# Data collection

# Collecting urban climate data in Paramaribo

## Overview

This document describes the data collection for the urban climate in Paramaribo, Suriname, for the project “Towards a Green and more Livable Paramaribo”, funded by UTSN.

This data collection protocol will provide information on the sampling strategy, the use of the measurement devices and data analysis.

This will be a living document and updated after the first experiences in the field – please report back any issues, unclear points, missing elements, … to n.schwarz@utwente.nl

| **Date** | **Ver-sion** | **Author** | **Main changes** |
|---|---|---|---|
| 17 March 2019 | 1 | Nina Schwarz | Initial file |
| 26 March 2019 | 2 | Nina Schwarz | Additions to placing the loggers, radia-tion shield building. |
| 27 June 2019 | 3 | Nina Schwarz | Included a footnote in Part B to explain that altitude readings can change de-spite having set it to a reference value. |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# Introduction

Urban green areas such as forests, parks and gardens and other green infrastructure provide manifold benefits to the urban population, often referred to as “urban ecosystem services” (Haase et al. 2014). One of these services is urban microclimate regulation, which can also reduce the urban heat island effect. The urban heat island effect is about the temperature difference between urban and nearby rural areas, with urban areas typically being warmer than their rural surroundings (Arnfield 2003). There are many reasons for cities being warmer than their surroundings, and one of them is the relative lack of green spaces in cities compared to rural areas (Arnfield 2003).

The scientific evidence for the role of urban green for the urban climate comes mainly from studies conducted in cities in subtropical or temperate climates (Roth 2007). Comparatively few studies so far have investigated that relationship for tropical cities (recent review by Giridharan & Emmanuel 2018). The dry and wet seasons and the high relative humidity in the tropics lead to different temperature patterns, both in air and surface temperatures and, thus, making this an interesting and challenging research field (Giridharan & Emmanuel 2018).

The research related to this data collection protocol will be conducted in Paramaribo, the capital of Suriname. Suriname has about 560,000 inhabitants, more than half of whom live in Paramaribo and its surroundings. Particularly in Paramaribo, a lacking green policy can be felt due to a lack of public recreation areas. What is more, uncontrolled urban expansion in recent decades and modernization of the existing buildings and road infrastructure has further increased asphalt and concrete which retain more heat. In addition, climate forecasts for Suriname predict an increase in mean temperatures due to climate change. Thus, investigating the urban climate and the role urban green plays for that is important for planning a more liveable urban environment.

This data collection protocol is about collecting urban climate-related data in the field, i.e. with stationary and mobile measurements. This is a living document and will be updated throughout the course of the project.

# Part A: Stationary measurements

## Introduction

Stationary measurements of air temperature and humidity will be conducted with Kestrel Drops (version D2). These loggers record air temperature and humidity and can be programmed as to how frequently they should log this data.

## Radiation shielding

Ideally, the loggers should be protected from direct sunlight and rain entering the device. Thus, we suggest covering them with a low-cost radiation shield as suggested by Hubbart (2011). Instructions for assembling the shields are given in the appendix.

The advantage of using such a radiation shield is mostly to avoid excessive temperature peaks due to direct sunlight heating up the logger itself, and thus is recommended in the guidelines issued by the World Meteorological Organization (WMO). However, the shield attracts much more attention to the loggers, both for humans (theft, vandalism) and also wildlife which might investigate and damage the equipment.

## Placing the loggers

*[Will be updated - The sampling design on where to place the Drops will be developed based on the map for urban green spaces or on local climate zones in Paramaribo developed at the beginning of the project.]*

For setting up meteorological stations in non-urban areas, WMO (2010) recommends placing loggers for air temperature and humidity at a **height** of 1.25m to 2m above ground, and definitely no less than 1.25m. For urban areas, this means loggers could be in easy reach and potentially even in the way of vehicles. Thus, WMO suggests that for urban areas, heights of 3 to 5m are also acceptable, since this will not distort temperature readings too much.

In any case, loggers should be placed far away from ventilation shafts and other **sources of heat or cold**. Since batteries will need to be exchanged once in a while, the loggers need to remain accessible in principle.

## Documenting sampling points

All loggers have a unique id which can be found on the project sticker on the drop. The excel file UrbanClimateLoggers.xlsx links the project ids with the serial numbers of all devices.

The WMO has specified which information should be recorded for meteorological stations (WMO 2010). The template Stations-template.docx combines the information needed for meteorological stations in general (e.g. Annex 1.C) and those placed in urban areas specifically (Chapter II.11). These templates need to be filled for all sampling points.

## Programming the loggers

The loggers can be programmed through the app called Kestrel Link. It is available on iTunes and in the Google PlayStore and is already installed on the five project-owned tablets. When installing the app on a new device, adjust the app settings as given in Table 1. How to do that is explained in the manual “Kestrel Connect – App Manual Content”.

*Table 1: Settings for the app Kestrel Link to access the loggers.*

| Setting | Value |
|---|---|
| Units | Metric |
| Auto connect devices | On |
| Device power saving | On |

The same manual also explains how to program the loggers themselves. When programming a drop for the first time, the plastic battery protection first needs to be removed. Table 2 gives the settings to be used for programing the loggers. The time is automatically set to the time of the device that is used for programming the logger.

*Table 2: Settings for the loggers.*

| Setting | Value |
|---|---|
| Name | “Drop#”<br>According to the sticker on the back (or through their serial number and their ID as given in the table UrbanClimateLoggers.xlsx |
| Date | Current date |
| Live readings – Data logging rate | 1 minute |
| Wrap log | On |
| Data logging rate | 1 hour |
| Data alerts | Disable all |
| Registering a new user | No need |

## Maintenance and transferring data

Two factors need to be considered when determining how often to visit each placed logger: battery life and data storage capacity.

The D2 drop stores a total of 8165 data points. With an hourly logging of two measurements (temperature and relative humidity), 1344 data points are being used in four weeks, and the data storage capacity is reached after 6 months.

The drops come with a Lithium battery (CR2032). According to the supplier, the estimated battery life at the baseline settings when shipped from the factory (10 min logging rate, 5 sec connection rate) and room temperature (25°C) is about 4 months. Users stated that for an hourly logging rate and a longer connection rate, battery life can extend up to 6 months or longer.

Thus, **after 6 months at the latest** all loggers need to be revisited, and it is not recommended to wait this long. Visiting them more frequently has the following advantages:

- Monitoring battery life.
- Should a logger be stolen or vandalised, the amount of lost data is less.

- Any changes in the surroundings of the loggers (new buildings under construction, fences, changes in vegetation, …) can be recorded timely.
- In case there is a delay, still no data are overwritten since the maximum storage capacity is not reached.

Considering these points, it is recommended to revisit the loggers **every 2-3 months**.

To check the **battery level**, you can press the button on the logger itself – it should blink green if the battery level is still fine.

The manual "Kestrel Connect – App Manual Content" explains different ways how to **transfer data** from the drop. The options given at the bottom of the screen under Stats – Export data vary depending on whether Ketrel Link is installed on a mobile phone or on a tablet. For the project tablets, choose Bluetooth and send it to a laptop.

Before transferring the data, make sure that data range is set to "All". There is no need to clear the data afterwards, since old data will be overwritten automatically. Rename the file using the same pattern, for instance:
Drop_rawdata_[ID of drop]_[date of visit in YYYYMMDD format].csv

To summarise, when visiting the loggers:

- ❑ Transfer data.
- ❑ Check battery and replace if required.
- ❑ Fill information in documentation for the respective logger.

# References


Arnfield, A.J. (2003). Two decades of urban climate research: A review of turbulence, exchanges of energy and water, and the urban heat island. International Journal of Climatology, 23, 1-26.

Giridharan, R., Emmanuel, R. (2018). The impact of urban compactness, comfort strategies and energy consumption on tropical urban heat island intensity: A review. Sustain. Cities Soc. 40, 677–687.

Haase, D., Larondelle, N., Andersson, E., Artmann, M., Borgström, S., Breuste, J., Gomez-Baggethun, E., Gren, Å., Hamstead, Z., Hansen, R., Kabisch, N., Kremer, P., Langemeyer, J., Rall, E.L., McPhearson, T., Pauleit, S., Qureshi, S., Schwarz, N., Voigt, A., Wurster, D., Elmqvist, T. (2014). A quantitative review of urban ecosystem service assessments: Concepts, models, and implementation. Ambio 43, 413–433.

Hubbart, J.A. (2011). An Inexpensive Alternative Solar Radiation Shield for Ambient Air Temperature Micro-Sensors. J. Nat. Environ. Sci. 2, 9–14.

Jaganmohan, M., Knapp, S., Buchmann, C.M., Schwarz, N. (2016). The Bigger, the Better? The Influence of Urban Green Space Design on Cooling Effects for Residential Areas. J. Environ. Qual. 45, 134.

Roth, M. (2007). Review of urban climate research in (sub) tropical regions. International Journal of Climatology, 27 (14), 1859-1873.

Spronken-Smith, R.A. (1994). Energetics and cooling in urban parks. University of British Columbia.

WMO (World Meteorological Organization) (2010): Guide to Meteorological Instruments and Methods of Observation. WMO report No. 8. ISBN 978-92-63-10008-5. Updated 2010.

# Appendix: Radiation shields

## Required materials per shield

- ❑ 1 plastic funnel
- ❑ 1 plastic cone with holes (already drilled)
- ❑ Rope (about 40 cm long)
- ❑ Heat shrink tube (5 cm long)
- ❑ Rigid tube (3 cm long)
- ❑ Modelling clay

## Required tools for assembly

- ❑ Scissors
- ❑ Firelighter


*Figure 1: Required material and tools for one radiation shield*

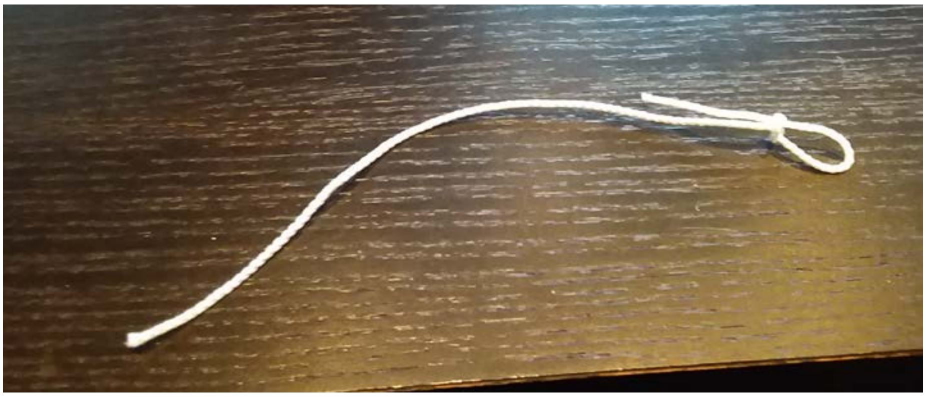

*Figure 2: Step 1 - Create a sling in the rope*


*Figure 3: Step 2 - Attach the logger*

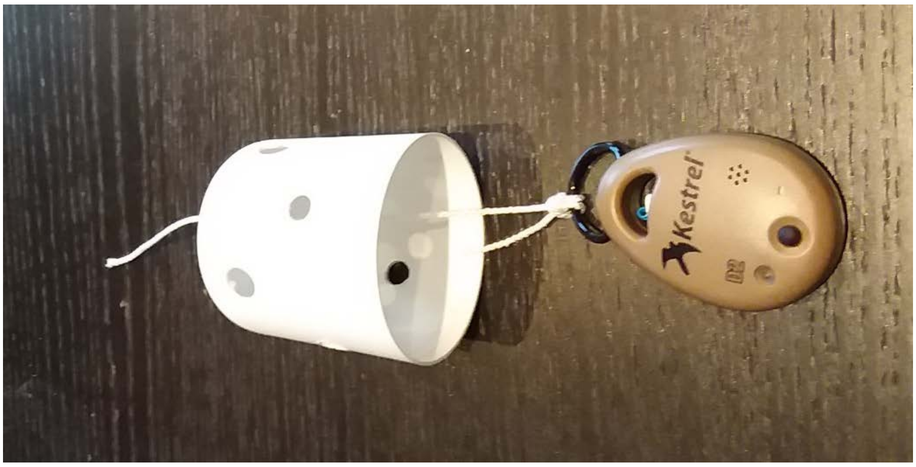


*Figure 4: Step 3 - Add the cone with holes*

*Figure 5: Step 4 - Add the funnel*

*Figure 6: Step 5 - Add transparent tube for stabilisation. Put the rigid tube in as far as possible while the drop should be as high as possible in the shield.*

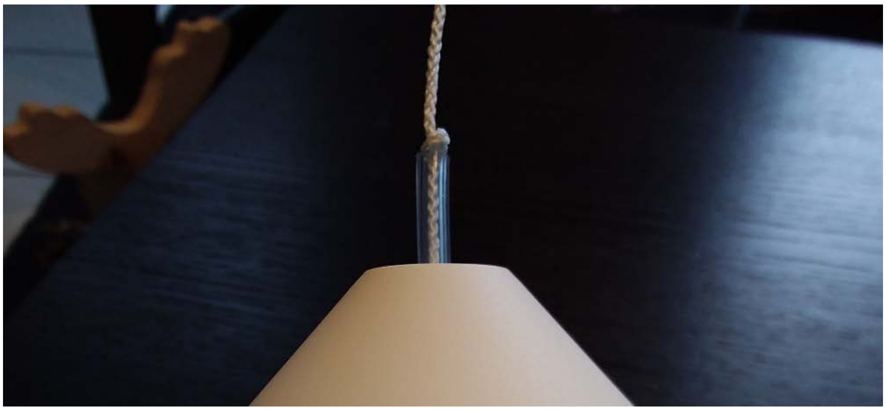

*Figure 7: Step 6: Fasten the tube with a knot, with the knot as close to the tube as possible.*

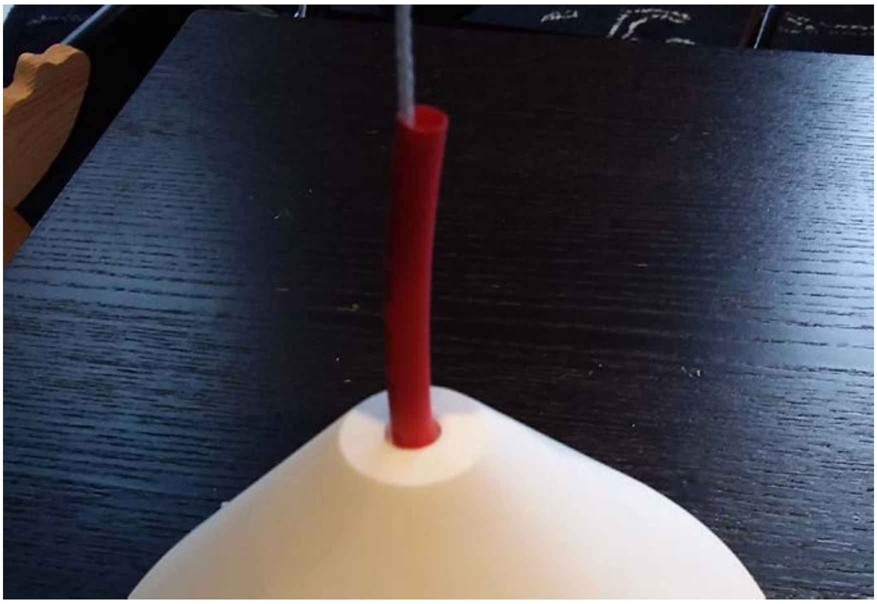

*Figure 8: Step 7 - Add heat shrink tube (available in different colours!)*

*Figure 9: Step 8 - Use firelighter to shrink the upper third of the tube so that rainwater cannot easily enter the rigid tube.*

*Figure 10: Step 9 – Use some modelling clay to seal the hole where the tube enters the funnel and the upper part of the heat shrink tube if necessary.*

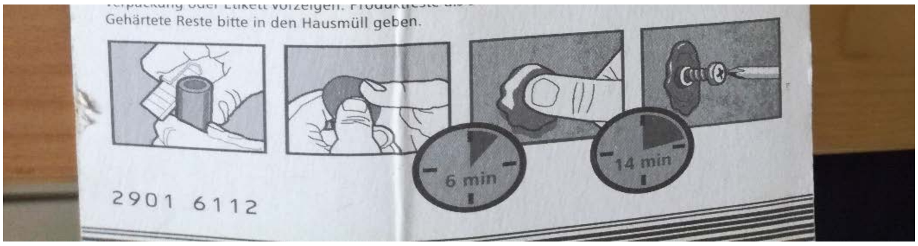


*Figure 11: Modelling clay instructions:*

- Surfaces need to be dry, clean and free of fat.
- Remove as much foil as needed and cut off clay. Beware that clay will harden after 6 minutes, so only cut off as much as can be used within that time.
- Reseal the remaining clay.
- Knead the clay until it is homogenous (i.e., different colours are no longer distinguishable).
- Place clay where needed.

*Figure 12: Done!*