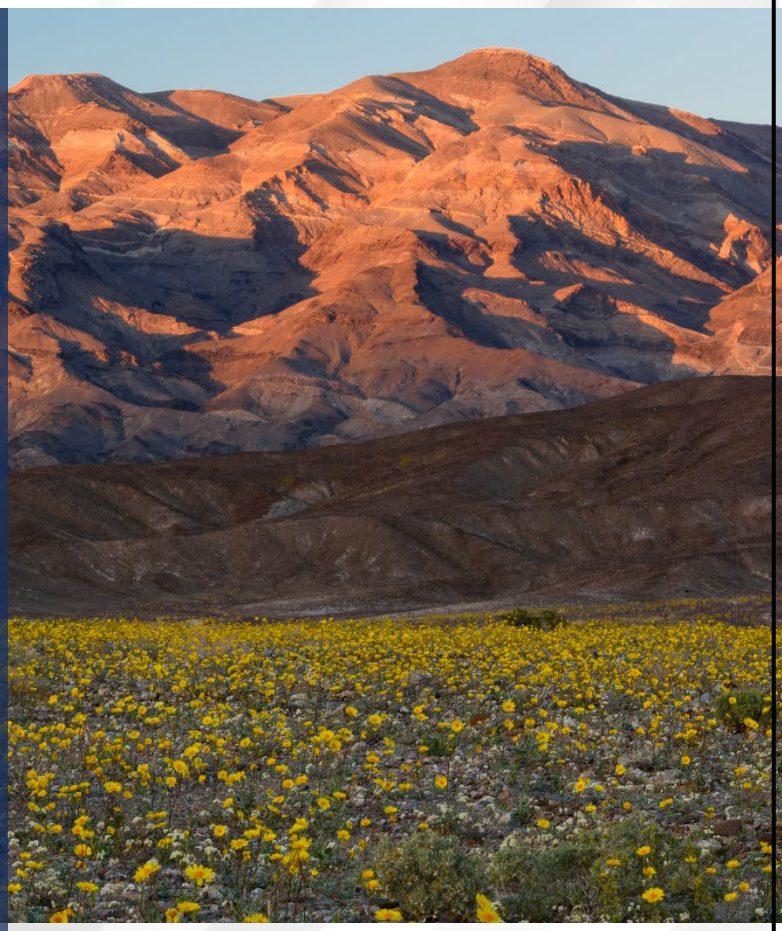
APN
ASIA-PACIFIC NETWORK FOR
GLOBAL CHANGE RESEARCH

FINAL REPORT

# Integrated assessment of existing practices and development of pathways for the effective integration of nature-based water treatment in urban areas in Sri Lanka, the Philippines and Vietnam



CRRP2021-06MY-Jegatheesan

2023

RMIT UNIVERSITY

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scpw society for the conservation of Philippine wetlands

Fundació Solidaritat UNIVERSITAT DE BARCELONA

Project Reference Number: CBA2021-06MY-Jegatheesan

Project Duration: 1 October 2021 – 30 September 2023

Funding Awarded: US$ 90,000

Grant DOI: https://doi.org/10.30852/p.18686

Date of Publication: 17 November 2023

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Recommended Citation:

Jegatheesan, V., Velasco, P., Pachova, N., Torrens, A., Dan, N. P., Trang, N. T. D., Pham, H. N. A., Thanh, B. X., Lecciones, A. M., Devanadera, M. C. E., Weragoda, S. K., Mowjood, M. I. M., & Jinadasa, K. B. S. N. (2023). I*ntegrated assessment of existing practices and development of pathways for the effective integration of nature-based water treatment in urban areas in Sri Lanka, the Philippines, and Vietnam*. Kobe: APN.

## 1. Summary

Water pollution is an increasingly pressing issue in urban areas, particularly in the rapidly expanding cities of Asia. Finding cost-effective and sustainable solutions is crucial, and one such approach is using Nature-based Solutions (NbS) for treating septic tank effluents, canals, and lakes. This study represents a significant step forward in addressing this challenge by formulating a comprehensive framework for assessing the effectiveness and impacts of NbS. The research conducted in this study draws on six case studies spanning the Philippines, Sri Lanka, and Vietnam. These case studies provide valuable insights into the practical application of NbS in various urban contexts. The study goes beyond theoretical discussions and offers practical guides for constructing and installing three key NbS components: Constructed Wetlands, Constructed Floating Wetlands, and Green Roofs. These guides were put into action through a series of trial implementations. This hands-on approach has significantly enhanced our understanding of how these NbS components perform in real-world conditions.

Stakeholder engagement was a cornerstone of this research endeavour. Gathering input and feedback from various stakeholders, including the public, is essential. These interactions provided essential data on public acceptance, the influence of policies, and the role of governance structures in implementing NbS. The knowledge and insights gathered from these interactions contribute significantly to our collective understanding of effectively replicating and implementing NbS for water treatment in urban environments. Our APN project has yielded significant outcomes in 27 diverse products. These include journal articles, book chapters, a comprehensive book, insightful perspectives, valuable resources, and informative videos, links to all of which are accessible on our project website (https://www.apn-gcr.org/project/integrated-assessment-of-existing-practices-and-development-of-pathways-for-the-effective-integration-of-nature-based-water-treatment-in-urban-areas-in-sri-lanka-the-philippines-and-vietnam/).

A strategic approach is recommended to further advance the replication of NbS for water treatment. Leveraging the progress made in this APN project across the three countries, it is essential to establish knowledge hubs. These hubs will serve as centres for disseminating information and expertise on NbS. Additionally, fostering living labs, which are experimental spaces for testing and demonstrating NbS, can provide valuable insights and encourage further innovation. Developing comprehensive toolkits that encompass the guidelines, case studies, and practical insights will facilitate the adoption of NbS in urban water treatment. Furthermore, providing short courses and training sessions focused on NbS can equip professionals, policymakers, and communities with the knowledge and skills to implement these solutions effectively.

## 2. Objectives

The project's key objectives are to enhance knowledge and capacities for integrating nature-based water treatment technologies in urban water management and planning across cities in Asia. The specific objectives of the project are to:

- Objective 1: Assess the potential of nature-based water treatment to improve water quality and human well-being while enhancing the livability and resilience of cities in Sri Lanka, the Philippines and Vietnam.
- Objective 2: Advance understanding of how natural-water treatment technologies can be effectively developed, maintained, replicated and upscaled across Asian cities.
- Objective 3: Enhance the capacities of researchers from the participating countries to engage in trans-disciplinary action research related to critical sustainability challenges.
- Objective 4: Raise awareness of local stakeholders of the potential of nature-based water treatment to address critical sustainability challenges.

## 3. Outputs, Outcomes and Impacts

| Outputs | Outcomes | Impacts |
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| **Objective 1**<br>Dissemination of the assessment on the potential of nature-based water treatment to contribute to improving water quality and human well-being, while enhancing the livability and resilience of cities in Sri Lanka, the Philippines and Vietnam through four book chapters (Dang et al. 2022, Pachova et al. 2022, Velasco et al. 2022, Weragoda et al. 2022). | The current status of water resources, wastewater treatment, and the application of NbS for water/wastewater treatment in urban areas and cities within the Philippines, Sri Lanka, and Vietnam has been effectively disseminated. This dissemination has thoughtfully incorporated considerations related to social acceptance, governance, policy, and financing needs. | A rigorous evaluation to examine the existing landscape and utilization of NbS for water and wastewater treatment across the triad of countries adds to the existing knowledge. |
| **Objective 1**<br>Dissemination of six case study assessments on the effectiveness and impacts of three existing nature-based water treatment technologies in cities in Sri Lanka, the Philippines and Vietnam through a journal article (Jegatheesan et al. 2023a) | Formulation of a joint methodology for an integrated assessment of the effectiveness and impacts of three natural water treatment technologies: floating wetlands, constructed wetlands, and green roofs. The joint methodology will have a positive and far-reaching impact on the environment, public health, and the overall sustainability of water resources in the target regions. It represents a significant step toward more effective, sustainable, and cost-efficient water treatment solutions. | **Improved Water Treatment:** This outcome will enhance the efficiency and effectiveness of water treatment processes by providing a standardized and comprehensive methodology for assessing the performance of these natural treatment technologies. It will lead to cleaner and safer water resources in areas where these technologies are employed.<br>**Environmental Benefits:** Using natural water treatment technologies is inherently eco-friendly, and this joint methodology will help ensure that their implementation aligns with environmental sustainability goals. It will result in reduced harm to aquatic ecosystems and improved water quality.<br>**Cost Efficiency:** By streamlining the assessment process, the methodology can lead to cost savings in the long term. Governments, organizations, and communities can make more informed decisions about investing in these technologies based on clear data and analysis.<br>**Knowledge Sharing:** The methodology promotes the |

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| | | exchange of knowledge and best practices among different stakeholders. This will facilitate collaboration and learning among researchers, practitioners, and policymakers across regions and countries.<br>**Community Health and Well-being:** Cleaner and safer water sources contribute to better public health and well-being, as access to clean water is essential for drinking, sanitation, and hygiene. The methodology can help ensure communities in the target areas have improved access to safe drinking water.<br>**Policy and Governance:** The methodology may also influence policy decisions related to water treatment technologies. It can provide governments and regulatory bodies with the data and insights necessary to develop or refine policies promoting these natural treatment methods.<br>**Scientific Advancement:** The development of this methodology will advance the field of water treatment and environmental science by providing a structured approach to evaluating the effectiveness and impacts of innovative technologies. This can lead to further research and innovation in this area. |
| **Objective 2**<br>Generation of web-based and GIS maps of NbS in all three countries to disseminate the information on existing NbS for water treatment and management in all three countries<br>https://www.google.com/maps/d/edit?mid=1Hb5pryV-7KXRSDL1MkIYO905KzuK5hGO&usp=sharing;<br>https://naturebasedsolutions.github.io/Map-of-Existing-NbS-for-wastewater-treatment-projects-in-the-Philippines-Sri-Lanka-and-Vietnam/ | Encapsulating knowledge within geographic markers. | Envisions an expansive horizon where the public can engage, contribute, and expand these maps by adding existing and new NbS projects in other countries. |

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| We have established a dedicated resource page within the project section of the APN website (Velasco et al. 2023a) | | |
| **Objective 2**<br>Dissemination of advanced understanding of how natural-water treatment technologies can be effectively developed, maintained, replicated and upscaled across cities in Asia through the publication of a guidebook (Jegatheesan et al. in press)<br>Five resource materials providing information on guides to the construction and installation of floating wetlands and green roof systems and operation of constructed wetlands as well as selecting plants for floating wetlands have been published within the project section of the APN website (Hemalal et al. 2023; Thanh et al. 2023; Trang et al. 2023a; Trang et al. 2023b; Velasco et al. 2023b) | Development of a nature-based water treatment pathways methodology and guide to support the establishment, up-scaling and replication of natural water treatment technologies.<br>The pathways methodology and guide have a positive and wide-ranging impact on water treatment, public health, environmental conservation, and sustainable development. It provides valuable tools and knowledge to promote the effective use of eco-friendly water treatment technologies. | Serves as conduits to share project knowledge and facilitate the replication of NbS for water treatment by providing a clear, standardized methodology and guide for establishing, up-scaling, and replicating natural water treatment technologies. It will make it easier for communities, organizations, and governments to implement and expand these eco-friendly technologies effectively.<br>**Cost-Efficiency:** The guide will help streamline adopting these technologies, potentially resulting in cost savings over traditional treatment methods. This can be especially beneficial for resource-constrained communities and regions.<br>**Knowledge Dissemination:** The guide supports the sharing of knowledge and best practices in water treatment, fostering collaboration among stakeholders, including researchers, practitioners, and policymakers. This, in turn, can lead to continuous improvement and innovation in the field.<br>**Community Empowerment:** By providing a structured methodology, the outcome empowers communities to take control of their water treatment needs. They can make informed decisions and independently manage and maintain these systems.<br>**Policy and Regulatory Impact:** The guide may influence policy and regulatory decisions related to water treatment technologies. It can provide governments and organizations with the information and guidelines needed to develop or refine policies supporting nature-based |

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| | | treatment methods.<br>**Sustainable Development:** The development and replication of nature-based water treatment technologies support the broader goals of sustainable development, including clean water and sanitation (SDG-6). |
| **Objective 2**<br>○ Replication of floating wetlands were trialed in Can Tho City in Vietnam.<br>○ Replication of green roof was trialed in Ho Chi Minh City in Vietnam.<br>○ The constructed wetland framework is trialed at Panguil River Eco-Park in Pangil Laguna, Philippines.<br>○ A constructed wetland in Calauan City in Laguna, Philippines was retrofitted with the help of the guidebook developed in the project. | Demonstrating<br>○ the replication of floating wetlands and green roofs<br>○ the utilization of the constructed wetlands framework<br>○ the utilization of the constructed wetlands guides to improve the performance. | Increase the confidence of multi-stakeholders in replicating nature-based systems for water treatment |
| **Objective 3**<br>○ Two regional and six national multi-stakeholder workshops were held by project partners.<br>○ Five quarterly meetings among the project partners along with invited multi-stakeholders, were conducted.<br>○ Based on the discussions and the knowledge gained on various aspects of the project, four Perspectives have been published within the project section of the APN website (Jegatheesan 2023b submitted; Mowjood et al. 2023; Trang et al. 2023c; Devanadera et al. 2023)<br>○ A journal article analyzing the willingness of stakeholders to pay to the water in the Bung Xang canal and maintaining the floating wetlands is under review (Trang et al. under review). | ○In Sri Lanka, clear understanding on the roles of regulators, beneficiaries and custodian as well as public awareness and their inputs to the lakes in Kandy and Kurunegala has been established where the floating wetlands have been installed to improve the water quality.<br>○In the Philippines, clear understanding on social acceptability, challenges, opportunities, policy options for constructed wetlands as a NbS for wastewater treatment has been established.<br>○In Vietnam, construction and installation of floating wetlands and green roof systems have been conducted to provide hands-on training to Can Tho University and Ho Chi Minh City University of Technology students. Also trialling of those systems at external stakeholders | Enhance the capacities for researchers from the participating countries to engage in trans-disciplinary action-research related to critical sustainability challenges. |

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| | premises have been conducted successfully. | |
| **Objective 4**<br>○ Conducted capacity-building, educating about constructed wetlands, and even cultivating effective Microorganisms (Bokashi) for the application in constructed wetland and local community use in the Philippines.<br>○ Conducted social acceptability surveys and focus group discussions in all three countries.<br>○ Three Resource pages providing the details of survey and questionnaires used have been published within the project section of the APN website (Jegatheesan et al. 2023c, d,e) | Determined the community's promising stance on applying nature-based solutions for water treatment. | Raise awareness of local stakeholders of the potential of nature-based water treatment to contribute to addressing critical sustainability challenges. |
| **Objective 4**<br>○ Prepared four videos and five brochures on floating wetlands, constructed wetlands, green roofs and plant selection for floating wetlands.<br>○ A report summarizing the offshoots of the project is published within the project section of the APN website (Jegatheesan et al. 2023f)<br>○ A manuscript providing the details of the project has been submitted to APN Science Bulletin for peer review and publication (Jegatheesan et al. submitted) | These activities contribute to knowledge dissemination, education, and awareness in nature-based water treatment technologies, potentially influencing further research, implementation, and policy development.<br>They create awareness on the construction/installation of floating wetlands, green roof and constructed wetlands. | **Knowledge Dissemination**: Help in disseminating valuable information to a wider audience. This can particularly benefit those looking to implement or learn about these technologies.<br>**Educational Outreach:** Videos and brochures are accessible and be engaging educational tools. They can serve as valuable resources for students, researchers, practitioners, and the general public who seek to understand or work with these technologies. The educational impact can be long-lasting.<br>**Increased Awareness:** These materials can raise awareness about the importance of nature-based water treatment solutions. Greater awareness can lead to increased interest and adoption of these technologies, potentially contributing to improved water quality and environmental sustainability.<br>**Accessible Resources:** The resource page on the APN |

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| | | website provides a centralized location for information related to the project's outcomes. This ensures that the project's insights and findings are readily accessible to a wide audience, contributing to knowledge sharing and collaboration.<br>**Peer-Reviewed Publication:** Submitting a manuscript to the APN Science Bulletin for peer review and potential publication is a significant step in academic and scientific recognition. When published, it can enhance the visibility and credibility of the project, encouraging further research and collaboration in this field.<br>**Legacy and Impact:** The project's outcomes, including the videos, brochures, resource page, and potential publication, leave a lasting legacy. They contribute to the body of knowledge in nature-based water treatment and will likely continue to benefit communities, researchers, and policymakers well into the future. |

## 4. Key facts/figures

72 early-career professionals and students trained:

- 40 students at Can Tho University were trained to construct and install floating wetlands in two canals
- 3 students at Ho Chi Minh City University of Technology were trained to construct and install green roofs
- 10 students at the University of the Philippines Los Banos were trained to research constructed wetlands
- 4 students were trained to conduct plant selection and monitoring the performance of floating wetlands at the University of Peradeniya
- 15 early-career professionals have been trained (7 from Vietnam, 3 from the Philippines, and 5 from Sri Lanka)

23 publications:

- 3 Journal articles
- 4 Book chapters
- 1 Book
- 4 Perspectives
- 9 Resources
- 2 Reports (including this final report)

29 Events held:

- 5 Quarterly meetings
- 6 National meetings (2 per year/country)
- 2 Regional meetings (in Ho Chi Minh City, Vietnam 2022 and in Manila, Philippines 2023)
- 2 Field Trips by the APN team during the regional meetings (to constructed floating wetlands at Bung Xang Canal installed by APN team members from Can Tho University and to the constructed wetland at Bayawan City which was one of the case studies of the project)
- 10 Focus group discussions (2 by Vietnam teams, 6 by Philippines teams, and 2 by Sri Lanka team)
- 4 Socio-economic surveys (1 by one of the Vietnam teams, 2 by SCPW, and 1 by the Sri Lanka team)

## 5. Publications

These publications are also cited as references in the text of this report:


i. Bui XT, Vo TKQ, Tran CS, Jegatheesan V, Nguyen TKN (2023). Guide to construct and install Green Roofs (GRs), Resources in in Asia-Pacific Network for Global Research. Retrieved from https://www.apn-gcr.org/publication/guide-to-construct-and-install-green-roofs-grs/

ii. Dang BT, Trang NTD, Thao VTP, Dieu NTN, Vo TKQ, Nguyen NKQ, Tran CS, Nguyen PD, Jegatheesan V, Bui HT (2022). Wastewater pollution in urban canals of Vietnam: Restoration using nature-based solutions. In: Pachova N, Velasco P, Torrens A, Jegatheesan V (eds.) Regional perspectives of nature-based solutions for water: Benefits and Challenges. Springer. pp. 127-174. https://doi.org/10.1007/978-3-031-18412-3_6

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iv. Hemalal DLHVW, Deegala HMSN, Jinadasa KBSN, Weragoda SK, Mowjood MIM, Jegatheesan V, Sanjeewani SN, and Chandrasekara SSK (2023). Guide for selecting plants for Constructed Floating Wetlands (CFWs) in Sri Lanka, Resources in in Asia-Pacific Network for Global Research. Retrieved from https://www.apn-gcr.org/publication/guide-for-selecting-plants-for-constructed-floating-wetlands-cfws-in-sri-lanka/

v. Jegatheesan V, Pachova N, Velasco P, Mowjood MIM, Weragoda SK, Makehelwala M, Trang NTD, Dang BT, Tran CS, Vo TKQ, Trang NTT, Pham H, Devanadera MC, Torrens A, Bui XT, Nguyen PD, Lecciones A, and Jinadasa KBSN (2023a). Co-development of an integrated assessment framework to evaluate the effectiveness and impact of selected nature-based water treatment technologies in Sri Lanka, The Philippines, and Vietnam, Environmental Quality Management, Vol.32(3), pp. 335-365. https://doi.org/10.1002/tqem.21922

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vii. Jegatheesan V, Pachova N, Velasco P, Mowjood MIM, Weragoda SK, Makehelwala M, Trang NTD, Dang BT, Tran CS, Vo TKQ, Trang NTT, Pham H, Devanadera MC, Estorba DS, Agaton C, Armengol AT, Bui XT, Nguyen PD, Lecciones A, and Jinadasa KBSN (2023c). Guide Questionnaire: Enhancing Water Resource Management in the Philippines, Resources in in Asia-Pacific Network for Global Research. Retrieved from https://www.apn-gcr.org/publication/guide-questionnaire-enhancing-water-resource-management-in-the-philippines/

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xii. Jegatheesan V, Velasco P, and Pachova N (Eds) (submitted) Water treatment in urban environments: a guide for the implementation and scaling of nature-based solutions - Examples from South/Southeast Asia, Applied Environmental Science and Engineering for a Sustainable Future Book Series, Springer Publisher.

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## 6. Media reports, videos and other digital content

Videos:

- Integrated Constructed Wetlands Framework: Advancing Implementation in the Philippines (1 September 2023) https://www.youtube.com/watch?v=De2V-JMZT_o
- Constructing and Installing Green Roofs: A Guide and Demonstration (31 August 2023) https://www.youtube.com/watch?v=0-BvivSNbWc
- Guide for Selecting Plants for Constructed Floating Wetlands (CFWs) in Sri Lanka (31 August 2023) https://www.youtube.com/watch?v=vZKzTwZj-yY
- Transforming Urban Water Treatment: Exploring Constructed Floating Wetlands in Vietnam (10 August 2023) https://www.youtube.com/watch?v=8NoFzaalCkM

## 7. Pull quotes

**Project Leader: Professor Veeriah Jegatheesan**

One of the most remarkable projects I've had the privilege to be part of, collaborating with an exceptionally cordial team from the Philippines, Sri Lanka, and Vietnam. We achieved outstanding results and significant impacts within a short time and with limited resources. The extensive support and active participation from collaborators and stakeholders worldwide played a pivotal role in shaping the project's direction and generating valuable outcomes. These cherished memories of collaboration, knowledge sharing, and the enduring impacts on replicating nature-based solutions for water treatment will be a lasting inspiration. I am extremely thankful to APN for Global Change Research for funding the project and the APN staff for their great support to the project.

**A member of the research team: VO THI PHUONG THAO (MSc student)**

I feel privileged to be part of this APN project with my supervisor, Assoc. Prof. Dr. Ngo Thuy Diem Trang. It has provided me with essential knowledge in nature-based wastewater treatment research and practical research experience. The project also allowed me to engage with experts, participate in seminars, and exchange valuable insights. I'm grateful to the APN Project for helping me complete my Master's thesis. These experiences and achievements hold great significance as I approach graduation, serving as an enduring source of research inspiration and cherished memories.

**Mr Nguyen Tien Anh - Rice Seed Center, Agricultural Seed Centre, Vinh Long province, Vietnam**

We would like to extend our heartfelt gratitude to the dedicated lecturers and researchers of the APN project team for their unwavering guidance and support in implementing the locally adapted model of constructed floating wetlands (CFWs). This model represents an innovative and eco-friendly approach to water treatment, offering a cost-effective and practical solution. The CFW model has yielded tangible results by effectively addressing water pollution issues, including the absorption of fertilizer residues, pesticides, and other contaminants. Participating in the implementation of this model has not only been a practical endeavor but also a valuable opportunity for both myself and those in my community to engage with experts, specifically the esteemed lecturers from the College of Environment and Natural Resources at Can Tho University. This engagement has broadened our knowledge of environmental solutions, particularly the use of CFWs for wastewater treatment. We are optimistic that this project will persist and extend its reach in the future, contributing to a more environmentally sustainable world.

## 8. Acknowledgments


- Mr. Nguyen Tien Anh at Rice Seed Centre, Agricultural Seed Centre, Vinh Long province, Vietnam for trialling constructed floating wetlands in the canal adjacent to the Agricultural Seed Centre.
- 40 Students from Can Tho University for their contributions to construct and install constructed floating wetlands.
- Ho Chi Minh City University of Technology and Vietnam National University Ho Chi Minh for their contribution in the green roof trials at Ho Chi Minh City.
- Local government unit (LGU) of Bayawan City, Engineer Antonio Aguilar, LGU of Pangil, Laguna, and Panguil Eco-park management for data gathering and for co-hosting APN activities.
- LP4Y team at Green Village, Calauan Laguna, particularly Sonny Author, Paul Dizon, and Pierre Delaporte, for their contributions in the retrofitting of their constructed wetlands.
- Basic Needs Services, Inc. Philippines for their invaluable database on green filters (included in the mapping).
- Sri Lanka team would like to extend their appreciation to the following:
  Mr. A.C.M. Nafeel (Additional Secretary, Ministry of Water Supply), Dr. (Eng.) N.S. Wijeratne (Deputy General Manager, Sri Lanka Land Reclamation and Development Corporation), Dr. Shamen Vidanage (Country Representative, IUCN), Eng. Mrs. K.A.D.K. Dheera (Director, Central Province, Irrigation Department, Kandy), Eng. Mr D.N.D.S. Gunatileke (Additional General Manager, Water Reclamation, National Water Supply and Drainage Board), Mr. Anura Bandara (Additional Secretary, Sri Dalada Maligawa, Kandy) Mr. P. Massumaarachchi (Deputy Commissioner, Kandy Municipal Council), Eng. Mr. Gayan Jayasekara (Chief

Engineer, Kandy Municipal Council), Mr. M.A.B.C. Alokabandara (Commissioner, Kurunegala Municipal Council), Eng. Mrs. H.G.D. Amarasinghe (Chief Engineer, Kurunegala Municipal Council), Eng. Mr. D.M.B Dissanayake (Engineer, Kurunegala Municipal Council), Mr. Harshana Jatasiri (Deputy Commissioner, Kurunegala Municipal Council), Eng. Mr. D.S.N. Jayanayaka (Chief Engineer, Irrigation Department, Kurunegala), Eng. Mr. I.R. Gamage (Manager, Kurunegala Water Reclamation Section, National Water Supply and Drainage Board), Eng. Mr. D.M.B.T.B. Dissanayaka (Senior Engineer, Kurunegala Water Reclamation Section, NWSDB), and Mr. E.M.S.B. Ekanayaka (Director, Urban Development Authority, Kurunegala)

- The project team would like to thank the following for serving as guest speakers during the project quarterly meetings:
  Engr. Asoka Ajantha, Engr. Dhanesh Gunathilake, Mr. Albert A. Magalang, Prof. John Robert Kemmel Argue, Dr. Christopher Walker, Prof. Magdalena Gayewska, Brigadier, K.M.S. Kumara, Ms. Yolanda Gomez, Jeremy Rudd, Fany Wedahuditama, Mr. A.C.M. Nafeel, Dr. Anuradha Jayaweera, Engr. Donny Rey Camus, Nuria Moncada, Doug Warner, Anh Tuấn Nguyễn, Assoc. Prof. Casper Boongaling Agaton, Patricia Marie Caparas Guila, Prof. Ignasi Rodriguez-Roda Layret, Dissanayake D.M.B.T.B., Rey J. Casas, and Anne Dominique Hitape Rodriguez.
- Dr. Renzo Mori Junior at RMIT University for assisting in creating the project webpage on the RMIT website.
- APN staff Dr. Linda Anne Stevenson, Dr. Nafesa Ismail, Ms. Aiko Seki and Ms. Naomi Young for their great support and timely responses to our requests.