MASTER THESIS

Public acceptance of greywater reuse in the Netherlands; barriers and motivations

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Summary

Over the last century, a lot of changes occurred in various environments: not only did society changed its lifestyle and do people have the tendency to live in urban surroundings, but also did the economic growth, population explosion, development in the industry sectors and climate change make water become a vulnerable resource these days. This study aims to provide information about the acceptance of greywater reuse in the Netherlands.

The aim of this study is: First, to assess the current situation of public acceptance of greywater in the Netherlands. To that end, the researcher researched five locations and compared public acceptance of greywater research in ecologically innovative neighborhoods and mainstream neighborhoods:

1) The ecological neighborhood Drielanden in Groningen

2) The ecological neighborhood in Sneek

3) An ordinary neighborhood in Zwolle

4) An ordinary neighborhood in Nijmegen

5) An ordinary neighborhood in Wapenveld.

Second, to identify the most influential factors with regard to public acceptance and also the core potential barriers which prevent the development of public acceptance. With the aim to recommend possible ways to overcome them. This research uses the survey in order to assess social acceptance and also conducts several interviews with experts in this fields.

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Acknowledgement

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1 Introduction

1.1 ***Background***

Water has always been essential for life on Earth. It has many functions for both the natural habitat and human activities (such as domestic use), as well as industrial and agricultural utilizations. Over the last century, a lot of changes have occurred in various environments: not only did society change its lifestyle and do people have the tendency to live in urban surroundings, but also did the economic growth, population growth, development in industry sectors and climate change make water become a vulnerable resource these days. The explosion of the Earth's population has an immediate impact on the availability of drinkable water resources. Moreover, climate change has changed the amount of precipitation and therefore caused droughts in several parts of the world, whereas floods appear elsewhere, both with an effect on ground water and surface water, i.e. on potable water resources. In addition, human activity is the main cause of water pollution by contaminating materials and by discharging wastewater in nature. The amount of wastewater has increased and it should be treated in order to protect public health as well as nature.

Wastewater is water that has been used and polluted and must be treated before it is released into the environment, so that it does not cause further pollution of water sources. Wastewater comes from a variety of sources: domestic, agricultural and industrial. In some cases it also contains rainwater and runoff, along with various pollutants. This study mainly focuses on domestic wastewater - originating from households. (Safe Drinking Water Foundation, 2016).

In the urban setting, since the end of the 19th century wastewater has been a known risk for public health due to the presence of pathogens. During the 20th century it became clear that wastewater also constituted a threat to the environment, partly because discharge of effluent leads to oxygen depletion of surface water (Sustainable wastewater treatment, an overview of Grontmij project references). For these reasons the wastewater chain was developed consisting of collection, treatment and sanitary disposal elements. Under this robust system wastewater is being collected and transported from urban areas to a central wastewater treatment plant after which the treated effluent meeting strict standards can be discharged back to the environment. In regions with acute water scarcity, reuse of effluent instead of discharging it to the environment, was developed to supplement the scarce potable water sources. Wastewater can be used, for example, for irrigation and industrial utilizations and hence reduce the pressure on the drinkable water resources. Effluent reuse can be mainly found in arid and semi-arid regions. Examples of arid regions are Sahara Desert, the Namib Desert and the Kalahari Desert; the Arabian Desert, The Desert in South Asia; deserts of the United States and Mexico, and deserts of Australia. Semi-arid regions for example, are Israel, Turkey and California, but also water scarce regions such as island states with extreme urban settings like Japan and Singapore. More recently, however, the possibility to reuse wastewater is gaining interest in regions which are not considered water scarce. This new trend is in line with the shift to a more circular resource use. As such, instead of considering wastewater as waste, it is now more and more seen as a raw material carrier. Via this method, wastewater is recognized as a source of water to be used in sectors except for drinking water.

The domestic wastewater can be divided into a black and a grey category. Greywater is the wastewater that is generated from household purposes, such as cleaning and washing clothes, while blackwater contains feces and urine and other bodily wastes and therefore carries bacteria. Due to this, greywater can more easily be recycled as it does not contain that much bacteria compared to blackwater. Greywater and blackwater are treated differently. Recycled greywater tends to turn into blackwater after use, as it can be used to flush toilets (Resource centres on urban agriculture & food security, 2016).

1.2 ***Current situation of wastewater reuse in Netherlands***

The Netherlands is water rich country covering an area of 41,543 km2, of which 18% is water. It has a 640 cubic meters per capita per year water withdrawal, which is very much compared to e.g. Israel with 176 cubic meters water usage per capita (The statistics Portal, 2016). Moreover, the average of daily water usage per person is about 200 liters in the Netherlands and it can be compared with Spain where 137 liters are being used (Human Development Report, 2006) (Spanish News Today, 2014).

Nonetheless, even the Netherlands has observed signs of periodic and spatial water scarcity during the last decade. As mentioned above this problem has various reasons such as climate change, economic growth etc. The resources for water management have not increased to the same extent as the increased problem pressure. So the tendency of wastewater reuse is increasing in some regions in the Netherlands and the Dutch have an experience in reusing of water for irrigation, firefighting, etc. But the amount of wastewater recycling and reuse in the Netherlands is still small (Updated Report on Wastewater Reuse in the European Union, 2013).

Though the Netherlands is still a water-rich country with little experience in dealing with water scarcity, a more extended wastewater reuse may become more relevant in the near future. The Dutch government, in line with EU policy and other global trends, had placed a priority on shifting to a circular economy approach (Kuiper, 2015). As such, shifting to a more sustainable water use as part of this overall shift to a circular resources management can be expected.

Because greywater reuse is more easily attained, this study focuses on greywater reuse in the Netherlands. If greywater reuse is to be implemented in the Netherlands, there is a need to assess its applicability. Since the public plays a great role in the acceptance of wastewater reuse (greywater), this study focuses on the applicability from public perception and acceptance perspective. Because as a water rich country there is not much evidence about drought or water scarcity, it is expected that the public has no urgent needs to shift to wastewater reuse (greywater), therefore, assessing current trends of public acceptance, influential factors, barriers and ways to overcome them, may assist in raising awareness and promoting public acceptance if and when wide-spread greywater reuse becomes relevant. For these reasons, this research tries to determine the influence of awareness about wastewater reuse on the public acceptance. So the research is based on the comparison between ecologically aware (eco-aware) people with ordinary people.

1.3 ***Problem statement***

The Netherlands is a water-rich country with traditionally little need for and experience with wastewater reuse. Nonetheless, due to population and economic growth combined with climate change, regional and periodical water scarcity can already be seen in this country as well. In addition, there is a growing recognition for the need to shift to a circular use of resources in support of sustainable management of the natural resources. Along these lines, reuse of greywater in the domestic sector may be relevant. However, this would require public acceptance for the use of this technological concept if and when the decision to apply it, will be made. Since the general public in this water-rich country may not yet be aware and is not experienced, there is a need to assess its levels of acceptance.

1.4 ***Research objectives***

The overall objective of this research is to assess the possibility of introducing greywater reuse in urban areas in the Dutch context based on public acceptance. More specially, the researcher aims to assess:

- the public acceptance,
- factors which influence public acceptance and
- potential barriers for greywater reuse from public acceptance perspective, and suggest ways to overcome them.

Moreover, due to the fact that the Netherlands is a water-rich country, the necessity of greywater reuse and experience in this subject is not high and popular here. So, the hypothesis is that eco-aware people would be more familiar with and willing to accept greywater reuse in comparison to the ordinary people. The sub objectives are:

- To study and find the support from the public greywater reuse in some urban sectors such as gardening, toilet flushing and bath (outdoor bath or swimming pool).

- To understand the factors which are affecting public acceptance and determine the most important of them. These factors will then be used as hypotheses.

- To determine the current barriers in public acceptance and suggest possible ways to overcome them.

1.5 ***Research Questions***

The general research question is:

> What is the level of public acceptance in the Netherlands for the use of greywater and how can barriers to that acceptance be overcome?

Based on the background, problem statement, and research objectives, the research questions in this study are as follows:

1. What is the current experience with greywater reuse in the Netherlands?

2. What is the situation with regard to public acceptance of greywater reuse for different purposes in the studied locations and how can it be explained? Which factors have an impact on public acceptance?

3. What are the barriers for public acceptance and how can they be overcome?

1.6 ***Research Boundaries***

Based on research questions and research objectives, the research is focused on the greywater reuse in the Netherlands, especially in urban areas. But in this study, the researcher concentrates on the communal system, not on the household level. Also, this study tries to define the factors which have an impact on public acceptance of greywater reuse in social level. Furthermore, the research can address some issues in the financial area (tariffs) and new regulations only in the public acceptance perspective.

2 Literature Review

In this chapter, the researcher describes the domain of wastewater and the sources of this. Also, definitions of the concept greywater in different literatures and characteristics of greywater are inventoried. Moreover, this study will elaborate experiences with greywater reuse practices around the world. It also elaborates on literature with regard to factors that influence acceptance.

2.1 ***Wastewater***

In literature, wastewater has several definitions in different sources. Wastewater is generally defined as a combination of:

- domestic effluents,
- water from commercial establishments and institutions,
- industrial effluent and
- agricultural effluent in various mixes

(Corcoran et al, 2010).

The constituents in wastewater can be divided in 8 main categories, but the contribution of constituents can vary strongly. As a source of greywater, is very important to have general information about wastewater. Table 2-1 shows the constituents generally present in domestic wastewater.

Wastewater constituents	
Microorganisms	Pathogenic bacteria, virus and worms eggs
Biodegradable organic materials	Oxygen depletion in rivers and lakes
Other organic materials	Detergents, fat, oil, solvents and phenols
Nutrient	Nitrogen, phosphorous, ammonium
Metals	Hg, Pb, Cd, Cr, Cu, Ni
Other inorganic materials	Acids, for example hydrogen sulphide
Thermal effects	Hot water
Odor and taste	Hydrogen sulphide

Table 2-1: Wastewater constituents

Nowadays, sustainable wastewater management and stormwater management have the attention from researchers and policy makers because via sustainable wastewater management, the amount of wastewater that needs treatment can be reduced. The larger part of wastewater, especially in municipal wastewater, is water. Thus, the water can return to the environment after treatment and reuse in non-drinkable sectors. It has an effect on potable water resources and reduces the pressure on it. Also nutrients in agricultural wastewater are reused and the dependency of chemical fertilizer will be reduced. Furthermore, there is

much less discharge of nutrients to the rivers. Also, industrial wastewater will be treated separately and not be mixed with domestic wastewater. In Figure 1 this concept is shown (United Nations Environment Programme).

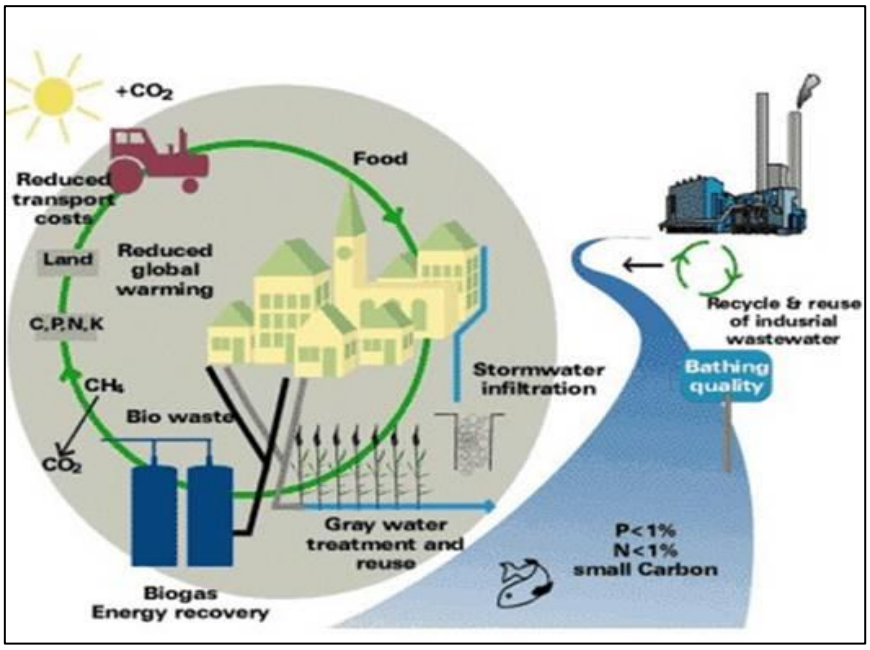


Figure 1: Sustainable wastewater management practice

In the next step, the meaning of sanitation in wastewater should become clear because it is an important concept; also it is a part of sustainable wastewater management. To determine the definition of sanitation, it should be determined what aspects are the most important. Sanitation is a big issue and many professionals get confused with this, but most of them would agree that sanitation can cover these aspects:

- Safe collection, storage, treatment and disposal/reuse/recycling human excreta
- Management/reuse/recycling of solid waste
- Drainage and disposal/reuse/recycling of household wastewater
- Drainage of storm water
- Treatment and disposal/reuse/recycling of sewage effluents
- Collection and management of industrial waste
- Management of hazardous waste(including hospital waste, chemical and other dangerous materials)
  (The United Nations Inter-Agency, 2016)

Urban wastewater is domestic wastewater from residential settlements or a mix of domestic with industrial wastewater (from premises used for trade or industry) and/or run-off rain water. Domestic wastewater contains different types of wastewater, which are produced in households (Mara, 2004).

Figure 2 shows an overview of the types of wastewater.

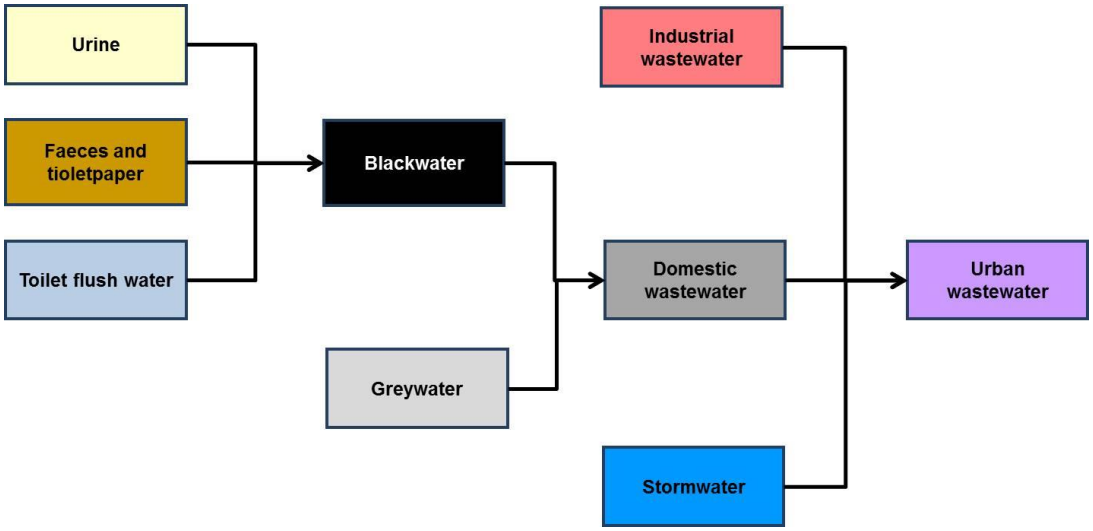


Figure 2: Overview of the types of wastewater

Blackwater: water coming from flushed toilets which consists of fecal matter, urine, toilet paper and flush water.

Greywater: water coming from personal hygiene, kitchen and laundry. The amount of greywater is generally much bigger than the amount of black water (United Nations Environment programme; Overview of greywater management Health considerations, 2006).

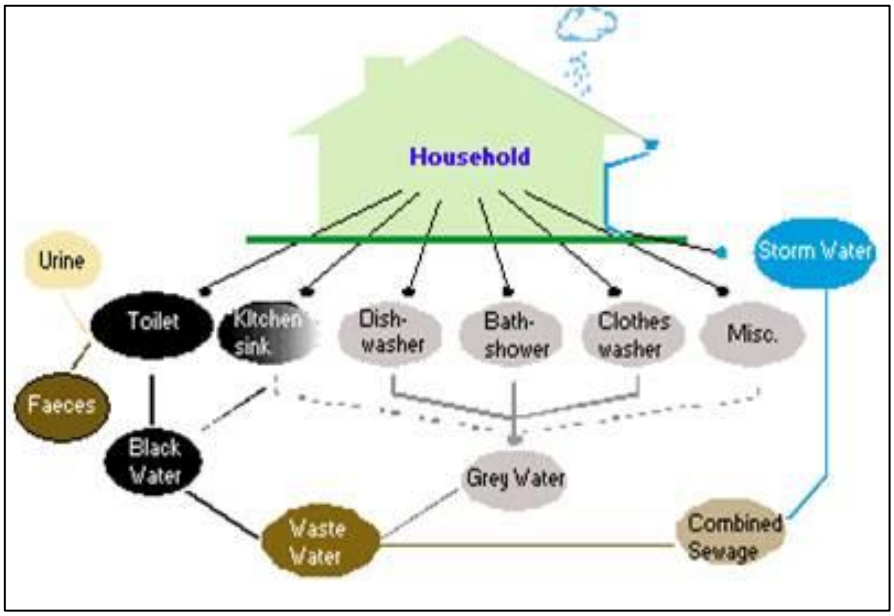


Figure 3: A range of possible sources of household wastewater

2.2 ***Greywater***

2.2.1 Definition

Contextualizing the definition of greywater given above, we now will elaborate several definitions of greywater in the literature with the main difference being including/excluding kitchen

wastewater. Table 2-2 gives an overview of definitions of greywater used in several literature sources. These various definitions are presented here, because decisions to leave kitchen wastewater out of the equation might influence the public acceptance, if the benefits would be too small compared to the costs in that case.

Definitions	Kitchen included	References
Wastewater from baths, showers, hand basins, washing machines and dishwashers, laundries and kitchen sinks.	Yes	(Ledin et al., 2001a)
Wastewater without any input from toilets, which means it corresponds to wastewater produced in bathtubs, showers, hand basins, laundry machines and kitchen sinks, in households, office buildings, schools…	Yes	(Eriksson et al., 2002)
Wastewater excepting toilet wastes and food wastes derived from garbage grinders.	Partially	(Greywater.com, 2004)
Wastewater from washing machines, washing bowls, showers, bath tubes, cleaning containing mainly detergents	No	(Wilderer, 2003)
Grey water arises from domestic washing operations. Sources include waste from hand basins, kitchen sinks and washing machines, but specifically exclude black water from toilets, bidets and urinals.	Yes	(Jefferson et al., 2001)
Greywater is defined as all wastewater from non-toilet plumbing fixtures around the home. The use of kitchen greywater is not recommended as a greywater source.	No	(Christova Boal et al,. 1996)
Greywater is defined as all wastewaters generated in the household, excluding toilet wastes. It can come from the sinks, showers, tubs, or washing machine of a home.	Yes	(Casanova et al,. 2001)

Table 2-2: Definitions of greywater in literature

2.2.2 Characteristics of greywater

The characteristics of grey wastewater depend on the quality of water supplied, the type of distribution net for drinking water (leaching from piping, chemical and biological processes in the biofilm on the piping walls) and grey wastewater from the activities in the households. The compounds in the greywater are various and differ from source to source. It depends on lifestyle, customs, installation, geographical location and chemical products that households use (Eriksson et al., 2002). During the transport and storage of water, the chemical and biological degradation of chemical compounds occurs. So the chemical reaction can change the chemical composition of water during the storage and transportation of greywater. Biological growth can cause the enlargement in the amount of microorganisms like fecal coliforms. Furthermore, it may also cause new organic and inorganic compounds in the greywater.

Greywater can be divided into the three groups according to the source. Table 2-3 points to the general characteristics of three main greywater sources.

Source	Characteristics
Laundry	Microbiological: variable thermotolerant coliform loads Chemical: sodium, phosphate, boron, surfactants, ammonia and nitrogen from soap powders and soiled clothes Physical: high in suspended solids, lint and turbidity Biological: high in biochemical oxygen demand (BOD)
Bathroom	Microbiological: lower levels of thermotolerant coliforms Chemical: soap, shampoo, hair dyes, toothpaste and cleaning chemicals Physical: high in suspended solids, hair, and turbidity Biological: lower levels of concentrations of biochemical oxygen demand
Kitchen	Microbiological: variable thermotolerant coliform loads Chemical: detergents, cleaning agents Physical: food particles, oils, fats, grease, turbidity Biological: high in biochemical oxygen demand

Table 2-3: Characteristics of untreated greywater from each source

Moreover, greywater can be divided into two categories according to the source and pollution load: Light greywater and dark greywater. Greywater from the bathroom and washbasin, is including showers and tubs, is light greywater (Friedler and Hadari, 2006). Greywater which includes more contaminated materials from laundry facilities, dishwashers and some waste from kitchen sinks is called dark greywater (Birks and Hills, 2007).

The main pollutants in greywater are powdered laundry detergents which contain high salt concentration and phosphorus. In chemical parameters, greywater contains lower concentrations of organic matter, some nutrients and microorganisms than blackwater. But the amount of phosphorus, heavy metals and organic pollutant are the same levels. The acidity (pH) of greywater from laundry source is 9.3-10, from bathroom 5-8.1 and from kitchen sink 6.3-7.4 (Ledin et al., 2001a). Furthermore, there are nutrients in greywater such as ammonia (NH_3-N), nitrate as N, nitrate (NO3-N) and phosphorus as PO4 (Ledin et al., 2001a). In physical parameters, temperature, color, turbidity and content of suspended solids are important. (Eriksson et al., 2002). This is the least level of understanding constituents of greywater, which may be taken into account by the public, once they are asked to accept greywater reuse.

The reuse of greywater is easier and affordable due to some difference between greywater and blackwater, but the great difference between greywater and blackwater is observed in the rate of decay of the pollutants in both of them. Greywater decomposes much faster than blackwater. Due to the decomposition rate, discharged greywater can impact immediately on water resources, much faster than blackwater. Moreover, greywater can decompose in the soil faster after infiltration because of the same reason. Transfer to drinking water sources or combination with other wastewaters or blackwater discharge must at all times be prevented. Another big distinction is in the amount of nitrogen. Greywater contains only one-tenth of the nitrogen contained in blackwater (Greywater.com, 2004).

Therefore, whole ranges of applications exist around the world for greywater reuse. Greywater can be used for car washing, toilet flushing, irrigation of lawns (parks, domestic gardens, golf courses and athletic fields), fire protection, boiler feed water, develop and conserve wetlands and agriculture (Imhof and Mühlemann,2005).

Reusing greywater can provide more benefits. Thus it leads to a huge reduction on a household's water bill, it reduces the demands on public (potable) water supply, and therefore,

drinkable water resources are spared. The amount of water and thus also wastewater discharged into nature decreases, because no potable water is used directly for gardening, car-washing and toilet flushing, until after it has been used again and is regarded greywater. The characteristics of greywater vary across all regions in the world and it depends on factors that change from one county to the other (Imhof and Mὺhlemann, 2005).

2.3 ***Greywater reuse experience in other countries***

Greywater can be reused for different purposes and in different scales and applications. Non-potable water usages of greywater for non-domestic purposes include for example re-use in parks, industries, golf courses, as well as indoor usage, e.g. for toilet flushing.

Several countries around the world have experience in greywater reuse and they utilize the recycled water in many fields such as irrigation, gardening and etc. The countries which have most experience are Australia, Japan, United States, Cyprus and Jordan (Greywater Reuse in Other Countries and its Applicability to Jordan, 2003). But due to the perspective of this study, greywater reuse in urban areas is the main focus in this section.

In USA, many studies and assessments have been done and reported. Several states have improved the regulations and legislations to permit greywater reuse in different fields. California was the pioneer state that investigated this subject and started reusing greywater in several circumstances. For the first time in the 19th century, greywater was being used in Santa Barbara (Jeppesen & Solley, 1994). Greywater reuse in Los Angeles was started in the 1980s for the first time. A Code to regulate the reuse of domestic greywater was issued in 1977. Ten other states followed California and started between 1989 to 1992 reusing greywater. Twenty-two states of America allowed the direct reuse of untreated domestic greywater for sub-surface watering in 1998 (Emmerson 1998). There are different greywater reuse systems across the United States now and they operate in several fields such as indoor planter beds, vegetable gardens, landscape features, and greenhouse gardens (Lindstrom 2000).

In Australia, there are greywater regulations and policies in the majority of its states and territories. There are still some problems despite the regulations and permits about greywater reuse, because they vary from state to state in Australia. For instance, in Australia's capital, Canberra, no permit is required for the installation of a greywater reuse system in single family residences, but for commercial and multi-family complexes one is required to submit an application of approval. In Queensland, West, and South Australia people need permits and ratifications before installing greywater reuse devices (Research of Greywater for Use in Residential Applications, 2010).

Due to the shortage of potable water resources in Japan, the Japanese utilize the wastewater reuse (greywater) for toilet flushing, landscape watering and ornamental ponds. The government of Japan approved only quality guidelines for water reuse and the owners of buildings have a responsibility for onsite water reuse. The greywater reuse system for toilet and hand basin is common in Japan and huge amounts of this system have reportedly been installed in most new houses in Japan (Jeppesen & Solley 1994; Emmerson, 1998).

Cyprus is a water scarce country with the highest water stress index in Europe (Hochstrat, R. & Kazner, K, 2009; see also Figure 4). In 1997, the government of Cyprus started the

greywater reuse programme. The first project involved a hotel, a stadium and 5 houses. Cyprus has about 1.1 million people, but it has 2.5 million tourists every year.

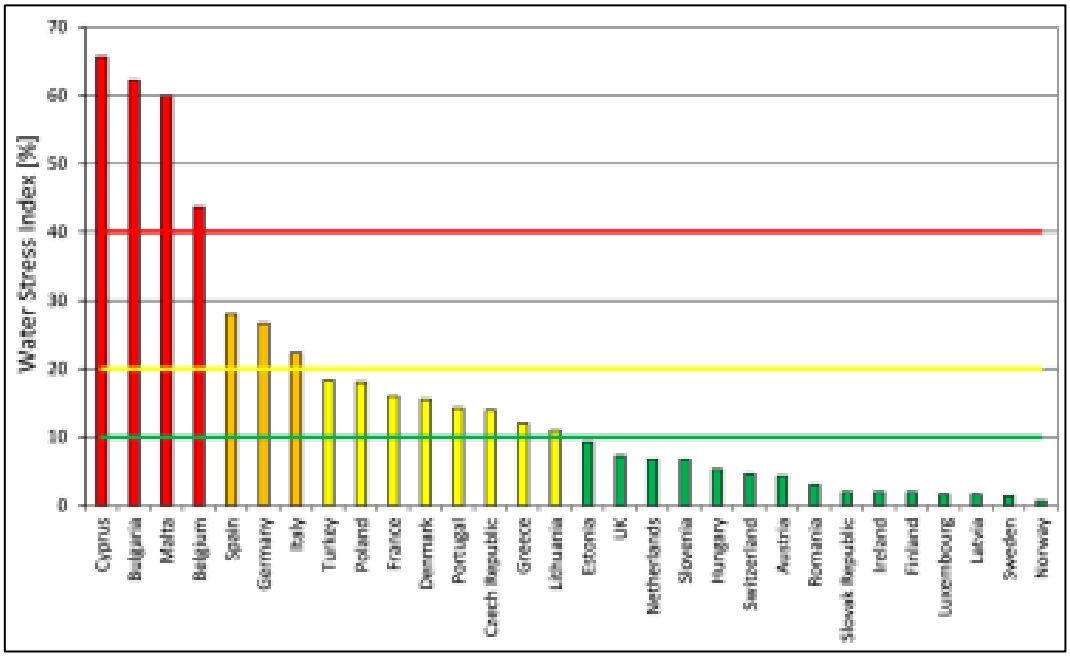


Figure 4: Water stress index for European countries

The water resources in Cyprus are completely developed and the greywater reuse was changed as part of an initiative to save water at household level (greywater reuse study report, 2004).

Singapore is a small, wealthy island that depends heavily on its neighboring countries for their natural resources including water. It imports half of the country's water demand from Malaysia (Seah, 2002). The water-dependency of Singapore was always a sensitive issue for people of Singapore, the government started to seek alternatives for water supply (Kyodo News International, 2003). The recycled water program was generally called NEWater in Singapore. This project proved that reuse of wastewater is cheaper than other choices like desalination of water. Because of possible resistance to using water from NEWater in the public, the government decided to mix the recycled water with reservoir water (Agence France Presse, 2003). The government started to support study for 2 years by a panel of international experts which concluded that the quality of NEWater was well within standards specified by the World Health Organization and the US Environmental Protection Agency (PUB, 2002).

Despite all the efforts taken by the countries mentioned above, there are no obvious wastewater standards that every country or organization adheres to with regard to greywater. The main reason is that circumstances around the world are different and demands from governments vary strongly. This is illustrated below.

Greywater reuse is being increasingly practiced around the world. So, the technical means of providing safe ways to reuse greywater, and the issues associated with health and environment have been examined in detail by a number of authorities, international and national organizations. They try to improve the guidelines and regulations in the water reuse sector in order to minimize the health and environmental risks of reusing it as a source of water.

Some international and national organizations have improved the regulations and guidelines for water reuse such as WHO, FAO, ISO etc. These standards provide some form of a management framework in order to utilize water reuse systems in sustainable ways (Sanaz, L.A., Gawlik, B.M., 2014). Table 2-4 provides information about international organizations which have developed water reuse regulations.

Organization	**Guidelines**
World Health Organization (WHO)	Organization (WHO) "Guidelines for the safe use of wastewater, excreta and greywater" (2006)
United Nations Environment Programme (UNEP)	(UNEP) "Guidelines for municipal wastewater reuse in the Mediterranean region" (2005) "Development of performance indicators for the operation and maintenance of wastewater treatment plants and wastewater reuse" (2011)
United Nations Water Decade Programme on Capacity Development (UNW-DPC)	Proceedings on the UN-water project "Safe use of wastewater in agriculture" (2013
International Organization for Standardization (ISO)	ISO/TC282 Water reuse (under development
Food and Agriculture Organization (FAO)	"Water quality for agriculture" (1994)

Table 2-4: Water reuse guidelines

The guidelines give information on difference aspects of water reuse practices. There are no guidelines or regulations at the European Union level for all EU members. Although there is a lack of water reuse regulation at the EU level, some members have produced their own frameworks, regulations and guidelines for water reuse applications same as Cyprus, France, Greece, Italy, Portugal and Spain. Also, because of the same reason, several environmental directives struggle to make water reuse legislation at the level of EU for the future. For example, The Water Framework Directive establishes a legal framework to guarantee sufficient quantities of good quality water across Europe for the different water uses and environmental quality (Sanaz, L.A., Gawlik, B.M., 2014).

The new regulation should be provided based on health and environmental protection; also it should consider treatments and economical water quality monitoring. The social aspects of water reuse must be considered in order to be able improve this project. Without social support, water reuse projects will fail, even for non-drinking reuse projects. In every country, the level of public awareness and understanding of the safety and applicability of water reuse play a great role in the success of any water reuse programme.

2.4 ***Social acceptance of greywater reuse***

Positive public acceptance of water reuse is a key factor for successful introduction and implementation of wastewater reuse projects nowadays (Dolnicar and Hurlimann, 2011). Social

acceptance covers three dimensions generally; social-political acceptance, market acceptance and community acceptance (Wustenhagen, et al.2007). Figure 5 illustrates the elements of every dimension. Community acceptance identifies distribution and procedural justice. Market acceptance determines the customers and investors in the greywater reuse projects. Social-political acceptance points to the policy makers, stakeholders and public. The social-political acceptance is the most relevant aspect of social acceptance in this study, despite the importance of the two other aspects of social acceptance. But because of limitations in the time and domain, this study cannot cover all of aspects and the researcher will focus only on social-political acceptance during the research.

In social-political acceptance, there are three actors: policy makers, stakeholders and the public. The research focus is on the public in order to determine some factors which have an influence on social acceptance to recycled water (greywater). For this target, the researcher would be operating the survey in some neighborhoods in the Netherlands in order to gain data. This can help to understand and find relevant information on this issue. Moreover, the researcher will not measure the level of knowledge (awareness) in the studied locations. This study concentrates mainly on the public acceptance.

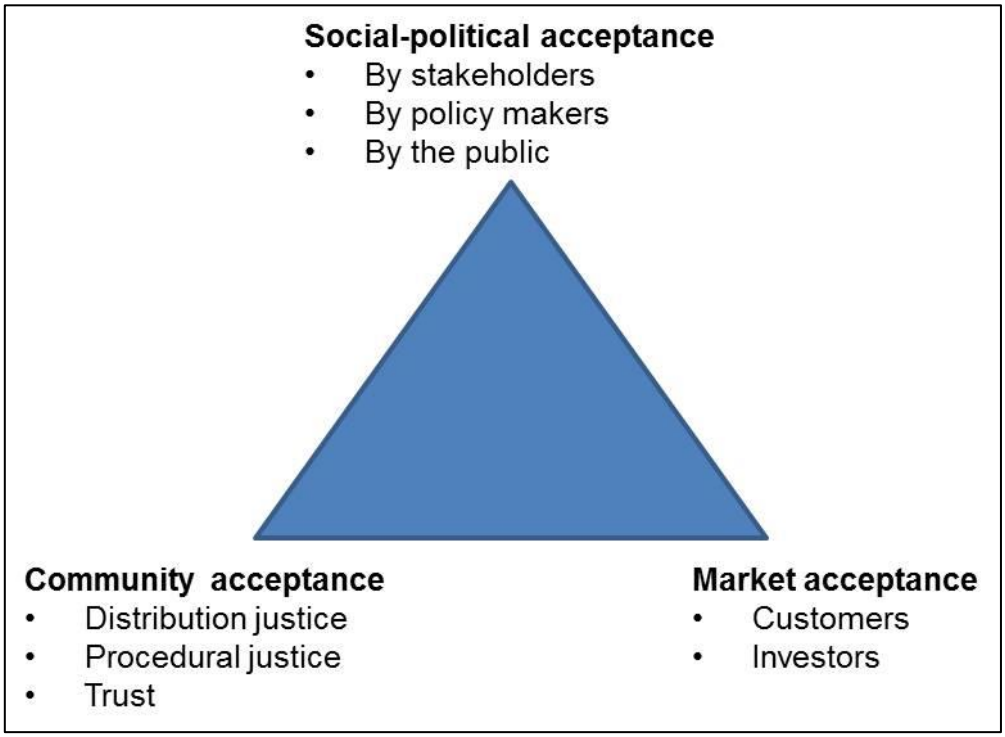


Figure 5: The triangle of social acceptance of greywater reuse

The following provides a summary of different factors mentioned in the literature that may influence the general public acceptance related to a communal reuse scheme. According to (Dolincar et al., 2010), there are many factors that can impact attitudes to recycled water around the world in two categories. Firstly, in the attitude and experience part like trust in authorities associated with recycled water, it is about knowledge/information, past experience with alternative water resource, perception of good water quality and health concerns (negative). The other category is a socio-demographic variable that involves age (old/young), gender (male/female), education level, etc. Furthermore, other factors have been observed in literature according to (Po et al, 2003), like the source of water to be recycled, trust and knowledge issues, attitudes toward the environment, the cost of recycled wa-

ter and the specific uses of recycled water. The specific environmental and social/cultural realities of countries or regions should be taken into account, when any water reuse programme wants to begin (Hartley, 2003). These factors can be changed during the implementation. The common factors that are always used in several researches around the world in the last two decades and are also adequate for public acceptance in the Netherlands are as follows:

1- *Trust in authorities associated with recycled water:* Trust in the authorities could play a crucial role in determining public acceptance of water reuse (greywater). Trust could be the main reason that people with different intentions have an interest to use recycled water (Kaercher et al., 2003). In many research projects, trust in the water authorities has been identified as a main indicator that can persuade people to trust the quality of water (Syme and Williams, 1993). According to (Sydney Water, 1999) researchers and scientists who work in the universities are trusted by the community to create awareness about recycled water. Although, public always puts trust in authorities and certain organizations to monitor and set the quality of recycled water, but (Jeffery and Jefferson, 2002) pointed out that many people stay reluctant to reuse this water. They always make a decision about water quality according to turbidity and the content of suspended solids. Trust can be defined in a specific or general sense. But in the limitations of knowledge, trust could have an unknown effect.

2- *Available water resources*: The reuse of water has rapidly become a pressuring issue. The success of water reuse applications depends on public acceptance and of course the public acceptance has a link to the water availability (Sene Alka and Buyukkamaci, 2013). For instance, it is estimated that water availability will fall in Turkey below 1000 m^3 per capita by 2015 (WHO, 2007). Thus, the efficient water management program should be implemented and the treated wastewater (greywater) has to be reused as an alternative water source for future demand. This approach can create a strong trust among the public and it is obvious that the social acceptance is obtained more easily when there is a water scarcity and a need to save high quality water for domestic usage (Crook et al, 1992; Fawell et al, 2005).

3- *Information provided to the public:* In many wastewater reuse projects, the power of the public for the implementation process should be taken into account (WHO, 2006). It is so important to create trust and that begins through contact with potential users. Then an advisory committee can hold public workshops in the society and introduce the reasons, benefits, etc. Through such meetings, the information between authorities and public representatives can be exchanged to improve the knowledge about greywater. It is very important to raise awareness for water use and also for wastewater reuse (greywater) by public information. Awareness-raising and educational campaigns may be performed through different channels: flyers sent to households, phone calls, signs in public bathrooms, web-based communication; through initial or occupational education, or public campaigns; to different types of public, with differing interests and motivations. For instance, Jordanian authorities have succeeded in order to inform and convince the population about the importance of wastewater use in agriculture, via implementing an active educational campaign with strong community development (EMWATER 2004). They have a programme in Jordan in order to be successful which include; distribution of newsletters, guidebooks,

coverage of water issues in newspapers and on television and radio, websites, public educational places. Moreover, the educational materials were published in schools, universities and libraries (Al-Momani, 2011). Katz & Tennyson, (1997) stated that public information is the key to the successful implementation of a water reuse program.

4- *The sources of water to be recycled:* researchers found the impact of greywater resources on the public acceptance (Jeffrey, 2002; Kaercher et al., 2003). It is found that the reuse of greywater which originates from one's own household is more acceptable than water collected from communal sources and that the reuse of greywater which originates from the own neighborhood is more acceptable than water from the municipal wastewater treatment plant (Jeffry, 2002). In contrast to this finding, Kaercher et al., (2003) discovered a tendency to shift toward a more public source of recycled water and also they preferred to use greywater from the neighborhood rather than from the own household. People also tended using treated wastewater from whole city rather than from their own neighborhood. They believe that they could not manage and monitor an on-site greywater treatment system. Also, they have similar concerns about neighborhood wastewater treatment plants. People predicted the risks of failure in operation; therefore, the quality of water might be compromised. So, they had a tendency to join in the wide-city wastewater treatment plant. Reusing greywater was more acceptable than treated wastewater. In addition, Nancarrow et al. studies (2002, 2003) found aquifer recharge of recycled water to be less acceptable than using greywater for home gardens and wastewater for parks and gardens.

5- *Cost of potable and recycled water:* Cost is an important factor for public acceptance of greywater reuse because people always think that they should pay less for using recycled water due to the lower quality. According to (Marks et al., 2002a) the majority of people who were living in a house with dual system, expected to pay less money for this type of water because of limitations of using the sort of water and water quality. Some owners believe that the lower price of recycled water is essential to increase the public acceptance and for more investments in this sector. But there are two different reports about public hesitation to reutilizing recycled water. First, the study that has been done by two newspapers in Singapore, determined that the majority of participations preferred to pay more money for importing water rather than dinking recycled water (Seah, 2002). But another study which was done by Forbes research identified the adequate level of NEWater acceptance between Singaporean (Kyodo News International, 2003).

6- *Socio-demographic factors:* Demographic factors have been determined as important in public perception of water reuse. In 2003, McKay and Hurlimann did a research assuming the greatest opposition to water reuse could come from people aged 50 years and over, therefore, they suggested information campaigns and education in order to improve the public acceptance in this specific age group. In contrast with this research, (Jeffery, 2002) discovered no substantial variation in the public acceptance and support of greywater reuse according to gender and age. Furthermore, in an early study in Australia in 1991 by Hamilton and Greenfield, they identified that a person with a higher education and a male, was more interested to accept water reuse.

Wandel and Bugge (1997) showed that people in the highest education group were more likely to give priority to environmental matters and they also understood that women are more likely to prioritize environmental aspects in their quality evaluation of food. These inconsistent findings may show that socio-demographic factors could not describe the individual difference in the perceptions and acceptance of water re-use (greywater reuse) separately.

In chapter 5, the researcher aims to elaborate and evaluate these factors through some hypotheses in order to assess which of these factors are most important and have the most influence on the public acceptance of greywater reuse. In part 4 of the survey that is held in the five studied locations, the researcher utilizes these hypotheses in order to make a link between them and the factors mentioned above.

It is obvious that these factors have strong links to each other and development on one of them can influence the other. For instance, trust in authorities as a factor has links to public information and improvement of the level of awareness can increase the trust, and also, the cost of potable and recycled water and available water sources are two other factors which have close links to each other. In the end, all factors have an impact on each other as well as on the public acceptance.

These factors are used in this study to assess the factors that influence public acceptance as well as barriers and ways to overcome them.

3 Research Design and Methodology

3.1 ***Research design and methods***

Research design is the strategy to integrate the components of the research which will become the main focus in a coherent and logic manner (De Vaus, 2001). In other words, research design is applied as a strategy to answer research questions or to test research hypotheses (Pollit et al, 2001). This research will investigate the public acceptance of greywater reuse in different urban settings in the Netherlands. The research further addresses the potential barriers to public acceptance which may prevent the increase of support of greywater reuse. Furthermore, the research will determine the level of knowledge of the public on the subject of greywater reuse. The focus of this study is on the social acceptance. The main strategy in this study is a survey through a closed questionnaire for gathering data about public acceptance of greywater. This will be complemented by semi-structured interviews with specialists.

This research utilizes quantitative and qualitative methods combined in order to answer the research questions, but the main method in this study is quantitative. The social acceptance will be determined via quantitative method, especially in the part that is related to the closed questionnaire. However for analyzing the results of the interviews in the part of public acceptance, the qualitative method will be used.

3.2 ***Methods and Locations of survey***

According to the research objectives and strategy of research, the survey will be operated in five neighborhoods with different characteristics in various cities in The Netherlands. To obtain a clear perspective of social acceptance of greywater in the Netherlands, the survey should be run in multiple locations, five neighborhoods in this research. These locations are divided into two groups on purpose. In the first group there are two locations which separate the wastewater and use it for other purposes. One in which a communal greywater reuse already takes place (Drielanden), the other, a location in Sneek which separates the wastewater into greywater and blackwater. Then both the greywater and the blackwater are purified in this location.

In the other group, there are three locations without any reuse programs and without experience with greywater. These three locations are: Wiecherlinckstraat-Schuurmanstraat neighborhood in Zwolle, Kastanjefhof neighborhood in Nijmegen and Annenkamp in Wapenveld. Via data collection from these neighborhoods and comparison of the findings, the researcher will obtain information about the current situation and discover the effect of the six factors which are mentioned in literature review (paragraph 2.4) on the public acceptance of greywater reuse.

1- Drielanden, Groningen: This neighborhood is a location with an existing infrastructure for separating wastewater into greywater and blackwater, and reusing greywater for communal purposes. Further, this is an eco-neighborhood in which inhabitants are aware of and exercise ecological principles. Thus, house owners in this neighborhood have an involvement and information about greywater reuse.

Drielanden is a neighborhood located between the neighborhoods Beijum and Lewenborg in the northeastern part of the city of Groningen. In 1989, the municipality of Groningen decided to build Drielanden. In 1995, the first houses were completed, and the whole neighborhood was completed at the end of the 90s. The ecological residential Drielanden consists of three parts: Waterland, Zonland and Mooiland. The Ecological Society in Groningen wanted that utmost account of the environment would be taken and be implemented in the construction of the houses. There were a lot of green spots in the neighborhood (grass fields or lawns, parks and trees) and the concept was meant to conserve energy, raw materials and water. The houses have been built with sustainable materials. The wastewater is treated and cleaned in the neighborhood itself. There are infrastructure facilities to separate greywater from blackwater. The neighborhood consists of 166 households. This study will focus on one specific part of Drielanden called Waterland, because that part alone takes part in the greywater reuse project.

Figure 6: Drielanden neighborhood (Waterschap Noorderzijlvest, 2016)

2- Lemmerweg-Oost in Sneek: In 2005, in the district of East Lemmerweg in Sneek a project started which uses a number of new technologies for treatment of wastewater. This project has been installed in 32 households and the black (toilet) water is collected separately via a vacuum toilet system. This black water is purified in the neighborhood in a specially designed installation. The residues of the purification process are reused. The collected grey water will also be treated. The effluent can be reused.

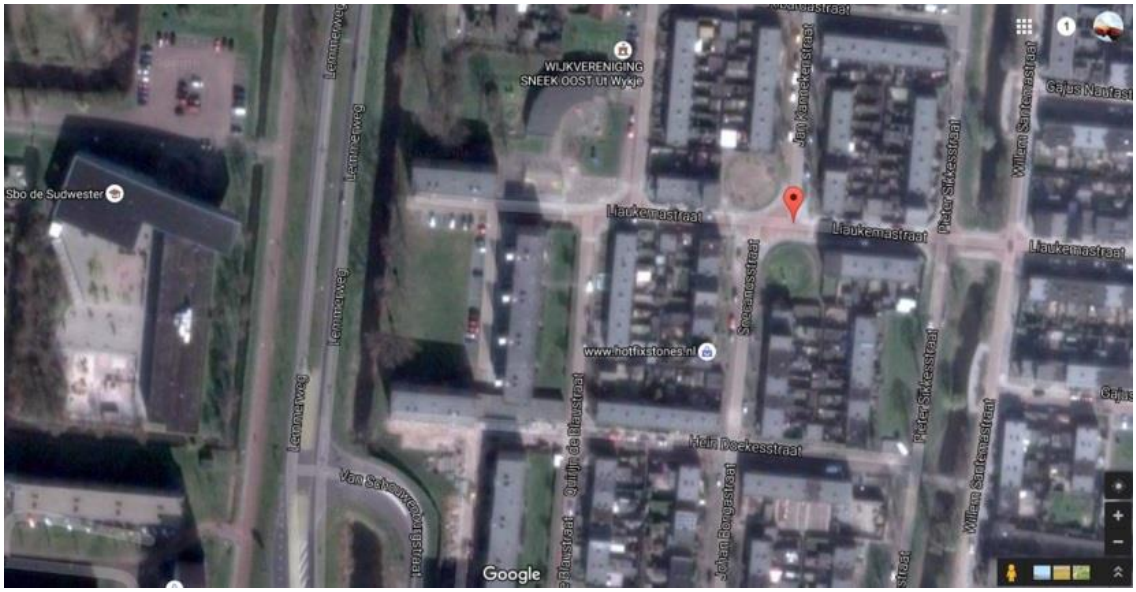


Figure 7: Lemmerweg neighbourhood in Sneek

3- Wiecherlinkstraat-Schuurmanstraat, Zwolle: In this residential neighborhood people do not get in contact with and have no infrastructure for separating their wastewater. They do not have any involvement in greywater reuse projects, so it can be considered a representative selection group of ordinary people without awareness of this subject. The neighborhood is a compound of six apartment buildings with 180 households together. The postal codes are 8011KC to 8011KT, Zwolle.

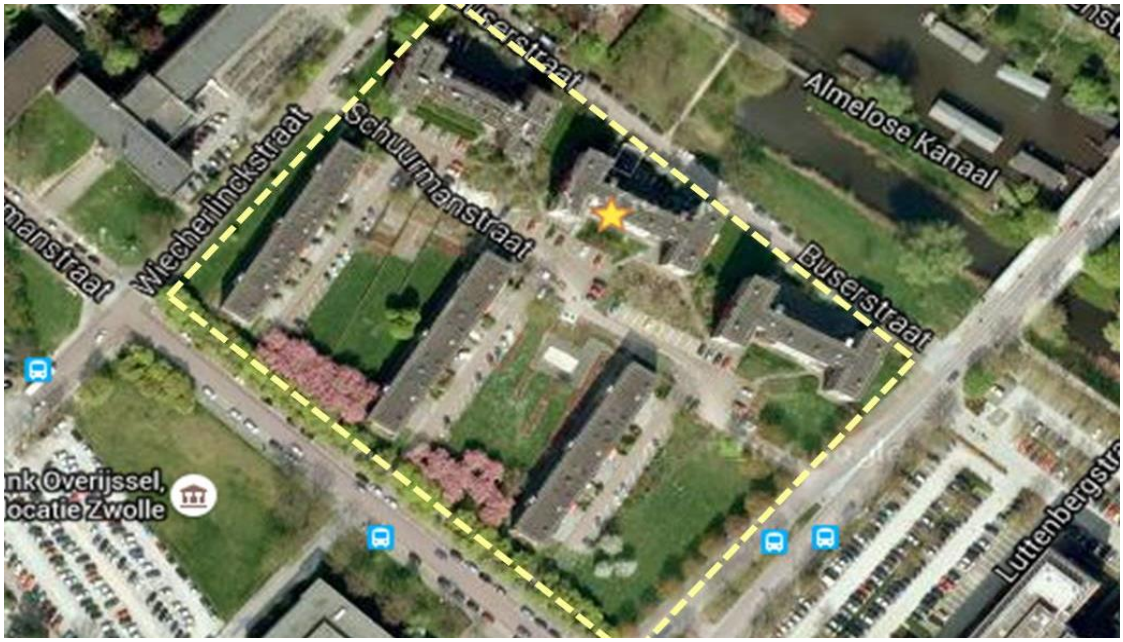


Figure 8: Wiecherlinckstraat-Schuurmanstraat neighborhood in Zwolle

4- Kastanjefhof neighborhood in Nijmegen: in this neighborhood, people do not have any infrastructure for separating their wastewater same as location number 3. There

are 65 apartments in 10 buildings in this area. The postal codes are 6533 BC, Nijmegen.

Figure 9: Kastanjefhof district in Nijmegen

5- Annenkamp neighborhood in Wapenveld: same as locations number 3 and 4, this area is an ordinary place without any facilities for separating wastewater. There are 40 apartments in this place. The postal codes are 8191 LX, Wapenveld.

Figure 10: Annenkamp district in Wapenveld

3.3 ***Data collection***

There are two kinds of data which are collected via different tools during this study. The first one of them is primary data that is gained directly through the researcher. Another kind of data is secondary data which was collected by someone else for some other purpose, but

being utilized by the researcher for this purpose. The sources of secondary data are previous research, official statistics, government reports, web information etc. In this study, the researcher will use several tools such as closed questionnaire, online questionnaire, and semi-structured interview with some experts in professional fields that are related to the research subject, and literature review. The summary data, type of data, source and tool that will be used, are illustrated in Table 3-1.

Research Question	Data	Type	Source	Tool	Method
What is the current experience with greywater reuse in the Netherlands?	-Situation of grey water in the Netherlands - level of public acceptance in the studied locations -Public involvement in the greywater reuse	Primary and secondary	Experts Surveyed people Official statistics, Articles, Web pages,	Semi- structures interviews Closed questionnaire Document Review	Quantitative/Qualitative
What is the situation with regard to public acceptance of greywater reuse for different purposes in the studied locations and how can it be explained? What factors have an impact on public acceptance?	- Factors which influence public acceptance in the Studied locations -Motivation for increasing the usage of greywater -Curious of pubic in the greywater reuse subject	Primary and secondary	Surveyed people Experts Government reports, journals, web pages	Closed questionnaire Semi-structured interviews documents review	Quantitative/Qualitative
What are the barriers for public acceptance and how can they be overcome?	-Threats for public acceptance -Information about new plans, actions and regulations for decreasing the hesitated of public about greywater reuse	Primary	Surveyed people Experts	Closed questionnaire Semi-structured interviews	Quantitative/Qualitative

Table 3-1: Matrix to answer research questions

3.4 ***Research development framework***

According to the research development framework, this study is based on the evaluation oriented research. The research aims to clarify the current situation of acceptance and knowledge about greywater reuse in the Netherlands, therefore, the researcher needs to know the potential barriers and the motivations, the most important factors that impact public acceptance of greywater in Netherlands, the current level of achievement and satisfaction in greywater reuse. Figure 11 illustrates the path of the research and the steps of the development during this study.

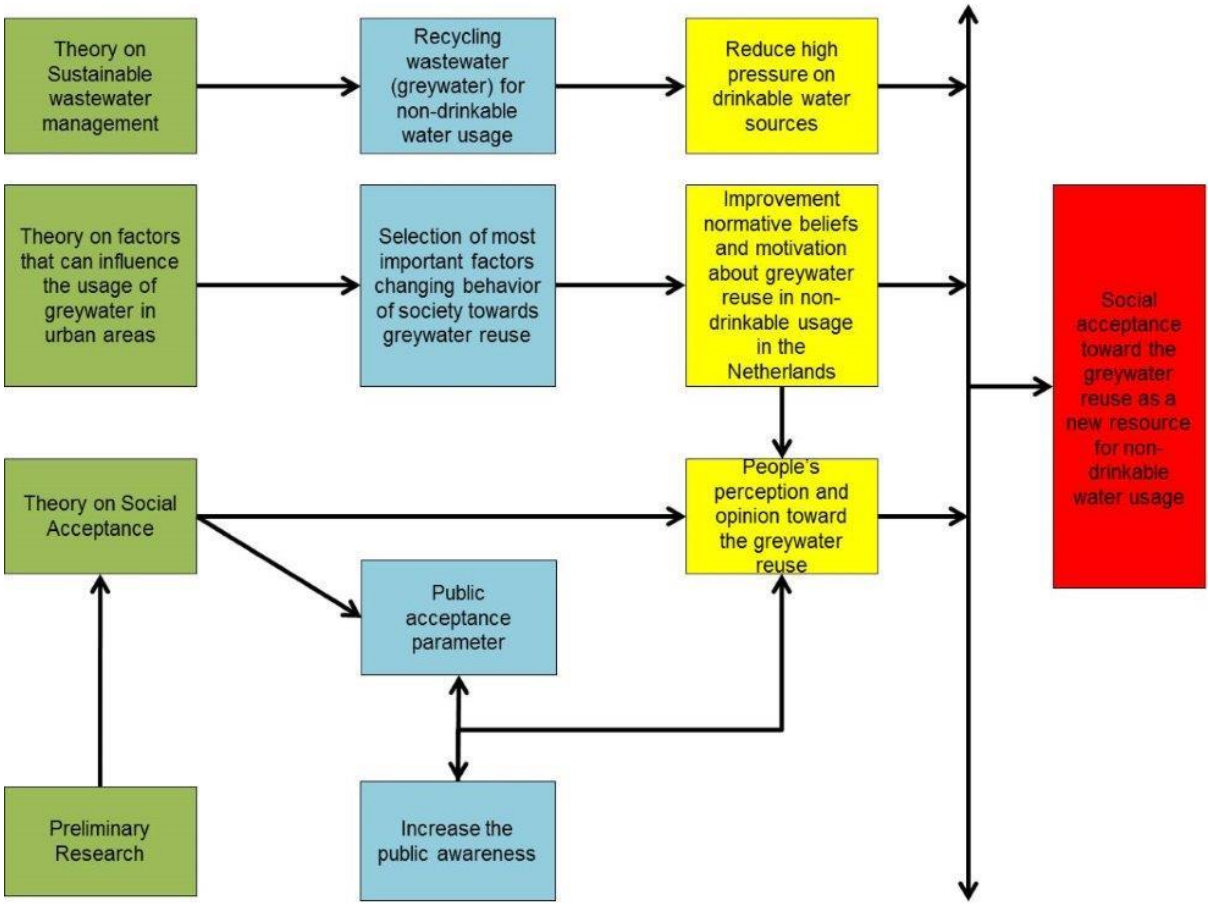


Figure 11: Research Development Framework

Legend to Figure 11:

- Theoretical component is green
- Data which help to identify the research object is blue
- Expected outcome is yellow
- The final result and recommendation are red.

3.5 ***Main concepts***

The following key concepts are determined in this research:

Sustainable wastewater management: Wastewater management should consider the sustainable management of wastewater from source to re-entry into the environment ('re-use/disposal' in the sanitation service chain) and not only concentrate on single or selected areas or segments of the service provision process.

Urban wastewater: Urban waste water is domestic waste water (from residential settlements) or a mixture of domestic waste water with industrial waste water (from premises used for trade or industry) and/or run-off rain water.

Blackwater: water coming from flushed toilets which is consisted faecal matter, urine, toilet paper and flush water

Greywater: Wastewater from baths, showers, hand basins, washing machines and dish-washers, laundries and kitchen sinks.

Trust in authorities associated with recycled water: trust in the authorities could play a crucial role in determining public acceptance of water reuse (greywater). Trust could be the main reason that people with different intentions have an interest to use recycled water.

Public involvement (participation): public participation seeks and facilitates the involvement of those potentially affected by or interested in a decision. This can be in relation to individuals, governments, institutions, companies or any other entities that affect public interests.

Social acceptance: it is a fact that most people, in order to fit in with others, attempt to look them. Or sometimes it is the ability to accept or to tolerate differences and diversity in other people or groups of people.

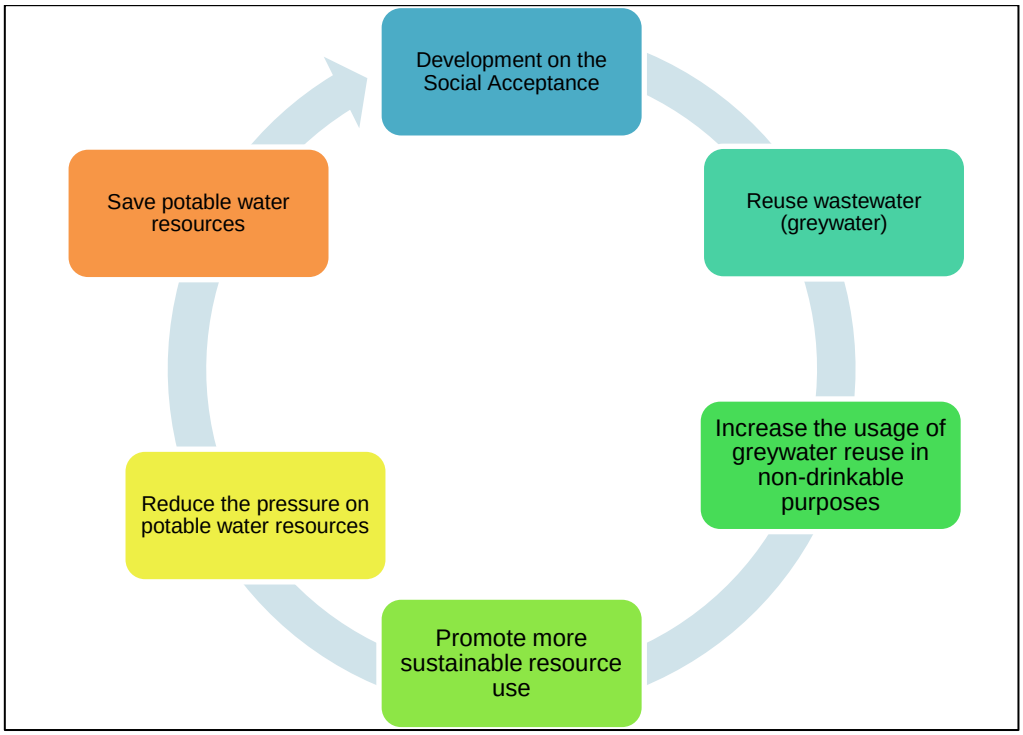


Figure 12: Conceptual model

3.6 ***Data Analysis:***

Data analysis guides the researcher to carry out and find answer the research questions. As mentioned before, this study will review the social acceptance and because of this the researcher will be operated questionnaire in the society. The Likert scale will be used in this research in order to gain and record data in the public acceptance, by transposing the simple

linear dimension from ‘negative’ to ‘positive’ to some form of attitude measurement (Johns, 2010). This method of scoring is illustrated in Figure 13.

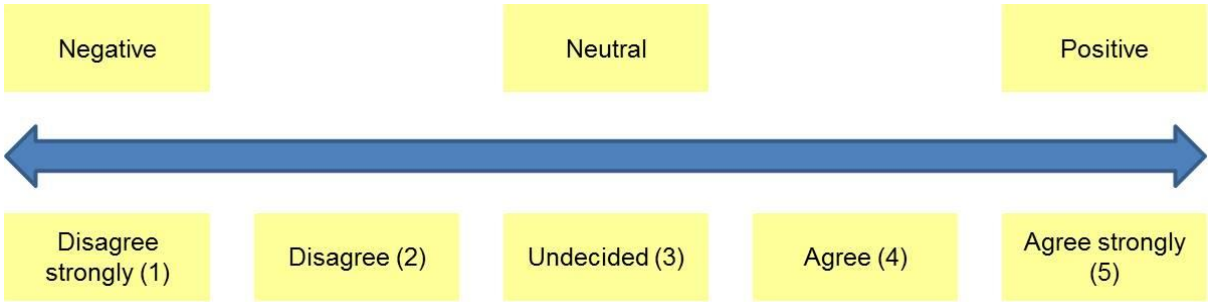


Figure 13: The Likert Scale of Scoring

For providing a suitable conclusion via this scale, the research should take some steps into the account. Firstly, it should be calculated the total score which is gathered in every item. In second step, the researcher has to determine the maximum score of each item. At the end, the general accumulated score should be divided into the maximum score and then it has to multiply by 100%. This method is more applied in the social acceptance subject because it has a tool for supporting (agree, strongly agree) and also the tool for refusing (disagree, strongly disagree). Moreover, this method is common and use in many researches around the world. Furthermore, it is so accurate scale and it covers the various facets which are complex and multidimensional attitude. (Johns, 2010).

1. 0-19.99% = strongly disagree
2. 20%-39.99% = Disagree
3. 40%- 59.99% = Neutral
4. 60%- 79.99% = Agree
5. 80%- 100% = Strongly agree

3.7 ***Analytical Research Framework***

The analytical research framework is presented in Figure 14.

From left to right, the three research questions are presented, as in paragraph 1.5.

Research question 1, (What is the current experience with greywater reuse in the Netherlands?) is answered in chapter 4.

Research question 2 (What is the situation with regard to public acceptance of greywater reuse for different purposes in the studied locations and how can it be explained? Which factors have an impact on public acceptance?) boils down into six factors, which form the basis for the hypotheses and main factors that will be evaluated in paragraphs 5.2 and 5.3.

Research question 3 (What are the barriers for public acceptance and how can they be overcome?) is answered in chapter 6.

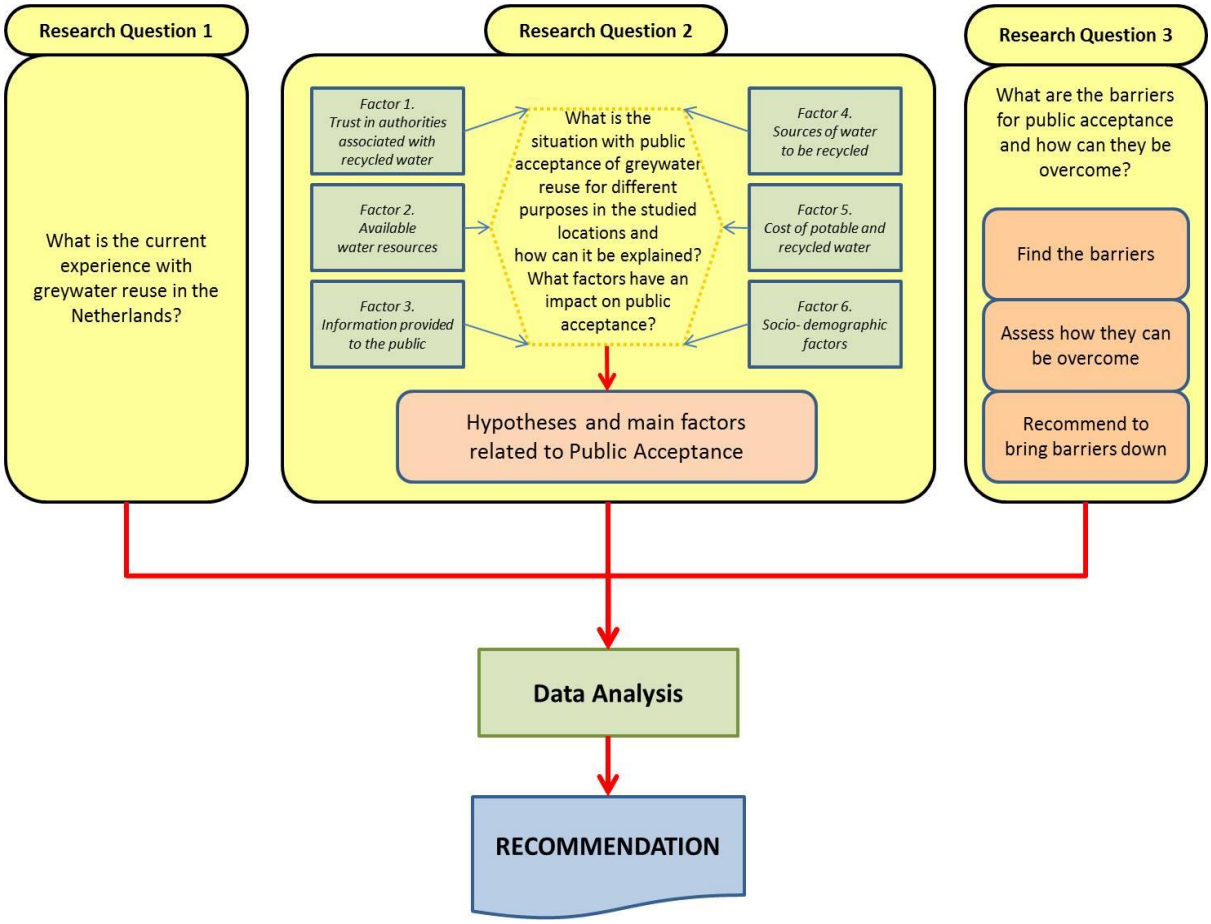


Figure 14: Analytical research framework

3.8 ***General information about participants***

The total number of participants in this survey is 145 people in 5 different locations. The researcher distributed the survey brief with QR codes (appendix 3) in studied locations in order to persuade people answering the questions. In the Drielanden area in the Groningen, the brief was distributed through help from the municipality. But in the other locations, distribution was done independently. The information of distribution presents in below:

1- Zwolle: 180 households + 2 times distribution= 360 briefs
2- Drielanden : 166 households + 3 times distribution= 498 briefs
3- Nijmegen : 65 households + 2 times distribution= 130 briefs
4- Wapenveld : 40 households + 2 times distribution = 80 briefs
5- Sneek : 32 households + 2 times distributions= 64 briefs

The total number of briefs which are distributed in studied locations is 1132. With 145 responding participants, the response result on the survey is 12.8 %.
The detail information such as gender, civil status, age, level of education, and the place of residence are shown in the tables below.

Gender	Male	Female
Participants	81	64
Percentage	55.8%	44.2%

Table 3-2: Gender of participants

Civil status	Single	Single+children	Married	Married+children
Participants	60	7	30	47
Percentage	41.38%	4.8%	20.7%	33.12%

Table 3-3: Civil status of participants

Education	High school	MBO	Bachelor	Master	PhD
Participants	15	31	66	33	0
Percentage	10.3%	21.38%	45.5%	22.82%	0%

Table 3-4: Level of education of participants

Age	15-30	31-45	46-60	61-75	76-90
Participants	36	38	46	22	3
Percentage	24.80%	26.2%	31.72%	15.2%	2.08%

Table 3-5: Age category of participants

City	Number of participants
Zwolle	84
Groningen	27
Wapenveld	13
Nijmegen	11
Sneek	10
Total	145

Table 3-6: Participants according to the city

4 Current experience with greywater reuse in the Netherlands

This chapter reviews the situation of greywater reuse in the Netherlands, therefore, provides an answer for research question number1:

‘‘What is the current experience with greywater reuse in the Netherlands?’’

This review is done through several methods, including interview with experts in the municipalities and water boards, document review and analysis articles and web pages.

4.1 ***General information about Greywater***

Environmental pollution is a global concern because of the harmful effects on public health and the environment. The irresponsible disposal of untreated wastewater into surface waters, soil and groundwater results in polluted water resources and environmental damages. Pollution prevention is most successful through the reduction or elimination of pollution at the source instead of the common end-of-the-pipe approach. The treatment at the source is the most efficient environmental protection by avoiding the generation of mixed waste streams and harmful emissions. There are adequate and appropriate solutions for integrated wastewater treatment available, both on community and household level. Greywater reuse is one of the solutions (Huhn et al., 2015).

The amount of greywater is directly related to the water consumption of the residents and to the appliances used in the household. The average greywater production per person varies between 30 to 120 liter daily depending on access to piped water and people´s habits and their culture. The separated greywater can then be routed to an on-site treatment system or sent to a communal greywater facility and reused for another purpose (Diaper and Sharma, 2007). Greywater recycling not only reduces the input water needs of a building (or residence, JGM); it also significantly reduces the volume of waste sent to the sewer or septic system. In developed countries, greywater makes up about 60-70% of domestic wastewater volume (Friedler 2004).

4.2 ***Current situation of greywater reuse in the Netherlands***

While greywater treatment is a relatively new concept in Netherlands and in the past greywater reuse was not widely practiced in the Netherlands, it has been practiced for several years in places where water is less abundant or expensive to use. In the southern USA, Australia, and many Middle Eastern countries, simple greywater diverting schemes are common as a means of irrigating landscape plants in arid regions.

The current situation of greywater in the Netherlands is changed and the water boards, municipalities and national government are now looking for ways to use the greywater as a source. The researcher found, however, that the municipalities and water boards have are interested in wastewater reuse from mainly 3 aspects about wastewater. They want to recover the nutrients (1st aspect) that are in it and then they want to recover the energy that’s

in it (2nd aspect) and to a lesser extent for the reuse of greywater as a water source (3rd aspect). Regarding nutrients recovery, due to the lack of mines and mineral materials, all authorities involved in the water management (national government, water boards and municipalities) tend to invest in the projects which are related to blackwater and yellow water (the yellow water comes from toilets and is mainly urine). They try to regenerate the nitrate and phosphorus from these types of wastewater and it is economic. Energy recovery is also seen as a recently developed renewable way to lowering operation cost of a wastewater treatment plant. In recent years, the operating costs of wastewater treatment plants have increased substantially due to the increase in the cost of energy. Nowadays, the energy consumption is very high. To lower the energy consumption and within also the economic costs, energy recovery can be offered as a good option. Some examples of energy and nutrients recovery can be found in municipalities such as Groningen and Amsterdam. In Amsterdam, for example, an attempt is made to recover energy from wastewater. For instance, in Amsterdam, it is obvious that the water board is so interested to use the blackwater as a source of energy and nutrients that they should separate the wastewater for this idea. The researcher discovered that in several locations, there are some water reuse projects from Waternet and other organizations experimenting with greywater. For example, the office building of Waternet itself in Amsterdam uses a new way for heating. This system is called heat and cold storage (University of Technology Eindhoven). The excess thermal energy in greywater is used in this method and stored for basic heating when weather temperatures lower. Also, it is detected that this system as new method in several public buildings will be used by the water board and municipality of Amsterdam (Reinstra, personal communication, 17/06/2016). This system could be implemented in modern houses because modern houses are very well insulated and need very little heat. These modern houses need 30 degrees or 25 degrees to heat up your house, Whereas, old houses only need 70 degrees. Also, the old ones are increasingly hot in summer, they also need to cool. Therefore this method can create completely energy-neutral houses. In doing so, excess energy storage from greywater can be an interesting application for greywater.

In addition, the municipality of Groningen which is one of the leading municipalities in greywater reuse projects has found that though the first two (nutrients and energy recovery) seem to be the most interesting in the Dutch context – so far, since it requires separation of waste streams, it leaves the greywater which could be utilized for water reuse untouched (Helbig, personal communication, 19/08/2016; Reinstra, personal communication, 17/06/2016).

At the moment, the municipality of Groningen is working on a new area and new houses (Reitdiep neighborhood in Groningen). It is discovered that the municipality of Groningen wants to separate greywater and blackwater again and also have residents add kitchen materials (only biological) to the blackwater in order to gain energy and nutrients. The municipality has a plan to treat the greywater locally and use it for secondary purposes via constructed wetlands. Also, the researcher has found that the municipality as an executive of this idea wants to use a vacuum system for blackwater, similar to the Sneek project. (https://www.wetsus.nl/demonstration-and-pilot-projects/desah-sneek). The vacuum system is useful and also prevents the problem which had happened in Amsterdam 10 years ago. In those days, some water companies suggested to provide two qualities of drinking water; one that's totally pure for drinking and one that is less purified and that's been sold as greywater, grey (drinking) water. The purification was less intensive. It was still clean water but it was not microbiologically safe. This idea was created to prevent that drinking water is used to

flush the toilet. The project started to implement this idea in a big new neighborhood in Amsterdam, but the pilot of the system went very wrong. After a few years it was discovered that 10% of the piping connections from the main supply pipeline to household distribution were made the wrong way: people were drinking greywater and washed the car with pure drinking water. (Reinstra, personal communication, 17/06/2016). Therefore the Sneek system could be useful to prevent the mistake in the installation because this method is so clearly different from the greywater system and makes mismatching practically impossible. (Helbig, personal communication, 19/08/2016).

As mentioned in the previous paragraph, the Groningen municipality is a pioneer in the field of wastewater in the Netherlands. Therefore, due to the previous experience in Drielanden, the municipality of Groningen has new idea about wastewater. The municipality started to separate the urine in buildings such as the library, a hotel, a hospital and a cinema because it is easier than in resident neighborhoods. At the moment, there is one public complex in the central of the city, see https://www.groningerforum.nl/. (Helbig, personal communication, 19/08/2016). This idea is more interesting for both the municipality and the hospital or hotel because these stakeholders on both sides can use this philosophy in the market and introduce themselves into the society as environmental friendly company. Furthermore, the extra investment from governmental and EU energy programs and from energy companies will be absorbed by this plan of the municipality (Helbig, personal communication, 19/08/2016).

Also, several examples are to be found in Amsterdam. At the moment there is one neighborhood in Amsterdam where it is proposed to separate wastewater. The name of the neighborhood is Buiksloterham (http://buiksloterham.nl). There is a program going on, it's called 'Circular Buiksloterham', it means that several organizations, like Waternet and the municipality of Amsterdam want to make Buiksloterham as circular (sustainable) as possible. One of the aspects of circularity is that the stakeholders want to recover the nutrients and energy from the blackwater but also to apply heat from greywater. In addition, there is one real greywater reuse installation in Amsterdam: the Arena football stadium. They are doing a project to separate all kinds of water: blackwater, greywater and yellow water (urine), and they want to reuse the greywater to irrigate the football field. This is a true greywater project. Also, there is an exposition in Amsterdam where for example a dual kitchen sink system is shown. The municipality of Amsterdam and Waternet of Amsterdam show new lifestyle methods and appliances in order to persuade people to adopt sustainable ways in every field of water use and reuse, energy, etc. The expo is called FabCity. (http://europebypeople.nl/fabcity-2) (Reinstra, personal communication, 17/06/2016).

In contrast to these, it is discovered that the prospective of every province/municipality in the Netherlands is different. For instance, Waternet of Leeuwarden stated that the water boards have a responsibility to clean water, so they invested money for water treatment and made huge facilities for this purpose. Also, the Waternet, water board, and the municipality have a special budget only for their sewer system (maintenance and reparations). The expenditures of maintenance and reparations are huge. In Friesland, all the parties work closely together to keep the cost as low as possible. In addition, the amount of water that is sent to the facilities in the wastewater treatment plant will be reduced, if the wastewater is separated from precipitation effluent. Moreover, economically it's not feasible, because of the investments that were made and the return on investments over a 50 to 70 year period. Also, the benefits of any greywater system are very low, for people who pay taxes to have their sewer water cleaned (Valk, personal communication, 06/07/2016).

4.3 ***Public acceptance of greywater in the Netherlands for non-drinkable usage***

This section shows the public acceptance of greywater reuse in studied locations. The level of public acceptance is obtained via questions number 13 20 in the survey (see appendix). In these questions, the participants could answer from 3 options: Yes, No and I do not know. The responses to these questions have a different value in this study in order to calculate a clear and exact result for the various locations. The value of answering to questions number 13 to 20 is:

- Yes 3
- I do not know 2
- No 1

The total number of answers to these questions is 145 for the studied locations all together. The results are collected according to the number of participants in every location; therefore, the averages show the obvious snapshot from every location in this subject. It should be noted that the highest average in the part is 3 according to the value of the question. The results which are collected from participants' response show the public acceptance of grey-water reuse for non-drinkable usage in different locations. These questions regarded the opinion of people toward using the greywater for firefighting, car washing, lawn irrigation, crop irrigation, toilet flushing, industries, and ground water recharge. The next table illus-trates the results according to the cities and reuse purposes.

Usage	Sneek	Groningen	Nijmegen	Wapenveld	Zwolle
Firefighting	2.80	2.88	2.90	2.53	2.40
Car washing	3	2.66	2.54	2.69	2.38
Lawn irrigation	3	2.55	2.45	2.61	1.97
Crop irrigation	2.60	2.33	2.63	2.23	1.59
Toilet flushing	2.80	2.92	2.72	3	2.83
Industries	2.60	2.70	2.90	2.61	2.22
Ground water recharge	2.80	2.22	2.45	2.30	1.70

Table 4-1: Level of public acceptance of greywater for non-drinkable usage in studied locations

According to Table 4-1, it is discovered that the public acceptance of greywater reuse for all usages in Sneek and Groningen, are in average more than 2.6 and this shows high public acceptance in these two eco-neighborhoods, because the maximum score is 3. Whereas, the averages of greywater reuse usage for different purposes vary in Zwolle, Wapenveld and

Nijmegen from 1.7 to 2.9 with a total average of less than 2.5. It shows that in so called ordinary places, participants have a tendency to utilize the greywater for firefighting and car washing rather than ground water recharge. For instance, the averages of firefighting and car washing are 2.4 and 2.38 in Zwolle, but the average for ground water recharge is 1.7. When these averages are compared, it is clear that there is a huge positive tendency for using greywater for car washing and firefighting. Moreover, this issue is visible in all ordinary places. Also, it is found that the usage of greywater reuse for toilet flushing ranks high in all locations. Moreover, the industries usage is acceptable by the participants in all locations, except in Zwolle.

Furthermore, it is detected that the public acceptance of greywater reuse is high in the eco-neighborhoods in comparison with ordinary places, but the difference between the eco-neighborhoods and ordinary places is not visible any better in all usages. So, the researcher cannot draw a conclusion only according to this study and it is clear that more projects and researches are required in order to find the obvious result in the area.

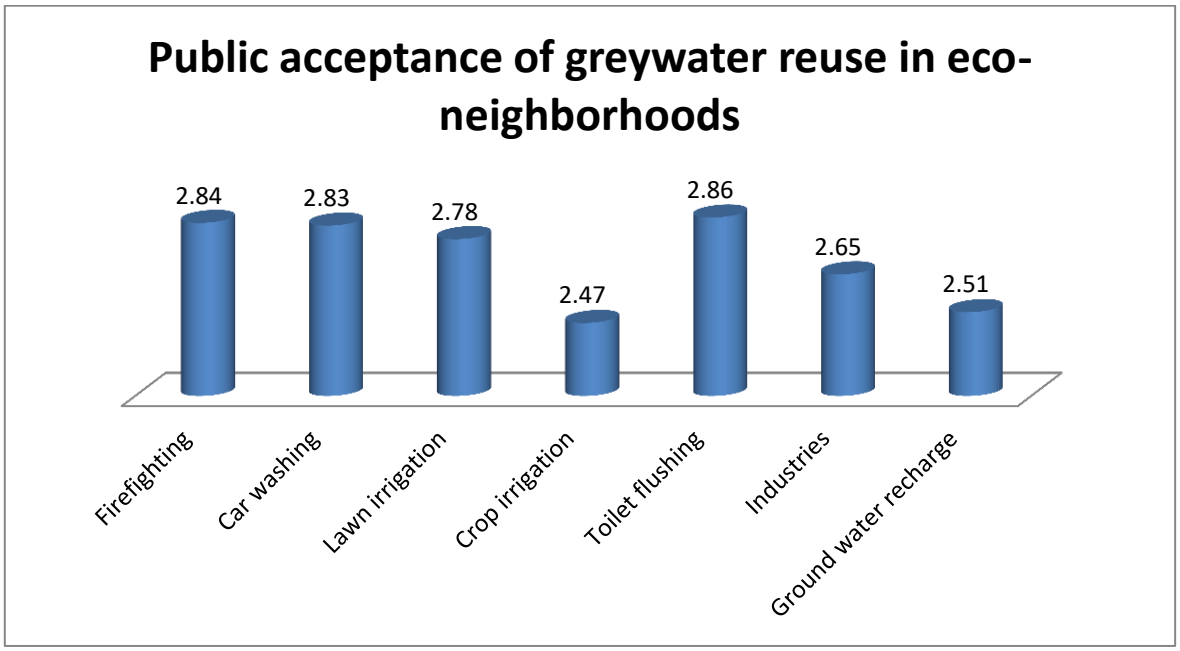


Figure 15: Public acceptance in eco-places

The results of survey have demonstrated that the awareness about greywater reuse in eco-districts is remarkable and it has caused the high public acceptance in these areas. Also, the awareness has increased due to the wastewater recycling projects in Sneek and Groningen. It is confirmed that public information and awareness is one of the most important factors. In chapter five, more results and evidence are illustrated about factors which have the most influence on the public acceptance of greywater reuse in the Netherlands.

So, Waternet and the municipality of Amsterdam have a plan to expend to new neighborhood, starting informing about possibilities of separation of wastewater and in this way to convince people. This area is called IJburg west Amsterdam. It is sustainable district in the eastern part of Amsterdam (Reinstra, personal communication, 17/06/2016).

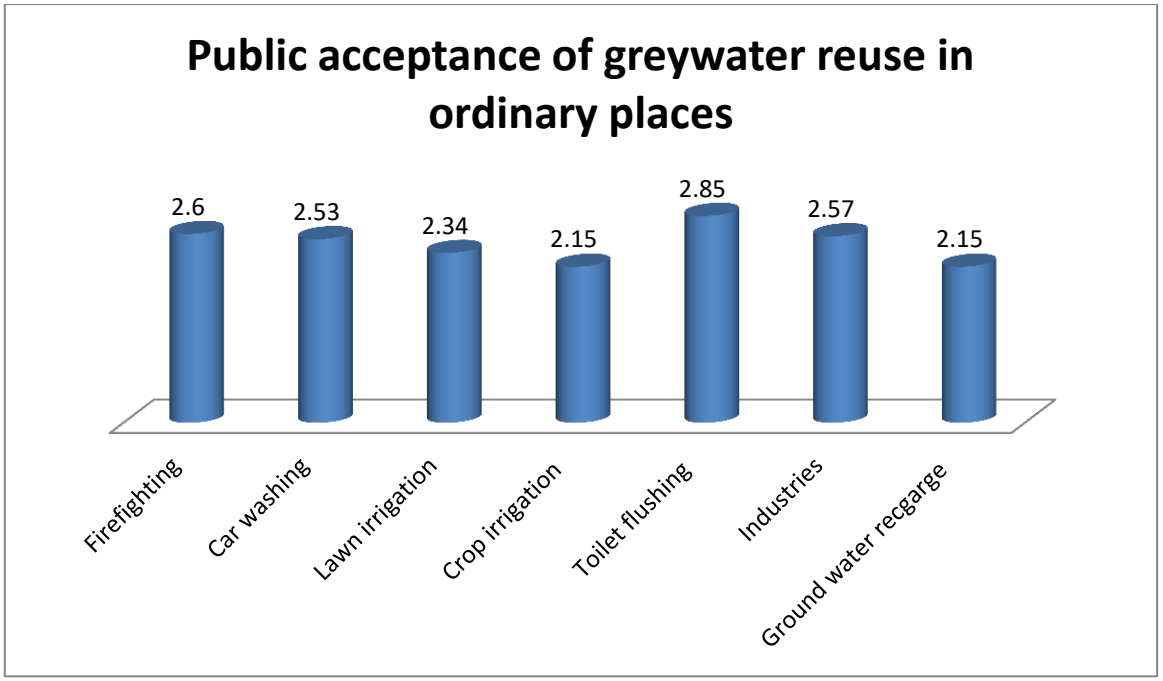


Figure 16: Public acceptance in normal neighbourhoods

The next figure represents the total average of public acceptance of greywater for different purposes in all studied locations.

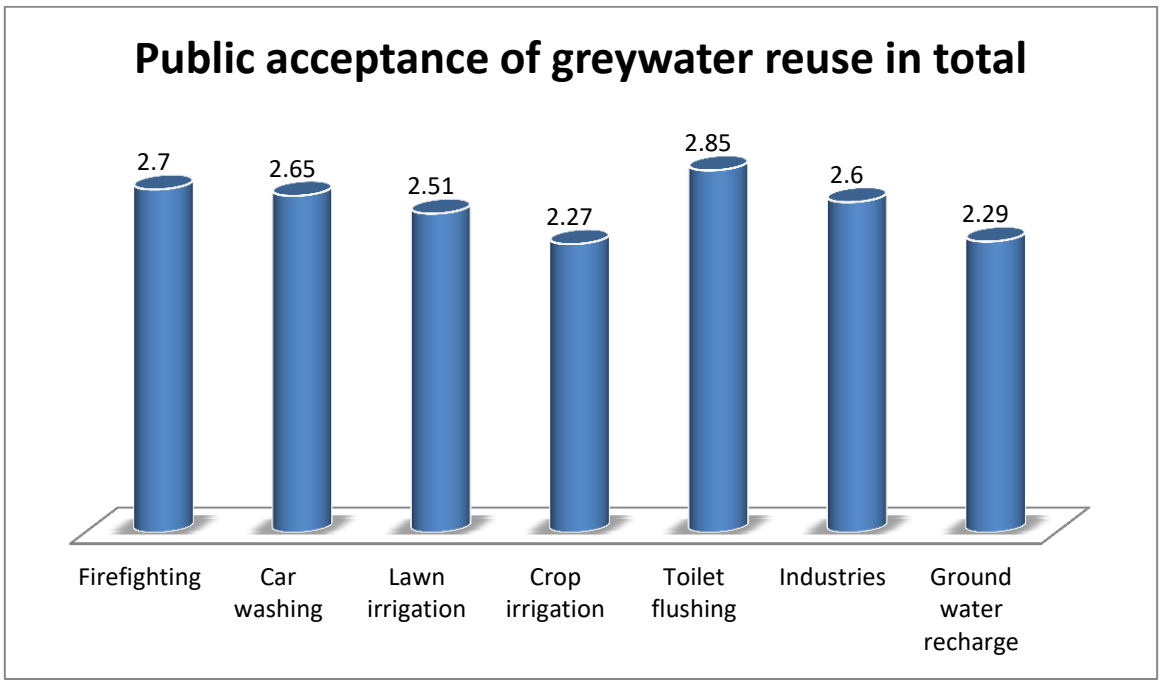


Figure 17: Public acceptance in total

5 Data analysis from the survey

This chapter shows and analyzes the data which are collected via the survey in five different locations in the Netherlands to determine important factors that have an impact on public acceptance. Therefore, it provides an answer for research question nember2:

“What is the situation with public acceptance of greywater reuse for different purposes in the studied locations and how can it be explained? What factors have an impact on public acceptance?”

The evaluation of this research question is done through the analysis of the data from the survey which is presented in several tables and charts. The comparison between eco-neighborhoods and ordinary districts is easily visible. This chapter reviews the level of awareness, important hypotheses which have a link to the public acceptance, and the most important factors which have the most influence on public acceptance of greywater reuse in the Netherlands.

5.1 *Level of awareness about greywater reuse in studied locations*

This paragraph reviews questions number 6 to 13 in the survey in order to obtain information about the level of awareness about greywater reuse in eco-neighborhoods and ordinary districts. The data is shown in the tables and charts below. First the data from eco-neighborhoods and then from ordinary districts. Secondly, all districts are compared with each other in order to gain a better overview via the column chart.

5.1.1 Eco-neighborhoods

Question	Yes(3)	I do not know(2)	No(1)	Total	Average	Level of AW
Q6/Knowledge	7	0	3	24	2.4	4
Q7/Experience	5	0	5	20	2	6
Q8/Former information	7	0	3	21	2.1	5
Q9/Difference	7	0	3	21	2.1	5
Q10/is essential	6	3	1	25	2.5	3
Q11/is legitimate	8	2	0	28	2.8	2
Q12/Investment	10	0	0	30	3	1

Table 5-1: Level of awareness in Sneek

Question	Yes(3)	I do not know(2)	No(1)	Total	Average	Level of AW
Q6/Knowledge	23	0	4	73	2.7	3
Q7/Experience	15	0	12	57	2.11	6
Q8/Former information	18	0	9	63	2.33	5
Q9/Difference	23	0	4	73	2.7	3
Q10/is essential	16	9	2	68	2.51	4
Q11/is legitimate	23	2	2	75	2.77	2
Q12/Investment	26	0	1	79	2.92	1

Table 5-2: Level of awareness in Groningen

5.1.2 ***Ordinary districts***

Question	Yes(3)	I do not know(2)	No(1)	Total	Average	Level of AW
Q6/Knowledge	3	0	8	17	1.54	4
Q7/Experience	1	0	10	11	1	6
Q8/Former information	2	0	9	15	1.36	5
Q9/Difference	6	0	6	24	2.18	3
Q10/is essential	4	7	0	26	2.36	2
Q11/is legitimate	7	4	0	29	2.63	1
Q12/Investment	7	4	0	29	2.63	1

Table 5-3: Level of awareness in Nijmegen

Question	Yes(3)	I do not know(2)	No(1)	Total	Average	Level of AW
Q6/Knowledge	2	0	11	17	1.30	4
Q7/Experience	2	0	11	17	1.30	4
Q8/Former information	2	0	11	17	1.30	4
Q9/Difference	1	0	12	15	1.15	5
Q10/is essential	6	7	0	32	2.46	3
Q11/is legitimate	8	4	1	33	2.53	2
Q12/Investment	11	1	1	36	2.76	1

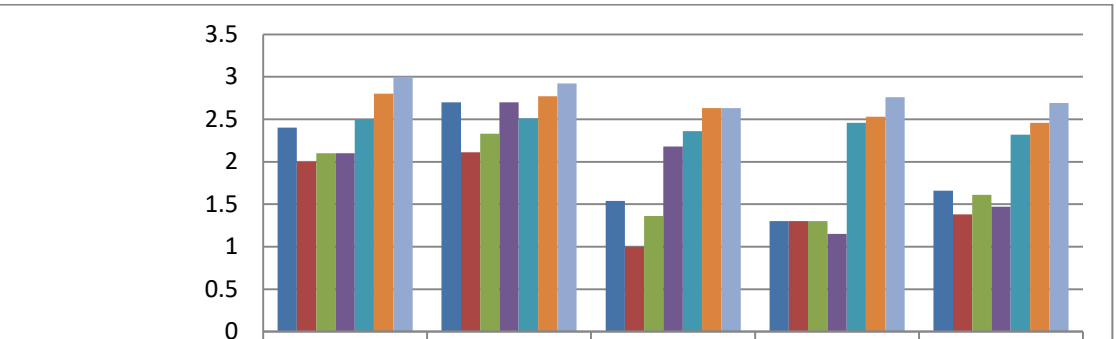
Table 5-4: Level of awareness in Wapenveld

Question	Yes(3)	I do not know(2)	No(1)	Total	Average	Level of AW
Q6/Knowledge	28	0	56	140	1.66	4
Q7/Experience	16	0	68	116	1.38	7
Q8/Former information	26	0	58	136	1.62	5
Q9/Difference	20	0	64	124	1.47	6
Q10/is essential	35	41	8	195	2.32	3
Q11/is legitimate	47	29	8	207	2.46	2
Q12/Investment	63	16	5	226	2.69	1

Table 5-5: Level of awareness in Zwolle

5.1.3 ***Analyze Data***

According to the tables, the researcher has found the interesting points about the level of awareness in studied locations. It is clear that people in 5 locations have a positive perspective about investment in the projects which are related to reusing greywater. Moreover, it is obvious that the level of knowledge about wastewater recycling, former information about greywater, experience about wastewater treatment, and information about greywater and blackwater, is more common in the eco-neighborhoods than in ordinary places. For instance, the average of knowledge about wastewater recycling is 1.66 in Zwolle and in Groningen it is 2.7. For better understanding the difference of the level of awareness in the studied locations, see Figure 18 below.



	Sneek	Groningen	Nijmegen	Wapenveld	Zwolle
Knowledge	2.4	2.7	1.54	1.3	1.66
Experience	2	2.11	1	1.3	1.38
Former information	2.1	2.33	1.36	1.3	1.61
Difference	2.1	2.7	2.18	1.15	1.47
Is essential	2.5	2.51	2.36	2.46	2.32
Is legitimate	2.8	2.77	2.63	2.53	2.46
Investment	3	2.92	2.63	2.76	2.69

Figure 18:Total level awareness

5.2 ***Review of questions which are related to the public acceptance***

In figure 14 in section 3.7 the six factors are presented in the research framework that we derived from literature as factors that influence potentially the public acceptance of re-use. These were *(1) Trust in authorities associated with recycled water, (2) Available water resources, (3) Information provided by/to the public, (4) Sources of water to be recycled, (5) Cost of potable and recycled water, (6 Socio-demographic factors.*

This section reviews questions number 20 to 38 in the survey for information about the hypotheses that have an impact on public acceptance of greywater reuse in the Netherlands. The information is collected through some hypotheses presented asked from the participants in part 4 of the survey (see appendix 1).

The data is presented in the tables and charts below. First, the table from eco-neighborhoods will be presented and then table from ordinary districts. Second, all districts are compared to each other in order to gain better insight in the 6 hypotheses through the column chart

5.2.1 Tables and chart:

This section illustrates the data which are collected from eco-districts and ordinary places in the Netherlands in two tables.

Data from Eco-neighbourhoods	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Total	Average	Level of Im-portance
1-Trust in authorities plays crucial role in the public acceptance	0	0	6	22	9	151	4.08	5
2-I trust the authorities with respect to protection of public health when reusing grey-water	0	1	9	23	4	141	3.81	11
3-I would be afraid to use recycled water (greywater) due to health risks	3	13	10	10	1	104	2.81	15
4-The media can influence the public's behavior about greywater reuse	0	0	4	24	9	153	4.13	3
5-The involvement of the public has an impact on social acceptance	0	0	3	28	6	151	4.08	5
6-Providing information about water recycling process has an impact on social ac-ceptance	0	0	3	25	9	154	4.16	2
7-Providing additional information that addresses the safety of recycled water can influ-ence social acceptance	0	0	3	24	10	155	4.19	1
8-Availability of alternative water resources has an impact on social acceptance	0	1	11	19	6	141	3.81	11
9-Climate change is a big threat for water supply	0	2	6	18	11	149	4.02	6
10-The level of rainfall in the Netherlands is sufficient and there is no need to recycle wastewater	4	13	13	7	0	97	2.62	16
11-The Netherlands will be faced with water scarcity in the future	2	5	13	16	1	120	3.24	14
12-If the Netherlands should ever face water scarcity, I will accept non-traditional water sources such as reused greywater	0	1	4	22	10	152	4.10	4
13-I agree to use the recycled water(greywater) if the source of water is my own house	0	1	7	24	5	144	3.90	7
14-I agree to use the recycled water (greywater) if it is from a communal source in my neighborhood	0	3	7	20	7	142	3.83	10
15-The source of greywater to be recycled is an important factor that influences social acceptance of greywater reuse	0	1	10	20	6	142	3.83	9
16-Reusing greywater which is collected from the whole city in non-drinkable purposes is acceptable	0	1	7	25	4	143	3.86	8
17-I find current water tariffs acceptable and there is no need for a lower price i.e. for a cheaper source of water	0	2	12	17	6	138	3.73	12
18-In case water tariffs would rise, I would consider the use of recycled water (grey-water) if it lowers the price	1	3	13	17	3	129	3.48	13

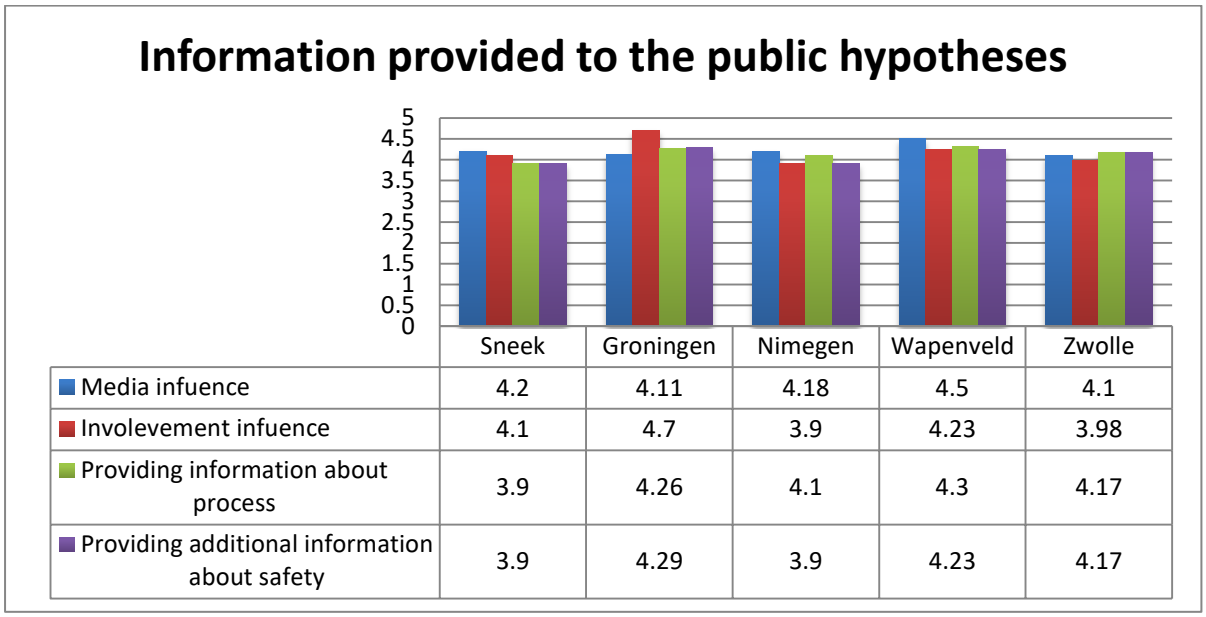
Table 5-6: Distribution of scores in eco-neighbourhoods

Data from ordinary neighbourhoods	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Total	Average	Level of Importance
1-Trust in authorities plays crucial role in the public acceptance	1	4	26	52	25	420	3.88	4
2-I trust the authorities with respect to protection of public health when reusing grey-water	0	13	42	45	8	372	3.44	11
3-I would be afraid to use recycled water (greywater) due to health risks	5	22	37	33	11	347	3.21	15
4-The media can influence the public's behavior about greywater reuse	1	2	9	63	33	449	4.15	2
5-The involvement of the public has an impact on social acceptance	1	1	14	73	19	432	4	3
6-Providing information about water recycling process has an impact on social acceptance	0	0	11	66	31	452	4.18	1
7-Providing additional information that addresses the safety of recycled water can influence social acceptance	0	0	16	59	33	449	4.15	2
8-Availability of alternative water resources has an impact on social acceptance	0	3	27	63	15	414	3.83	5
9-Climate change is a big threat for water supply	0	11	27	53	17	400	3.70	8
10-The level of rainfall in the Netherlands is sufficient and there is no need to recycle wastewater	7	42	40	19	0	287	2.66	17
11-The Netherlands will be faced with water scarcity in the future	4	25	55	18	6	321	2.97	16
12-If the Netherlands should ever face water scarcity, I will accept non-traditional water sources such as reused greywater	4	10	23	54	17	394	3.65	9
13-I agree to use the recycled water(greywater) if the source of water is my own house	2	9	41	41	15	382	3.53	10
14-I agree to use the recycled water (greywater) if it is from a communal source in my neighborhood	3	11	46	43	5	360	3.33	13
15-The source of greywater to be recycled is an important factor that influences social acceptance of greywater reuse	0	5	32	49	22	412	3.81	6
16-Reusing greywater which is collected from the whole city in non-drinkable purposes is acceptable	1	7	25	59	16	406	3.76	7
17-I find current water tariffs acceptable and there is no need for a lower price i.e. for a cheaper source of water	3	19	40	42	4	349	3.23	14
18-In case water tariffs would rise, I would consider the use of recycled water (grey-water) if it lowers the price	1	18	37	43	9	365	3.38	12

Table 5-7: Distribution of scores in ordinary neighbourhoods

5.2.2 ***Analyze data***

The researcher has collected data to elaborate the mentioned factors and thus to assess the hypotheses on factors having influence on the public acceptance. We start the analysis with factor/hypothesis *3 Information provided by/the public* and analyze the found distribution on the questions 4, 5, 6 and 7 for this (compare table 5-7). Figure 19 illustrates the details of public information indicators.



	Sneek	Groningen	Nimegen	Wapenveld	Zwolle
Media infuence	4.2	4.11	4.18	4.5	4.1
Involevement infuence	4.1	4.7	3.9	4.23	3.98
Providing information about process	3.9	4.26	4.1	4.3	4.17
Providing additional information about safety	3.9	4.29	3.9	4.23	4.17

Figure 19: Public Information fact according to the city (average)

Health risk is one of the factors that show different results in de various locations. We expect in our assumptions on to be found differences that participants in eco-neighbourhoods are less anxious towards health risks when (re-) using greywater than people in the ordinary neighbourhoods. The public in the eco-neighbourhoods has more information and involvement in the subject. The perceived health risk therefore results in a relatively low number of 2.81 for Sneek and Groningen, whereas the perceived health risk in the other neighbourhoods is 3.21 which mean there is more hesitation towards greywater in Zwolle, Nijmegen and Wapenveld.

Furthermore, looking at factor *4 Sourced of water to be recycled* and the found distribution on the question 13, 14, and 16 (compare table 5-6 and 5-7) three neighbourhoods tend to agree with greywater from their own neighbourhood, whereas Groningen and Sneek more easily agree with greywater from the whole city. For this hypothesis, the average score in the ordinary neighbourhoods is lower than in the eco-areas, according to Table 5-6 and Table 5-7, questions 13, 14 and 16).

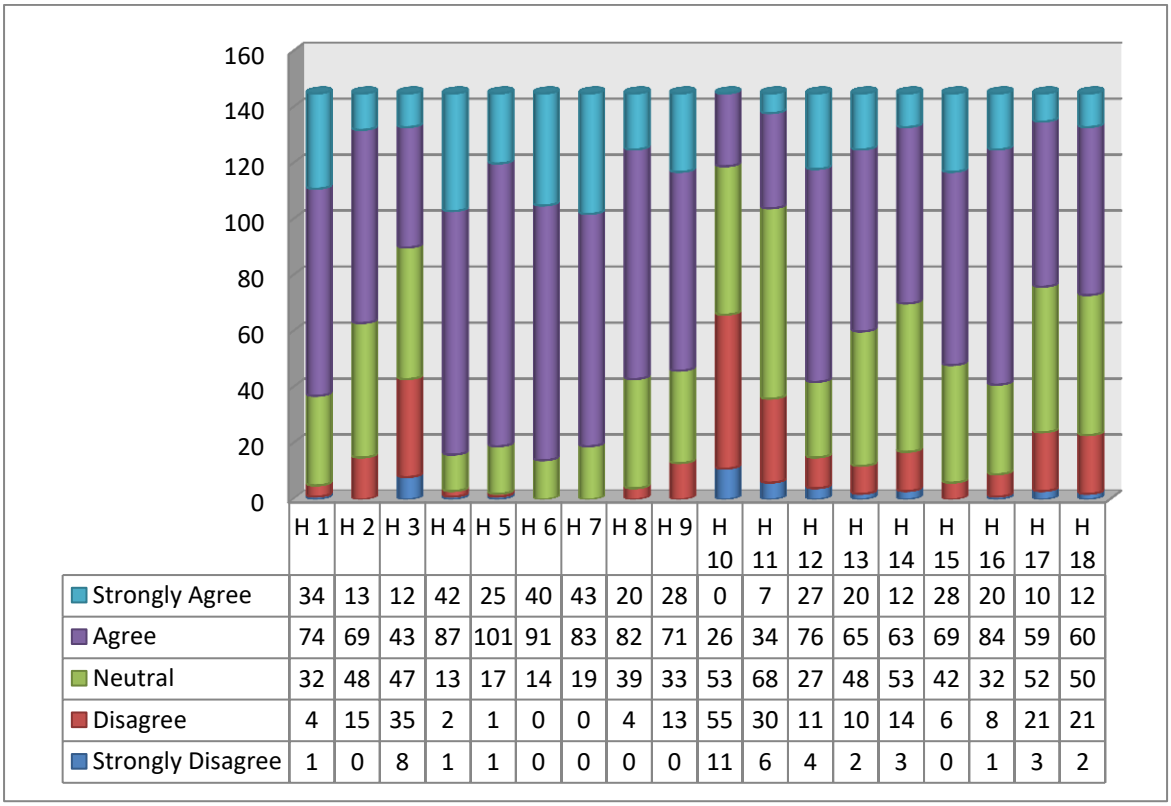
Source of greywater	Eco-neighbourhood	Ordinary place
Own house	3.9	3.5
Own district	3.83	3.33
Whole city	3.86	3.76

Table 5-8: Difference between eco and ordinary districts about source of greywater reuse (average scores)

In addition, although the Netherlands is a water rich country, it is known that the level of rainfall in the Netherlands is not sufficient and wastewater recycling is considered a source of water according to the result of survey. If we in this context now look at factor/hypothesis 2 *Available water resources* and the found distribution on the questions 10, and 11 (compare table 5-6 and 5-7) the analysis is as follows:

The average on indicator 10 is 2.62 in eco-areas and 2.66 in ordinary ones. Also, it is found that the opinion of participants about water scarcity in the future is high and it is proved with the average of this indicator in eco and ordinary districts (3.24, 2.97, question 11). These hypotheses (water scarcity in future and level of rainfall in the Netherlands), could prove the high positive agreement for investment in wastewater projects via the municipalities. For the average scores see sub-sections 5.1.1 and 5.1.2.

In Figure 20 the complete snapshot of all indicators all studied locations is presented. In this figure one can observe the results from 145 participants and also it shows which indicators are more acceptable in these locations. For example, as mentioned before, the hypothesis number 5 which is link to the public information could obtain more appreciation in the survey (101). Also, the indicators number 6 and 4 that are connected with public information, take the second and third place (91, 87). Thus, this figure 20 could give the reasonable view from all indicators in the different locations (H1 in Table 5-6 and Table 5-7 and in Figure 20 refers to Indicator 1; H2 thru H18 accordingly.)



	H 1	H 2	H 3	H 4	H 5	H 6	H 7	H 8	H 9	H 10	H 11	H 12	H 13	H 14	H 15	H 16	H 17	H 18
Strongly Agree	34	13	12	42	25	40	43	20	28	0	7	27	20	12	28	20	10	12
Agree	74	69	43	87	101	91	83	82	71	26	34	76	65	63	69	84	59	60
Neutral	32	48	47	13	17	14	19	39	33	53	68	27	48	53	42	32	52	50
Disagree	4	15	35	2	1	0	0	4	13	55	30	11	10	14	6	8	21	21
Strongly Disagree	1	0	8	1	1	0	0	0	0	11	6	4	2	3	0	1	3	2

Figure 20: Indicators in total

5.3 ***Factors with most influence on public acceptance***

This section analyses the date collected by questions asking the interviewee what the most important factors from the participants' point of view are (compare annex 1, part 5). This in order to supplement the analysis presented in the previous section.

The participants selected multiple of the most important out of 6 factors, of course the factors that relate to our hypothesis (see figure 14). Firstly, the results from eco-areas are presented and then the normal districts. Finally, the most important factors are illustrated in total and are analyzed.

5.3.1 Tables and charts:

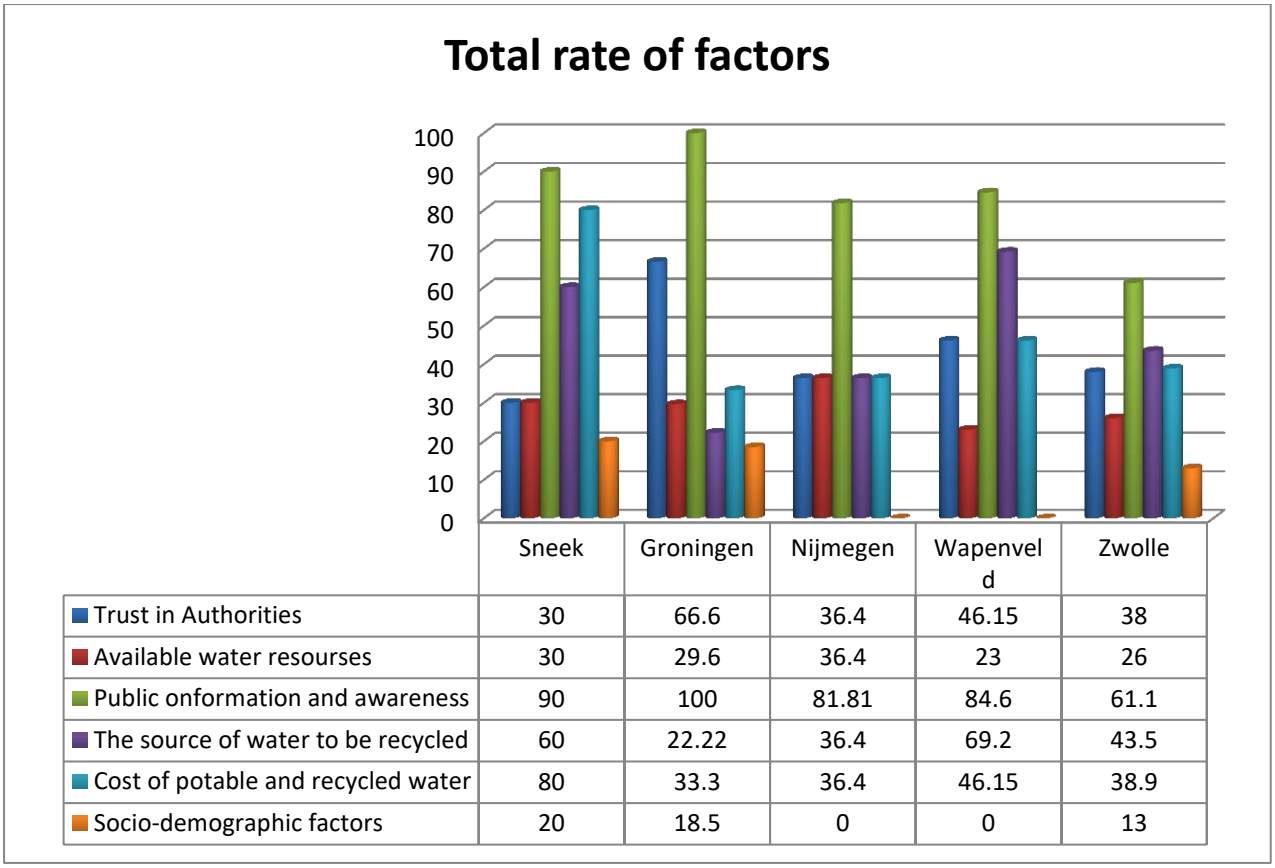
This section illustrates the data in the tables which are collected from eco-districts and ordinary places in the Netherlands (compare annex 1, part 5).

Factors	Number of selection	percentage	Rate
Trust in authorities with recycled water	**18**	**48.6**	**3**
Available water sources	**11**	**29.7**	**5**
Public information and awareness	**36**	**97.3**	**1**
The source of water to be recycled	**22**	**59.4**	**2**
Cost of potable and recycled water	**17**	**46**	**4**
Socio-demographic factors	**7**	**18.9**	**6**

Table 5-9: Rate of factors in eco-districts

Factors	Number of selection	percentage	Rate
Trust in authorities with recycled water	**51**	**47.2**	**4**
Available water sources	**35**	**32.4**	**5**
Public information and awareness	**86**	**79.6**	**1**
The source of water to be recycled	**60**	**55.5**	**2**
Cost of potable and recycled water	**52**	**48.14**	**3**
Socio-demographic factors	**14**	**12.9**	**6**

Table 5-10: Rate of factors in ordinary neighbourhoods



	Sneek	Groningen	Nijmegen	Wapenveld	Zwolle
Trust in Authorities	30	66.6	36.4	46.15	38
Available water resourses	30	29.6	36.4	23	26
Public onformation and awareness	90	100	81.81	84.6	61.1
The source of water to be recycled	60	22.22	36.4	69.2	43.5
Cost of potable and recycled water	80	33.3	36.4	46.15	38.9
Socio-demographic factors	20	18.5	0	0	13

Figure 21 : Total rate of factors in cities

5.3.2 Analysis of data:

According to the literature review in chapter two, there are common factors that are always used in researches around the world and also adequate for public acceptance in the Netherlands. We used these as hypothesis in our research framework (compare figure n14). This study was asking these factors in order to determine which factors have a great influence on public acceptance from point of view specifically of people in the Netherlands. So, the findings about factors will be presented in some figures in order to give the brief conclusion and then the complete conclusion will be discussed in chapter 7.

Trust in authorities

Trust in authorities could play a crucial role in public acceptance of greywater reuse. (Kaercher et al., 2003), stated that this trust in authorities is the main reason that people with different intentions have an interest to use recycled water. Also, in several research studies, trust in the water authorities has been determined as a main factor that can influence the trust level (Syme and Williams, 1993). Whereas, the results from the survey show that the trust in authorities is not the single main factor which can affect the public acceptance in the Netherlands according to the participants response, but it is *one of* the most important of these factors. It is clear that the percentage of this factor in four locations is less than 50% (in Wapenveld 46.15% and in Nijmegen 36.4%) and only in Groningen about 70%. The next figure demonstrates the average of trust in authorities as a factor which is considering three hypotheses in total in studied locations.

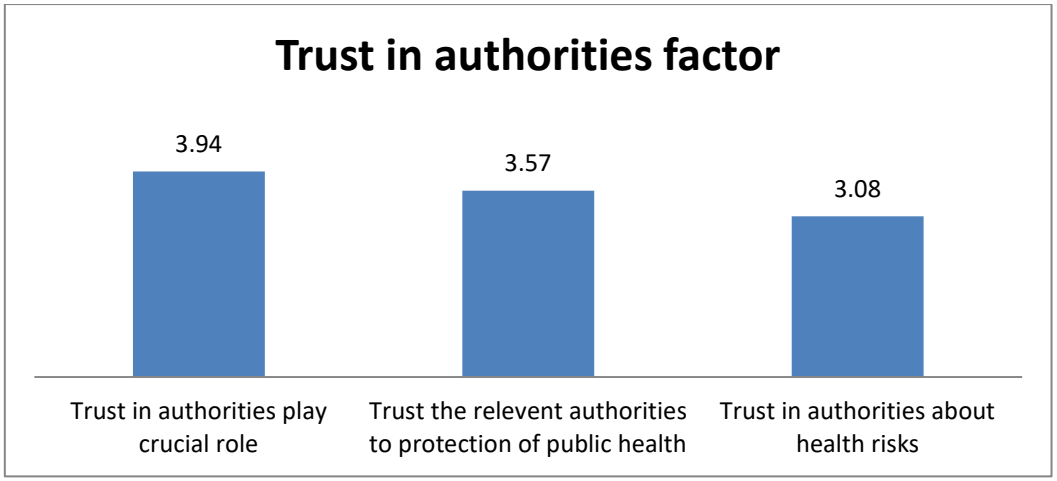


Figure 22: Trust in authorities in Total

Available water resources

As predicted by many researches, the available water resources factor is one of the most important factors in this subject. According to Sene Alka and Buyukkamaci (2013), the success of water reuse applications depends on public acceptance and of course the public acceptance has a link to the water availability. Also, it is obvious that the social acceptance is obtained more easily due to the water scarcity and the need to save high quality water for domestic usage (Crook et al, 1992; Fawell et al, 2005). The results of survey in the different locations in the Netherlands show that this hypothesis is correct and the public acceptance has a strong link to water scarcity. But as the Netherlands is a water rich country and the percentage of available water sources as a factor in five locations in the Netherlands is less than 35%, nevertheless it is interesting to see that the participants give a huge positive trend and they agree that the municipalities invest in projects which are related to wastewater recycling (greywater reuse). Also, it is found that the level of rainfall in the Netherlands is not sufficient according to the response of participants and there is a requirement to recycle wastewater. It can be found the generally accessible evidence on the internet about this subject as well as in the sub-sections 5.2.1 and 5.2.2.

The next figure illustrates the average of available water resources as a factor which is considering four hypotheses in total in studied locations.

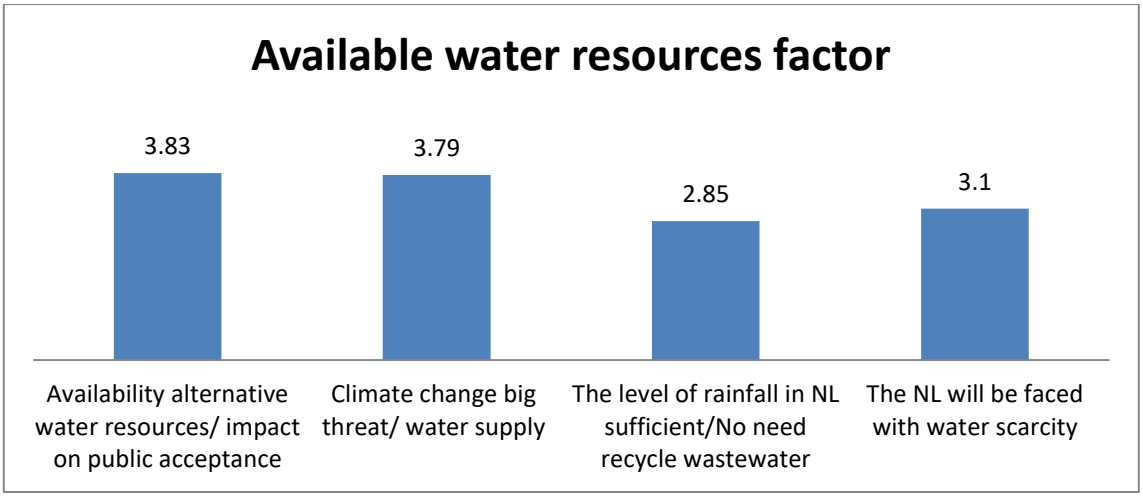


Figure 23: Available water resources in total

Source of water to be recycled

The next factor is source of water to be recycled. Jeffrey, 2002; Kaercher et al., 2006) stated that the sources of greywater has an impact on the public acceptance. The results from survey in different locations show that this factor is important for the people especially in ordinary neighborhoods (Nijmegen 36.4%, Zwolle 43.5% and Zwolle 69.2%). Whereas, this factor is 22.2% in Groningen and the participants in Drielanden have no hesitation about the source of greywater. Also, according to Jeffrey (2002), the reuse of greywater which originates from one's own household is more acceptable than water collected from communal sources and that the reuse of greywater which originates from own neighborhood is more acceptable than water from the municipal wastewater treatment plant. The source of water to be recycled (greywater reuse) as a factor is considered in four hypotheses. The results of survey confirm that the opinion of Jeffrey (2002) about the source of greywater and the participants has more interest toward the source from own houses rather than their neighborhood. The average of source from own house is 3.76 against the 3.62.

Kaercher et al. (2003) state that there is a tendency to use treated wastewater from the whole city rather than from the own neighborhood. Also, people have similar concerns about neighborhood wastewater treatment plants. People predict the risks of failure in operation; therefore, the quality of water might be compromised. So, they had a tendency for more trust in the city-wide wastewater treatment plant. According to the result of survey, the theory of Kaercher is correct because the participants prefer to using the greywater which is collected from whole city rather than from the own neighborhood (3.77, 3.62).

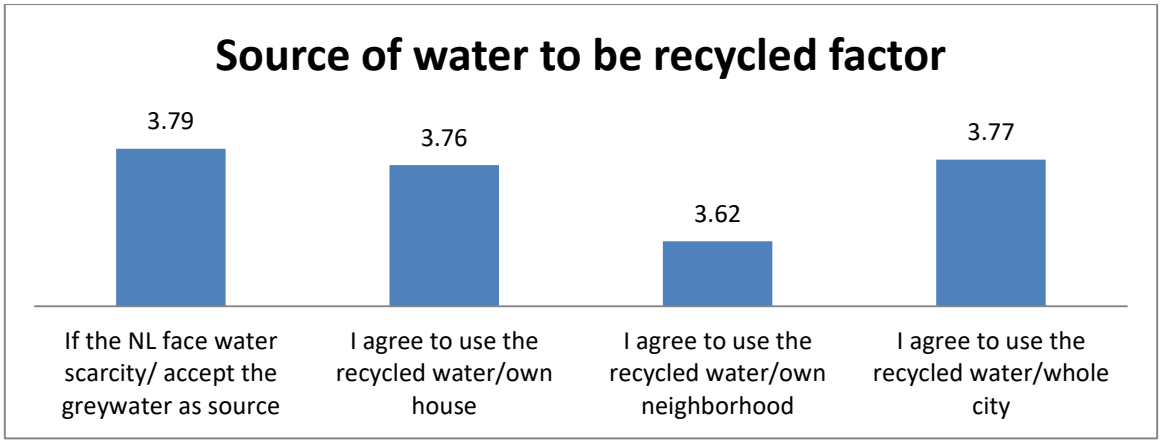


Figure 24: Source of water to be recycled in total

Information provided to the public

According to the literature review in chapter 2, information provided to the public is one of the factors that can influence public acceptance. As stated by WHO (2006), in many wastewater reuse projects, it should take the power of public for implementation process into the account. Also, (Katz & Tennyson, 1997) stated that public information is the key to the successful implementation of a water reuse program. The result of survey confirms this: according to the participants' response, information provided to the public are the most important factors that can influence the public acceptance of greywater reuse in the Netherlands. This factor scored high numbers in all studied locations. The percentage is more than 90% in the eco-neighborhoods (Sneek 90% and Groningen 100%) and in the ordinary places (Nijmegen 81.1%, Wapenveld 84%, and Zwolle 61.1%). All hypotheses that have a link to the information provided to the public factor obtain a score higher than 4. The next figure demonstrates the average of this factor in total in all studied locations. The media influence ranks high rank with 4.25 and next comes providing information about the water recycling process with score 4.13.

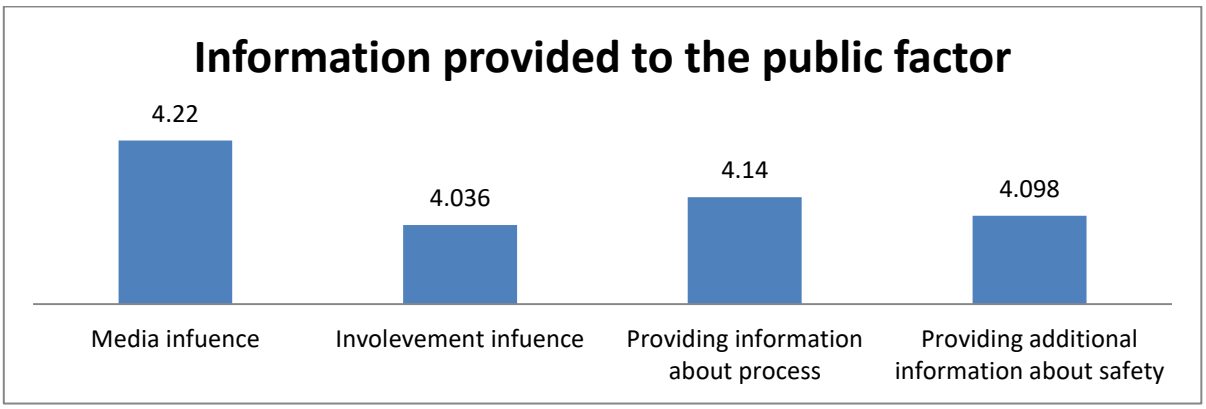


Figure 25: Public information factor in Total

Cost of potable and recycled water

The researcher estimates that the cost of potable and recycled water is also an important factor for public acceptance of greywater reuse because people expect that lower quality water is cheaper than the purest drinking water. But the survey shows that the cost is not very important according to the responses. The percentage of participants that consider the cost of greywater very important is less than 50% in four locations (Groningen 33%, Nijmegen 36%, Wapenveld 46%, and Zwolle 39%). Only in Sneek, the cost is more important and has a high percentage 80%. The next figure demonstrates the average of the cost of potable and recycled water as a factor which is considering two hypotheses in total of the studied locations.

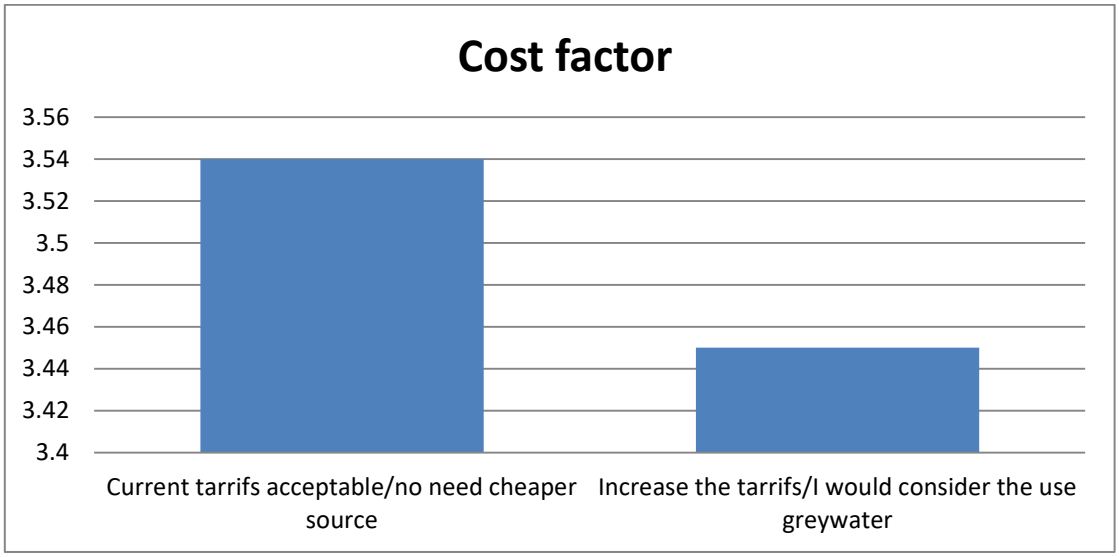


Figure 26: Cost factor in total

Socio-demographic factors

The result of survey shows that the socio-demographic factors are not important according to the response of participants. It shows that the socio-demographic factor is poorly interesting for only 3 locations (Sneek 20%, Groningen 18.5%, and Zwolle 13%). In Wapenveld and Nijmegen, this factor is not considered as significant.

Finally, the next figure presents the rate of the most important factors which have a great impact on public acceptance of greywater in the Netherlands according to the responses to the survey in five locations.

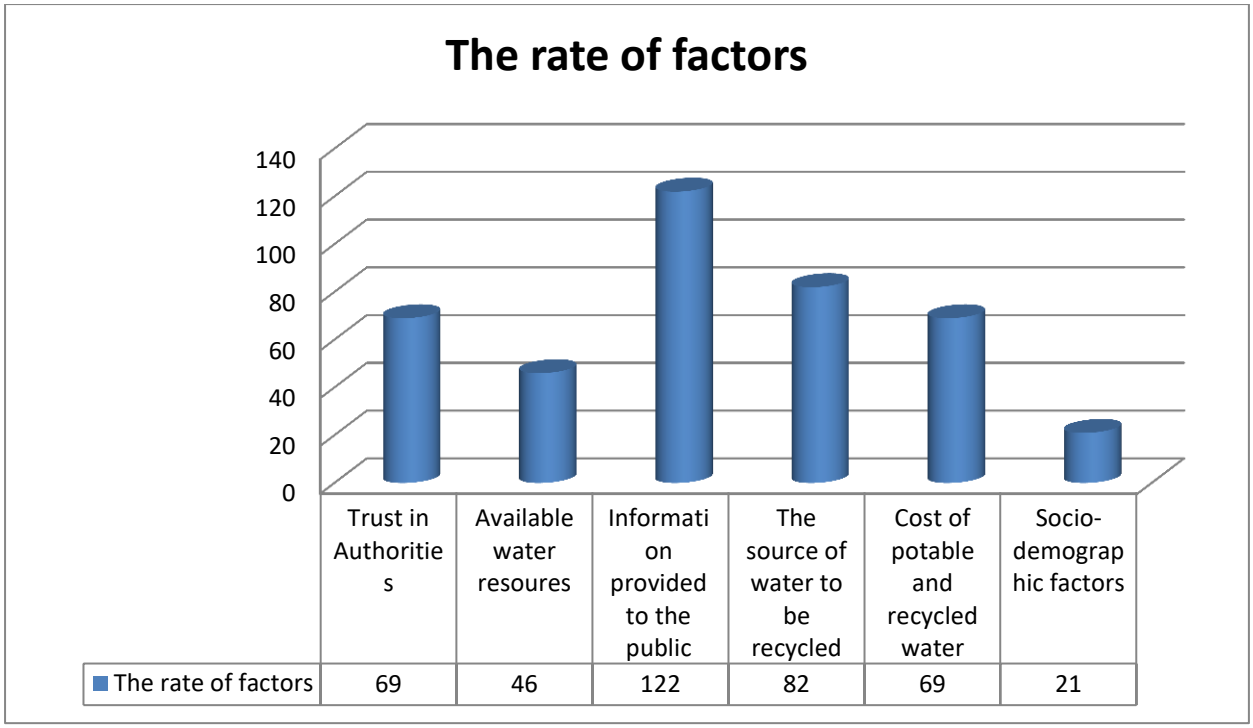


Figure 27: The rate of factors in total

6 Barriers for developing public acceptance of greywater

This chapter reviews the barriers for improving the public acceptance of greywater reuse in the Netherlands; therefore it provides an answer for research question number 3:

''What are the barriers for public acceptance and how can they be overcome?''

This review is done through several methods, including interviews with experts in the municipalities and water boards, document review and analysis articles. Moreover, the most important aspects which can improve the public acceptance of greywater reuse are determined according to the data which are collected through the survey in five different locations.

6.1 ***Barriers for improving greywater reuse in the Netherlands***

Rain water

As mentioned in pervious chapters, the Netherlands is a water rich country. Also, the level of rainfall is acceptable in this country. Due to climate change, the Netherlands has a shorter summer and more rain. Perhaps the rainwater is attractive for national government, municipalities and people as they can save rainwater and use it for various purposes. Rainwater is safe and there is hardly any consideration on health risks. Rainwater is clear so saving rainwater can reduce the demand for drinking water production and also it can reduce the energy consumption for the production of drinking water. Therefore saving rainwater is interesting in the Netherlands as a source of water (Reinstra, personal communication, 17/06/2016; Van Dijk, personal communication, 19/08/2016). As **rainwater** and other easily accessible sources are so easy to use, they can form a bottleneck for greywater reuse development in the Netherlands (Helbig, personal communication, 19/08/2016).

In addition, the focus of Waternet, municipalities, water boards, and national government is mainly on blackwater, because it is a source of energy and minerals such nitrates and phosphorus. These are very valuable in the Netherlands due to the lack of mines. (Reinstra, personal communication, 17/06/2016; Valk, personal communication, 06/07/2016).

Project costs

It is also found that greywater development **project costs** will be a threat, because in some cases a project needs dual piping and a vacuum system in order to separate the blackwater and greywater (Reinstra, personal communication, 17/06/2016). Furthermore, the stream of greywater is larger than the stream of blackwater. For example, the average of greywater is about 24 cubic meters for 180 households in Drielanden every day and 17 cubic for blackwater and if the wastewater is separated and only the blackwater is transferred to the wastewater treatment plant there is less water going to the cleaning facilities. It is not possible from an economic point of view that the amount of wastewater will be reduced. It is certain that the municipalities and Waternet made huge investments for the facilities such as a wastewater treatment plant in order to clean the wastewater. The return on investment period is calculated 50 to 70 years, but if greywater is reused and the facilities run partially idle, it would damage the investment. (Valk, personal communication, 06/07/2016).

Lack of infrastructure

The **lack of infrastructure** is another barrier for development the public acceptance of greywater in the Netherlands. In most existing houses and buildings, there is no equipment to separate wastewater. Existing infrastructure collects all water, grey and black. In new houses or districts it is easier to install wastewater separation infrastructures, but in old houses and buildings it requires enormous investments (Valk, personal communication, 06/07/2016; Van Dijk, personal communication, 19/08/2016).

The cost of water and the high quality of drinking water

In addition, **the (low) cost of water and the high quality of tap water** form another barrier for greywater. Due to this there is practically no incentive to reuse greywater. As there are two financial systems, one for maintaining water levels (the dikes) and various water systems (i.e. canals, polders), and one for cleaning and the quality of water; these two components are being used to calculate the local or regional tax on water management.

Cleaning will probably cost € 50-60 per person per year. A household consists of an average of three persons, so that's approximately € 200 per year. The other system (the dikes and water levels) costs about € 100-€ 150 per year for each household. In total that makes € 300-€ 400.

Also, if the consumption of water is 120 m^3 per capita per year, the water bill will be only € 120. As the total cost of water usage is no more than € 700 per household per year – which is considered a relatively low price – and given the extreme high quality of the water produced, these low costs form another barrier for greywater development in the Netherlands (Reinstra, personal communication, 17/06/2016; Valk, personal communication, 06/07/2016; Helbig, personal communication, 19/08/2016).

General remarks on barriers

The researcher has found that wastewater reuse next to the use of drinking water is the largest barrier, because of the costs and effort of installation of equipment. The implementation of the greywater reuse system should be flawless in order to be sure about the quality of water reuse. Any mistake in the connection and piping can issue a huge blow to the trust and acceptance of people in greywater (Helbig, personal communication, 19/08/2016).

The researcher also has found information about barriers for greywater treatment systems in Australia. There are some similar barriers, even though the Netherlands and Australia are completely different. The barriers are determined via some case studies and surveys in locations in Australia. (Dinema and Bus, 2008) stated that cost of system for clients and builders, lack of builder awareness, lack of minimum government regulations, and lack of demand are the largest barriers in Australia. Furthermore, the greywater installation is more expensive and difficult as a whole for customers and builders. So, the cost of the greywater system and the system to be put in place (lack of the infrastructure in houses) are the same barriers encountered in the Netherlands. In section 6.2, the main barriers that were found through this study will be mentioned.

6.2 ***Main barriers in the Netherlands***

The findings of the research show that the main barriers for improving greywater reuse in the Netherlands. According to the study, the main barriers are:

- Cost of greywater system
- Level of rainfall in the Netherlands
- More focus on blackwater
- Cost of the water
- Lack of infrastructure
- Population density and thus area occupation density are high

The last barrier is considered to have a showstopping effect because it is difficult to implement huge infrastructure for water treatment while all the traditional infrastructure is already in place. This is a technological issue.

6.3 ***Aspects that can help public acceptance***

The results from question 39 of the survey shows that most aspects can help the public acceptance for greywater reuse from the point of view participants. The next table and chart illustrate the data.

City	Build trust in authorities	Inform the public and involve the public in projects	Public awareness campaigns
Zwolle	34	74	51
Wapenveld	3	11	11
Groningen	15	24	21
Sneek	7	8	4
Nijmegen	3	9	4

Table 6-1: Helpful aspects for improve the public acceptance

According to table 6-1, it is obvious that in all locations the aspect of information to the public is the most important aspect to help improve the public acceptance.

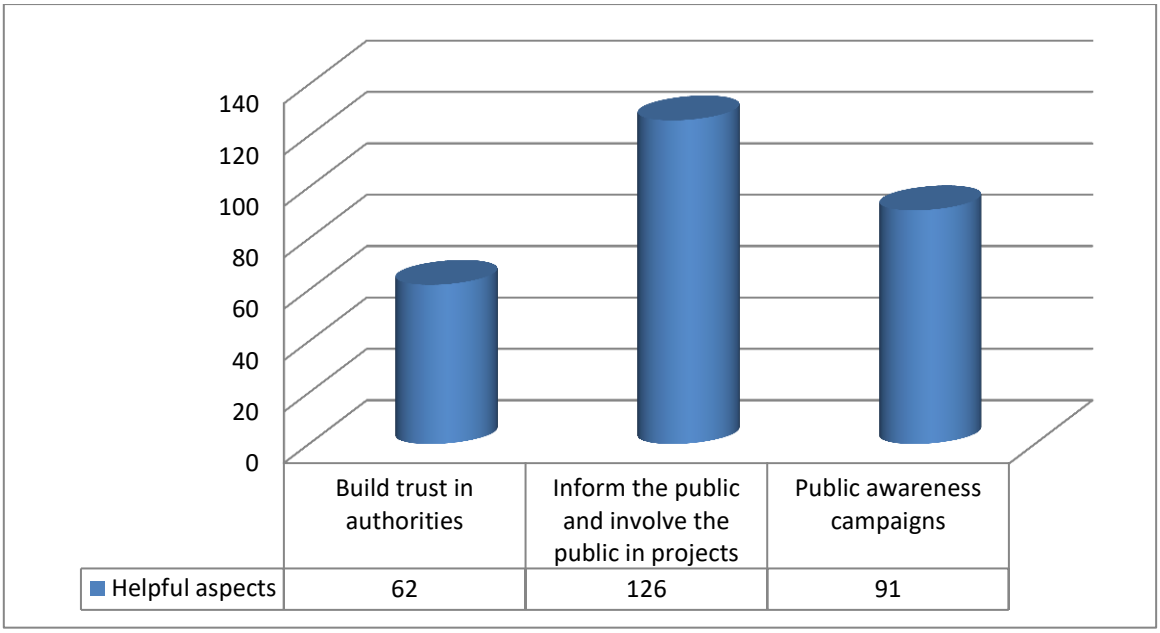


Figure 28: Helpful aspects in total

Inform the public aspect ranks high with 126 responses and the public awareness campaigns is in the second place with 91 responses from participant. Therefore, according to the result of survey, the public acceptance can be improved if the national government, municipalities, and water boards make some programs in order to develop the information about wastewater reuse and also involve the public in projects.

7 Conclusion

In general, the conclusion is done through several ways including, the results which are collected and analyzed from survey in 5 studied location, interview with experts in municipalities and water boards, documents review and web page. Also, the researcher utilized different locations (eco-neighborhoods and ordinary districts). The comparison between these locations appeared interesting points that will be presented in below.

Research question 1 is: “What is the current experience with greywater reuse in the Netherlands?”

With regard to this question the researcher has discovered that the greywater treatment is a relatively new concept in the Netherlands. In the past greywater reuse was not widely practiced in the Netherlands. There are only a few examples in the Netherlands such as Drielanden and Sneek. They are not representative enough to show and attract people to this concept. Also, it is found that the national government, municipalities, and water boards are more interested in other sources of wastewater such as blackwater instead of greywater.

Research question 2 reads: “What is the situation with regard to public acceptance of greywater reuse for different purposes in the studied locations and how can it be explained? Which factors have an impact on public acceptance?”

The purposes identified in general for the reuse of greywater via this study include

- industries,
- crop irrigation,
- toilet flushing,
- firefighting,
- car washing,
- ground water recharge, and
- garden irrigation.

However the first three purposes which are acceptable for the people are

- toilet flushing,
- firefighting,
- car washing.

There is a distinction between eco-neighborhoods and ordinary neighborhoods with regard to their intended greywater usage for crop- and lawn irrigation and ground water recharge. This might be because of supposed health risks.

Furthermore, the results of survey show notable issues. It is obvious that the people who live in eco-neighborhoods have more awareness and experience about the subject and it is predictable. But, it is very interesting that there is a positive prospective about wastewater projects in all locations. Most respondents confirmed that they hugely agree with investment in projects related to wastewater recycling.

According to the results from this survey, the researcher discovered that **Information provided to the public** is the factor which has the greatest impact on the public acceptance of greywater reuse. The next factor of great importance is **the source of water to be recycled**. The third place of the most important factors is shared by the factors **cost of potable and recycled water**, and **trust in authorities**. This study also shows that although the **socio-demographic** factors are the common factor mentioned in researches around the world, but in this study it appears that it is not so important in the Netherlands because it is in the last place.

Research question 3 is: “What are the barriers for public acceptance and how can they be overcome?”

The researcher found that there are some barriers to improve the public acceptance, mentioned in paragraph 6.2, but it appears that **information to the public and involvement of the public in projects** form the key to develop the greywater reuse in the Netherlands. Every **public awareness campaign** must have the priority in the strategic plan for any wastewater recycling project in order to gain the better outcome.

The researcher underpins that these facts contribute to the sustainability of wastewater (greywater) projects and the reuse of greywater for non-drinkable purposes.

As the barriers in paragraph 6.2 (result from the review) do not correspond at all with the objectives at municipal and water board level (see paragraph 6.1), especially with the return on investment period of 50-70 years, it is expected that greywater reuse projects will not be performed, but that instead blackwater treatment to recover energy and nutrients will have a wide preference.

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Appendix 1- Public questionnaire about greywater reuse in the Netherlands

In this survey, you will be asked to give your opinion on different aspects that are related to greywater reuse in the Netherlands. Greywater is wastewater without any input from toilets, which means it corresponds to wastewater produced in bathtubs, showers, hand basins, laundry machines and kitchen sinks, in households, office buildings, schools.

This information will be used by the researcher and supervisors at the University of Twente in order to evaluate the public acceptance of greywater reuse. Moreover this information can be used in new policy and standards in the field of wastewater reuse in the province or at municipality level. We thank you very much for your cooperation. My name is Javad Gharehdaghy Mianjy and I am a student in the MEEM program at the University of Twente (Master of Energy and Environmental management). My contact information is: **j.gharehdaghymianjy@student.utwente.nl, telephone 06-41253226.**

Part 1 - Personal Information

1	What is your gender?	Male	☐	Female	☐
2	What is your age?	……..	Years		
3	What is your civil status?	Single Married	☐ ☐	Single + Children Married + Children	☐ ☐
4	What is your highest completed education?	High school MBO Master	☐ ☐ ☐	 HBO/Bachelor PhD	 ☐ ☐
5	Where do you live?	Zwolle Wapenveld Nijmegen	☐ ☐ ☐	Groningen Sneek	☐ ☐ ☐

Part 2

		Yes	**No**
1	Did you have any knowledge of wastewater recycling and/or greywater reuse, prior to this questionnaire?	☐	☐

2	Do you have experience with any kind of wastewater treatment and /or reuse?	☐	☐
3	Have you heard about greywater reuse in the Netherlands?	☐	☐
4	Do you have information about difference between greywater and blackwater?	☐	☐

Part 3

		Yes	No	I do not know
1	Greywater reuse will be essential for the Netherlands in the future	☐	☐	☐
2	Wastewater reuse is a legitimate water source	☐	☐	☐
3	I agree that the municipality invests in projects which are related to reusing greywater	☐	☐	☐
I my opinion, greywater is suitable for several purposes:				
4	It can be used for firefighting	☐	☐	☐
5	It can be used for car washing	☐	☐	☐
6	It can be used for lawn irrigation	☐	☐	☐
7	It can be used for crop irrigation	☐	☐	☐
8	It can be used for toilet flushing	☐	☐	☐
9	It can be used for industries	☐	☐	☐
10	It can be used for ground water recharge	☐	☐	☐

Part 4

		Strong-ly dis-agree	Disa-gree	Neutral	Agree	Strong-ly agree
1	Trust in authorities that work in recycled water plays a crucial role in the public acceptance	☐	☐	☐	☐	☐
2	I trust the relevant authorities with respect to protection of public health when reusing greywater	☐	☐	☐	☐	☐
3	I would be afraid to use recycled water (greywater) due to health risks	☐	☐	☐	☐	☐

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4	The media can influence the public's behavior about greywater reuse	☐	☐	☐	☐	☐
5	The involvement of the public has an impact on social acceptance	☐	☐	☐	☐	☐
6	Providing information about water recycling process has an impact on social acceptance	☐	☐	☐	☐	☐
7	Providing additional information that addresses the safety of recycled water can influence social acceptance	☐	☐	☐	☐	☐
8	Availability of alternative water resources has an impact on social acceptance	☐	☐	☐	☐	☐
9	Climate change is a big threat for water supply	☐	☐	☐	☐	☐
10	The level of rainfall in the Netherlands is sufficient and there is no need to recycle wastewater	☐	☐	☐	☐	☐
11	The Netherlands will be faced with water scarcity in the future	☐	☐	☐	☐	☐
12	If the Netherlands should ever face water scarcity, I will accept non-traditional water sources such as reused greywater	☐	☐	☐	☐	☐
13	I agree to use the recycled water(greywater) if the source of water is my own house	☐	☐	☐	☐	☐
14	I agree to use the recycled water (greywater) if it is from a communal source in my neighborhood	☐	☐	☐	☐	☐
15	The source of greywater to be recycled is an important factor that influences social acceptance of greywater reuse	☐	☐	☐	☐	☐
16	Reusing greywater which is collected from the whole city in non-drinkable purposes is acceptable	☐	☐	☐	☐	☐
17	I find current water tariffs acceptable and there is no need for a lower price i.e. for a cheaper source of water	☐	☐	☐	☐	☐
18	In case water tariffs would rise, I would consider the use of recycled water (greywater) if it lowers the price	☐	☐	☐	☐	☐

Part 5- Final notes

1- Which of factors have the most influence regarding public acceptance of greywater reuse in the Netherlands?(you can choose more than 1 answers)

A	Level of awareness and familiarity with the subject	☐
B	Trust in authorities	☐
C	The source of the greywater	☐
D	The socio-demographic factors like age, gender and educational level	☐
E	Public information and involvement	☐
F	Availability of water resources	☐
G	The specific use of greywater	☐
H	The cost of recycled water	☐

2- Which of following aspects can help improve the public acceptance of greywater reuse?

a	Public awareness campaigns	☐
b	Build trust in authorities	☐
c	Inform the public and involve the public in projects	☐

Appendix 2- Publieksvragenlijst betreffende grijswaterhergebruik in Nederland

In deze enquête wordt aan u gevraagd om uw opvatting te geven over verscheidene aspecten die samenhangen met het hergebruik van grijswater in Nederland. Grijswater is afvalwater behalve afkomstig van wc's, wat inhoudt dat het bestaat uit water van het bad, douche, handenwasbakken, de was en keukenwasbakken, in huishoudens, kantoorgebouwen en scholen.

Deze informatie wordt door de onderzoeken en begeleiders aan de Universiteit Twente gebruikt om de maatschappelijke acceptatie van grijswaterhergebruik te onderzoeken. Bovendien kan deze informatie worden gebruikt in nieuw beleid en nieuwe standaards op het gebied van afvalwaterhergebruik op provinciaal of stedelijk gebied. Wij danken u bij voorbaat voor uw medewerking.

Mijn naam is Javad Gharehdaghy Mianjy en ik ben een student in het MEEM-programma van de Universiteit Twente (Master of Energy and Environmental Management). Mijn contactgegevens zijn: **j.gharehdaghymianjy@student.utwente.nl, telefoon 06-41253226.**

Deel 1 – Persoonlijke gegevens

1	Wat is uw geslacht?	Man	☐	Vrouw	☐
2	Wat is uw leeftijd?	……..	jaar		
3	Wat is uw burgerlijke staat?	Alleenstaand Gehuwd	☐ ☐	Alleen + kinderen Gehuwd+kinderen	☐ ☐
4	Wat is uw hoogst voltooide opleidingsniveau?	Middelbaar onderwijs MBO Master	☐ ☐ ☐	HBO/Bachelor PhD	☐ ☐
5	Waar woont u?	Zwolle Wapenveld Nijmegen	☐ ☐ ☐	Groningen Sneek	☐ ☐ ☐

Deel 2 – Kennis over grijswater

		Ja	**Nee**
1	Had u – voorafgaande aan deze enquête – enige kennis van	☐	☐

	afvalwater-recycling en/of grijswaterhergebruik?		
2	Hebt u ervaring met enige vorm van afvalwaterbehandeling en/of –hergebruik?	☐	☐
3	Hebt u iets vernomen over grijswaterhergebruikin Nederland?	☐	☐
7	Hebt u informatie over het verschil tussen grijswater en zwartwa-ter?	☐	☐

Deel 3 – Criteria voor duurzaam afvalwater hergebruik (grijswater) in Nederland

		Ja	Nee	Ik weet het niet
1	Grijswaterhergebruik zal voor Nederland in de toekomst essentieel zijn	☐	☐	☐
2	Hergebruik van afvalwater is een legitieme bron van water	☐	☐	☐
3	Ik ben het ermee eens dat de gemeente investeert in projecten die te maken hebben met grijswaterherge-bruik	☐	☐	☐
Ik vind dat grijswater bruikbaar is voor verschillende doelen:				
4	Het kan worden gebruikt voor brandbestrijding	☐	☐	☐
5	Het kan worden gebruikt voor auto’s wassen	☐	☐	☐
6	Het kan worden gebruikt voor gazonbesproeiing	☐	☐	☐
7	Het kan worden gebruikt voor gewasirrigatie	☐	☐	☐
8	Het kan worden gebruikt voor toiletten spoelen	☐	☐	☐
9	Het kan worden gebruikt voor de industrie	☐	☐	☐
10	Het kan worden gebruikt voor grondwaterpeil-handhaving	☐	☐	☐

Deel 4 – Maatregelen om grijswaterhergebruik te regelen

		Geheel oneens	Oneens	Neu-traal	Eens	Geheel eens
1	Vertrouwen in autoriteiten werkzaam in waterhergebruik speelt een cruciale rol in de maatschappelijke acceptatie	☐	☐	☐	☐	☐

		Geheel oneens	Oneens	Neu-traal	Eens	Geheel eens
2	Ik heb vertrouwen in de betrokken auto-riteiten betreffende de bescherming van de volksgezondheid bij het hergebruik van grijswater	☐	☐	☐	☐	☐
3	Ik ben bang om water te hergebruiken (grijswater) wegens gezondheidsrisico's	☐	☐	☐	☐	☐
4	De media kunnen de publieke houding tegenover grijswaterhergebruik beïnvloeden	☐	☐	☐	☐	☐
5	Betrokkenheid van het publiek heeft een invloed op de maatschappelijke accep-tatie	☐	☐	☐	☐	☐
6	Informatie vertstrekken over waterherge-bruik heeft een invloed op de maatschap-pelijke acceptatie	☐	☐	☐	☐	☐
7	Het verstrekken van aanvullende informat-ie over de veiligheid van hergebruikt water beïnvloedt de maatschappelijke accep-tatie	☐	☐	☐	☐	☐
8	Beschikbaarheid van alternatieve water-voorraden heeft invloed op de maatschappelijke acceptatie	☐	☐	☐	☐	☐
9	Klimaatverandering is een grote bedreiging voor de watervoorziening	☐	☐	☐	☐	☐
10	De hoeveelheid neerslag in Nederland is voldoende en er is geen noodzaak om afvalwater te hergebruiken	☐	☐	☐	☐	☐
11	Nederland wordt in de toekomst gecon-fronteerd met waterschaarste	☐	☐	☐	☐	☐
12	Als Nederland ooit wordt geconfronteerd met waterschaarste, dan zal ik onge-bruikelijke watervoorraden zoals herge-bruikt grijswater, accepteren	☐	☐	☐	☐	☐
13	Ik ga akkoord met het hergebruik van grijswater als de bron mijn eigen huishouden is	☐	☐	☐	☐	☐
14	Ik ga akkoord met het hergebruik van grijswater ook als het uit een gemeen-schappelijke bron in mijn buurt of wijk komt	☐	☐	☐	☐	☐
15	De herkomst van het grijswater is een belangrijke factor die de maatschappelijke acceptatie van grijswaterhergebruik beïnvloedt	☐	☐	☐	☐	☐
16	Hergebruik van grijswater dat verzameld wordt van de hele gemeente voor andere doelen dan drinkwater is aanvaardbaar	☐	☐	☐	☐	☐

		Geheel oneens	Oneens	Neu-traal	Eens	Geheel eens
17	Ik vind de huidige waterprijzen aanvaard-baar en er is geen noodzaak voor lagere prijzen, ofwel er is geen noodzaak voor een goedkopere watervoorraad	☐	☐	☐	☐	☐
18	Als watertarieven zouden stijgen, zou ik het gebruik van grijswater overwegen als daardoor de prijzen weer dalen	☐	☐	☐	☐	☐

Deel 5 – Afsluitende opmerkingen

Welke van de volgende factoren heeft de meeste invloed op de maatschappelijke acceptatie van grijswaterhergebruik in Nederland? U kunt meer dan één antwoord kiezen.

a	Het niveau van bewustzijn en bekendheid met het onderwerp	☐
b	Vertrouwen in autoriteiten	☐
c	De herkomst van het grijswater	☐
d	Maatschappelijke demografische factoren als leeftijd, geslacht, en opleidingsniveau	☐
e	Publieke informatie en betrokkenheid	☐
f	Beschikbaarheid van watervoorradenAvailability of water resources	☐
g	Het specifieke gebruik van grijswater	☐
h	De kosten van hergebruikt water	☐

Welke van de volgende aspecten kan bijdragen de maatschappelijke acceptatie van grijswaterhergebruik te verbeteren? U kunt meer dan één antwoord kiezen.

a	Campagnes om het publiek ervan bewust te maken	☐
b	Vertrouwen in autoriteiten opbouwen	☐
c	Het publiek informeren en bij projecten betrekken	☐

Appendix 3- Survey brief with QR codes

WILT U MIJ ALSTUBLIEFT HELPEN DOOR MIJN ENQUÊTE IN TE VULLEN?

Hallo, mijn naam is **Javad Gharehdaghy Mianjy** en ik ben student aan de Universiteit van Twente. Vriendelijk vraag ik u om mijn enquête in te vullen. De gegevens worden gebruikt om mijn masterscriptie te voltooien.

De enquête gaat over het hergebruiken van afvalwater uit keuken, van de was en uit de badkamer, ofwel: **grijswater**. De enquête is gericht op uw buurt en een of meer andere buurten in Nederland. Het invullen van de enquête duurt ongeveer 10 minuten. Als u deze tijd kunt missen, dan waardeer ik dat enorm! Deelname is volledig anoniem, afgezien van uw buurt.

De Nederlandse versie van de enquête vindt u via URL: https://surveyplanet.com/5766dbf826f371f8547b7267). U kunt ook met uw mobiele apparaat (tablet of smartphone) de betreffende QR-code scannen die u naar de enquête leidt. Het gemakkelijkste vult u de enquête in als uw mobiele apparaat een kwartslag is gekanteld.

Bij voorbaat heel erg bedankt voor uw hulp!!

Javad

Juli 2016

Voor Nederlandse enquête,

scan mij:

WILL YOU PLEASE HELP ME BY TAKING THIS SURVEY?

Hello, my name is **Javad Gharehdaghy Mianjy** and I am a student at the Twente University. I would kindly like to ask you if you would please take this survey. The data will be used to complete my master thesis.

The survey is about the reuse of wastewater from your kitchen, laundry and from the bathing room, or rather: **greywater**. The survey is focused on your neighborhood and one or more neighborhoods in the Netherlands. Answering the questions takes about 10 minutes. If you could spare me this time, I would very much appreciate that! Your participitation is fully anonymous, except your neighborhood.

The English version of the survey can be found through URL: https://surveyplanet.com/5761a0f626f371f8547b6aa0. You can also choose to scan the appropriate QR-code with your mobile device, which takes you to the survey. It's easiest if you tilt your mobile device sideways.

I thank you very much in advance for your help!!

Javad

July 2016

For English survey,

scan me:

Appendix 4- First interview

University of Twente

CSTM- Department of Governance and Technology for Sustainability

MEEM- Master of Environmental and Energy Management Program (2015-2016)

Student: Javad Gharehdaghy Mianjy

Thesis Subject: **Public acceptance of greywater reuse in the Netherlands; barriers and motivations**

Abstract:

Over the last century, a lot of changes have occurred in various environments: not only did society change its lifestyle and do people have the tendency to live in urban surroundings, but also did the economic growth, population explosion, development in the industry sectors and climate change make water become a vulnerable resource these days. This study aims to provide information about the acceptance of greywater reuse in the Netherlands. The aim of this study is: First, to assess the current situation of public acceptance of greywater in the Netherlands. To that end, the researcher conducts the survey in two types of locations:

1) The ecological neighborhoods Drielanden in Groningen and Lemmerweg in Sneek

2) Ordinary neighborhoods in Zwolle, Nijmegen, and Wapenveld.

Second, to identify the most important factors which have an impact on the public acceptance in the Netherlands and also the potential barriers which prevent the development of community acceptance and recommended possible ways to overcome them. This research uses the survey in order to gain social acceptance and also conducts several interviews with experts in this fields.

Interview with Mr **Otto Reinstra** member of the Waternet of Amsterdam

Date of interview: 17th of June 2016

Location: Amsterdam

List of questions about greywater reuse in the Netherlands.

1- What is the current situation of greywater in the Netherlands? Did you have any information about greywater reuse? In Amsterdam or Waternet

2- Do you have any program/ actions to separate wastewater into the greywater and blackwater in the Amsterdam province? Do you have any project/ investment about this subject?

3- Based on your experience what are the reasons/incentives to make a plan to use the greywater as a source in future?

4- What is the main problem to increase the usage of greywater reuse in the Netherlands? What are the potential barriers that not allow improving the greywater reuse?

5- Did you hold any survey about public acceptance of greywater reuse in the Amsterdam province?

6- Did you have programs to improve the level of knowledge of people about wastewater reuse via pamphlet, booklet and others for non-drinkable purpose like toilet flushing, car washing and gardening?

7- What do you think that about public involvement? It can increase the social acceptance of greywater reuse?

8- What are the most important factors in the Netherlands to developing the level of public acceptance? (price, source of greywater, trust in authorities, use of greywater, public information, and level of awareness)

9- In your opinion, what is the situation of the greywater reuse in the future?

10- Who is the main responsible on the developing of greywater reuse, if this plan determines as an essential action in the Netherlands?

11- What are the main threats for public acceptance of greywater? How can we reduce hesitate of public about greywater reuse?

Who else can I / should I interview, do you have their contact details?

Can I contact you again for clarification if needed?

Are there any documents / reports that you know even in Dutch about public acceptance and greywater in the Netherlands?

Thank you very much for your cooperation

Appendix 5 - Second interview

University of Twente

CSTM- Department of Governance and Technology for Sustainability

MEEM- Master of Environmental and Energy Management Program (2015-2016)

Student: Javad Gharehdaghy Mianjy

Thesis Subject: **Public acceptance of greywater reuse in the Netherlands; barriers and motivations**

Abstract:

Over the last century, a lot of changes have occurred in various environments: not only did society change its lifestyle and do people have the tendency to live in urban surroundings, but also did the economic growth, population explosion, development in the industry sectors and climate change make water become a vulnerable resource these days. This study aims to provide information about the acceptance of greywater reuse in the Netherlands. The aim of this study is: First, to assess the current situation of public acceptance of greywater in the Netherlands. To that end, the researcher conducts the survey in two types of locations:

1) The ecological neighborhoods Drielanden in Groningen and Lemmerweg in Sneek

2) Ordinary neighborhoods in Zwolle, Nijmegen, and Wapenveld.

Second, to identify the most important factors which have an impact on the public acceptance in the Netherlands and also the potential barriers which prevent the development of community acceptance and recommended possible ways to overcome them. This research uses the survey in order to gain social acceptance and also conducts several interviews with experts in this fields.

Interview with Mr **Hans Valk** member of the Waternet of Leeuwarden

Date of interview: 06th of July 2016

Location: Leeuwarden

List of questions about greywater reuse in the Netherlands.

1- What is the current situation of greywater in the Netherlands? Did you have any information about greywater reuse? In Leeuwarden or Waternet

2- Do you have any program/ actions to separate wastewater into the greywater and blackwater in the Leeuwarden province? Do you have any project/ investment about this subject?

3- Based on your experience what are the reasons/incentives to make a plan to use the greywater as a source in future?

4- What is the main problem to increase the usage of greywater reuse in the Netherlands? What are the potential barriers that not allow improving the greywater reuse?

5- Did you hold any survey about public acceptance of greywater reuse in the Leeuwarden province?
6- Did you have programs to improve the level of knowledge of people about wastewater reuse via pamphlet, booklet and others for non-drinkable purpose like toilet flushing, car washing and gardening?

7- What do you think that about public involvement? It can increase the social acceptance of greywater reuse?

8- What are the most important factors in the Netherlands to developing the level of public acceptance? (price, source of greywater, trust in authorities, use of greywater, public information, and level of awareness)

9- In your opinion, what is the situation of the greywater reuse in the future?

10- Who is the main responsible on the developing of greywater reuse, if this plan determines as an essential action in the Netherlands?

11- What are the main threats for public acceptance of greywater? How can we reduce hesitate of public about greywater reuse?

Who else can I / should I interview, do you have their contact details?

Can I contact you again for clarification if needed?

Are there any documents / reports that you know even in Dutch about public acceptance and greywater in the Netherlands?

Thank you very much for your cooperation

Appendix 6 - Third interview

University of Twente

CSTM- Department of Governance and Technology for Sustainability

MEEM- Master of Environmental and Energy Management Program (2015-2016)

Student:

Javad Gharehdaghy Mianjy

Thesis Subject: **Public acceptance of greywater reuse in the Netherlands; barriers and motivations**

Abstract:

Over the last century, a lot of changes have occurred in various environments: not only did society change its lifestyle and do people have the tendency to live in urban surroundings, but also did the economic growth, population explosion, development in the industry sectors and climate change make water become a vulnerable resource these days. This study aims to provide information about the acceptance of greywater reuse in the Netherlands. The aim of this study is: First, to assess the current situation of public acceptance of greywater in the Netherlands. To that end, the researcher conducts the survey in two types of locations:

1) The ecological neighborhoods Drielanden in Groningen and Lemmerweg in Sneek
2) Ordinary neighborhoods in Zwolle, Nijmegen, and Wapenveld.

Second, to identify the most important factors which have an impact on the public acceptance in the Netherlands and also the potential barriers which prevent the development of community acceptance and recommended possible ways to overcome them. This research uses the survey in order to gain social acceptance and also conducts several interviews with experts in this fields.

Interview with Mr **Anne Helbig** member of the municipality of Groningen

Date of interview: 19th of August 2016

Location: Groningen

List of questions about greywater reuse in the Netherlands.

1- What is the current situation of greywater in the Netherlands?

2- Do you have any program/ actions to separate wastewater into the greywater and blackwater in the Groningen province? Do you have any project/ investment about this subject? (exception of Drielanden)

3- Based on your experience what are the reasons/incentives to make a plan to use the greywater as a source in future?

4- What is the main problem to increase the usage of greywater reuse in the Netherlands? What are the potential barriers that not allow improving the greywater reuse?
5- Did you have programs to improve the level of knowledge of people about wastewater reuse via pamphlet, booklet and others for non-drinkable purpose like toilet flushing, car washing and gardening?

6- What do you think that about public involvement? It can increase the social acceptance of greywater reuse?

7- What are the most important factors in the Netherlands to developing the level of public acceptance? (price, source of greywater, trust in authorities, use of greywater, public information, and level of awareness)
8- Who is the main responsible on the developing of greywater reuse, if this plan determines as an essential action in the Netherlands?

9- What are the main threats for public acceptance of greywater? How can we reduce hesitate of public about greywater reuse?

10- The projects about greywater reuse are interesting for municipality or not? Because I had some interviews and most of them thought that black/yellow water more interesting?

11- Do / did you have any programme to generate energy from greywater/blackwater?(in Groningen)
12- Did you hold any survey about public acceptance of greywater reuse in the Groningen province?
13- Do / did you have any projects to gain phosphorus from urine/ or pee in your province?

14- In your opinion, what is the situation of the greywater reuse in the future?

Who else can I / should I interview, do you have their contact details?

Can I contact you again for clarification if needed?

Are there any documents / reports that you know even in Dutch about public acceptance and greywater in the Netherlands?

Thank you very much for your cooperation

Appendix 7 - Fourth interview

University of Twente

CSTM- Department of Governance and Technology for Sustainability

MEEM- Master of Environmental and Energy Management Program (2015-2016)

Student: Javad Gharehdaghy Mianjy

Thesis Subject: **Public acceptance of greywater reuse in the Netherlands; barriers and motivations**

Abstract:

Over the last century, a lot of changes have occurred in various environments: not only did society change its lifestyle and do people have the tendency to live in urban surroundings, but also did the economic growth, population explosion, development in the industry sectors and climate change make water become a vulnerable resource these days. This study aims to provide information about the acceptance of greywater reuse in the Netherlands. The aim of this study is: First, to assess the current situation of public acceptance of greywater in the Netherlands. To that end, the researcher conducts the survey in two locations:

1) The ecological neighborhoods Drielanden in Groningen and Lemmerweg in Sneek

2) Ordinary neighborhoods in Zwolle /Nijmegen, and Wapenveld.

Second, to identify the most important factors which have an impact on the public acceptance in the Netherlands and also the potential barriers which prevent the development of community acceptance and recommended possible ways to overcome them. This research uses the survey in order to gain social acceptance and also conducts several interviews with experts in this fields.

Interview with Mr **Jan van Dijk** owner of house in Drielanden neighbourhood in Groningen

Date of interview: 19th of August 2016

Location: Groningen

List of questions about greywater reuse in the Netherlands.

1- What is the current situation of greywater in the Netherlands?

2- Do you find any program/ actions to separate wastewater into the greywater and blackwater in the Groningen province/Netherland? (same as Drielanden) Do you have any project/ investment about this subject?

3- Based on your experience what are the reasons/incentives to make a plan to use the greywater as a source in future?

4- What is the main problem to increase the usage of greywater reuse in the Netherlands? What are the potential barriers that not allow improving the greywater reuse?

5- What do you think that about public involvement? It can increase the social acceptance of greywater reuse?

6- What are the most important factors in the Netherlands to developing the level of public acceptance? (price, source of greywater, trust in authorities, use of greywater, public information, and level of awareness)

7- Who is the main responsible on the developing of greywater reuse, if this plan determines as an essential action in the Netherlands?(in your opinion)

8- What are the main threats for public acceptance of greywater? How can we reduce hesitate of public about greywater reuse?

9- The projects about greywater reuse are interesting for municipality or not? Because I had some interviews and most of them thought that black/yellow water more interesting?

10- Do / did you have any programme to generate energy from greywater/blackwater?

11- In your opinion, what is the situation of the greywater reuse in the future?

Who else can I / should I interview, do you have their contact details?

Can I contact you again for clarification if needed?

Are there any documents / reports that you know even in Dutch about public acceptance and greywater in the Netherlands?

Thank you very much for your cooperation

Appendix 8 - Fifth interview

University of Twente

CSTM- Department of Governance and Technology for Sustainability

MEEM- Master of Environmental and Energy Management Program (2015-2016)

Student:

Javad Gharehdaghy Mianjy

Thesis Subject: **Public acceptance of greywater reuse in the Netherlands; barriers and motivations**

Abstract:

Over the last century, a lot of changes have occurred in various environments: not only did society change its lifestyle and do people have the tendency to live in urban surroundings, but also did the economic growth, population explosion, development in the industry sectors and climate change make water become a vulnerable resource these days. This study aims to provide information about the acceptance of greywater reuse in the Netherlands. The aim of this study is: First, to assess the current situation of public acceptance of greywater in the Netherlands. To that end, the researcher conducts the survey in two types of locations:

1) The ecological neighbourhoods Drielanden in Groningen and Lemmerweg in Sneek

2) An ordinary neighbourhood in Zwolle, Nijmegen, and Wapenveld

Second, to identify the most important factors which have an impact on the public acceptance in the Netherlands and also the potential barriers which prevent the development of community acceptance and recommended possible ways to overcome them. This research uses the survey in order to gain social acceptance and also conducts several interviews with experts in this fields.

Interview with Mr. **Jannes Schenkel and Mr. Kees van de Ven** members of waterschap Noorderzijlvest

Date of interview: 13th of September 2016

Location: Groningen

List of questions about greywater reuse in the Netherlands.

1- What is the current situation of greywater in the Netherlands? Did you have any information about greywater reuse? In Groningen

2- Do you have any program/ actions to separate wastewater into the greywater and blackwater in the Groningen province? Do you have any project/ investment about this subject?

3- Based on your experience what are the reasons/incentives to make a plan to use the greywater as a source in future?

4- What is the main problem to increase the usage of greywater reuse in the Netherlands? What are the potential barriers that not allow improving the greywater reuse?

5- Did you have programs to improve the level of knowledge of people about wastewater reuse via pamphlet, booklet and others for non-drinkable purpose like toilet flushing, car washing and gardening?

6- What do you think that about public involvement? It can increase the social acceptance of greywater reuse?

7- What are the most important factors in the Netherlands to developing the level of public acceptance? (price, source of greywater, trust in authorities, use of greywater, public information, and level of awareness)
8- Who is the main responsible on the developing of greywater reuse, if this plan determines as an essential action in the Netherlands?(in your opinion)

9- What are the main threats for public acceptance of greywater? How can we reduce hesitate of public about greywater reuse?

10- The projects about greywater reuse are interesting for municipality or not? Because I had some interviews and most of them thought that black/yellow water more interesting?

11- Do / did you have any programme to generate energy from greywater/blackwater?

12- In your opinion, what is the situation of the greywater reuse in the future?

Who else can I / should I interview, do you have their contact details?Can I contact you again for clarification if needed?

Are there any documents / reports that you know even in Dutch about public acceptance and greywater in the Netherlands?

Thank you very much for your cooperation

Appendix 9 - Information of interviewees:

1) Mr. Anne Helbig, water policy officer at City of Groningen, Groningen municipality,
   Email address: anne.helbig@groningen.nl

2) Mr. Hans Valk, plane maker / adviser on water cycles (Plan former adviser water cycle), Wetterskip Friesland
   Email address: hvalk@wetterskipfryslan.nl

3) MR. Jan van dijk, Owner of the house in Drielanden district/ charge of holding excursion in Drielanden
   Email adree: johannes.van.dijk@home.nl

4) Mr. Jannes Schenkel/ Member of Waternet of Groningen (Waterschap Noorderzijlvest)
   Email adress: j.schenkel@noorderzijlvest.nl

5) Mr. Kees van de Ven/ Strategic Policy Advisor/ Waternet of Groningen (Waterschap Noorderzijlvest)
   Email adress: k.vandeven@noorderzijlvest.nl

6) Mr.Otto Reinstra, Conselor/ Promoter gerywater reuse// Waternet of Amsterdam
   Email address: otto.reinstra@waternet.nl