

PAVING THE WAVES

WCFS2020

2nd WORLD CONFERENCE ON
FLOATING SOLUTIONS 2020

CONFERENCE BOOK

06-08 Oct 2020

pavingthewaves.blue



Edited by

L. Piątek, R.E de Graaf, S.H. Lim and C.W. Wang

THE RELEVANCE OF CLIMATE ADAPTATION PLATFORMS FOR FLOATING URBANISATION AND NATURE-BASED SOLUTIONS. CASE STUDY: JAVA, INDONESIA

Floris C. Boogaard, Henny Pratiwi Adi, Slamet Imam Wahyudi, Rui L. P. de Lima and Eric Boer

There is a clear demand for a collaborative knowledge-sharing on climate adaptation and mitigation. The aim of most climate adaptation platforms is (inter)national knowledge exchange and raising awareness about climate adaptation in urban areas and promote solutions such as Nature-based solutions (NBS) and floating infrastructure. However their multiple benefits are often unknown to the wider public. During seminars (February 2020) in Indonesia climate adaptation measures were mapped and the relevance of the climate adaption platforms such as ClimateScan was evaluated by the means of workshops and a survey. The platform ClimateScan holds now over 5000 locations in 5 main categories of climate adaptation (water, nature, agriculture, energy and people). The conclusions from the workshops in Semarang and Surabaya show high relevance scores for NBS: permeable pavement and swales; for infiltration of stormwater to groundwater; for mitigation of high temperatures with heat stress measures; and flood barriers to mitigate flooding. There were low scores for floating urbanization because this is not a culturally accepted practice in contradiction to other parts of the world. Indonesian floating infrastructure as a floating library, restaurant and airport terminal were mapped during workshops bringing the total of international floating structure locations to 150. The workshops have raised awareness among participants and contributed to capacity building by empowering the participants to map and review climate adaptation measures. A high majority see the value of climate adaptation platforms and will use it in the future.

Keywords Climate Adaption Platform · ClimateScan · Floating Structures · Nature-based Solutions

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1 Introduction

Among the most pressing environmental challenges facing us today are: extreme weather events and temperatures; accelerating biodiversity loss; pollution of air, soil, and water; and failures of climate-change mitigation and adaptation measures [1]. The majority of the world's population now live in cities. Urban areas are constantly expanding in terms of space and density, with their population around the world expected to rise. These cities are becoming increasingly vulnerable to climate change, and there is an urgent need to make them more resilient. Increased heat stress, drought and flooding due to a changing climate forces action to be taken within already heavily urbanized areas where the battle of Semarang [2]. Urban areas, such as Semarang and Surabaya in Indonesia, are constantly expanding and the space available for green areas is decreasing significantly, making these cities highly vulnerable to climate change. Nature-based solutions (NBS) comprises methods inspired and supported by nature that help societies to adapt to climate change.

1.1 Climate Adaptation Platforms and ClimateScan

There is a clear demand for a collaborative knowledge-sharing on climate adaptation and mitigation. Climate adaptation platforms raise awareness on climate change effects and stimulate (inter)national knowledge exchange on solutions as floating infrastructure and NBS. Twelve climate adaptation platforms were identified and analyzed during the "2nd International Climate Change Adaptation Platform Workshop", in Dublin October 2019 (Figure 1). Only three of the platforms are operating globally. Most stakeholders at this conference indicated that they would like to have tools that are (top 5):

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



Fig. 1 Global Climate Change Adaptation Platforms as presented during 2nd international climate change adaptation platform workshop in Dublin October 2019 [3]

As presented in Figure 1 climate adaptation platforms are available for several regions or countries around the world offering information to different target groups. ClimateScan [4], a web-based international knowledge exchange tool on urban resilience is a citizen science tool created through

‘learning by doing’. After its launch in 2014 [5] the ClimateScan platform is in continuous development as more data is uploaded, and improvements are made to respond to feedback from users [6]. 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 video material). In 2020, ClimateScan has grown into an interactive web-based map application for international knowledge exchange on climate adaptation projects around the globe. It is adapted as a ‘solutions-broker’ and helps mobilizing action in the field of climate adaptation and creating a network of collaborators and providing resources for assistance in their efforts towards achieving resilience. Its widespread user base and diverse portfolio of adaptation projects/solutions is a widely used support tool for Climate Adaptation measures, but also as a database of other initiatives, such as databases for floating projects (urbanization/houses, solar parks, or floating communities) and green energy (solar panels/parks, windmills, sustainable buildings).

1.2 Nature-Based Solutions (NBS)

NBS is a concept that can be defined as: “a transdisciplinary umbrella that encompasses experience from existing concepts such as ‘blue-green infrastructure’ in engineering, ‘natural capital’ and ‘ecosystem services’ in economics, and ‘landscape functions’ in environmental planning” [7]. NBS aim to use ecological functions in order to mitigate the negative impacts of climate change on the urban environment whilst improving well-being. An example of this can be the positive effects of urban greening on rainwater infiltration, urban heat, productivity, liveability, and health [8]. Examples of these NBS are rain gardens, bio swales, permeable pavement, green roof and green walls which are implemented around the world. The benefits of these solutions are well-known in the academic world but they are often less understood by the wider public. To overcome this, international knowledge sharing on this topic has been promoted in the form of Climate Change Adaptation Platforms such as the open source web-based ClimateScan platform (www.climatescan.org). This platform maps over 5000 case studies where climate adaptation measures are implemented around the world. These locations are often uploaded during international projects information-sharing events such as ClimateCafés. Climatecafe.nl developed a city-scanning methodology to measure, map, scan and assess different parameters that give insight in the vulnerability of a defined urban or rural area. ClimateCafe involves the development of a set of measurement tools that can be applied in different areas in a low-cost, low-tech approach. One of those tools is the ClimateScan app that allows participants of ClimateCafés around the world to map and share knowledge on their NBS [9]. This climate adaptation platform is used during workshops in Indonesia to raise awareness on climate change and capacity building on climate adaptation.

1.3 Floating Infrastructure in ClimateScan

The platform ClimateScan is hosted in The Netherlands and supported by several EU projects as WaterCoG and INXCES shows the highest density of projects related to floating urbanization in Europe (Figure 2). For example: over 50 Dutch projects with floating (and amphibious) houses, roads, offices, restaurants and (large) floating solar panels. Small floating infrastructure such as green float lands and houseboats are not regarded in this category. Outside Europe floating houses and airports are uploaded in Asia such as a floating library in Indonesia, a floating office in the Philippines and airports in Japan. Analyzing the data harvested by means of citizen science showed 126 projects with floating infrastructure around the world.

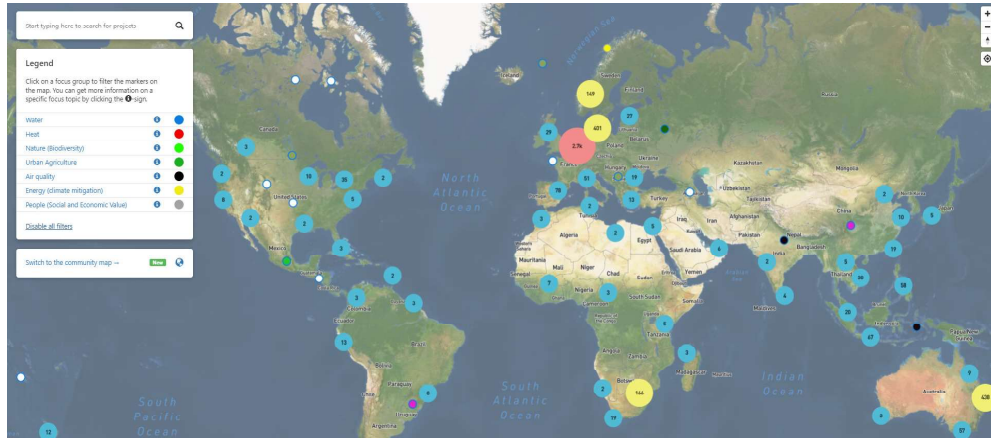


Fig. 2 Over 5000 locations with climate adaptation solutions mapped on Climatescan.org including 126 with the category 'floating infrastructure'

2 Methodology

2.1 Case Study Area: Climate Adaptation (Floating Urbanisation) Java, 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 [11]. Two major problems linked to climate change are land subsidence and sea level rise. According to previous studies subsidence is in the range of 5-10 cm / year. The increase in sea level, in the order of 3 mm/ year, causes tidal flooding and saltwater intrusion from the sea to the mainland [12]. High sea levels also hinder free discharge of storm water to the sea causing inland flooding and malfunctioning of the available sewage system.

To increase the resilience of cities, such as Semarang, to climate change, 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). For this, small-scale climate adaptation measures are being promoted under various names such as Best Management Practices (BMP), green infrastructure (GI), water sensitive urban design (WSUD), sustainable drainage systems (SuDS), low impact development (LID), ecosystem-based adaptation (EbA) and nature-based solutions (NBS). Nature-based solutions (NBS) refers to the implementation of methods inspired and supported by nature, which provide multiple benefits and help society to adapt to climate change [8, 13]. NBS implementation results in increased vegetation coverage combating the problem of green area loss in cities. NBS also aims to increase the perviousness rate in different urban areas to increase the infiltration of rainwater.

2.2 Workshops: Surveys and Mapping of Climate Adaptation

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. 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 were 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 4 were at master's degree level.

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.

To collect, distribute and share knowledge, the open access, web-based ClimateScan adaptation tool was used (Section 1.1.; www.climatescan.org). This tool helps policymakers and practitioners to gather valuable data for a rapid appraisal at the neighbourhood level, mapping specific climate adaptation measures at specific locations with information. ClimateScan is a citizen science tool giving the exact location, website links, downloadable photos and film material on measures regarding climate mitigation and adaptation, such as NBS related to stormwater infiltration such as swales, rain gardens, water squares, green roofs, and permeable pavement to mention some that improve the liveability in cities.

3 Results

3.1 Mapping Climate Adaptation in Java, Indonesia

In the past years over 5000 NBS locations from all areas of the world have been mapped on the open source ClimateScan platform during several international projects and workshops. Over 100 locations were mapped where climate adaptation measures have been implemented in Java, Indonesia (Figure 3). 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.

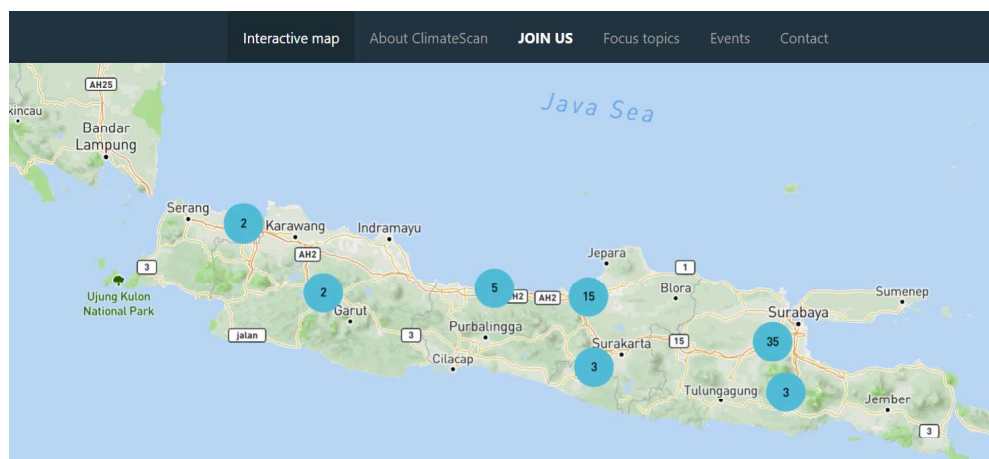


Fig. 3 ClimateScan for Java Indonesia after the workshop in Semarang: more than 50 projects mapped on the open-source nature-based solution platform

Table 1 shows some of the examples that were included in the survey and mapped during workshops, as well as examples that may be used in Indonesia. Further NBS cases are planned to be mapped and more knowledge exchanged during new international climate adaptation projects which are to be held in the near future. Climate Change Adaptation Platforms such as ClimateScan are an inspiration to stakeholders to make their cities more resilient to climate change. Potential upgrades of these platforms have been identified with stakeholders and discussed during the workshops. The categories that were considered to be relevant for Indonesia by the participants include bio-swales, constructed wetland, green roofs, floating urbanization, permeable pavement hollow gully free roads, sub-surface infiltration, heat stress measures, flood barriers.

Table 1 Examples of climate adaptation methods: floating urbanisation and NBS

Category	Definition [Susdrain, 2020]	Example Java (source: climatescan.org)
Floating urbanization	Floating buildings are used to maintain the existence of space and the volume of water. This water space is an important reservoir in the tidal flood areas. In the meantime, it protects buildings prone to flooding	Library floating semarang  https://www.climatescan.org/projects/2140/detail
Floating urbanization	Floating restaurant: Rawapening lake All floating structures can be found at: https://www.climatescan.nl/map#filter-1-2)	 https://www.climatescan.org/projects/2563/detail
Floating urbanization	Ahmad Yani International Airport On June 6, 2018, a new terminal was opened. It is the first floating terminal in Indonesia, which has an area of 58,652 square metres, nearly 10 times larger in size than the old terminal.	 https://www.climatescan.org/projects/3080/detail
NBS: (Bio) Swale	A swallow vegetated channel designed to conduct and retain water but may also permit infiltration. The vegetation filters particulate matter.	Swales at Jakarta airport  https://www.climatescan.org/projects/973/detail
NBS: Green roofs (and walls)	A roof with plants growing on its surface. The vegetated surface provides a degree of retention attenuation and treatment of rain-water, contributes to local biodiversity and promotes evapotranspiration.	Some buildings in Semarang  https://www.climatescan.org/projects/2139/detail
Sub-surface infiltration	Make a hole in the land surface so that water can infiltrate to the ground water	Tegal infiltration pit or biopori infiltration  https://www.climatescan.org/projects/2350/detail

3.2 Results of the Surveys to Participants

Highest scores in Semarang and Surabaya (Figure 4) 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. Surprisingly the lowest scores for floating urbanization 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 [14]. 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 [15]. Low scores were acquired for floating urbanization, but research will continue to find floating houses innovations that are cheap, easy to build and environmentally friendly and may turn out to be attractive to future residents. There are several materials that can be used as a floating house platform. Materials such as steel plate beams, hollow concrete plates, wooden rods, bamboo, plastic drums, Styrofoam and PVC pipes. The durability and strength of the material still requires further development and study so that later it can be implemented well [15].

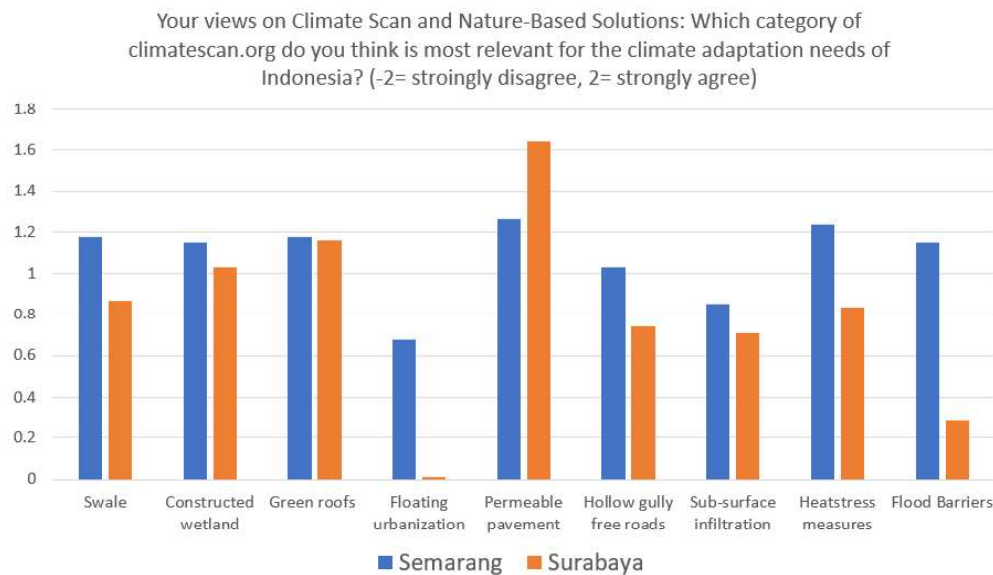


Fig. 4 Results from mapping of climate adaptation measures in Central Java (Figure 4a Semarang, 4b Surabaya)

The workshop has raised awareness giving a value on using NBS to support climate adaptation (Figure 5). Some participants preferred working with the 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 This will be monitored by the authors of this paper.

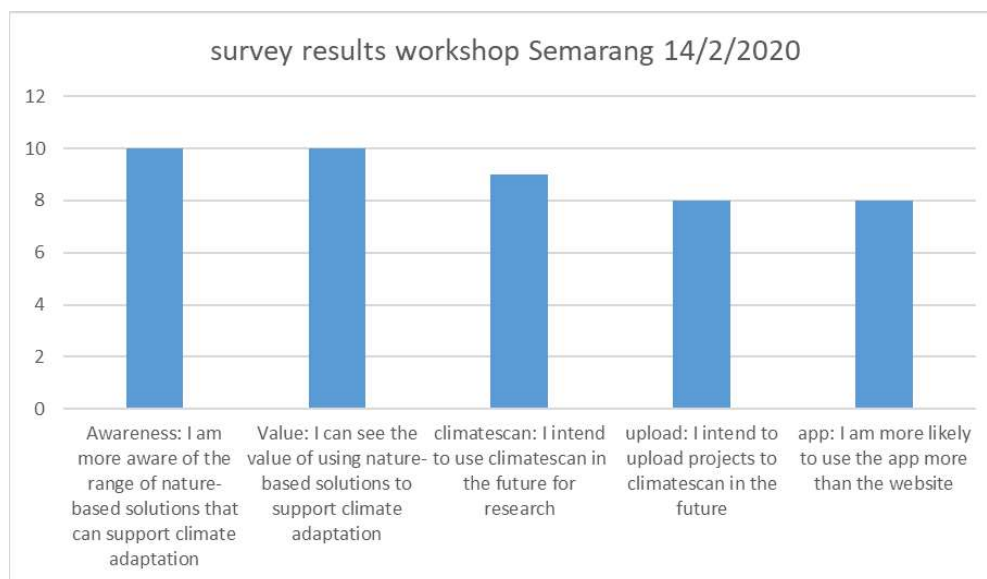


Fig. 5 Awareness giving a value on using NBS to support climate adaptation

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.

4 Conclusion

The ClimateScan platform has proven to be successful in mapping more than 5,000 international climate adaptation projects. The platform is used in several international workshops, ClimateCafés, international workshops and field trips, serving the needs of different stakeholders in different settings and locations. The tool helps stakeholders to gather data about climate adaptation in a rapid appraisal at the neighbourhood and city level. The results create awareness providing several Best Management Practices, insights and bring together stakeholders in the Climatescan community.

In several workshops around the world the relevance of climate adaption platforms and individual solutions as floating infrastructure was evaluated with different stakeholders by the means of a workshop and a survey. The conclusions from workshops show high relevance scores for: biofiltration and (temporarily) flood barriers to mitigate flooding. Floating infrastructure showed low scores in Indonesia (Java Indonesia February 2020: Semarang and Surabaya) in contradiction to other parts of the world. According to respondents; floating urbanization is synonymous with humid, dirty, wet conditions, mold on the walls, fuel residues from stoves and disturbing marine ecosystems. Building a floating house (equipped with sewage and sanitation treatment systems) would require higher costs to avoid polluting urban surface water. Innovation is needed for cheap, easy to build and environmentally friendly floating infrastructure that is attractive to future residents. The durability and strength of the material used in floating infrastructure still requires further development and study.

The workshops raised awareness and is part of capacity building for climate adaptation, and UN Sustainable Development Goals. 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 global scale. Most participants preferred working with the app above the website that will be used in the field to map new projects. The survey showed high scores for infiltration of stormwater to groundwater with permeable pavement and swales. It also showed that mitigation of high temperatures with heat stress measures and flood barriers to mitigate flooding are very relevant for Semarang. An important improvement raised during the survey on climate adaptation platforms regards the need for quality control when the method of acquiring data is done by citizen science. A high majority of the participants acknowledge the value of ClimateScan and intend using it in the future. This will be monitored by the authors of this paper.

The locations placed on ClimateScan during and after the workshops can be further used for raising awareness and to promote implementation of NBS in Indonesia. In the Semarang area, where groundwater levels have to be restored to stop 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. Studies will be set up on the long term efficiency of these NBS to ensure sufficient hydraulic performance. After introducing this workshop in Semarang the survey will be conducted in other regions of the world to see the relevance of this platform and compare research outcomes. In Java island (Indonesia) the workshop will be held also on other cities, such as Surabaya, to get a broader picture of climate adaptation knowledge.

5 Acknowledgements

Our gratitude goes to the Civil Engineering Department of Sultan Agung Islamic University, Semarang, Indonesia; The department of Built Environment from Hanze University of Applied Sciences, Groningen, the Netherlands, Erasmus + program, as well as all those stakeholders who participated and supported. Tools and training developed under the Interreg project WaterCoG are used and evaluated.

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