Climate Change Adaptation in Africa, Asia, and Europe with the Citizen Science Climate Scan Platform Promoting Nature-Based Solutions

Floris Boogaard

Contents

Abstract

There is a clear demand for a collaborative knowledge-sharing by online climate adaptation platforms that contribute to (inter)national knowledge exchange and raising awareness about climate change. Climate adaptation platforms (CAPs) can contain decision-support tools to facilitate the process of decision-making, and may include capacity building, networking, dissemination to assist planning and implementation of proven adaptation concepts such as Nature-based solutions (NBS) to mitigate floodings, drought, and heat stress. From 2014 over 6000

F. Boogaard (✉)
Department Research Centre for Built Environment NoorderRuimte, Hanze University of Applied Sciences Groningen, Groningen, The Netherlands

Deltares, Utrecht, The Netherlands

Global Center on Adaptation, Energy Academy Europe, Groningen, The Netherlands
e-mail: floris@noorderruimte.nl

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global climate adaptation projects have been mapped on an open source platform ClimateScan using citizen science. This chapter describes the potential of this climate adaption platform by illustrated case studies with mapped climate adaptation measures in Africa, Asia, and Europe. The case studies illustrate engagement and tangible results related to online platforms such as: the period of relevance of ClimateScan, inclusiveness and engagement of users in different stages and continents. Workshops in Indonesia illustrate the need for validation of needs from potential users before implementing CAPs. Analyzing projects in Africa showcase best management practices in water conservation and water demand management that are of interest in many other regions in the world facing drought. In Europe detailed analysis of over 3000 climate adaptation measures in relation to neighborhood typologies is inspiring urban planners and stormwater managers to design, plan, and implement climate resilient measures with more confidence. These three global examples illustrate that mapping, promoting, and sharing knowledge about implemented proven concepts is raising awareness, contribute to community-building, and accelerate climate action around the world.

Keywords

Climate adaptation platforms (CAPs) · Nature-based solutions (NBS) · ClimateScan · Mapping · Sustainable drainage systems (SuDS) · Citizen science

Introduction

Climate change and urbanization effect the water balance in our cities, resulting in challenges such as flooding, droughts, and heat stress (IPCC 2019; GCA 2019). For this reason, climate adaptation measures such as nature-based solutions (NBS) are promoted under various names such as Best Management Practises (BMP), green infrastructure (GI), water sensitive urban design (WSUD), sustainable drainage systems (SuDS), low impact development (LID), and ecosystem-based adaptation (EbA) (Fletcher et al. 2014). The benefits of these measures include strengthening local capacity and information to better incorporate climate risks in the planning process, harnessing the power of nature (nature-based solutions) to respond to flooding, drought, and heat stress. This can be utilized by using community knowledge to improve the living conditions of vulnerable communities, and increasing the volume of climate-resilient investments to capture value from adaptation benefits (GCA 2019).

(Benefits of) Nature Based Solutions

Urban areas are constantly expanding, and green areas are decreasing significantly making cities more vulnerable to climate change. Urban green and blue spaces have the potential to counteract pressures arising from loss and degradation of natural areas and loss of ecosystem functionality and human well-being in cities. To increase the resilience of cities to climate change collaborative knowledge-sharing on climate adaptation measures are needed. There is a demand for proven concepts that prevent flooding by creating more space for water. Greening cities can provide a number of environmental and cultural benefits while contributing to climate change adaptation (Kabisch et al. 2016). The world could benefit from knowledge exchange on nature-based solutions (NBS) that allow infiltration of stormwater to restore groundwater levels to mitigate drought and minimize extreme temperatures in the urban dense areas.

Implementing nature-based solutions (NBS) comprises solutions inspired and supported by nature, which provide multiple benefits and help society to adapt to climate change (Nesshöver et al. 2017; Raymond et al. 2017). NBS implementation can increase the vegetation coverage and green areas that are decreasing significantly in cities (Liu et al. 2014), and will increase the perviousness rate in different urban areas to increase the infiltration of rainwater. NBS can simplify implementation actions in urban landscapes by making use of different services provided by nature. For this, small-scale climate adaptation measures are being promoted, which provide multiple benefits and help society to adapt to climate change (Majidi et al. 2019).

Examples of these NBS includes raingardens, bio swales, permeable pavement, green roofs, and green walls. Allocation of natural habitat space in floodplains can minimize the impacts of flood events or architectural solutions for buildings such as green roofs and wall installations to reduce heat stress. By integrating NBS in urban landscapes, multiple benefits are being recognized especially on determinants of human health and well-being (Goddard et al. 2010).

The implementation of small-scale Nature-Based Solutions (NBS) or Sustainable Drainage Systems (SuDS) can help to restore the water balance by capturing, retaining, treating, and infiltrating stormwater that runs off roofs and impermeable surfaces and potentially into the subsurface (Prudencio and Null 2018). NBS will contribute to minimizing flooding, restoring groundwater levels, increasing soil moisture to alleviate drought impacts, protect cultural heritage, and lowering temperatures by evapotranspiration to mitigate heat stress (Majidi et al. 2019; De Beer and Boogaard 2017). However, the multiple benefits of NBS regarding mitigating flooding, drought, and heat stress are often unknown to the wider public.

While advocacy for NBS in scientific literature is on the rise, implementation in practice is often hampered (Kabisch et al. 2016). NBS have the reputation to be very costly and the multiple benefits of NBS are not well-understood and difficult to quantify (Nesshöver et al. 2017). Moreover, many NBS require the involvement and enthusiasm of a multitude of stakeholders (Restemeyer and Boogaard 2021). This is particularly true for implementing small-scale NBS in the urban (densely populated) public space. For a resilience of the city, NBS need also to be implemented on private land, requiring non-governmental actors such as individual house owners, housing corporations, and property owners of business parks to take action.

To build momentum and foster implementation of NBS, Kabisch et al. (2016) have pointed out that it is important to “learn from action that is already taking place," and share existing approaches and experiences among different countries. Everywhere in the world, stakeholders are experimenting with NBS and climate adaptation. However, many of these experiments are on such a small-scale that they do not reach beyond their regional boundaries. International knowledge exchange should be stimulated among borders and stakeholders.

Climate Adaptation Platforms (CAPs)

An online platform could be an ideal tool to increase international knowledge exchange and raise awareness, with the ultimate goal that good examples of affordable and well-functioning NBS can help actors in other regions of the world to move forward in the implementation process. Especially during the current covid-19 pandemic, we have all come to realize the importance and the opportunities of being connected through the Internet. The Internet offers the advantage that it is accessible to anyone (with an internet connection) at any time (Palutikof et al. 2019a; Uitermark 2015). This means that an online platform could potentially reach a multitude of stakeholders: those that already have a say in climate adaptation and water governance, and those who were not involved thus far. Web-based climate change adaptation knowledge and community-building platforms provide a vital means to enable international knowledge sharing; sharing information, evidence, and guidance, and showcasing adaptation solutions to accelerate their uptake on a wider context.

The term "online knowledge adaptation platform" or "web-based knowledge portals" refers to a comprehensive resource with various data, tools, guidance, and information needed to adapt to a changing climate that can be used by various stakeholders such as for decision-makers (Palutikof et al. 2019b). Adaptation platforms can contain decision-support tools to facilitate the process of decision-making, and may include capacity building, networking, dissemination, and other components to assist adaptation planning and implementation. Depending on the specific scope of each platform (political mandate, target audience, sector focus, funding model, etc.), they can have prominent or minor roles in the whole process, ranging from the provision of an overarching climate adaptation strategies (such as drought, flooding, and heat,stress) to the contribution of specific input in the implementation of practical actions (e.g., with inspiring case study examples). Similarly, depending on the above features and their main aims, these web portals contribute to different extents to sharing exemplary and/or innovative insights in climate adaptation (EEA 2021).

There are many platforms around the world (see Fig. 1), such as the European platforms as Climate-ADAPT, weADAPT, NATURVATION Urban Nature Atlas, OPPLA, BISE, DRMKC, Natural Hazards NBS, NBS Initiative, NWRM, PANORAMA, ThinkNatureand, and ClimateScan (EEA 2021). The platforms have different scopes, for example: policy relevance/mandate; target audience/profile; geographical coverage and governance level; content focus; functionalities and other features.

The platforms (Fig. 1) were evaluated during the second International Climate Change Adaptation Platform Meeting in in Dublin, Ireland, on the 10th and 11th of October 2019 (WeAdapt 2020). The meeting "Bridging the Gap between User Requirements and Climate Adaptation Services" focused on Climate Adaptation Platforms (CAPs) supporting decision-making for climate change adaptation and an exploration of the co-benefits of these approaches for service providers and users. The workshop set out to develop an understanding of best practice in user engagement and capacity building, to gather and distil lessons learned and suggest future directions. Therefor key challenges were identified by the participating adaptation service providers in engaging users:

- Defining Adaptation Platforms in an understandable manner for the users with a common language, datasets, and interoperability.
- (changing) Landscape of climate change adaptation and adaptation of CAPs itself.
- Continuous co-design, co-development, and co-production with evolving requirements of users and their engagement.
- Maintaining users and user interest – during the development of the platform.
- (method of) Measuring the value of adaptation platforms/evaluation.
- Resources, continuity, and evolution.

Some of the initial findings to address these challenges in this workshop are (WeAdapt 2020):

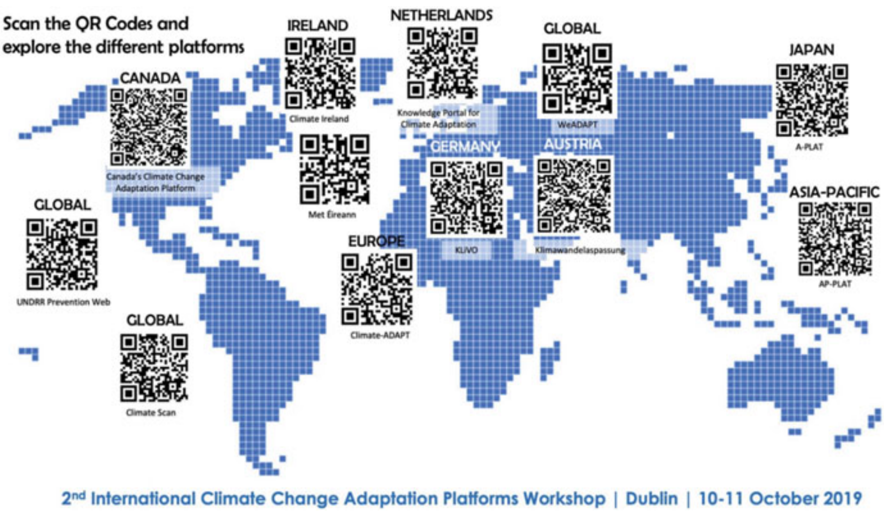


Fig. 1 Global Climate Change Adaptation Platforms as presentented during second international climate change adaptation platform workshop in Dublin October 2019 (WeAdapt 2020)

- CAPs should adopt a wide range of user engagement approaches with the primary aim to ensure that information contained is relevant to its users.
- Embrace co-design, co-development, and co-evaluation approaches to ensure platforms stay user focused with continuous engagement.
- When users requirements are considered, it is essential that CAPs are tailored according to the specific needs of individual user groups.

To conclude, involvement and engagement of the platforms is essential for maintaining the user interest or recruitment of new users. One way of supporting this is by the means of citizen science, where users themselves are responsible for the content of the platform. ClimateScan is one of the discussed CAPs during the second international climate change adaptation platform workshop in Dublin October 2019 (WeAdapt 2020) that has adopted a "bottom-up" approach in which users have much freedom to create and update content. Within 6 years, this has resulted in an illustrated map with over 6000 NBS projects around the globe and an average of more than 100 visitors a day. This chapter illustrates this open source global platform with a focus on implemented climate actions uploaded by the means of citizen science in Asia, Africa and Europe.

ClimateScan

As presented in Fig. 1 climate adaptation platforms are available for several regions or countries around the world offering information to different target groups. Climatescan, a web-based international knowledge exchange tool on urban resilience, is a citizen science tool created through "learning by doing." After implementation around 2014, the climatescan platform is in continuous development as more data is uploaded, and improvements are made to respond to feedback from users (Tipping et al. 2015). In the early stage of Climatescan, the tool was evaluated by semi-structured interviews in the Climatescan community with the following result: stakeholders demand tools that are interactive, open source, and provide more detailed information (location, free photo and film material). Most stakeholders would like to have tools that are (top 5):

1. Interactive
2. Open source
3. Provide detailed information (location, free photo, and film material)
4. Link to scientific research outcomes for that specific location
5. Local and international examples

In 2021, Climatescan has grown into an interactive web-based map application for international knowledge exchange on 'blue-green' projects around the globe. It is adapted as a "solutions-broker," a role which will help in mobilizing action in the field of climate adaptation and creating a network of collaborators and providing these collaborators with a resource for assistance in their efforts towards achieving resilience. Its existing widespread user base and diverse portfolio of adaptation projects/solutions is a widely used support tool for Climate Adaptation.

One of the biggest Unique Selling Point of ClimateScan scan has been its open-source platform which allowed users to record and map climate adaptation solutions themselves by the means of citizen science. Unlike its contemporaries (other knowledge dissemination platforms), ClimateScan is global in its approach and scope allowing international knowledge exchange on (small scale) already implemented climate actions of any category. Other platforms are either restricted in their geographical scope or have a singular focus on one kind of adaptation solution. The diversity in topics and its global outreach has enabled it garner a widespread user base, becoming particularly popular among young practitioners and academicians (Restemeyer and Boogaard 2021).

The global platform can be used as a first step to collect data by the means of citizen science and share the knowledge on realized climate adaption measures of that region compared to other parts of the world. Climatescan focuses mainly on the topics surrounding the areas of urban resilience, climate proofing, and climate adaptation. The main objective of the interactive international open access platform is knowledge exchange on climate adaptation projects through the platform itself and the connected social media channels as twitter, Instagram, and facebook.

Climate scan collects climate adaptation locations from all over the world and classifies adaptation solutions into different categories. Currently, all the data points are categorized into seven subgroups (Water, People, Nature, Heat, Energy, Urban Agriculture, and Air quality) holding over 20 categories, which are each assigned a different color as shown in the legend to the left of the webpage (Fig. 2). The first set up of subgroups or themes are originated by the biggest challenges in (North East) of The Netherlands (Climate-initiative 2020) where the ClimateScan platform has its origin.

Users of ClimateScan can create their own climate adaptation categories and upload projects. Most of the uploaded projects belong to categories related to Nature-Based Solutions (NBS), Sustainable urban Drainage Systems (SuDS), and

Fig. 2 ClimateScan platform with around 6000 projects around the world (left) and app for uploads of climate adaptation projects (right)

Best Management Practices (BMP) that are designed to reduce the rate and quantity of surface water runoff from developed areas and to improve runoff water quality. Most uploads relate to nature-based solution approaches: EA/EbAp Ecosystem Approach/Ecosystem-based Approaches, GI/BGI Green Infrastructure and Blue-Green Infrastructure, EbM Ecosystem-based Management, SFM Sustainable Forest Management, SM Sustainable Management, NWRM Natural Water Retention Measure and Eco-DRR Ecosystem-based Disaster Risk Reduction (EEA 2021). Uploads on ClimateScan include: constructed wetlands, swales, green roofs, permeable pavements, rainwater gardens, and floating structures on public and private property (see Table 1 for definitions and examples). Along with uploading implemented climate adaptation measures also “problem areas” or “climate adaptation opportunities” are mapped with photos and videos of flooding at that specific point, where solutions can be implemented.

Due to the method of citizen science and increasing number of users, the platform is under constant changes. The current status of the climatescan has over 1000 registered users that (can) upload projects around the world. More than 60% of the users are younger than 34 and 51% of users are female (Boogaard et al. 2018). With over 6000 uploaded projects, the platform is considered to be the biggest inventories of “blue-green” projects around the globe for international knowledge exchange.

Due to the method of citizen science, the platform can raise awareness and builds capacity (Wamsler and Raggers 2018) and with an increasing number of users and categories the platform is under constant change. As mentioned, ClimateScan is a “learning by doing” platform and is depending on enthusiastic registered users uploading projects and categories. Some projects only have a location with short description, the basis of analyzing these points (see illustrated case study Europe). Citizen science does require quality control that now is being done by a dozen volunteers that have required administration rights and check and adjust new projects and categories out of their own interest and share their views on the development of ClimateScan.

The tool is developed with support from several international projects (such as WaterCoG, IMPETUS) serving the need of different stakeholders creating maps on climate resillence in different regions of the world. ClimateScan is used in several international knowledge exchange activities as ClimateCafes and climate adaptation workshops serving the needs of different people participating in those workshops (Boogaard et al. 2017).

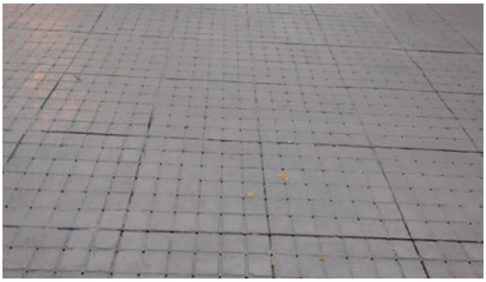
The platform is applied in international city ClimateCafés (climatecafe.nl) targeting young professionals who were very helpful with uploading several projects around the world as South America, Africa, Europe, and Asia (Boogaard and de Jong 2020) and the platform will be used in various new projects and ClimateCafés in the near future.

Table 1 ClimateScan categories with definitions

Category	Definition	Example
Swale	A shallow vegetated channel designed to conduct and retain water, but may also permit infiltration. The vegetation filters particulate matter. Example (picture to the right): Swales at Jakarta airport, more infio: https://www.climatescan.org/projects/973/detail	
Constructed wetland	Wetland: Flooded area in which the water is shallow enough to enable the growth of bottom-rooted plants. Wetlands are constructed in urban areas to store water after stormwater events and improve waterquality. Example: Parcul natural vacaresti, bucharest Roemenia (183 hectare) https://climatescan.org/projects/828/detail	
Green roofs	A roof with plants growing on its surface, which contributes to local biodiversity. The vegetated surface provides a degree of retention, attenuation and treatment of rainwater, and promotes evapotranspiration. Example: Scandinavian green roof institute Malmo, Sweden https://climatescan.org/projects/3238/detail	

(continued)

Table 1 (continued)

Category	Definition	Example
Floating urbanization	Floating or amfibious constructions as floating homes will adapt to variation of waterlevels (flooding, drought). Floating homes are constructed around the world to adapt to climate adaptation. Example: Floating Library in Semarang, Indonesia https://climatescan.org/projects/2140/detail	
Permeable pavement	A permeable surface that is paved and drains through voids between solid parts of the pavement. A permeable is a surface that is formed of material that is itself impervious to water but, by virtue of voids formed through the surface, allows infiltration of water. Example: Permeable pavement at sustainable building in Tainan, Taiwan https://climatescan.org/projects/222/detail	
Hollow gully free roads	Roads that are constructed as drainge. An example is a surface flood pathway: Routes in which exceedance waterflows are conveyed on the ground. Also referred to as ‚hollow‘or ‚gullly free‘roads. Example: Gully free road in Nieuwleusen, The Netherlands https://climatescan.org/projects/1113/detail	

(continued)

Table 1 (continued)

Category	Definition	Example
Sub-surface infiltration	A sub-surface structure into which storm water is conveyed, designed to promote infiltration to restore groundwater levels. Example: Tegal infiltration pit or biopori infiltration at Java, Indonesia https://www.climatescan.org/projects/2350/detail	
Heatstress measures	An upcomming categorie linked to implementation of green and blue measures in previous categories (swales, green roofs and walls, raingardens etc.) implemented to cool down the city and mitigate heatstress. Example: Implementing green and creating shadow in Hue, Vietnam https://climatescan.org/projects/3765/detail	

ClimateCafe

ClimateCafé is a field education concept involving different fields of science and practice for capacity building in climate change adaptation. ClimateCafés focus on the education of young professionals and can thus be seen as a bridge between bottom-up (as ClimateScan) and top-down. This multidisciplinary approach highlights obstacles from several perspectives for a collective understanding of the challenges. These include areal planning, management, (lack of) regulations, technical design, (lack of) maintenance, pollution, water quantity and quality, ecosystem services, biodiversity, sustainability, and the improvement of life quality by mapping and implementing NBS in urbanized areas. By teaching young professionals to gather local knowledge and data within several disciplines connected to climate adaptation they become aware of multiple challenges that need to be addressed. The Climatecafe method was developed by Dutch Universities of Applied Sciences Groningen and Rotterdam to enable young professionals and practitioners to gather essential data in a short period of time (1–2 weeks) in order to assess the "level of resilience" of a specific district or city. The ClimateCafe method is applied more than 25 times all over the world and aims to use low-cost and low-tech tools and instruments such as ClimateScan that enables participants to map climate adaptation measures (Boogaard et al. 2020a). The aim of the ClimateCafés is to create awareness, connect practitioners, and generate data on adaptation measures. ClimateCafe must produce a tangible result such as an open source interactive map with NBS (Boogaard and de Jong 2020). During ClimateCafés, the current state of climate adaptation in a city is assessed and the collected data is placed on ClimateScan for international knowledge exchange. The relevance of ClimateScan is evaluated during ClimateCafe Malmo with the question of "if ClimateScan is of value to their daily practice and if they are inclined to use it in the future" which was answered with strongly agree (50%), between strongly agree and neutral (30%) and neutral (20%). None of the participants saw no value in ClimateScan for their work or study (Boogaard et al. 2020b).

In the next paragraphs, three international examples are given to illustrate the content of the ClimateScan platform used as a tool during the ClimateCafes (Table 2).

Note that concern related to online adaptation platforms refers to the actual users and the inclusivity of online adaptation platforms are addressed. Online platforms often tend to have an overrepresentation of researchers and the Global North (Hammill et al. 2013). ClimateScan certainly shows similar characteristics, with a dominance of uploaded projects from the Netherlands and Western Europe (Table 2) due to its origin and active promotion in the Netherlands or in European projects but is gaining engagement and leadership in continents as Asia and Africa being in different stages of CAP Climatescan as illustrated more in detail in the next paragraphs.

Asia: First mapping of climate adaptation measures requires basic knowledge on the challenges (described in introduction) and the solutions such as Nature based solutions. An example of such a ClimateScan workshop is described in the next paragraph 1: workshop in Java, Indonesia.

Africa: With basic knowledge of climate adaptation and working with the ClimateScan platform numerous projects can be mapped in a certain area such as South Africa. An example of the analysis of this data in Johannesburg is giving in paragraph 2.

Europe: When a high density of different measures available on the platform a more detailed analysis can be made on individual measures such as been conducted in The Netherlands (over 3000 projects), which is described in the last paragraph 3.

Asia: Indonesia

Several locations in the North of Central Java have experienced significant effects by climate change. Among these are Semarang City, Pekalongan City, Tegal City, Pekalongan Regency, and Demak Regency (Adi and Wahyudi 2018). Two major

Table 2 Overview characteristics of illustrated case studies in three continenets

	Asia	Africa	Europe
Stage of using CAP ClimateScan	Starting	Using and analyzing	Analyzing and decision support
Goal and action	Workshops on the relevance of platforms for potentials user and content	Evaluation of the use of the platform in Africa by analyzing uploaded NBS projects	Detailed analyses of projects and development decision support tools
Country	Indonesia	South Africa	The Netherlands
Focus region case study	Java, cities of Surababya and Semarang	Gauteng (includes Johannesburg) is the smallest province of South Africa and highly urbanized	The Netherlands, national study
Number of projects on climatescan (2020)	50	200	3000
Area (km^2)	Surabaya (350) and Semarang (374). Java total (128.297)	18000	42543
Inhabitants of targeted area in this study (million)	Surabaya (2.7) and Semarang (1.6) Java total (141)	15 South Africa: (58)	17
ClimateCafe and ClimateScan Results	Workshops on mapping climate adaptation measures with ClimateScan. Raising awareness on climate adaptation and relevance study on platforms and focus of content. Frrst uploads of projects on climatescan and publication	Climatecafe and workshop and presentations at international congress Adaptation future. Several uploaded Best Management Practices in Gauteng area and Capetown. Basic analysis of first mapped projects with ClimateScan Publications, guidelines and reports	Several ClimateCafes resulting in a high density of mapped projects of climatescan, high involvement, presentations, guidelines and reports Detailed analysis of status of climate adaptation measures and guidance for decision makers

problems linked to climate change are land subsidence and sea-level rise. To increase the resilience of cities to climate change, such as Semarang, there is a clear demand for collaborative knowledge-sharing on climate adaptation measures that prevent flooding by creating more room for water storage, greater infiltration of water to restore groundwater levels and reducing extreme temperatures (heat stress). Before implementing small-scale climate adaptation measures to increase the infiltration of rainwater and promote increased vegetation coverage combating the problem of

Akademisi Beri Kontribusi Pecahkan Banjir & Rob di Pantura

SEMARANG -Fakultas Teknik (FT) Unissula Semarang, telah melakukan kerjasama dengan sejumlah perguruan tinggi (PT) di luar negeri. "Termasuk dengan Hanze University of Applied Sciences, Groningen, Be landa," jelas profesor bidang ke-airan dari Fakultas Teknik (FT), Unissula, Prof Dr Ir S Imam Wahyudi DEA, Jumat (14/2).

Penandatangan kerjasama telah dilakukan tahun lalu. Dan salah satunya disetujuinya proposal yang lolos dari Erasmus Plus, untuk jalinan kerjasama dengan Hanze University of Applied Sciences Groningen tersebut, dengan pertukaran profesor dan mahasiswa antar kedua belah pihak.

"Tiga profesor dan empat mahasiswa dari sana akan datang ke Indonesia. Sedangkan dari FT Unissula, akan mengirim empat profesor dan empat mahasiswanya. Selain pertukaran mahasiswa dan profesor, juga dilakukan penelitian bersama," jelas Imam Wahyudi.

Dua profesor dari Hanze University of Applied Sciences Groningen, Belanda yakni Dr Ir FC Floris Boogaard dan JH Eric Boer MSc, hadir dalam simposium bertajuk Climate Adaptation and climate scan.

■ Penanganan Banjir

Boogaard mengatakan, penelitian yang dilakukan bersama meliputi bidang keairan, yakni penanganan banjir dan rob dan struktur konstruksi apung di sejumlah wilayah pantura, seperti Kota Semarang, Kota Pekalongan, Kabupaten Pekalongan, Kota Tegal dan Jepara.

Selain penanganan banjir dan rob, juga pemanfaatan air yang ada di wailayah tersebut. Misalnya, ada ide membuat pasar apung di daerah Kecamatan Tegalsari, Kota Tegal.

Eric Boer menambahkan, setelah melakukan pendataan, pemotretan dan pengumpulan data problematika, maka akan dicari penyelesaian penanganannya. Sebab, pengelolaan air bukan hanya banjir, tapi juga holistik, termasuk terkait penggunaan air.

"Kami akan mengunjungi lokasi permasalahan yang ada seperti tanggul, stasiun pompa, polder, parameter cuaca dan kondisi air pasang yang juga direkam dan dipublikasikan di web kami," timpal Boogaard. ■ *Skh-jie*

SIMPOSIUM: *Profesor dari Hanze University of Applied Sciences Groningen, Belanda jadi pemb dalam simposium bertajuk Climate Adaptation and climate scan di FT Unissula.* ■ **Foto: skh**

Fig. 3 Raising awareness with media coverage of ClimateScan workshop in Semerang

green area loss in the cities Semarang and Surabaya, workshops were held to get more information about NBS and the ClimateScan platform.

Two capacity building workshops were held on the 14th of February 2020 in Semarang and Surabaya to discuss NBS and climate adaptation. The workshops aimed at raising awareness regarding these topics, and evaluating the perception of the participants about the different measures. Media coverage was also present of national and local newspapers that helped raising awareness also outside the university walls (Fig. 3).

The workshops consisted of activities such as introductory presentations, mapping of climate adaptation methods on climatescan.org, and surveys to participants. The workshops were designed as knowledge sharing events, and the outcomes were linked to the UN Sustainable Development Goals, namely, SDG #13 Climate action, SDG#11 Sustainable Cities, and SDG#9 Industry, Innovation and Infrastructure (UN 2020), such as flood resilience by floating infrastructure.

The survey during workshops was distributed to 36 participants in Semarang and 31 in Surabaya and the responses were analyzed. The participants in Semarang where in the age of 18–45 years, of which 11% had an undergraduate level of education, and 89% had a postgraduate education level. Most of them live in Semarang and are currently studying at Sultan Agung Islamic University. The 31 participants in Surabaya were mostly students (26) working on their university degree and four were at master's degree level (Boogaard et al. 2020a).

Additionally, the participants were instructed to upload the locations of interest regarding climate adaptation themselves directly with the ClimateScan app. The mapping included a short description, the GPS location, the category of NBS and selected photographs. For some locations additional information, documents, and websites for further study were added later by the use of a desktop computer.

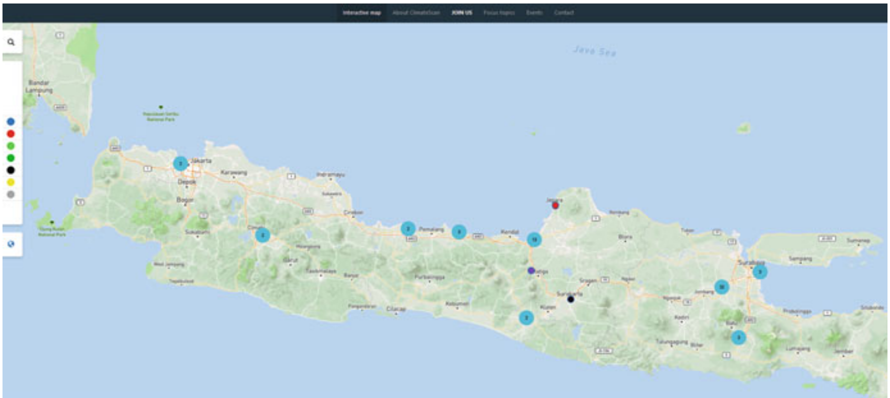


Fig. 4 ClimateScan for Java Indonesia after the workshop in Semarang: more than 50 projects mapped on the open-source nature-based solution platform

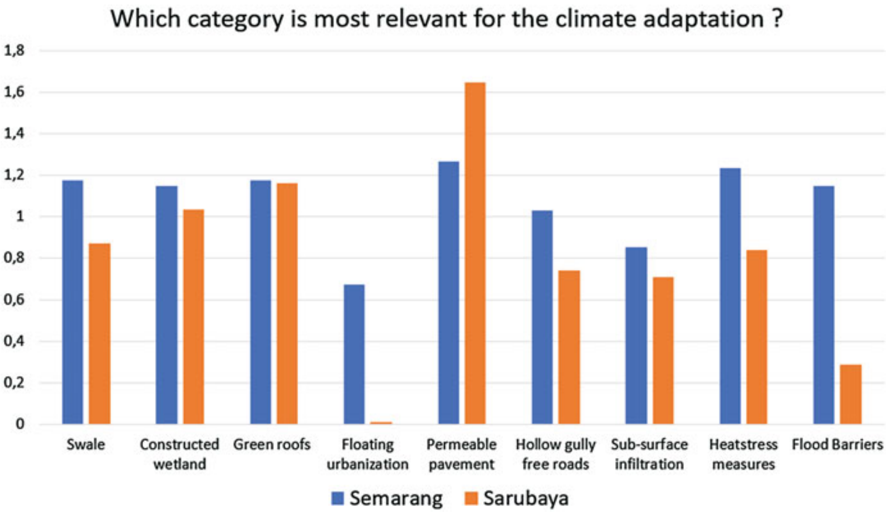


Fig. 5 Results from mapping of climate adaptation measures in Central Java

Results

This resulted in the mapping of over 100 locations where climate adaptation measures have been implemented in Java, Indonesia (Fig. 4). This mapping exercise showed the variety of climate adaptation methods that have been implemented on

Java such as: (bio) swales, floating infrastructure, permeable pavement, constructed wetlands, and retention ponds.

Highest scores of interest in specific climate adaptation measures in Semarang and Surabaya (Fig. 5) were acquired for the categories: permeable pavement and bio-swales, for infiltration of stormwater to groundwater and mitigation of high temperatures with heat stress measures and flood barriers to mitigate flooding. Floating urbanization received low scores in Semarang and Surabaya because of the culture of Indonesian people, who prefer to live on land instead of on the water. According to respondents, floating urbanization is synonymous with humid, dirty, wet conditions, mold on the walls, fuel residues from stoves, and disturbing marine ecosystems (Asrasal et al. 2018; Wahyudi et al. 2020). Building a floating house also requires a greater cost because it must be equipped with sewage and sanitation treatment systems so as not to pollute the sea or river (Adi et al. 2020).

The workshops raised awareness giving a value on using NBS to support climate adaptation (Fig. 6). Some participants preferred working with the ClimateScan app as opposed to the website that will be used in the field to map new projects. A high majority see the value of ClimateScan and intend using it in the future.

After presenting the categories on ClimateScan, the participants were asked if they knew other categories that could help Indonesia to become climate proof. Some of the answers are: “start a climate conservation, implementation of infiltration wells (for infiltration stormwater) and drainage under the paving roads (for flood protection)”. Important improvements raised in the survey on the ClimateScan are: quality control since the method of acquiring data is done by citizen science. For quality control a small commission of enthusiastic users is granted administration rights for the platform. This commission will review new projects on the description and locations of the new projects and will meet on regular basis to discuss uploaded projects and stimulate more projects being uploaded to the database in the future.

South Africa: Johannesburg

Climatescan had a relatively large number of uploads in (South) Africa due to international projects that are engaged with visualization and mapping of climate adaptation measures in the Gauteng Province in South Africa. Not surprisingly since climate change is a key concern within South Africa. Over the past five decades, the mean annual temperatures have increased by at least 1.5 times the observed global average of 0.65 °C and extreme rainfall events have increased in frequency. Both, the 2013 South African Long-Term Adaptation Scenarios and the Fifth Assessment Report of the IPCC have suggested that these changes are likely to continue. Climate change, therefore, poses a very potent threat to South Africa’s water resources, food security, health, infrastructure, and ecosystem and biodiversity (Ziervogel et al. 2014). In the recent years, however, the issue of climate adaptation has also gained some importance. In the South African context, the urgent need for social and economic development and to protect the ecosystem services has led to adaptive responses that can reduce vulnerability to current and future climate variability.

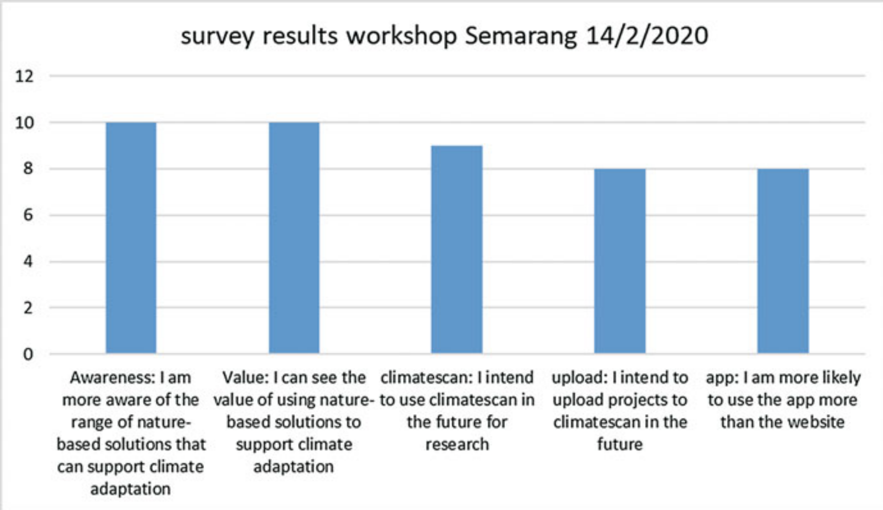


Fig. 6 Awareness giving a value on using NBS to support climate adaptation (Boogaard et al. 2020a)

South African cities face several challenges of rapid urbanization, rising populations, expanding informal settlements, and inadequate water supply. For instance, droughts experienced in cities like Cape Town and Windhoek have become for frequent, intense, and widespread, while variations in the inter annual rainfall have increase in the past half century. The South African cities due to these reasons face a multiple stressor context with several development challenges (Ndebele-Murisa et al. 2020). It has therefore become imperative for cities to respond to this swiftly and flexibly by developing systematic, systemic, sustainable, and resilient solutions to the climate crisis. These solutions can include physical planning responses such as hardening of infrastructure, including storm-drainage systems among others, and/or ecosystem-and community-based adaptation (Campbell 2016; Roberts et al. 2012).

The ClimateScan platform was presented and applied during the Adaptation Futures & WISA conferences, both held in June 2018 in Cape Town (Boogaard et al. 2018; Heikoop and Boogaard 2018). After the introduction of ClimateScan at these conferences, the tool was implemented by stakeholders from Cape Town, Durban, and Johannesburg. The first African projects were uploaded on ClimateScan in the field (during fieldtrips) using the ClimateScan app for uploading of several projects. New categories such as "water demand management" were created on a desk top computer. Participants of a Wetskills challenge and the workshops at the WISA and Adaptation Future conferences gave feedback on the ClimateScan platform, which resulted in some changes in the platform and a fast-growing number of projects being uploaded. The "learning by doing" concept raised legitimate questions of quality control, ownership, maintenance, business model, and sustainability.

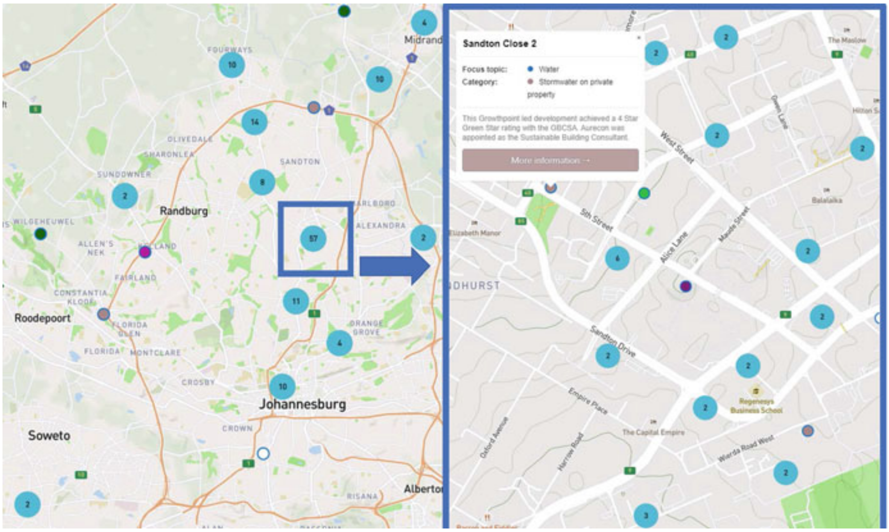


Fig. 7 Left: projects on ClimateScan in Johannesburg Africa (162 of 5000 projects around the world). Right: over high density of (water demand management) projects in the Sandton area uploaded on Climatescan.org

The recommendation of intensifying the interaction with stakeholders with social media channels was implemented in the months after.

ClimateScan has been used in the project "Research on the Use of Sustainable Urban Drainage Systems in Gauteng Province 2018–2019" (Dollie et al. 2019), resulting in around 100 projects mapped in South Africa related to climate adaptation (Fig. 7).

The 162 uploaded projects all have their own category and location. Some just have a short summary of what is of interest in the project, some uploads have pictures, movies, and links to websites and documents. In the next paragraph the uploads in Gauteng Province are analyzed as a first glimpse of what kind of climate adaptation measures are implemented in this region of South Africa.

Results

This orientating mapping analyses in Johannesburg area showed that many climate adaptation measures are available such as nature-based solutions (NBS): (bio) swales, permeable pavement, green roofs and walls, constructed wetlands, and retention ponds.

Water Demand Management was a category created by a user needed to upload 32% of the projects (Table 2 and Fig. 8). Water conservation, such as Rainwater harvesting or wastewater recycling have a high density in South Africa compared to other regions in the world due to problems with severe drought. The most uploaded climate adaptation projects within categories are listed in Table 3.

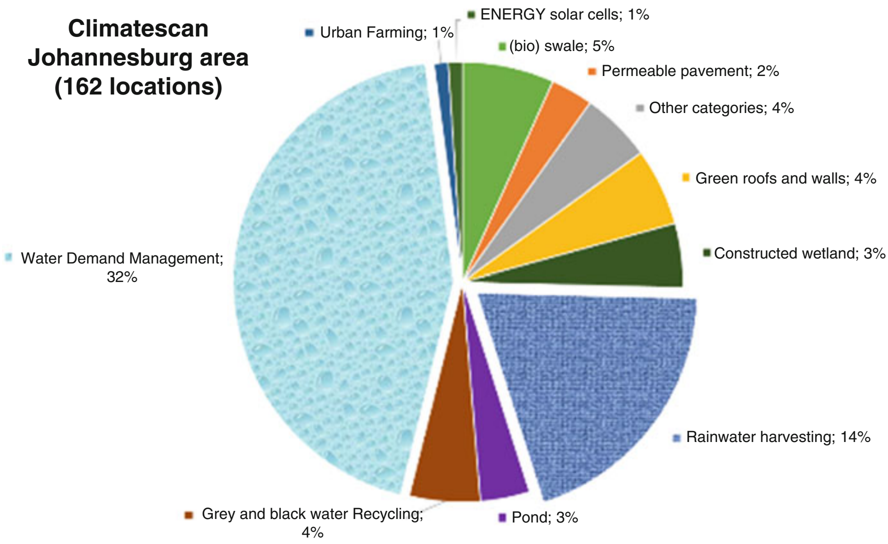


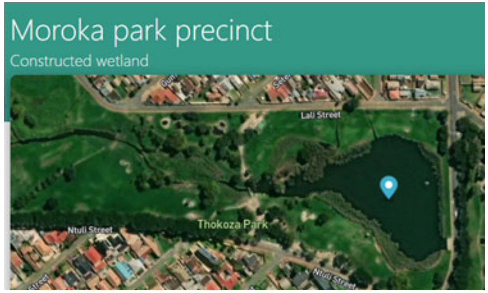
Fig. 8 Results of categorizing several projects mapped on climatescan in the Johannesburg region

One of the largest category "water demand management" was added to climatescan by an African registered user to map projects in Africa. It is a broad category with different definitions that needs background information or knowledge exchange since different interpretation of definition might affect the quality of data with citizen science. A workshop for a common understanding of challenges and definitions of solutions is therefore advised. The International Union for Conservation of Nature (IUCN) defined WDM in 2000 as: *a management approach that aims to conserve water by influencing demand. It involves the application of selective incentives to promote efficient and equitable use of water. WDM has the potential to increase water availability through more efficient allocation and use. This is guided by economic efficiency; equity and access; environmental protection and sustainable ecosystems functioning; governance based on maximum participation; responsibility and accountability and political acceptability* (IUCN 2000).

With the citizen science approach of climatescan, we cannot be sure if this definition was in the mind of the uploaders. Since this is a broad category, phrases added to the project are reviewed to catch the aim of the project and relate this to WDM. This category involves project decriptions as:

- To reduce water demand there are efficient water fittings installed on the taps, shower heads, WC's, and urinals.
- Water saving features include a rainwater harvesting system, infrared motion-controlled taps, and dual flush WC cisterns.
- Energy and water submeters inform screen displays of water and energy consumption to meter and manage consumption.
- Collecting and re-uses rainwater for toilet flushing and irrigation.

Table 3 Top 10 upload categories with examples in South Africa

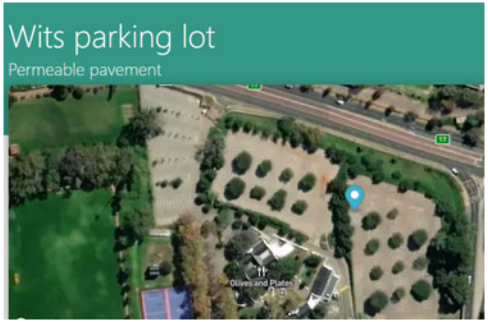
No	Category (n projects %)	Definition (Susdrain 2020)	Example South Africa Visual (source: climatescan.org)
1	(Bio) Swale 5%	A shallow vegetated channel designed to conduct and retain water but may also permit infiltration. The vegetation filters particulate matter	 Bioswale Woodmead Northern Office Park (photo: AquaLinks) https://www.climatescan.nl/projects/2513/detail
2	Constructed wetland 3%	Wetland: Flooded area in which the water is shallow enough to enable the growth of bottom-rooted plants. Wetlands are constructed in urban areas to store water after stormwater events and improve water quality Waterharmonica ecological engineering treating waste water into usable surface water. The Waterharmonica focuses on integrated ecological engineering processes, by optimizing multifunctional constructed wetland processes	 The wetland is constructed for the purpose of filtration, sediment trapping and flood attenuation. The project also includes three bioswales for the purpose of flood attenuation and ground infiltration as well as a silt trap for sediment build up https://www.climatescan.nl/projects/2878/detail

3	Rainwater harvesting (water conservation management) 14%	A system that collects rainwater from where it falls rather than allowing it to drain away. It includes water that is collected within the boundaries of a property, from roofs and surrounding surfaces	 Description: This is the first green star certified building in South Africa. The office design and as-built both achieved a 4 star GBCSA rating. The building has a blackwater treatment system and rainwater harvesting system installed for non-potable water uses such as toilet and urinal flushing, cooling towers and irrigation to the indigenous campus garden. Through the use of alternative water sources and the implementation of high-efficient fixtures and fittings, outflows to the sewerage system are reduced by 50% and up to 120kl of potable water is saved per day https://www.climatescan.nl/projects/4388/detail

(continued)

Table 3 (continued)

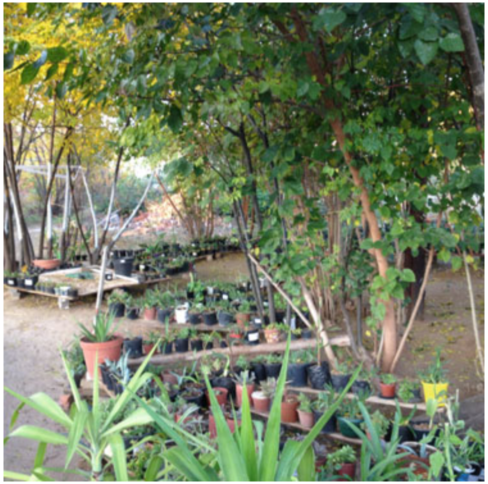
No	Category (n projects %)	Definition (Susdrain 2020)	Example South Africa Visual (source: climatescan.org)
4	Green roofs (and walls) 4%	A roof with plants growing on its surface. The vegetated surface provides a degree of retention, attenuation, and treatment of rainwater, contributes to local biodiversity and promotes evapotranspiration	 No description No text or links on climatescan Green Roof (source: Insite Group) https://www.climatescan.nl/projects/2915/detail

5	Permeable pavement 2%	A permeable surface that is paved and drains through voids between solid parts of the pavement. A permeable surface is made up of material that is itself impervious to water but, by virtue of voids formed in the surface, it allows infiltration of water to the sub-base through the pattern of voids	 Two under-utilized sports fields at the University of the Witwatersrand were converted into permeable paving parking lots. https://www.climatescan.nl/projects/2900/detail
6	Retention pond 3%	A pond where runoff is detained for a sufficient time to allow settlement and biological treatment of some pollutants	 Description: The ornamental pond in the golf course is gravity fed by rainwater collected on the site. The design also includes carefully shaped berms, swales and hollows that hold stormwater or direct it into the pond. The harvested water is used to irrigate the course and landscaping around the buildings on the site. Pond for harvested water storage (source: SALI) https://www.climatescan.nl/projects/2893/detail

(continued)

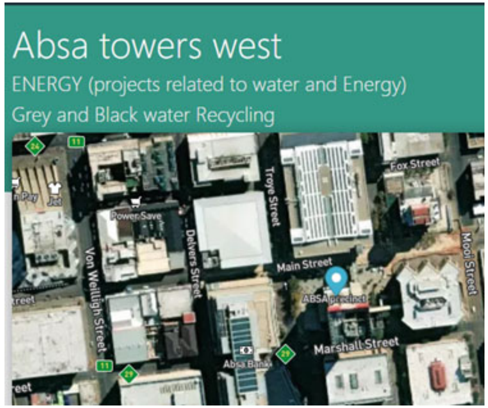
Table 3 (continued)

No	Category (n projects %)	Definition (Susdrain 2020)	Example South Africa Visual (source: climatescan.org)
7	Water demand management (WMD) 32%	WDM is a management approach that aims to conserve water by influencing demand. It involves the application of selective incentives to promote efficient and equitable use of water. WDM has the potential to increase water availability through more efficient allocation and use. This is guided by economic efficiency; equity and access; environmental protection and sustainable ecosystems functioning; governance based on maximum participation; responsibility and accountability and political acceptability (IUCN 2000)	 Description: The building achieves water savings through the use of water efficient fittings that limit the occupant water usage to 0.52 L/day/sq.m. Sub-metering of major water consumers is in place to gather information to understand and manage building systems and to assess opportunities for water savings. To further reduce potable water wastage, the building does not make use of a fire sprinkler system. Evaporative cooling towers that creates the risk of legionella disease is eliminated from the design of the building. The development is designed to minimize stormwater run-off and pollution of the natural watercourses. To further reduce water demand there is xeriscape landscaping https://www.climatescan.nl/projects/4424/detail

8	Urban farming 1%	Urban agriculture, urban farming, or urban gardening is the practice of cultivating, processing and distributing food in or around urban areas. Urban agriculture can also involve animal husbandry, aquaculture, agroforestry, urban beekeeping, and horticulture	 Description: An entrepreneurial spirit in Johannesburg has taken job creation in his own hand by starting a guerilla-gardening nursery along the road, next to a stormwater drain for watering. Sympathetic initiative (although some commercial nurseries in same neighborhood probably do not like it and it is officially forbidden.) This is a project uploaded by AquaLinks.co.za to make green infrastructure in Johannesburg more visible. Guerilla Gardening Entrepreneur Johannesburg (photo credit AquaLinks.co.za) https://www.climatescan.nl/projects/2515/detail

(continued)

Table 3 (continued)

No	Category (n projects %)	Definition (Susdrain 2020)	Example South Africa Visual (source: climatescan.org)
9	Energy 1% The Absa Tower is also an example for grey water recycling with 8%	Category showing projects with renewable energy such as solar and wind energy implementations in rural and urban areas	 Description: One of the largest office **grey water plants** in South Africa, with the capacity to recycle 45 cubic meters of grey water. The efficiency and power saving of the building are also enhanced with daylight and motion sensors https://www.climatescan.nl/projects/4395/detail

10	Combinations	Description	 The grey water from the handwash basins and kitchen basins is directed into a 20 sq.m constructed wetland located in the central courtyard. The natural purification of the water is achieved through the root action of the reed bed. This treated greywater together with harvested rainwater is used for flushing and irrigation. The wetland also attracts bird and insect life which enhances the biodiversity of the site. The site makes use of indigenous and endemic plants which require less water and are more robust against insects and disease. 70% of the site is covered in indigenous gardens which reduces the heat island effect associated with a tarmac parking lot. There are also underground detention tanks for the storage of water and a feature pond to enhance indoor amenity value https://www.climatescan.nl/projects/2904/detail

- The stormwater is managed with the aim of limiting the disruption of natural ecology, pollution, and site deterioration. Stormwater management plans to limit the disruption of natural hydrology, minimize pollution, and site deterioration.
- Black and greywater recycling facility to supply WC flushing and landscaping irrigation.
- To reduce potable water demand, the water saving features include a rainwater harvesting system, infrared motion-controlled taps, and dual flush WC cisterns.
- Landscape design makes use of drought resistant plant species and employ a water conserving drip irrigation system.
- To further reduce water demand there is xeriscape landscaping.
- Efficient sanitary ware for taps, shower heads, WC's and toilets/urinals are installed.
- Smart irrigation system that makes use of drip irrigation, moisture sensors and mulching are to save on potable water usage.
- Water uses are sub-metered and monitored via BMS to ensure that leaks are identified and mitigated, ensuring no water wastage.
- Grey water harvesting from the showers to flush toilets and urinals and for irrigation. A water benchmark for potable water consumption.
- Effective automated monitoring mechanism for water consumption data that is able to perform as a leak detection system. Water meters are provided for all major water uses to be effectively monitored.

As can be concluded from this summary, WDM is a broad spectrum with several small- and large-scale implementations meeting the definition of IUCN in 2000. With the projects checked in the categories we can count the number of projects assigned to the different categories (Fig. 8).

The percentages in Fig. 8 and Table 2 should be interpreted as "a first glimpse" or rough indication since it presents only what has been uploaded and should not be used as a representative distribution of climate adaptation measures implemented in this region. The content is depending on the citizen science of the registered users. The uploaders will have a certain interest or aim with mapping and might not always have the same definitions in mind. However, it does provide a valuable list of projects and categories in the area and therefore an interpretation of what is implemented and maybe could be promoted to increase the resilience to climate change in this region. When no data is available, this can be a good start to accelerate climate adaption in many regions around the world.

The data shows that multiple climate adaptation methods, and NBS in particular, are implemented in the area of Johannesburg such as: (bio) swales, permeable pavement, green roofs and walls, constructed wetlands, and retention ponds. All these 162 locations with measures divided in the 12 categories can be used for raising awareness and to promote implementation of NBS around the country. Water conservation and water demand management such as rainwater harvesting have a high density in South Africa due to problems with drought. Many countries around the world will face severe drought in the near future and can be inspired by the methods and measures taken in South Africa that are now easy to find on the open source platform ClimateScan. It seems that renewable energy was a known topic of the uploaders (1% of the uploaded projects) but not widely available in this region. Again, this inventory is not representative, but this observation seems in line with several reports and articles with titles as “Africa’s bumpy road to sustainable energy” (Mourdoukoutas 2017) on this topic.

The results of this inventory have been discussed with several stakeholders from international projects. So far this quick visualisation of proven implemented concepts has proven to be helpful for practitioners and decision makers (triple helix: private, public, and research institutes) in South Africa working with climate adaptation and is a particularly useful tool for (PhD) students and lecturers. Information on this is widely available in reports as “Gauteng launches sustainable drainage manual published 31 March 2020 by GCRO (Gauteng City-Region Observatory) with free available documents as: (GCRO 2020).”

1. Literature review on SUDS
2. Selection of three case study areas
3. Data collection
4. Analysis of study areas
5. Decision support tools
6. Best management practices
7. Implementation manual

These project outputs are a result of the Gauteng Department of Agriculture and Rural Development (GDARD) research into sustainable drainage systems (SUDS) technology options for Gauteng using ClimateScan as a database for SuDS and NBS.

Looking Forward: Living Labs and Climatecafes in Africa

As previous discussed, new ClimateCafés will be organized around the world in the near future using the ClimateScan platform (Boogaard and de Jong 2020). New international projects will map more projects on ClimateScan such as ‘Bridging the water’ which, as Climatecafe, also uses the living lab approach with South African and Dutch triple helix partners. A living lab is triple helix initiative that connects public, private and academic partners who apply their specific expertise in a specific sector real life challenges. The living labs are an instrument to facilitate bilateral cooperation and joint development of applied knowledge in close cooperation with industry and with human capital development at their core. The living lab method is being applied in this project that started in February 2019 and ends in 2021. The project “Bridging the water” is a collaboration of triple helix partners in The Netherlands and South Africa with the aim to address water challenges in relation to climate change in both Durban and Cape town. In these cities several projects have already been mapped on the climatescan platform (Fig. 9).

The project has set-up student centric research and research projects in partnership with the professional practice. Authentic workplace issues and real-life water

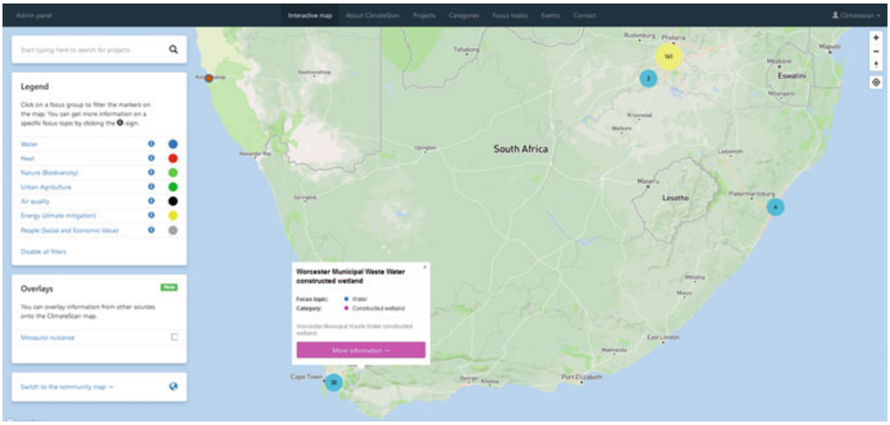


Fig. 9 "Popping up" African projects on climatescan uploaded in Capetown and Durban

challenges such as drought and waste water treatment in both cities are at the core of each living lab with the aim to narrow the gap between real life challenges and academic programs.

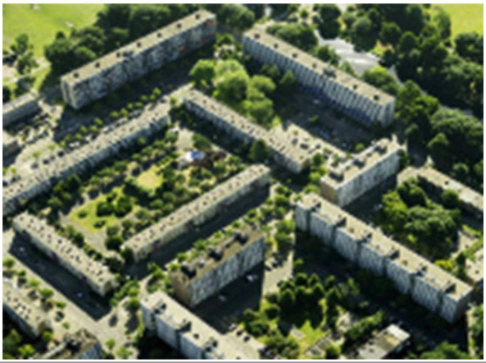
The "Bridging the water" project is just one example, more knowledge will be exchanged in new international projects on climate adaptation where mapping of BMPs will take place in the near future. ClimateScan and other Climate Change Adaptation Platforms can be a source of inspiration to stakeholders to make their cities more resilient to flooding, heat stress and drought.

EUROPE: The Netherlands

ClimateScan started in The Netherlands in 2014 which is one of the reasons for its high density of climate adaptation projects (over 3000). This high density of climate adaptation measures and their specific location enables more detailed analyses of the implementation of NBS. Urban planners and decision makers use adaptation platform with decision support tools (Palutikof et al. 2019a) and want to know where we can implement certain NBS and ClimateScan and neighborhood typologies can help to give this insight (Kluck and Boogaard 2021). Mapping, showing and analyzing multiple existing examples in practice where ordinary residential streets can be made climate resilient will help accelerating climate adaption convincing municipalities and water authorities to choose for a climate resilient design. Analyzing the "evidence based" existing examples should be presented in a way that stakeholders as urban planners can relate to the existing large amount of data. A relation of this data is made to neighborhood typologies making it easier to identify changes of climate resilience in the urban dense areas around the world.

Street design in the Netherlands is often based on a particular philosophy of its time. Ideas and technologies that were available at the time of constructing, are

Table 4 Dutch Neighborhood typologies, based on (Kleerekoper 2016)

Dutch neighbourhood typology	Period	Features
Urban city block	Before 1930	No front garden nor green skirting, 4–5 layers
Pre-war city block	1900–1940	Occasional front garden, 3–4 layers, wider streets than urban blocks and occasional green skirting 
Garden village	1910–1930	Spacious front and back garden, 2–3 layers, ample parking space,1930s architecture, limited public green and rarely street trees
Working-class neighborhood	1930–1940	No front garden, little public green, 2–3 layers, single-family units
Low-rise post-war garden city	1945–1955	Open building block with ample green, 2–3 layers, single-family units
High-rise post-war garden city	1950–1960	Open building blocks with ample green, 4–6 layers, apartments, storage on the ground level 
Post-war neighborhood	1940–1990	Front and back garden, 2–3 layers, single- family terraced houses, semi-detached or detached
Community neighborhood	1975–1980	Single-family unit with front- and back garden, meandering street pattern, courtyards, wide green skirting around the neighborhood

(continued)

Table 4 (continued)

Dutch neighbourhood typology	Period	Features
		
High-rise city center	1960–present	More than ten layers in grid formation
Suburbanization – Vinex	1990–2005	Single-family unit, terraced, semi-detached or detached apartments

captured in the authentic details of these streets, such as the size of the houses, gardens, public space for greens and playgrounds, the width of the streets and the architecture of the buildings (Kluck and Boogaard 2021). Table 4 describes a set of neighborhood typologies for urban climate adaptation. The typological variants give direction to the approach to combat more extreme climate effects. For instance, the abundance of public space in post-war neighborhoods can easily be employed for climate adaptation, whereas in the dense urban housing blocks and pre-war blocks, underground solutions are more important. The structure of garden cities offers space for swales to absorb heavy rainfall locally. Knowledge of the neighborhood typology, gradient (flat or sloping), type of soil, and the groundwater level enables us to give a reliable projection of the possibilities and effectivity of local climate adaptation. The typologies apply to many of the streets and neighborhoods across The Netherlands. In every country common typology can be determined to present climate adaptations that generally fit in. Throughout Europe typologies will vary strongly, especially from North to South due to difference in climate. Northern countries tend to have more spacious streets to allow sunlight entering the houses during winter.

To illustrate how ClimateScan and neighborhood typologies can help Urban planners one of the most frequent implemented climate adaptation measure "bio-swales" is discussed. Since 1998 first swales were implemented in The Netherlands and now almost every municipality has swales to store and infiltrate stormwater in their urban area. Over 700 districts with Swales have been mapped in The Netherlands (Fig. 10) allowing a detailed analysis related to neighborhood typologies.

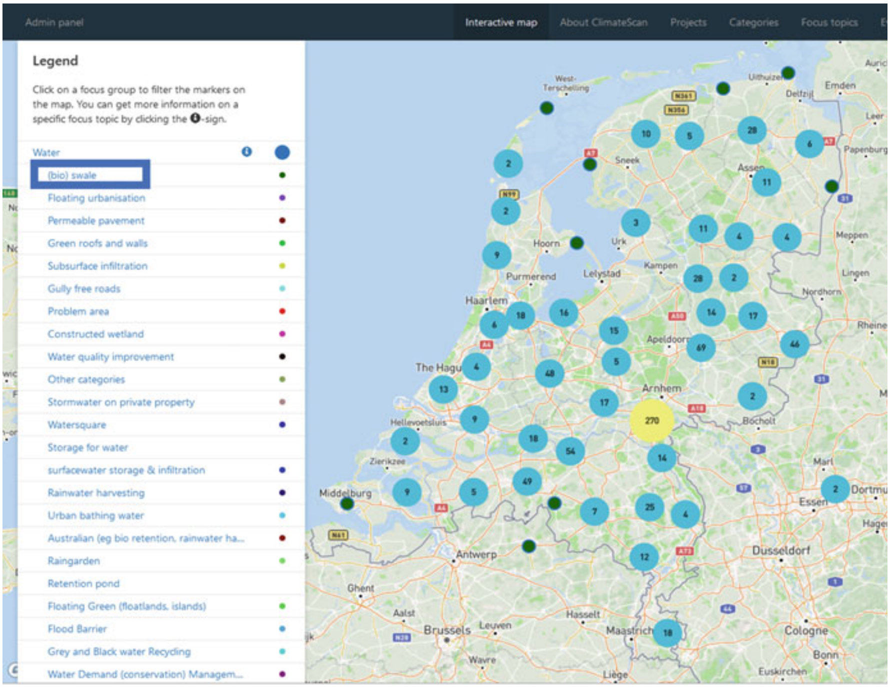


Fig. 10 Over 700 districts with Swales spread out over The Netherlands (also lower parts that are below sea level) on large scale implemented after 1998

Categorization of the specific swale locations to their neighborhood typology leads to the conclusion that most of the Dutch swales are located in the three more spacious and newer types of urban areas (Fig. 11): suburbanization – Vinex area (30%), community neighborhood (22%), villa district (14%), and post war neighborhood (14%). Swales that infiltrate stormwater require space in the urban area in contrast to subsurface infiltration facilities that can be found more in densely built up areas as working-class neighborhood and historical center. But exceptions of swales being implemented in urban dense areas give best management practices to urban planners in need for stormwater infiltration examples in specific districts.

This information gives an evidence-based proof to urban planners that swales can be implemented in any type of district but mostly are constructed in spacious districts built after 1970. Furthermore, examples of stormwater infiltration projects in low lying districts with high groundwater tables and low permeable soil can be found also in densely built up areas. Another example of a climate resilient urban retrofit measure at street level is permeable pavement: 50% of the 168 locations of permeable pavement are located in the three more spacious and newer types of urban areas: villa district, community neighborhood, and suburbanization area. Permeable pavement is also present in densely built up areas like working-class neighborhood, and historical center. This information gives an evidence-based proof to urban planners

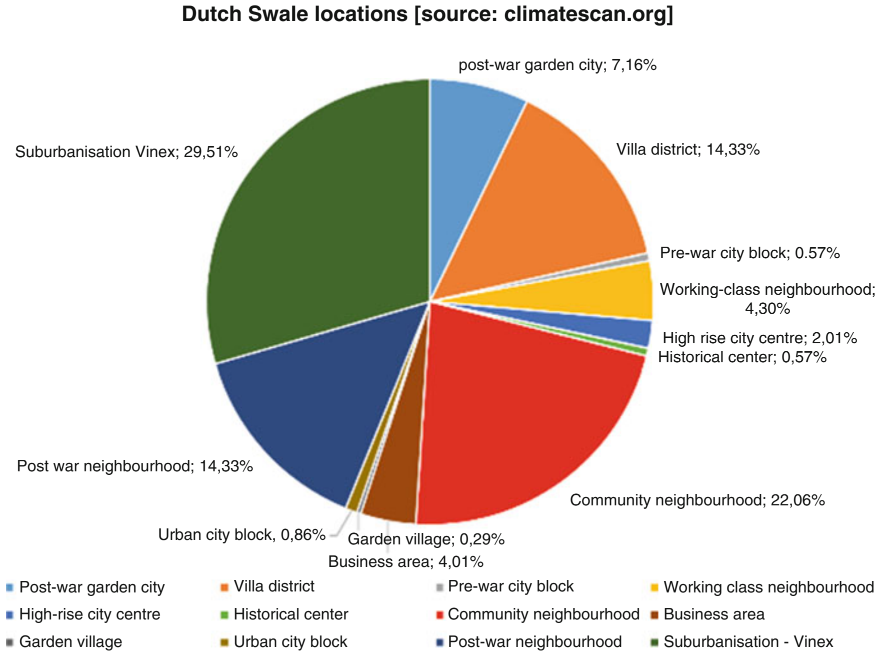


Fig. 11 Dutch Swale implementations categorized in neighborhood typologies

that permeable pavement is implemented in any type of district but mostly is constructed in spacious districts built after 1970 (Kluck and Boogaard 2021). The fact that climate adaptation measures can be implemented everywhere in the urban (dense) area can inspire urban planners and stormwater managers with the design, plan, and implement climate resilient measures with more confidence.

Looking Forward: Upgrading Climate Adaptation Platforms

ClimateScan is a constantly evolving platform addressing Climate Adaptation. Stakeholders have identified challenges and potential in an update to ClimateScan 2.0. Biggest challenge named during workshops is quality control and engagement of users. Using citizen science as data acquisition provides engagement but also requires quality control in order to make representative scientific presentations of the data as regarded in this chapter. The following features are identified as high potential upgrades for ClimateScan 2.0 and will be implemented in the near future:

- Problem-based categorization of adaptation solutions
- Uniformity in language and content
- Adding Case Studies to the platform
- Equal distribution of solutions across different categories

- One-of-kind knowledge management and assistance tool. Extensive repository of verified solutions
- Providing assistance to users (stakeholders) in decision-making
- User-driven and dynamic mapping of climate adaptation solutions globally
- Country profiles and Adaptation Scores to gauge efforts to become resilient in different countries
- Tailormade services for a diverse group of stakeholders
- An additional page for effective and widespread solution-brokering

To do so, a team for content curation and collaboration with ICT specialist and web designers will be crucial in carving the way forward. Effective transferring and relaying of the existing content without compromising the integrity of the information will stay a major challenge. Once up and running, an improved version of ClimateScan will require a team of researchers to constantly update the information on the platform and vet any incoming information. These ideas can be further developed in future international projects. Use this open source data and join us to accelerate climate adaptation.

As mentioned, online adaptation platforms often struggle with creating and maintaining a well-functioning community of practice (Hammill et al. 2013; Palutikof et al. 2019b). The openness of ClimateScan and active promotion in online and offline fora has resulted in quite a diverse and practice-oriented user group and case studies around the world illustrated in this chapter. However, although quite an amount of people have registered over the years, people can lose interest after a while. Engaging with the ClimateScan community with workshops and social media updates could stimulate long-term engagement and recruit new users. Workshops could address different actor groups. Creating teams and using the element of competitiveness (who finds most nature-based solutions in a short amount of time) could be an idea to grow and foster the ClimateScan community in the future (Restmeyer and Boogaard 2021).

Conclusion

ClimateScan is an open-source platform that was started in 2014 with the objective of providing an interactive web-based map application for international knowledge exchange on climate adaptation solutions. Few years later, it has grown to become a tool being used by academicians and young practitioners garnering over 1000 registered users and over 6000 projects listed worldwide viewed by hundreds of people per day. These projects span across different cross-cutting themes and are diverse in their scale and impacts.

Case studies in three continents illustrate how online knowledge-sharing platforms can promote climate adaptation. In the case of ClimateScan – an innovative, bottom–up approach – to map best practices of NBS around the world citizen science used to gather data. The ClimateScan platform has proven to be successful in mapping thousands of international climate adaptation projects. The platform is used in several international workshops, climatecafes, international workshops, and field trips, serving the needs of different stakeholders in different settings and locations. The tool helps policymakers and practitioners to gather valuable data for decision-makers at street, neighborhood and city level. The results create awareness providing several Best Management Practices and nature-based solutions, insights and bring together stakeholders in the different regions of the world as Africa, Asia and Europe as presented in this chapter.

In several workshops around the world the relevance of climate adaption platforms and individual solutions were evaluated with different stakeholders by the means of a workshop and a survey. The conclusions from workshops in **Asia** (Indonesia) showed high relevance scores for: biofiltration and (temporarily) flood barriers to mitigate flooding. Floating infrastructure showed low scores in Indonesia in contradiction to other parts of the world. The workshops raised awareness and contributed to capacity building for climate adaptation. Participants are now able to find climate adaptation measures that are relevant for their work and are able to share their Best Management Practices (BMPs) on a local and global scale. The over 100 locations placed on ClimateScan during and after the workshops can be further used for raising awareness and to promote implementation of NBS in Indonesia. For example in the Semarang area, where groundwater levels have to be restored to mitigate subsidence and saltwater intrusion, water conservation and water demand management such as rainwater harvesting can get more attention as in regions such as South Africa and Asia. Research projects on stormwater infiltration methods which scored high on the survey will be set up in the near future. After introducing this workshop in Semarang and Surabaya the survey will be conducted in other regions of the world to see the relevance of climate adaptation platforms and compare research outcomes.

Projects uploaded using citizen science in South **Africa** have been reviewed as a first representation what strategies are applied in several locations in urban areas related to climate adaptation and water management. The results show a large variety of climate adaptation projects such as Nature-based solutions: (bio) swales, green roofs and walls, constructed wetlands, retention ponds permeable pavement and rain gardens implemented to conserve water, cool down the city, and mitigate temperatures in the urban dense area (heat stress). Not surprising is the largest category "water demand management" since drought is a major challenge in South Africa. The approaches and projects in Johannesburg area can be an inspiration for all regions in the world facing drought problems.

High density of mapped climate adaptation strategies in **Europe** allows more detailed categorization of specific measures as illustrated for bio swales in The Netherlands. Relating existing implementations to neighborhood typologies gave urban planners evidence-based proof that climate adaptation measures can be implemented in any type of city district. Furthermore, challenging examples of stormwater infiltration projects in "worse case" low-lying districts (under sea level) with high groundwater tables and low permeable soil have been an inspiration to stakeholders around the world. General analysis of climate adaptation and specific examples enables stakeholders such as urban planners and stormwater managers with the design, plan, and implement climate resilient measures with more confidence.

In conclusion, the outcomes of three selected case studies with ClimateScan illustrate some of the possibilities of climate adaptation platforms with stakeholders and shown that there is a clear demand for open source collaborative knowledge-sharing tools, where first impressions of different urban resilience projects can be quickly gained. In the near future, climatecafes and new international projects will proceed with mapping and analyzing climate adaptation measures with this method presented in this chapter. We hope that you, as a stakeholder will join us and benefit from this open source platform that helps to increase the resilience to climate change in many regions of the world.

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