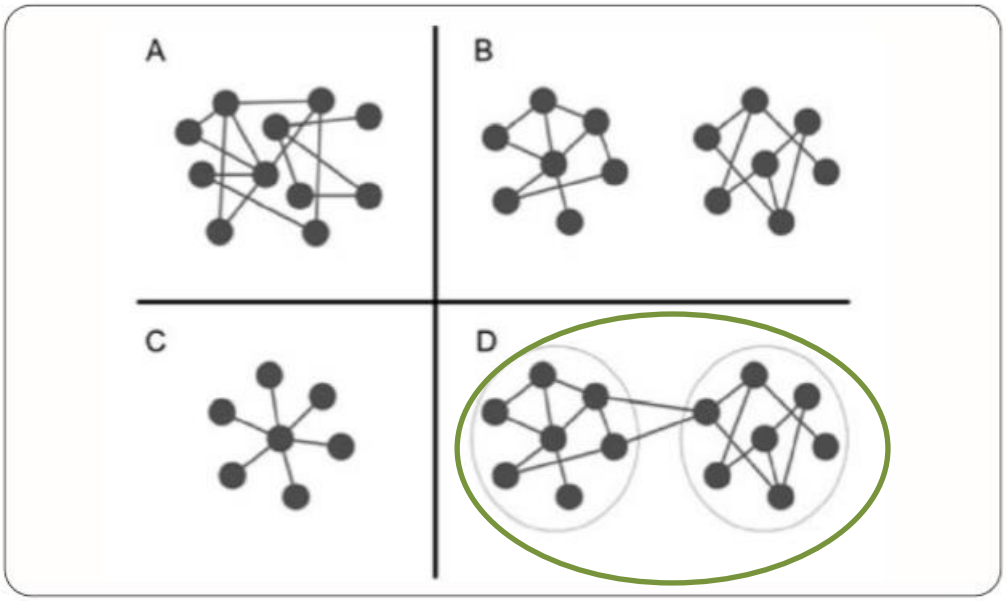

Fig. 3.10. Schematic presentation of some archetypical network structures (Resilience Alliance 2010)

"(A) represents a network without any clearly distinguishable subgroups, whereas (B) presents a network that is divided into two isolated subgroups. (C) represents a highly centralized network), and (D) represents a network with two distinguishable groups which are connected by two bridging ties (Resilience Alliance 2010, 40)."

Foundation "Het Groninger Landschap" stands out with its persistent and proactive work (Schuit 2019). Foundation is looking at Hunze river stream restoration much more persistent than municipality does. Although, municipality is integrating Hunze river restoration in its planning documents and appreciates its significance (Gemeente Groningen 2018), yet, Hunze river restoration project doesn't have a strategic plan that could sustain its implementation. Thereby Hunze river historical area remains vulnerable to development and urbanisation processes.

Regarding local stakeholders like business parks in Euvelgunne neighbourhood and local neighbourhood community initiatives, bottom-up movement can be describes as more reactive than proactive. For example, if there are any issues emerging, only than encountered problems are being addressed. A positive feature is that problem solving takes place in close cooperation with the municipality of Groningen (Borgman 2019; Boonstra 2019). There have been identified public participation efforts where municipality of Groningen and foundation "Het Groninger Landschap" mentions that they have organised public participation events and meetings where they introduce local inhabitants with their ideas and visions towards Huzne

river historical area. In these meetings citizens are welcome to express their thought and ideas regarding Hunze river historical area (Reintsema 2019; Schuit 2019).

In general involved stakeholders can be characterised as interconnected structural entities that in case of necessity are able to cooperate, but it not possible to observe signs of facilitative leadership, collaborative network framing and learning within the focal system.

4 DISCUSSION

From previous assessment it was feasible to identify five alternative system states of the focal system. Various possibilities of transformations highlight dynamic character of the system and show a great deal of influences pressuring the system. Regarding historical area of Hunze river, many possible development scenarios makes the system vulnerable due to its uncertain development direction. Therefore it is crucial to discuss sustainability of the most desirable future system states and address these characteristics from various perspectives of involved stakeholders.

Most detailed and developed scenario is “Groningen: Stad aan de Hunze” project (Het Groninger Landschap 2019) made by “Het Groninger Landschap” foundation whose main aim is to renew historical flow of the river although severely adjusting river flow to the existing urban situation. They also envision comprehensive project that will encompass ecological significance, cultural values, recreational features and enjoyable living and working environment for its inhabitants (Reintsema 2019). Despite the fact that “Groningen: Stad aan de Hunze” project (Het Groninger Landschap 2019) seems to capture wide range of stakeholder requirement in comprehensive urban green river corridor vision, after in-depth interviews and report analysis it was observed that predominant focus of the project is on the renewal of river flow and ecologically significant green areas (Oosterveld et al. 2019; Schuit 2019). It is also evident that this vision includes a lot of limitations, as for example, Eemskanaal - as the main obstacle crossing historical Hunze river trajectory, which makes it difficult and expensive to renew previous river flow, water level differences throughout the city of Groningen and ending with protected cultural values that wouldn’t support any alterations (Reintsema 2019, van Klinken 2019; Kortekaas 2019). Considering these difficulties and costs, sustainability of river flow renewal can be questionable. Stream renewal would include a lot of technical alterations that would endanger existing habitats and cultural heritage values (van Klinken 2019; Kortekaas 2019).

From the perspective of formal institutions municipality of Groningen and water board “Noorderzijlvest” conceptualise historical Hunze river area as connected canal system with more gradual slopes and wherever possible adjust bordering green areas to wetlands that would perform water storage function, biodiversity enrichment service and provide recreational amenities (Mollema 2019; Schuit 2019). In fact there is already a specific project vision for Hunzeboord park that integrates above mentioned solutions. It is one of the areas that provide enough space for broad urban green infrastructure solutions. In general, project

vision shows flexibility and more inclusive approach, where also cultural relics are highlighted (Mollema 2019; Schuit 2019).

Both scenarios have been presented to the local communities, where inhabitants of the neighbourhoods get the chance to reflect on the proposed ideas and visons (Boonstra 2019). Although there is wider room for collaborative community engagement approaches. Engagement practices like discussion workshops, practical site visits and story based discussions are examples how inhabitants can be encouraged to engage and learn about their surroundings characteristics, issues and overall identity (Bos 2019). Fragmented ideas and uncertainty hinders community stewardship towards one vision.

In conclusion, obtained research results are not only place-specific but also shows the importance of social-ecological sustainability and resilience assessment integration in to governmental planning process.

CONCLUDIONS AND PROPOSAL

In the introduction of the research there was presented Eden and Tunstall (Eden and Tunstall 2006, 662) statement about urban riparian ecosystem alterations: "…bury them, turn them into canals, line them with concrete and build upon the (now protected) floodplains". This statement perfectly sums up the pattern of economic - driven decision - making process which results in short - minded solutions. In order to prevent such sequence of events this research presented sustainability and resilience assessment of historical Hunze river area (during the research also called as focal system), which helped to indicate systems characteristics, its strengths and weaknesses and most importantly forecast the possible system transition possibilities:

– Focal system can be characterized as limited and highly human-modified system, which is vulnerable to foreseen climate change.

– In order create more climate adaptive system, presented transitions to alternative system states is the key method to prepare decision makers beforehand shift has happened. In addition alternative system state analysis identified decision-making process as the main threshold that supports system state transitions.

– Considering urban environment obstacles but at the same requirements historical Hunze river area is seen as multifunctional urban green areas that requires alternative green infrastructure management solutions, such as allocated water storage areas, local scale wetlands that would create room for the water in case of severe flooding events.

– There is a need for more detailed inventory of landscape, cultural, ecological elements and their network. Evaluation of the valued attributes, ecosystem services as well as problematic places and obstacles could serve as important background for balanced and multifunctional development vision that could encompass environmental, cultural and social values throughout the urban green corridor.

– Collaborative planning and versatile public engagement would facilitate space for adoptive solutions which in turn would take into consideration specific peculiarities and circumstances of the place.

– In order to consolidate and protect collectively made decisions there is a need for stable and rigid zoning plan as well as comprehensive strategic plan.

– To steward focal system toward more sustainable development there is a need for neutral management group that could serve as the main catalyst of grassroots initiatives from both: informal organizations and local communities.

– Urban green infrastructure planning practices should be combined with thoughtful grey infrastructure planning improvements that could enhance accessibility of valued attributes and would improve connectivity of the green nature patches.

Additionally conducted case study research revealed qualitative and practically useful information that can be applied to research focal system:

– It is important to carry out urban green infrastructure renewal with respect towards place authenticity and originality.

– Active project writing and obtaining of funds from higher national and international instances can support decision making power in the desired direction and also facilitate financial background for development projects concerning environmental, cultural and social issues.

– By introducing collaborative planning approach it can enhance multifunctional projects leading to satisfaction, evolvement and responsibility from stakeholders.

– Shared learning process through workshops, meetings and discussions can help to steward distinct groups of people towards common vision and understanding.

– Information sharing and transparency from the project leaders can show appraisal of stakeholder input and therefore can increase further community engagement. Reflectiveness facilitates increase of feedbacks that can help the system to adjust management practices towards stakeholder concerns and requirements.

– Ecosystem service assessment and monitoring strategies are useful instruments for public education and gives an opportunity to transfer scientific and profession-specific information to broader community in much accessible and understandable way.

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