

Impact of blue/green infrastructure interventions and future land use scenarios on dynamic evolution of natural capital (Ref IAP2-18-104)

Heriot-Watt University: Institute for Infrastructure and Environment, Institute of Life and Earth Sciences, School of Energy, GeoScience, Infrastructure and Society

In partnership with **Newcastle University**

Supervisory Team

- [Professor Scott Arthur](#), Heriot-Watt University
- [Dr Vassilis Glenis](#), Newcastle University
- [Professor Teresa F Fernandes](#), Heriot-Watt University
- [Dr Sikhululekile Ncube](#), Heriot-Watt University
- [Dr Greg O'Donnell](#), Newcastle University

Key Words

Natural capital; blue/green infrastructure systems; ecosystem services; environmental assessments; urban planning.

Overview

The natural capital and ecosystem services concepts are a popular way of describing the multiple benefits we get from the natural environment. The publication of the Millennium Assessment in 2005 have, along with national publications such the UK National Ecosystem Assessment (2011), raised the profile of the importance and study of these concepts. Natural capital refers to the stock of natural features/assets - e.g. freshwater, land, soil, minerals, air, seas, habitats, biodiversity and processes which together provide the foundation for the flows of ecosystem services (Rouquette, 2016; Guerry et al., 2015; Natural Capital Committee, 2015). Ecosystem services are the flows of benefits such as food, flood regulation, climate regulation, recreational opportunities which people gain from natural ecosystems (Constanza et al., 2017).

Both global and national trends show that natural capital has been on the decline due to human influenced land use changes such as urbanisation

and natural resource depletion (Natural Capital Committee, 2015; Holt et al., 2015). Understanding of these concepts have led to an interest in the development of suitable metrics, models, datasets and tools for measurement of natural capital as well as assessing how it is changing overtime. The Natural Capital Committee suggests the concept of natural capital be tried in core environmental context such as urban settings. This PhD will take this research further, focusing on natural capital assessments and opportunities associated with different blue/green infrastructure systems for urban resilience and sustainability in light of future uncertainties associated with factors such as climate change, demographic changes etc.

Although urban expansion/intensification impacts on natural capital and the multiple benefits available to the urban population, it is recognised that blue/green infrastructure systems (e.g. rain gardens, swales, ponds etc.) can at least reduce these impacts (Hansen and Pauleit, 2014). While ecosystem services knowledge is already in use in urban planning, especially the multiple benefits from blue/green infrastructure systems (Meerow and Newell, 2017; O'Donnell et al., 2017), there is

still need for natural capital assessments at the relevant scales to inform planning decisions and outcomes (Cortinovis and Geneletti, 2018). Furthermore, the multifunctionality of blue/green infrastructure systems beyond addressing just one main issue such as urban flooding - in most cases, has not been adequately explored and accounted for (Cortinovis and Geneletti, 2018) yet blue/green infrastructure systems are often promoted on their multifunctionality potential compared to grey infrastructure (Hansen and Pauleit, 2014). The multifunctionality of green infrastructure is mostly traded-off for locational/technical/physical factors and this in turn influences the multiple benefit areas among the urban communities. The question is whether such multiple benefits are located where they are needed the most in a locality. While the quality and quantity of blue/green infrastructure is important, the Natural Capital Committee, 2015 also argues that its distribution and equity is of equal importance as it is usually the poor who lack access to good quality green infrastructure and associated multiple benefits.

The aim of this PhD is in twofold; firstly, to investigate how different blue/green infrastructure investment pathways and future land use change scenarios affect the dynamic evolution of natural capital and secondly, this study will also seek to compare the technical suitability location of blue/green infrastructure to where the multiple benefits from such intervention systems are needed the most (demand areas) in a locality as identified by local stakeholders. Working with key stakeholders such as local authorities, planning agencies, developers and local communities, this research will demonstrate natural capital assessments in practice. This will be based on case studies focussing on natural capital changes associated with existing urban expansion/intensification plans and different blue/green infrastructure investment pathways. Such an assessment will also aid planners and decisions makers to understand the interdependency between the natural environment, economy and society in the planning process. When undertaken as part of wider environmental assessments, natural capital assessments could ensure that natural capital is considered alongside built, financial, social and human capital in sustainable urban development.

Methodology

The PhD student will be expected to undertake original research on natural capital assessment and develop novel techniques and approaches which can be applied in practice. Understanding of natural capital and blue/green infrastructure systems requires biophysical knowledge on the elements of these concepts and approaches as well as a recognition of the multiple benefits provided to local communities – more suited to social sciences. In this regard the potential PhD candidate will tackle this challenge from both angles based on an integrated methodological approach (mixed research methods). Tasks such as mapping natural capital areas, locations of multiple benefit provision areas and blue/green infrastructure systems for example, will be complemented by knowledge of beneficiaries of these multiple benefits and stakeholder prioritised benefits.

There is growing interest in using practically applicable analytical tools that link the natural environment and society. A wide range of tools have recently been developed to analyse ecosystem services, natural capital and green infrastructure (see: tinyurl.com/y8teql9g). This PhD study will for example utilise tools such as the Natural Capital Planning Tool (NCPT) to assess the impact of proposed housing developments on natural capital and ecosystem services, and a GIS based analysis will be used to evaluate current and future natural capital spatiotemporal changes associated with different blue/green infrastructure investment pathways. Fieldwork will be undertaken to case study sites for activities such as verifying the natural capital maps, stakeholder consultations. A 6 month student placement will also be arranged with the Local Authority in the case study areas for an in depth understanding of the project focus and data collection.

Timeline

#	Research Activity	Y1	Y2	Y3	Y3.5 (6m)
1	Agree detailed aims	x			
2	Literature review	x	x	x	
3	Data Collection	x	x		
4	Data Analysis		x	x	
5	Training/Workshops.	x	x	x	x

#	Research Activity	Y1	Y2	Y3	Y3.5 (6m)
6	Progress meetings	x	x	x	x
7	Thesis writing and submission of drafts			x	x
8	Final thesis				x

Training & Skills

The student will receive and have access to the full variety of the extensive IAPETUS2-cohort training, including workshops and cohort meetings. This will enable the PhD student to develop broader transferable skills and knowledge.

As part of the PhD programme at Heriot-Watt University, the student will be offered training and development opportunities. It is anticipated that over the course of the PhD study, the student will develop knowledge skills and expertise to undertake independent research in his/her field or future employment in policy or practice. The student's training needs will be identified within the first year of study. These will be compiled into a training and development plan tailor made to the specific student needs and skills set. As part of annual progress monitoring, training undertaken will be recorded and discussed with the student. To develop key skills and expertise such training and skills development will broadly be on:

1. Subject specific training e.g. GIS, use of natural capital assessment analytic tools etc.
2. Research methods training e.g. qualitative or mixed research methods etc.
3. Development skills training (including professional and transferable skills) e.g. academic writing, publishing, presentation skills, viva training and stakeholder engagement etc.

References

Cortinovis C and Geneletti D. 2018. Ecosystem services in urban plans: What is there, and what is still needed for better decisions. *Land Use Policy*, 298-312.

Costanza, R., de Groot, R., Braat, L., Kubiszewski, Fioramonti, I., Sutton, L., Farber, P., & Grasso, S. 2017. Twenty years of ecosystem services: How far have we come and how far do we still need to go? *Ecosystem Services*, 28: 1-16.

Guerry, A. D., Polasky, S., Lubchenco, J., Chaplin-Kramer, R., Daily, G. C., Griffin, R., Ruckelshaus,

M., Bateman, I. J., Duraiappah, A., Elmqvist, T., Feldman, M. W., Folke, C., Hoekstra, J., Kareiva, Keeler, P. M., Li, B. L., Mckenzie, S., Ouyang, E., Reyers, Z., Ricketts, B., Rockström, T. H., Tallis, J., & Vira, B. 2015. Natural capital and ecosystem services informing decisions: From promise to practice. *Proceedings of the National Academy of Sciences*, 112, 7348-7355.

Hansen, R. & Pauleit, S. 2014. From Multifunctionality to Multiple Ecosystem Services? A Conceptual Framework for Multifunctionality in Green Infrastructure Planning for Urban Areas. *Ambio*, 43, 516-529.

Holt, A. R., Mears, M., Maltby, L. & Warren, P. 2015. Understanding spatial patterns in the production of multiple urban ecosystem services. *Ecosystem Services*, 16, 33-46.

Lennon, M., & Scott, M. 2014. Delivering ecosystems services via spatial planning: Reviewing the possibilities and implications of a green infrastructure approach. *Town Planning Review*, 85(5), 563–587.

<http://doi.org/10.3828/tpr.2014.35>.

Meerow, S., and Newell, J.P. 2017. Spatial Planning for multifunctional green infrastructure: Growing resilience in Detroit. *Landscape and Planning*, 159, 62-75.

Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Synthesis*. Washington (DC): Island Press.

Natural Capital Committee. 2015. *The state of Natural Capital: Protecting and improving natural capital for prosperity and well-being*, Third Report to the Economic Affairs Committee, England.

O'Donnell E, Woodhouse R and Thorne C. 2017. Evaluating the multiple benefits of a Newcastle surface water management scheme. *Proceedings of the Institution of Civil Engineers – Water Management*,

<http://dx.doi.org/10.1680/jwama.16.00103>.

Rouquette, J.R. 2016. *Mapping Natural Capital and Ecosystem Services in the Nene Valley*. Report for the Nene Valley NIA Project. Natural Capital Solutions.

Further Information

Professor Scott Arthur: Email:

S.Arthur@hw.ac.uk Tel: +44 131 451 3313