SuDS+

Community-Led Futures

Urban SuDS

by communities for communities

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1. Introduction

Traditionally, the process of creating urban drainage has excluded local communities, leading to a lack of inclusivity and benefits for those who live there. The SuDS+ project (https://stanleysuds.co.uk/) in Stanley South, County Durham is changing this by working with local people from the beginning to co-design and build Sustainable Drainage Systems (SuDS) that provide numerous benefits beyond the standard water quantity, water quality, biodiversity and amenity.

Our project involves the community in every stage of the process, from idea-sharing to securing the ongoing impact and longevity of whatever is built. In this way our first-of-its-kind project will develop a new framework, support the creation of truly sustainable communities and build the resources for others to follow in our footsteps.

One aspect of the process is to help communities achieve the benefits they want from SuDS+ installations, such as accessible community spaces, job opportunities and multi-functional play areas. In effect, this makes flood reduction the ‘co-benefit’ rather than the focus. The ‘+’ element of SuDS+ can be wider than purely physical assets to help with intangibles such as sense of place, community cohesion ad wellbeing.

The ultimate goal is to go beyond consultation and even co-creation, so we reach the point where communities can take control of the entire process from concept through to delivery and maintenance. We aim to create a repeatable methodology and complete toolbox, but must somehow accommodate each community’s unique character. There are other major challenges as well: how do we make it simple enough to scale up, encourage widespread adoption, and essentially influence flood risk management policy?

If SuDS+ is to be successful, we must encourage stakeholders to step beyond their areas of expertise and direct training, and embrace an integrated, multidisciplinary approach. Training, communication, engagement, innovation, cross-sector collaboration, governance, organisational structure, adoption and funding are all pieces of the jigsaw we are trying to fit together: all whilst ensuring projects reduce flood risk.

This document discusses some of the challenges and opportunities around this process, especially concerning the blending of technical hydrology with ‘soft’ co-creation techniques.

2. Community Visioning and Co-Design

2.1 The SuDS+ Process

Traditional SuDS design focuses almost entirely on reducing flood risk. Designers usually complete this technical stage before adding any extra benefits that they think people might appreciate. In contrast, SuDS+ looks to understand the larger problems affecting communities and places from the outset.

Figure 1: Co-creation event in Stanley.

The first phase of SuDS+ is to work together with local communities to understand what these challenges are and what people would like their area to be like. The SUDS+ process calls this 'vision-setting'. This phase also helps to capture what local people like and dislike about where they live, so that strengths and barriers can be appreciated and utilised in later phases of the project.

The key question to answer in this phase is: 'What challenges exist in the local area which SuDS+ can contribute to solving and what collective vision should we work towards to solve these?' The vision creates a high-level set of aspirational goals which are then used to guide the design and delivery of infrastructure, like guiderails or measures of success. Not all of them will be addressed directly by the physical SuDS infrastructure installed; but the SuDS+ process itself should help towards the realisation of as many goals as possible.

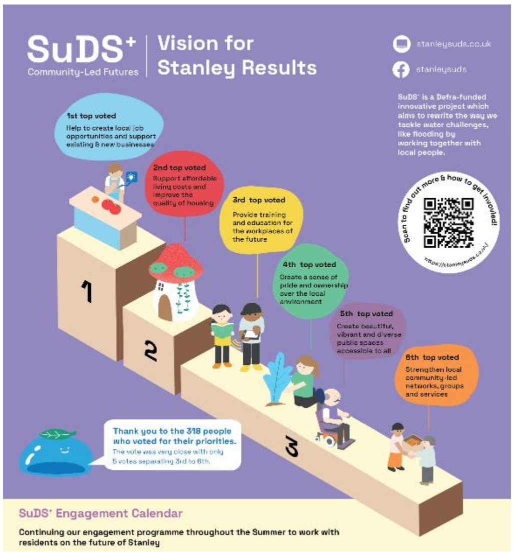

Figure 2: Most popular themes in Stanley were employment, housing, cost of living, training, environment (sense of place) and community.

For example, the implementation and maintenance of SuDS can be designed to foster participation of local people and include sufficient training for them to do so effectively. Post-construction maintenance activities could also be given to local contractors to support job creation.

The vision informs subsequent opportunity mapping to identify locations for new infrastructure that will deliver multiple benefits to as many people as possible. This approach goes beyond traditional flood risk reduction methods by helping stakeholders identify underutilised areas that could benefit from new investment. Combining opportunity maps and constraints maps allows for the prioritisation of locations to deliver the greatest benefit.

The key question to answer in this phase is: 'Where are the opportunities for installing new infrastructure and what might they do?

The visioning phase may also provide valuable insights and opportunities for other service providers working in the area. These stakeholders could potentially lead the delivery of some community aspirations through their own projects and funding streams.

2.2 Stanley South Outcomes

In Stanley South, the above steps resulted in 383 initial concepts being co-created at different locations across the study area. This creation of the vision, opportunity mapping and long-list of locations involved extensive, iterative engagement and interaction with local people and organisations.

Key interests of the community were: activities for young people, reducing antisocial behaviour, reducing litter, planting wildflowers and enhancing existing vegetation.

Figure 3: The 12 short-listed concepts and locations for SuDS+ interventions.

Flood mitigation and SuDS was rarely mentioned as it was only interesting to those that have already flooded. The main aim of SuDS+ is to meet community desire, which is why flooding formed a 'foundation' upon which the visible community benefits were constructed.

The results of these cycles then required substantial expertise to disentangle competing from complimentary aspirations, constraints and suggestions. A system of scoring was developed to rank each opportunity for its contribution to the vision themes and give an overall 'idea popularity score'. This meant that the community's aspirations ('+') drove the initial filtering activities. This was then blended with national flood risk mapping as well as integration with project-specific flood modelling, for SuDS and ranked to produce a short-list of 12 sites with SuDS+ concepts. These underwent further rounds of community engagement (voting),. This filtering process is not fixed, it will depend on project specific aspirations and constraints.

3. Optimising SuDS for Floods

We first wanted to identify the optimal placement of SuDS to reduce local flooding and then demonstrate to the community why these locations were effective. One aspect of this was to get across the 'top of the hill' concept, whereby SuDS in one part of the town can protect houses in another part from flooding.

The SuDS optimisation aspect was achieved using Viridian's eco-hydrological model called HydroloGIS. We then experimented with communicating the results to community participants, in the hope that they could include flooding into their SuDS+ designs. These steps are discussed below.

3.1 The Eco-Hydrological Model

HydroloGIS is an advanced, spatial model that predictively specifies, ranks and prioritises nature-based solutions to water problems. It mathematically calculates the current and future ability of every 'pixel' across a landscape to mitigate problems such as flooding, drought, erosion/siltation and diffuse pollution. It optimises landscapes to maximise the delivery of multiple benefits and its numerical basis aids the quantification of service delivery.

HydroloGIS has been applied successfully across landscapes up to 15,000km^2, but rarely in urban settings. Rural land managers intrinsically understand how different parts of their holding are better or worse for different uses, so it is effective to add NbS into their management planning through visuals such as heat maps. Urban areas are far more complex over small distances and their communities do not have a similar degree of background understanding. Helping them understand SuDS optimisation within the 'top of the hill' context is therefore very challenging.

This is demonstrated by Figure 4 to the right. The top image shows the SuDS optimisation, with darker colours showing more effective locations to reduce local flooding. The bottom image adds in the flood locations, overland flows and community shortlisted locations for SuDS+ actions: it is extremely busy and difficult to understand. We therefore attempted to simplify the presentation to help stakeholders understand the hydrology and include consideration of flooding in their SuDS+ designs.

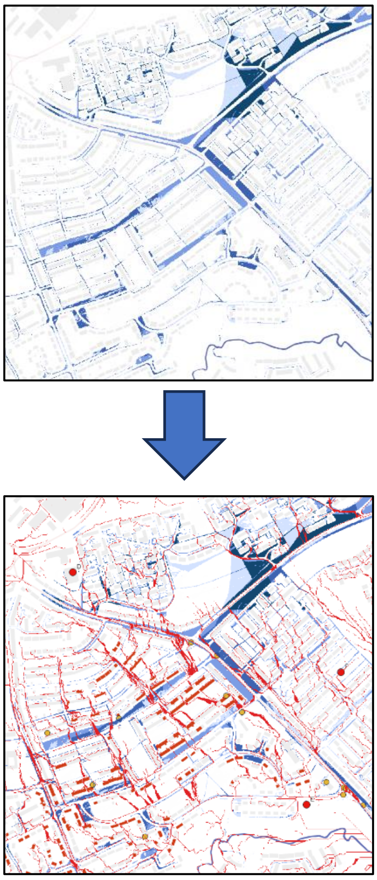

Figure 4: Displaying hydrology and SuDS prioritisation.

4. Getting the Hydrology Message Across

We experimented with presenting the modelling outputs to professional SuDS+ team members with no hydrological experience. This included splitting apart the SuDS priorities, flows and flood locations to view separately; as well as combining in different combinations. None of these proved particularly successful nor practical, so we tried to reinterpret the modelling to create a simple, more intuitive visualisation.

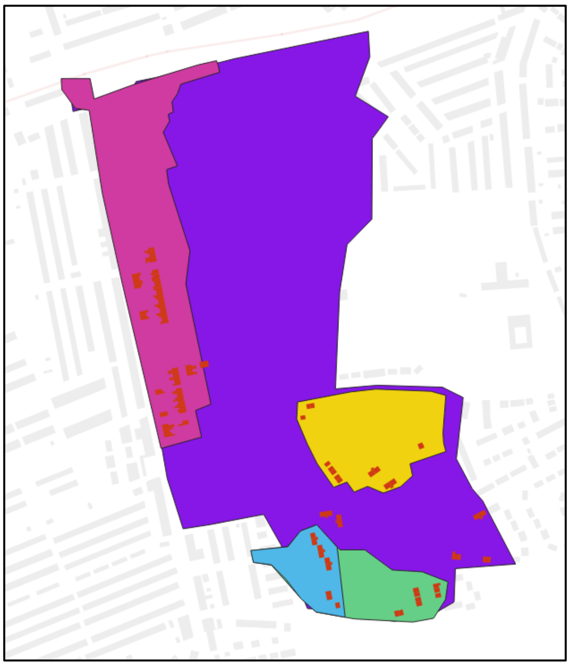

Figure 5: Aggregating SuDS and benefiting flood locations into single-colour blocks.

We tried to show the interaction between SuDS and floods by using blocks of colour, as demonstrated by Figure 5 to the left. SuDS created in any of the coloured blocks will reduce flooding at the relevant houses within that block (shown in red), but not in other colours. For instance, SuDS created in the pink block will help the red houses within the pink area, but no in the yellow, blue or green blocks.

Unfortunately, the flow network results in complex interactions and results in some blocks overlapping others. In Figure 5 the purple block underlies all the other colours and so, in effect, creating SuDS in any of the blocks will help the flood-prone buildings in the south of the purple block. In addition to this, the green extends beneath the blue block.

This system offered some improvements in understanding over the original outputs, but was neither simple nor intuitive enough to offer a reliable resource for community engagement.

We did not find any other acceptable solutions. Instead, we divided the processes of choosing the final four target sites into two strands: one involved community consultation and co-design around the vision statements and the other involved our expert interpretation of the hydrology.

The co-design resulted in each of the 12 short-list sites being scored between +30 and -15, depending on how many positive or negative stakeholder reactions each received to the final proposals (created through earlier community co-design). This involved concepts such as providing space for community activities, planting wildflowers, creating edible SuDS, helping wildlife, providing education and offering children's play spaces.

The second strand involved Viridian scoring each of the 12 sites for flood-related ‘needs’ both within the site and in the surrounding area; as well as the opportunity each site offered for creating effective SuDS. Figure 6 below shows an example of the scoring, which was qualitative and subjective.

Location J

1. There are no properties downflow from the site. Score 0.
2. Durham Road is downflow from site and known to flood. Site itself has flood risk. Score 4.
3. Major flows from a substantial area flow onto and across the site. Score 5.
4. Surface water sewers draining a fairly small area cross or border the site, so simple to capture. Score 3.
5. There are some lower priority locations across the site. score 2.
6. There is plenty of space for SuDS. Score 5.

Needs score: 4
Opportunity score: 15

Figure 6: Example of the scoring logic for one of the 12 short-list sites.

The needs were divided into four aspects that could each score between 0 (no occurrence) and 5 (high occurrence). These comprised the number of properties downflow of the site that are at risk of flooding; flood risk on the site; degree of overland flow crossing the site; and surface water drainage that could be diverted onto the site.

The opportunities comprised the presence of high-priority SuDS locations from HydroloGIS; and the amount of space on the site where SuDS could sensibly be created. These also scored between 0 and 5.

The final four sites were chosen by blending the community and hydrology scores together to find those that best met community aspirations whilst also reducing flooding.

5. Insights

The SuDS+ process involves many aspects that are of interest to other approaches, with its uniqueness due largely to the focus, extent and blend of such aspects. Our relevant, mid-project observations are divided below into the challenges we have faced and the opportunities we have identified.

5.1 Challenges

The SuDS+ process has not been simple. We have had to experiment, adapt and iteratively improve our processes along the way and there are still several challenges yet to conquer.

1. The engagement process took a major investment in time and needed a high level of skill to implement effectively. The return rates were often lower than we might hope, although we found that piggy-backing on existing community events improved outcomes. Achieving satisfactory attendance at SuDS+ events took a substantial degree of carefully devised promotion online, across social and traditional media, and direct to local households. This may be due in part to Stanley having a high degree of deprivation, but will be ubiquitous to some degree. Every community is different, so the process needs to be flexible and adaptable for future iterations.

2. The engagement and co-creation process could duplicate the work of other initiatives, such as town master-planning. This could waste time and resources, as well as lead to stakeholder fatigue. The SuDS+ process should expand beyond such existing consultations into full co-creation, but learning from them can reduce both initial research and foundational engagement to prepare stakeholders for co-design.

3. Many professional stakeholder will be working in silos. It can be challenging to get different directorates or service areas working together in a field that is not their focus. The message that SuDS+ can intersect and influence all of their projects will often take energy and ingenuity to get across. In Stanley, many council departments we spoke to initially said that they had no expertise in drainage and could not help/be helped by flood projects. This took longer to resolve in Stanley than we initially thought and this should not be underestimated in future iterations.

4. Part of the SuDS+ process is to educate external professions about its multiple benefits such as improved sense of place. Communication needs to use each department's individual lens to show that they can help and be helped. Such education is difficult and time consuming, but everyone involved 'wins' once it is accomplished .

5. There can be timing constraints during the design phase that are difficult to foresee. These can be very varied depending on individual stakeholder groups, but can include different deadlines for funding bids, regulatory cycles, school calendar, seasonal planting limits and business compliance delays. It is worth taking time and resource to map potential blockers or dependencies early in the SuDS+ process.

6. Incorporating hydrology into engagement and co-design processes can be challenging with any stakeholders that do not have former experience. Scale is a part of this: people can understand how property-level actions can helping themselves or neighbours, but it is harder for them to visualise how actions in one part of the town will benefits houses in a completely different one.

This was largely obviated by our approach in Stanley that considered flood reduction as a foundation upon which the co-designs were built. This allowed the flood benefits to be considered separately by specialists and later blended with the community priorities.

7. Funding can come from many sources, from altruistic pots and community benefit funds (e.g. landfill tax) through to local authority maintenance contracts. Some of these can only be accessed for certain community-based entities, so the governance structures should be considered carefully before setting up any new organisations or appointing existing ones to 'own' SuDS+ in their area.

8. The ownership of land to host SuDS+ features is vital. In Stanley South there is a high degree of ownership by Durham County Council, so we targeted all SuDS+ features to council land. This was not a simple process, as different departments were responsible for different parcels and had to be approached independently. This resulting in similar conversations being held multiple times (see point 3 above).

9. Trying to measure and monitor non-physical benefits is difficult. For instance, how can we best monitor the health benefits and wellbeing from dog walking down a nature trail rather than simply around amenity grassland?

5.2 Benefits

The opportunities of the SuDS+ approach are great. We hope to create a template or toolbox that empowers local organisations or even individuals to take the reins and drive SUDS+ projects forward within their own communities. This would enable many more community-improvement projects across the UK, embedding climate resilience and flood reduction along the way.

SuDS+ projects are likely to offer some or all of the following benefits:

1. Improved longevity of projects, as they will be founded on sustainable financing principles rather than fixed-term funds that expire and risk degradation of installed features. Community 'ownership' and multiple benefit delivery will strengthen local bonds with SuDS+ infrastructure, again increasing the likelihood of sustaining and even adapting that infrastructure into the far future.

2. The infrastructure installed will truly be wanted by their community and will deliver real, relevant benefits.

3. More meaningful community engagement and participation, especially when projects are initiated and run by local organisations. This reduces distrust in comparison with projects that superficially engage or consult with residents.

4. Combined strategies and reduced duplication due to cross-sectoral working. This will help the delivery of multi-sector, integrated solutions that are informed or guided by citizens. In Stanley, many organisations appreciated our long list of 383 ideas as they had insufficient funding to complete similar work themselves. Collaboration offered useful information to a wide audience and gave SuDS+ the benefit of their knowledge to extend modelling and residents' replies. Collaborator examples included highways inspectors, Clean and Green operatives and grass cutters.

5. Raising awareness of flooding issues and potential solutions within the community.
6. Flood resilience and overall urban resilience will become more closely aligned for countering biophysical (such as heatwaves) and cultural (such as community fragmentation) pressures.
7. The SuDS+ resources such as templates and guides will offer a flexible, adaptable and scalable process applicable to non-professionals. This will help democratise access to its benefits.
8. Lifestyles and life outcomes will be imporved by channelling money into communities. Training people with green skills can improve job prospects and using local maintenance contractors can directly crate local jobs.
9. Helping community organisations or local groups to lead SuDS+ projects can unlock funding from sources that standard flood approaches cannot, such as the Landfill Communities' Fund. This can blend with more standard elements such as greenspace maintenance payments or nature trading to make SuDS+ financially viable in the long term.
10. Using the '+' element as the main driver can release smaller parcels of land for mini-developments that would not normally be considered for SuDS schemes. These can contribute in a small way to flood reduction while making a big impact to residents. This process could be used in reverse to add flood resilience to external developments and infrastructure projects.
11. Working with and for the community brings local knowledge and insight to the project beyond those recorded officially. For instance, areas of land that are permanently wet, locations with persistent anti-social behaviour, and more practical scheme designs.

A1. Ecohydrology Optimisation Modelling

Water-flow ecosystem services need to be understood in the context of the entire landscape, the flows of water across that landscape and the distance between solutions and beneficiaries. HydroloGIS is a hybrid, ecohydrological model that accomplishes this by characterising the landscape in terms of target problems: flooding, drought (improved resource), erosion/siltation and diffuse pollution.

HydroloGIS works by iteratively varying the land use of each pixel and calculating the change in the quantity of the target problem reaching the end of the flow network. This allows it to assign a number to each pixel for how much impact it can have on target problems. It also specifies the broad type of NbS that should be created there to realise this degree of impact.

The numbers are normalised and relative, but their scale has meaning. It can therefore rank all potential NbS locations for how effective they will be. It could also, for instance, specify the most effective 1% or 50ha of all potential NbS options; or show where to avoid investing in NbS as they will not deliver appreciable benefit.

HydroloGIS usually has a resolution of between 1m and 30m. The former is appropriate for studies up to 50km^2 in extent and is best for urban areas; the latter can model areas up to 20,000km^2.

The system uses LiDAR Digital Terrain Model and various open-source data as standard inputs. The latter include numerous land use and land cover datasets, weather, soil, rivers and catchment boundaries. We can compliment these with any appropriate local data to improve accuracy or relevance.

HydroloGIS has some exclusions hardwired, such as planting trees on peatland, but specific local constraints and 'needs' can be modelled separately and added to HydroloGIS.

The outputs are data layers, maps, tables and graphics showing current, relative landscape function across the study area and prioritised solutions that most improve the provision of water-flow service. These are described in more detail below

A1.1 Baseline Landscape Function

This is the current, relative function of the landscape. Each pixel is ranked for how well it is currently functioning to keep flood waters out of the streams, reduce diffuse pollution and reduce erosion/siltation. This assesses entire flow paths and connectivity, as well as individual characteristics of each pixel across the entire catchment.

Figure 7 to the right shows results for flooding; similar outputs are created for soil-adsorbed pollutants (such as phosphates), soluble pollutants (such as nitrates), erosion/siltation, and all services combined. The dark areas on the map show a high degree of current service provision, the pale areas a low provision.

The dark areas can be prioritised for conservation so that their level of service provision is not degraded.

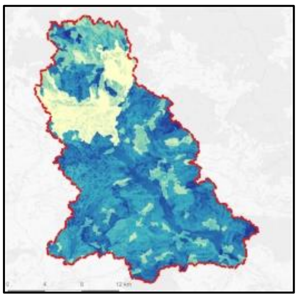

Figure 7: Baseline level of service provision.

A1.2 Prioritised Catchment Solutions

These are the ranked or prioritised solutions for the study area, considering the broad NbS type of planting trees, reversion to semi-natural grassland and water retention features (rewetting peat, leaky dams, wetlands, bunds and the like). Each pixel is ranked for how much impact if will have on local problems, if the habitat on that pixel is optimised.

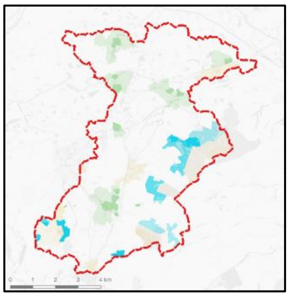

Figure 8: Ranked NbS to solve multiple problems.

Figure 8 to the right shows the ranked solutions that will simultaneously reduce flooding, diffuse pollution and siltation. The green is for woodland, orange grassland and blue wetland. The darkest shades represent the most effective 2% of options and the palest shades the 10-20% options range.

The flood layer works by keeping bulk water volumes within the landscape for longer. This can therefore be repurposed for improving water resource supplies with some additional modelling steps, such as including aquifer characteristics.

A1.3 Flow Accumulation Network

The hydrological aspect of HydroloGIS identifies where water flows over the surface of the landscape. The magnitude of water flowing across each pixel is calculated and concatenated to form the flow accumulation network. This is useful for identifying where most water naturally crosses the landscape and so where features such as ponds will intercept good volumes.

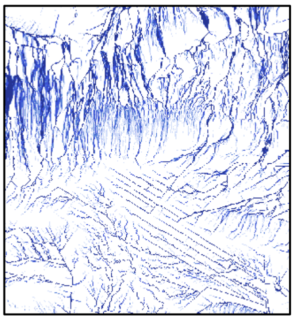

Figure 9: Land drains and overland flows.

Figure 9 to the right shows a flow accumulation extract, with the darker blue denoting higher degrees of flow.

A1.4 Natural Depressions

The landscape contains depressions and areas of flat ground, which can confuse hydrological algorithms as they assume water always flows downhill. This can be overcome by ‘filling’ the DTM: the depressions and flat areas are altered so that they have a very shallow gradient in the direction of the neighbouring flows.

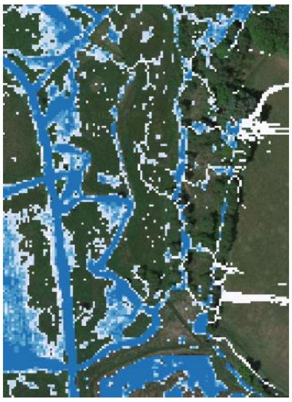

Figure 10: Ghost channels east of a straightened stream.

The filling method captures the depth of each depression, so understands just how much water could accumulate there during heavy rains before being able to flow out again. This gives an idea of the depth of rainfall flooding that could be experienced in that location, or how much water could be captured in a pond.

Depressions close to streams can be well deployed for leaky dam and flood plain works. Combining them with the flow network can be powerful at identifying ghost ponds, palaeochannels and former oxbows.