Effective communication on urban water conservation begins by understanding citizens' prerequisites for behavior change

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Effective communication on urban water conservation begins by understanding citizens' prerequisites for behavior change.

Applying the Behavior Change Wheel on water use behavior in two neighborhoods in Malmö, Sweden.

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Abstract

Climate change will likely cause future water crises in many parts of the world, making it crucial for humanity to adapt to a life in which sustainable water use behaviors are key. To achieve this, organizations managing drinking water need increased knowledge on how to communicate conservation messages that will lead to behavior changes.

This study used the framework *the Behavior Change Wheel* (BCW) which is grounded on three different prerequisites for change (dimensions) that influence behavior: *Capability*, *Opportunity*, and *Motivation*. One high water use neighborhood (230 LPCD) and one low water use neighborhood (145 LPCD) in Malmö, Sweden, were studied and differences in prerequisites within and between groups were assessed. The participants (N = 38; mean age = 47.8 years; SD = 17.4) completed an online questionnaire and the results were used to develop ten ways for the local drinking water producer, *Sydvatten*, to streamline their water conservation message.

No significant differences in dimensions were found between the neighborhoods, contradicting the idea that targeted messages for high- and low use neighborhoods would be suitable. However, the subdimensions *Physical Capability* and *Automatic Motivation* were slightly lower in both groups compared to other subdimensions, meaning that Sydvatten could focus on strengthening these to achieve a higher degree of water conservation in urban households.

Future research could apply the BCW on other Swedish cities to create a much-needed basis of knowledge with which to determine what interventions to adopt in countries with high average water consumption and good access to freshwater resources.

Keywords: climate change, water consumption, water use, behavior change, water conservation, behavior change wheel, COM-B, communication strategies.

Populärvetenskaplig sammanfattning

Vad krävs egentligen för att svenskarna ska sluta diska under rinnande vatten?

Hur ofta reflekterar du över varifrån ditt dricksvatten kommer, vad det kostar och vad som krävs för att det ska nå hem till just dig?

Det enkla svaret är: förmodligen nästan aldrig.

Att förändra invanda beteendemönster är svårt. Framför allt när det inte tycks finnas tillräckligt med incitament för det. Men det finns faktiskt flertalet viktiga anledningar att vi bör bli bättre på att hushålla med just dricksvatten, även i Sverige. En är att det går åt mycket energi för att producera dricksvatten och rena avloppsvatten. Det säger ju sig självt att ju mer vi förbrukar, desto mer energi går åt för detta ändamål och därmed bidrar vi till klimatförändringarna på ett sätt vi kanske inte ens är medvetna om. Att hantera vattenfrågan blir dessutom särskilt aktuellt när faktumet att världens framtida vattentillgång kommer att förändras på grund av klimatförändringarna framkommer. Det är därför av stor vikt att detta mångfacetterade problem tillrättaläggs och att vår påverkan på samhället och världen synliggörs.

Den här studien gjordes i Malmö och tog avstamp i bostadsrättsägares uppfattning om deras egna vattenvanor och vad som hindrar och möjliggör för dem att använda mindre. Ekonomiska incitament, kunskap och mer feedback kring ens konsumtion var några viktiga möjliggörare medan flera ansåg att brist på dessa försämrade förutsättningar för att spara. En särskilt intressant aspekt som kom fram var det faktum att flertalet deltagare var osäkra på vilket system för mätning och debitering av vattenanvändning var på plats i den egna föreningen. Detta signalerar att det finns vissa fundamentala kunskapsglapp som måste adresseras för att svenskarna ska kunna påverka sitt vattenanvändningsbeteende i rätt riktning.

Resultatet från studien användes för att ta fram tio olika förslag för hur Sydvatten (den kommunägda organisation som ansvarar för att producera dricksvatten för stora delar av Skåne) kan förbättra sin kommunikation till invånarna så att den leder till faktisk beteendeförändring. Även andra typer av VA-organisationer kan dra nytta av resultaten från den här studien för att fördjupa sin förståelse för hur svenskarnas förutsättningar för att påverka sitt klimatpåverkande beteende kan förbättras.

Sydvatten, precis som flera andra liknande organisationer, har sedan ett par år tillbaka blivit mer aktiva i att kommunicera nyttan av att spara vatten genom informationskampanjer, reklamfilmer med mera. Samtidigt är det svårt att bedöma hur stor genomslagskraft denna typ av kommunikation har och mer forskning på dess faktiska effekt behövs för att ännu fler förslag på hur kommunikationen kan förbättras kan tas fram.

Generellt behöver svenskarna bli bättre på att hushålla med vatten för att kunna motverka och anpassa sig till de effekter som klimatförändringarna kommer bära med sig i framtiden och VA-organisationer spelar en stor roll i denna omställning. De hanterar inte bara vattenrening och produktion av dricksvatten som är livsviktigt för svenskarna utan sitter även på en enorm mängd information som kan vara avgörande för vår framtid om den förmedlas till allmänheten på rätt sätt.

Contents

1 Introduction

1.1 Context and background

1.1.1 Drinking water management in Europe

Climate change is a complex problem that will affect many aspects of life as we know it, one being the access to and quality of drinking water (Mastrandrea et al., 2014; Unicef, 2020). While more than two billion people worldwide currently do not have access to clean drinking water (United Nations, 2021), some have had the luxury to take this valuable resource for granted. The average household water use in some of the more affluent countries, such as several of the EU-member states, far exceeds the UN-recommended amount (Statista, 2019), which lies between 50-100 *liters per capita per day* (LPCD) (United Nations, n.d.-b). But even in Europe, climate change and population growth have begun to put pressure on freshwater resources, particularly in the southern regions, such as Greece, Italy, Malta and Spain (European Environment Agency, 2018).

Drinking water abstraction rates also varies greatly among European countries. Some, like Sweden, rarely experience demand exceeding supply whereas others, such as Malta, being continuously forced to use over 40% of their available freshwater supplies, thus considered facing perpetual acute water stress (European Environment Agency, 2020). The consequences that climate change is predicted to have in Europe will only exacerbate these disparities, causing the climate in arid regions to become drier and regions already rich in precipitation to get even wetter. Meanwhile, the likelihood for weather extremes forms another threat to the European population which will need to adapt to increased frequencies of disasters like heat waves and floods (European Environment Agency, 2018; Mastrandrea et al., 2014).

It is also likely that the quality of drinking water in Europe will decline due to issues like pollution, saltwater intrusion (seawater leaking into, and damaging freshwater aquifers) and eutrophication, which occurs when an excess of nitrogen in water bodies cause algal blooming which can have detrimental effects on, for example, biodiversity (European Environment Agency, 2018). This adds additional urgency to the promise of resolving a forthcoming water management crisis and

emphasizes the need for strategies that mitigate the consequences of climate change and helps us prepare for whatever is to follow.

Several interventions and policies have already been implemented to address the current and future water stress in Europe. One such policy is the EU-wide *Directive on Energy Efficiency* which took effect in 2012. This legislation calls for, among other measures, individual metering of household hot water use (Directive 2012/27). Many member states have opted for additional measures to curtail water use, some behavioral, some financial and some administrative (Dige et al., 2017); many of them focused on reducing household water use which stands for roughly 10% of the water consumption in Europe (European Environment Agency, 2018, 2020).

1.1.2 Drinking water management in Sweden

This study focuses on Sweden, a country in northern Europe where rainfall is abundant, freshwater lakes are common and the quality-control of drinking water rigorous (Swedish Food Agency, 2019). At 140 LPCD (Svenskt vatten, 2019), the average household water use in Sweden is only slightly lower than the EU-average, which in the last few years has been estimated to 144-147 LPCD (European Environment Agency, 2018, 2020). However, the neighboring country Denmark consumes only roughly 100 LPCD (Danish Water and Wastewater Association, 2017), leading to some questions about what causes this difference.

As opposed to Denmark, Sweden does not have a tradition of metering individual water use, instead having opted for metering water and heat on building level. This sum is then divided among residents based on apartment size, and is often merged into the monthly fee or rent that is paid if one lives in an apartment building (Boverket, 2015a; Dige et al., 2017). This makes it difficult for residents to become aware of their actual water consumption as their use is not reported separately in the invoice.

This could imply that residents of apartment buildings have not yet had reason to pay much attention to their water use, a rationale that is further supported by the evidence that residents in apartments in Sweden use more water than those living in detached houses (Hjerpe & Krantz, 2006). But with the implications of a new legislation that enters into force on July 1st 2021, the use of individual metering and debiting systems (*IMD*) will become more common nationwide (Boverket, 2020a). Although there may still be some reluctance toward the introduction of a nationwide IMD-system, due to ambiguities concerning the cost-effectiveness (Boverket, 2015b), signs of increasing use of IMD have already begun to show as more building owners are incorporating this as a way to become more economical with resources.

Currently, a mere 1% of Sweden's available freshwater resources is abstracted for drinking water with some seasonal variation (European Environment Agency, 2020). But despite this, water scarcity has become a factor to consider, especially during the summer months. Between 2016-2018, large parts of Sweden suffered three consecutive dry summers which led to less precipitation overall and declines in groundwater reserves (Havs- och vattenmyndigheten, 2018). The main problems arising in such cases chiefly concern supply and demand as freshwater resources may not replenish at the same rate as under usual circumstances and that citizens use more water than normal, to which the water supply network is not dimensioned (SMHI, 2021; Sydvatten, 2021c). Due to climate change, Sweden will likely continue to face periods of drought, especially in the southern counties (European Environment Agency, 2018; Naturvårdsverket, 2020). This calls attention to the fact that, despite the country's abundant natural water sources, Swedes need to change their current water use practices and learn how to use the resource in a more efficient, responsible way.

In and around Malmö, the third most populated city in Sweden and the hub of the southwestern part of the county Scania, connecting Sweden to Denmark via the *Öresund bridge*, the 2018 drought had widespread consequences, resulting in poor harvests and forest fires, along with temporary declines in the quality of drinking water (Sydvatten, 2020). The use of drinking water became heavily constrained during this period with several authorities urging inhabitants to cut water use. One of the authorities that were involved in spreading this message was *Sydvatten*, the municipal organization that produces drinking water for large parts of Scania. In recent years, Sydvatten has become increasingly noticeable to inhabitants in Scania as the organization's desire to spread information about water use has led to a number of informative campaigns for inhabitants and educational programs for youth in the region (Sydvatten, 2019).

Overall, the issues of reduced availability and diminishing quality of drinking water in the world has become more apparent and it has become clear that also Swedes needs to develop a different perspective on their water use. To aid Scanian citizens in this transition, Sydvatten aims to improve their communication on water conservation with measures that focus on behavioral aspects to have a greater impact on the target group. This study aims to provide Sydvatten with suggestions for how this can be done by attempting to gain a deeper understanding of what makes it difficult for urban households to conserve water, using two neighborhoods in Malmö as the areas of study: *Söderkulla* and *Västra Hamnen*.

1.1.3 Location of study: Söderkulla and Västra Hamnen

Västra Hamnen is a former shipyard area which in the beginning of the 21st century began its transformation into an attractive housing area with access to the sea, characterized by a holistic integration of sustainable solutions and innovation (Malmö stad, 2013). This is visible in the way the neighborhood has been designed to provide ample space for nature-based solutions like brooks and green spaces to reduce the impact of extreme weather events (*Fig. 1*).

Along with other climate and environment-related strategies, household water use has also been addressed in Västra Hamnen. The aim is to reduce consumption by encouraging and enabling drinking water conservation. One way this is attained is by having *VA SYD* (the organization that is responsible for waste and wastewater treatment in Scania) carry out regular information campaigns in the area (Malmö stad, 2013).

Figure 1. Nature-based solutions in Västra Hamnen
Green spaces and a small canal in the neighborhood Västra Hamnen as examples of measures to prevent flooding in case the urban runoff grid becomes congested. *Source*: A. Dahlbeck.

In a different part of the city, further from the seaside but closer to the open fields in the south lies Söderkulla. This neighborhood is characterized by its cultural significance to Swedish architecture as it was largely built as part of the so called *Miljonprogrammet* (Stigendal, 2007), a political decision to build one million homes for the rapidly expanding population in Sweden from 1965-1974 (Boverket,

2020b). Historically, Söderkulla has been primarily populated by many families with children but the demographic has in recent years shifted and the average age in the neighborhood is now higher than the national average of 45 years of age (*table 1*).

A majority of apartment buildings in Söderkulla are so called *housing co-ops* in which the owners of the apartments together form a cooperative which is responsible for financing renovation projects and similar. But compared to Västra Hamnen, the proportion of housing co-ops relative to rentals is much less pronounced in Söderkulla (*table 1*).

The two neighborhoods also differ in another aspect, which is crucial for this study and has formed the foundation for the decision to choose these two areas: their average water consumption. Västra Hamnen is in this study considered a low use neighborhood at 145 LPCD while Söderkulla is considered a high use neighborhood at 230 LPCD (A. Järvegren Meijer, personal communication, February 25, 2021).

Table 1. Demographic information on Västra Hamnen and Söderkulla
Demographic data for each of the two neighborhoods, including average age and income levels, proportion of housing co-ops among apartment buildings and percentage of population that have completed certain levels of educational degrees. *Source*: hitta.se.

Area	Co-ops	Water use	Avg. age	Education level (%)	Avg. income
Västra Hamnen	86%	Low use (approx. 145 LPCD)	42 years	University (60) High school (19) Elementary school (3)	31,767 SEK
Söderkulla	55%	High use (approx. 230 LPCD)	49 years.	University (16) High school (38) Elementary school (10)	18,565 SEK

1.2 Prior research

1.2.1 Factors that influence water use behavior

Clean drinking water is essential for many daily activities taking place both indoors and – to some extent – outdoors. Typically, most of the drinking water consumed daily is used for sanitary behaviors like showering and flushing the toilet, which is evident also in Sweden where a majority of the water consumed per day in households is used for these purposes (Svenskt vatten, 2019).

Out of indoor and outdoor water uses, the latter seems to be easier to curtail as shown in a study by Sadalla et al. (2012). They let participants prioritize water use behaviors when given a pretend budget that they were to spend on different water uses of higher or lower costs. Both the high- and low-budget groups allocated more of their budget to indoor behaviors, specifically those for sanitary purposes, and less money to their outdoor uses, involving watering plants and planting water-demanding vegetation in their gardens. But while outdoor use in some cases can be easier to reduce, indoor water use needs to be targeted for a different reason: these are behaviors performed by everyone with access to indoor hygienic facilities and more aid from authorities may be needed to allow people to reduce this type of consumption.

The reasons for why certain water use behaviors may be more difficult to change than others vary but many of the obstacles seem to be connected to how good we perceive our prerequisites for change to be. Water conservation has been connected to one's own ability to change current behaviors, such as possessing enough knowledge or skills, external circumstances like socio-demographic factors, social situation or household size, as well as internal factors like attitudes, habits and values (Addo et al., 2018a; Addo et al., 2018b; Aldiwari et al., 2019; Fielding et al., 2012; Graymore et al., 2010).

Knowledge of water management and consequences for the climate and environment in culture is one factor that affects our water use behavior. A large part of the existing literature covers research on water conservation behaviors in areas well-known for recurrent bouts of drought, for example certain areas in Australia (Addo et al., 2018a; Aldiwari et al., 2019; Graymore et al., 2010) and arid states in the USA like Arizona (Harlan et al., 2009; Larson & Redman, 2014; Sadalla et al., 2012). Residents in such areas are raised in an environment where water conservation is an important part of everyday life (Graymore et al., 2010), as opposed to countries like Sweden. But since even countries like Sweden have begun to sense the consequences of water scarcity and drought, the urgency of adding to already existing knowledge becomes apparent. To address water consumption, we also need to focus on carrying out research also in countries where water consumption per capita is high and may be difficult to change due to a history of abundant water supply and a different culture surrounding water conservation (Dige et al., 2017). Until recently, water stress has not played a significant role in Swedes' view on drinking water use. Hence, more research on behavior changes and water consumption in Sweden is needed. This would allow for an easier comparison to existing research and makes it possible to investigate what types of interventions are most effective when it comes to reducing Swedes' water use as their prerequisites for change may differ from those living in countries where water stress has since long been something to adapt to.

Motivation is another important factor in behavior change and an individual can be driven to reduce their water consumption based on habits and attitudes that

together form internal motivation, as opposed to external motivation arising from factors like social pressure that are formed in an individual's environment (Addo et al., 2018b). Many different psychosocial factors can influence our intentions to conserve water and our attitudes. But despite this, there is evidence to suggest that our actions do not always align with our intentions or views. For example, it seems like attitude is not always a good predictor of actual water use (Aitken et al., 1994; Gregory & Di Leo, 2003). An individual may regard themself as pro-environmental and a supporter of water conservation when they could actually be using more water than a neighbor who may not have the same views on their own behavior. Similarly, people may have the wrong perception of their own water use and falsely believe that they are using a lot less water than they are (Araya et al., 2020; Fan et al., 2014). Certain groups seem to be worse predictors of this type of behavior, such as high-income households signaling that there are socio-demographic effects at play as well in that higher-income residents can afford a greater number of water-demanding appliances and do not have to worry about the costs in comparison to low-income households (Fan et al., 2014).

Overall, it seems like companies that use communication to achieve a higher degree of water conservation would do good in first establishing an understanding for what facilitates behavior change in the target population. These facilitators can then be promoted by appealing to some key psychosocial aspects while considering the socio-demographic context in which they are implemented.

1.2.2 Water conservation interventions and their effectiveness

Countless water conservation interventions have been used to target people in different countries. Some of them draw from more restrictive measures such as prohibitions or financial rebates or other types of pricing interventions, while others employ softer measures like informative messages.

There is evidence to show that non-pricing interventions and programs for behavior change can be effective – even as effective as pricing interventions if implemented correctly (Allcott, 2011). A good way of implementation could mean focusing on a target behavior, tailoring the way a message is conveyed to appeal to the audience, and identifying an adequate target group (Ehret et al., 2020; Goette et al., 2019; Larson & Redman, 2014; March et al., 2013).

Focusing on specific target behaviors (i.e., behaviors that the intervention intends to affect) can be a useful influencing tactic, especially when it comes to distinguishing outdoor and indoor use. Research speaks for targeting all behaviors that need to be curtailed and not assuming that one behavior will lead to another (a so-called *spillover-effect*). This issue was illustrated by Kneebone et al. (2018) who showed that people may view indoor and outdoor water uses as completely separate from each other and that interventions targeting only one of them, hoping that it

will lead to a decrease in both, may fail to achieve the desired effect. However, as shown by (Mayer et al., 1999), some unsustainable behaviors may lead to an increase in other unsustainable behaviors, independent of where in the house they take place. An example of this was the fact that people who owned a swimming pool tended to use more water overall as well as using more water for other behaviors (such as flushing the toilet) than people without a swimming pool.

The type of intervention or the way a message is conveyed has also been shown to be of importance for changing behavior as a result (Ehret et al., 2020; Martínez-Espiñeira et al., 2014). Numerous successful attempts to reduce unwelcome or unsustainable behavior such as littering have been put in place based on different types of appeal. In general, the messages that use social normative messages (e.g. "Don't mess with Texas" that was used to stop Texans from littering along the highway) are more successful than those that are purely informative (Ehret et al., 2020; Lede et al., 2019) Although informative messages have a clear value and have been effective – and even essential – in the past (Dige et al., 2017; Hodges et al., 2020; Lede et al., 2019), there is evidence to show that information that increases knowledge does not alone automatically result in behavior change (Abrahamse et al., 2005; Fielding et al., 2016; Schultz et al., 2016). This indicates that informative, measures like education campaigns, would benefit from being accompanied by other measures.

In recent years, evaluations on the effectiveness of water conservation messages and interventions have become more common and one conclusion drawn from some of these studies is that sometimes, conservation interventions have failed to target the most important audiences, meaning the groups that are the highest users (Larson & Redman, 2014; March et al., 2013). What groups use the most can vary depending on the area but in general include households with high income, since these tend to be able to afford to use more water than low-income households (Fielding et al., 2012; Harlan et al., 2009), and home owners with access to a garden and potentially also a swimming pool (Mayer et al., 1999).However, Sweden proves to be an interesting exception to this common notion as there is ample evidence to show that people living in apartments use more water than those living in houses in Sweden (Hjerpe & Krantz, 2006).

Another notable aspect pertaining to target audience is that youth can be a suitable such group for some interventions, like educational programs, but that they rarely have influence over all types of household water uses, such as outdoor water use (Larson & Redman, 2014). In general, teenagers are heavy water users (Mayer et al., 1999), which makes for a high total water consumption but focusing on the adults that make the final decisions could be more effective in terms of achieving water conservation.

Thus, based on existing literature that covers the success of water conservation messages, interventions seem to be more effective when they target a suitable behavior and audience, and if they appeal to a combination of psychosocial factors

to influence the audience. As established, these factors could be connected to people's motivation to change behavior, their perceived capability of doing so and the external circumstances that promote or hinder change. These three aspects are the components that make up the core part of the framework *The Behavior Change Wheel* (BCW) (Michie et al., 2011), which will be the analytical framework used in this study.

The three terms capability, opportunity and motivation are complex and may be defined differently depending on context. Therefore, in an attempt to demarcate their different meanings and condense them into something more tangible, this study defines the terms to be connected to water conservation in much the same way as Addo et al. (2018a, 2018b, 2019), which is elaborated further in the methods section.

1.2.3 The Behavior Change Wheel and the COM-B system

The BCW is a framework that aims to understand the underlying prerequisites for behavior change and use this understanding to determine the most effective interventions to influence the target behavior. BCW was developed to combine aspects of existing frameworks that Michie et al. (2011) meant fell short in addressing the complicated nature of behavior and communication. Hence, BCW is a comprehensive framework which takes both policy and behavior into consideration and placing interventions as a mediator between the two. This makes the framework well suited for this type of study where the focus is on developing an in-depth understanding of behavior and formulate adequate ways to change it.

The core of the framework is made up of three dimensions: *Capability*, *Opportunity*, and *Motivation*. Each is further divided into two subdimensions that can be seen as prerequisites that need to be in place to facilitate an individual's capacity to alter behavior. The three dimensions influence and are influenced by each other and behavior, (*Fig. 2*), resulting in the acronym COM-B (Michie et al., 2011).

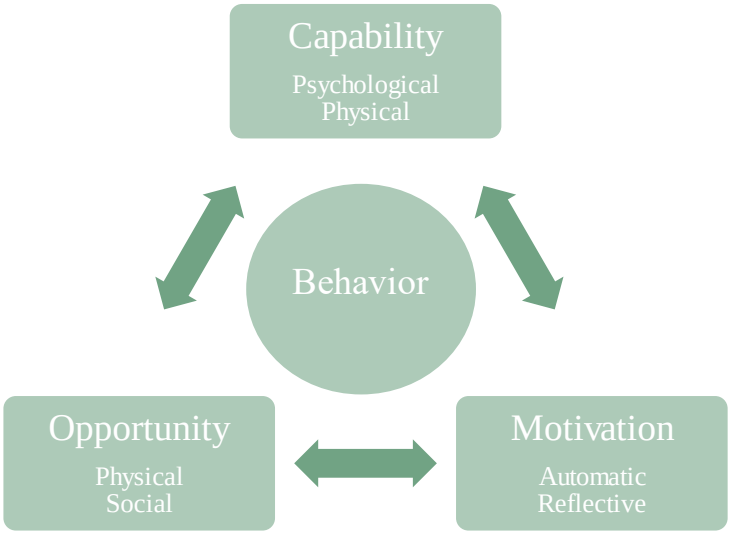

Figure 2. The COM-B system
Illustration of how the different dimensions of the COM-B system influence and are influenced by each other. Source: created by author based on Michie et al. (2011).

Based on the COM-B system, Michie et al. (2011) suggest intervention types they have deemed most effective in facilitating behavior change. In their article, they identified nine intervention types that could be used to promote an individual's prerequisites for changing behavior (*table 2*). The interventions will be further elaborated in the discussion of this study.

Table 2. Intervention types suitable to strengthen subdimensions
Suitable intervention types to help increase lack or weakness of specific prerequisites for behavior change as identified by the creators of the BCW framework. Source: created by author based on Michie et al. (2011).

COM subdimension	Intervention types in case of absence/weakness of subdimension
C-Physical	Training, Enablement.
C-Psychological	Education, Training, Enablement.
O-Physical	Restriction, Environmental restructuring, Enablement.
O-Social	Restriction, Environmental restructuring, Enablement.
M-Automatic	Persuasion, Incentivization, Coercion, Environmental restructuring, Modeling, Enablement.
M-Reflective	Education, Persuasion, Incentivization, Coercion.

The BCW was originally developed to address health issues such as obesity and smoking and has since been widely applied within the health field. However, in recent years, the framework has also gained more traction in other fields, including water conservation (Addo et al., 2019; Addo et al., 2018a; Addo et al., 2018b). BCW has shown promise when it comes to understanding and enabling water conservation, but more research is needed to fully appreciate its usefulness in this field. This study makes use of adaptations to the original framework that have been made by other authors that have applied the BCW on water conservation and follows their definitions of the different COM dimensions.

Capability refers to an individual's capacity to change their behavior, which could include accessing information needed to conserve (Psychological) or possessing the skills required to fix a leaking faucet (Physical), thus – in simple terms – being equivalent to the commonly used concept of *self-efficacy* (Addo et al., 2019; Addo et al., 2018a). Opportunity concerns external factors that hinder or facilitate the ability to change behaviors, like financial resources available to invest in water-saving appliances (Physical) and social norms (Social). Lastly, Motivation arises from internal processes such as habits and emotions (Automatic) or experiencing a sense of obligation to the environment and future generations (Reflective) (Addo et al., 2018a; 2018b; 2019).

1.3 Purpose of study

This study aims to contribute to existing knowledge on water use behavior by applying the BCW framework on data from Sweden – a country which has plenty of freshwater resources and has long had a different mentality regarding household water use than most other countries previously studied. Moreover, the BCW, despite having shown some promise in earlier research has not yet been extensively used in connection to water use but by using it in this study, we will gain more insight into its possibilities for future research and the development of interventions to reduce drinking water consumption in Sweden specifically.

The aim of the first part of the study is to investigate whether there are differences between the two neighborhoods in access to the different COM dimensions and if one of the subdimensions is weaker than the others, making it clearer what type of intervention Sydvatten could try to focus on. If there are differences in perceived access to the COM dimensions between neighborhoods, it would be valuable to consider whether more targeted interventions could be used to strengthen the prerequisites that are low to promote people's chances of being able to reduce their water consumption.

1.3.1 Research questions

1. Are there differences in strength of the COM dimensions between apartment owners in a neighborhood with high indoor water use and a neighborhood with low indoor water use?
2. Is one of the subdimensions significantly lower or higher across the entire sample which would indicate strengthening this one as especially important?
3. What interventions have potential to reduce household water consumption and how can Sydvatten use these to convey the importance of water conservation to the residents in Malmö?

2. Methods

2.1 Design

The first part of the study took the shape of an comparative survey study that used both a more deductive approach by basing some items on an already existing framework, as well as a more inductive method since some items were developed with the goal of simply finding out more about Behavior Change Interventions (BCI) and their effectiveness. The respondents' data, consisting of answers to multiple-choice questions and free-text answers, were coded using a method adopted from the BCW and then analyzed using quantitative and qualitative methods to judge strength of the COM dimensions.

2.2 Survey

2.2.1 Location

To narrow the study's target group to households that could be presumed to use the most drinking water in Malmö on average, only neighborhoods that consisted mainly of apartment buildings were considered for the study. The organization VA SYD was contacted in February 2021 for more information on individual-level water use in these types of neighborhoods as this information was not readily available to the public. The choice to include only neighborhoods consisting mainly of apartment buildings was made since it would allow VA SYD to easier estimate water consumption on household-level, seeing as certain assumptions had to be made regarding who lives in these areas, as well as the fact that mixed neighborhoods (apartment buildings and detached houses) of either high or low use could be difficult to identify.

Per calculations from VA SYD, two different neighborhoods were identified as places of interest (A. Järvegren Meijer, personal communication, February 25, 2021). In February, satellite images showing specific areas of high- and low use respectively for the neighborhoods Söderkulla and Västra Hamnen were obtained from the organization (*Fig. 3* and *Fig. 4*). A third satellite image outlining the

location of the two neighborhoods in relation to each other in the city was shortly thereafter obtained from Google maps (*Fig. 5*).

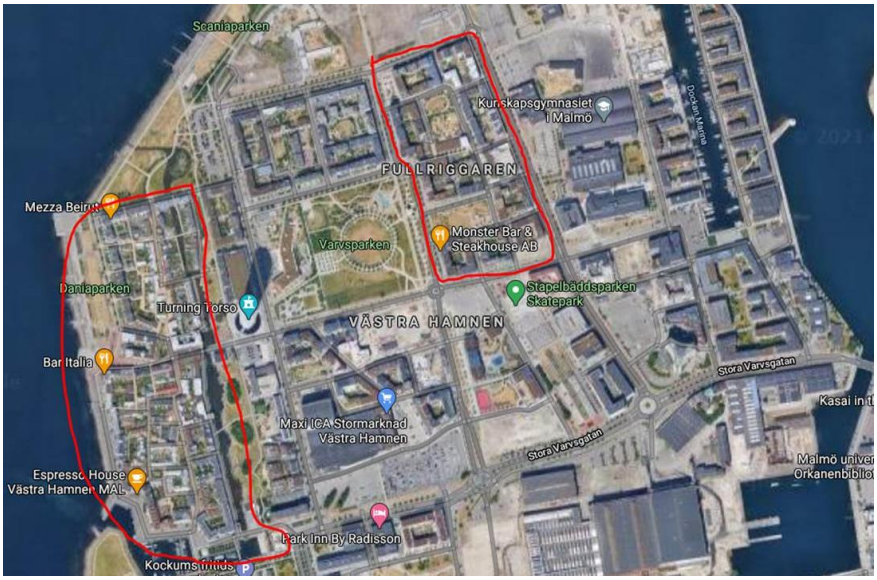

Figure 3. Low use quarters
Low use quarters in neighborhood Västra Hamnen outlined in red. *Source:* Google maps. Image manipulated by A. Järvegren Meijer, VA SYD.

Figure 4. High use neighborhood
The southern part of high use neighborhood Söderkulla outlined in red. *Source*: Google maps. Image manipulated by A. Järvegren Meijer, VA SYD.

Figure 5. High use and low use neighborhoods' location in Malmö
The total areas finally included in the study outlined in red and their location relative one another in Malmö outlined in red. The entire neighborhood Västra Hamnen in the north and Söderkulla in the south. *Source*: Google maps. Image manipulated by author.

2.2.2 Pilot study: semi-structured interview in low use neighborhood

The initial plan was to let the study take a deep dive into finding out how citizens in the two neighborhoods perceive their prerequisites for changing water use habits through semi-structured interviews with participants from each identified area. This, however, proved more difficult than anticipated as the sampling method resulted in no more than one interviewee. This person volunteered to participate when contacted by the housing co-op in which they lived, after the author of the study had sent an e-mail to the head of the board asking for assistance in reaching out to its members. This type of convenience sampling was used to keep to the study's relatively narrow geographical location and was deemed a better method in the current situation as the prevailing pandemic made options that would otherwise have been more suitable less ideal, such as asking people on the streets or simply knocking on doors.

The interview was conducted via telephone in March 2021 and was largely based on the COM-B system while allowing for a more thorough understanding of one resident's views on water conservation in the low use neighborhood Västra Hamnen. While this interview could not be used in the analysis of this thesis, it contributed a great deal to the way the questionnaire and the associated coding scheme were designed.

Due to the unforeseen challenges with sampling, the study's method had to be restructured to allow for data collection through an online questionnaire in the hopes of reaching more participants. However, while the open-ended questions included in the questionnaire could not compare to the amount of qualitative data that would have been collected through interviews, a survey study made it possible to receive responses from residents who had little to no interest in the topic.

2.2.3 Questionnaire

An online questionnaire containing in total 17 items (*appendix 1*) was created using Google Forms in April 2021. The questionnaire separated the items into four parts; one determining demographic information, one respondents' performed behavior, and two designed to capture the essence of the COM dimensions as well as views on behavior change interventions.

The questions reflecting the COM dimensions were developed by using some items and themes from the survey studies carried out by Addo et al. (2018a) and Addo et al. (2019). Not all items/themes from the previous studies were included since the questionnaire in this study was developed to be short and to allow for more qualitative data rather than purely quantitative. The items/themes that were chosen were the ones which were deemed to fit a Swedish context the best and they were then translated to Swedish before the questionnaire was published. The

multiple-choice question on performed behavior and the Likert-scale questions on opinions on water conservation, as well as a few of the demographic questions resulted in seven items (*appendix 1*) that were analyzed quantitatively using *IBM SPSS version 27*. An additional three items were open-ended questions (*appendix 1*) and were instead analyzed qualitatively using the coding system developed from Addo et al. (2018a; 2018b; 2019) (*table 3*). The two items that were meant to mirror the respondents' views on behavior change interventions were instead developed largely based on the pilot study and previous literature to inductively investigate the reach of previous water conservation messages and whether these had been effective in changing behavior.

The respondents were required to answer every question in the questionnaire but, in most instances, they had the option to either tick a box saying "I don't know" or write this as their response to the open-ended questions.

A final item at the end of the survey asked the respondents to fill in their e-mail addresses in case they were interested in participating in an in-depth interview via phone in the following weeks. Only one participant left their e-mail address but did not respond to the follow-up e-mail.

2.2.4 Procedure

For comparison purposes, only the data of apartment owners was included and not the data collected from residents of rental apartments. The reason for this was the assumption that as an apartment owner and member of a housing co-op, you have greater freedom and responsibility when it comes to choosing and installing water-demanding appliances such as dishwashers, washing machines and shower heads as opposed to renters who usually depend on the owner of the apartment for such things.

In April 2021, the questionnaire was posted on Facebook in three groups. The first was *Söderkulla en del av Malmö* with 761 members. It was comprised of members currently living in Söderkulla as well as some having lived there previously. However, the call for participants made it clear that the survey was for current residents of the neighborhood. To increase the likelihood of getting enough answers to do a statistical analysis, the whole of Söderkulla was included in this group, meaning that the total area reached was outside what was outlined in the information from VASYD (*Fig. 4*). A reminder was sent to the group after one week and another after two weeks from the day the questionnaire was posted. In May, the questionnaire was posted in a second group, *Malmökäris*, with 5948 members calling for more participants from Söderkulla only.

The third group was named *Västra Hamnen-koll* with 5459 members, including both residents and local companies in Västra Hamnen. The residents that

were reached also included the entire neighborhood, including areas outside the outlined quarters (*Fig. 3*).

2.2.5 Participants and characteristics

During the three weeks the survey was online, it garnered a total of 13 respondents from Söderkulla and 37 from Västra Hamnen. Seven participants residing in rental apartments were excluded from Västra Hamnen and one who owned a house without connection to a housing co-op. In Söderkulla, one participant was excluded since they lived in a house without connection to a housing co-op and an additional three were excluded as they rented their apartments. This left a total of 38 respondents: 9 from Söderkulla and 29 from Västra Hamnen. Demographic data of the sample is summarized below (*table 3*).

Table 3. Summary of demographic information of sample
Demographic information collected from questionnaire.

Area	Gender	Avg. age	Occupation (%)	Education (%)	IMD (%)
Västra Hamnen (low use) (*n* = 29)	59% female 41% male	47.6	Working (72) Retiree (21) Student (3.5) Other (3.5)	Elementary (24) University (86)	Yes (41) No (52) Unsure (7)
Söderkulla (high use) (*n* = 9)	67% female 33% male	48.4	Working (44.5) Retiree (33.5) Student (11) Other (11)	Elementary (22) University (22) N.A.* (56)	Yes (56) No (22) Unsure (22)

Note. * = missing data. Question was added after the first four responses.

2.2.6 Ethical procedures

To ensure the participants' anonymity, the questionnaire did not contain questions that would make it possible to deduce any private information from the responses. As the questions did not aim to investigate any private matters and since participants could choose not to answer the questions by simply ticking "other" or "don't know", the right to anonymity was the most important ethical issue that had to be managed in the survey.

Prior to participating in the questionnaire, the respondents were informed of the purpose of the survey, what the results would be used for, as well as the fact that the questionnaire would be entirely based on self-reports and that no

measurement of actual water consumption would be conducted. In addition, they were also given the author's e-mail address in case of questions.

All e-mails that had any connection to the survey study were deleted after the thesis was approved to delete traces that could lead to any unauthorized person being able to track down the participants.

The interview included in the pilot study was also carried out with regard to the participatory rights to ensure that ethical standards were met. Before the interview was commenced, the participant was informed of their rights, such as their right to opt out at any time and right to anonymity throughout. The interview was recorded with the participant's approval and was transcribed and sent to the participant to allow for any mistakes to be corrected. Throughout the transcript, the participant's name was withheld, and they were instead referred to as Interviewee 1. Immediately after the thesis' approval, the transcript was destroyed, and the recording deleted.

2.3 Analysis

2.3.1 Questionnaire

2.3.1.1 Quantitative data analysis.

There were in total seven items in the questionnaire that were connected to the COM dimensions and could be analyzed quantitatively. These items focused on demographic data (occupation, age, household size and presence of IMD-system in housing co-op), performed behaviors, opinions on nine statements pertaining to water consumption and management (a 5-point Likert-scale ranging from "Is incorrect" to "Is correct") and a 10-point Likert-scale self-evaluation of awareness of the water issue, ranging from "I am not very aware" to "I am very aware".

The answers to these items were quantified by creating a point-system for each alternative given. The behaviors ranged from 0-1 points ("I do not perform" or "I do perform"), the 5-point scale gave 0-4 points, and the 10-point scale gave 0-9 points. Each respondent's points were summed up to create the raw data.

To determine differences in strength of a dimension/subdimension between the two neighborhoods, the raw data was converted into percentages and an independent samples t-test was conducted. The reason for using proportions and, in some cases, reporting the data in percentages was due to the relatively uneven sample size which was heavily dominated by participants from the low use neighborhood relative to participants from the high use neighborhood.

Lastly, the raw data was standardized by dividing each value by the standard deviation for each subdimension. This was done to avoid Type I and II errors (either running the risk of not accepting a significant result or the risk of accepting a non-significant result respectively) as using a *repeated measures one-way Analysis of Variance* (*ANOVA*) on proportions can lead to incorrect results that may increase the likelihood of committing one of the two errors (Jaeger, 2008). A repeated measures one-way ANOVA was deemed the best option to determine differences between the six subdimensions across the entire sample as the raw data held true to the assumptions needed to be fulfilled for the analysis to provide reasonable results (The Odum Institute, 2018). The one assumption that was not fulfilled at first glance was the assumption of the data being normally distributed. According to the *Central Limit Theorem*, a rule of thumb says that samples with a number of $n \geq 30$ can be assumed to be normally distributed (Schumacker, 2015). Nevertheless, the raw data was plotted on histograms using SPSS and was judged to approximately follow a normal distribution, which, according to The Odum Institute (2018), is enough for a repeated measures one-way ANOVA. In this statistical analysis, the independent variable was defined as COM dimensions with each subdimension forming a related group within the variable (equivalent to different experimental conditions). The dependent variable was the participants' scores.

2.3.1.2 Qualitative data analysis.

The analysis of the qualitative material collected from the questionnaire's open-ended questions was done using a conceptual-driven approach (Gibbs, 2018). In this approach, conceptualizations of the COM-B system as developed by Addo et al. (2018b) and Addo et al. (2019), acted as basis for the coding scheme (*table 4*).

Table 4. Coding system for qualitative data analysis
Compilation of the codes used for the qualitative data analysis grouped into the respective subdimensions of the COM-B system. Not all themes (e.g., Trust) were found in the sample. C = Capability; O = Opportunity; M = Motivation.

Category/theme	Code
C-Physical	*Repair/install*: • Possesses skills and physical ability to repair/install appliances.
C-Psychological	*Feedback*: • Receives feedback on behavior. • Uses feedback to change behavior. *Information*: • Aware of water use and its connection to climate change. • Concern for the environment/climate. • Seeks information. Finds it understandable and accessible.
O-Physical	*Household*: • Finds water conservation time consuming. • Household prevents water conservation (e.g., size or composition). *Income*: • Considers financial incentives important to facilitate change.
O-Social	*Social norms*: • Engages in behavior that may be outside what is considered the norm, e.g., not flushing toilet after every use. *Social identity:* • Participates in discussions about water use among friends/family. • Performs behaviors that feel natural, self-evident, or sensible. *Trust:* • Shows trust in authorities and other citizens' ability to conserve.
M-Automatic	*Attitude*: • Attitude to water-saving devices (e.g., difficult to use). *Habits*: • Mentions performing certain behaviors due to habit. • Does not reflect on water use behaviors. • Is driven by convenience.
M-Reflective	*Intentions*: • Shows intentions to conserve water. *Reflections on water conservation*: • Finds water conservation mentally strenuous. *Obligation*: • Shows a sense of obligation to society and to future generations. • Wishes to be part of a greater cause.

Each answer was coded according to the system outlined in table 4 based on statements made by the participants that were interpreted by the author as either showing strength or a weakness of a subdimension. In addition, each respondent's views on BCI coded according to the scheme developed for this purpose (*table 5*).

Table 5. Coding system for Behavior Change Interventions (BCI)
Compilation of the codes used for the qualitative data analysis on BCI. One code concerned the type of BCI the participants reported having seen and the other code was to determine effectiveness of the messages sent out and participants' views on preference to help determine how future messages can become more effective.

Type of BCI	Coding for effectiveness of BCI
TV	Have been reached by water conservation messages.
Radio	Have changed behavior due to water conservation messages.
Newspapers	Preferred ways of communicating.
Social media	Expresses preferences for certain senders.
Other	

2.3.2 Determining suitable behavior change interventions

The results from the quantitative and qualitative analyses of the questionnaire were used in conjunction with findings of previous research and the BCW framework to determine what interventions would be suitable to strengthen the residents' perception of their Capability, Opportunity, and Motivation, i.e., their prerequisites for behavior change. The recommended intervention-types corresponding to the different subcomponents (Michie et al., 2011) (*table 1*) made up the main part of the suggestions but were further enhanced using literature on water use behavior and opportunities given by the local context to which this study was adapted.

In the end, a total of ten suggestions were developed, all with the aim of illustrating how Sydvatten can improve their future communication aimed toward promoting sustainable water use.

3. Results

3.1 Quantitative data

3.1.1 Behavior

The participants were asked to indicate from a list of water-saving behaviors which ones they performed at home, (*Fig. 6)*. Turning off the tap while brushing teeth was the most common behavior: 83% of participants in low use neighborhood and 78% in high use neighborhood reported doing this. In the low use neighborhood, showering instead of taking baths was the second most common behavior (76%). In the high use neighborhood, the most common behaviors aside from turning off tap while brushing teeth were fixing leaks within one week of discovery and only washing full loads of laundry, both performed by 67% of the participants. One participant from the low use neighborhood mentioned avoiding dishwashers as an example of another regularly performed behavior to conserve water (*Fig. 6)*.

The least performed behaviors differed somewhat between the two groups. The two least common water saving behaviors in the low use neighborhood were not flushing toilet after every use and washing vegetables in a bowl, both behaviors only performed by 7% of participants. A higher number of participants in the high use neighborhood reported not flushing toilet after every use (22%) and in this group, the least commonly performed behaviors were instead washing vegetables in a bowl, reusing water in apartment, and installing water saving devices at home, such as low-flow shower heads and water-efficient dishwashers. Only 11% of the participants indicating performing these behaviors (*Fig. 6)*. In the entire sample, only one participant (3%) said they did nothing at all.

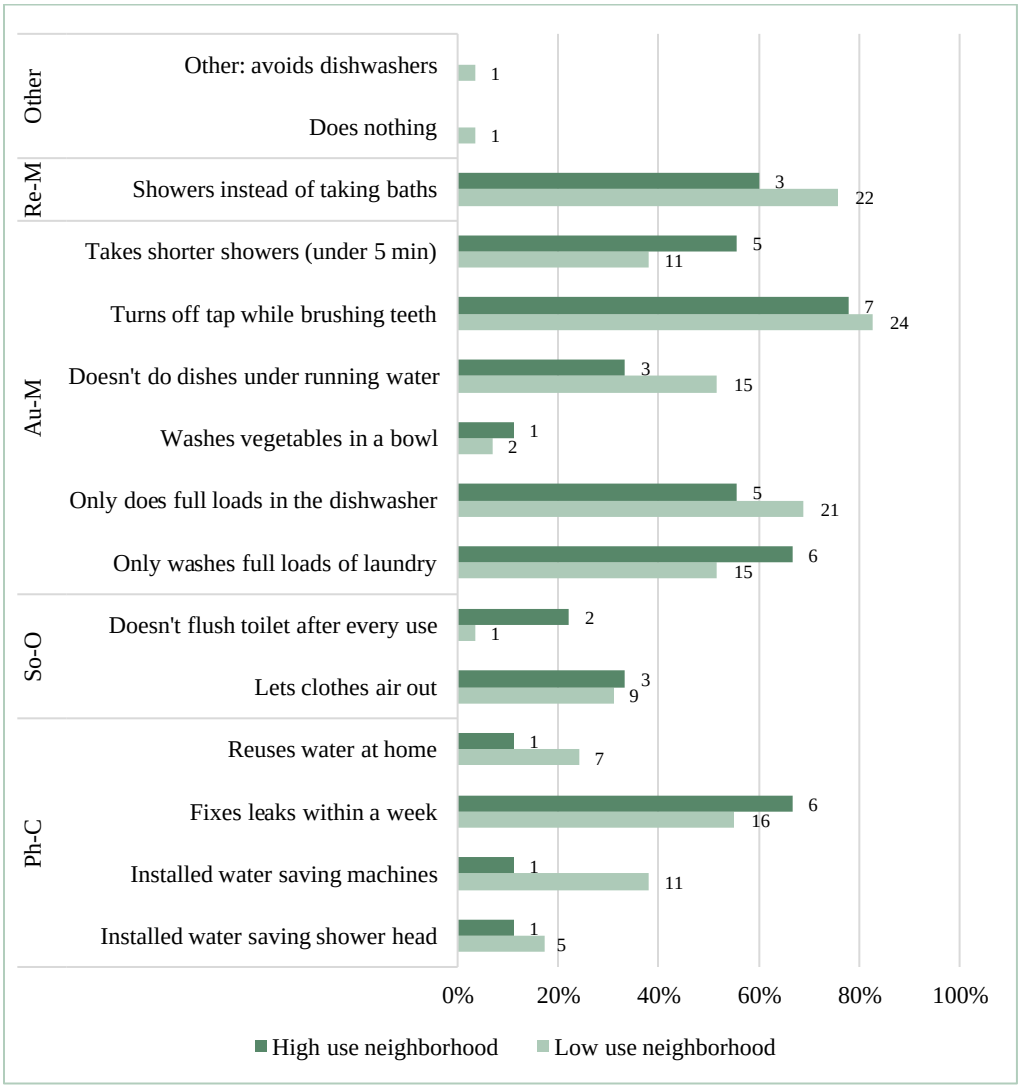

Figure 6. Participants' regularly performed behaviors at home
Comparison between the two neighborhoods using the percentage of participants that indicated performing a certain behavior on a regular basis at home. The number of participants having given a certain answer is given next to the bar.
* = missing answers. Four out of 38 participants were not asked this question.
Ph-C = Physical Capability; So-O = Social Opportunity; Au-M = Automatic Motivation; Re-M = Reflective Motivation.

3.1.2 COM dimensions

An independent samples t-test was used to determine differences between the two groups in perceived access to the COM-dimensions and the respective subdimensions. The alpha value used to determine significant results was $p < 0.05$.

There were no significant differences in perceived Capability, Opportunity, or Motivation and neither in the subdimensions between participants from the two neighborhoods (*table 6*).

Table 6. Summary of results from independent samples t-test
Results showing levels of perceived level of each subdimension and the overarching dimensions (in bold text) for the two neighborhoods, as well as p-values to denote the differences between the groups as obtained through an independent samples t-test. Ph-C = Physical Capability; Ps-C = Psychological Capability; Ph-O = Physical Opportunity; So-O = Social Opportunity; Au-M = Automatic Motivation; Re-M = Reflective Motivation.

Dimension	Low use (*n*=29)		High use (*n*=9)		t-test
	M	*SD*	*M*	*SD*	
Ph-C	42.8	17.5	33.3	22.4	0.195
Ps-C	58.6	20.8	63.4	27.9	0.572
Capability	**55.3**	**17.6**	**57.0**	**22.9**	**0.820**
Ph-O	69.2	18.7	68.7	26.4	0.942
So-O	51.1	20.8	58.3	25.0	0.388
Opportunity	**60.9**	**16.3**	**64.4**	**23.0**	**0.612**
Au-M	55.2	22.5	51.1	29.8	0.664
Re-M	65.3	27.7	71.2	27.3	0.580
Motivation	**59.3**	**21.0**	**60.7**	**23.1**	**0.870**

Note. *M* = mean, *SD* = standard deviation. *M* and *SD* given as percentages of sum of points for each dimension and subdimension. Higher percentage indicates higher perceived access to a dimension.

To determine whether any of the subdimensions received a significantly lower score than the others among all participants, a repeated measures one-way ANOVA with a Greenhouse-Geisser correction (due to sphericity not assumed) was conducted. The results showed a significant difference between the subdimensions (F (41.022, 128.800) = 11.784, $p < 0.001$) and a post hoc pairwise comparison with a Bonferroni correction revealed that Physical Opportunity was significantly higher than all the other subdimensions and that Physical Capability and Automatic Motivation received a lower score than most of the other subdimensions, although this difference was not always significant (*table 7*).

Table 7. Summary of results from post hoc test with Bonferroni correction
Results showing the differences between the means of the subdimensions across both participant groups.

Subdimension			Pairwise comparisons					
	M	*SE*	Ph-C	Ps-C	Ph-O	So-O	Au-M	Re-M
Ph-C	2.22	0.173	-					
Ps-C	2.77	0.166	0.135	-				
Ph-O	3.44	0.177	0.001**	0.035*	-			
So-O	2.43	0.160	1.000	0.897	0.001**	-		
Au-M	2.21	0.166	1.000	0.028*	0.001**	1.000	-	
Re-M	2.50	0.160	1.000	1.000	0.001**	1.000	1.000	-

Note. *M* = mean of normalized data, *SE* = standard error.
* = value significant to $p < 0.05$. ** = value significant to $p < 0.01$.

3.2 Qualitative data

3.2.1 Drivers and barriers for water conservation

The perceived drivers and barriers that either enable or prohibit water conservation behaviors varied greatly among participants, but still, certain patterns emerged. Drivers for both groups were intentions to save, good habits having been established as well as the fact that some behaviors were easier to perform as they were viewed to be convenient for the participants. Some participants also cited environmental concern as a driver while others mentioned social norms as reason for their conservation (*Fig. 7*).

The most common driver among participants from the high use neighborhood was habits but in the low use neighborhood, two other drivers were mentioned more often: intentions to save and social norms. In the answers given, intentions to save were coded as instances where participants showed a clear intention to save, for example by citing performing certain behaviors specifically for the purpose of saving water. Social norms were coded as the cases where the participants mentioned a way of living that had connections to, what many participants called sensible thinking or that something felt natural, reasonable, or hygienic.

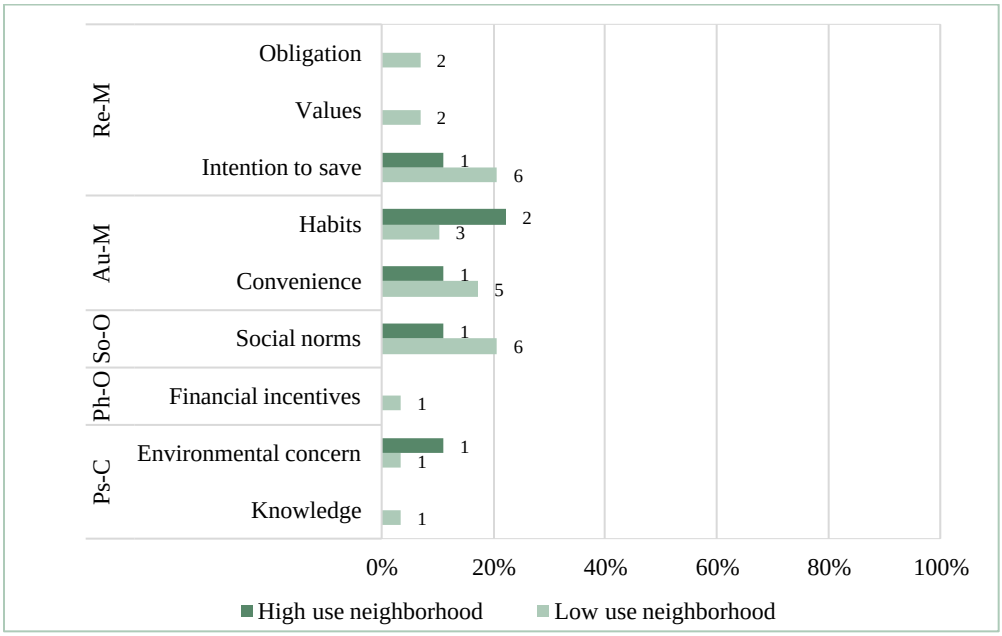

Figure 7. Answers to question *Why have you chosen to perform these water-saving behaviors?* Summary of participants' answers to what makes them choose water-saving behaviors grouped into themes belonging to specific subdimensions. Summary is given in percentage of participants mentioning a topic in the questionnaire. The number of participants having given a certain answer is given next to the bar. Ps-C = Psychological Capability; Ph-O = Physical Opportunity; So-O = Social Opportunity; Au-M = Automatic Motivation; Re-M = Reflective Motivation.

The most often cited barrier among participants in both groups was unwillingness to change behavior, see (*Fig. 8*). In some instances, this meant unwillingness to conserve more and in others, it was a sign of unwillingness to participate.

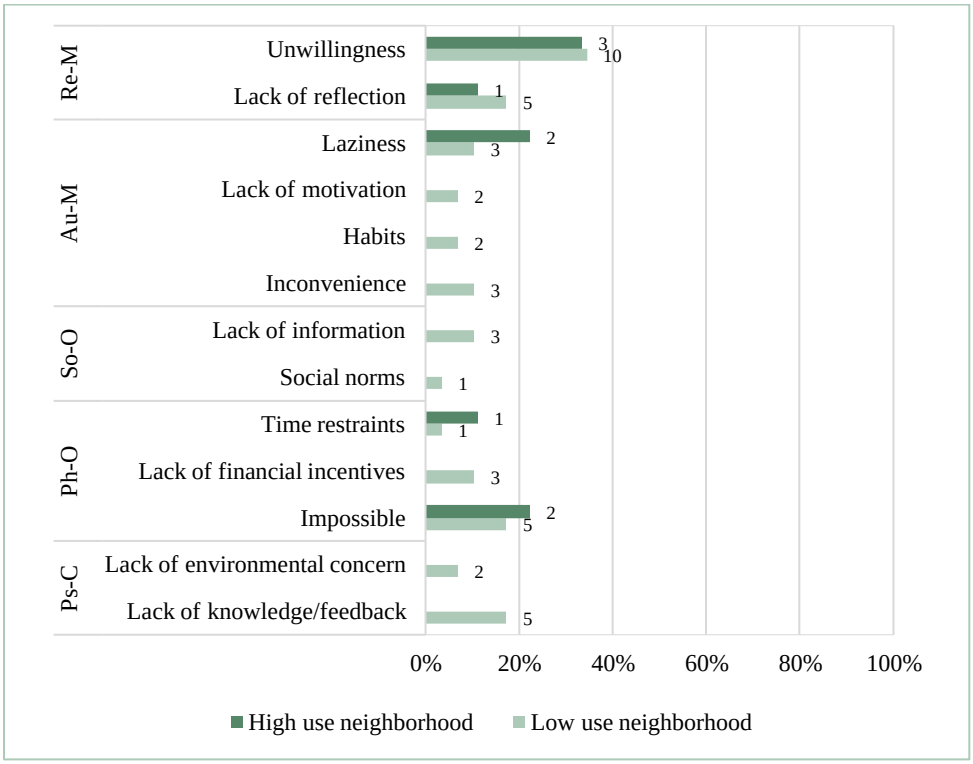

Figure 8. Answers to questions *Why have you chosen to not perform more water-saving behaviors?* and *What hinders you from conserving more water?*
Summary of participants' answers to what prohibits them from performing more water-saving behaviors grouped into themes belonging to specific subdimensions. Summary is given in percentage of participants mentioning a topic in the questionnaire. The number of participants having given a certain answer is given next to the bar. Ps-C = Psychological Capability; Ph-O = Physical Opportunity; So-O = Social Opportunity; Au-M = Automatic Motivation; Re-M = Reflective Motivation.

The result to the question about what would make it more attractive for residents to conserve water varied in both neighborhoods but particularly in the low use neighborhood where 69% said that at least some sort of increased influence would make it more attractive for them to conserve water, but the most popular (financial incentives) such driver was only mentioned by 14% of the participants in the low use neighborhood. This in comparison with the high use neighborhood where the answers were less diverse and financial incentives was mentioned by 56% of the participants, making it the most mentioned driver in both groups (*Fig. 9*).

The second most common driver that participants said could have an influence on them conserving more water also varied between the two groups. In the high use neighborhood, it was concern for the environment (22%) while the low use

neighborhood saw four different drivers as popular, namely intentions to save, convenience, more feedback and increased knowledge, each mentioned by 7% of the participants.

More participants from the low use group said that there was nothing that would make it more attractive for them to save more water or that they were unsure what type of driver this would be (31%). The same number in the high use neighborhood was 22% (*Fig. 9*).

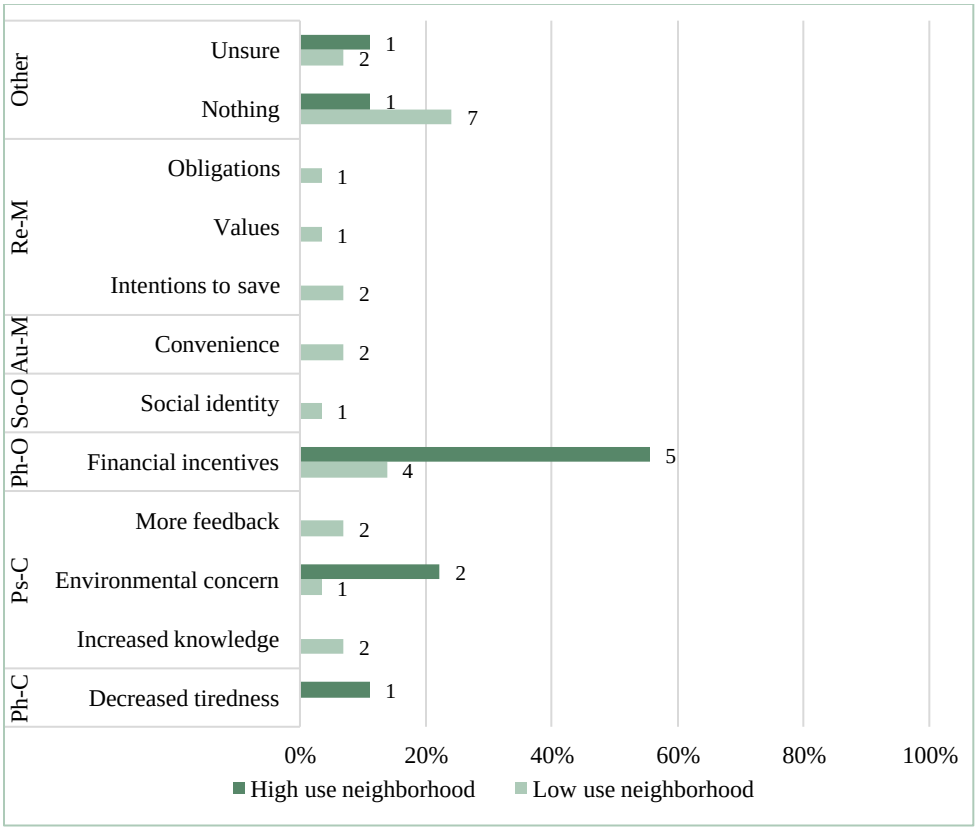

Figure 9. Answers to question *What would make it more attractive for you to conserve water?* Summary of participants' answers to what would make it more attractive for them to conserve water grouped into themes belonging to specific subdimensions. Summary is given in percentage of participants mentioning a topic in the questionnaire. The number of participants having given a certain answer is given next to the bar. Ph-C = Physical Capability; Ps-C = Psychological Capability; Ph-O = Physical Opportunity; So-O = Social Opportunity; Au-M = Automatic Motivation; Re-M = Reflective Motivation.

3.2.2 Behavior Change Interventions

The low use group showed more diversity in what types of messages that had been seen (*Fig. 10*). However, a few participants from both groups had received an information sheet in their mailbox and/or seen advertisements on TV. Participants from both groups had also been confronted with messages designed to conserve water from companies other than Sydvatten or VA SYD, for example signs in hotels and campaigns from companies designing and installing kitchens and bathrooms.

Many participants from the low use neighborhood (69%) had not seen or could not recall having seen any information regarding water conservation. The same number for the high use neighborhood was 33%, equal to those who indicated having received information in their mailbox or having seen information on TV (*Fig. 10*).

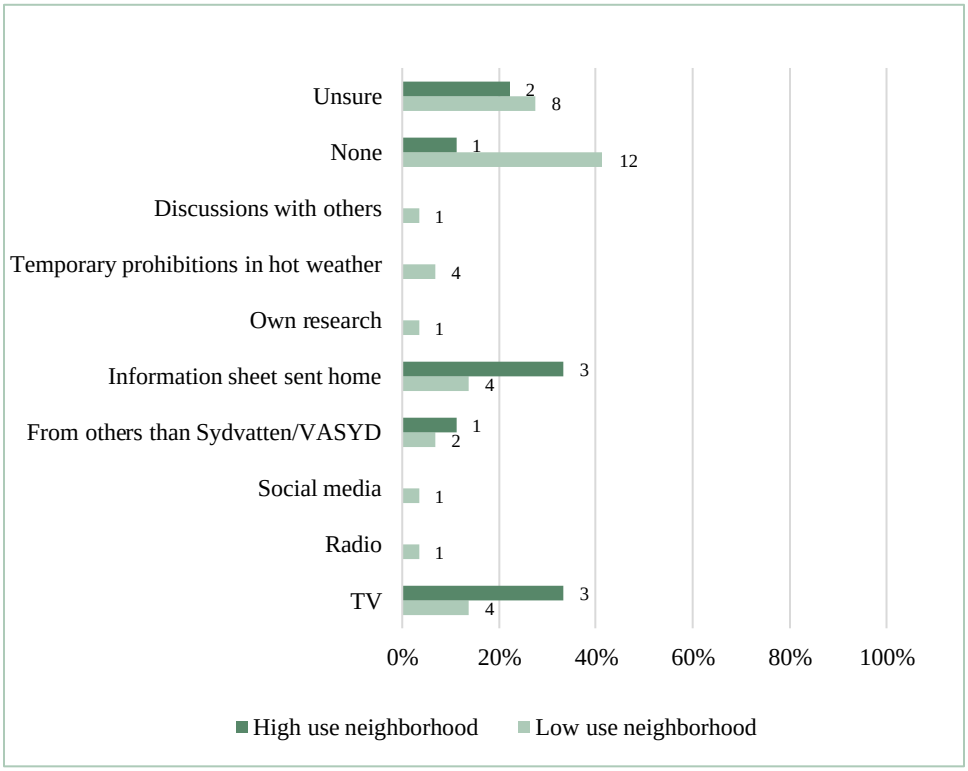

Figure 10. Answers to question *What type of information regarding water conservation have you seen?*
Summary of participants' answers to what information regarding water conservation they have seen. Given in percentage of participants mentioning a topic in the questionnaire. The number of participants having given a certain answer is given next to the bar. Ph-C = Physical Capability; Ps-C

= Psychological Capability; Ph-O = Physical Opportunity; So-O = Social Opportunity; Au-M = Automatic Motivation; Re-M = Reflective Motivation.

When asking those who indicated having seen water-conservation messages what changes these had led to, 40% of the low use neighborhood responded that nothing had changed whereas half of participants from the high use neighborhood said the same (*Fig. 11*).

Conversely, 50% of participants from the high use neighborhood stated different water-saving behaviors they had begun to perform after having seen the message in comparison to the low use group in which only 20% said the same. Instead, 40% of the participants from the low use group cited increased awareness (including interest and realizations of the necessity to conserve) as a result of the messages, (*Fig. 11*).

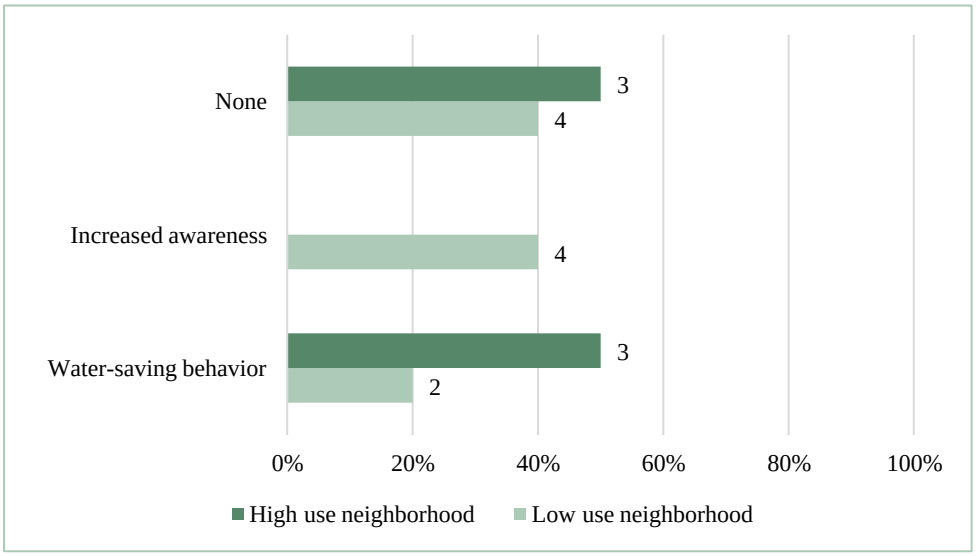

Figure 11. Answers to question *What changes have this information led to for you?*
Summary of participants' answers to what changes this information has led to in their lives. Given as a percentage of those having indicated that they saw some type of information. The number of participants having given a certain answer is given next to the bar.

4. Discussion

The discussion is carried out based on the COM-B system, where the most important themes identified from the data is discussed in relation to previous literature and the most suitable interventions included in the BCW framework, as shown in *table 1*. Each of the different subdimensions is discussed to some extent to shine some light on different challenges that need to be addressed by several authorities in an interdisciplinary fashion, but the final suggestions are given with specific consideration to the means of influencing the population available to Sydvatten.

4.1 Capability

4.1.1 Physical Capability

4.1.1.1 "I don't know how to fix a leak". Promoting self-efficacy at home.

Among all subdimensions, Physical Capability received the lowest average score across both participant groups. The items that were connected to this subdimension were related to more physical actions taken at home to conserve water, such as reusing water at home, as well as age. It could be argued that age belongs to Physical Opportunity, but in this study, it was decided to connect it to Physical Capability since age has been shown to affect an individual's capacity to conserve water (Addo et al., 2018a; Addo et al., 2018b).

What was encouraging about the data on performed behavior was that more than half of all participants reported fixing leaks within a week after discovery, indicating that people may know how to do this – or at the very least can afford to pay someone to help them out.

However, fewer than a fifth of the sample had installed low-flow shower heads and taps which may show that some residents need help with this specific aspect as well as installing water-efficient dishwashers and laundry machines. The potential difficulty for all behaviors connected to Physical Capability may be that some people lack the knowledge of *how* to repair/install certain things or that they may

find it difficult to know what sort of water-saving device to purchase. Similarly, reusing water at home (e.g., using water left after washing vegetables for watering plants) was a relatively rarely performed behavior which could indicate that people may not know how to do this.

4.1.1.2 Improving residents' Physical Capability.

Assuming that people struggle with knowing what to do and how to do it, there are ample opportunities for Sydvatten to improve residents' self-efficacy in the home. According to Michie et al. (2011), a low Physical Capability can be helped by Training and Enablement. Enablement is connected to promoting physical capacity (for example through medication and surgery) and therefore, focus will be on training, which instead concerns improving people's skills.

One way to offer Training could be through social media-platforms such as YouTube, Facebook, or Instagram where Sydvatten is at least partly active. Videos showing how to fix a leak or exchange a broken gasket in a step-by-step-process would be one example. Simple "how-to-guides" that are sent home to teach inhabitants strategies for tips on what they could reuse water for in the home, as well as what to look for when choosing a new water-efficient device could be another useful technique to employ when wanting to improve an individual's Physical Capability.

4.1.2 Psychological Capability

4.1.2.1 "Why should I conserve?" Informing about climate change and water use.

In general, participants from Västra Hamnen – the low use group – reported being driven to conserve by having enough knowledge on water use and more hindered by a lack thereof to a greater extent than participants from the high use neighborhood Söderkulla. Since there was no significant difference between the two neighborhoods, we cannot draw the conclusion that this is the case, but as opposed to participants from the high use neighborhood, several participants from Västra Hamnen specifically mentioned knowledge as either a driver or barrier. Some admitted to lacking the knowledge needed to be able to change their behavior and some said that they felt that they were not given enough advice and information from authorities.

The fact that some mentioned not receiving enough information from authorities is an interesting result of the study. Although this was not echoed by participants from the high use neighborhood, more than two thirds of participants

in the low use neighborhood said they could not recall having seen any information or were sure they had not. Instead, only a third of participants from the high use neighborhood said the same. The fact that a majority of participants from Västra Hamnen had not certainly seen any communication contrasts with the idea of the neighborhood having a reputation for being very sustainable and also addresses water use behavior by carrying out regular campaigns to enable residents to lower their water consumption (Malmö stad, 2013). This leads to questions such as whether only specific parts of the neighborhood are being reached and why it seems like the messages have not been successful? However, it could also just indicate a deeper interest for water conservation among participants from Västra Hamnen which could be ascribed to the fact that it is relatively easy to see that the neighborhood they live in is designed to be more sustainable than other, older parts of Malmö. It is undeniable that average per capita water consumption in Västra Hamnen is lower than in Söderkulla although, currently, it is difficult to determine what causes this difference.

4.1.2.2 "I'm not given enough advice or tips." Providing residents with feedback.

Feedback, another part of Psychological Capability was also mentioned by participants from the low use group who said that an increased level of feedback would make it more attractive for them to conserve water. The IMD-system, which will be further discussed in relation to Physical Opportunity, could be seen as providing residents with one sort of feedback (financial) that at least some of the participants get regularly, see *table 3*. However, not a lot of other feedback on specific household use is given and there might be a need for this to create willingness to change, depending on how this feedback is given.

It also seems like messages would benefit from containing information to increase environmental concern as several participants in both groups mentioned environmental concern as a driver, and lack of it a barrier, see *figures 6* and *8*. This could be achieved by letting inhabitants know what environmental effects their water use has. This could potentially have an impact on people's behavior but should be accompanied by other types of messages as previous research has shown that increased knowledge does not always result in behavior change (Abrahamse et al., 2005; Fielding et al., 2012; Schultz et al., 2016).

Targeting misinformation may also be useful to some degree and proof of there being some misinformation prevalent in society was shown also in this study as one participant cited avoiding dishwashers as a way to conserve water, which is not fully correct according to *Energimyndigheten* (the Swedish Energy Agency), as the eco-program on a dishwasher with the EU energy label A+++ uses both less water and electricity compared to washing the same amount of dishes by hand (Energimyndigheten, 2017). However, Fielding et al. (2012) noted in their study

that households with water efficient washing machines, among other things, used more water on average than other households. This could be indicative of the so called "Rebound-effect" being present in their sample. The Rebound effect is the backlash that occurs when having an energy/water-efficient device (e.g., water-efficient washing machine) increases the behavior (doing laundry) overall because having a more climate and environment-friendly machine may be viewed as a justification to increase the frequency of the behavior. This indicates shows everyone should be encouraged to cut their water consumption by reducing the frequency with which they perform certain unsustainable behaviors. After all, the least resource-intense behavior is the one not being performed in the first place.

Awareness of one's own water use could also help individuals realize their impact and try to change their behavior. In Sweden, it seems more likely that such awareness could be created by the IMD-system than by the building-level system that is largely prevalent in society (Boverket, 2020a; Dige et al., 2017). But before awareness can be created in Malmö, it seems like we may need to address another issue at hand. Surprisingly, when looking at the current sample, roughly 14% of participants did not know whether their building had an IMD-system or not, (*table 3*). This could be indicative of some residents not caring about it – potentially because they do not have to care for financial reasons, which will be discussed in connection to Physical Opportunity – or simply because they are uninformed. How this situation arises is difficult to say, but it could be a mixture of different issues: lack of engagement among residents and lack of information from the housing co-op.

Furthermore, it would be interesting to investigate if residents are aware of how the metering system in their building works, regardless of which system for debiting is in place. If a building does not have IMD installed, it can be assumed that they meter water use on building level (Boverket, 2015a) and since not all residents know what type of system is used, it would be safe to assume that not all know how the water use on household level is calculated either. This could mean that some are under the impression that they pay a fairer price for their water consumption than they are.

4.1.2.3 Improving residents' Psychological Capability

In cases where there is a lack of Psychological Capability, Michie et al. (2011) suggests three interventions: Education, Training, and Enablement (*table 1*). The meaning of education is relatively clear but has a broad scope which needs to be explained. Sydvatten already does plenty to include youth in educational programs, like their annual camp for High-schoolers *Tänk H_2O* ("Think H_2O"), as well as their development of course programs to be taught in schools (Sydvatten, 2021a, 2021b). But although youth can have an impact at home, they do not have influence over

all water uses (Larson & Redman, 2014). Therefore, the adult population should not be forgotten when it comes to education on water conservation. One way of reaching this demographic would be to send out information sheets and making sure that those who are meant to be reached by this information also are.

Such information could contain tips to decrease water use that may not be readily thought of (such as washing vegetables in a bowl instead of under running water) and potentially also "debunking" a few myths around water conservation that may linger in the population (e.g., that doing dishes by hand requires less water than dishwashers).

Giving feedback on use has been shown to be effective when it comes to reducing energy consumption, especially if this feedback is repeated (Abrahamse et al., 2005). Therefore, it might be a good idea to find ways of giving more feedback as part of improving several subdimensions and making residents' actual water use more visible than the current systems allow, which one of the participants from the low use neighborhood said was a current barrier to wanting to conserve more. This will be discussed more when addressing Social Opportunity.

Another way to increase knowledge would be to establish a collaboration between housing co-ops and rental companies to have increased access to residents but also creating an opportunity of regularly informing of the water use concerning a specific building. Thus, one task for a collaboration between building owners and Sydvatten could be to inform the residents of how the system in place works and what is included in the sum they pay for water consumption.

In general, informing citizens more directly, whether this is through sending out information sheets or by using ads on TV or radio, means that people do not have to go through an extra step of finding information. It is evident that there is already plenty of very useful information out there on websites such as Sydvatten's but taking the extra step it takes to access this information requires people having a certain level of interest for the topic. However, when performing a study such as this, it becomes clear that this is not always the case. Therefore, focus on making information accessible to everyone, regardless of situation, interest, or socio-demographic status should be key to achieve a higher degree of water conservation among citizens of Malmö.

4.2 Opportunity

4.2.1 Physical Opportunity

4.2.1.1 "Water is too cheap." Creating financial incentives.

One of the most prominent drivers among participants from both neighborhoods was financial incentives which was cited as a driver for conservation multiple times and the lack of financial incentives as a barrier for conservation among a small proportion of participants in the low use neighborhood.

Looking at the data from *table 1* showing the demographics of the two neighborhoods, it becomes clear that there are differences between them that cannot go undiscussed. A notable aspect that separates the two is income level, which in general seems to be significantly higher in Västra Hamnen compared to Söderkulla. This would speak for residents in the high use neighborhood Söderkulla being more driven by financial incentives, which could be linked to the the current study in which almost 60% of the participants from Söderkulla said that financial incentives would make it more attractive for them to save water. Still, financial incentives and a lack thereof was mentioned among participants in Västra Hamnen as well.

Financial incentives as a measure to reduce household water use is already in place for some residents in the form of the IMD-system, also visible in the current sample, (*table 3*). What is interesting about this data is that a larger proportion of participants in Söderkulla reported having IMD compared to Västra Hamnen, especially since Västra Hamnen is a more recently developed area with heavy focus on sustainability and it would thus seem natural to let residential buildings in such an area be equipped with a system that would enable citizens to reduce their water consumption through financial incentives. But even in the early 2000s when the neighborhood began its transformation from an industrial area into what it is now, the implementation of IMD may still not have been favorably regarded among building owners and the municipality. That could be an answer to why not more people in Västra Hamnen reported living in a housing co-op with IMD. Sweden is known for having a lot of water and traditionally, the use of IMD has not been generally embraced (Boverket, 2015b). This could have sent the signal to citizens that water is not a resource that we need to be stingy with as there is plenty of it to go around.

Another noticeable aspect that did not originate as part of the results but is nevertheless interesting to discuss is the fact that even the low use neighborhood has a higher per capita use than the national average in Sweden, per calculations from VA SYD. This indicates that the measures for water conservation that have been put in place as part of creating a more sustainable city-quarter have not been

used to their full potential. In this case, it is difficult to say who the 'culprits' are as there are virtually no private pools in the area and not much space for large, water-demanding private gardens. Instead, we may in Västra Hamnen have a perfect example of the rather odd Swedish phenomenon that occurs when apartment-dwellers are seen consuming more drinking water than residents of single-family detached homes (Hjerpe & Krantz, 2006). Since it is evident that not all residential buildings in Västra Hamnen have an IMD-system, it could mean that apartment owners in this neighborhood do not feel the need to reduce their water consumption, partly because there are not enough financial incentives to do so. Conversely, it could also mean that the high income-level in this neighborhood indicates that residents do not have to worry too much about the financial aspects of their water consumption, as pointed out by Fan et al. (2014). This helps explain the importance of using "soft measures" that purely appeal to psychology as it could very well be that those that do not have an IMD-system in place may not reduce their consumption simply from such an intervention being implemented.

A discourse around a nationwide implementation of the IMD-system is currently underway and overall, IMD seems to lead to a fairer distribution of costs among tenants and owners in comparison to the traditional way of calculating water costs in Sweden. But it is impossible to further this discussion without including those who would not benefit from a large-scale implementation of the IMD. These people typically belong to groups that are already marginalized by society in some way or another; citizens with lower income-levels and refugee families that can be forced to live many people in smaller spaces. Here, we can draw from previous literature that has shown that the more people in one household, the more total water use but the less water used per capita (Araya et al., 2020). This could mean that these groups are forced to pay a higher price for water but without having the means to lower their consumption as it is already low seen to per capita consumption.

It is important to note that Physical Opportunity was significantly stronger among participants from both neighborhoods. This is promising for future communication strategies as it shows that certain prerequisites for behavior change are already in place, such as housing situation, socioeconomic status, and infrastructure. However, there is still something to be said about financial incentives as participants from both neighborhoods mentioned this in some way. This means that interventions to promote an increased level of Physical Opportunity among all could be beneficial, especially when it comes to financial incentives.

4.2.1.2 Improving residents' Physical Opportunity

As summarized in *table 1*, low Physical Opportunity could be improved by the following types of interventions: restriction, environmental restructuring, and enablement. Restrictions are already used to some extent, which was also felt by a couple of participants who mentioned temporary prohibitions during warm weather as a message they had seen that was aimed at reducing water consumption. While restrictions can be helpful, they are not always welcome and may antagonize some citizens, especially considering Sweden's relative inexperience with drought before. Enabling will also not be further discussed as it is more focused on a different kind of measure that Sydvatten may not have any influence over, for example policies that enable water conservation through introducing and improving systems such as IMD. Hence, the focus on improving the communication strategies of Sydvatten will be drawn from Environmental restructuring. This revolves around restructuring residents' environments, (Michie et al., 2011). Something like this could be achieved by helping housing co-ops and rentals open up for discussion among residents whether the idea of introducing an IMD-system would be something worthwhile. In such a situation, residents could speak their minds and come with additional suggestions for how else to improve the co-op's/rental's general water footprint and how to work together to make it more attractive to lower one's own consumption.

Lastly, it is important to encourage the inclusion of all social groups in the journey toward a more sustainable water consumption. For Sweden to transform into a truly sustainable society in all ways, we should look to include all citizens in our environmental progress to address social sustainability as well as environmental and economical sustainability. Therefore, Sydvatten would do good in making an effort to aid those that need help with water conservation – whether it is for environmental, financial, or social reasons.

4.2.2 Social Opportunity

4.2.2.1 "It matters to me what others do or think." Addressing social norms

Social norms were brought up among some participants in connection to water conservation, especially in the low use neighborhood. However, it is important to acknowledge that as social norms is an abstract concept and it was not specifically asked for in the questionnaire, the results on this are drawn from an interpretation of what was said by the participants.

One interesting example of social norms affecting behavior among some participants in the sample was the behavior of not flushing toilet after every use. In

Västra Hamnen, only 7% of participants reported this behavior whereas in the high use neighborhood, 22% said the same. None of the participants in Söderkulla commented on this behavior in their free-text answers but a few participants from Västra Hamnen mentioned this in some form. For example, one participant said that the only behavior they could not imagine doing was to stop flushing every time since they believed it would be unpleasant.

In their study of flushing behavior, Lute et al. (2015) found that the majority of participants always flushed after urinating and showed low willingness to reduce this type of behavior. Lute et al. (2015) identified social norms as one of the main barriers for the "always flushers" to making this sacrifice for the environment. In short, people seemed to be too conscious of what others would think of them so that it prevented them from getting past a habitual behavior and recognize the environmental (and economic) impact it would have, which some others had done. It is reasonable to believe that social norms were a similar reason for why most participants reported always flushing also in the current sample. Although not many participants actively recognized social norms as an obstacle for this specific behavior, some did mention factors connected to unpleasantness and reported values that showed they would not consider it hygienic.

With increased access to indoor facilities, good hygiene has become more important than ever in industrialized society and in a country like Sweden that does not readily experience forced restrictions due to reduced water availability, it would be reasonable to expect that certain hygienic behaviors are performed with little or no afterthought. Another example of such a behavior, apart from only occasionally flushing, was whether participants reported letting their clothes air out or washed them after every use. It is a common misunderstanding that clothes need to be washed after every use and in the sample of this study, there seems to be room for improvement as only roughly 25% of participants in both neighborhoods reported letting clothes air out. Hence, it would seem as though addressing social norms, especially those connected to hygiene, could be an important part of communication from Sydvatten to residents of Malmö. As most water in Sweden is used for hygienic purposes (Svenskt vatten, 2019), it is safe to assume that there will be plenty of room for conservation here.

Another aspect of social norms appeared in the form of "normative thinking", namely participants' decision to conserve based on what other people do. One example of this that appeared in the results was the sense of water conservation feeling natural or sensible to some participants. It could be argued that this topic can belong to either Opportunity or Motivation, but in this thesis, the choice to do something because it felt sensible was connected to Social Opportunity as it contains an element of what society views sensible. It is for example perhaps not regarded reasonable in parts of today's society – especially not in a neighborhood that is considered to be sustainable – to use water utterly without inhibition and it can therefore be regarded normative. Several participants from the low use group

stated that they did something because it felt natural or sensible, thus indicating normative thinking as a potential driver for water conservation. Interestingly, participants from the high use group did not mention this to the same extent, instead tending to draw more toward Physical Opportunity in terms of financial incentives. Some of the participants that mentioned sensible/natural thinking also said that they do not exchange devices in their homes until they are broken which could also be indicative of social norms; you use something until you can no longer use it. This sort of thinking might be more related to having the knowledge of what is typically considered more environmentally friendly. Nevertheless, it could be another type of misinformation among people that want to do good but do not have the right information at hand. It could be argued that producing a new, efficient device has a lower carbon footprint than using an inefficient machine until broken. However, this is not always clear and would be interesting to study further.

Another interesting idea that connects to sensible thinking is that some people may have this sort of view on water conservation from their childhoods or from closer friend groups. No direct evidence of this was noted in the qualitative data from the current sample. However, Social Opportunity was not significantly low in comparison to the other subdimensions apart from Physical Opportunity, which indicates that the sample does have a higher need for strengthening all parts that can be associated with Social Opportunity. According to the study conducted by Fielding et al. (2012), people who carry with them water saving habits from their families typically conserve more water than people who do not have this background. This culture of water conservation is an interesting parallel to draw to Sweden, where most people have not been exposed to regular periods of drought that would have helped teaching people that conservation is important; a way of life that could then have been passed down in generations. This means that there is ample opportunity for Sydvatten to focus on creating prerequisites for behavior change based on social interaction, perhaps especially for families with children who can then form good habits based on water conserving behaviors at home that they may then carry with them as they go through life.

4.2.2.2 Improving residents' Social Opportunity

According to Michie et al. (2011), weak Social Opportunity can be strengthened in much the same way as Physical Opportunity through restriction, environmental restructuring, and enablement. As for Physical Opportunity, the communication from Sydvatten cannot be fully restrictive and therefore, softer measures are encouraged.

Restructuring the social context and enabling inhabitants of Malmö to conserve more water can be done in different ways. For example, by facilitating

discussions between people. Only one participant in the current sample mentioned partaking in discussions about water use as a source of information and while this does not mean that the other participants never take part in discussions with others, it is interesting to acknowledge that not many people seem to regard this as a way to impart and receive information. Therefore, Sydvatten could try to incorporate similar strategies for adults as they do for youth, perhaps by offering online conferences or "water days" for companies that work within the environmental field and want to learn more about the topic. Another way of doing this could be to participate in local festivals and events by putting up a booth and encourage people's engagement with water and issues surrounding the management of it in different ways. Topics that could be discussed could be information about how to lower one's water footprint, and attention to the fact that clean water and sanitation are such important aspects of everyone's lives that they have their own goal within the *UN's 17 Sustainable Development Goals* (United Nations, n.d.-a). Emphasis could also be placed on the *Water Action Decade* 2018-2028 (United Nations, n.d.-c) and allow residents to learn more about this valuable resource while paying attention to the increasing need to address water management all over the world. Inviting adults to take a more active part in water conservation would not only benefit current water use but also future water use as parents with knowledge of water conservation can teach children from an early age to take more care of this valuable resource.

Furthermore, as the way a message is communicated has an impact on how it is received (Ehret et al., 2020), Sydvatten could try to incorporate aspects of social norms and social identity in the information and feedback given to residents. For example, by (relying on) descriptive norms (Schultz et al., 2016). One way of appealing to residents in this way would be to compare water use between neighboring areas and even neighboring buildings or apartments, which could be a more effective intervention than using injunctive norms, such as providing residents with feedback on their behavior to let them know whether it was "good" or "bad" (Allcott, 2011).

In general, while it may not be necessary to immediately stop flushing toilets in Sweden, the fact is that Swedes need to lower their water use significantly and since most water use is connected to hygienic behavior in some way, we should consider changing some of our habitual behavior patterns. By changing the norms and realizing that our clothes do not have to be washed after a single use and that showering every day may be superfluous, we can hopefully cut our average water footprint a little bit more.

4.3 Motivation

4.3.1 Automatic Motivation

4.3.1.1 "I do things without thinking about it." Breaking bad habits.

There is evidence to show that habits can be useful predictors of water conservation (Gregory & Di Leo, 2003) but there is also literature arguing against this idea (Aitken et al., 1994; Harlan et al., 2009). Whether habits and water conservation are related in this way, habits have been shown to play an important role in water conservation (Dieu-Hang et al., 2017; Gregory & Di Leo, 2003; Russell & Knoeri, 2020) and their importance was also clearly visible in this study.

Several participants cited habits as either barriers or drivers for water conservation. As shown by the results on performed behaviors at home, some habits were more common among the sample compared to others. Turning the tap off while brushing teeth was the most reported behavior across the sample. However, the behavior of washing vegetables in a bowl was one of the least reported behaviors, which could indicate that the habit of doing this has not been formed for most participants.

This has several implications for Sydvatten's future communication strategies. Since turning off the tap while brushing teeth is an action that has been promoted by Sydvatten, the results of this study could indicate that their past informational campaigns have worked. But considering that only roughly 40% of participants in this sample could recall having seen a water conservation message and even fewer reported it having resulted in them adopting water-conserving measures at home, it would also be likely that there are other explanations for this as well. One such explanation might be convenience which can be viewed as being linked to habit formation. For example, Simmons et al. (1984) showed in their study of energy-conserving measures that people tend to prefer measures that are convenient and familiar to them. Hence, convenience seems important to the formation of water-conserving habits.

This could explain why there is such a large discrepancy between some behaviors in this sample. Consider the difference in numbers between the participants reporting they turn off the tap while brushing teeth and the participants reporting that they wash vegetables in a bowl instead of under running water. Turning off the tap does not require a lot of effort as opposed to washing vegetables in a bowl where one must take out a bowl, fill it with water and clean it after having washed the vegetables. It would seem as though the latter behavior requires more effort and thus would take a bit more time rather than simply letting the tap run while washing vegetables. Several people mentioned convenience as being a barrier

or driver for water saving behaviors, indicating that people are aware of what hinders them from changing unsustainable habits. This is positive but the question of what we can do about this remains to be answered.

The fact that 97% of participants in this study reported performing some sort of behavior regularly shows that sustainable behavior patterns have already been formed in society. This, in turn offers a positive view on future water conservation strategies, especially when connected to the spillover-effect – maybe the step to conserving more water and thus lower one's own carbon footprint is shorter if one already knowingly does perform some behavior for this purpose.

4.3.1.3 Improving residents' Automatic Motivation.

One way of improving residents' Automatic Motivation could be to send colorful stickers to families with children bearing conservation messages that they could stick on the walls in their kitchens, bathrooms etc. The purpose these stickers would serve would then be to help reinforce a behavior until it becomes habitual. Such an intervention would also tie in well in with the suggested intervention to improve low Automatic Motivation, namely modeling, which focuses on our desire to imitate the behaviors performed by a role model (Michie et al., 2011). Depending on what the stickers show, this could also be viewed as a persuasive intervention as imagery that elicits emotions to persuade an individual to act a certain way is another way to promote Automatic Motivation. Hopefully, all the suggestions given are robust enough to translate into water conservation habits that can be passed down in generations to not only cut water consumption short term but also have a lasting effect on society.

4.3.2 Reflective Motivation

4.3.2.1 "I intend to conserve but..." Bridging the gap between intention and action.

As there were no differences between the two neighborhoods in terms of prerequisites for change, it is difficult to say whether one group reported being more driven by Reflective Motivations than the other. However, as seen in the qualitative data collected from the sample, especially participants from the low-use neighborhood Västra Hamnen cited intentions as a driver for current water conservation, and something that would potentially make them conserve more.

This could signal to Sydvatten that some people listen well to messages that aim to increase intentions to save and that it might be worth trying to incorporate such interventions as well. However, even though education may help increase

knowledge and intentions to save, there is not enough evidence to prove that either of the two automatically translate into changed behaviors (Abrahamse et al., 2005; Fielding et al., 2012). The implication this has for authorities like Sydvatten when it comes to improving citizens prerequisites for behavior change is that several different interventions with varying aims may be useful and increase the chances of resulting in a decrease of household water consumption.

4.3.2.2 Improving residents' Reflective Motivation.

Michie et al. (2011) suggest that Reflective Motivation be strengthened through education, persuasion, incentivization or coercion, and out of these different interventions, persuasion and education may be the easiest for Sydvatten to use. The types of interventions that have been mentioned earlier that focus on educating inhabitants may prove useful not only to strengthen Psychological Capability but also to improve Reflective Motivation as well.

4.4 Summary of suggested interventions

1. Establish collaborations with housing co-ops and rental companies to inform residents of building-specific aspects of water conservation and to facilitate discussions about water consumption among residents.
2. Extend reach of information sheets by potentially increasing area and making sure to inform repeatedly. Citizens may have to be actively targeted with information and advice as it cannot be presumed that everyone has the physical energy, or the interest required to find this information on their own.
3. Bring attention to water conservation and management in Sweden and around the globe, for example by using festivals and events as foundations for creating opportunities to interact and learn for people of varying ages.
4. Create educational programs focused on teaching people skills for water conservation behaviors. Such as "how-to-guides" on choosing and installing water conservational devices.
5. Create educational videos to show, step-by-step, how to repair devices at home, such as fixing a leak or exchanging a broken gasket.
6. Set up online-conferences and "water days" for companies and organizations within the environmental field to encourage the conversation be brought up in places where it has previously not had a large impact.
7. Work toward changing certain well-established norms, especially regarding hygiene through informational campaigns and similar. One thing to target

would be the unnecessary need to wash clothes after every use. In many cases, letting clothes air out will prove to be enough.

8. Appeal to people's innate tendency to adapt to social norms. For example, by comparing to others (e.g., "You used 40 % more water in comparison to your neighbors this month"). This would also provide ample opportunity to make visible some of the consequences to residents' behaviors that has prior to this been lacking.
9. Collaborate with the municipality when it comes to other environmental projects, such as "Det ska vara lätt att göra rätt".
10. Sending colorful stickers with reinforcing messages to families with children to promote water-saving behaviors that will have a lasting impact on water consumption.

4.5 Limitations and future research

This study shows promise when it comes to adding to the current knowledge of water consumption but still has some limitations that need to be addressed so that any future studies that wish to take a similar approach to water conservation can do this better.

As this thesis was meant to be more qualitative from the beginning and only in the last few weeks of the study was forced to change course, several issues based on time-constraints arose. These mainly revolved around the questionnaire which has a few unanticipated shortcomings. The questionnaire was developed and published quickly to allow for a greater number of participants. However, this led to one item not being added until later which meant that not all participants had the opportunity to answer this. A similar issue occurred with the behavior "Showers instead of taking baths" which was also not added until later. In addition, there was a missed opportunity to ask about whether people had reduced the frequency with which they shower to save water, something that would have been interesting for the discussion around social norms. Future studies would benefit from spending more time making sure that all items are complete and that none that would be interesting for the results are lacking.

The coding of the results, specifically for the qualitative data, depended heavily on the author's interpretation of the participants' responses. This is problematic in that there are risks that some responses were categorized wrongly or that the meaning of a certain response was distorted as there was no way to reach participants and clarify what they meant. Because of this, future research dealing with qualitative data could approach the topic in a similar way but avoiding such mistakes by, for example, conducting interviews where the participants are reachable or by simply keeping a questionnaire completely quantitative. However,

this questionnaire was developed to be short to allow for more participants as opposed to an interview study, while also fulfilling the needs of Sydvatten who had asked for a more qualitative approach to water consumption. Hence, a questionnaire with both quantitative and qualitative items was determined to be the best option to achieve this. The questionnaire also may have some validity issues that have not been accounted for, mainly due to lack of time. A future study adopting a similar result would benefit from conducting an Alpha Cronbach's test to determine the validity of the instrument being used. More efforts to collect qualitative data on the topic is needed and wanted by authorities such as Sydvatten who strive to understand on a deeper level what causes people to conserve or not.

A third aspect that had effects on the current study was the difficulty of distinguishing some dimensions and subdimensions from each other. An example of this is the two subdimensions Social Opportunity and Reflective Motivation which contain the further specifications norms and values, respectively. Separating norms and values from each other is not necessarily easy to do and there were several instances in which a respondent's answer was coded into either norm/value without a clear difference between the two. This could be avoided by turning to the authors of the studies that have adapted the BCW framework to water consumption and ask for clarifications on the different dimensions. Future research could also specify questions in a different way, which allows for each question to be intrinsically linked to a certain dimension. It could be valuable for gathering a larger quantity of data on each dimension to give a more holistic picture of what sort of dimension is more prominent in its weakness among the sample and thus worth targeting when it comes to adopting water conservation measures in the household.

Due to the relatively low number of participants, we lose the ability to generalize the results to a greater population and the significant results in themselves should also be handled with caution. The reasons being the above-stated difficulties with categorization of certain subdimensions, but also because of the pitfalls of conducting a statistical analysis on such a small sample. Furthermore, the study relied solely on self-reported behaviors which comes with its own set of problems, such as self-reports not always accurately predicting actual water use, potentially due to social desirability bias or because it might be difficult to predict water use on household-level as an individual. But while there is some research to discredit the use of self-reported water use as a proxy for household water use, there is some research that support it, suggesting that self-report measurements are an adequate way of predicting water use but that we may still need to find ways to make the two align more accurately (Fielding et al., 2016).

To conclude, despite these shortcomings, the study has provided insight into what hinders and facilitates water conservation in apartment households in Malmö, Sweden and hopefully, the suggestions that have resulted from it will be useful in future communication. In addition, the BCW has proved to be a very useful tool also in a Swedish context and more research using this framework is encouraged.

One way to explore the BCW's usefulness in a Swedish context is to use it in a similar way but targeting water use in sectors other than the household sector. More research on other fields could be carried out to help people and organizations in all sectors conserve water. This is also well in line with the collective effort that should be put in to mitigate and adapt to climate change.

5. Conclusions

No significant differences of COM dimensions (*Capability*, *Opportunity*, *Motivation*) between low- and high use neighborhoods were detected, but across both neighborhoods, the subdimensions Physical Capability and Automatic Motivation were lower than some of the other subdimensions. Perhaps unsurprisingly, Physical Opportunity was significantly higher than all other subdimensions, indicating that Swedish people have ready access to infrastructure provided to lower water consumption and financial means to do so.

The analysis resulted in ten suggestions to help Sydvatten improve their communication around sustainable water use, including – among others – collaborations with housing co-ops/rental companies to allow for better information distribution to increase Psychological Capability, and educational programs focused on improving residents' self-efficacy when it comes to ability to install/repair devices at home to improve residents' Physical Capability.

This study offers important insight into how the BCW can be applied on both quantitative and qualitative data from Swedish cities. However, future research should aim for a more structured method for data collection and analysis and try to collect data from larger sample sizes for more conclusive evidence. Future studies could potentially also benefit from gathering more qualitative data that could be useful to gain a deeper understanding of residents' prerequisites for changing water use behaviors.

In general, more research on the ever-growing field of water consumption and behavior change is needed to understand how to work together toward a more sustainable future. The threats to the world's water supply that climate change pose will not be mitigated without a realization of the resource's importance, and increased incentives to reduce consumption for those who currently use the most.

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Appendix

Appendix 1. Questionnaire Swedish

Vattenanvändning i hushållet

Denna enkät är en del av en undersökning som görs på uppdrag av Sydvatten AB och syftar till att undersöka hur du som privatperson använder vatten i din bostadsrättslägenhet och vad du tänker om den information som du stött på som gäller vår vattenanvändning i Malmö och i Sverige.

Enkäten beräknas ta ca. 5-10 minuter att fylla i.

Om du har några frågor gällande din medverkan får du gärna kontakta mig på josefin.dahlberg.926@student.lu.se

Med vänliga hälsningar,
Josefin Eidrup Dahlberg
Mastersstudent på Lunds universitet

*Required

1. Välj ett av följande alternativ. Jag är... *

Mark only one oval.

- ◯ Kvinna
- ◯ Man
- ◯ Annat
- ◯ Vill ej uppge

2. Hur gammal är du? *

_____

3. Vad är din huvudsakliga sysselsättning? *

Mark only one oval.

- ◯ Arbetande
- ◯ Studerande
- ◯ Pensionär
- ◯ Arbetslös
- ◯ Annat

4. Vilken är den högsta utbildningsnivå du har slutfört? *

Mark only one oval.

- ◯ Grundskoleexamen
- ◯ Gymnasieexamen
- ◯ Kandidatexamen
- ◯ Mastersexamen
- ◯ Doktorandexamen eller högre utbildningsnivå
- ◯ Vill ej uppge
- ◯ Other: _____

5. Hur många bor i hushållet (inklusive dig själv)? *

Mark only one oval.

1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

6. Hur många i hushållet är under 18 år? *

Mark only one oval.

0	1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

7. Äger eller hyr du din bostad? *

Mark only one oval.

- ◯ Äger bostadsrätt
- ◯ Hyr bostadsrätt
- ◯ Hyr hyresrätt
- ◯ Äger villa/radhus (ej medlem i bostadsrättsförening)
- ◯ Hyr villa/radhus (ej medlem i bostadsrättsförening)

8. Har din bostadsrättsförening/hyresförening Individuell Mätning och Debitering (IMD) för vattenförbrukning? *

Mark only one oval.

- ◯ Ja
- ◯ Nej
- ◯ Vet ej

9. Vilket/vilka av följande åtgärder för att spara vatten utför ditt hushåll? *

Tick all that apply.

- ☐ Installerat snålspolande duschmunstycken och kranar
- ☐ Tar kortare duschar (under 5 minuter)
- ☐ Installerat vattensnål tvätt- eller diskmaskin
- ☐ Stänger av kranen medan man borstar tänderna
- ☐ Låter kläder vädra istället för att tvättas efter varje användning
- ☐ Tvättar bara full maskin
- ☐ Diskar bara full maskin
- ☐ Tvättar grönsaker i en skål istället för under rinnande vatten
- ☐ Diskar inte under rinnande vatten
- ☐ Återanvänder vatten i hemmet (t.ex. låter vatten du har tvättat grönsaker i användas till krukväxter)
- ☐ Spolar inte toaletten efter varje användning
- ☐ Åtgärdar droppande kranar och läckande toaletter inom en vecka vid upptäckt
- ☐ Duschar istället för att bada
- ☐ Inget av ovanstående

Other: ☐ _____

10. Varför har du/ditt hushåll valt just dessa åtgärder för att minska vattenförbrukningen i hemmet? Varför har du valt bort vissa åtgärder? *

_____

_____

_____

_____

_____

11. Hur pass medveten anser du dig vara när det gäller vattenfrågan i Sverige och övriga världen? *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Inte alls medveten	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Väldigt medveten

12. Nedan följer ett antal påståenden. Välj den siffra som stämmer bäst överens med vad du tycker. *

Tick all that apply.

	Stämmer dåligt	Stämmer ganska dåligt	Stämmer varken bra/dåligt	Stämmer ganska bra	Stämmer bra
Det finns anledning att minska vattenförbrukning i Sverige.	☐	☐	☐	☐	☐
Jag har tillräckligt med kunskap om åtgärder för att kunna minska min vattenförbrukning.	☐	☐	☐	☐	☐
I min bekantskapskrets finns ett intresse för att spara vatten.	☐	☐	☐	☐	☐
Jag vet var jag kan hitta information om vattenförbrukning och hur jag kan påverka hemma.	☐	☐	☐	☐	☐
Ekonomiska incitament är bra för att minska vattenförbrukning.	☐	☐	☐	☐	☐
Det är ansträngande och tar tid att spara vatten hemma.	☐	☐	☐	☐	☐
Det är kostsamt att spara vatten.	☐	☐	☐	☐	☐
Sveriges befolkning har en plikt gentemot samhället och framtida generationer att spara vatten.	☐	☐	☐	☐	☐
Jag kan bli frustrerad när jag ser andra jag tycker slösar med vatten.	☐	☐	☐	☐	☐

13. Vilka hinder finns för att ditt hushåll ska minska er vattenförbrukning? *

14. Vad gör det mer attraktivt för dig att spara vatten hemma? *

15. Vilka budskap som syftar till att minska vattenförbrukning har du sett (t.ex. reklamfilm, informationsblad)? *

16. Vilka förändringar har dessa budskap lett till i ditt hushåll? *

17. Skulle du vara intresserad av att ställa upp på en telefonintervju inom de närmaste veckorna? Isåfall är du varmt välkommen att fylla i din mailadress i fältet nedan så kontaktar jag dig om detta skulle bli aktuellt.

Appendix 2. Questionnaire

Water use in households (English translation)

This questionnaire is a part of a study commissioned by Sydvatten AB and aims to find out how you use
in your housing co-op apartment and what you think about the information that you have seen regarding
water use in Malmö and Sweden.

The questionnaire is estimated to take approximately 5-10 minutes to complete.

If you have any questions regarding your participation, please contact me at
josefin.dahlberg.926@student.lu.se

Kind regards,
Josefin Eidrup Dahlberg
Master student at Lund University

*Required

1. Choose one of the following. I am... *

Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Other
- ◯ No answer

2. How old are you? *

3. What is your main occupation? *

Mark only one oval.

- ◯ Working
- ◯ Student
- ◯ Retiree
- ◯ Unemployed
- ◯ Other

4. Which is the highest level of education you have finished? *

Mark only one oval.

- ◯ Elementary school
- ◯ High school
- ◯ Bachelor's degree
- ◯ Master's degree
- ◯ PhD or higher
- ◯ No answer
- ◯ Other: _____

5. How many live in your household (including yourself)? *

Mark only one oval.

1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

6. Hur many in the household are under 18 years of age? *

Mark only one oval.

0	1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

7. Do you own or rent your apartment/house? *

Mark only one oval.

- ◯ Own apartment (co-op)
- ◯ Rent apartment (co-op)
- ◯ Live in rental apartment
- ◯ Own house (not member of co-op)
- ◯ Rent house (not member of co-op)

8. Does your housing co-op or rental organization have IMD for water use? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Don't know

9. Which one/ones of the following behaviors do you perform at home? *

Tick all that apply.

- ☐ Installed low flowing shower heads and taps
- ☐ Take shorter showers (under 5 minutes)
- ☐ Installed water efficient dish washer or washing machine
- ☐ Turn off tap while brushing teeth
- ☐ Let clothes air out instead of washing after every use
- ☐ Wash only full loads of laundry
- ☐ Only do full loads of dishes
- ☐ Wash vegetables in a bowl instead of under running water
- ☐ Don't do dishes under running water
- ☐ Reuse water at home (e.g., let water you have washed vegetables in be used for plants)
- ☐ Don't flush the toilet after every use
- ☐ Fix leaking taps and toilets within a week after discovery
- ☐ Shower instead of taking baths
- ☐ None of the above
- Other ☐ _____

10. Why have you/your household chosen to take these measures to reduce the water use in your home? Why have you chosen not to take certain measures? *

_____

_____

_____

_____

_____

11. How aware would you consider yourself to be concerning water use in Sweden and the rest of the world? *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not at all aware	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very aware

12. Below are a number of statements. Choose the number that according to you is the most accurate. *

Tick all that apply.

	Not accurate	Moderately inaccurate	Neither accurate nor inaccurate	Moderately accurate	Accurate
There are reasons to reduce water consumption in Sweden.	☐	☐	☐	☐	☐
I have enough knowledge to be able to reduce my water consumption.	☐	☐	☐	☐	☐
There is an interest among my acquaintances to conserve water.	☐	☐	☐	☐	☐
I know where I can find information about water consumption and do this at home.	☐	☐	☐	☐	☐
Financial incentives are important to reduce water consumption.	☐	☐	☐	☐	☐
It is energy- and time consuming to conserve water at home.	☐	☐	☐	☐	☐
It is expensive to conserve water at home.	☐	☐	☐	☐	☐
The population in Sweden has an obligation to conserve water for society and future generations.	☐	☐	☐	☐	☐
I can become frustrated when I see someone I believe is wasting water.	☐	☐	☐	☐	☐

13. What barriers are there that prevent your houshold from reducing your water consumption? *

14. What makes it more attractive for you to conserve water at home? *

15. What messages aimed at conserving water have you seen (e.g., television ads, information sheet)? *

16. What changes havet hese messages led to for your household? *

17. Would you be interested in partaking in a phone interview within the coming weeks? In that case, you are welcome to fill in your e-mail address below and I will contact you if need be.

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