

RESEARCH COLLABORATION OPPORTUNITY

*“Determination of nutrient and water budgets and surface energy fluxes
in urban and forest ecosystems”*

1. Invitation

- 1.1 The National Parks Board (NParks) is inviting potential research collaborator(s) to submit proposals for grant funding, under the research topic “Determination of nutrient and water budgets and surface energy fluxes in urban and forest ecosystems”.

2. Research Topic

- 2.1 Please refer to **Annex A** for the details of the research topic.

3. Eligibility

- 3.1 Researchers from all Singapore-based research institutions or companies are eligible to apply.
- 3.2 The Lead Principal Investigator (“PI”) must be based in Singapore¹. All research work should be undertaken in Singapore, unless expressly approved by NParks. The Lead PI may involve researchers from other institutions or companies in the proposal.
- 3.3 The research team should possess the necessary expertise to address the objectives of the proposal. The PI is encouraged to engage other researchers outside his/her lab to develop a comprehensive proposal that addresses the stated objectives. Proposals that only address the objectives partially will not be considered favourably.
- 3.4 The PI is also encouraged to collaborate with industry partners, where relevant, to develop innovative solutions that address the stated objectives and demonstrate strong potential for real-world application within and beyond Singapore.
- 3.5 Proposals already funded by other government agencies will not be considered for funding. Proposals with similar scope to proposals or projects which are currently under evaluation by other funding initiatives, must be declared in the proposal submission, and will not be considered until the results from the other funding initiatives are finalised. PIs are encouraged to describe the synergies between past or current projects and this proposal.

¹ Lead PIs must have an employment contract of a minimum of 9 months’ future employment (calculated from the date of the submission of the proposal) with a Singapore-based organisation (e.g., Singapore-based Institutions of Higher Learning (IHLs), not-for profit research laboratories as well as companies and company-affiliated research laboratories/institutions). The Lead PI must also fulfil at least 6 months of residency in Singapore over a period of 1 calendar year, from the date of proposal submission throughout the project.

4. Funding Support

- 4.1 The proposed budget should not exceed the funding support limit stated in the **Annex**. Proposals exceeding this limit will be regarded as ineligible.
- 4.2 The proposed budget should be based on realistic costings with appropriate justifications. The reasonableness of the budget will be considered in the assessment of the proposal and may be subjected to amendments and revisions.
- 4.3 When budgeting for funding, the total cost of the project should include all approved direct costs² and indirect costs³. All expenditures should be budgeted inclusive of any applicable Goods and Services Taxes (GST) at the prevailing rates, where applicable. No additional claims for GST will be reimbursed.
- 4.4 Direct costs are incremental cost required to execute the programme. Supportable direct costs can be classified into the following cost categories:
- (a) Expenditure on manpower (EOM);
 - (b) Equipment;
 - (c) Other Operating Expenses (OOE); and
 - (d) Overseas Travel.
- 4.5 For all direct cost items proposed for the project, please note that:
- (a) Funded Institutions must strictly comply with their own procurement practices;
 - (b) Funded Institutions must ensure that all cost items are reasonable and are incurred under formally established, consistently applied policies and prevailing practices of the funded Institution; and
 - (c) All items/ services/ manpower purchased/ engaged must be necessary for the R&D work.
- 4.6 The Lead PI should exercise due diligence and ensure that the proposed budget is correct and free from error.
- 4.7 Please ensure that proposed equipment to be purchased are currently unavailable in the funded Institution or institution of collaborators. In the event where a similar equipment is available in a funded Institution, necessary justifications for purchase have to be provided, and NParks' explicit approval has to be obtained. Equipment purchased using NParks' funding support needs to be available for NParks' use during the project as needed.
- 4.8 At the end of the project, NParks shall have the option to own any equipment purchased using NParks' funding support at no transfer cost.

² More information on the non-fundable direct costs of research can be found in **Annex B**.

³ Indirect costs are costs that are incurred for common or joint objectives and therefore cannot be identified readily and specifically with a particular sponsored research project but contribute to the ability of the Institutions to support such research projects (e.g. providing research space, research administration and utilities), and not through the actual performance of activities under the sponsored projects.

- 4.9 NParks will support 100% of the approved qualifying direct costs of a project for Singapore-based IHLs / public RIs. Private sector entities⁴ will qualify for up to 50% of the approved qualifying direct costs of a project, depending on the entities involved:
- (a) 30% for all non-Singapore entities based in Singapore (including non-Singapore not-for-profits) and Singapore-based Large Local Enterprises; and
 - (b) 50% for Singapore-based Small, Medium Enterprises and start-ups.
- 4.10 Support for indirect costs, in the form of overheads, will only be provided for Singapore-based IHLs / public RIs. Funding support of 30% of the total qualifying approved direct costs will be allowed. Funded Institutions will be responsible for administering and managing the support provided by NParks for the indirect costs of research. Indirect costs must be specifically provided for in the grant, and approved by NParks based on the nature of the research.

5. Evaluation of Proposals

5.1 Proposals will be evaluated based on the following criteria:

(a) **Strength & Quality of Proposal**

- *Research Approach* – The proposal should demonstrate clear relevance to addressing the research objectives and expected deliverables stated by NParks. The methodology is technically sound and appropriate for addressing the research topic. The proposed research builds upon outcomes of published research and/or other ongoing/past research.
- *Potential for Application, Deployment or Commercialisation/Export* – The proposed research should generate outcomes that are suitable for deployment or application (e.g., for policy, operational, commercial needs), both in Singapore and globally.
- *Execution Plan* – The proposed plans to execute the research, and to facilitate the deployment or application of the research outcomes, should be clear and practical to implement. The proposed timeline should be reasonable and achievable, with the project outcomes produced in a timely manner. The proposed budget should be reasonable and based on realistic costings to achieve the research deliverables.

(b) **Strength & Quality of Research Team**

- The proposed research team composition should have the relevant expertise and experience to effectively fulfil all project tasks.

(c) **Value-Added Research Components**

- Proposals which demonstrate scientific novelty and potential for scientific breakthrough / innovation, and with added research outcomes (exceeding those in the expected deliverables stated by NParks) deemed of value to NParks, will be favourably considered.

⁴ Definitions of the different private sector entity types can be found in **Annex C**.

- 5.2 Proposal submissions will be subject to evaluation by a Project Evaluation Panel appointed by NParks. NParks may also decide to send the research proposal to third-party reviewer(s) for comments.
- 5.3 NParks reserves the right, at its sole discretion, not to select any of the proposals submitted for this Research Collaboration Opportunity for funding. NParks may require proposals to be revised as it sees fit to enhance research outcomes, facilitate integration of research concepts and technologies, and optimise funding resources. **NParks' decision on project and funding support will be final** and shall be abided by the applicants.

6. Project and Funding Agreement

- 6.1 Before the start of any project, a research collaboration agreement ("RCA"), or a similar agreement, setting out the full responsibilities and obligations of collaborators, will be signed between the institution of the Lead PI and NParks.
- 6.2 For an institution acting as a party to the Singapore Public Sector Organisations Master Research Collaboration Agreement ("MRCA"), a Project Agreement ("PA") will be signed between the institution of the Lead PI and NParks.

7. Submission Instructions

- 7.1 All project proposals for this Research Collaboration Opportunity must be submitted using the prescribed Project Proposal Template, and in Microsoft Word format, to Sorain_Ramchunder@nparks.gov.sg by **31 May 2024, 2:00pm, Singapore time (UTC +08:00)**. **Late submissions will not be entertained, and submissions received through other means will not be considered.**
- 7.2 Files must be named in the following convention: *FP_<RCO Number>_<Name of Lead PI>*
- 7.3 Full proposals and supporting documents shall only be deemed to be submitted if all relevant forms with relevant attachments are submitted. Incomplete or non-compliant submissions may be considered disqualified. Please refer to the Project Proposal Template in **Appendix 1**.

8. Enquiries

- 8.1 For transparency, all enquiries and associated clarifications will be published on the NParks website for the Research Collaboration Opportunity. We regret that phone enquiries will not be accepted.
- 8.2 For any enquiries or clarifications, please contact Sorain_Ramchunder@nparks.gov.sg.

ANNEX A

Research Collaboration Opportunity Ref No.: RCO-NPARKS-2024-01

Research Topic: Determination of nutrient and water budgets and surface energy fluxes in urban and forest ecosystems

1. Background

- 1.1 The flux of materials such as Carbon (C), Nitrogen (N), Phosphorus (P), water and energy through various components in an ecosystem are fundamental processes that underlie the resilience of ecosystems and the benefits that ecosystems provide for people.
- 1.2 Nutrient and water cycles and surface energy fluxes are dynamic and subject to fluctuations due to weather patterns, climate variations and environmental changes associated with urbanisation and climate change. Therefore, long-term data collection and monitoring is required to get accurate estimations of rates and to discern any differences or temporal trends.
- 1.3 As part of the Cities of Tomorrow City in Nature research vertical, a project has been awarded to study nutrient releases and fluxes from leaf litter to the soil in Singapore's forest and urban green spaces. While this research will provide insights on nutrient fluxes occurring at the vegetation-soil interface, little is known about the hydrological pathways that transport nutrients at the soil-water interface, as well as the surface energy fluxes that occur between the vegetation and the atmosphere.
- 1.4 A key contribution of City in Nature vision to the liveability of Singapore is the application of nature-based solutions to enhance the city's environmental quality. Strategies such as the expansion of the Nature Park Network, intensification of nature in gardens and parks, forest restoration, cultivation of high-diversity, high density landscapes and strengthening ecological connectivity between Singapore's green spaces can provide environmental benefits that include mitigating urban warming, sequestering and storing carbon and strengthening stormwater retention while minimising discharge into drainage systems. However, such strategies are likely to influence nutrient and water cycles in different types of ecosystems (Fig. 1). Similarly, energy fluxes between the land surface, vegetation and atmosphere are expected to be influenced by the extent and types of vegetation introduced (Fig. 1). The extent to which benefits from nature-based solutions are realised are thus influenced by the fluxes of carbon, nutrients, water and energy. At the same time, ecological responses of different ecosystems to environmental drivers such as climate change and urbanisation are also mediated by such fluxes.

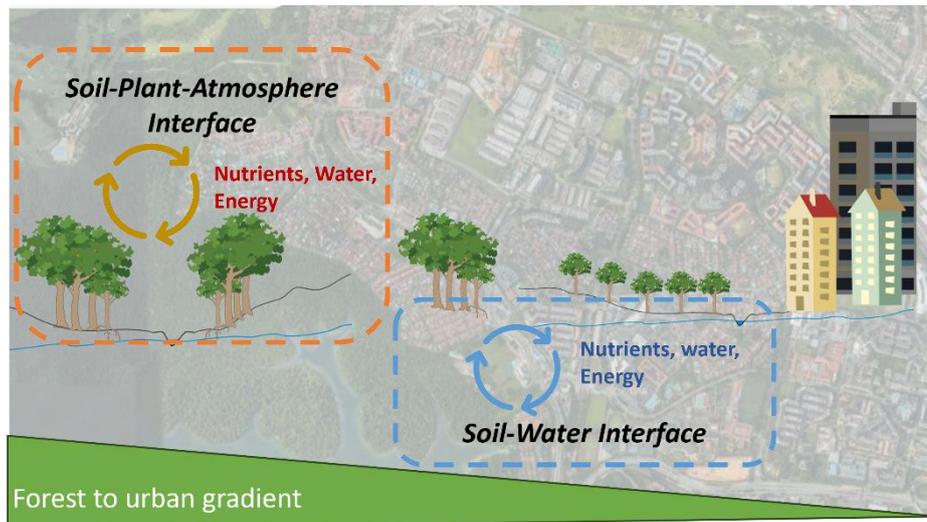


Fig 1. Different types of vegetation, such as primary forest, degraded forest and manicured landscapes can have varying nutrient, water, and energy fluxes at different interfaces.

- 1.5 However, we currently lack data on the rates of these fluxes for major types of greenery in Singapore, leaving us without baselines for comparison. This data gap hinders our capacity to refine greenery management strategies, particularly for enhancing nutrient control and thermal comfort.
- 1.6 The project aims to compare fluxes of nutrients, water and surface energy in forested areas to greenspaces where naturalistic, high diversity/density landscaping has been implemented, to areas that are more conventional in terms of urban landscaping (Fig 2). To achieve this, the project will monitor the levels of these fluxes along a forest-urban gradient, measure the effects of City in Nature strategies on these fluxes at different spatial scales and investigate the impact of these fluxes on the ecological functioning of Singapore's forest and urban ecosystems. It includes quantifying the fluxes of nutrients, stable isotopes at the soil-water interface and surface energy fluxes at the soil-vegetation-atmosphere interface (Fig. 1). Monitoring systems such as eddy covariance should be considered. Study sites should include the Long-Term Sites such as Jurong Lake District, Jurong Lake Gardens, Central Catchment Nature Reserve, Bishan Ang-Mo Kio Park, Bishan Ang-Mo Kio District, Singapore Botanic Gardens and the Tanglin-Orchard District (Fig 3).



Fig 2. Examples of greenspace types that are of interest to this study.

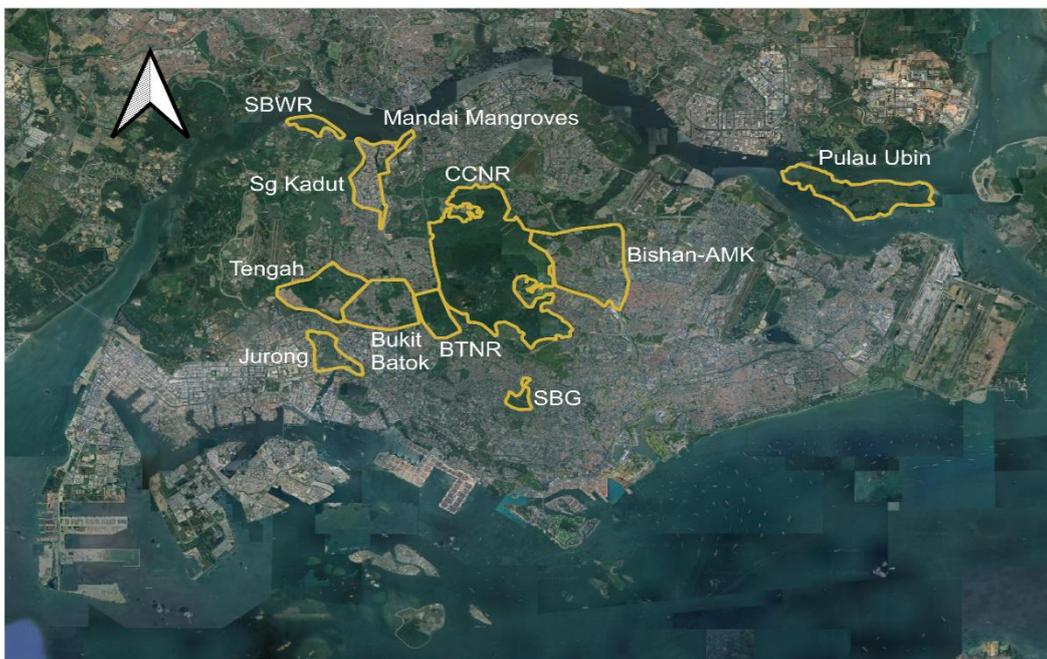


Fig 3. Locations of long-term forest and urban ecosystems that can be used as study sites to determine the nutrient and water budgets and surface energy fluxes.

2. Objectives

- (a) To develop a cost-effective and robust long-term monitoring system for the nutrients and water fluxes at the soil-water interface and surface energy fluxes between the land surface, vegetation and atmosphere.
- (b) To determine and compare baseline rates of these nutrients, water and surface energy fluxes along a forest to urban gradient:
 - (i) Across major forest types: primary forest (as reference baseline) against native-dominated and exotic-dominated secondary forests.
 - (ii) Between forest and urban greenspaces (parks and streetscapes).
 - (iii) Between naturalistic, high density/diversity plantings versus more conventional planting schemes in parks and streetscapes.
- (c) To identify and test suitable indicators/tools (e.g., Net radiation, Ground heat fluxes, Bowen's Ratio, Water Use Efficiency, Nutrient Use Efficiency, Mass balance models)

that can be used to quantify the suitable fluxes to allow monitoring of the long-term impacts of City in Nature on these fluxes:

- (i) At different spatial scales, from plot to region and city.
 - (ii) Between major forest types and urban greenspaces.
 - (iii) Optional objective: Explore the development of a predictive tool which can predict changes in nutrient, water and energy fluxes arising from future changes in land cover, including in the types of green spaces.
- (d)** To develop guidelines for greenery planning and design to improve nutrient, water and surface energy cycling.

Projects are also encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.

3. Minimum Project Deliverables

3.1 The deliverables described here represent the minimum outcomes arising from the proposed project:

- (a)** Set-ups and protocols for long-term monitoring of: (i) the hydrological pathways involved in transporting nutrients at the soil-water interface, and (ii) surface energy fluxes associated with the vegetation and atmosphere.
- (b)** Hydrochemical and surface energy balance models for different vegetation types with diurnal and seasonal resolutions.
- (c)** Development and validation of indicators to quantify the suitable fluxes to allow monitoring of the long-term impacts of City in Nature on these fluxes. At least one indicator (Bowen Ratio) should be tested.
- (d)** Models for quantification of the relationships between nutrient, water and surface energy fluxes on the ecosystem performance (nutrient cycling, water cycling and surface energy balance of forest and urban greenspaces).
- (e)** Final report with literature review, must cover all the above deliverables, integrate results of comparisons between forest and greenspace types, and provide guidelines for forest and urban greenery management, including which monitoring methodology to adopt that is most cost-effective in Singapore's context.
- (f)** Publications in top scientific journals of relevant fields.
- (g)** Workshops and presentations for demonstration of monitoring protocols, dissemination of information and other forms of knowledge transfer.

Projects are also encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.

4. Funding Support and Duration

4.1 The Call for Proposals offers funding support up to S\$2.675 million (including all direct and indirect costs). Proposals that exceed this limit will not be considered.

- 4.2 This Call for Proposals offers funding support for a period up to 3 years, but the proposed project duration can be shorter depending on the proposed workplan.
- 4.3 NParks' decision on the funding support to be awarded for this project is final.

ANNEX B

Non-Fundable Direct Costs of Research

This list may be subject to revision.

Type of Expenses	Description
Salaries of Lead PIs / Investigators / Project Leads	Not allowable, to ensure no double-funding of salaries and related costs, as the salaries are already supported from other sources (e.g. faculty salaries are supported separately by the IHL as it is in support of the IHLs' core mission).
Salaries of teaching staff / teaching substitutes	Not allowable, as this is already being supported from capitation grants.
Undergraduate tuition support	Not allowable, as this should be supported under the respective scholarship grants and bursary schemes.
Salaries of general administrative support staff	Not allowable, as this is an indirect cost*.
Costs related to general administration and management	Not allowable, as this is an indirect cost*. This includes common office equipment, such as furniture and fittings, office software, photocopiers, scanners and office supplies.
Costs of office or laboratory space	Not allowable, as this is an indirect cost*. This includes renovation/outfitting costs, rent, depreciation of buildings and equipment, and related expenditures such as water, electricity, general waste disposal and building/facilities maintenance charges.
Personal productivity tools & communication expenses	Not allowable, unless the use of mobile phones and other form of smart devices were indicated in the methodology for the Research/I&E Project. All other costs under this expense type is an indirect cost*.
Entertainment	Not allowable, as this is an indirect cost*.
Refreshment	Not allowable, unless this is related to a hosted conference or workshop for the Research/I&E Project. All other costs under this expense type is an indirect cost*.
Audit fees (Internal and external audit) and Legal fees	Not allowable, as this is an indirect cost*.
Fines and Penalties	
Professional Membership Fees	

Staff retreat and team-building activities	
Patent Application	Not allowable, as this should be supported from overheads given to I&E Office (IEO)*. This includes patent application filing, maintenance and other related costs.

* Note: Indirect cost items should be supported from overheads or other funding sources.

(Aligned with National Research Fund Guide, version w.e.f. Dec 2020)

ANNEX C

Definitions of Different Private Sector Entity Types

S/N	Type	Criteria
1	Non-Singapore entities based in Singapore	<ul style="list-style-type: none">• <30% local shareholding , determined by the ultimate individual ownership
2	Large Local Enterprises (LLEs)	<ul style="list-style-type: none">• ≥30% local shareholding; and• More than \$100M in annual turnover
3	Small Medium Enterprises (SMEs)	<ul style="list-style-type: none">• Have Group Annual Sales Turnover of not more than \$100M, or maximum employment of 200 employees• To qualify as an SG entity, the entity must also have at least 30% local shareholding, i.e. local equity held directly or indirectly by Singaporean(s) and/or Singapore PR(s)
4	Start-ups	<ul style="list-style-type: none">• Registered for less than 5 years at time of grant application• Has individual ownership of more than 50% at reference year; and• Employs at least 1 worker• To qualify as an SG entity, the entity must also have at least 30% local shareholding
5	Not-for-profits	<ul style="list-style-type: none">• Registered as a public Company Limited by guarantee, society or charity trust• Main purpose is to support or engage in activities of public or private interest without any commercial or monetary profit, and are prohibited from distributing monetary residual to their own members• To qualify as an SG not-for-profit, the entity must meet all 3 of the following criteria:<ol style="list-style-type: none">(1) Registered and physically present in Singapore;(2) Core funding (i.e. excluding competitive grant funding) is derived entirely/mostly from SG entities;(3) Managed by a Board, which is at least half appointed by SG entities

(Aligned with National Research Fund Guide, version w.e.f. 19 Jul 2021)