



ADAPTATION FUND



PORTFOLIO MONITORING MISSION REPORT

NATURE-BASED CLIMATE ADAPTATION PROGRAMME FOR THE URBAN AREAS OF PENANG ISLAND





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PROJECT INFORMATION

Project Title	Nature-based Climate Adaptation Programme for the Urban Areas of Penang Island
Country	Malaysia
Sector	Urban Development
Implementing Entity (name and type)	UN-Habitat (Multilateral Implementing Entity)
Executing Entity(ies)	Majlis Bandaraya Pulau Pinang (MBPP), Jabatan Pengairan Dan Saliran (JPS), Think City
Funding Amount	US\$ 10 million
Project start date	09/06/2022
Project expected completion date	09/06/2027
Portfolio Monitoring Mission Date	March 17-21, 2025



Figure 1 - Project Locations in George Town and Bayan Lepas, Malaysia (source: Think City)

PROJECT BACKGROUND AND OBJECTIVES

This project pioneers the use of Nature-Based Solutions (NBS) to address increasing urban heat and flooding caused by extreme climate events in Penang Island, Malaysia. The Island is in a low-lying area with greater than 50 percent impervious surfaces along with an ageing and inadequate drainage system. As a result, the Island is extremely prone to monsoons and flash flooding, as well as high urban heat. The project aims to boost urban resilience to climate impacts by using NBS to cool the Island, manage stormwater, and strengthen social and institutional capacity. Specifically, the project is being implemented in two subdistricts of Penang: George Town and Bayan Lepas (Figure 1). The two sub-districts were selected due to their underlying vulnerabilities to climate change, including increased urbanization that reduces stormwater absorption, outdated and insufficient drainage systems, and decaying infrastructure; these factors significantly heighten the potential impact of extreme climate events, along with the concentration of ethnically diverse urban poor.

The project is implementing NBS to achieve the following objectives:

1. Enhance urban resilience and reduce human and ecosystem health vulnerability to climate change impacts and extreme weather events (increased temperature and stormwater),
2. Increase social resilience and,
3. Build institutional capacity.

As a community-driven project, 343,739 direct beneficiaries and 311,257 indirect beneficiaries stand to benefit when completed. The project has a strong knowledge management component to support the collection, documentation, transfer and scaling up of NBS across Malaysia and regions with similar climate risk exposures, if proven to be successful.



PROJECT COMPONENTS

The project is structured around the following 5 components:

1. Adaptation to the urban heat island effect through urban greening (including tree-lined streets, green parking spaces, green rooftops, and urban agriculture)
2. Built projects for stormwater and flood management (including blue-green corridors, retention pond, swales, and infiltration wells).
3. Comprehensive vulnerability/baseline assessment and action plans in targeted communities.
4. Strengthening social resilience program (including school-level awareness; women and girls' program).
5. Institutional capacity and knowledge transfer platform (including Climate Board and Climate-related public health program).

PROJECT [MISSION] RESULTS & FINDINGS – PROJECT IS ON TRACK

Field data collected during the Portfolio Monitoring Mission (PMM) and the review of annual performance reports indicate significant progress in project execution. With 30 percent of project funds disbursed, key soft components have been successfully implemented; these include a school-level awareness program, the construction of pocket parks and vacant space revitalization, and community engagement activities. Stakeholder and technical consultations for the Tree-Lined Streets and Green Parking components have also been

completed. Additionally, Phase 1 of the Green Facades and Green Rooftops initiative has been finalized, while Phase 2 was launched in December 2024 with revised selection criteria based on lessons learned from Phase 1. Urban agriculture for vegetable planting has been successfully completed, and Phase 2 of sea grape cultivation is now fully underway.

On the infrastructure side, all technical work has been completed and approved by relevant agencies; contractors are on site to start groundwork for the construction of the stormwater retention tank. The Blue-Green Corridor initiative is also in progress, with a targeted completion date of April 2026 (see Figure 2 below). The school-level awareness program saw the successful organization of a Youth Climate Summit, engaging 76 male and 121 female students from 38 schools and institutions, while the Women and Girls' Program is scheduled to launch in late 2025.

As part of the knowledge-sharing component, a workshop has been conducted through the Malaysia Adaptation Sharing Hub (MASH) with 62 participants, including representatives from local councils, civil society organizations, universities, and governance institutions. Also, a Penang Climate Board is set to be established in 2027 to undertake monitoring and evaluation of climate-related issues, and to promote a structured and holistic approach to addressing climate-related risks within the municipality. Furthermore, an ongoing public health study on temperature-related mortality has obtained ethics approval and made progress in the collection of primary data (pending full scope analysis). This is a pilot project to monitor heat and climate-related illnesses in three selected Penang health institutions.



Figure 2 - Blue-Green Corridor Components under construction by the Drainage and Irrigation Department (JPS)



KEY FEATURES OF THE PROJECT

Sustainability of the project beyond Adaptation Fund (AF) funding timeline

Country ownership and alignment with national adaptation priorities and needs

The project falls within the government's five priority thematic areas for adaptation therefore, it has received the needed political buy-in across the different levels of the Malaysian Government. Technical and political representatives from the federal and state governments involved in the mission demonstrated a strong understanding of the project's objective and its overall alignment with national development priorities. Senior government officials noted government readiness to support the maintenance and adoption of successful solutions after the completion of the project; this support will be budgeted for at the relevant government level.

Voluntary co-financing and potential to unlock continuous local budgetary support

Similar to country ownership, the mayor of the Penang City Council (MBPP), one of the executing entities, stated that the project aligns with their medium-term strategy and the Council has been able to provide co-funding. The Council also indicated their interest in expanding the project to other parts of the city beyond its current scope. These are indications of clear political buy-in which can support the sustainability of the project. The Mayor stated:

"We have already demonstrated our commitment to this project in diverse ways including the alignment of the project with a local council development plan, the co-finance provided for the project, the dedication of technical staff for the project, and our strong community engagement which in turn creates a social contract and failure to deliver will lead to me losing my job."

Additionally, there is strong community interest as demonstrated by the beneficiaries that were interviewed on site. They highlighted that the project would help address pressing issues related to flooding and urban heat and showed a strong interest in using diverse advocacy tools to ensure that the government continued to support the project and rehabilitation of the sites when needed.

Active involvement of beneficiaries including the most vulnerable (ethnically diverse urban poor, women, and youth)

The project has deployed robust approaches to enhance community engagement and prioritize the voices of relevant stakeholders, particularly the most vulnerable (*Figure 4 on the next page*). Through its Gender Responsive Participatory Process, a benchmark of 40 percent women representation was allocated for the Penang Climate Board committee; at least 30 percent of surveys that were meant to collect the views of project beneficiaries in the design and implementation of the project reflect the view of women. This was achieved through targeted engagement including door-to-door surveys reaching those that are usually excluded from public surveys. Additionally, the project employed a multicriteria framework to focus on high risk and socio-economically disadvantaged areas, ensuring that benefits are directed to those most in need.

As part of its commitment to sustainability and community empowerment, Think City, one of the project's executing entities, has launched an Urban Greening Grants Program designed to actively involve beneficiaries in urban greening efforts. With over 100 stakeholders engaged and nearly 25 grant applications received to date, the program promotes the adoption of vertical green structures and green roofs to help reduce temperatures and mitigate the Urban Heat Island effect, particularly in George Town and Bayan Lepas. By emphasizing community participation and knowledge transfer, the initiative ensures long-term sustainability, enabling its methodology to be scaled and replicated in other cities across Malaysia and the region.



Figure 3 - Mayor of Penang City Council and other government officials at the inauguration of the Union Square Pocket Park



Figure 4 - Community engagement and focus group discussions targeted at the most vulnerable

Lastly, beneficiaries that were interviewed on site demonstrated evidence of involvement in the project execution and acknowledged the potential impact of the project in its ability to address recurring floods. The beneficiaries mentioned that they will continue to engage with the government to ensure that the community's concerns are fully addressed including effective maintenance of the project post construction.

Self-learning and feedback loops

The institutional capacity and knowledge transfer component of the project, combined with a phased implementation approach, fosters self-learning and feedback loops that could significantly enhance the sustainability of the project. The phased approach allows insights gained from previous phases to inform subsequent phases. For example, Think City has successfully developed the first Tree Atlas for Malaysia. This Atlas identifies the tree species most likely to thrive under varying climate conditions and those that exhibit optimal urban heat absorptive capacities. The Atlas also helps identify trees that present minimal risk to urban infrastructure, while being cost effective. The potential presence of feedback loops and self-learning will not only facilitate continuous improvement but also reinforce the project's resilience and adaptability to fast-changing socio-ecological systems.

Scaling up successful and/or innovative components of the project

As a pioneering proof of concept, once this NBS approach is successfully implemented and demonstrates potential to address urban floods and extreme

heat, it could be scaled up or replicated in many other areas within Penang Island; other states in Malaysia facing similar climate hazards could also replicate the project's approach. It was noted during the mission, that a workshop organized through the Malaysian Adaptation Sharing Hub drew strong interest from participants, with many expressing the need to expand the initiative beyond its current scope.

Seventy-nine percent of Malaysians live in urban areas, and the government prioritizes holistic solutions tackling urban flooding and rising temperatures. This project is a practical demonstration of how well-designed, community-centered NBS can enhance urban climate resilience. The government intends to replicate and scale up the project, leveraging domestic budgets, applying to the Adaptation Fund, and engaging other climate funds.

The Adaptation Fund has a funding window for innovation and hence, any component of the Project that proves to be innovative could benefit from future and further funding (apart from its traditional single country funding windows that also scale up projects). Also, within the framework of complementarity and coherence, the Green Climate Fund (GCF) has already funded several successful projects in the country therefore, the project can be scaled up by the GCF pending a successful outcome.

Before the project is even completed, it has already attracted significant interest from a wide range of development actors within Malaysia and internationally.



Figure 5 – Plant species selected for the blue-green corridor (Source: JPS)

Notably, the project drew on international best practices such as lessons from China's Sponge City concept; this concept focuses on flood management through NBS such as green spaces, wetlands, and permeable surfaces. These elements are reflected in the project's integrated design. Furthermore, during its presentation at the World Urban Forum in Cairo, the project received valuable feedback from stakeholders including NBS specialists, urban planners, and representatives from the private and public sectors, further enriching the project's potential for replication in other urban contexts.

Innovation

NBS to address flash floods and heatwaves

This project represents a pioneering application of NBS in Malaysia to address climate-related risks in urban areas, particularly extreme heat and flooding. An innovative component is the development of a multipurpose leisure park featuring swales and an upstream flood water retention pond equipped with natural filtration systems. This combination serves to mitigate flood risks while replenishing groundwater, effectively balancing both flood control and water conservation within urban environments. The integration of NBS in this park exemplifies the potential of urban green infrastructure to provide multiple co-benefits. By incorporating natural filtration, the project not only alleviates the risk of flooding but also ensures that groundwater levels are maintained, which is critical for the resilience of urban ecosystems.

Development of Malaysia's first Tree Atlas under varying climate conditions

Think City, an executing entity has undertaken research and developed the Atlas of Climate Resilient Tree Species (ACRest) for Malaysia. The atlas serves as a key reference in guiding the selection of climate-resilient tree species for various components of the project (See Figure 5), specifically, the blue-green corridor led by JPS and the tree-lining initiative implemented by MBPP. These efforts contribute to greater complementarity and cohesion across the project's nature-based infrastructure interventions.

Real time data gathering through Internet of Things (CO₂ levels, air quality, temperature, humidity)

Cutting-edge technologies, such as the Internet of Things (IoT), are planned to be integrated into the urban greening components, particularly in the tree-lined streets component. Through IoT-enabled sensors, the project can monitor parameters, including CO₂ levels, air quality, temperature, and humidity. These real-time data measurements enable a better understanding of the environmental impact of green spaces, allowing for adaptive management strategies to be implemented as needed. Furthermore, the use of tree codification systems provides valuable insights into the health and growth patterns of urban trees, contributing to long-term urban biodiversity management. The project also showcases innovation through the use of heat sensors and thermal imaging to assess the impact of green

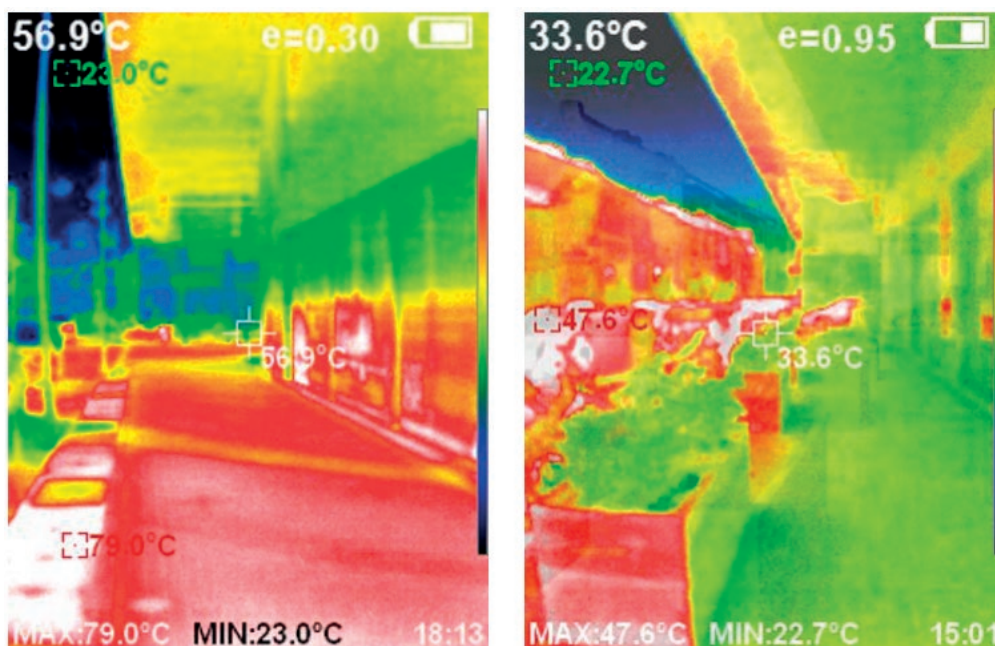


Figure 6 - Thermal imaging showing the cooling effect of green spaces. Surface temperature dropped from 56.9°C (left) to 33.6°C (right) with the introduction of vegetation, under similar weather conditions.

facades in reducing the urban heat island effect in Penang Island (*Figure 6*). These technologies provide real-time, precise data on temperature variations, allowing the team to track the effectiveness of green infrastructure in cooling urban areas. By monitoring surface temperatures before and after the installation of green facades, the project can quantify how NBS contribute to cooling urban environments and reduce the heat island effect.

Through the combination of pioneering application, collaborative partnerships, and advanced technologies, this project exemplifies a comprehensive and innovative approach to integrating NBS in urban planning. Its success will not only provide immediate benefits in addressing climate-related risks but also set a precedent for the wider adoption of NBS across Malaysia and other urban areas in the Asia region.

Building institutional capacity and the next generation of actors

Building institutional capacity and facilitating knowledge transfer are integral to the project's success. To support this, the Malaysia Adaptation Sharing Hub (MASH) was launched as part of the project's Knowledge Management objective, ensuring transparency

and broad access to the methodologies and strategies used during implementation. This initiative aims to enable other municipalities in Malaysia and across Southeast Asia to replicate successful approaches and develop their own climate adaptation plans.

As part of the project's capacity-building efforts, sea grape cultivation has been introduced as an innovative and sustainable initiative. Sea grapes are a low-cost yet high-value seafood, that are not only a viable economic resource but also play a critical role in coastline stabilization. The cultivation setup was designed in collaboration with the Centre for Marine and Coastal Studies (CEMACS), Malaysia's first marine research center, ensuring the integration of scientific expertise and best practices. Given their urban-friendly and cost-effective nature, sea grape cultivation presents an opportunity for local communities to engage in sustainable aquaculture. Through training and technical support, beneficiaries will be equipped with the necessary skills to successfully cultivate and manage sea grape production as an alternative income source enhancing their economic resilience and local food systems.

In the longer term, the initiative aims to serve as a proof of concept for scaling up urban agriculture



Figure 7 - Seagrape cultivation setup in collaboration with the Centre for Marine and Coastal Studies (CEMACS)

across Penang, showcasing the potential of innovative, community-led approaches to enhance climate resilience, food security, and sustainable livelihoods in urban settings.

Additionally, a school-level awareness program, including a Youth Climate Summit, was successfully conducted, engaging students from schools and educational institutions in Penang. This initiative aims to enhance resilience and increase climate knowledge among students, teachers, and education authorities in Penang.

To address climate-related health risks, a pilot Public Health program will be established to monitor and systematically document heat and climate-related diseases in select hospitals across Penang. As part of this initiative, professional development workshops will be conducted for Penang-based medical professionals, focusing on climate-related health impacts such as heat stress, flooding, and the management of at-risk patients. Community-level awareness campaigns will also be implemented to support public health interventions. Also, a Public Health Technical Advisory Group (TAG-PH) comprising local and international experts from health, academia, disaster management, and civil society has been created to provide advice and share opportunities for knowledge transfer and scaling efforts. The TAG-PH will also strengthen the public health program and support knowledge transfer efforts.

Lastly, the project will establish the Penang Climate Board, a dedicated unit responsible for monitoring, evaluating, and addressing climate-related risks, ensuring a structured and long-term approach to climate adaptation efforts in the region.

Managing potential environment and social risks

The executing entities continue to monitor potential risks related to each of the activities to ensure that the project does not create other forms of risk or lead to maladaptation. For example, with the implementation of Blue-Green Corridor, there could be potential environmental and social risk related to water pollution from upstream; the implementing entity intends to analyze options for water treatment along the river by investigating how certain plant species can be strategically introduced to help mitigate pollution in the river. There are already ongoing discussions with local environmental experts and stakeholders to ensure that the plant species chosen for the project will effectively address the pollution without altering the project's objectives or outputs.

Furthermore, in line with the Gender Policy of the Adaptation Fund, the project prioritized gender responsiveness and inclusivity in all stages of its design and implementation. The Gender Responsive Participatory Process is a guiding framework which has been followed all through the project, ensuring that at least 30 percent of the perspectives captured come from women.



LESSONS LEARNED

Careful tree species selection and long-term environmental benefits

A key lesson learned from the project is the importance of careful tree species selection, which is crucial for the success of the urban greening component. The selection criteria focused on climate resilience, low maintenance, and compatibility with local environmental conditions. Aquatic plants were chosen for their water quality purification properties. A long-term approach, including species like acacia trees which take time to mature but offer significant long-term benefits, helped ensure the project's lasting environmental impact. The selection of 17 diverse species addressed various environmental challenges while promoting ecological and aesthetic sustainability.

Committed local executing entities

Another lesson learned is the importance of involving capable and committed local executing entities. The collaboration between UN-Habitat, MBPP, and other local partners like JPS and Think City is pivotal for the project's progress (*Figure 8*). The executing entities are local entities and have played a critical role in identifying site-specific needs, mobilizing required local resources, and ensuring the integration of community-driven approaches in urban climate adaptation solutions. The progress and potential success of the project significantly depends on the technical capabilities and local knowledge these organizations offer, which helps address the unique challenges posed by Penang Island's vulnerability to urban heat and flooding. Their effective involvement ensures the successful implementation of both soft components, awareness programs, and hard infrastructure projects such as the stormwater retention systems.

Country ownership and effective stakeholder engagement

Country ownership and stakeholder engagement are crucial factors for the project's progress and potential success. The Malaysian government at the federal and state levels demonstrate strong political buy-in by aligning the project with the country's five priority thematic areas for climate adaptation. This alignment ensures that the project addresses national adaptation priorities and receives the necessary support for implementation. Additionally, the engagement of local government representatives and community stakeholders is remarkable. The project adopted a Gender Responsive Participatory Process, ensuring diverse stakeholder representation, especially from women and marginalized groups. This inclusivity will drive the social support for long-term project sustainability.

Voluntary co-financing

Another key lesson emerging from project implementation is that voluntary co-financing from local actors can significantly enhance project ownership and long-term sustainability. In this case, MBPP has voluntarily matched 100 percent of the volume of project funding allocated to them, enabling expansion of the project scope and the realization of additional adaptation benefits. When local entities invest in their own adaptation, it not only strengthens their commitment to the project's success but also ensures greater alignment with local development priorities. This deepens stakeholder engagement throughout implementation and increases the likelihood of sustained resource allocation beyond the project's initial funding period.

SEE MORE ABOUT THE PROJECT HERE



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