

Using Dense Monitoring Networks in Urban Environments: National Green Infrastructure Facility 'Swale'

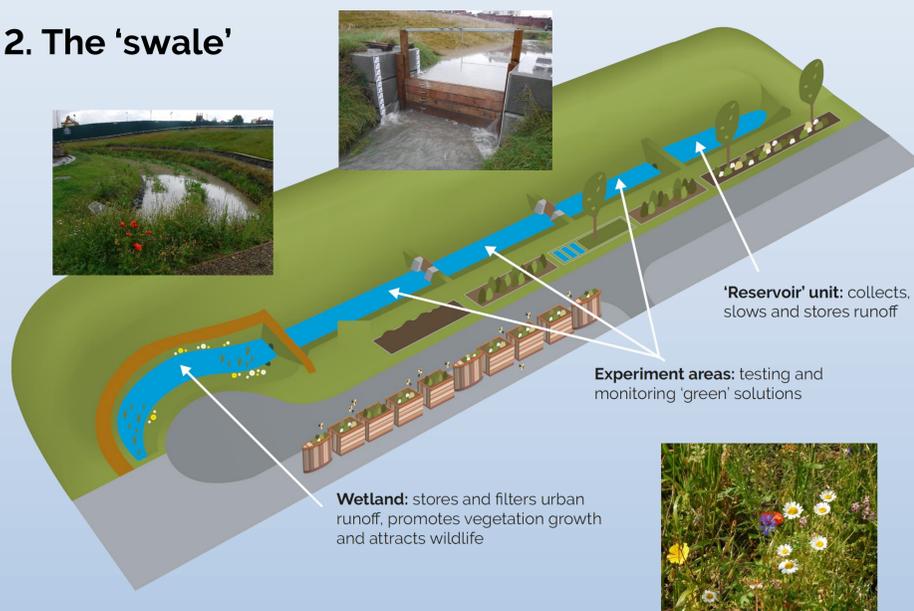
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1. Introduction: National Green Infrastructure Facility (NGIF)

- NGIF is a full-scale real-world laboratory for multidisciplinary testing and demonstration of green infrastructure (GI) and sustainable drainage systems (SuDS), operated by Newcastle University as part of the UKCRIC consortium for research on infrastructure and cities;
- NGIF's outdoor laboratory is located in the heart of Newcastle upon Tyne and is accessible to the public 24/7;
- The outdoor facility includes a series of 'lysimeters' and 'ensemble' plots, and a 140m long swale. These SuDS features have a primary aim of slowing, storing, filtering and managing water at source using nature-based designs which enable natural processes to prevail;
- Whilst they are used for research purposes, they are also fully operational SuDS features working at scale to reduce flood risk in this part of Newcastle upon Tyne. Monitoring a broad range of hydro-meteorological parameters at high spatial and temporal resolution is crucial. Monitoring in dense urban environments has its challenges, especially in the public domain.

2. The 'swale'



The swale works in two ways:

- Fully operational SuDS by interacting with **natural rainfall-runoff** events;
- Manually fill the swale with harvested rain water to **simulate flood events** and test both urban and rural nature-based flood mitigation measures.

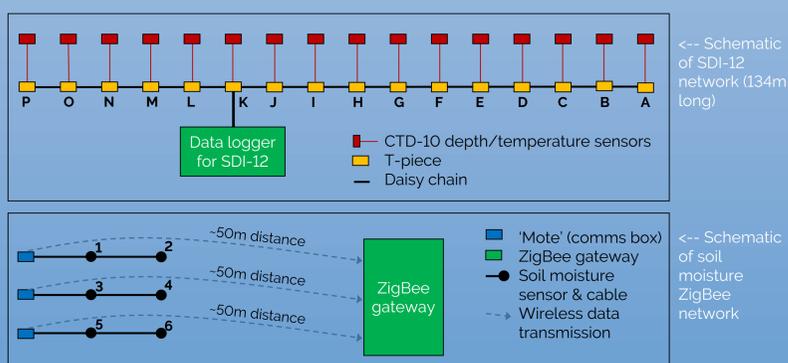
3. Monitoring requirements

Hydrologists are **quantifying** the swale's ability to reduce flood risk during rainfall-runoff events. They are also tweaking the design (e.g. **leaky barrier** arrangement) during flood simulations (experiments) to better-understand the attenuation and storage effect of nature-based solutions.

- Parameters:** rainfall, water depth, temperature, soil moisture, water velocity (therefore flow) and wider weather parameters. Low and high-cost sensors.
- Location:** urban street, **open to the public** therefore possible theft/vandalism. H&S considerations - people can walk into the swale where sensors are located.
- Spatial resolution:** sensors required across the entire length of the swale.
- Temporal resolution:** very high - observations every 10-60 seconds.
- Data transmission:** access to Wi-Fi/mobile network/power/ZigBee but not always feasible with such a high number of sensors. **Open data via API.**
- Public engagement and involvement:** **citizen science** monitoring scheme has been launched - do people participate in urban environments?
- Visual demonstration site:** the swale is also used to **engage** with **stakeholders**, including the public. Cameras (photos, videos and time-lapse) play a vital role in our monitoring programme

4. The monitoring network & example outputs

A) Cabled (in-situ) network



B) Citizen science



The team have launched a citizen science monitoring scheme to try increase the number of observations collected. This is being compared against rural citizen science schemes that they have led to date.

C) Hand-held 'deploy on the day' kit

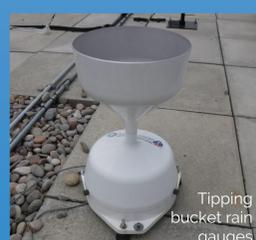


D) Example output data



5. Lessons learned

- Scheme enables researchers to monitor x52 datasets within ~0.26 hectare area;
- First green infrastructure monitoring scheme of its kind;
- Public have not interfered with in-situ sensors to date;
- Despite monitoring in the middle of a city, with abundant data connectivity, it is still a challenge. Some data is not telemetered and there are gaps / failed sensors;
- Visual (qualitative) outputs help communicate clear messages;
- SDI-12 network enables many sensors to be connected (therefore cost effective), but it is sensitive to interference;
- Citizen science participation levels are low because a 'community structure' is absent.



- Visit NGIF**
- Collaborate with NGIF:**
 - Monitoring networks
 - Citizen science
 - Green Infrastructure
 - Research proposals and student projects

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