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IMPLEMENTATION FACTORS OF SUSTAINABLE DRAINAGE SYSTEMS IN ESTONIA

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Säästlike sadeveesüsteemide vähene levik Eestis. Soov teada saada mis on selliste maailmas laialt levinud süsteemide arengut takistavad faktorid. Töö on koostatud Eesti seaduseid ja strateegiad uurides ning interviueerides alaga seotud spetsialiste. Tulemuseks selgus, et faktoreid on mitmeid, nagu näiteks säästlike süsteemide külmakartlikus, ruumipuudus, informatisoonipuudus ja toru süsteemide laialdane kasutus. See töö oli loogiliseks jätkuks teistele Eestis sellel teemal tehtud töödele. Töö jätab võimaluse jätkata tulevaste uurimustega näiteks kuidas suurendada teadlikust ja luua ühtset strateegiat erinevate valdkonda puudutavate organisatsioonide vahel.

Märksõnad: SUDS, säästlikud, sademeveesüsteemid, Eesti, sademevesi

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Sustainable drainage systems are not popular in Estonia. I wanted to know why is that so and what are the factors that limit this. Work is constructed by looking at different Estonian legislations and strategy documents and making interviews with specialists. Result was that there are several factors such as problems from cold weather, lack of information and wide use of pipe systems. This work was as a logical continues to the other works on that field. This thesis gives an opportunity to continue future research on how to raid the knowledge among professionals and how to create unified strategies between different professional fields.

Keywords: SUDS, sustainable, drainage, Estonia, runoff

TABLE OF CONTENTS

INTRODUCTION

Drainage systems are a main part of out densely populated cities. This system cannot stop or break without having huge negative influence on our lives. Sustainable drainage systems are good flexible environmental alternatives to our conventional pipe sewer system.

In this work I am going to look at sustainable drainage systems and a why they are not used in Estonia as in other parts of the world. I Want to know what are the factors that limit this their development here. Work is constructed by looking at different Estonian legislations and strategy documents and making interviews with specialists.

Results are not that surprising but interesting is that unique situation exists were several factors together prevent sustainable drainage implementation here. Main problem such as lack of information, cold weather and dense cities.

This work was as a logical continues to the other works on that field. This thesis gives an opportunity to continue future research on how to raise the knowledge among professionals and how to create unified strategies between different professional fields.

LITERATURE REVIEW

In this chapter I am going to give a theoretical overview of increasing precipitation and urban development impact on water cycle in developed areas.

Climate projections

Rainfall in Estonian region due to always changing weather patterns is difficult to predict. There are periods of increased precipitation and periods of drought. The bigger and drastic the changes, the harder it is to take into account the effects that it brings to us. Recent studies show that overall storm surge in Europe are projected to rise 15% by year 2100 under high emission scenario (Vousdoukas et al 2016). That means there will be higher sea levels and more storminess. The increase in precipitation and climate extremes has been brought out and confirmed by „Eesti tuleviku kliimastsenaariumid aastani 2100 (Climate Scenarios in Future Estonia until 2100) (Anders et al 2014).

In „Kliimamuutuste mõjuga kohanemise arengukava aastani 2030 eelnõu“ (Climate Change Adaptation Development plan until 2030 draft from now known as KMK development plan) indicates that in general Europe temperature will rise together with river and sea water levels due to more rain and storm activity (Kliimamuutuste mõjuga kohanemise arengukava aastani 2030. 2016). That means increasing hazards for our coastal areas; these areas are also the most densely populated areas. In order to better understand which areas are in the greatest risk, KMK development plan evaluates floods that have occurred in Estonia and distinguishes areas with most influential economic effect. Those areas are Audru vald, Papsaare küla tiheasustusala; Haapsalu linn; Haaslava vald, Aardlapalu küla; Hanila vald, Virtsu alevik; Häädemeeste, Häädemeeste alevik; Järvakandi alev; Kohtla-Järve linn; Kuressaare linn; Kärdla linn; Maardu linn; Kaarma vald, Nasva alevik; Paide linn; Pärnu linn; Ridala vald, Paralepa ja Uuemõisa alevik; Saue vald, Maidla tiheasustusala; Tahkuranna vald, Võiste alevik; Tallinna linn, Haabersti, Põhja-Tallinn, Kesklinn ja Pirita linnaosa; Tartu linn; Tähtvere vald, Ilmatsalu alevik; Võru linn activity (Kliimamuutuste mõjuga kohanemise arengukava aastani 2030. 2016).

Urbanization impact on stormwater

It is important to know our future climate, based on this knowledge we can prepare our living environments for these events. Because the climate is changing and there will be more rainwater, we need to understand what are the effects and how these effects influence our lives. By building and shaping our environment, we disturb the nature and its processes around us. In this way, urbanization alters the natural water cycle. Region's natural situation has developed throughout the years and water runoff does not disturb or off balance trees, plantation, ground soil etc. Trees, plantation, natural depression, rivers, lakes water dissipates an infiltration to the (Hormoz 2016). This process filtrates the water from debris and pollutants that it might contain.

Urbanization starts with preparing the site for buildings and that means that trees, vegetation, humus layer, organic matter, natural forms of the ground (depressions and puddles) are removed and there will be nothing to absorb, impound the (Daniel et al 2015). The result will be the levelled and hard compacted ground where water cannot infiltrate through. Because there are no elements that could hold the water, runoff starts, and it becomes even worse when roads, sidewalks, buildings, parking lots and other impervious surfaces are constructed. Adding to it, all ground water level will drop because the water cannot infiltrate and renew the water table.

Urbanization impact on runoff

Because the environment has been changed and most of the ground is covered with impervious surfaces it is really easy for the water to start flowing. In developed areas runoff can be generated from 2 mm of (Daniel et al 2015). It means that almost every time it rains, there will be runoff and all the pollutants that are produced daily, are carried to the receiving watersheds. Overlooking problems like increase in runoff, decrease in infiltration and reduction of the water quality can aggravate flooding, end up polluting streams, rivers and lakes, and reduce the water level (Hormoz 2016).

Water in our cities and towns is the necessity, but an excess of it can lead to problems. We need to transport the excess water away using constructed drainage, pipes, channels and rivers but this turns the overland flow to concentrated runoff. That means that precipitation

is concentrated and carried to the outlet point much faster. Reduction of rainfall abstraction and shortening of the time of concentration create increase in both the peak and volume of runoff, but local ground water level will drop from lack of recharge (Hormoz 2016).

When the rain is too heavy or storms occur, the amount of water will overwhelm the pipe systems, resulting in floods. In case of natural environment, this water will infiltrate through the porous natural terrain, especially when the terrain is diverse like forests, grasslands and wetlands. With urbanization, the natural porous ground is removed and water cannot penetrate through it and filter the water. On impervious surfaces rain water and melting snow are mixed with man-made pollutants and this mix will flow into the sewage pipes ending up in rivers and lakes. This water has a lot of eroding power and it can erode the bottom and banks of the river, sediments will end up in receiving waters and polluting it with sediments and other pollutants (Hormoz 2016).

Impact on water quality and quantity

Pollutants come from different sources, some of them we can pinpoint and monitor. Single source pollutants can be outfalls from factories, sewage treatment plants, chemical plants etc. Monitoring these sources is easier because in many cases we know where the outfall is. Harder to identify are nonpoint sources; there can be several smaller sources spread out over land. Nonpoint pollutants can include excess fertilisers, herbicides, oil, toxic chemicals; sediments from construction sites, bacteria, nutrients from livestock, atmospheric deposits (Polluted Runoff: Nonpoint Source Pollution 2017). Depending on the receiving waters, these pollutants can cause different harmful results.

Besides the harmful pollutants that are in the water, there is a problem of water volume. As mentioned before, the water that comes from impervious surfaces has a lot of eroding power. It is estimated that after development 75-100% impervious cover, there is a 45% increase in surface runoff, a 20% decrease in deep infiltration, 15% decrease in shallow infiltration and 10% decrease in evaporation compared to natural landscape (Gary et al 2016). So, water that should infiltrate into the ground has to find its way on surface, usually in the sewer pipes. If there is no sewage, there is a high risk of flooding.

Source reduction

Source reduction means controlling the volume of water runoff and its peak flow before the water is discharged from its source into the sewer system and (Hormoz 2016). Source control practices work by reducing impervious surfaces like sidewalks, narrow streets and driveways and disconnecting paved areas, adding elements such as rain gardens, cisterns, depressions etc. Taller buildings also reduce buildings footprint and impervious surfaces. Impact of reducing the runoff at the source can be highly effective when it is used widely.

Treatment challenges

Stormwater treatment presents different problems than domestic sewage or **grey** water. Domestic wastewater treatment is relatively consistent concentration of pollutant that are fed continuously to the constructed wetlands for treatment plants, but stormwater flows intermittently to the treatment wetland (Gary et al 2016). The volumes and frequency of runoff varies greatly due to climate and seasonal regime and can stress the plants if there is no rain.

Used practices

There are several practices that can be used to maintain or develop the environment that we are living in. Green stormwater infrastructure (GSI), low impact development (LID), environmental design (ESD), water sensitive urban design (WSUD), sustainable urban drainage system (SUDS) – they all serve the same purpose by managing the hydrological cycles and improving water quality (Daniel et al 2015). In this chapter I am going to give **a** short overview of more relevant ones to my work.

Low impact development

Low impact development (LID) is environmentally friendly approach with minimal impacts on hydrological regime and water quality (Hormoz 2016).

LID objectives:

- Minimize the amount of runoff by reducing impervious surfaces such as roads, parking lots and driveways
- Maximize on site infiltration to the ground
- Minimize erosion by reducing grading and clearing the trees
- Promote small depressions and retention basins to store water
- Routing runoff and disconnecting impervious surfaces such as rooftops and driveways from roads
- Minimizing or eliminating stormwater treatment systems.
- Public awareness

Living roofs

Living roof is a green living open space with plantation and, if possible, trees that is located on the roof of a building. It is essential to look at living roofs from two sides: from technical side of engineers point of view and from environmental, social and aesthetic side (Daniel et al 2015). Designers try to create space that has high aesthetic value for people, but the fact that this site is on roof means that it cannot happen without engineers.

Prevention of runoff is the main role of a living roof. Living green roofs can introduce some of the precipitation back to the water cycle and acts like a natural sponge. In stormwater management goals living roofs provide retention and detention and increase the time of concentration, delaying and lowering runoff discharge rates (Daniel et al 2015).

Sustainable urban drainage systems

To reduce the pollutants that are carried with the runoff, there are several ways and methods in purifying the water. One alternative method to conventional purification is sustainable urban drainage systems (SUDS). SUDS are natural approach to managing drainage in and around properties and other development (Sustainable Urban Drainage Systems (SUDS) 2017). This method works by slowing and holding the water back that runs off from properties or other sites, allowing natural processes to purify it. SUDS have different types.

Source control – these measures deal already with the runoff where the rainfall lands for example near dwellings (Sustainable Urban Drainage Systems (SUDS) 2017).

Site control – manages surface runoff from large areas such as major roads, business parks or housing estates (Sustainable Urban Drainage Systems (SUDS) 2017).

Regional control measures deal with runoff that is gathered from a larger area. These systems use the same principles as smaller scale SUDS but can deal with large volumes of water as well (Sustainable Urban Drainage Systems (SUDS) 2017). It is a good idea to use small SUDS systems together with larger ones. To avoid using pipes, it is good to connect SUDS with swales, filter drains or ditches; that adds more filtering and cleaning power to the system.

There are many benefits from SUDS based on „Costs and Benefits of Sustainable Drainage Systems“ case study in the United Kingdom (Costs and Benefits of Sustainable Drainage Systems. 2012).

- First and main benefit is reduction of surface water runoff. This reduces the risk of flooding and pressure on sewage systems.
- Reduction of receiving water body pollution
- Alternative source of non-potable water for domestic and commercial use (landscape irrigation, car washing etc.)
- Groundwater recharge
- Adding biodiversity through valuable habitats for wildlife in urban areas
- Reduction in energy consumption through installation of green roofs
- Aesthetic value and through that rise in quality of life

Tools of SUDS

Because this work is based on the practice of SUDS I am going to look into its techniques more precisely. There are many techniques in SUDS that can be used to clean the runoff and reduce the water peak volume. I will introduce the main methods to a large degree based on the book Urban Storm Water Management by Hormoz Pazwash.

- Rainwater harvesting – rainwater will be collected mainly from rooftops and hard surfaces and stored for later reuse. Proper design of this system can also reduce the rates and volumes of runoff (Component: Rainwater harvesting. 2017).

- Submerged gravel wetlands - small-scale filter that uses wetlands plants in a rock media to provide water quality treatment (Hormoz 2016). Runoff drains into the lowest rock media level; the pollutants are removed by plants or stored in the submerged gravel media.

- Landscape infiltration process uses planting areas to capture, store and treat runoff. Rainwater is stored initially, it filters through the planting soil and gravel media below and infiltrates into native soil (Hormoz 2016). This system can be integrated to site design using planter storage features, or in natural areas where the natural soil has been excavated and filled with stones and gravel media and topsoil.

- Infiltration berm is a mound of earth that is placed on a relatively gentle slope. Berm contains soil and stone and functions in two ways, firstly creating depression and storage area above a berm and secondly, water can filter through the berm and maintain steady flow (Hormoz 2016).

- Dry well is essentially an excavated pit that is filled with gravel or stones and provides temporary storage for storm water. It can be constructed as a shallow trench or deep well. Runoff is directed to dry wells and infiltrates into the surrounding soil after the (Hormoz 2016).

- Micro-bioretention are the landscaped depressions that treat runoff through filter mixture of sand and organic matter (Hormoz 2016). Filtered water is partially infiltrated or returned to the drainage system. These systems can be integrated in design and adapted to different situations.

- Rain garden is an excavated landscape feature, depression that during the raining holds runoff for some time. It consists of an absorbent, planted soil and mulch layer and plants, shrubs and grass (Hormoz 2016). It also contains overflow system that passes large amounts of water.
- Swales – are channels that remove pollutants through vegetative filtering, sedimentation, biological uptake and infiltration into the underlying soil media (Hormoz 2016).

- Enhanced filters stone reservoir under a conventional filtering device to collect runoff, remove nutrients and allow infiltration into the surrounding soil (Hormoz 2016).

Using these micro-scale practices on the right situation gives reduction in water runoff level and reduces pollutants in water.

ESTONIAN CONTEXT

This chapter gives an overview of state laws, development strategies and other legislations that steer the rainwater system development and treatment in selected cities over Estonia. There are many documents that organize and direct development on this subject and they are different from place to place, but it is important to get an overview of the main ones and understand the legislation to answer the questions asked in this thesis.

Waterlaw

Estonian„Veeseadus“ (Water law) is the basis that defines the meaning of rainwater. By the definition, rainwater is precipitation that has fallen to the ground or collected from buildings by ditches (Veeseadus. 2013). Government regulation act nr 99 „Reoveepuhastamine ning heit- ja sademevee suublasse juhtimise kohta esitatavad nõuded, heit- ja sademevee reostusnäitajate piirmäärad ning nende nõuete täitmise kontrollimise meetmed“ (Requirements for transporting waste and rainwater to the receiving waters, management requirements and monitoring measures) has been given into force based on „Veeseadus“.

Water supply and sewer law

„Ühisveevärgi ja -kanalisatsiooni seadus“ (Water and sewer law) regulates how drinking water is supplied to the houses and how waste, rain and other water from the properties are transported away (Ühisveevärgi ja -kanalisatsiooni seadus. 2015). Also this law states the rights and obligations for the clients and municipalities.

It is said that if owner decides to connect its property to the waste and rainwater sewer then there will be a fee for that. It is one time fee just for making the connection, and the fee cannot be taken several times. It is allowed to collect tax for transporting and treatment of rain, ground or any other water that originates from the property.

According to this law it is allowed to tax owners for using the sewer system (tax for the water service) and for water treatment. Size of this tax may vary according to the level of water pollution and weather; it is transported through combined water system or through rainwater system. Consumed clean water amount is the basis for calculating the water

treatment price. The amount of rainwater treated is not taken into account (property or housing size, impervious surface size etc.).

Local municipality organization law

„Kohaliku omavalitsuse korralduse seadus“ (Local municipality organization law) states that among other aspects municipality has to plan how to provide drinking water, plan sewer systems, spatial planning etc. (Kohaliku omavalitsuse korralduse seadus. 2013). In this way, municipality is the first step which actually has to plan and organize all the waste and repair sewer systems, water treatment and taxing property owners for that.

Treatment, conveyance and monitoring requirements

Government regulation act nr 99: „Reoveepuhastamine ning heit- ja sademevee suublasse juhtimise kohta esitatavad nõuded, heit- ja sademevee reostusnäitajade piirmäärad ning nende nõuete täitmise kontrollimise meetmed“ (Requirements for transporting waste and rainwater to the receiving waters, management requirements and monitoring measures). This act is based on the government Water Law and its goal is to regulate how waste water is treated, also how rain water is transported (by sewer system) to the receiving waters (Reovee puhastamise ning heit- ja sademevee suublasse juhtimise kohta esitatavad nõuded, heit- ja sademevee reostusnäitajate piirmäärad ning nende nõuete täitmise kontrollimise meetmed. 2013).

Act says that when conveying waste or runoff water to the receiving waters, it has to be guaranteed that the receiving waterbody or land ecosystems connected to the waterbody will not be harmed in any way. It is allowed to convey the runoff water to the waterbody in case it's pollution norms stay in the limits set by law. Also the level of naphtha in the water is stated. The actual limits are brought out in the law but they will not be described in this text because they are not relevant to this paper.

If the runoff water pollution levels do not meet the requirements stated by the act then the water will be classified as polluted runoff (Reovee puhastamise ning heit- ja sademevee suublasse juhtimise kohta esitatavad nõuded, heit- ja sademevee reostusnäitajate piirmäärad

ning nende nõuete täitmise kontrollimise meetmed. 2013). Polluted runoff is required to be treated before conveyed to the receiving waters.

Environmental strategies

Strategic plans are needed to direct the development direction of environmental protection. These plans are taken as a base and guide to construct plans, technologies and other marketing purposes. This chapter takes a look into main municipal strategies in Estonia and gives an overview of the directions or lack of them on the point of view of sustainable drainage systems.

Estonian environmental strategy until 2030

According to the strategy, it is essential to achieve good condition of surface and groundwater and preserve those water bodies that already have good condition. Human activity is the main factor that affects the quality of the water and therefore it is strategically important to either limit the economic activity, that influences water or to be liberal and promote the economic development (Eesti Keskkonnastrateegia aastani 2030. 2017). It is preferred to promote economic activity in a way that human influence to the surface and ground water would reduce and water bodies' health would be good or would increase. Action programs to increase the water quality are in a developmental stage.

Tallinn

Overview of Tallinn rainwater strategy based on regulation Tallinna sademevee strateegia aastani 2030 (Tallinn rainwater strategy until 2030) (Tallinna sademevee strateegia aastani 2030. 2012). This document gives a good overview of Tallinn's current situation, problematic situations and future goals.

Strategy says that to prevent the reduction of rainwater quality, it is necessary to use preventive measures already at the source. Measures can be such as dry cleaning the streets, reducing the lead content in the gasoline etc. Depending on the pollution levels, it would be necessary to reduce the amount of water that goes into the combined or separate sewer systems. It can be done by local infiltration measures, if the ground layer allows that.

Water that comes from the factory sites, where the runoff is heavily polluted, has to be treated separately, every case like that has to be evaluated according to the site. When separate sewer system runoff is collected from roads with heavy traffic where the first flush of water is heavily polluted then first part of the runoff should be directed to the precipitation tank and after that, if possible, this part of water should be directed to water treatment plant.

In case of combined sewer system the event of overflow is not allowed to happen more than 10 times in a year or cannot be over 10% of sewer water amount. Several overflows are taken as one. It can be achieved by introducing proper sewer development plan and equalization tanks that hold the first, the most polluted water.

Tallinn's rainwater strategy gives an overview of pros and cons of separated sewer system. Main pros are: no overflows, less sand and better waste water treatment due to steady water flow. Main cons are: more expensive to build, hazard of wrong connections (washing machine wastewater goes to rainwater sewer), hydraulic overpressure in case of heavy rainfall.

Strategy brings out investments that have been made and that are planned for years to come. Main investments are for developing the separate sewer systems. In some parts swales are closed and replaced by pipes but there are also investments to reconstruct and maintain them.

Main problem for Tallinn is the central city that uses only combined sewer system and there is no room due to high buildings to develop the separate system. The same problem occurs also in other parts of the city. It is also written that no land area is separated for open ground water treatment development in the city.

Four general areas are mentioned for rooftop water infiltration into the ground. Green roofs conception and its benefit have been brought out very well. New development detail plans should bring out ways to deal with rainwater, that the water would not overwhelm the sewer systems.

Future goals for 2030 foresee that idea for source infiltration and treatment has been implemented. Rainwater is collected and used in buildings (in toilets). Green roofs are used widely. City has detailed map of where runoff water comes also of pollution sources and drainages. City has worked out a plan how to tax runoff water.

Pärnu

Overview based on „Pärnu sademevee strateegia aastani 2026“ (Pärnu rainwater strategy until 2026) (Pärnu linna sademevee arendamise strateegia ja tegevuskava aastani 2026. 2016). As in other cities, one of the problems brought out concerning rainwater is the lack of unified strategy between different departments (city planning, environmental protection agency, sewer system development etc.). That prevents unified goals to be developed.

Pärnu’s runoff sedimentation level in water discharge to the receiving water bodies is within the limits stated by law. Problem is with extremely high level of chemical pollutants that are over the limit and indicate to the industrial source. Most of the problems with runoff are related to organic pollutants, not efficient wastewater treatment and nonpoint pollutants.

The polluted runoff and lack of treatment facilities keep Pärnu from reaching environmental goals. There are other factors like

- sanding and salting the roads,
- road construction
- chemicals from roads
- increase in traffic intensity
- No concept how to store snow from roads
- Agricultural sediments
- More impervious surfaces

Main future standpoints come from sustainable development views. Dealing with the rainwater problems in Pärnu falls into two groups, first runoff treatment and developing new areas with environmentally best solutions. Ideas like using rainwater for irrigation, infiltration on the property, runoff water is directed to green areas, equalization tanks, using swales and ditches to convey runoff water. Separate sewer systems are developed.

Tartu

Tartu city rainwater sewage situation based on Tartu Comprehensive plan until 2030 (Tartu linna üldplaneering 2030. 2017) and Tartu linna ühisveevärgi ja -kanalisatsiooni arendamise kava aastateks 2016-2030 (Tartu water and sewer development plan 2016-2030) (Tartu linna ühisveevärgi ja –kanalisatsiooni arendamise kava aastateks 2016 – 2030. 2016). Tartu has seen already big positive steps in increasing the rainwater treatment system. From 2015, 61% of Tartu city was developed and built as a separate sewer system. It is the main goal of Tartu Water Company to develop separate sewer system in the nearest future. Updated version of rainwater scheme has been developed that shows the rainwater sewer pipes and watersheds. High river (Emajõgi) level poses a threat to rainwater sewer because the outlets can be under water and the water starts to flow backwards, thus creating problematic floods where they are tried to keep away.

Main vision is to develop separate sewer systems. The receiving water is Emajõgi and rainwater is mostly treated at the receiving water with sand and oil catchers. New solutions are connected to the present system or local treatment systems are developed.

Due to the recent climate changes and risks from heavy rain, the goal is to develop infiltration systems on the site. Swales, ditches, infiltration ponds, infiltration wells, surface media filters, can be used where ground or population density supports that. Usage of these natural methods is allowed when geological investigation has been done and presented in the planning process. When planning this kind of systems, all environmental safety principles have to be taken into account.

Water from parking lots larger than 10 spaces, has to be cleaned. If water from parking lot is collected and conveyed to the receiving water then it has to be cleaned. Small parking lots, less than 10 places, where water seeps through the pavement, cleaning would not be necessary.

If it is not possible to drain rainwater to the city sewage system and there are technical solutions for that, collecting rainwater is one possibility. In that case sufficiently large tank has to be installed and water that is collected in it can be used to water plants or in toilets.

Põlva

Overview of Põlva rainwater drainage situation based on Põlva Linna Ühisveevärgi ja -kanalisatsiooni arendamise kava 012-2024 (Põlva water and sewage development plan 2012-2024.) Monitoring has shown that Põlva city runoff to its receiving waters has had no negative effect on it. When monitoring shows any change in that, it is possible to develop a treatment system. Main problem today is that runoff drains into Võru street wastewater pumping station. In case of heavy rain the mixture of waste and runoff water will be pumped to the overflow to the Orja river wetland from where it goes directly to Lake Põlva. It is important for the lake's condition that this will not happen in the future. To prevent this problem a new sewage pipeline will be constructed and water will be transported to the wetland near Orja Street.

Areas where runoff is transported away using pipe system will stay the same in future. Runoff from small housing areas is directed to the grass areas where they infiltrate, or by ditches to the closest appropriate place. It is also good to develop swales, slopes, shallow ponds and other solutions like that.

Põlva is special in a way that rainwater conveyance is taxed as sewage water. Rainwater tax is calculated using also meteorological data about precipitation. Water from impervious surfaces is calculated using fixed constant, and it changes depending on surface.

PURPOSE OF THE STUDY

We have experineced Increasing extreame weather patterns arround baltic sea over the last years and this tendency is projected to rise. There are more intense rain showers that in some parts overwhelm the sewar systems. Flooding occure in places we have not seen beafore and if they happen in densly populated areas, there can be costly results. It is not possible to increase sewar pipe dimension everywere to fix the problem and it is costly. It is possible to integrate alternative systems to treat the water and reduce the risk of flooding.

There are alternative solutions to these problems. One of the methods used to reduce the risk of floodings and pollution in the runoff water is sustainable drainage systems that was discribed earlier. This method is used in different locations arround the world but not so widely in Estonia. There are only few sites that have the charactaristiks of SUDS. Why is that?

This theses questions what are the obstacles and shortwalls for implementing SUDS in Estonia. There is the theory that our climate is too cold at winter and these practices would not work here, but is this the main reason? Or is the old way of thinking were old systems are working and why should there be need to change them.

How our legal and strategy documents direct our rain water managment? How the rainwater treatment is regulated and what we can and cannot do? Is there any hint on sustainable development and if not then what can be done to improve the situation?

This theses objective is to answer these questions and if possible give solutions how to overcome the shortfalls and how to improve.

METHODOLOGY

To find answer to researche question: what are the obstacles/shortfalls for implementing SUDS in Estonia, desk studie and qualitative data analysis were used.

After formulating the purpose and reashearch questions of this work,base knowlage was needed about this subject. Literature research was used to build theorethical base and knowlege. Literature research focuses only to the relevant sources to this work and shows how this subject has been studied or discribed earlier. Beside the benefit of giving an overview of the subject it is nessesceary to gather knowlage for the researcher and to give overview about the possible methods available (Sirkka et al 2005).

In second part it was needed to understand what are the main regulations in Estonia that dictate development of runoff water drainage systems. For that deskstudie was made on legal documents, development plans and other relevent documents. To bring out the points most relevant to the subject that can be used to analyse against later findings.

Third part comprises of interviews with specialists who deal with drainage systems, watermanagment or make the laws. The respondents fall roughly into these groups: Municipalities/city gouvernemnt, arcitects, inseniers, developers, water companies. To gather the information from them meetings had to be organized. At the start there were only few respondents, but from every interview came new contacts.

The information that the persons give out is different and could also be interperd depending the point of view. Here the literature review is neasccessery to interpert the answers in the bounderis of this subject and the subjects are selected purposefuly (Sirkka et al 2005). Semi structured interwiew is a situation where interviewer and respondendts engage in an conversation that follows the interview guide, a list of questions and topics, but the conversation may stray when it is appropriate and in the lines of theme (Meriliis 2008). Dictofon is used when possible to ease the notes making process.

After the information is gathered it will be analysed as follows:

- Firstly each respondents texst were gathered to unifyed data document and read through cearfully. From the text codes or unit of meaningful segments were created
- The codes were gathered into a table in a way that each respondent has one colum.

- The whole table was looked at and the codes analysed in a way that all codes that fall under same gathegory are colored same color. That is tone until all the codes are gathegorized. Color makes it easier to assemble codes that belong to same gathegory.
- All same color codes are categorized and final tabel is formulated. Firstly came the gathegories that had the most codes and last the ones that had the least. Also comments by the respondants were added that it would be possible to see who satated what.

In the disscussion the results from deskstudie and tabel from interviews were analysed and conclusions made. Answers were given to research questions.

RESULTS

Desk studie findings

Deskstudie gave an overview of the legislations in Estonia that direct the development of sewar systems. Waterlow is the basis for government regulation nr 99 legislation for rain and waste sewer systems and it defines the meaning of precipitation.

Water supply and sewer law states the rights and obligations for the clients and municipalities. According to this law it is allowed to tax owners for using the sewer system (tax for the water service) and for water treatment.

Municipalities have has to plan how to provide drinking water, plan sewer systems, spatial planning etc. Municipality is the first step which actually has to plan and organize all the waste and repair sewer systems, water treatment and taxing property owners for that.

Government regulation act nr 99 goal is to regulate how waste water is treated, also how rain water is transported (by sewer system) to the receiving waters Estonian laws regulate really well the waht can and cannot be tone. The levels of pollutants in the runoff water is specified. There is no info about any legislations that can be connected to sustainable drainage systems.

The state and city strategy documents state all that it is nesseccary to monitor human activity and to keep in mind environmentally safe and sustainable principles. In specific Estonain environmental strategy sets goals to achieve good condition of surface and groundwater and preserve those water bodies that already have good condition.

If to compare the findings from different city strategy and sewar development plans then there are differences. Tallinn and Tartu strategys were the most evolved when it comes to sustainable drainage system principles. Only negative side was they brought in only few methods and it raised questions that why not all the main principles?

It turned out that Pärnu had the most problems with pollutants from different sources. Dealing with the rainwater problems in Pärnu falls into two groups, first runoff treatment and developing new areas with environmentally best solutions.

Põlva is a unique case where the runoff water is taxed by the property values (precipitation values). Põlva uses the tax to maintain and develop pipe system.

Interview

Semi-structured interview gave predicted results. The test group size was 9 people.

Subject number and occupations, names of the persons are nor revealled.

Subject 1 – Water company water network director

Subject 2 – Store complex development projec tleader

Subject 3 – Landscape architect

Subject 4 – City gouvernment insenier

Subject 5 – Landscape architect

Subject 6- Water company representative

Subject 7 – Landscape architect

Subject 8 - Landscape architect

Subject 9 - Water company representative

The result are given in the appendices under Addition 1. This is a collection of quotations of subjects that was analyzed as described in the mothods chapter.

From analysing the answers themes were developed. It was essentially answers that fall under same category. Themes are as follows

Theme 1: Pipe system is the first choise (6/9 subjects stated that)

Theme 2: Rain water conveyance and treatment should be taxed (6/9 subjects stated that)

Theme 3: Positive abut SUDS (5/9 subjects stated that)

Theme 4: There is no room to develope SUDS in densly populated areas (5/9 subjects stated that)

Theme 5: We should test SUDS (4/9 subjects stated that)

Theme 6: Economical calculations (4/9 subjects stated that)

Theme 7: Present enviromentally negative impact (3/9 subjects stated that)

Theme 8: Limitating SUDS factors due to cold climate (3/9 subjects stated that)

Theme 9: SUDS maintanence (3/9 subjects stated that)

Theme 10: Vanad tavad (2/9 subjects stated that)

Theme 11: Information that we do not know about SUDS (2/9 subjects stated that)

The Themes have ratings how many different subjects stated answers that fall under same theme. So based on that it is possible to see what are the most popular subjects and wat are the least.

The test group size gould have been bigger but the method used does not support many subjects because there is high amount of data to analyze.

DISCUSSION

When starting this thesis I had a different view of this subject and especially when it comes to Estonia. There was an assumption that there are no active sustainable drainage system idealogu to find in the legislations nor strategy or any other documents. I had heard of this subject only through architects and other specialist.

When looking through different legislations it turned out that the state laws interpet really well the situation with the sewage systems, how they work, what are the regulations, pollution levels etc. But there was no actual regulation about the subject in hand. Not to mix with known environmental point of views.

It seems taht main factor that is behind pollution in several municipalities is the sewer system itself. Years ago most of the sewer systems were combined systems with waste and runoff water running together. It brings many problems, mainly when it rains the water level can rise rapidly and overflow the system, resulting in pollution to the receiving waters. The rise water passes the treatment plant and will go directly to the environment.

Many municipalities in some parts face still the same problem and are maintaining and developing the systems to separate sewers. This is now the main goal for example Tallinn, Tartu and Pärnu (to many others as well). Municipalities are in different levels of success in that field. But it is written in all strategy documents as a high value goal. This is important to them also because the economical side. It is costly to maintain the old systems and in most parts pose even a threat, old sewer pipes can collapse. So it is goal for municipalities and for environment aswell.

There is another goal as well that falls into subject of sustainable drainage. Good example is Tartu where almost every new development (where geologially possible) it demanded that the new developments have new inflitration systems, meaning that all the percipitation will be infiltrated to the ground on the site. This is also something that subject in the interwiew pointed out. There are not much roome in the city to build bigger natural water treeatment systems then infiltration systems can be smaller and fit for example proivate housing sites.

One method from Tallinn strategy was green roofs. It is also one of sustainable ways to deal with the rain water. The main idea was explained well, what green roofs can do and

that they are good in holding rainwater like a sponge. For me this was unclear why only this method was brought in and so many other left out. To take the SUDS, it is a good ideology to bring out in the strategy documents and there are more ideologies to consider.

The interview results were in some ways anticipated but brought also new information. Firstly there was 11 theams that evolved from the interviews. The first and most mentiond one was negatice toned: Pipe system is the first choice. Under this it was menth that if there is a situaton wer desisions are made choosing how to solve rain water problem on the site then automatically pipe systems are in mind. Subject 5 (landscape architect) said that developers are always thinking right away to the simple pipe solution, it is easy to keep the water underground were we cannot see it. Other problems are the facts that pipe systems can be fit underneath narrow streets where on ground solutions would not fit.

Theme 2: Rain water conveyance and treatment should be taxed (6/9 subjects stated that). Taxing was a popular theme because it brought a lot of positive and negative responses.There are two ways of thinking, first it is good to tax because then there will be more money to maintain the sewer systems. But for Põlva example the tax system does not mean sustainable development. More money would be good for maintenance but there is a lot of people against it, including politician who do not want to bring new taxes on people. It is unclear and open for debate that how rainwater tax should be calculated.

It was unified feeling among the subjects that SUDS are good for environment and for aesthetic value of the city. And it was understood that SUDS are not only about pollution treatment but has a huge role in our ever changing climate, in preventing floods.

As the positive feelings also the issue of no room for alternative systems was among every subject. It does not come out from the Theme 4 because people did not make that much strong statements about that. It was mentioned that the alternative solutions should be small enough to fit the thighs city conditions. Cities should be dense.

In Theme 5 testing SUDS technologies is an important factor. It was mentioned most from architects that many customers need hard facts when it comes to suds, because our climate is gold and systems freezing up is a reality. It was proposed to make special tests to see what systems work in our climate and which do not. Also suggestions that combined systems can be the solution where the city core is covered by pipe system and on later stages where there is more roome the SUDS systems are applied. It is also good because when some part of SUDS fails then it happens away of the city on a safe ground.

Factor of old habits is also something to think about. It was mentioned several times that a lot of municipality workers are holding on from old safe habits and to not want to try new ways that include more rist or paperwork.

In overall what are the implementation factors of sustainable urban drainage systems in Estonia. I believe that information from the case study and the interviews can conclude that there are several factors. There are the old habits and old systems still at work that need some time to be maintained and worked on. There is the real problem of cold climate of ours that buts the systems to the test and it necessary to test and combine different systems and work out the ones that suit our climate the best. The deficit of room in our citys directs us also towards testing and maybe it is possible to produce boutineer typed SUDS that can be changed out in hours and replaced with new filter medias.

The one that in my mind is the most important and also came out from the analysis is knowledge. We need to edjucate the clients, architects, municipality workers and work to gather with specialists and inseniers. It was mentiond many times that ther is a cap in information. There has to be initative on the side of municipalyty with informative maps for architects and informative guids to people that they would start collecting rainwater again and using it to wash theyr cars and irrigate the garden

There would have been more participants in the interviewes to have more answers and ideas but I think the test group that was chosen in this work illustrated the main problems really well. With more people the order of the problems could have been different but the problems would have stayed the same.

CONCLUSION

This thesis gave an overview of the basic background information about sustainable drainage systems, where and how they are used. In the desk study Estonian legislations were looked at, together with strategy and development papers. Few cities were looked more closely.

Interviews were made with specialists who deal with the problems current sewers pose to us. From the interview analysis new information was developed about the possible implementation factors that prevent alternative sewer systems to be used.

The research question was answered and backed up to case study and interview findings. Suggestions were made how and what should be done to improve the situation. Theses opens new questions that can be answered on later studies.

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APPENDIXES

Addition 1: Primari and sub-theams formualted from semi structured interviews.

Theme 1: Pipe system is the first choise (6/9 subjects stated that)

- „Mõeldakse kohe, et paneme toru ja kõik maaalusesse kanalisatsiooni.“ Subject 5
- „Väga palju tahetakse sademevesi ajada torudesse.“ Subject 7
- „Küsimus ei ole selles, et kas sademevett peab puhastama vaid selles, et sademevett kogutakse kokku mööda torustikku ja selle hooldus on kulukas ning nõuab spetsiaalset eritehnikat. See on kallis.“ Subject 6
- „Kui palju tegelikult paberil lubatud hoolduskavadest kinni peetakse?“ Subject 3
- „Tõesti on lihtsam torustikku suunata ja asi korras. Subject 3
- „Linna sadeveetorustiku läbilaskevõime on piiratud“ Subject 2
- „Hirmsasti tahavad igasugust tõestust, et ikka töötab jne, samas torustiklahendus oleks ammu kooskõlastatud juba.“ Subject 3
- „Tallinna probleemsem koht on kesklinn, mis on olnud aastasadu ühisvoolne, maja on majas kinni ja raske on muuta seda.“ Subject 1
- „Tänavale pannakse kusagile suurema läbilaskega torud, et midagi kompneseerida.“ Subject 1
- „Vee-ettevõtte kohalt ei tee elu kergemaks kui kusagil on vahel mahutid, mis jooksevad liiva täis ja mida oleks vaja puhastada. Subject 1
- „kuna ei ole ruumi tiike teha linnatingimustes, siis pannakse suuremad torud ja juhitakse sadevesi ära“ Subject 1

Theme 2: Rain water conveyance and treatment should be taxed (6/9 subjects stated that)

- „Maksustamine annaks kohalikule omavalitsusele mingisugust täiendavat rahalist abi sademevee ja pinnavee ära juhtimise võrgustiku korrashoiuks.“ Subject 9

- „Kaldun arvama, et sademeevee maksustamine ei ole kõige parem vahend aitamaks kaasa uute säästlike lahenduste kasutusele võtmises.“ Subject 9
- „Probleem täna on ka küsimuses, mida ei ole kusagil käsitletud, et täna Eestis sademevee ärajuhtimine on 0 EUR kulutustega, sest polegi raha sadevee võrke arendada.“ Subject 1
- „sadevee arendussüsteteemide lahendus on kohalike omavalitsuste ülesanne, aga kui kohalikel omavalitsustel euroraha ei ole, siis tegelikult raha ei olegi.“ Subject 1
- „Sademevee maksustamine on poliitikutele ebamugav teema, aga see on tuleviku teema.“ Subject 1
- „Maksustamine meenutab praegu pigem karistamist.“ Subject 3
- „Maksustamine on võimalus raha korjata, milline on tulemlahendus?“ Subject 4
  „Strateegia on pigem olemas, aga puudub raha.“ Subject 1
- „Teinekord, kui ruumi on, ei pea arendaja seda majanduslikult mõttekaks: kui on valida, kas alale ehitada veel üks hoone või rajada selle asemel viibetiik, siis kipub ta eelistama esimest.“ Subject 8
- „asi võib jääda rahaliste vahendite puudumise taha, kuna eks SUDS rajamine ka kohati kallis - taimmaterjal jms.“ Subject 5
- „vihmavee süsteem lihtsalt natuke uudne süsteem meie jaoks või siis paljud lihtsalt polegi üldse nii selle peale mõelnud, et nii võiks teha ja teisalt tundub vb see isegi alguses kallim.“ Subject 5

Theme 3: Positive abut SUDS (5/9 subjects stated that)

- „Säästlike süsteeme on vaja ja mitte ainult sademevee reostatuse aspektist, vaid laiemas plaanis näiteks ka selleks, et sademeveest vähemalt osa maasse juhtida võimalikult selle tekkimiskoha läheduses“ Subject 8
- „Näen potentsiaali antud maa-alade kombineerimiseks puhkeala funktsiooniga“ Subject 8
- „sademeveest vähemalt osa maasse juhtida võimalikult selle tekkimiskoha läheduses“ Subject 8
- „On vaja mõelda veidikene suuremate immutus- puhastussüsteemidele“ Subject 7

- „Selle asemel, et torusid dimensioneerida ja suuri puhastusjaamu lõpu osasse planeerida, saaks tihtilugu palju lokaalsemalt sademeveesüsteem lahendatud.“ Subject 7
- „Säästlike sademeveesüsteemidega kogutakse vihmavett ja kasutatakse pärast WC“ Subject 1
- „Kindlasti on säästlike süsteeme vaja: kraavid, tiigid jne.“ Subject 1
- „Sademevee akumuleerumine peaks toimuma tekkekoha lähistel.“ Subject 1
- „Looduslikke voolumustreid matkivad lahendused toovad linna pigem ainult kasu.“ Subject 3
- „Viimaste aastate trend on lahkvoolsete süsteemide ehitus.“ Subject 1
- „ja probleem on see, et siiski odavam lahendus võidab... ja tihipeale on torudega odavam (juba planeerimise osas) - kusjuures tegelikult ei ole!“ Subject 3
- „Pärnusuguses linnas on kraavisüsteemide korrashoidmine ja uute kraavide rajamine ratsionaalse ja otstarbeka majandamise seisukohalt mõistlik tee.“ Subject 9

Theme 4: There is no room to develope SUDS in densly populated areas (5/9 subjects stated that)

- „Tallinnas eeldatakse, et iga kinnistu akumuleerib sademevee oma territooriumil, sest lihtsalt ei ole kuskil mujal maad selleks.“ Subject 1
- „kuna ei ole ruumi linnatingimustes tiike teha, siis paigaldatakse suuremad torud ja juhitakse vesi ära.“ Subject 1
- „kraavid ja tiigid vajavad ruumi aga ruumi pole“ Subject 2
- „Linnas maakasutus peab olema intensiivne, rohkem hooneid ja tänavaid.“ Subject 4
- „Kõik mis arendame allapool külmumispiiri, teeme sinna alla suure kasti killustikuga või moodulitega millest vesi ära imbub, siis see süsteem on täitsa vastuvõetav, pealpool on muru ja haljastus, kus saab mängida palli“ Subject 4
- „loodulikuks sademevee ärajuhtimiseks saab nimetada kraavitust – seda aga linnas ehitada keeruline. Subject 6

- „SUDS lahenduste ruumivajadus on traditsiooniliste sademeveelahenduste (nt sademevee kanalisatsioonitorustik) ruumivajadusest suurem. Leian, et see on tiheasustusaladel üks peamisi põhjusi, miks nende kasuks ei otsustata.“ Subject 8
- „Väljaspool linna on ruumi rohkem ja linnas on kahju SUDSi peale ruumi kasutada.“ Subject 4

Theme 5: We should test SUDS (4/9 subjects stated that)

- „Hirmsasti tahetakse igasugust tõestust, et ikka töötab jne, samas torustiklahendus oleks ammu kooskõlastatud.“ Subject 3
- „Maapealsete lahenduste puhul on märksa lihtsam visuaalselt hinnata süsteemi töökindlust.“ Subject 3
- „Igatahes peaks meil olema testala/näidisala, mis tõestab, et asi töötab ja kõik on hästi ja siis sellest lähtuvalt.“ Subject 3
- **“** kui see lahendus oli laual, siis oli probleem, et ei ole seda ennem katsetanud ja kui tihti peab ikkagi filtersüsteemi vahetama ja hooldama?“ Subject 7
- „Kui kusagil Saksamaal on midagi tehtud, siis see siin ei päde, sest meil on omad klimaatilised tingimused jne. Ilmselt sademeveesüsteemi kelleltki üks ühele üle ei saa alati võtta, selleks peab kohandatud variandi leidma.“ Subject 7
- „Lisaks teavitustööle on julgemalt vaja ette võtta katsetusi ja olemasolevate toimivate projektide kallal peavad omavalitsused ise andma julgust ja sisendit.“ Subject 7
- „kui on valida, kas alale ehitada veel üks hoone või rajada selle asemel viibetiik, siis kipub ta eelistama esimest. Põhjusteks on kindlasti ka heade eeskujude puudumine, teadmatus ning lihtsalt sissejuurdunud tavad. Subject 8
- Alati uuendusliku kasutusele võtmisega on risk. Võime ju valmis ehitada, see ei ole küsimus, aga just edasine, et kui töökindel üks või teine lahendus on ja kas tal ikka on selged eelised tavapärase restkaevu sademeveekanalisatsiooni toru ees.“ Subject 7
- „Saab SUDS elemente kasutada ka linnas sees, aga peab otsima millised sobivad linna.“ Subject 7
- „on palju nüanse, kuidas saab sadevett ära kasutada“ Subject 7

- „Kindlasti peab olema ka rohelist ala, aga kui me sunnime roheala kasutusele võtta märgpeenardega, siis kas see on alati õige?“ Subject 4

Theme 6: Economical calculations (4/9 subjects stated that)

- „Omavalitsused saaksid palju ära teha nõudes iga arenduse puhul ka säästlike lahenduste kaalumist ja põhjendust, miks on kasulik just siin torustik või maapealsed lahendused.“ Subject 3
- „Immutamise eest maksu ei saa korjata, aga seni ei ole sellele ka mõelnud.“ Subject 4
- „asi võib jääda rahaliste vahendite puudumise taha, kuna selle rajamine on kohati väga kallis - taimmaterjal jms“ Subject 5
- „Kaldun arvama, et sademevee maksustamine ei ole kõige parem tulemus aitamaks kaasa uute säästlike lahenduste kasutusele võtmises.“ Subject 9
- „Rajamine on kallis, sest takistuse põhjus võib olla isegi poliitiline“ Subject 5

Theme 7: Present enviromentally negative impact (3/9 subjects stated that)

- „Kinnistuomanikud ei ole motiveeritud sademevett tekkepõhiselt käitlema. Iga veenire, mis kinnistul on või tekib, tahetakse suunata linna tänavate äärsetesse/kinnistu esistesse kraavidesse.“ Subject 9
- „Täna vastavalt seiretulemustele ei ole meie ületanud meile esitatud piirnorme. See tähendab, et meie poolt kokku kogutud sademevett ei ole vaja puhastada“ Subject 6
- „tähendab, et meie poolt kokku kogutud sademevett ei ole vaja puhastada, seega meie puhul ei saa rääkida saastunud sademeveest.“ Subject 6
- „Täna on suhtumine küsimusse, kuhu sadevesi läheb, enamasti ükskõikne“ Subject 1
- „Ülemiste ristmiku veed lähevad läbi Kardioru pargi otse merre.“ Subject 1
- „Hetkel sadevesi juhitakse lihtsalt merre ilma puhastuseta.“ Subject 1

Theme 8: Limitating SUDS factors due to cold climate (3/9 subjects stated that)

- „Kraavid on lahendus, sest kui on külm ja pinnas on jäätunud siis vesi leiab ikka kraavi.“ Subject 1
- „Külmakartlikumad lahendused rakendatakse seal, kus ajutine üleujutus pole enam nii suureks mureks.“ Subject 1
- „Klimaatilised tingimused – pinnas külmub läbi ja süsteemid ei toimi enam.“ Subject 4
- „näen peamise probleemina looduslikke, sh ka klimaatilisi tingimusi“ Subject 4
- „Elementaarne külmumine, kui süsteem on mingis osas mingil perioodil külmunud, siis kas ta üldse toimibki.“ Subject 7

Theme 9: SUDS maintanence (3/9 subjects stated that)

- „Peamine probleemi allikas on seal, kus tuleb lahendada hooldamise küsimus.“ Subject 3
- „Kui kujunduses palju taimestust kasutada, siis see tõstabki hinda.“ Subject 3
- „Kui palju tegelikulkt paberil lubatud hoolduskavadest kinni peetakse? torusid peaks ka puhastama umbes 3 kuu tagant. Tegelikult läheb survepesu masin kohale alles üleujutuse korral. Nii on.“ Subject 7
- „Kärgede elementidest kogumismahuti, seda Tallinnas väga ei tehta, sest mahutit on väga raske hooldada.“ Subject 1
- „Hilisemat igaastast hooldust on raske korraldada ja hooldustööd käivad kompleksemalt suuremate vastavate teenuseosutajate kaudu ja see on lisatöö.“ Subject 7

Theme 10: Vanad tavad (2/9 subjects stated that)

- „Peamine probleem hetkel on, et omavalitsused ja enamik planeerijatest, projekteerijatest on vanades harjumustes kinni ja ei anna säästlikele lahendustele võimalust.“ Subject 3
- „Vanades harjumustes ollakse kinni harjumusest, laiskusest, teadmatusest ja hirmust, et mis saab siis, kui asi ei toimi jne.“ Subject 3
- „Omavalitsused ja arendajad on hetkel minu arvates kõige suuremate silmaklappidega.“ Subject 3
- „Vähene valmisoleks katsetusteks ja see on ka loogiline, et tellija tahaks selliseid äraproovitud kindlaid asju (et viimased 15 aastat on asju nii tehtud ja miks peaks teisiti tegema).“ Subject 7
- „Mida lihtsam on hange ja mida ühetaolisem eelnevaga, seda lihtsam on hanget ka koostada ametnikul.“ Subject 7

Theme 11: Information that we do not know about SUDS (2/9 subjects stated that)

- „Mingisugused ülevaatlikud linnakaardid peaks eskisteerima, millel on välja toodud linnaosade tingimused mida sadmeveesüsteeme arendades arvestada tegutseda.“ Subject 7
- „meil ei ole linnaaiandus nii levinud enam kui 20 a tagasi. Auto pesemine, aia kastmine ja nüanse, kus sadmeevett saaks ära kasutada“ Subject 7
- „kui tihti peab ikkagi pinnase filtersüsteemi vahetama ja hooldama?“ Subject 7
- „kui olen lahendusi pakkunud, siis olen mitmel korral ise SUDS alternatiivi välja pakkunud. Sellised vihmavee süsteemid on lihtsalt natuke uudsed meie jaoks“ Subject 5
- „Ausalt öeldes hetkel on 0 klienti olnud, kes ise ütleks, et ma soovin sellist lahendust“ Subject 5

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