Summary report on cost–benefit analyses for urban stream restoration projects of the Heawater project

Heawater Deliverable D.T2.1.4

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November 24th 2020

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Photo in the cover by Sari Väisänen (SYKE)

1. Introduction

In cities, human activities have significant and direct impacts on the state of urban nature. This also applies to the status of urban water bodies and small waters. Rainwater often ends up untreated in urban streams and other urban water bodies, degrading their condition. In addition to the quality of stormwater, problems can also be caused by rapid and extreme fluctuations in their volumes. Heavy rains, which are becoming more frequent as a result of climate change, may contribute to increasing stormwater floods, thus affecting the lives of people and the rest of urban life. Long rainless summer seasons, in turn, can drain at least smaller urban streams. Although city streams are often close to people living in cities, they can nevertheless receive very little attention. Therefore, many people do not comprehend the impact of small and everyday human activities on their condition.

The surveys presented in this report were a part of the international Heawater project (Achieving healthier water quality in urban small rivers of the Baltic Sea catchment by restoration of water bodies and preventing of nutrients and hazardous substances inflow from watershed), an EU project funded by the Interreg Central Baltic Programme 2018–2021. Participants in the project were the City of Tallinn (the leading partner), Tallinn University of Technology in Estonia, the municipality of Söderhamn in Sweden, the Finnish Environment Institute (SYKE) and Turku University of Applied Sciences (TUAS) in Finland.

The overall goal of the Heawater project was to demonstrate possible and sustainable solutions to achieve better water quality in small, urban watercourses around the Baltic Sea. In addition, the aim was to raise awareness of the benefits of better water quality in small urban streams and the impact of streams on human well-being. The target areas of the project were the city of Turku in Finland, the municipality of Söderhamn in Sweden and the city of Tallinn in Estonia.

As part of the Heawater project, surveys were conducted in Turku, Söderhamn and Tallinn on the attitudes and willingness of residents to improve the condition of small waters and the sustainable management of stormwater in their area. The method used was the contingent valuation method, which aims to quantify the impact of environmental change on people's well-being using a carefully designed survey (see for example Mitchell and Carson (1993); Champ et al. (2003)). A scenario is created for the survey to assess willingness to pay (WTP). In this project, the scenario described what environmental changes would be seen in small urban waters after new and more sustainable restoration measures. The environmental changes described were reduced flooding, an improved water status, increased recreational opportunities, increased spawning grounds for fish and more diverse habitats for birds, mammals and insects in water front. For the implementation of the presented scenario, respondents were asked if they were willing to pay a monthly (or annual) payment in the future. The results of the surveys were used to evaluate the overall benefits of improving the status of small waters. The overall environmental benefits could then be compared with an estimate of the cost of measures to achieve this change.

This report describes the implementation of the surveys in all three pilot areas in three countries, the annual and total costs and benefits, and the annual benefit–cost ratios calculated on the basis of these estimates for the proposed measures. Each survey has also been reported in its own Deliverable in the target country's language (Deliverable T.2.1.1 Estonia, Deliverable T.2.1.2 Finland and Deliverable T.2.1.3 Sweden). Attachments to these Deliverables include the full survey material for each area and more detailed results. The English version of the Turku questionnaire can be found in Appendix 1 in this Deliverable. In addition, a summary report (Deliverable C.3.2) of the results of all three surveys has been prepared.

2. Description of the study areas and implementation of the surveys

In all three areas, the survey was conducted as a combination of a paper survey and an online survey. Researchers at the Finnish Environment Institute were responsible for planning the content of the survey, while partners in each country helped to design a regional perspective and write content for the questionnaire. JP Postitus was selected based on a competitive bidding process to manage printing and mailing, to execute the Internet questionnaire and to collect the material for three of the Heawater project's valuation surveys. The Internet questionnaire was based on JP Postitus' own survey platform. Freelance editor Erika Varkonyi was responsible for the layout of the printed materials and the drawings used in them. These drawings were created to visualize stormwaters and their management for citizens.

The recipients were contacted three to four times. In the first contact, they were sent a paper questionnaire with a cover letter that explained the ongoing survey and also provided the address of the Internet survey. Next, a reminder card was sent to the recipients twice. In addition, in Turku and Söderhamn, recipients were contacted a fourth time, when they were sent a paper questionnaire and another cover letter. The English version of the Turku questionnaire is provided in Appendix 1. In the second, third and fourth mailings, most of those who had already responded by then were removed from the recipient list.

1.1. The city of Turku, Finland

Turku, located in southwestern Finland with a population of almost 200,000, is the oldest city in Finland. In addition to the Aura River and the Archipelago Sea flowing through the city, there are numerous small watercourses in the city area. The most significant of Turku's small waters are the city streams Jaaninoja and Kuninkoja, but there are also many ditches and small ponds in the urban area, which can be locally significant for biodiversity and people's well-being. The water quality and biota of Jaaninoja and Kuninkoja have been studied since the beginning of the 21st century. Based on the biota studies, the ecological status of both streams would be classified as inadequate or poor. According to the water quality studies, the water quality of the streams has deteriorated, especially due to stormwater from streets and industrial areas, as well as construction sites. Both streams have been restored, for example as trout habitats. If the water quality of Kuninkoja and Jaaninoja were to improve, they would be better suited than at present for crabs and trout, as well as many other species. The state of urban watercourses is greatly affected by the way the city treats stormwater and snowmelt.

The survey was conducted both as a paper questionnaire and as an Internet questionnaire at the end of 2018. The study area was the city of Turku, as indicated in Figure 1. The basic population of the study comprised the inhabitants of this area, and the sample was based on approximately 28,000 residential buildings in the area. The questionnaire was sent as a random sample to one adult per household and was limited to native Finnish speakers. Altogether, 1,200 people randomly sampled from the Population Register Centre were sent a survey based on the listed building codes. The area was delimited in advance according to the postal codes, so that the distance of the respondents' homes from the city streams of Turku would not be too great.

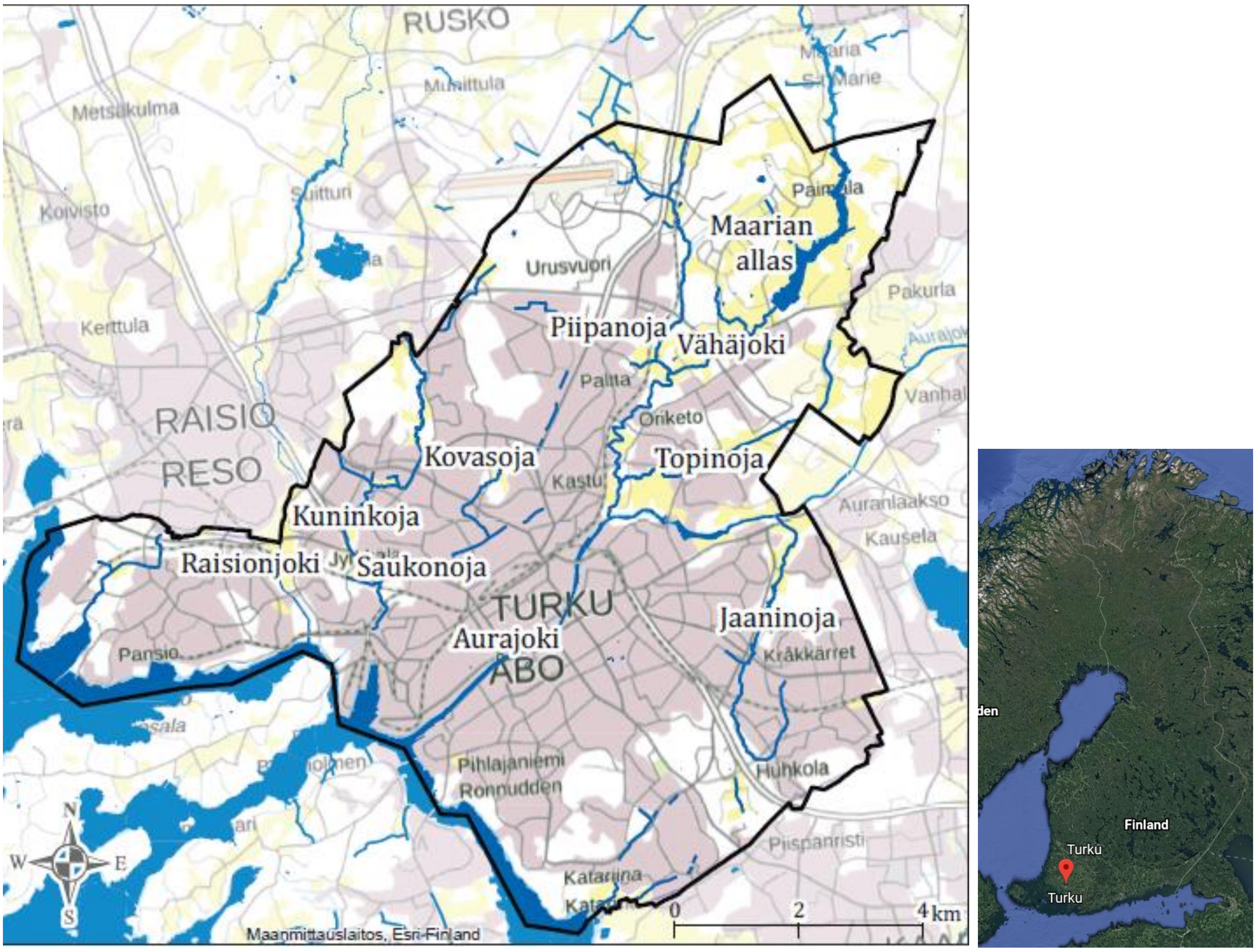


Figure 1. Study area in Turku, the study area outlined in black. @City of Turku

The questionnaire was tested in September 2018 by sending it by e-mail to 15 employees of the City of Turku. Based on the comments received from the testers, a few questions were refined. In order to increase the response rate and representativeness, respondents were contacted a total of four times: first by sending a paper questionnaire, then with two reminder cards and finally again by sending a paper questionnaire. All questionnaire materials for Turku can be found in Finnish in Deliverable D.T2.1.2.

The paper questionnaires were mailed between October 2018 and January 2019. The Internet questionnaire was open until 8 January 2019. In the second, third and fourth mailings, most of those who had already responded by then were removed from the recipients list. In total, 465 responses were received. After eliminating multiple replies from the same persons, inadequately completed questionnaires and clear protest responses, the final data set comprised 438 respondents, representing a response rate of 36.5%. Such a response rate can be considered good. Of these, 349 (80%) responded on paper and 89 (20%) via the Internet.

1.2. The municipality of Söderhamn, Sweden

Söderhamn is a 400-year-old town at the bottom of Söderhamn Bay. The city has developed along the Söderhamnsån River, and the river has always been important for the city's traffic, fishing and trade. The catchment area of Söderhamnså is 92.3 km^2. Söderhamn is home to about 26,000 people. Söderhamnsån flows through woodlands, agricultural land and residential areas. Heavy rains and melting snow easily cause flooding, as the flow increases sharply because there are very few flow-compensating lakes in the catchment area. Both the river and the bay are impacted by a high loading of solids and high nutrient concentrations, resulting in eutrophication. With stormwater, harmful substances also end up in the river and bay. Söderhamn Bay is particularly sensitive to environmental impacts because it is both narrow and shallow.

The water quality of Söderhamn has been studied since the 1970s, and in 2018 an extensive study was carried out on the state of Söderhamnså water. According to the latest classifications, the ecological status of Söderhamn Bay is poor and that of Söderhamnså is moderate. However, trout breed in Söderhamnså.

The survey area in Söderhamn was already defined in the project application. A random sample of addresses for 1,200 people from Söderhamn was ordered by JP Postitus Oy from Data Refinery Oy. The gender distribution was set equal, so 600 women and 600 men were included in the sample. The survey was aimed at residents living around Söderhamnsån and the inner part of Söderhamnsfjärden (Figure 2), and the postal code areas were used to delimit the area. Because of the aim to include the northern part of Söderhamnsfjärden, the questionnaire was also sent to residents with the postal code 82691, even though some of these lived far from Söderhamnsån. The survey was targeted at people in the age range of 18–79 years and at one respondent per household. However, as the survey progressed, it became apparent that some of the addresses (n = 266) were out of date. The company that collected the address and name information was requested to provide new personal and address information for these addresses.

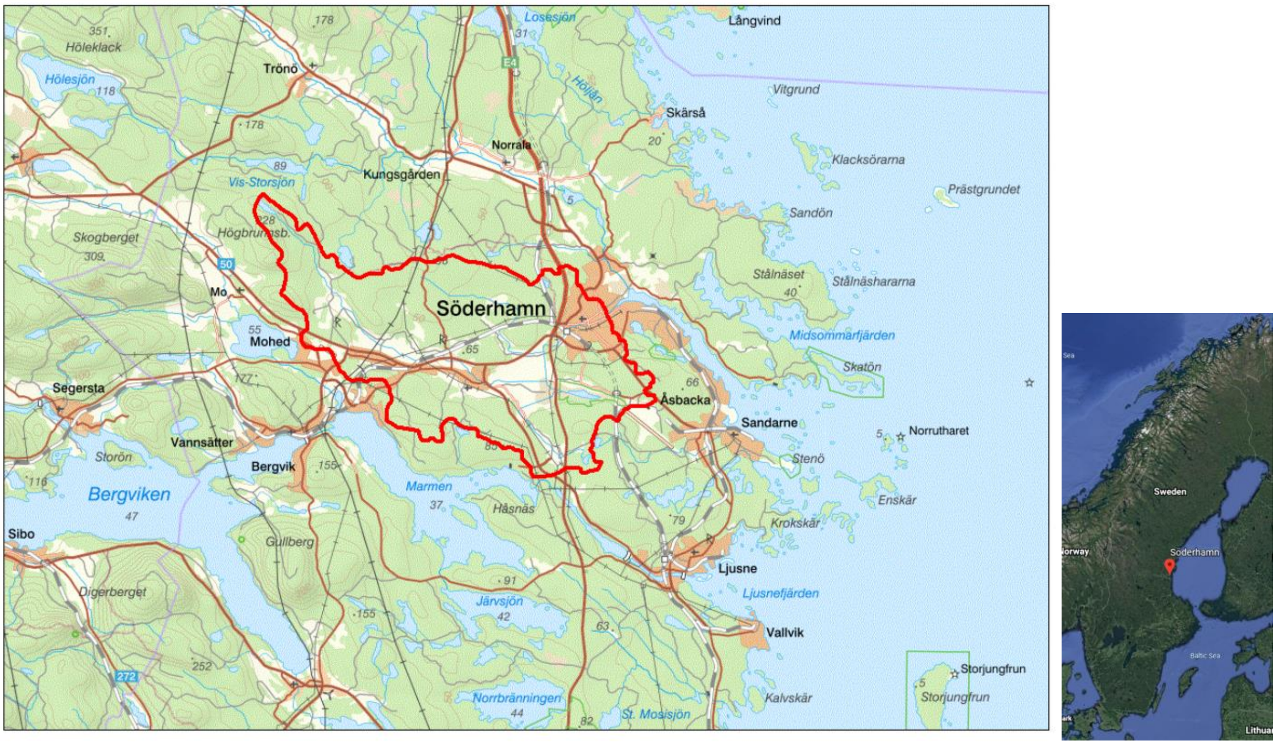


Figure 2. Study area in Söderhamn the study area outlined in red. @Municipality of Söderhamn

The Finnish Environment Institute (SYKE) designed and otherwise executed and managed the questionnaire in cooperation with the municipality of Söderhamn. The questionnaire was tested in March and April 2019 by sending it to a several residents in Söderhamn. Based on the comments received from the testers, minor changes were made to a few questions. The survey was conducted in Söderhamn in summer 2019, in Swedish, and both as a paper and an Internet questionnaire.

In order to increase the response rate and representativeness of the data, respondents were contacted a total of four times: first by sending them a paper questionnaire, then with two reminder cards and finally again by sending a paper questionnaire. All questionnaire materials for the Söderhamn study can be found in Swedish in Deliverable D.T2.1.3. as attachments. The cover letters and reminder cards were signed by John-Erik Jansson, Chairman of the Municipal Board of Söderhamn.

In total, 475 responses were received. After eliminating empty replies (16), double replies (17) and 28 replies from the postal code 82661, which was outside of the study area, the final data set comprised 424 respondents, representing a response rate of 35.3%, which can be considered good. A total of 348 (82%) responded on paper and 76 (18%) via the Internet.

1.3. The city of Tallinn, Estonia

Tallinn, the capital of Estonia, has a population of about 445,000. The Pirita River is the longest of the 16 rivers and streams in the Tallinn city area and it is more than 100 km long. Many of the streams are shorter than ten kilometres and some of them have been moved to run through pipes under the city. In the past, streams served as wastewater passageways and discharge points, but today, they are mainly used as stormwater ways. As a result, the natural catchment area of some streams has increased and the hydrology and water quality have changed. According to measurements, the ecological status of the water of the Mustjõe and Tiskre streams is poor. The water quality of Lake Harku, from which the Tiskre stream originates, is also poor. The water quality of the Mustjoki River has deteriorated, especially due to the contaminated stormwater discharged into it from streets, industrial areas and construction sites. Monitoring of the water quality of the Mähe River did not begin until 2019, but its condition also appears to be poor.

As shown in Figure 3, the survey was targeted at residents of three residential areas, namely Pirita, Haabersti and Kristiine. The areas were selected based on the small surface waters located in them. The Mähe stream (Mähe oja) runs in the Pirita area and the Mustjõe and Tiskre streams are in the Haaberst area. The Kristiine area was also selected for the study because the Mustjõe stream runs underground in this area and most of the stream's catchment area is in this area.

The survey was conducted only in Estonian as a paper and Internet survey in early 2020. The survey was targeted at a random sample of city residents aged 18–80 years, one person per household. The sample (N = 2,500) was divided between three selected areas according to the known population: Pirita (467 people), Haabersti (1190 people) and Kristiine (843 people). In addition, the sample was targeted at 1509 (60%) Estonian-speaking and 991 (40%) Russian-speaking recipients. SYKE received addresses from the Estonian Ministry of the Interior (Siseministeeriumi infotehnoloogia- ja arenduskeskus). The Finnish Environment Institute was responsible for preparing the surveys with the help of local partners, while mailing of the survey was handled by JP Postitus Oy.

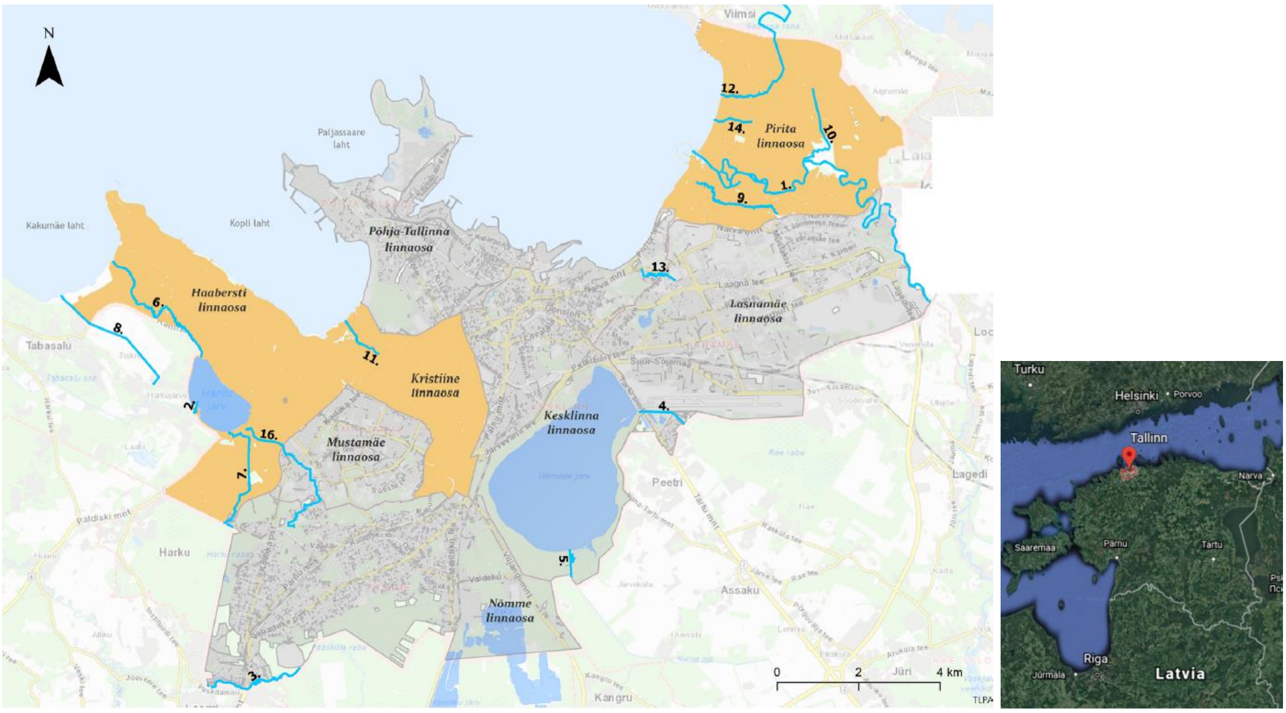


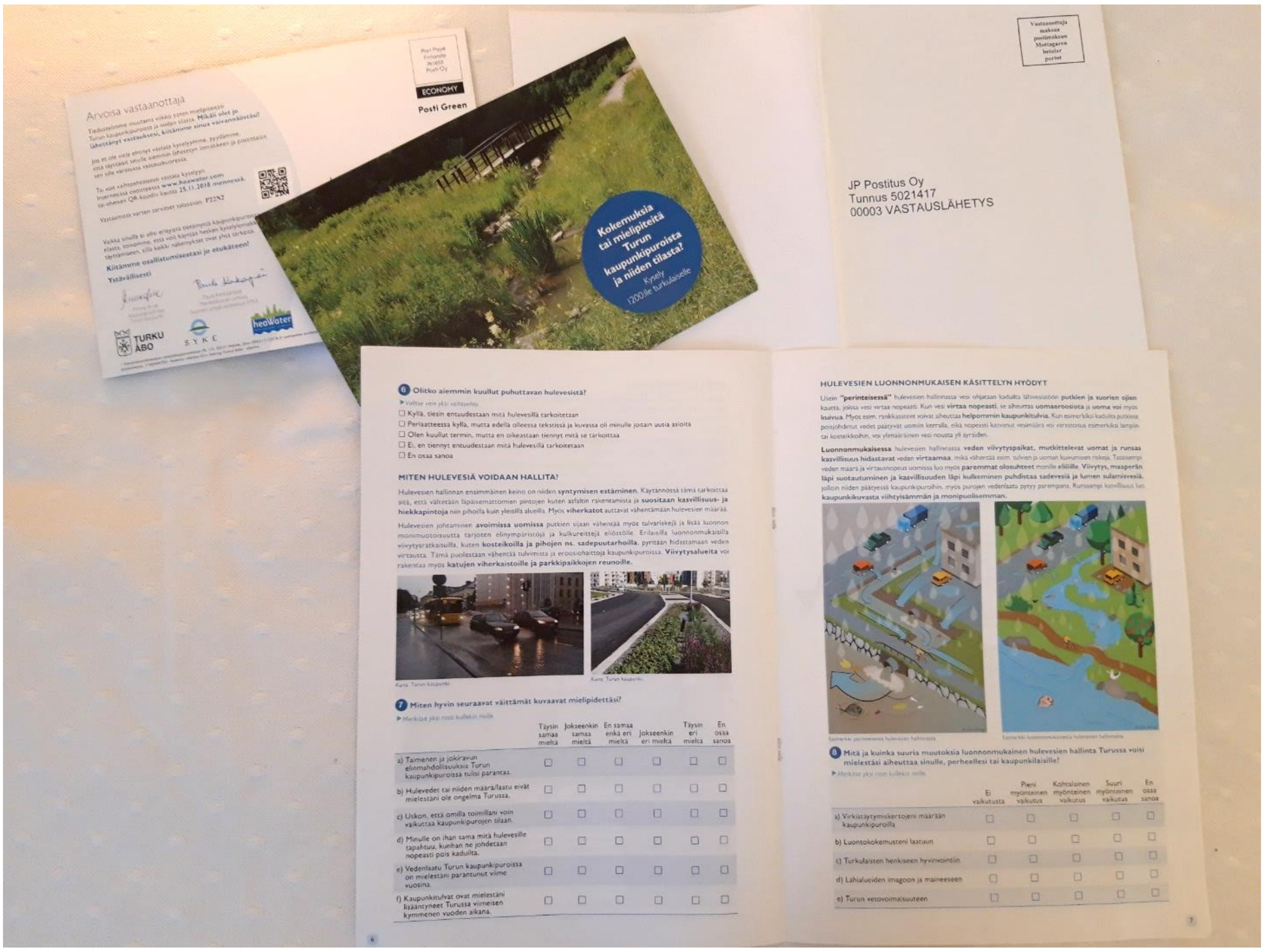
Figure 3. Three study areas, Haabersti, Kristiine and Pirita, in Tallinn @City of Tallinn

The questionnaire was tested in November 2019 by employees of the City of Tallinn by sending it to a total of ten people. Based on the comments received from the testers, a few questions were refined. To increase the response rate and representativeness of the data, respondents were contacted three times. First, a paper questionnaire with a cover letter was mailed to the recipients in March 2020. The cover letter was signed by the Mayor of Tallinn, Mihhail Kõlvart, and it described the ongoing survey and provided the address of the Internet survey. Those who had not yet responded to the questionnaire were reminded once or twice with a reminder card. The tentatively planned fourth contact was nevertheless not made, as the number of responses had already decreased significantly in the third round of the survey. The Internet survey was kept open until the end of May 2020. In addition, a short questionnaire was sent to several non-respondents (n = 400) in June 2020 to ask for the reasons that contributed to their non-response.

Thus, respondents were contacted three times between February and April 2020. In total, 323 responses were received. After eliminating empty replies, double replies and protest replies, the final data set comprised 311 respondents, representing a response rate of 12.4%. The response rate can be considered quite low. Overall, 54% responded on paper and 46% via the Internet.

1.4. The content of the surveys

The surveys also served as a communication tool, as in addition to the 25 questions, they contained a large amount of up-to-date information on small urban waters and their status, as well as stormwater management in each survey area. The survey texts followed the same pattern in all three areas, but were tailored to suit each target area. The surveys also told about stormwaters in general and about sustainable stormwater solutions, as stormwater affects the state of small urban waters. All surveys used the same images drawn in the Heawater project for surveys and environmental education purposes. The images illustrated the formation of stormwater and aspects that can influence its quality, as well as different stormwater treatment practices. These images are presented in Appendix 1. The surveys also included a number of questions about respondents' attitudes, opinions and level of knowledge. These attitudinal and background questions are essential in the contingent valuation method. These questions and their answers have been discussed in more detail in the country-specific deliverables[1] and they are also compiled in English in Deliverable D.C.3.2.



@ Virpi Lehtoranta SYKE

[1] Deliverable D.T2.1.1 in Estonian, D.T2.1.2 in Finnish, and D.T2.1.3 in Swedish

2. Environmental benefits and costs in the Turku study

The study area comprised the city of Turku (excluding the archipelagos and northern Turku), as shown in Figure 1, and this was already decided in the project application. The target group was the Finnish-speaking adult population of the area, i.e. persons aged 18 to 79 years. The share of adults in the population of Turku was estimated to be about 80% (Tilastotieto Turusta 2020).

2.1. The scenario used in the Turku study

The “light” social cost–benefit analysis promised in the project informs decision-makers about the imaginary relationship between the total costs of improving Turku's small water status, biodiversity and recreational use and the social benefits achieved through their improvement. These benefits, estimated using the contingent valuation method, reflect the positive change in Turku city streams described in the survey scenario and the change in the well-being of residents caused by this environmental change. The survey described for residents a scenario to improve the condition of urban streams as follows:

“In order to achieve the above-mentioned goals for minimising city flooding, improving the condition of city streams and safeguarding the diversity of nature and biota in Turku, more wide-ranging and sustainable small watercourse/body restoration measures and stormwater management must be implemented.

***Now, imagine** that the citizens of Turku would be able to pay a voluntary ‘city stream fee’ over the next ten years to the already existing Archipelago Protection Fund, which has funded water protection projects in the Archipelago Sea and its vicinity. This would encourage businesses and residents in the City of Turku area to participate in comprehensively improving the condition of city streams. The City of Turku would maintain existing stormwater systems, but the additional revenue gained from these ‘city stream fees’ would be put toward the more comprehensive restoration of city streams and making some conventional stormwater solutions more sustainable.*

After implementing new, more sustainable measures, the following changes would be evident in city streams:

- *Building flood plains will ensure that streams do not flood their surroundings in a destructive manner and channel flow will be maintained even during dry periods.*
- *The stormwater from newly built areas will be directed through wetlands into streams.*
- *Stepping stones, benches and waste receptacles will be placed along streams, where people can come to walk, relax or observe local nature.*
- *Streams and their surroundings will form a complex habitat for different species, such as birds, mammals and insects.*
- *The number of migratory fish ascending the stream to spawn will increase.*
- *The streams will wind and babble.”*

2.2. Willingness to pay for improving the state of urban streams in Turku

One of the most important purposes of the survey was to estimate the willingness of residents to personally contribute to the costs of protecting urban streams. Approximately 60% of all respondents would at least consider paying a voluntary city stream fee in 2019–2028 to improve the condition of Turku city streams and their surroundings (Figure 4).

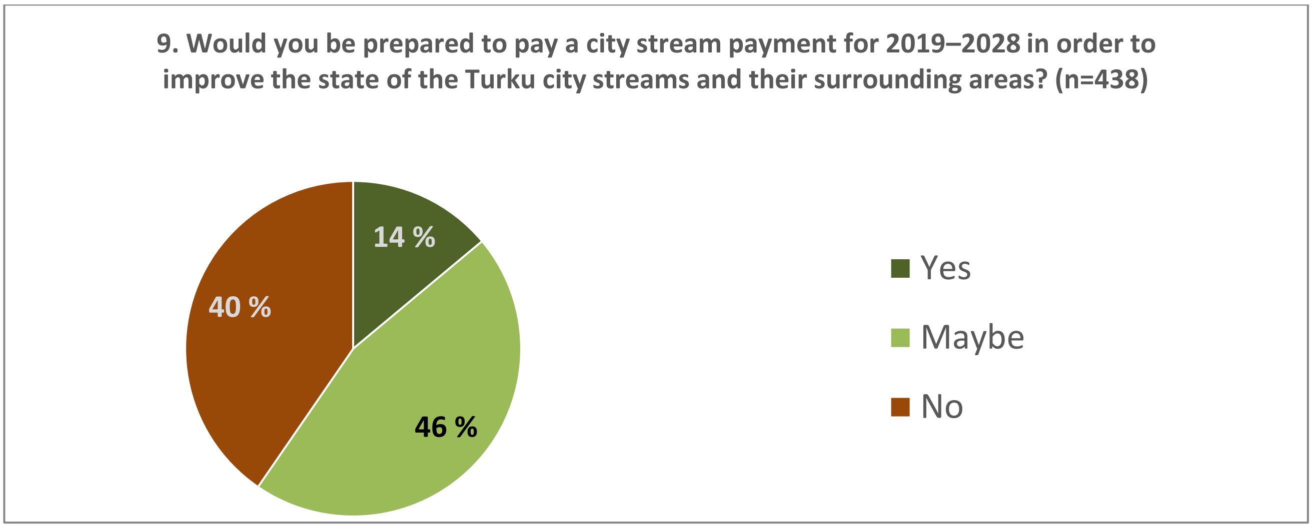


Figure 4. The willingness of the respondents (n = 438) to pay for an improvement in the state of urban streams in Turku

Those who replied "Yes" or "Maybe" to the willingness to pay question were then asked how certain they would be about paying different amounts each month for the next ten years. Table 1 summarizes the estimated average sums that respondents would be willing to pay annually for the improved status of small waters in the Turku area. Based on the results, the respondents were on average willing to pay a voluntary city stream fee of EUR 12.20–32.00 per year in 2019–2028. The lower and upper values of average willingness to pay were calculated in two different ways (Kristrom 1990; Turnbull 1976).

Table 1. Respondents' (n = 438) average annual willingness to pay (and standard deviation, €) per person for more sustainable treatment of stormwater and small waters over the next ten years.

Certainty expressed by respondents about paying the annual fee of their choice	Willingness to pay (WTP) [€/year/person]	
	Lower bound (Turnbull estimate)	Upper bound (Kriström estimate)
I would definitely pay	12.2 (23.7)	18.3 (21.3)
I would definitely or probably pay	21.1 (38.1)	32.0 (40.2)

Factors related to the respondents or their attitudes that together contributed to the positive willingness to pay were analysed using a regression model. The model explained respondents' willingness to pay some positive monthly city stream fee over the next ten years. Based on the results, the willingness to participate was increased by the following factors: perceiving the protection of the Archipelago Sea as very important, belonging to younger age groups of respondents and considering water, stormwater or wastewater fees as the best way to raise funds for more sustainable stormwater treatment and urban stream improvement. In addition to these, the willingness to participate was increased by the respondent's higher income level and having Jaaninoja as the nearest stream.

About 54% of the respondents were women and the average age of the respondents was approximately 56 years. The mean age was thus slightly higher than that of all survey recipients (Table 2). Similarly, the proportion of female respondents was slightly higher than in the whole sample (n = 1,200).

Table 2. A comparison of the sample and the respondents in the Turku study

	Turku*	Sample n = 1200	Respondents n = 438
Share of women	52.2%	51.3%	53.9%
Average age (years) at the time of the survey		49.7	55.6

**) Tilastotieto Turusta 2020 https://www.turku.fi/turku-tieto/tilastot/tilastotietoja-turusta#V%C3%A4est%C3%B6,%20asuminen%20ja%20koulutus*

2.3. The validity of benefit data in Turku

The goodness of the obtained questionnaire data needed to be assessed, as the aim was to produce a representative understanding of the opinions of the residents of the Turku area on the state of urban streams and plans for its improvement, as well as their willingness to participate in improving local waters. To assess the validity of the data, a short non-response survey was sent to 200 respondents who did not respond to the actual survey. The aim was to find out not only the reasons for their non-response but also their opinions about nearby waters and their condition. The survey was conducted by the Finnish Environment Institute (SYKE) and mailed in late May 2018. After a response time of about three weeks, a total of 21 responses were received.

Based on the non-response analysis, by far the most common reason for non-response was the respondent's feeling that their knowledge of urban streams or stormwater was inadequate. Other reasons were that it felt too laborious to respond to the survey, there was a lack of time to respond, or not generally responding to any surveys. For a smaller proportion (25%), the explanation for non-response was related to the fact that the respondent did not believe that answering would help the research project. The least chosen reason (19%) for non-response was experiencing the status of urban streams and stormwater as uninteresting topics.

Compared to the response data received (42%), a larger proportion of respondents to the non-response survey (57%) could not say in what state they thought the city streams were. However, almost all the respondents to the non-response survey knew what stormwater meant, and they felt even more strongly than respondents to the actual survey that they were not indifferent to what happens to stormwater.

Compared to the actual respondents, the respondents to the non-response survey agreed to the same degree about their own possibilities to influence the state of the city streams and that the city streams should be more visible in the Turku cityscape. In contrast, a significantly higher proportion of respondents to the actual survey were concerned about the condition of urban streams than respondents to the non-response survey. Somewhat more than half of the respondents to the non-response survey were women, as were the respondents to the actual survey, but the average age of the respondents to the non-response survey was about two years lower than the average age of the respondents to the actual survey.

Based on the answers in the non-response survey and the actual survey, the data from the actual survey can be considered sufficiently representative to describe the studied population, i.e. the Finnish-speaking adult population in the Turku area.

2.4. Environmental benefits

Based on average willingness to pay, it is possible to estimate the willingness to pay of the entire adult population in Turku. About 40% of respondents were unwilling to pay for the proposed change in water status of the city streams. The willingness to pay for this group was assumed to be EUR 0. In addition, the willingness of non-respondents to participate was assessed. Based on the non-response analysis described above, it was assumed that the willingness of non-respondents to participate is of the same order of magnitude as the average in the data. However, the overall benefits were determined conservatively, i.e. based on the lowest average willingness to pay estimates.

When assessing the benefits, it was assumed that at the time of the study, approximately 150,000 Finnish- or Swedish-speaking residents aged 18–79 lived in the Turku area. With the average willingness to pay presented by the study (€12.20–18.30 per year, which the respondent was *definitely* willing to pay), it can be estimated that the total willingness to pay totals approximately EUR 1.83 million to EUR 2.75 million per year. This estimate reflects the annual benefits to the residents of the Turku area that would be achieved by conservatively estimating the improvement in water quality and flood protection in urban streams in the period 2019–2028.

2.5. Measures and total costs

The total costs of improving the status of small waters and stormwater management have not been estimated for the entire Turku area, but the available plans and programmes were used for the assessment. An estimate of the total costs was needed to prepare the light social cost–benefit analysis promised in the project.

In assessing the measures to be implemented and their costs, the Kuninkoja Management Plan (Tolonen & Ahonen 2018), the Helsinki Small Water Programme (Helsingin kaupungin rakennusvirasto 2007) and the Skanssi Stormwater Plan (FCG Suunnittelu ja tekniikka Oy 2015) were utilized in this study. The information obtained from these documents was combined and generalized to create an annual cost estimate for the Turku study area (Table 3). In this way, a sufficient level of precision for this analysis to assess the benefit–cost ratio was achieved. The analysis focused on annual estimates over a ten-year period.

From the Kuninkoja Management Plan, the planned measures and their quantity for the Kuninkoja urban streams area were collected. As the area of this study is larger than the Kuninkoja area, the cost calculations presented here assume that three times the number of measures would be applied to the streams of the entire Turku area as planned for the Kuninkoja area. However, the measures assumed for the bog in the Kuninkoja area were not extended to elsewhere in the study area in these calculations.

The costs for individual measures were obtained from the Helsinki Small Water Programme (Helsingin kaupungin rakennusvirasto 2007). From the measures presented in that programme, those measures that best corresponded to Kuninkoja's measures were selected and their cost estimates were used in the calculations. The costs were changed to correspond to the monetary value of 2020, i.e. the amounts originally presented in the Helsinki Small Water Programme were multiplied by 1.22. For floodplains, the estimates of the Helsinki Small Water Programme were also compared with the cost estimates of the Skanssi Stormwater Plan.

In addition, the Helsinki Small Water Programme was used to estimate annual or otherwise recurring costs. A similar change in monetary value was also made for these costs. The number of these recurring measures was assumed to be directly proportional to the length of the streams in the Turku study area. In these calculations, the total length of the streams was assumed to be approximately 35 kilometres, in accordance with the Turku Regional Stormwater Plan (Pöyry Finland Oy 2014). The assumption for management measures was that 40% of the streams' surroundings consist of 'meadow' and 40% are 'forested', and these were assumed to have the annual and less frequent measures described in the Helsinki Small Water Programme for these environments. The remaining 20% were assumed to be in no need of such treatment. Furthermore, the Helsinki Small Water Programme described the need to go through streams every year, for example to remove debris. No cost estimate had been provided for this measure, but a cost estimate of 500 euros per stream kilometre for the total length of 35 km of streams was assumed. Additionally, the investment and operating costs of filtration equipment developed by Turku University of Applied Sciences (TUAS) in the Heawater project were also taken into account over a ten-year period. A total of ten sets of filtration equipment have been assumed to be needed for the streams of the study area according TUAS.

Table 3. Measures planned for Kuninkoja and for the entire study area and their cost estimates. The amounts are three times the amounts assumed for Kuninkoja, except for the TUAS filter amount, which is arbitrary here

Measures for Turku area	Unit costs in euros	Quantities	Total costs in euros
Renewal of culverts	10,000	24	240,000
Flood plain / wetland	10,000	60	600,000
Restoration of spawning areas or rapids/habitat restoration	12,000	54	648,000
Planting of trees, landscaping	8,000	6	48,000
Renewal of bog	20,000	2	40,000
Filter by TUAS	27,700	10	277,000
Development of recreational use and management of streams (during 10 years)	550,000	1	550,000
Total	€637,700		€2,403,000

The costs have not been discounted, i.e. changed into present values. The cost estimates used involve a considerable amount of uncertainty in terms of both the costs and the number of measures, so discounting would not refine the cost estimates. Discounting would also have reduced the costs, so not discounting them will actually give a more conservative, i.e. more expensive, estimate of the costs. The annual total benefits were calculated using average willingness to pay, as determined by the environmental valuation survey.

2.6. Benefit–cost ratios in the Turku study

Residents of the city were asked about their willingness to pay for the better condition of Turku's small waters. The survey served as an environmental valuation study that could be used to quantify the environmental benefits of a positive change in the state of Turku city streams. Based on the results, the well-being of the residents of the study area in Turku would increase by at least EUR 1.83 million per year if the improvements presented in the survey were to be realised. This environmental benefit can be compared to the costs that bring about this change (i.e. the costs of restoration measures). The previous section presented a rough estimate of the total annual cost if the necessary measures were to be implemented over the next ten years. Annual environmental benefits and total costs can be compared using a benefit–cost ratio.

Based on the estimates of benefits and costs made in this study, the environmental benefits of improving the condition and biodiversity of urban streams, reducing flooding and improving people’s recreational possibilities would outweigh the costs. The benefit–cost ratios are presented in Table 4. A conservative perspective was used when estimating the environmental benefits, i.e. the assessment was based on the lowest annual benefit assessment (see section 3.4). The annual benefit remained the same regardless of the length of time for which the restoration measures would be implemented. Regarding the implementation of the measures, the calculation in Table 4 presents annual cost estimates for three, five and ten years. The cost estimates always used the higher estimates of the unit costs.

Table 4. Benefit–cost ratios for more sustainable stormwater management in Turku based on this study

Annual total costs and benefits	Euros per year	Benefit–cost ratio
Environmental benefits	1,830,000	
Annual costs (with a time span of 3 years)	801,000	2.3
Annual costs (with a time span of 5 years)	480,600	3.8
Annual costs (with a time span of 10 years)	240,300	7.6

3. Environmental benefits and costs in the Söderhamn study

3.1. The scenario used in the Söderhamn study

To assess willingness to pay a scenario of a mandatory payment (VA tariff i.e., “The water and sewage tariff”) was created in the Söderhamn survey. In the scenario, the respondent had to imagine that, in order to finance the proposed activities, residents could pay a stormwater management fee as explained in the survey:

“*The Municipality of Söderhamn has adopted a stormwater strategy. It aims to develop the municipality's stormwater management towards a more sustainable approach. The strategy focuses on water quality but also wants to show how stormwater can be utilized and deal with challenges arising from climate change and when urban environments are more densely built up.*

More money is needed to achieve sustainable stormwater management. Now, imagine that the inhabitants of Söderhamn would pay a stormwater fee included in the regular VA tariff over the next ten years to make stormwater management more sustainable.”

Respondents were told what changes would be seen in terms of a reduced risk of flooding along the rivers and in central Söderhamn, and improved water quality in Söderhamnsånand Söderhamn Bay. Management actions would also create increasingly diverse habitats for wildlife and plants in Söderhamnsån and the urban environment, as well as more places for recreation and socializing.

After presenting the environmental objectives and method of financing, the respondents were asked whether they would be willing to pay a monthly stormwater payment at all and, if so, what amount they would be willing to pay.

3.2. Willingness to pay for stormwater management in Söderhamn

The starting point for the study was the stormwater strategy developed in 2018 for Söderhamn. The Heawater project sought to determine the non-market benefits that arise from sustainable stormwater management. The research method used was the contingent valuation method, one of the stated preferences methods.

The aim of the study was to produce a monetary estimate of the well-being of residents for the implementation of the stormwater strategy over the next ten years. In order to assess the positive environmental changes brought about by the implementation of the strategy, a valuation survey was conducted, which produced an estimate of the lower and upper value of the total benefits. Thus, one of the main purposes of the survey was to identify the willingness of residents to contribute to the implementation of the stormwater strategy through a stormwater fee.

The willingness to participate was determined in the survey by two questions: would the respondent be prepared to participate in stormwater charges at all and, if so, what monthly amount during 2019–2028 would they be willing to pay. Over half of all respondents (58%) would at least consider paying a stormwater fee between 2019 and 2028 to increase the more sustainable ways of handling stormwaters (Figure 5).

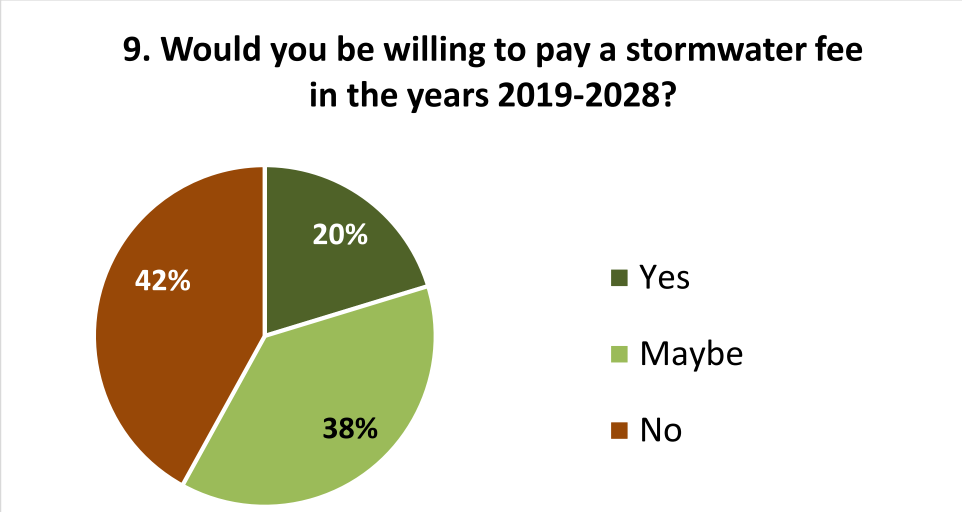


Figure 5. The willingness of the respondents (n = 424) to pay a stormwater fee in Söderhamn.

Respondents who were willing or potentially willing to pay were then asked how much they would pay each month for the next ten years. Figure 6 shows how the responses were distributed in terms of the chosen payments and the certainty related to payment. Two respondents expressed a willingness to pay €50 per month for the next ten years. The veracity and credibility of these responses were assessed by reviewing the whole response forms of these respondents. The respondents were concerned about the state of the river and the Gulf, and the responses did not appear illogical or unbelievable. Thus, these two responses were left in the data.

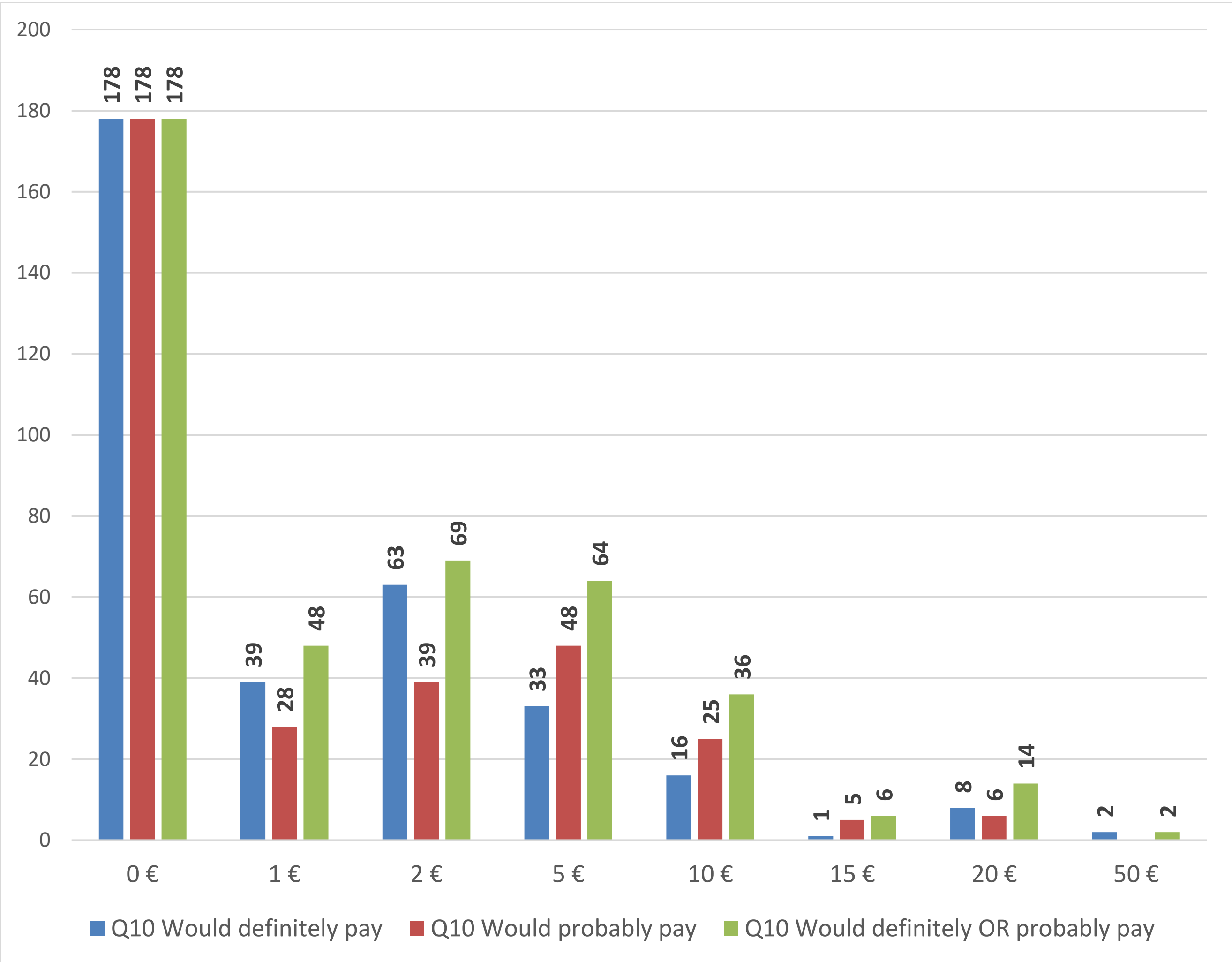


Figure 6. Distribution of chosen monthly payments per person and the related certainty (the Söderhamn study).

As shown in Table 5, the respondents were, on average, prepared to pay approximately €2.30–4.70 per month, depending on the certainty of the answer, for the next ten years. An interesting result was that the younger age groups chose higher amounts from the available payment amounts than the older respondents (see Figure 7).

Table 5. Respondents' (n = 424) average annual willingness to pay per person and standard deviation [€] for more sustainable management of stormwater for the next ten years.

Certainty expressed by respondents about paying the monthly fee of their choice	Willingness to pay (WTP) [€/year/person]	
	Lower bound (Turnbull estimate*)	Upper bound (Kriström estimate*)
I would definitely pay	25.9 (60.6)	39.4 (57.9)
I would definitely or probably pay	36.9 (64.8)	54.6 (66.2)

**) (See Kriström, 1990; Turnbull, 1976). In addition, monthly willingness to pay was multiplied by 12 and the krona was converted into euros at a rate of 0.096*

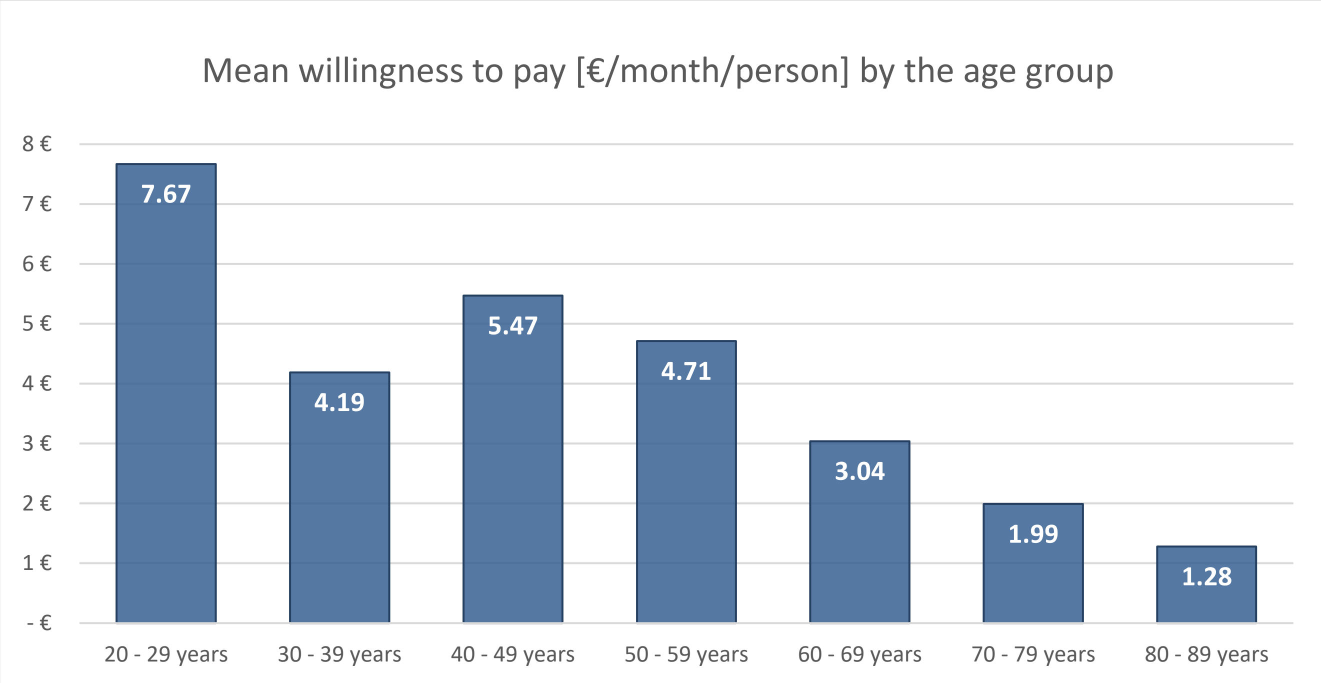


Figure 7. Distribution of the mean willingness to pay sums [€] that respondents (n = 401) were definitely willing to pay or could at least imagine paying (Q10) according to the age group (the Söderhamn study).

3.3. The validity of benefit data in the Söderhamn study

About 48% of the respondents were women, which corresponded well with both the sample and the population. The youngest respondent was 23 years old and the oldest 92 years old. However, the average age of the respondents was approximately 64 years, which was higher compared to the survey recipients and the population (Table 6). The mean age of the respondents in the data set can be compared to the mean age of the Söderhamn adult population (22 years or over), which is about 55 years, calculated from Table 6. The comparison shows that the older respondents were overrepresented in the data. The proportion of respondents under the age of 50 was only 15%, compared with 42% of the adult population in Söderhamn. This is a factor that should be considered when generalizing the views and other results of the survey.

Table 6. Comparison of the sample population and respondent population according to age

Age group (years)	Population in Söderhamn		Respondents	
20–29	1,575	15%	12	3%
30–39	1,335	13%	26	6%
40–49	1,487	14%	36	9%
50–59	1,770	17%	68	17%
60–69	1,682	16%	90	22%
70–79	1,680	16%	116	28%
Total	**9,529**	**100%**	**408**	**100%**
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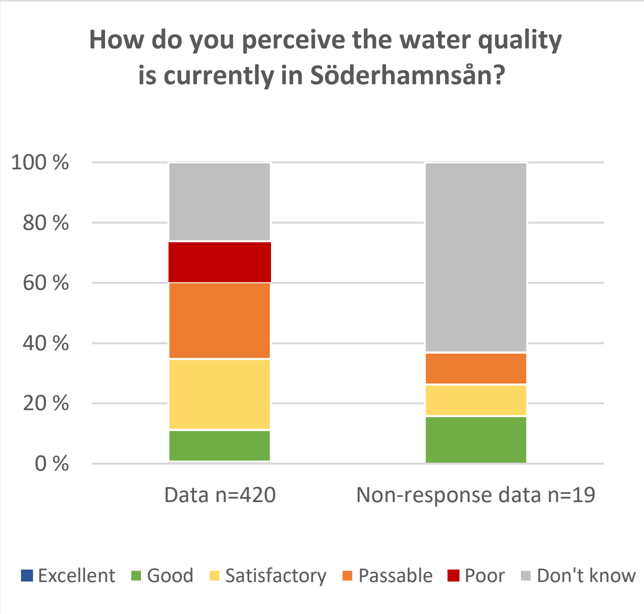
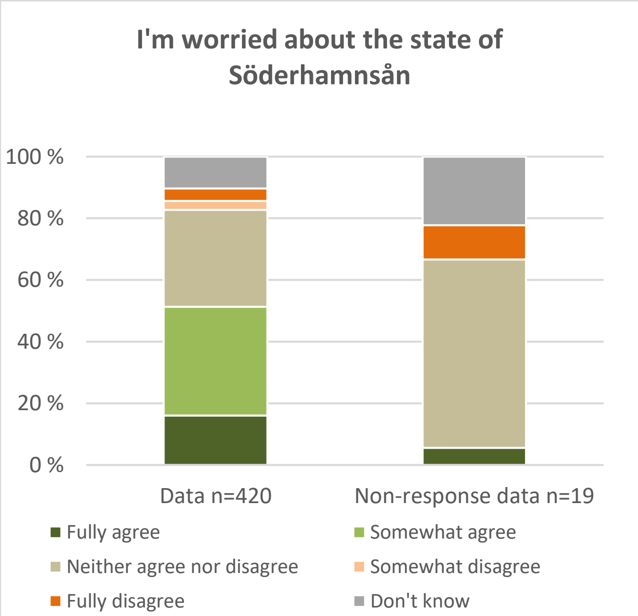
The reliability of the data can be assessed by simply comparing the willingness to pay estimates given by the respondents in different phases of the survey process. If the answers of the quicker respondents differ from those of the slower respondents in this respect, this may be an indication that the data do not fully represent the studied population. The speed of responding, i.e. whether a person responded on time or after a reminder, did not have a statistically significant effect on the mean willingness to pay estimate. On average, the use of willingness to pay to calculate total willingness to pay may therefore be justified on the basis of this analysis.

In addition, the reliability of the obtained survey data was analysed by means of a follow-up survey, in which a group of non-respondents was sent a short questionnaire on the reasons and attitudes related to not responding (so-called non-response analysis). Thus, in March 2020, a two-page questionnaire was sent to 100 non-respondents to find out why they had not responded to the original questionnaire, and whether their opinions varied from the respondents in the final data set. The questionnaires were printed and mailed in the municipality of Söderhamn from 16–27 March 2020. This questionnaire was sent only once and a total of 19 responses were received.

The most common reasons for not responding to the original survey were that the respondents felt that they did not know enough about city streams or stormwater to respond, that they did not have time to answer it and that they do not usually respond to questionnaires. Compared to the actual response data (26%), a significantly higher proportion respondents to the non-response survey (63%) could not say in what state they thought Söderhamnsån was. Similarily, the respondents to the non-response survey were not as concerned about the state of Söderhamnsån as respondents in the final data (Figures 8a and 8b). According to the results of the non-response survey, the data gained from the original survey might not fully explain the preferences, ideas and attitudes of the study population. Thus, it is advisable to use the most conservative willingness to pay estimates for the aggregation of total benefits.





Figures 8a & b. Comparison of the final survey results and the non-respondent survey results.

3.4.Environmental benefits in the Söderhamn study

The environmental benefits of more sustainable stormwater management were assessed based on the responses to the environmental valuation survey. This survey was based on a random sample of the adult population in Söderhamn. As indicated by the non-response survey results, the most conservative mean WTP estimates were used in the aggregation of the benefit estimates.

Since the average willingness to pay clearly differed between younger and older respondents, this must be taken into account when transferring the results, i.e. benefits. As shown in Figure 12, younger people were more willing to pay higher monthly amounts as a stormwater fee than older respondents.

Based on average willingness to pay according to the age group, it is possible to estimate the willingness to pay of the entire adult population in Söderhamn. About 40% of the respondents were unwilling to pay a stormwater fee. The willingness to pay for this group was assumed to be EUR 0. Tables 7a and 7b summarize the results of the aggregated willingness to pay estimates during 2019–2028 with sensitivity analysis. The total willingness to pay is estimated at about EUR 0.41 ± 0.02 million to EUR 0.51 ± 0.026 million per year for ten years. The benefit assessment reflects the annual benefit to residents that would be achieved by sustainable stormwater management in Söderhamn. During the whole ten-year period, this would amount to EUR 4 million. Note that the benefit estimates are not discounted to the present value.

Table 7a. Aggregated willingness-to-pay estimates [kr] respondents had chosen to pay for certain according to the age group, lower bound

Age group (years)	Population in Söderhamn	Proportion (%)	Willingness to pay [€/month]	Willingness to pay [€/year]	Sensitivity analysis, ± 5%
20–29	1,575	15	13,475	16,170	8,085
30–39	1,335	13	2,734	32,803	1,640
40–49	1,487	14	6,134	73,606	3,680
50–59	1,770	17	6,565	78,781	3,939
60–69	1,682	16	3,537	42,439	2,122
70–79	1,680	16	1,604	19,243	962
Total	**9,529**	**100**		**408,573**	**20,429**

Table 7b. Aggregated willingness-to-pay estimates [€] respondents had chosen to pay for certain according to the age group, upper bound

Age group (years)	Population in Söderhamn	Proportion (%)	Willingness to pay [€/month]	Willingness to pay [€/year]	Sensitivity analysis, ± 5%
20–29	1,575	15	12,075	144,901	7,245
30–39	1,335	13	5,597	67,161	3,358
40–49	1,487	14	8,137	97,646	4,882
50–59	1,770	17	8,329	99,953	4,998
60–69	1,682	16	5,121	61,448	3,072
70–79	1,680	16	3,346	40,147	2,007
Total	**9,529**	**100**		**511,255**	**25,563**

3.5. Measures and total costs in the Söderhamn study

For the analysis in the Heawater project, only those stormwater management measures were chosen that would have both flood-reducing and water quality effects. The suggested measures stem from discussions during the Heawater project, as well as from the Sweco Environment (2017) report (see Table 8).

Investment costs have been updated and maintenance costs have been added. Table 5 summarizes the estimated total costs over a ten-year period in three hypothetical situations: A, B and C. The total sum for the planned budget for these stormwater facilities in situation A is EUR 0.18 million for a ten-year period, comprising the total costs of constructing, implementing, operating and maintaining the measures. All these cost estimates were received from the municipality of Söderhamn. Among the measures and their cost estimates are also the restoration projects implemented in Söderhamn by the Heawater project.

In situation B, these measures were complemented by two sets of measures to even better fulfil the list of environmental changes illustrated in the willingness to pay scenario of the questionnaire. That is, increasing biodiversity in different ways (along and in the river) and even further improving the recreational potential of the riverside. Cost estimates for such measures were taken from the Helsinki Small Water Programme (2007), which was also used in the analyses of the Turku pilot case. Adding these cost estimates to the previous, the total cost is EUR 0.2 million for situation B for the same 10-year period.

In addition, one more theoretical situation C was estimated: two more restoration measures and estimates of their costs were added to the whole. These measures had not been discussed with the local experts and were thus purely a desktop review. The third situation involved the construction of flood plains (1 hectare in total) and wetlands (1 hectare in total) in the catchment area of Söderhamnså. The cost estimates for these restoration measures were taken from Finnish cases and expert estimates (e.g. the Skanssi Stormwater Plan). With these measures, situation C aimed to reduce the flooding events by further detaining waters in the upper parts of the river basin outside the city. With these cost estimates, the total costs would rise to EUR 0.4 million. None of the investment or maintenance costs are discounted to present value.

Table 8. The estimated total costs of implementing measures for sustainable stormwater management during a ten-year period from 2019–2028

Measures	Costs	
	Total investment costs (€)	Total operation/ Maintenance costs (€)
Permeable surface for parking	60,000	1,100
Rain garden in the centre of the city	16,600	700
Infiltration dams in the upper secondary school yard	29,500	3,000
Green areas surrounding a car park	20,000	1,600
Underground filter in a car park area	30,000	1,450
Infiltration along a main street	10,000	3,250
Total	**166,100**	**11,100**
Total costs A	**€177,200**	
Increasing biodiversity (1 km) *	*€33,000*	
Improving recreation potential (1 km) *	*€4,000*	
Total costs B	**€214,200**	
Flood plains in the upper parts of the river basin (1 ha) **	*€200,000*	
Wetlands in the upper parts of the river basin (1 ha)****	*€10,000*	
Total costs C	**€424,200**	

** Cost estimates from the Helsinki Small Water Programme to complement the scenario presented in the questionnaire*
*** Cost estimates from the Skanssi Stormwater Development Plan*
**** Expert cost estimate of the average costs of wetland construction*

Besides the suggested measures, information campaigns were held for employees in the technical department and Söderhamn Nära (the municipality infrastructure company) to make the stormwater strategy part of their daily work. Many minor measures can be implemented during normal work, such as lifting stones, pavers, along streets and car parks to allow the stormwater to infiltrate in nearby areas. This work would also help to improve the water quality, but is not accounted for in the socioeconomic risk reduction mentioned above, although it would most certainly have an effect.

The technical department of the municipality of Söderhamn has an annual budget of EUR 45,000 for cleaning stormwater wells. The building of sustainable stormwater installations would not affect this sum to any great extent. The figure might be slightly lower if stormwater to a greater extent infiltrates green areas or rain gardens, for example. The budget for normal maintenance would be left unchanged.

3.6. The benefit–cost ratios in the Söderhamn study

Neither the costs nor the benefits are discounted to present value. This was an expert judgement made for this study for a number of reasons: i) there is no set timetable for executing the measures; ii) both benefits and costs include considerable uncertainty; iii) in this study, it would be “realistic” to assume that the execution of the measures (costs) and collection of “revenues” (benefits) would be spread out over the duration of this 10 years. For all these reasons, it was concluded that discounting would not significantly improve the accuracy of the estimates in this particular study. The benefit–cost ratio was then tentatively determined by using undiscounted annual estimates of total costs and total benefits.

Residents of Söderhamn were asked about the potential benefits and their willingness to pay for more sustainable stormwater management in Söderhamn and for improving the water quality of Söderhamnså and Söderhamnsfjärden through a survey conducted in the Heawater project. The survey served as an environmental valuation study and the results could be used to quantify the benefits of environmental change. Based on the results, the well-being of Söderhamn residents would increase by about EUR 0.4 million a year if the improvements presented in the survey would take place. This environmental benefit can be compared to estimates of the total cost of the change required. In the previous section, a rough estimate of the total cost was made if the necessary measures were to be executed during the next ten years. Annual environmental benefits and total costs can be compared using a benefit–cost ratio.

Based on the annual benefit and cost estimates for the Heawater project, the environmental benefits of more sustainable stormwater management would outweigh the costs. The benefit–cost ratios are presented in Table 8. The benefits were estimated conservatively, i.e. based on the lowest annual benefit assessment. In the study, the annual benefits remained the same regardless of the length of time for which the measures would be implemented. Regarding the implementation of the measures, the calculation presents annual cost estimates for three, five and ten years. Table 8 also includes all three total cost estimates illustrated in Table 8 and described in section 4.5. In all cases, the benefits are higher than the costs, i.e. the benefit–cost ratio is above 1. In Table 10, only situation B is presented.

Table 9. Benefit–cost ratios for more sustainable stormwater management in Söderhamn based on studies of the Heawater project with different costs and the lower bound benefit estimates

	Euros in total	Annually for 10 years	Annually for 5 years	Annually for 3 years
Total benefits per year	**408,500**	€408,500	€408,500	€408,500
Total costs A	**177,200**	€17,720	€35,440	€59,067
Annual benefit–cost ratio A		**23.1**	**11.5**	**6.9**
Total costs B	**214,200**	€21,420	€42,840	€71,400
Annual benefit–cost ratio B		**19.1**	**9.5**	**5.7**
Total costs C	**424,200**	€42,420	€84,840	€141,400
Annual benefit–cost ratio C		**9.6**	**4.8**	**2.9**

Table 10. Benefit–cost ratios with the costs of situation B and the lower bound benefit estimates

Annual total costs and benefits in situation B	Estimate in euros	Benefit–cost ratio
Annual benefits	408,500	
Annual costs (with a time span of 3 years)	71,400	5.7
Annual costs (with a time span of 5 years)	42,840	9.5
Annual costs (with a time span of 10 years)	21,420	19.1

4. Environmental benefits and costs in the Tallinn study

4.1. The scenario used in the Tallinn study

The scenario of the survey stated that additional funding would be needed to improve the condition of Tallinn's urban streams and to implement more sustainable ways of treating stormwater. It was further noted that one way to increase funding would be to introduce a stormwater tax. The proceeds of the stormwater tax could be used not only to improve the status of urban waters, but also to develop stormwater solutions and introduce more sustainable solutions. In addition, the biodiversity of small urban waters could be improved.

Next, a scenario to improve the status of urban streams and stormwater management was presented. It was stated that after the implementation of sustainable stormwater measures, water delay systems such as ponds and ditches would reduce flood damage. Furthermore, stormwater from new residential areas would be diverted through wetlands to urban streams, rivers and lakes, places for recreation would be built along streams, the streams and their surroundings would provide more diverse habitats for animals, insects and plants, and the streams that currently go underground in pipes would be exposed to the surface as part of the urban environment.

4.2. Willingness to pay a stormwater tax in Tallinn

One of the most important purposes of the survey was to estimate the willingness of residents to pay a stormwater tax for more sustainable management of stormwater. Approximately 70% of all respondents would at least consider paying such tax in 2019–2028 to improve the condition of Tallinn's city streams and their surroundings (Figure 9).

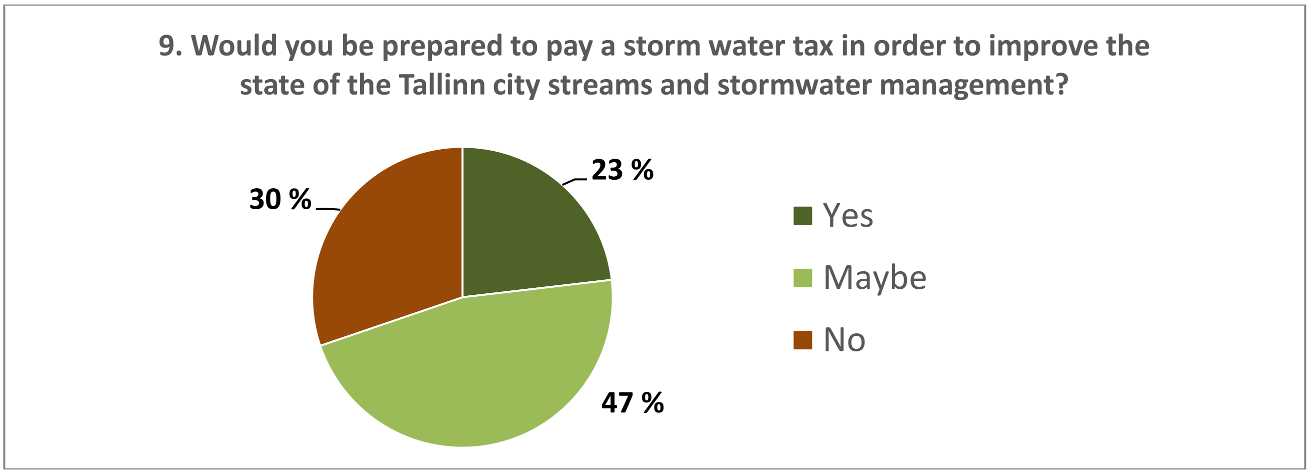


Figure 9. The willingness of the respondents (n = 311) to pay for an improvement in the status of urban streams.

Those who replied "Yes" or "Maybe" to the willingness to pay question were then asked how certain they would be about paying different amounts each month for the next ten years.

Table 11 summarizes the estimated average sums that respondents would be willing to pay annually for the improved status of small waters in the Tallinn area. A total of 110 respondents were not willing to pay, i.e. their willingness to pay was assumed to be EUR 0. Based on the results, the respondents were on average willing to pay a stormwater tax of EUR 10.90–23.70 per year. Table 12 presents the average willingness to pay for Estonian and Russian native speakers separately. Out of interest, the average willingness to pay was also determined for different age groups (Figure 10). The lower and upper values of average willingness to pay were calculated in two different ways (Kristrom 1990; Turnbull 1976).

Table 11. Respondents' (n = 311) average annual willingness to pay per person (and standard deviation, €) for more sustainable management of stormwater.

Certainty expressed by respondents about paying the fee of their choice	Willingness to pay (WTP) [€/year/person]	
	Lower bound (Turnbull estimate)	Upper bound (Kriström estimate)
I would definitely pay	10.9 (20.0)	15.2 (17.8)
I would definitely or probably pay	17.3 (29.6)	23.7 (29.1)

Table 12. Mean annual willingness to pay (and standard deviation, €/person/year) in different language groups

Native language	Mean willingness to pay (WTP)		N, lower bound	N, upper bound
	Lower bound (Turnbull estimate)	Upper bound (Kriström estimate)		
Estonian	10.3 (15.1)	17.1 (33.2)	220	246
Russian	13.2 (32.0)	18.2 (36.1)	62	65

Factors related to the respondents or their attitudes that together contributed to the positive willingness to pay were analysed using a regression model. The model explained respondents' willingness to pay a positive monthly stormwater tax. Based on the results, the willingness to participate was increased by the following factors: whether the survey provided the respondent with new information on stormwater, the respondent's age (younger respondents were more willing to pay than older ones) and if the respondent lived in the Pirita area.

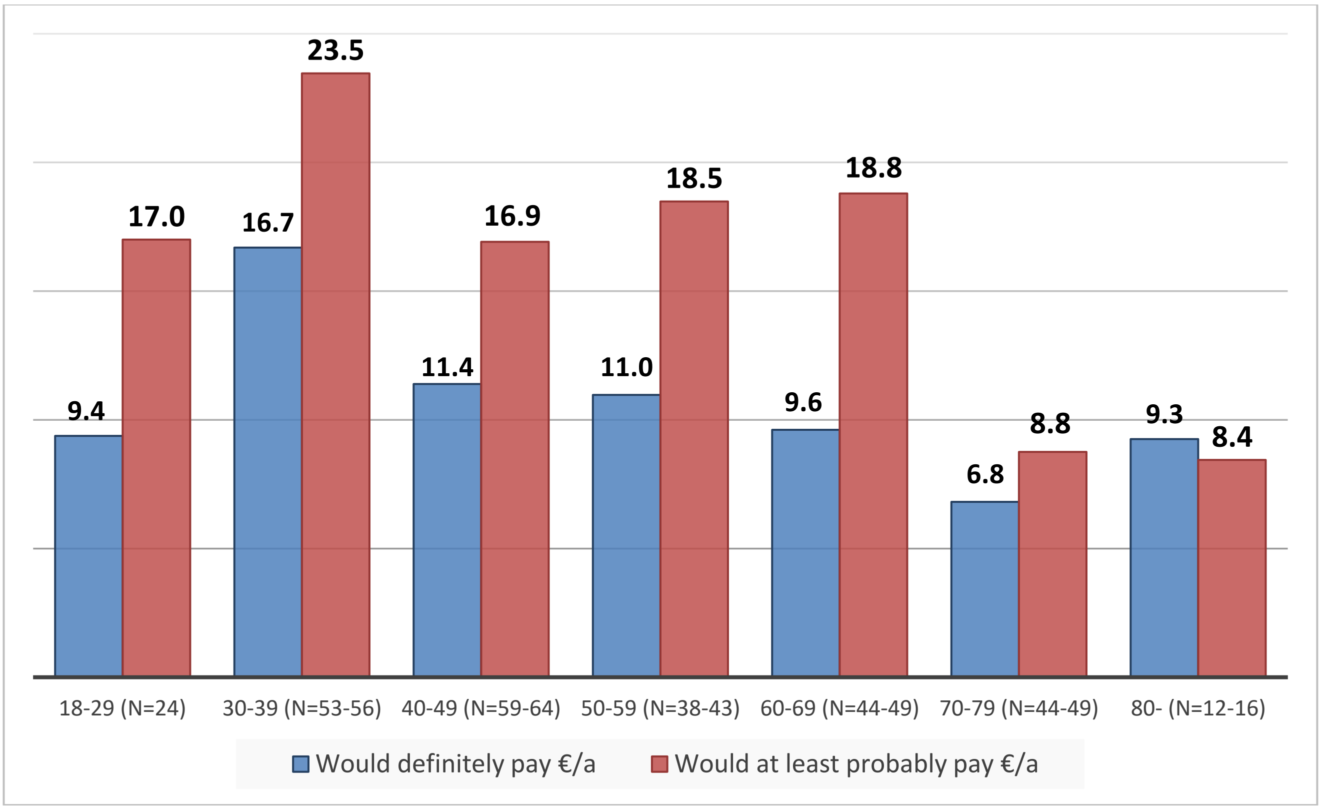


Figure 10. Mean annual willingness to pay [€] in different age groups (in the Tallinn study).

4.3. Validity of the data in the Tallinn study

About 58% of the respondents were women and the average age of the respondents was about 53 years. The share of Estonian speakers among the respondents was clearly higher than the share of native speakers of Russian. The survey questionnaires were only sent in Estonian, which most certainly explains the difference. Families with children accounted for about 39% of respondents, and only a small proportion of respondents (about 2%) reported being a member of an environmental organization (Table 13). A total of 38% of the respondents had a master's degree and 3% of the respondents had a doctoral degree. Most respondents (66%) lived in an apartment building, one in four in detached houses and less than a tenth in semi-detached or terraced houses. The average household income was asked as a categorical variable. Based on the responses, the median household income (gross) was about EUR 1,200 to EUR 1,799 per month in 2019. Responses were received from all three regions, as shown in Table 14.

Table 13. General information on the respondents

	Respondents (n = 311)
Native language: Estonian	79.1%
Native language: Russian	20.9%
Women	58.1%
Families with children	39.0%
Average age	52.9 years
Member of an environmental organization	2.3%

Table 14. Distribution of the respondents in the three sub-areas of the study.

Sub-area	Respondents	Percentage of the whole study area
Haabersti	153	49%
Kristiine	84	27%
Pirita	74	24%
Total	311	100%

Table 15. Age groups of respondents

Age group (years)	Respondents	Percentage
18–29	24	9%
30–39	56	20%
40–49	64	23%
50–59	43	15%
60–69	49	18%
70–79	49	18%
80–93	18	6%
Total	279	100%

Before generalizing the results of the survey, it is necessary to assess how well the obtained survey data represent the studied population, i.e. in this case, the adult population and their opinions in the Haaberst, Pirita and Kristiine areas. To this end, a 2-page non-response survey was sent to a group of non-respondents (n = 400) in June 2020. However, for unknown reasons, only two responses were received, although the response rate in the Turku and Söderhamn non-response surveys was 10% and 20%, respectively. In general, only 100–200 non-response surveys had been sent, but as it was now thought that the response rate could be lower than in previous surveys, an attempt was made to ensure that at least 10 responses would be achieved. Perhaps the COVID-19 pandemic at the time affected either the mailing of questionnaires or willingness to respond.

Therefore, other means were needed to assess the representativeness of the data. One of these was an analysis of whether the responses received differed according to the time taken to respond. For this, the data were divided into two groups based on whether the person responded before the first deadline or only after a reminder. Table 16 compares the average willingness to pay of these two groups. According to the results, the average willingness to pay was lower for those who responded later than among those who responded by the deadline. This may indicate that the data and the averages calculated from it are not fully generalizable to the whole population.

Table 16. Mean annual willingness to pay (and standard deviation, €/person/year) according to the rapidity of responding ("quicker" March 2020, "slower" April 2020).

Time of responding	Mean willingness to pay, €/person/year		N, lower bound	N, upper bound
	Lower bound (Turnbull estimate)	Upper bound (Kriström estimate)		
March 2020	14.2 (30.1)	21.8 (42.6)	82	88
April 2020	9.8 (17.3)	13.8 (33.3)	46	56

Next, representativeness was examined by comparing the sample data with the population for some general factors. The survey asked respondents for some sociodemographic information, which could be compared with similar data from the population (Haabersti, Pirita and Kristiine). The average age of the respondents was 53 years, which is close to the average age of the whole population (approximately 49 years). The proportion of female respondents was also about 58%, which is very close to the proportion of women (56%) in the whole study area. Comparing the distribution of respondents in different age groups with the age distribution of the population, the youngest age groups were under-represented in the survey data. However, this is a common result in many surveys. Correspondingly, the age group 70–79 years was slightly over-represented in the data. On the other hand, the share of families with children among the respondents was higher than in the population (39% vs. 24%). The average gross monthly salary of households in Tallinn (€1,545) in 2019 compares quite well with the average salary of the data, as the median salary range of the data was EUR 1,200–1,799 per month. The population data were obtained from the Estonian Ministry of the Interior (Population Register Tallinn Figures 2020).

This comparison between the data and the population variables indicates that the data were reasonably representative of the population under study and that the generalisation of the results to the Haaberst, Pirita and Kristiine areas is therefore possible and justified.

4.4. Total willingness to pay in the Tallinn study

Based on the average willingness to pay, it is possible to assess the willingness of the entire adult population to pay in the Haabersti, Pirita and Kristiine residential areas of Tallinn. In 2020, about 80,000 people aged 18–79 lived in these areas. Generalisation of the willingness to pay results to the entire study area was carried out here in three ways: using the average willingness to pay calculated from the data in different language groups, residential areas and age groups.

The population of Tallinn consists of several different nationalities. Of its approximately 444,000 inhabitants, 52% are Estonians, 38% Russians and 10%, for example, Ukrainians, Belarusians and Finns. The share of Estonians is highest in the Nõmme, Pirita, Kristiine and city centre areas (Tallinn Development Plan 2014–2020). In this study, it was assumed that the proportions of the language groups presented above are, according to the sample, 60% Estonian and 40% Russian speakers. It is also known that of the total population in the three residential study areas, 47% live in the Haabersti, 33% in the Kristiine and 19% in the Pirita area, based on 2020 data. The age distribution of the population is presented in Table 17.

Table 17. Population and age distribution in the study area according to Tallinn arvudes Statistical Yearbook of Tallinn 2020

Age groups (y), Adults	Adults in Tallinn	%	Study area	%	Respondents	%
18–29	56,172	16	12,166	16	24	9
30–39	77,342	22	15,871	21	56	20
40–49	62,642	18	14,773	19	64	23
50–59	51 637	15	11,298	15	43	15
60–69	49,732	14	9,816	13	49	18
70–79	33,876	10	8,148	11	49	18
80–93	24,114	7	5,083	7	18	6
Total	**355,515**	**100**	**77,155**	**100**	**279**	**100**

The average willingness of residents to pay can be generalised to the study area under certain assumptions. Here, it was assumed that in 2020, about 80,000 residents aged 18–90 lived in the Haabersti, Kristiine and Pirita residential areas, and that about 52% of them were native Estonian speakers and 38% Russian speakers. The total willingness to pay for the change described by the study is about one million euros per year based on the results (see, for example, Tables 18 and 19). This assessment reflects the benefits to residents that would be achieved from more sustainable management of the city's stormwater each year in the future. The annual benefit is thus proportional to the size of the adult population. It is therefore to be expected that this benefit will increase in the future, as the population of Tallinn is growing steadily, and according to the Tallinn Development Plan (2014–2020), the population growth has been fastest in the Pirita city centre and Haabersti areas.

Table 18. Average willingness to pay used in calculating the total willingness to pay

Native language	Mean willingness to pay, €/year/person		N, lower bound	N, upper bound
	Lower bound (Turnbull estimate)	Upper bound (Kriström estimate)		
Estonian	10.3 (15.1)	17.1 (33.2)	220	246
Russian	13.2 (32.0)	18.2 (36.1)	62	65

Table 19 Total willingness to pay calculated based on the proportions of the language groups

Native language	Sample	%	Mean willingness to pay, €/year/person		
			Sample, 2,500	Population, 80,000*	
Estonian	1,509	60	15,450	428,480	711,360
Russian	991	40	13,200	422,400	582,400
Total	**2,500**		**28,650**	**850,880**	**1,293,760**

**) The share of Estonian speakers is assumed to be 52% and that of Russian speakers 38%.*

4.5. Total costs in the Tallinn study

The total costs of improving the status of small waters and stormwater management have not been estimated in Tallinn, so the available expert assessments and other plans and programmes were used for the cost assessment. An estimate of the total costs was needed to produce the light social cost–benefit analysis promised in the Heawater project. The cost estimate was made using four city streams. Because the uncertainties related to the number of restoration measures needed were very high, the analysis was also done in reverse, i.e. by estimating what could be the maximum total cost estimate for a restoration programme in the Haabersti, Kristiine and Pirita areas that would still be socially acceptable when considering the benefits over the next ten years.

4.5.1. Restoration measures and unit costs

The resident survey described the study area and the streams and rivers in it. According to the information received by the project researchers, the city of Tallinn does not currently have any practical plans for the restoration of small waters in the Pirita, Kristiine and Haabersti areas or for more sustainable stormwater management. However, for this study, we roughly assessed those urban streams for which it would seem most realistic to plan rehabilitation measures.

Restoration measures were considered for a total of four stream sections, namely Mustoja, Varsaallikas oja, Tiskre and Järveotsa oja (see Table 20 and Figure 3). Based on expert estimates, it would be possible to implement the measures described in Table 21 in these streams. For example, the state of the Mähe stream is considered to be quite natural, as its state has not been greatly affected by human activities. Experts therefore did not see the need to assume remediation measures for this stream for the next ten years.

Table 20. Urban streams for which it was possible to estimate restoration costs

Urban stream in the study area	Estimate of the length within the study area	Water basin*
Mustoja	1.3 km	11.3 km^2
Varsaallika oja	3.4 km	1.6 km^2
Tiskre oja	4.7 km	50 km^2
Järveotsa oja	4.9 km	4.1 km^2

*) Tallinna keskkonnaamet. Aastaraamat 2016

Estimates of the investment costs of individual restoration and management measures were obtained from employees of the City of Tallinn. The estimates also include cost estimates for the Tallinn restoration projects implemented in the Heawater project. The unit cost data presented in Table 21 thus allowed a rough estimate of the annual investment costs in relation to the change described in the survey scenario, i.e. the benefits.

Table 21. Urban water restoration measures with unit costs for those measures that would correspond to the scenario presented in the survey.

Measure	Unit of investment costs	Investment cost in euros	Potential brooks
River bank protection	m^2	100	Mustoja, Varsaallika oja
Removal of alluvial sediments	m^3	3,000	Mustoja, Varsaallika oja
Construction of spawning areas/rapids	10 km^2	9,000	Tiskre oja, Varsaallika oja, Järveotsa oja
Regaining of urban rivers	A section of 100 m	500,000	Mustoja
Construction of retention pools	1,500 m^3	300,000	Mustoja, Varsaallika oja

4.5.2. Combination of measures and total costs

A rough estimate was made of the extent of restoration measures needed for each of the four city streams, i.e. Mustoja, Varsaallika ditch, Tiskre and Järveotsa ditch, over the next ten years. No information was available on existing plans for the extent of measures. However, the costs of restoration measures implemented in Mustoja were assumed to a sufficient extent to also describe the costs of improving the state of Tiskreoja, Varsaallikka oja and Järveotsa oja. Estimates of the extent of measures and their costs are presented in Table 22.

In the case of Mustoja, it was estimated in this study that the restoration activities started in the Heawater project would be continued for a further 300 metres, i.e. erosion protection and alluvial sediment removal would be carried out there. In addition, it was estimated that an approximately 100-m portion of the now piped section of the stream would be brought to the surface and that one larger flood plain would be built in the catchment area of the stream. It was estimated that erosion protection and the removal of alluvial sediment would be implemented in the Varsaallikka stream, as well as the construction of two smaller flood plains and one fish spawning area. For Tiskre and Järveotsa oja, one spawning area was assumed for each.

In addition to these measures, it was assumed that floodplains would be built for a total of about ten kilometres of streams to equalize the flow of flood waters and stop solids. Measures to improve the landscape and recreational use were also assessed for a total of about ten stream kilometres. These last two measures would implement the objectives along the survey scenario to compensate for floods and improve recreational use and biodiversity in the stream surroundings. For these two measures, the cost estimate is based on the Helsinki Small Water Programme 2007 (Helsingin kaupungin rakennusvirasto 2007), which presents cost estimates for a number of measures planned for urban streams in the Helsinki area.

As shown in Table 22, the total cost of the measures described above is approximately EUR 3.5 million. The restoration activities are assumed here to be spread over the next ten years, with the total annual cost being around EUR 350,000.

Table 22. A rough estimate of the quantity and costs of possible urban stream restoration measures over the next ten years.

	Unit costs for investments (€)	Quantity	Total costs in 10 years (€)
Regaining of urban rivers (a 100-m section)	500,000	2	1,000,000
Construction of retention pools (ca. 1500 m^3)	300,000	3	900,000
Removal of alluvial sediments (m^3)	3,000	140	420,000
Construction of spawning areas/rapids	9,000	3	27,000
River bank protection (m^2)	100	4,000	400,000
Flood plains for 1 km	32,000	10	320,000
Improving the biodiversity and recreation potential of brooks and their surroundings for 1 km	4,000	10	40,000
Restoration projects executed in the Heawater project in Mustoja			369,455
Total			**€3,476,455**

4.6. Benefit–cost ratios in the Tallinn study

Residents of three residential areas in Tallinn were asked about the potential benefits and their willingness to pay for better stormwater management to enhance the state of the city's small waters. The resident survey served as an environmental valuation study and can be used to quantify the benefits of environmental change. Based on the results, the well-being of the residents of the Pirita, Haabersti and Kristiine residential areas would increase by about one million euros a year if the improvements presented in the survey were to take place. This environmental benefit can be compared to estimates of the total costs of the change required. In the previous section, a rough estimate of the total annual costs was made if the necessary measures were scheduled for the next ten years. Annual environmental benefits and total costs can be compared using a benefit–cost ratio. Based on estimates of the benefits and costs made for this study, the environmental benefits of more sustainable stormwater management would outweigh the costs in the Pirita, Haabersti and Kristiine residential areas if restoration measures were carried out in five or ten years. The benefit–cost ratios are presented in Table 23.

A conservative perspective was used when estimating the environmental benefits, i.e. the assessment was based on the lowest annual benefit assessment. The annual benefit remained the same regardless of the length of time for which the restoration measures would be implemented. Regarding the implementation of the measures, the calculation in Table 22 presents annual cost estimates for three, five and ten years.

Table 23. Benefit–cost ratios for more sustainable stormwater management in three residential areas in Tallinn based on studies of the Heawater project.

Annual total benefits and costs	Estimate in euros	Benefit–cost ratio
Annual total benefits	850,880	
Annual costs (with a time span of 3 years)	1,158,818	0.7
Annual costs (with a time span of 5 years)	695,291	1.2
Annual costs (with a time span of 10 years)	347,646	2.4

The benefit–cost ratio can also be considered in another way. For example, in the light of the total benefits, the extent or number of restoration measures in the study area that can be expected to be socially acceptable based on the environmental valuation study carried out can be assessed. Table 24 shows three fully imaginary, annual sets of measures that would be acceptable in terms of cost within the framework of achievable and conservatively assessed environmental benefits. The purpose of Table 23 is only to illustrate how different combinations of measures could be implemented so that the total cost estimate does not exceed the minimum annual benefit estimate, i.e. EUR 850,000.

Table 24. Three imaginary sets of measures that would be socially acceptable based on the results of a valuation study carried out in the Heawater project.

		Example A		*Example B*		*Example C*	
	Unit costs for investments	Quantity	*Total costs in euros*	Quantity	*Total costs in euros*	Quanti ty	*Total costs in euros*
Regaining of urban rivers (a 100-m section)	€500,000	**0**	*0*	**0**	*0*	**1**	*500,000*
Regaining of urban rivers (a 100-m section), cheaper option	€300,000	**1**	*300,000*	**0**	*0*	**0**	*0*
Construction of retention pools (ca. 1500 m^3)	€300,000	**0**	*0*	**0**	*0*	**1**	*300,000*
Construction of retention pools (ca. 500 m^3)	€100,000	**2**	*200,000*	**0**	*0*	**0**	*0*
Removal of alluvial sediments (m^3)	€3,000	**35**	*105,000*	**100**	*300,000*	**0**	*0*
Construction of spawning areas/rapids	€9,000	**8**	*72,000*	**2**	*18,000*	**1**	*9,000*
River bank protection (m^2)	€100	**1,000**	*100,000*	**3,000**	*300,000*	**0**	*0*
Flood plains for 1 km	€32,000	**2**	*64,000*	**6**	*192,000*	**1**	*32,000*
Improving the biodiversity and recreation potential of brooks and their surroundings for 1 km	€4,000	**2**	*8,000*	**10**	*40,000*	**2**	*8,000*
In total, €			**849,000**		**850,000**		**849,000**

5. Summary of the three studies

Accurate information on both benefits and costs is rarely available when carrying out a cost–benefit analysis of an environmental plan, programme or policy. In particular, the assessment of priceless or non-market benefits, such as the improvement of small urban waters, requires a specific evaluation method and is often associated with uncertainty, assumptions and limitations. In the study cases presented in this report, there was a great deal of uncertainty about costs, and assumptions had to be made regarding (i) what measures should be taken into account, (ii) to what extent and when the methods would be implemented and (iii) what their costs would be. Therefore, the reviews presented here are desktop studies, especially in terms of costs, i.e. they are largely based on expert estimates and generalizations.

These studies assessed the potential benefits of improved urban streams through comprehensive resident surveys applying the widely used method of environmental valuation. They surveyed people's attitudes and willingness to participate concerning issues related to urban small waters. Willingness to participate was assessed in relation to the presented scenarios of urban water improvement. In order to assess the willingness to pay, different ways of paying were also proposed: a voluntary fee to an existing foundation in the Turku study, an increase in existing (mandatory) wastewater fees in the Söderhamn study and a new (mandatory) stormwater tax in the Tallinn study. As the method of payment was assumed to influence the extent of willingness to participate, a separate question concerning this was included in the surveys. That is, respondents were asked to rate what they thought would be the best way to fund urban water management or more sustainable stormwater management (Figure 11). Although the approach to different forms of financing can be very cultural, the option "as part of water, stormwater or wastewater management fees" received the most support in all countries, although in Turku and Tallinn it was clearly more popular than in Söderhman.

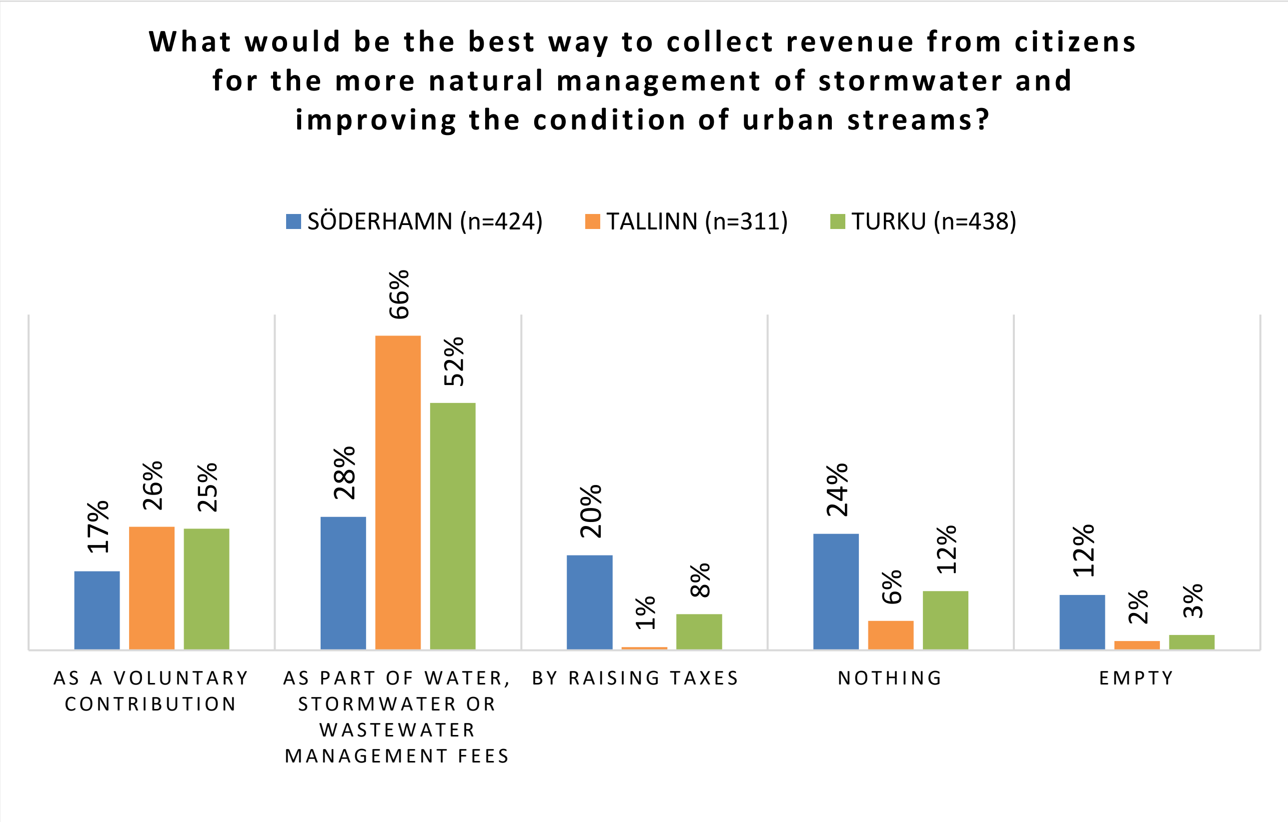


Figure 11. Payment methods preferred by respondents in the three study areas.

Overall, most of all respondents in different countries were at least willing to consider paying for the proposed improvement in urban water bodies (Figure 12).

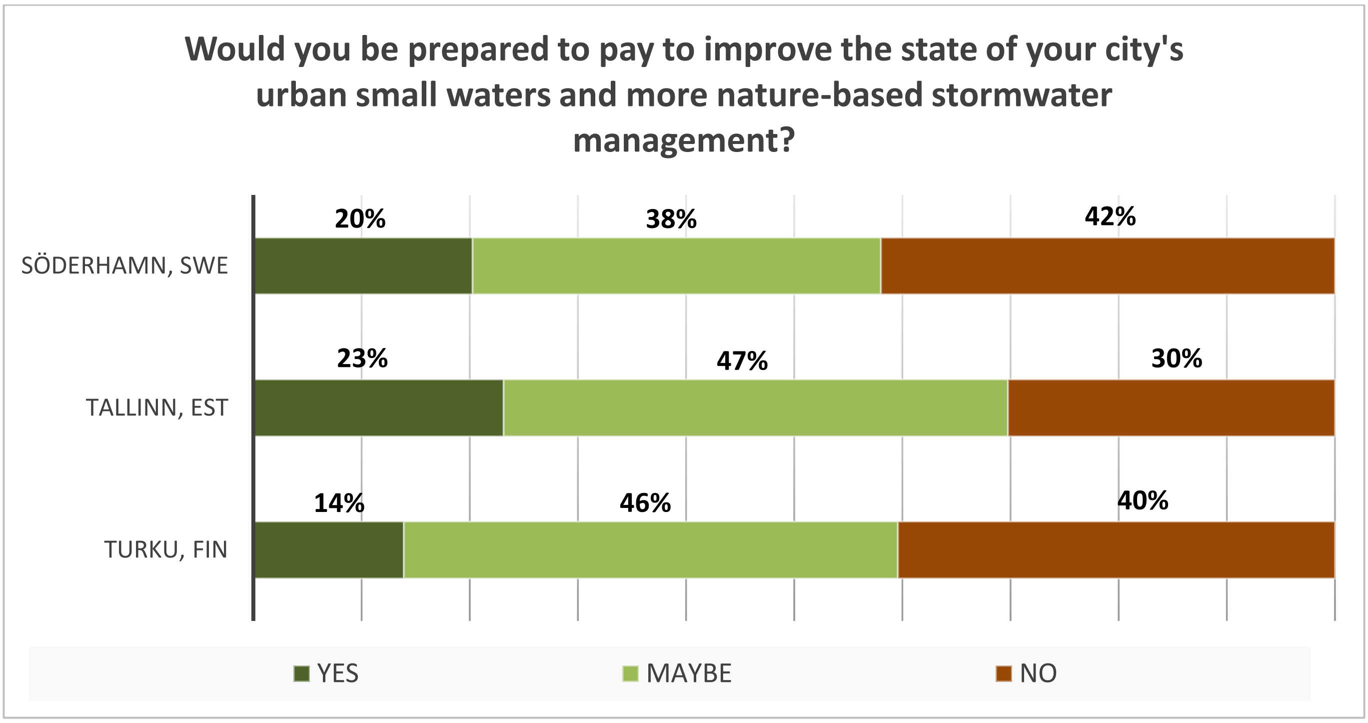


Figure 12. Respondents' willingness to participate according to question 9 of the surveys.

As tempting as it would be to compare the willingness to pay of the three countries in the graph above, it would also be misleading, at least in part. Although the content of the questionnaire used in the benefit assessment was very similar in all three countries, the areas and their small waters are different. These differences influenced the formulation of some questions, which were slightly different in each region, and also the content of the willingness to pay scenario, on the basis of which respondents assessed their willingness to pay in the graph above. The scenarios were quite similar, but not identical. Whether the voluntary or mandatory nature of the proposed payment had an effect on willingness to pay and whether the effect differs from country to country is not possible to assess on the basis of this study. Due to the diversity of the three study areas, the problems experienced with small waters are also different, as is the way in which people view them in different countries, even though these are practically neighbouring countries.

Although differences in average willingness to pay can be seen from country to country, a few common factors can be identified from the results. In all the study areas, young people were more willing than older respondents to participate in improving their urban environment. There were also regional differences in willingness to participate within the pilot areas. Overall, it is not particularly appropriate to compare the results of the three Heawater pilot areas, at least when it comes to small differences, as the baseline data used in them were not identical in terms of benefits or costs. At most, it is possible to assess whether they are at least of the same order of magnitude and whether their direction is the same. In this respect, it can be said that this was the case. In all three study areas, the estimated total benefits of urban water improvement would clearly outweigh the total costs over ten years, usually many times over. It can also be said that in all the areas, a large proportion of respondents had an interest in the issues addressed and a significant proportion were also willing to participate in improving the situation.

The light social cost–benefit analysis promised in the project was not intended to serve as a direct implementation plan or budget, but rather to provide guidance on whether more sustainable urban water management and stormwater management is a socially viable activity. If it is, it will give decision-makers the first evidence that investing in the issue is acceptable from the point of view of society, and the development of more detailed implementation plans would thus be justified. Based on the results of these studies, a ”green light” can be given to more detailed action plans, as the overall benefits of improving the state of small waters and/or sustainable stormwater management would outweigh the costs, at least over a period of several years.

6. References

Champp PA, Boyle KJ, Brown TC (2003) A Primer on Nonmarket Valuation. The Economics of Non-market Goods and Resources, vol 3. Kluwer Academic Publishers, Dordrecht, The Netherlands

FCG Suunnittelu ja tekniikka Oy 2015. Skanssin hulevesisuunnitelma - Loppuraportti. 2015. Turun kaupunki. FCG suunnittelu ja tekniikka oy, P25782. 38 p. (in Finnish)

Helsingin kaupungin rakennusvirasto 2007. Pienvesiohjelma. 2007. Helsingin kaupungin rakennusviraston julkaisut 2007:3 / Katu - ja puisto-osasto. 168 s. (in Finnish)

Kriström B (1990) A Nonparametric Approach to the Estimation of Welfare Measures in Discrete Response Valuation Studies Land Economics 66:135-139 doi:Doi 10.2307/3146363

Liljestam, A. och Söderqvist, T. 2004. Ekonomisk värdering av miljöförändringar. En undersökning om vindkraftutbyggnad med scenariovärderingsmetoden (CVM). Naturvårdsverket, Rapport 5403, 96 sidor.

Mitchell RC, Carson RT (1993) Using Surveys to Value Public Goods: The Contingent Valuation Method. Third edn. Resources for the Future, 1616 P Street, N.W., Washington, D.C. 20036

Perman R, Ma Y, McGilvray J, Common C (2003) Natural Resource and Environmental Economics. 3 edn. Pearson Education Limited,

Pöyry Finland Oy. 2014. Alueellinen hulevesisuunnitelma. Turku, Kaarina, Lieto, Raisio ja Rusko. ILKKA-hanke, Turku. Raportti. 108 s. (in Finnish)

Sweco Environment 2017. Rapport, Söderhamns kommun. Kostnads-nyttoanalys av översvämningsåtgärder i centrala Söderhamn. Uppdragsnummer 1321705000. 30 sidor.

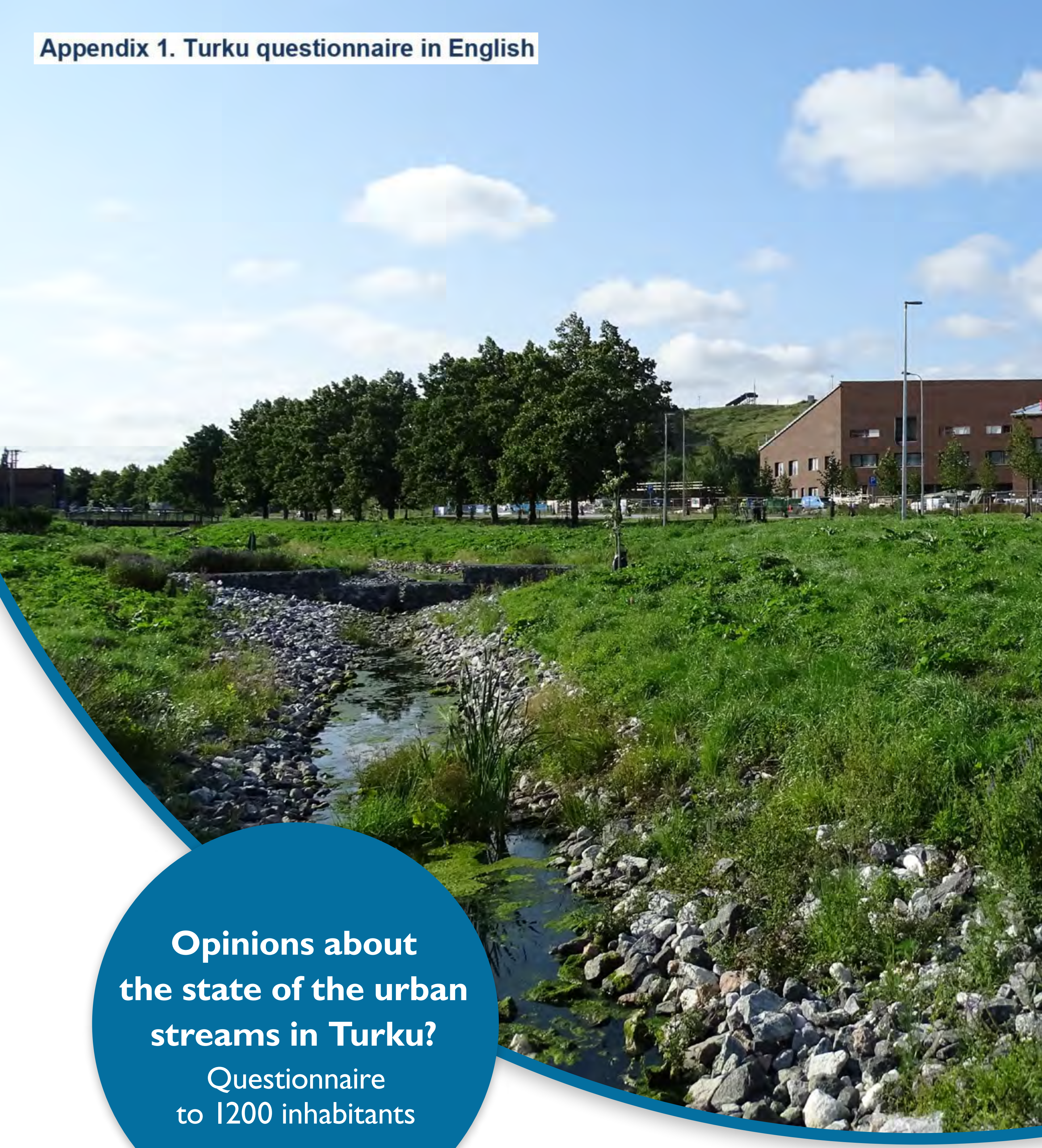
Söderhamn 2018. Dagvattenstrategi – Söderhamn 2018. Antagen 2018-04-23 Kommunfullmäktige § 100/18. 27 sidor.

Tilastotieto Turusta 2020. https://www.turku.fi/turku-tieto/tilastot/tilastotietoja-turusta#V%C3%A4est%C3%B6,%20asuminen%20ja%20koulutus

Tolonen, J. & Ahonen, K. 2018. Kaupunkipuro Kuninkojan hoitosuunnitelma. 33 s.

Turnbull BW (1976) The Empirical Distribution Function with Arbitrarily Grouped, Censored and Truncated Data Journal of the Royal Statistical Society Series B (Methodological) 38:290-295

Appendix 1. Turku questionnaire in English



Opinions about the state of the urban streams in Turku?

Questionnaire to 1200 inhabitants

TURKU ÅBO

SYKE

heaWater PIDÄ LÄHIVEDET KUNNOSSA

Interreg Central Baltic

EUROPEAN UNION European Regional Development Fund

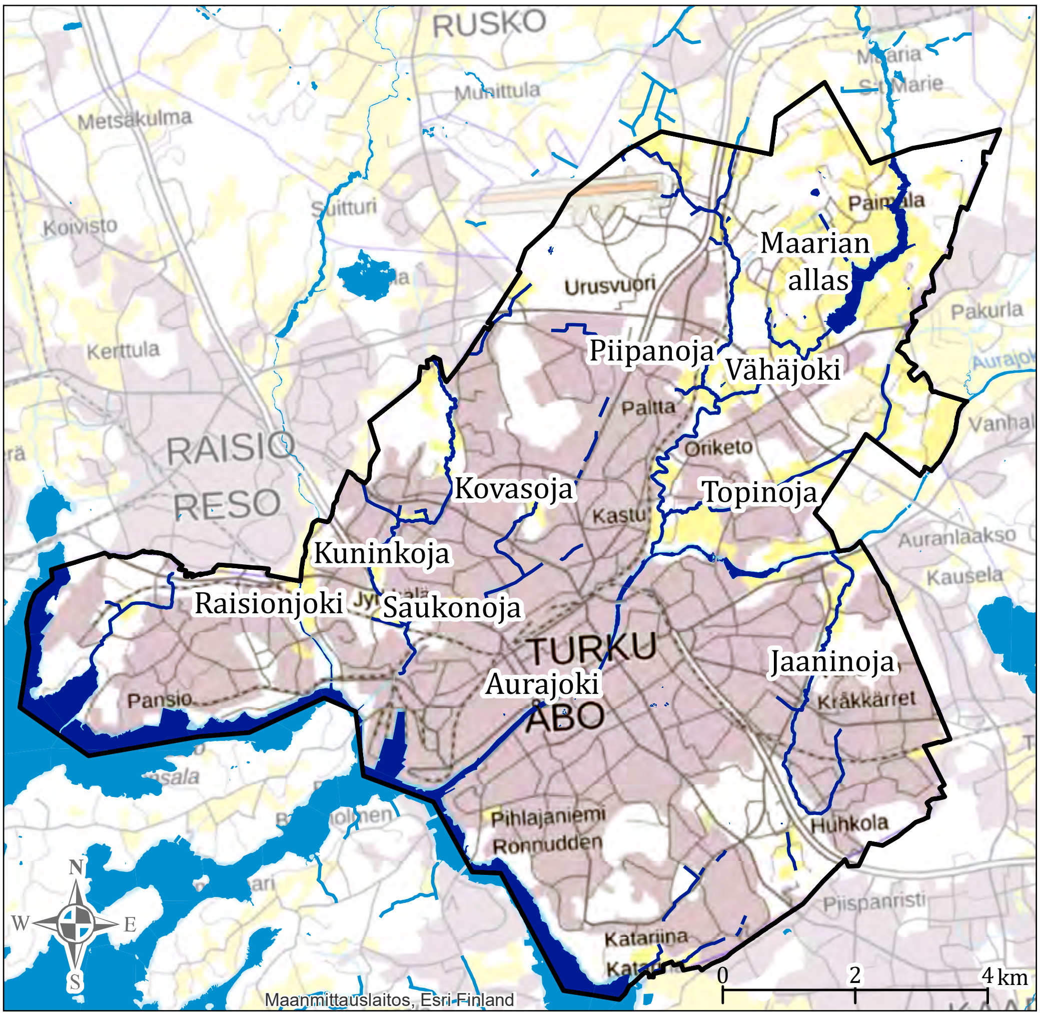
We are interested in your opinion and attitudes regarding the condition of small watercourses in the City of Turku area. There are no right or wrong answers to the questions, nor will your name be associated with any particular answers. All answers will be processed confidentially.

1 How important do think the following matters being promoted by public funding are <u>in Turku</u> right now?

▶*Mark only one response for each row.*

	Very important	Quite important	Neither important nor unnecessary	Quite unnecessary	Very unnecessary	Don't know
a) Promoting schoolchildren's access to recreational activities in after-school clubs	☐	☐	☐	☐	☐	☐
b) Protection of the Archipelago Sea	☐	☐	☐	☐	☐	☐
c) Improving the city's cycling route network	☐	☐	☐	☐	☐	☐
d) The renovation and expansion of the Wäinö Aaltonen Museum	☐	☐	☐	☐	☐	☐
e) Restoration of city brooks (e.g. Jaaninoja, Kuninkoja and Topinoja)	☐	☐	☐	☐	☐	☐

Below is a description of the subject area of this survey.



CITY BROOKS OF TURKU

In addition to the Aura River and sea, there are several small watercourses within the City of Turku area. The most important of these small watercourses are Jaaninoja and Kuninkoja, but there are also many streams, small ponds and creeks that may be vital to biodiversity and the enjoyment of people. Brooks are small, running watercourses, which collect water from an area approximately 10–100 square kilometres in size. Even the smallest channels, which have a continuous flow of water and are stocked with fish, are considered brooks.

Photo: Sari Väisänen, SYKE.

Photo: Sari Väisänen, SYKE.

2 Do you live near any brooks (within 1 km)?

☐ No
☐ Don't know

☐ Yes If you know the name of the brook/stream, please write it here: ______________________

____

____

3 a) What is your opinion regarding the water quality of city brooks in the Turku area?

▶ *Select only one response.*

☐ Excellent ☐ Good ☐ Satisfactory ☐ Passable ☐ Poor ☐ Don't know

b) Please explain why you feel the city brooks are in this condition: ______________________

____

____

____

4 In what way and how often have you made use of local watercourses/bodies in the City of Turku, alone or with your family, over the past 12 months?

▶*Mark only one response for each row.*

	Nearly every day	Nearly every week	Every month	Less frequently	Never	Don't know
a) Spending time along the banks of *brooks*	☐	☐	☐	☐	☐	☐
b) Spending time along the banks of the *Aura River*	☐	☐	☐	☐	☐	☐
c) Spending time along the coastline of the *sea*	☐	☐	☐	☐	☐	☐
d) Fishing in local waters	☐	☐	☐	☐	☐	☐
e) Boating on the Archipelago Sea	☐	☐	☐	☐	☐	☐
f) Other (specify): ______________________	☐	☐	☐	☐	☐	☐

5 How much do you agree with the following claims?

▶*Mark only one response for each row.*

	Fully agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Fully disagree	Don't know
a) I am concerned about the condition of the Archipelago Sea	☐	☐	☐	☐	☐	☐
b) City brooks are important to me	☐	☐	☐	☐	☐	☐
c) I am worried about the condition of small watercourses within the city area	☐	☐	☐	☐	☐	☐
d) City brooks should enjoy a higher profile in the cityscape	☐	☐	☐	☐	☐	☐

CITY BROOKS IN THE TURKU AREA ARE, AT MOST, IN PASSABLE CONDITION

The water quality and biota of Jaaninoja and Kuninkoja have been studied in various monitoring periods since the beginning of the 2000s. Based on the results of biota studies, the ecological state of Kuninkoja and Jaaninoja can be classified as passable or poor. The studies found that brook water quality is particularly deteriorated by run-off water from streets, industrial areas and construction sites. Both brooks have been restored as habitats for such species as rainbow trout. If the water quality of Kuninkoja and Jaaninoja were to be improved, they would likely be better habitats for crayfish, rainbow trout and other species. The condition of brooks in the city area is largely affected by how the city handles its stormwater and meltwater.

Photo: Turku AMK.

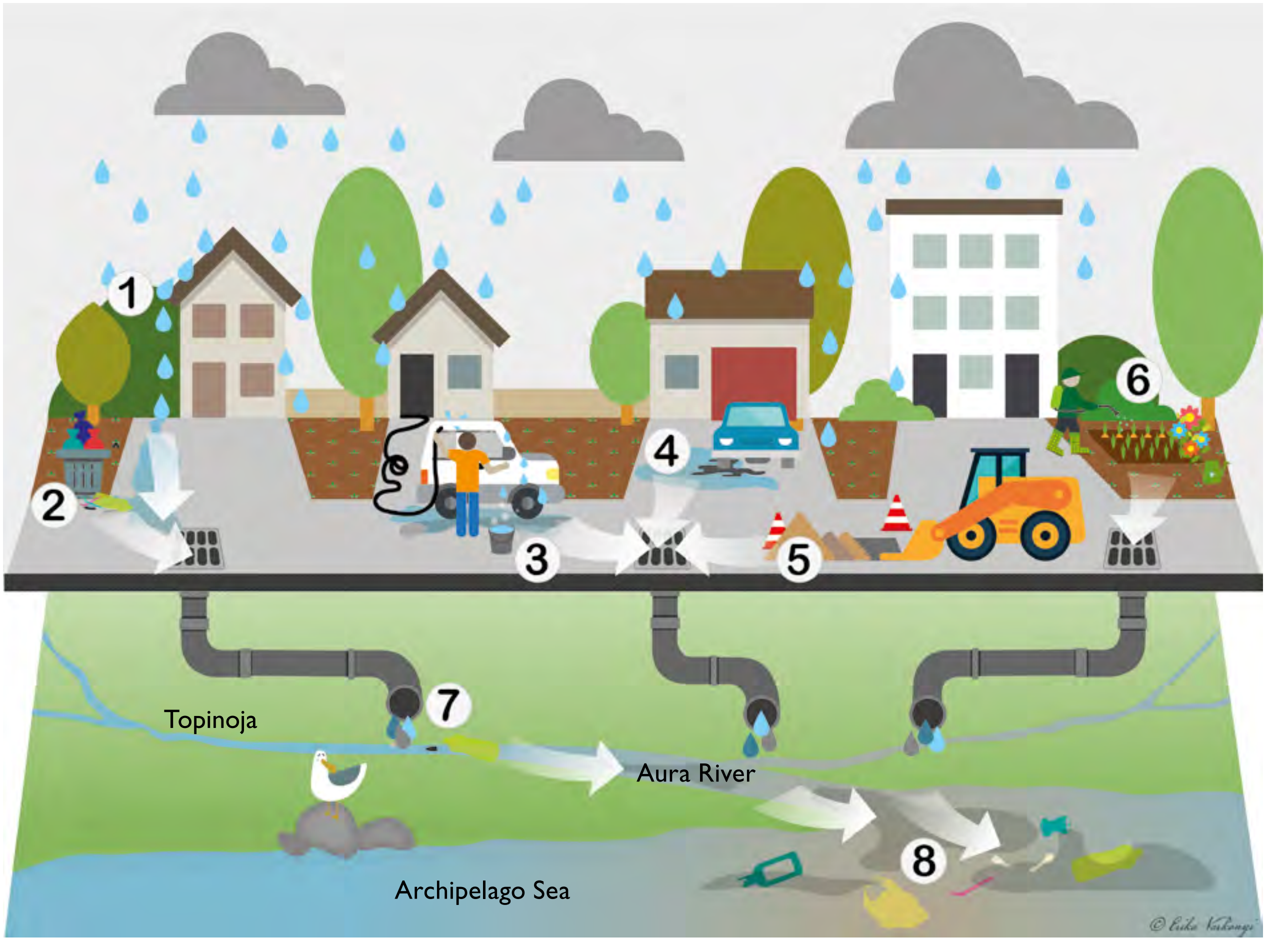
WHAT IS RUN-OFF WATER?

Run-off water is, for example, stormwater and meltwater from paved ground surfaces and building roofs that is not absorbed into the soil. Typically, run-off water is collected in street run-off drains, from which the run-off water ends up untreated in city brooks, rivers or the sea.

Run-off water from population centres, traffic, commerce and industry contain a variety of hazardous substances, which load and eutrophicate watercourses.

As cities become more densely populated, the percentage of paved and covered surface area further increases. In addition to this, winter precipitation and heavy summer rains are expected to increase with climate change. This means an increase in run-off water and the flooding and water quality problems that come with it. Run-off water does not simply stay within individual properties - it runs into drains or along street gutters, i.e. city run-off water systems. Previously, the maintenance of these systems was funded as part of wastewater fees. Beginning this year, these costs will also be covered by property-specific run-off water management fees.

Examples of how run-off water is formed and how human activity affects it.



1. Metals and other hazardous substances from building roofs are released into run-off water
2. Litter from waste receptacles may fall into run-off water and be carried along with it
3. Car washing soaps, among other things, run untreated from residential yards into the watercourse and can be hazardous to living organisms
4. Oil or other substances can leak from poorly maintained vehicles into run-off water
5. Soil from construction work is often carried away by run-off water
6. Pesticides and excess nutrients are easily carried by run-off water into watercourses
7. Run-off water from drainage pipes usually end up untreated in brooks and rivers
8. Litter and hazardous substances are also carried by brooks and rivers into lakes and the sea

6 Have you ever heard about run-off water before?

▶ *Select only one response.*

☐ Yes, I already knew about run-off water

☐ I had a general idea about it, but the descriptions and images above presented me with some new information on the subject

☐ I had heard the term before, but did not really know what it meant

☐ No, I had no knowledge of run-off water

☐ Don't know

HOW CAN RUN-OFF WATER BE MANAGED?

The primary way to manage run-off water is to prevent it from forming. In practice, this means avoiding the use of impermeable surfaces such as asphalt in building and, instead, favouring vegetation and sand/gravel surfaces in yards and public spaces. Green roofs also help to reduce the volume of run-off water produced.

Using open channels to direct run-off water instead of pipes also helps to reduce the risk of flooding and increases biodiversity by providing habitats and thoroughfares for biota. Various natural run-off detention methods, such as wetlands and 'rain gardens' in yards, are used in an effort to slow the flow of water. This, in turn, reduces the problems brought about by flooding and erosion in city brooks. Detention areas can also be built in green strips along roadways and around the perimeters of parking lots.

Photo: City of Turku.

Photo: City of Turku.

7 How much do you agree with the following claims?

▶ *Mark only one response for each row.*

	Fully agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Fully disagree	Don't know
a) The living conditions for rainbow trout and crayfish in Turku's city brooks must be improved	☐	☐	☐	☐	☐	☐
b) Run-off water or its volume/quality are not a problem in Turku	☐	☐	☐	☐	☐	☐
c) I believe that I can influence the condition of small watercourses through my own actions	☐	☐	☐	☐	☐	☐
d) I do not really care what happens to run-off water, just as long as it is moved off of the streets as quickly as possible	☐	☐	☐	☐	☐	☐
e) In my opinion, water quality in city brooks has improved in recent years	☐	☐	☐	☐	☐	☐
f) In my opinion, city flooding has increase in Turku over the past ten years	☐	☐	☐	☐	☐	☐

BENEFITS OF NATURALLY TREATING RUN-OFF WATER

In many cases, in 'conventional' run-off water management, water is directed from streets through pipes and straight drainage channels, which move the water quickly. When water flows quickly and there are no detention sites for it to 'rest', it may result in channel erosion and the channel itself may even dry out. Heavy rain, among others, can cause flooding in cities, because the water cannot be stored, thus resulting in water levels rising above verges.

In natural run-off water management, water detention sites, winding channels and thick vegetation slow the water flow, thus reducing, for example, the risk of flooding and channels drying out. A more even volume of water and flow rate in channels also creates better conditions for many organisms. Detention, soil infiltration and flowing through vegetation cleans stormwater and meltwater, so that when it ends up in city brooks it also improves their water quality. Thick vegetation makes for a more pleasant, diverse cityscape.

Conventional run-off water management

Natural run-off water management

8 In your opinion, what changes and on what scale could natural run-off water management have an impact on you, your family or others?

▶*Mark only one response for each row.*

	No impact	Minor positive impact	Moderately positive impact	Major positive impact	Don't know
a) Number of my recreational visits to city brooks	☐	☐	☐	☐	☐
b) Quality of my nature experiences	☐	☐	☐	☐	☐
c) Mental well-being of local residents	☐	☐	☐	☐	☐
d) Image and reputation of local areas	☐	☐	☐	☐	☐
e) Attractiveness of Turku	☐	☐	☐	☐	☐

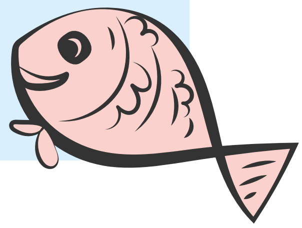
ADDITIONAL FUNDING IS NEEDED

In order to achieve the above-mentioned goals for minimising city flooding, improving the condition of city brooks and safeguarding the diversity of nature and biota in Turku, more wide-ranging and natural small watercourse/body restoration measures and run-off water management must be implemented.

Now, imagine that the citizens of Turku would be able to pay a voluntary 'city brook fee' over the next ten years to already existing Archipelago protection fund, which as funded water protection projects in the Archipelago sea and its vicinity. This would encourage the City of Turku, area businesses and residents to participate in comprehensively improving the condition of city brooks. The City of Turku would maintain existing run-off water systems, but the additional revenue gained from these 'city brook fees' would be put toward the more comprehensive restoration of city brooks and making some conventional run-off water solutions more natural.

After implementing new, more natural measures, the following changes would be evident in city brooks:

- ✦ Building flood plains will ensure that brooks do not flood their surroundings in a destructive manner and channel flow is maintained even during dry periods.
- ✦ The run-off water from newly built areas is directed through wetlands into brooks.
- ✦ Stepping stones, benches and waste receptacles are placed along brooks, where people can come to walk, relax or observe local nature.
- ✦ The brook and its surroundings form a complex habitat for different species, such as birds, mammals and insects.
- ✦ The number of migratory fish climbing the brook to spawn has increased.
- ✦ The brook winds and babbles.



9 Would you be prepared to pay a city brook fee for 2019–2028 in order to improve the biodiversity and water quality of Turku city brooks?

☐ Yes ☐ Maybe ☐ No ▶*VPlease go straight to question 13.*

10 How much would you be prepared to pay for a city brook fee?

▶*For each amount, indicate how much you would be willing to pay or not pay the amount in question. Take into account in your answer the fact that the money used would be separate from all your other expenses.*

Monthly fee over the next ten years	I would definitely pay	I would most likely pay	I am not sure I would pay	I would most likely not pay	I would definitely not pay
0.50 €/month **(i.e. 6.00 €/year)**	☐	☐	☐	☐	☐
1.00 €/month **(i.e. 12.00 €/year)**	☐	☐	☐	☐	☐
2.00 €/month **(i.e. 24.00 €/year)**	☐	☐	☐	☐	☐
4.00 €/month **(i.e. 48.00 €/year)**	☐	☐	☐	☐	☐
8.00 €/month **(i.e. 96.00 €/year)**	☐	☐	☐	☐	☐
16.00 €/month **(i.e. 192.00 €/year)**	☐	☐	☐	☐	☐
32.00 €/month **(i.e. 384.00 €/year)**	☐	☐	☐	☐	☐
Would you pay more than 32.00 €/ month? If so, how much? ________€/month	☐	☐	☐	☐	☐

11 How important are the following reasons for you being prepared to pay?

▶*Mark only one response for each row. Vastattuasi tähän kysymykseen, voit hypätä kysymyksen 12 yli.*

	Very important	Quite important	Quite inconsequential	Very inconsequential	Don't know
a) I want to improve the condition of small watercourses, because I use city brooks and their surroundings as a place for recreation.	☐	☐	☐	☐	☐
b) I want to improve the condition of small watercourses even though I do not use city brooks and their surroundings as a place for recreation.	☐	☐	☐	☐	☐
c) I want to make the cityscape greener.	☐	☐	☐	☐	☐
d) I support more natural approaches to run-off water management and reducing city flooding.	☐	☐	☐	☐	☐
e) I want better conditions for biota in small watercourses and their surrounding areas.	☐	☐	☐	☐	☐
f) I want small watercourses to have a higher profile than they do right now (out from underground pipes).	☐	☐	☐	☐	☐
g) Other reason (please specify): ______________________	☐	☐	☐	☐	☐

▶*Please go straight to question 12.*

Photo: Sari Väisänen, SYKE.

12 People might not be prepared to pay for improving or safeguarding the condition of city brooks for a variety of reasons. How important are the following reasons for <u>you not being prepared to pay</u> for improving the biodiversity and water quality of city brooks?

▶ *Mark only one response for each row.*

	Very important	Quite important	Quite inconsequential	Very inconsequential	Don't know
a) I cannot afford to pay for improving the condition of small watercourses.	☐	☐	☐	☐	☐
b) In my opinion, small watercourses do not need more protection or cleaning.	☐	☐	☐	☐	☐
c) In my opinion, the taxes and mandatory fees I pay should be more effectively used for the management and protection of small watercourses.	☐	☐	☐	☐	☐
d) I will pay the stormwater run-off management fee and it will be enough.	☐	☐	☐	☐	☐
e) Other reason (please specify): ______________________	☐	☐	☐	☐	☐

13 In your opinion, what would be the best way to collect revenue from citizens for the more natural management of run-off water and improving the condition of city brooks?

▶ *Select only one response.*

☐ As a voluntary contribution ☐ As part of water, run-off water management or wastewater fees ☐ By raising taxes ☐ Nothing

14 Have you taken part in any of the following measures on behalf of Turku's city brooks over the past three years?

▶ *Mark only one response for each row.*

	Yes	No	Don't know
a) Participating in collective volunteer efforts to restore brooks	☐	☐	☐
b) Collecting litter from brooks or their surrounding areas	☐	☐	☐
c) Washing my car in my yard only using environmentally-friendly soaps or at a car wash	☐	☐	☐
d) Always putting my waste in a proper waste receptacle and not on the street	☐	☐	☐
e) Other (specify what): ______________________	☐	☐	☐

We need some further background information from each respondent so that we can describe the typical resident's attitudes. ***The information you provide is confidential*** *- it will not be possible to identify either yours or anyone else's individual answers from the published material.*

Please also answer the following questions so that we use your responses in our research!

15 Gender

☐ Female ☐ Male ☐ Other/No comment

16 Date of birth ___________

17 Current size of your household, including yourself ________ adults and ________ children

18 What type of residence do you live in?

☐ Detached house ☐ Block of flats ☐ Semi-detached of terraced house ☐ Other, please specify ____________________

19 What is your post code? ____________________________

20 How long have you lived in the Turku area? Approximately ______ years

21 What is your level of education?

☐ Basic school education
☐ Vocational qualification
☐ University degree
☐ University of applied sciences or Bachelor's degree
☐ Higher university degree
☐ Licentiate or doctoral degree
☐ Other, please specify ________________
____

22 Which of the following groups do you feel you belong to?

▶*You may select several options.*

☐ Interested in water and nature through my occupation
☐ Interested in water and nature through my hobby(ies)
☐ Avid nature visitor (hunter, mushroom picker, berry picker, etc.)
☐ Other outdoor activities (cycling, running, etc.)
☐ Member of an environmental protection organisation or foundation
☐ Other, please specify ____
☐ None of the above

23 What was <u>your household's</u> total pre-tax income per month for 2017?

☐ less than €1,000/month
☐ €1,000 – 1,999/month
☐ €2,000 – 2,599/month
☐ €2,600 – 3,199/month
☐ €3,200 – 3,799/month
☐ €3,800 – 4,799/month
☐ €4,800 – 5,799/month
☐ €5,800 – 6,799/month
☐ €6,799/month or more

24 Please assess which of the following statements are true.

▶ *Mark only one response for each row.*

	Fully	Partially	Not at all
a) The questionnaire form gave me new information about urban streams.	☐	☐	☐
b) The questionnaire form gave me new information about storm waters.	☐	☐	☐
c) I'm more concerned about the urban streams now after answering the questionnaire	☐	☐	☐
d) It was hard for me to determine my household's yearly payment.	☐	☐	☐
e) I agree that collecting the funds through Archipelago protection fund is a good idea.	☐	☐	☐
f) I will pay more attention to the state of urban streams in the future.	☐	☐	☐
g) It would be important, that the payment could be targeted to enhance the state of a specific urban stream.	☐	☐	☐

25 a) How interesting was the topic of the survey? (4–10) __________

b) How would you rate this survey? (4–10) __________

If you have any thoughts regarding Turku's city brooks or improving their condition and biodiversity, or you would like to comment on this survey, please write your remarks in the field below.

____

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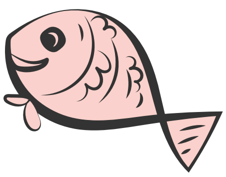
Many thanks for your response!



Any contact information we obtain from the Population Register Centre Population Information System (P.O. Box 123, 00531 Helsinki, Reg. no. VRK/5131/2018-3) will not be disclosed. Your response will be treated as strictly confidential.

Finnish Environment Institute SYKE 2018.
Layout: Erika Várkonyi. Cover photo: Turun kaupunki. Printed in JP Postitus.