SCOREwater

Smart City Observatories implement REsilient Water Management

DELIVERABLE D4.19

CITIZEN EMPOWERMENT THROUGH CITIZEN SCIENCE FOR WATER MEASUREMENT

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ABBREVIATIONS

Abbreviation	Definition
ICT	Information and Communications Technology
IoT	Internet of Things
SDG	Sustainable Development Goals
COA	City of Amersfoort
SO	Strategic Objective(s)

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PROJECT ABSTRACT

SCOREwater focuses on enhancing the resilience of cities against climate change and urbanization by enabling a water smart society that fulfils SDGs 3, 6, 11, 12 and 13 and secures future ecosystem services. We introduce digital services to improve management of wastewater, stormwater and flooding events. These services are provided by an adaptive digital platform, developed and verified by relevant stakeholders (communities, municipalities, businesses, and civil society) in iterative collaboration with developers, thus tailoring to stakeholders' needs. Existing technical platforms and services (e.g. FIWARE, CKAN) are extended to the water domain by integrating relevant standards, ontologies and vocabularies, and provide an interoperable open-source platform for smart water management. Emerging digital technologies such as IoT, Artificial Intelligence, and Big Data is used to provide accurate real-time predictions and refined information.

We implement three large-scale, cross-cutting innovation demonstrators and enable transfer and upscale by providing harmonized data and services. We initiate a new domain "sewage sociology" mining biomarkers of community-wide lifestyle habits from sewage. We develop new water monitoring techniques and data-adaptive storm water treatment and apply to water resource protection and legal compliance for construction projects. We enhance resilience against flooding by sensing and hydrological modelling coupled to urban water engineering. We will identify best practices for developing and using the digital services, thus addressing water stakeholders beyond the project partners. The project will also develop technologies to increase public engagement in water management.

Moreover, SCOREwater will deliver an innovation ecosystem driven by the financial savings in both maintenance and operation of water systems that are offered using the SCOREwater digital services, providing new business opportunities for water and ICT SMEs.

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EXECUTIVE SUMMARY

This deliverable describes the activities done in Amersfoort to include citizens in so-called citizens science. These activities fall into two tracks. Firstly, the City of Amersfoort (hereafter: COA) has collaborated with citizens science collective 'Measure Your City' to allow interested citizens to measure, research and discuss soil moisture. The data that was collected has been integrated into the SCOREwater and COA's open data platform to allow other interested parties to use it as well. Furthermore, citizens have been engaged by using so-called 'thermal walks'. In these walks, citizens are asked to provide (subjective) input on experienced heat stress on several locations within the city. Both activities provide subjective and objective data and insights on the effect of climate change on the local living environment, and simultaneously lead to enhanced public awareness on the effect climate change has on the local environment.

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1. INTRODUCTION CASE AND CITIZEN SCIENCE

Due to climate change the City of Amersfoort (hereafter: COA) like many cities is facing more frequently occurring periods of extreme precipitation, heat and drought. Within the SCOREwater project, several products and services have been developed that aim at effectively preventing or dealing with nuisance caused by climate change. Examples include the flood early warning system (deliverable 4.18, Koistra et al., 2021) and the soil moisture measurement network (deliverable 4.17, Meijer and Vrouwe, 2021), which both have been reported on earlier. However, the municipality cannot combat climate change and the effect it has on the living environment alone. Citizens are a crucial collaborator in tackling climate change. They can help in gathering data on the local effects of climate change, can take preemptive action to mitigate these effects that far exceed that which is solely in the power of (local) governments, and can spread awareness on what the effects of climate change are.

Because of this, COA actively collaborates with citizens in the form of citizen science (also called 'community-science', reflecting the focus on building collaborating groups or communities that can support each other). This report describes how COA works with citizens to gather data and insights on climate-related matters. This includes both individuals who are already organized as part of a citizen science collective and those who wish to help but are not currently organized in such a collective.

2. CITIZEN SCIENCE: TWO TRACKS

This chapter describes the two different tracks that are distinguished within the Amersfoort citizen science track. The first concerns the collaboration COA has with citizen science collective 'Measure Your City'. For the SCOREwater project, the already existing network of citizen science measurements has been expanded to include research and measurements of soil moisture, in gardens and on green roofs. The second track concerns so-called 'thermal walks', which will be extensively explained in section 2.2.

2.1 MEASURE YOUR CITY

In 2015, the Amersfoort-based citizen science initiative 'Measure Your City' was launched to involve citizens of Amersfoort in measuring and researching their living environment. This chapter describes the initiative, starting with the approach of Measure Your City. Next, the research and activities that were organized within the SCOREwater project are described, including a description of building workshops and other meetings, after which results and limitations are described.

2.1.1 APPROACH

As stated earlier, the goal of citizens science collective Measure Your City is to involve citizens in measuring and researching their living environment. The initiative was launched in 2015 because as climate change progresses, so do local effects in the form of more extreme periods of heat, drought and precipitation. Within the initiative, citizens run their own research projects, formulate and ask their own research questions and gather and analyze data. Whereas the initiative started solely in Amersfoort, collaboration with citizens from other cities resulted in Measure Your City expanding to the Dutch cities Tilburg and Utrecht and the Norwegian city Bergen.

Back in 2015 the research focused on temperature and humidity. As such, there is over five years of data on the local environment. In the years that followed air quality was added in collaboration with the province of Utrecht and citizens and the municipality of Zeist, a city located closely to Amersfoort. For the SCOREwater project, a similar approach was used to include gathering data on soil moisture and research its implications and practical use when it comes to gardens and green roofs. Figure 1 shows the Measure Your City sensors as displayed on the Measure Your City website.

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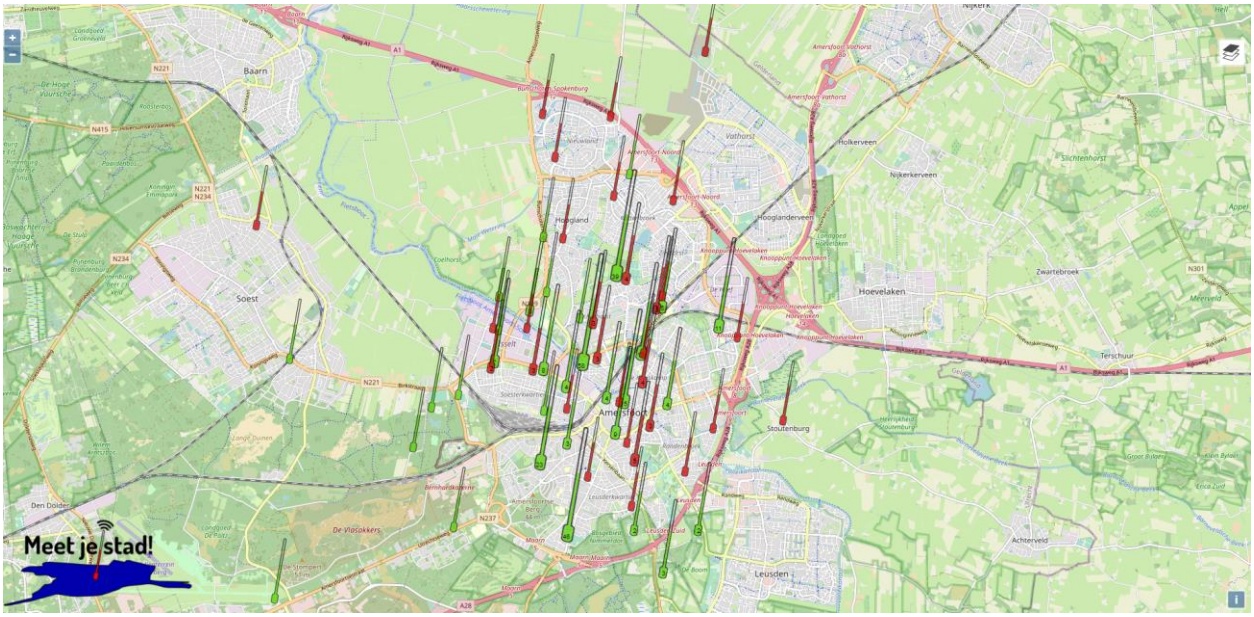

Figure 1: map of Amersfoort showing local Measure Your City sensors. Screenshot taken from the Measure Your City website on the 28th of November 2022 (https://www.meetjestad.net/).

Measure Your City uses measurement stations to collect data from environmental sensors. These measurement stations consists of a printed circuit board (PCB), firmware and a build-it-yourself housing. The PCB design files and firmware are open source and can be freely used, or re-developed as long as the resulting product is open source. Design files, firmware, documentation and the specific open source license can be found on the general Measure Your City github page.

The measurement stations use the LoRa communication network: The Things Network (TTN). Data is sent over the LoRa frequency and can be picked up by any LoRa gateway running the TTN software. This network is public, anyone can use this network to communicate, as long as the fair use policy is met. Gateways are not centrally deployed, but funded and connected to the internet by its users, which can be citizens, businesses, governments or other organizations. In the case of Amersfoort, Measure Your City has in the past installed several gateways in the city to established city-wide coverage, which is complemented by gateways of citizens.

Several sensors can be connected to the measurement stations, using basic connectors and communication protocols. By updating the firmware accordingly the data can be sent over the TTN network to the Measure Your City database. The database subsequently allows the data to be publicly accessed via the website, or a dedicated API (https://www.meetjestad.net/).

Within this project we expanded the Measure Your City setup, to include soil moisture sensors and organized workshops for citizens to build a setup to place in their garden, green roof or another place of interest, such as a public park, sports associations or vegetable garden. The data collected by Measure Your City participants using these setups was subsequently integrated into the SCOREwater dataplatform using this API.

Important to note is that the citizens science collective in Amersfoort follows a bottom-up approach. This implies that citizens themselves formulate what they want to research and how they want to organize the research. The municipality and water authority support and collaborate with the citizens. One of the ways they do so is by promoting ideas and research areas they themselves find interesting. For example, because they see a need for data to improve policy or because they are unaware of how people within the city feel about certain topics. Some spark the interest of local groups and lead to measurements. Others do not and are not followed-up on. One of the ideas that led to enthusiasm from both sides was that of measuring soil moisture within the SCOREwater project.

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Additionally, the Measure Your City collective want to make sure every citizen has equal opportunity to join the effort. Therefore, they aim to use only open source tools for designing measurement setups, data collection, visualization and online meetings. This ensures that citizens who want to participate are not limited by paywalls, subscription fees to software and/or concerns about privacy. Another implication of this aim is that sensors need to be affordable, so that they can be used widely.

2.1.2 MEASURING SOIL MOISTURE AND BUILDING WORKSHOPS

Soil moisture is the amount of water in the upper layer of soil. It is affected by several factors, such as precipitation, temperature, soil characteristics and other environmental characteristics. The relevance for citizens is that soil moisture provides data on whether or not the living environment is becoming dryer as an effect of climate change and if so, by how much. Furthermore, it may provide input as to how well green roofs function and whether or not citizens have to water their garden (which is necessary to make sure greenery grows well, but should not be done too extensively as water is a scarce resource).

For the SCOREwater project, Measure Your City aimed to

- co-design a soil moisture sensor setup;
- compare results to the municipality's soil moisture network;
- develop the workshops;
- attract citizens to participate in a workshop;
- organize community meetings to show results, spur new ideas and discuss implications of the data.

Co-designing a soil moisture sensor setup

At the start of the project there was not a soil moisture sensor setup available that met the demands of the Measure Your City initiative. The setup had to be reliable, open source and affordable. Hence it was decided to initiate a process to co-design a sensor with the community.

In May 2020 the project started with the design of an initial prototype, based on a design provided by a community member. This prototype (#1) was demonstrated at a community meeting on the 21st of July to stimulate citizens to help co-design the sensor. Following this meeting four community hackathons where organized to develop and build ten prototypes (#2) that were capable of measuring soil moisture and soil temperature at four depths (10,40,80 and 120cm). Figure 2 shows a photo of one of these meetings, as well as a photo of a building workshop that is described later in this report. The hackathons attracted groups of 4-5 citizens, who were mostly triggered by the technological challenge of designing an affordable, but reliable, sensor.

Figure 2: photos of a meeting and building workshop, showing citizens working on developing the Measure Your City sensors. Source second photo: RTV Utrecht

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Compare results to the municipality's soil moisture network

In September and October 2020 the ten prototypes built in the community hackathons were placed alongside the soil moisture network of the municipality to determine their reliability. On the 23rd of September a festive opening of the network was organised with citizens, company representatives, municipality officials and involved alderman. As sensors were placed in the public space, these were provided with a QR-code so that citizens could visit a web-page with additional information. Additionally, during maintenance rounds there were generally some citizens passing by that asked questions about the measurement device and the project.

Intermediate results of the soil moisture prototypes were presented to the Measure Your City local community and interested citizens at several meetings between October 2020 and June 2021. These meetings focussed on different topics: informing and educating citizens on soil moisture, showing collected data, collecting the wishes and hypothesis of the citizens and actively working on the data validation. The input provided by these meetings was used to organize the follow-up in 2021 and 2022.

From these meetings it was concluded that the previous prototypes (#2 and #3) where not sufficiently reliable and accurate for measuring soil moisture. From July to October 2021 several community hackatons were organized to work on an improved prototype. This led to several new insights on measuring soil moisture, including the importance of measurement frequency for reliable results. In these hackathons we designed a new prototype (#4) that was capable of measuring at a frequency of 20Mhz, performed several calibration experiments and compared sensor performance to readily available (affordable) sensors. In December 2021 this resulted in the choice of a measurement setup using a set of readily available sensors capable of measuring at 70MHz to measure soil moisture and temperature at 10cm and 40cm depth.

A similar setup was chosen to measure moisture and temperature in green roofs, using a single sensor-pair for measuring soil moisture and temperature. The table below summarizes the measurement setups developed in the project. Firmware and design files for the setups implemented in the pilot and workshop are made available open source on Github.

Table 1: summary of the developed measurement setups

Measurement setup	Development phase	Changes
Prototype #1	Lab	First prototype
Prototype #2	Pilot	Closed tube, measurement at four levels
Prototype #3	Pilot	Switched from I2C to TTL protocol, enhanced code for sensor microchip for measurements up to 3Mhz
Prototype #4	Testing	Re-designed electronics and programmed firmware for four-frequency measurements up to 20Mhz
Soil moisture setup	Workshops	Setup using readily available soil moisture sensors measuring at 70Mhz and added firmware
Green roof setup	Workshops	Adjustment of the soil moisture setup and firmware for single sensor pair and placement on green roofs

Develop the workshops

In the beginning of 2022 initial workshop concepts were developed for the soil moisture and green roof setups, including:

- a soldering plan for the hardware;

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- firmware for the Measure Your City dataplatform, where all data is gathered and published as open data;
- instruction manuals.

In the workshop citizens are informed about the Measure Your City community, measuring moisture in their garden and on their roof and are subsequently set to the task of soldering the electronics and building the housing for their own sensor. The concept of building a sensor yourself is that participants tend to have more devotion to the own-build sensor and thereby to the subject, the community and maintenance of the network.

In January 2022 and March 2023 two test-workshops were organized with citizens to build green-roof and soil-moisture measurement setups. This led to a number of improvements on the setup and workshop guidelines. Figure 3 shows a photo of one of these workshops, as well as a photo of a citizen scientist installing a Measure Your City sensor in the field.

Figure 3: pictures showing citizen scientists at work in Amersfoort. Left: installing a sensor by citizen scientist. Right: tinkering citizens working on the construction of a sensor.

Attract citizens to participate in a workshop

From May 2022 until November 2022 10 workshops were organised, of which 9 attracted sufficient citizens to take place. The workshops were guided by one or two professionals, depending on the number of participants. In total more than 70 citizens participated, of which 1/3rd in workshops for a green-roof setup and the remaining majority in workshops for a soil moisture for garden setup. An additional five citizens participated in a special workshop format, in collaboration with a community centre that provided daytime activities for youths that face social integration issues. They build a soil moisture setup to place at the community centre and in the gardens of local neighbours and volunteers. The first 73 sensors were or will be placed near citizens homes. Assuming an average household of 2,13 people (source: Statistics Netherlands) that means that by now, an estimated 150 people in Amersfoort have soil moisture sensors near their home.

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Publicity for the workshops was done using the website, newsletter and social media of Measure Your City and supported by Future City and COA, using their social media channels and weekly newspaper. Particularly the communication channels of COA proved successful in attracting citizens to the workshop.

Organize community meetings to show results, spur new ideas and discuss implications of the data

Throughout the project citizens were actively involved with the design of the setup, hypotheses formulation and building sensor in workshops. These meetings are mentioned above and summarized in the results section. In October 2022 organised a special meeting was organised to analyse to data of soil moisture and green roof sensors, following the extreme drought that faced the Netherlands, and most of Europe. From this meeting came the first examples of how citizens can take action to keep moisture levels high and their gardens green, during periods of extreme drought.

As an indirect result of this project, a new development was initiated by participating citizens to build a Measure Your City setup that can measure tree width fluctuations, to be able to couple soil moisture measurements to the health of different trees in the city. A first prototype was built and installed in Amersfoort in June 2022.

2.1.3 RESULTS

The above activities resulted in the following results:

- 11 community hackathons were organized to develop knowledge and technology together with citizens from Amersfoort and the broader community;
- 10 prototype sensors were placed in the public space;
- A sensor setup was developed and validated for measuring soil moisture and temperature;
- A sensor setup was developed and validated for measuring moisture and temperature in green roofs;
- Two workshops were developed, including an open source soldering plan, firmware and workshop instructions;
- 74 Citizens participated in a workshop to build a setup for soil-moisture or green roofs;
- 11 additional soil-moisture setups and 2 green roof setups were built by citizens to complement the network at strategic locations;
- Many meetings were organized involving citizens in the project;
- Several presentations were given at national and international meetings to present the approach and results to a broader citizen science community as well as the SCOREwater network.

2.1.4 LIMITATIONS DUE TO COVID-19

BUILDING WORKSHOPS

In 2020 COVID-19 spread among the Netherlands, as it did in many countries around the world. To stop the spread the Dutch government publicly announced measures such as limitations to physical meetings, limitations to the amount of people who could physically meet and limitations in terms of travelling. For this deliverable, this meant that activities had to be cancelled, postponed or shifted online. This hampered progress during the project. Citizens science activities are very dependent on being in a physical place together. Coming up with new research questions, building sensors, installing sensors in the field: they all depend on being together and interacting. As a results of these limitations, not all expected results were attained. In particular we anticipated a quicker transition from sensor-development to building workshops.

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However, it is important to note here that all that could be done to ensure progress was done. And: it even resulted in some positive side-effects. Firstly, when gatherings or larger groups were prohibited smaller and online workshops were organized to still be able to have progress. Although not ideal, they did lower barriers for people from other cities or even countries to join the meeting. Because of this, meetings were not only joined by people from Amersfoort, but also from other cities in the Netherlands (such as Utrecht and Tilburg) and even other counties (such as Norway and Germany).

2.2 THERMAL WALKS

The second track focuses on involving citizens in so-called 'thermal walks'. This research method, as among other described by Vasilikou and Nikolopoulou (2020), provides data and input on how citizens subjectively perceive heat stress within the city. This chapter describes the method and approach, results and limitations.

2.2.1 METHOD AND APPROACH

Usually city designers use maps, calculations and models to find solutions for urban heat stress. In this project, we explored the use of a different method: thermal walks. Thermal walks focus on involving citizens by asking them how they perceive heat stress. As such, it tries to incorporate data on their experience of heat 'in real life'. In Amersfoort we planned ten thermal walks for inhabitants in the summer of 2022. The city is, amongst others, designed for inhabitants, so our focus was to experience heat with inhabitants themselves. An additional benefit is that by doing so, awareness on heat stress and the negative effect it can have on health is enhanced.

During the thermal walks, groups of participants walked through predesigned routes throughout the city. They were accompanied by one or more representatives from COA. During the walks, participants were asked to fill out short surveys on predefined locations. The surveys had to be filled in digitally, so a smartphone with internet was required. To lower barriers to participate citizens who did not have a smartphone available were provided with a model owned by COA.

The walk focused on gathering data on subjective heat experience. Examples of questions that were included are: are the thermal conditions on this location pleasant for you? If not, would you prefer colder or warmer temperatures? And which circumstances on this location influence your thermal experience here?

The guided walks followed three routes and started on three predefined locations: near the Central Railway area, in the neighborhood called Schothorst and in the city centre (see figure 4). There were five to seven stops during each route. At each stop the survey was filled out on two locations: one in the sun and one in a shadow spot.

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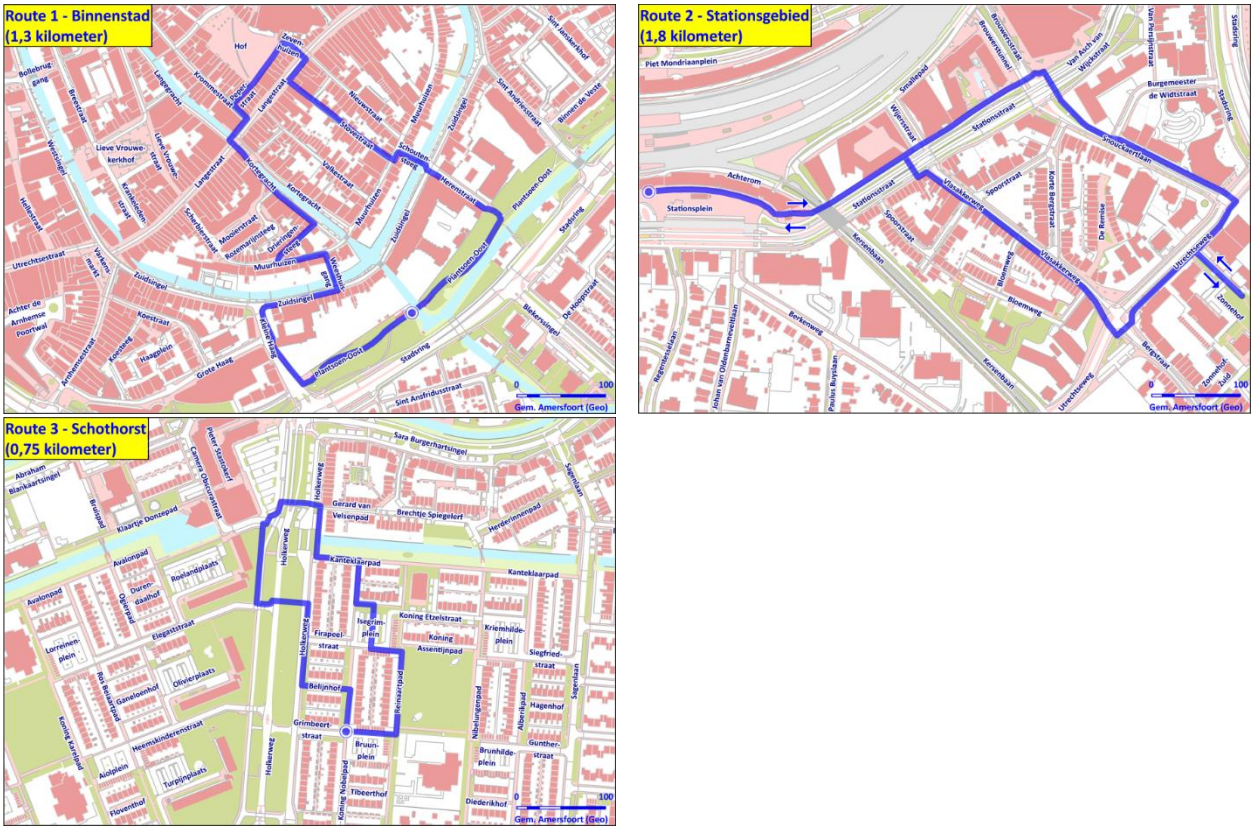

Figure 4: map showing the three thermal walk routes

Besides the subjective heat stress, a sensor was used to measure objective heat stress. The sensor used was a JDC Skywatch BL 500. It includes measurements of wind, air pressure, UV index, humidity and temperature. The sensor connects via Bluetooth with a smartphone to read the measurements. In the app a route can be tracked, saved and published online. At each location a waiting time of one minute was used to allow the sensor and participants to acclimatize.

2.2.1 RESULTS

In total 8 thermal walks were conducted with a total of 45 participants. The participants ranged from the age of 18 till 79 years. All three routes were walked, but the thermal walk in the city center was most popular. The surveys were analyzed by the Research and Statistics Department of the City of Amersfoort.

Due to the limited number of participants of the study, no generalizable conclusions can be made. However, a lot of information about the specific 19 locations that have been visited is gathered. As a result (despite the limited study size) relevant insights were gathered that can be used by COA.

The results show that shadow is a very important factor in making a place pleasant or not so pleasant to stay. As a result, having at least some shadow on all important locations makes these locations more pleasant. Furthermore, the results show that when temperatures reach 26 degrees Celsius or higher, participants started to find the temperature less pleasant. The lack of wind and shadow were mentioned as main causes of the unpleasant experience.

It is striking that the presence of surface water is not an issue in terms of heat perception. In the routes there were different greener stops (not parks). Although there was quite some greenery present, the stops were not perceived as pleasant to stay on warmer days. The expectation was that these green locations would stand out more positively. This expectation, however, was not supported by the data.

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Additional insights were gathered on specific locations. For example, in the Station Area (where one walk was held) temperature was considered mostly pleasant on a day when it was 21,4 degrees Celsius. At the Zonnehof a participant considered it too cold in the shadow and too hot in the sun. In residential area Schothorst there were two walks, with air temperatures of 25 and 26 degrees Celsius. At six of the seven locations there were participants who experienced the temperature as unpleasant. They indicate that they miss greenery, wind and shade. The location that was considered neutral or pleasant was Reinaartpad: a park with many trees.

The walk in the old inner city was most popular and in total there were five walks here. The air temperature differed from 17 till 31,5 degrees Celsius. The participants considered the locations temperature at Mariënhof, Herenstraat and Muurhuizen most pleasant. On the coldest days of the walks, Hof, Langestraat, Kortegracht and Muurhuizen were considered too cold, due to wind.

Before starting we expected differences in experienced temperature between younger and older participants. In this study we were unable to identify differences in heat perception between these age groups. Although speculative, this is expected to be due to the limited number of participants and the large air temperature differences between the thermal walks.

In the upcoming months, COA will use the results to see how locations can be further optimized. The information is a good addition to the models and measurements of objective heat in the city. Furthermore, the results will be used as input for the municipal heat plan (starting 2023). In addition, the results will be used to further elaborate the municipality's climate-poof directives.

The report including all results can be found on www.amersfoortincijfers.nl.

2.2.1 LIMITATIONS

Similar to the earlier mentioned limitations, the planning and progress of the thermal walks was negatively affected by the restrictions imposed to prevent spread of Covid-19. As the thermal walks were conducted physically, in groups and guided by someone working in the municipality, this was not possible when coming together in groups and meeting each other was prohibited. As a result, the planning was delayed in agreement with the European Project Officer. Because of this the thermal walks were conducted in the summer of 2022.

3. LINKING THE MEASURE YOUR CITY DATA TO THE SCOREWATER PLATFORM

All data gathered by the citizen scientists collective Measure Your City is published online as open data. All data is published both via their own platform and via the SCOREwater platform and via COA's open dataplatform, which were both developed by project partner Civity. As a result, all parties interested in using the data can do so. They can either view the data on a map (see Meet je stad!), or can download the data (see Meet je stad). Figure 5 shows a screenshot of the COA open dataplatform.

The details of the connection between the Meetjestad API and the SCOREwater platform are beyond the scope of this deliverable. More information can be found in SCOREwater deliverable 3.3 "Integration and connection of sensors and algorithms to the SCOREwater platform including processing, storage and transformation of data to open API's".

By including the Measure Your City-data in the SCOREwater platform, value is added to the data. Measure Your City publishes data using an easy-to-use proprietary REST API. However, on the SCOREwater platform the data is converted to standard API's and data models, allowing out-of-the box software to work with the data. Also, the data can be used together with other data-sources containing similar information which have been included in the SCOREwater platform. This allows for comparing data from different sources, as well as replicating solutions from one environment to another without a lot of effort.

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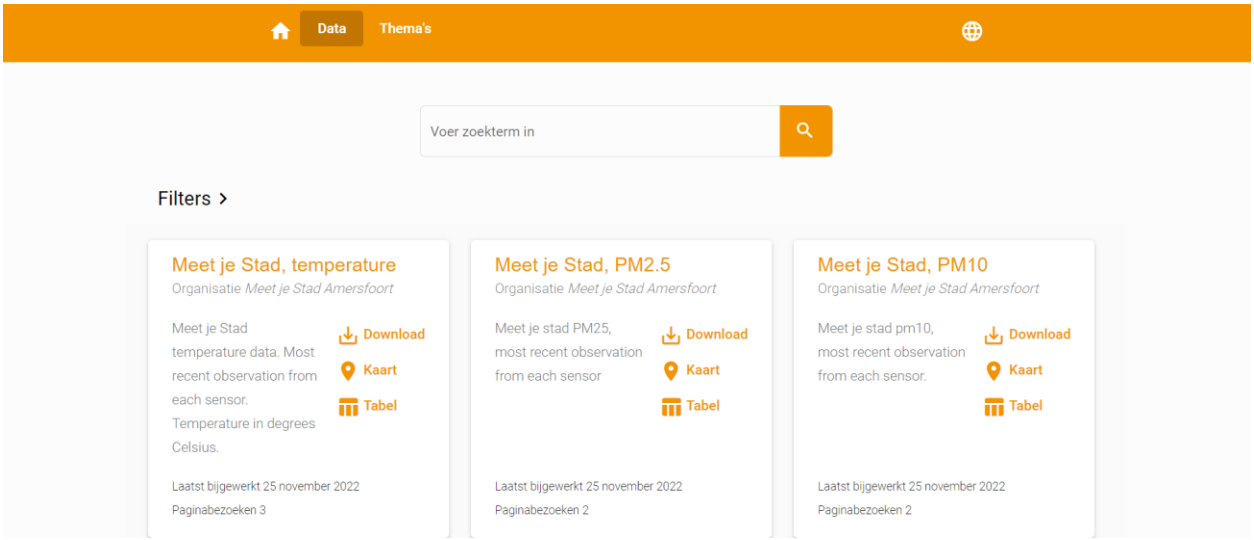

Figure 5: screenshot of the Measure Your City linked to COA's open dataplatform

4. LESSONS LEARNED

As stated earlier, to prevent the COVID-19 virus from spreading the Dutch government imposed restrictions on physical meetings, travelling and meeting in large groups. In order to have progress, many activities were switched to online settings. As a beneficial side-effect, this lowered barriers for interested citizens from other cities or even countries to join the meetings. Offline meetings require effort and travelling to join but lead to more creative, inspiring results as people meet and openly discuss new ideas or developments. Online meetings require no travelling and as such have a lower barrier to join, thus leading to a more diverse and international crowd. In the future, Measure Your City will combine offline, physical meetings with periodic, online meetings to have 'the best of both worlds'.

Furthermore, due to COVID-19 many of the citizens science activities had to be postponed or cancelled. Within the citizens science collective, there is a broad distinction that can be made between the people who are there regularly (say at least once per month) and those that are there incidentally (say once per three or six months). The first group remained active, joining online discussions and talks on different matters. The second group, however, focused its attention elsewhere as the physical meetings were no longer possible.

For the collective this was quite challenging, as now more work had to be done by the 'regular' group. Fast forward to summer 2022, and most of the imposed restrictions have been lifted. It took time, regular communication and the organization of several activities to bring back the 'incidental' group. But things are progressing as more and more citizens are again showing up at activities and events.

5. PRESS, COMMUNICATION AND EXPOSURE

When we started the work that is described in this deliverable, several media reported about it. Examples include an interview on the radio and articles by local newspapers Algemeen Dagblad and Stadszaken. This resulted in a lot of positive exposure. Figure 6 shows screenshots of two of these articles.

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Figure 6: screenshots of media exposure related to deliverable 4.19

Furthermore, many governmental organizations were interested in knowing more about the way COA and Measure Your City collaborate. To facilitate knowledge sharing a webinar was organized in march 2021 together with Future City Foundation. 172 people participated; the webinar can be found here.

Lastly, on the Measure Your City sensors a QR-code was placed, which after scanning redirects people to the SCOREwater website. The aim of this is to provide information to citizens who were interested in knowing more about the sensor, measurements and project. The page that citizens are redirected to is https://www.scorewater.eu/sensoren. Information was provided both in Dutch and English. In total the page was visited over 500 times, by more than 300 people (by November 2022). Most of the visitors (>90%) came from the Netherlands; other countries that visitors originate from include Sweden, Germany and Finland.

6. CONCLUSION AND FUTURE DEVELOPMENT

On Measure Your City

Within this project we developed a measurement setup and workshop that allows citizens to build their own sensor setup to join the effort of quantifying the effects of climate change on our living environment. From SCOREwater this resulted in an additional sensor network of 83 sensors in Amersfoort, that we aim to use to spur action among citizens to adapt their living environment to increased droughts and water stress. The data generated by the citizens is open and can be used by businesses or government to underline the need for action or even validate hypothesis and measures taken. Apart from the Amersfoort context we have provided an open source setup and workshop, that can be adapted by citizen science projects in other cities and countries as well.

Moving forward we aim to use our community resources to maintain the current sensor network and obtain funding to organize more workshops in Amersfoort and potentially in other cities. With more data being generated we aim to perform regular data analysis sessions and provide feedback to past participants. The aim is to look at how participants gardens or roofs perform with respects to others and which measures can be taken to improve water- or drought-stress. Additionally, this project has encouraged citizens to develop a new measurement setup for trees, for which we want to follow a similar process for developing a validated setup and workshop.

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On thermal walks

COA has policy for climate adaptation that is used when redeveloping the city. The so-called 'guidelines for climate adaptive development' are in use since 2020. The guidelines are aimed at altering the city to deal with the effect of climate change. Subgoals include avoiding water nuisance as much as possible, and tackling heat stress and drought to ensure that Amersfoort remains a pleasant city to live, work and recreate in. The thermal walks provided insights in the subjective experience of heat in the city. By doing so, they provided insight in the experience on comparable locations, such as parks, residential streets and squares. The input provided by the thermal walks will be incorporated in the guidelines COA uses.

7. REFERENCES

Koistra, T., Meijer, H., vas den Brink, M. Early warning system for flooding. SCOREwater deliverable 4.18. Horizon 2020 project, Grant agreement No 820751. 2021.

Meijer, H., Vrouwe, A. Deployment of sensors around the Amersfoort railway station, including selection adn formal permit for monitoring. SCOREwater deliverable 4.17. Horizon 2020 project, Grant agreement No 820751. 2021.

Vasilikou, C., Nicolopoulou, M. Thermal Walks. *PLEA*. 2013.

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ANNEX 1 – STOCKTAKING

A final Annex of stocktaking was included in all Deliverables of SCOREwater produced after the first half-year of the project. It provides an easy follow-up of how the work leading up to the Deliverable has addressed and contributed to four important project aspects:

1. Strategic Objectives
2. Project KPI
3. Ethical aspects
4. Risk management

STRATEGIC OBJECTIVES

Table 2 lists those strategic objectives (herafter: SO) of SCOREwater that are relevant for this Deliverable and gives a brief explanation on the specific contribution of this Deliverable.

Table 2: stocktaking on deliverable's contribution to reaching the SCOREwater strategic objectives.

Project goal	Contribution by this Deliverable
SO1: Deploy and demonstrate a smart water management approach, which is people-centred, inclusive, Market development of integrated and cyber-secure ICT solutions	The deliverable describes the development of a citizen science measurement network. The data is connected to the SCOREwater platform, thus contributing to SO1.
SO5: Identify and mitigate key barriers to implementation of smart, resilient water management	The work in this deliverable has led to the discovery of several barriers that may hamper involving citizens in measuring in their local environment and on raising awareness about issues related to climate change. These were described in this report and in reports in work package five. By identifying and mitigating these barriers the deliverable contributes to SO5.
SO6: Increase citizen involvement and engagement in the transition to a water-smart, resilient society	This deliverable focuses on directly involving citizens in the transition to a water-smart, resilient society. As a results, it is a direct contributor to SO6.

PROJECT KPI'S

Table 3 lists the project KPI's that are relevant for this deliverable and gives a brief explanation on the specific contribution of this Deliverable.

Table 3: stocktaking on deliverable's contribution to SCOREwater project KPI's.

Project KPI	Contribution by this deliverable
KPI 2: Number of input datasources connected and consumed	The data described in this deliverable is connected to the SCOREwater platform, thus contributing to KPI 2.

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Project KPI	Contribution by this deliverable
KPI's 11, 12 and 13: behavioural, technological and organizational barriers identified and mitigating options demonstrated	As stated in this report and the reports in work package five, there are several key lessons learned from actively collaborating with citizens. By identifying and mitigating these barriers the deliverable contributes to KPI's 11, 12 and 13.
KPI 15: number of involved and engaged citizens in demo cities	In this deliverable citizens were actively involved in the project. As a results, it contributes to KPI 15.

ETHICAL ASPECTS

Table 4 lists the project's Ethical aspects and gives a brief explanation on the specific treatment in the work leading up to this Deliverable. Ethical aspects are not relevant for all Deliverables. Table 4 indicates "N/A" for aspects that are irrelevant for this Deliverable.

Table 4: stocktaking on deliverable's treatment of ethical aspects.

Ethical aspect	Treatment in the work on this deliverable
Justification of ethics data used in project	N/A
Procedures and criteria for identifying research participants	N/A
Informed consent procedures	An informed consent was used by Measure Your City to ensure that sensors used and data collected by the citizen science sensors could be used and published.
Informed consent procedure in case of legal guardians	N/A
Filing of ethics committee's opinions/approval	N/A
Technical and organizational measures taken to safeguard data subjects' rights and freedoms	N/A
Implemented security measures to prevent unauthorized access to ethics data	N/A
Describe anonymization techniques	N/A
Interaction with the SCOREwater Ethics Advisor	An informed consent was used by Measure Your City to ensure that sensors used and data collected by the citizen science sensors could be used and published.

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RISK MANAGEMENT

Table 5 lists the risks, from the project's risk log, that have been identified as relevant for the work on this Deliverable and gives a brief explanation on the specific treatment in the work leading up to this Deliverable.

Table 5: stocktaking on Deliverable's treatment of risks.

Associated risk	Treatment in the work on this Deliverable
NC11	As stated earlier, due to Covid-19 not all expected results have been achieved. Specifically, the restrictions imposed to prevent the spread of the virus also prevented us from meeting each other. This was partly resolved by shifting from physical meetings to online meetings. This hampered progress and led to a drop in involvement. After contacting the project officer the deadline of this deliverable was postponed, which allowed us to involve more citizens and improve the corresponding involvement and thus results.

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