



Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin

Ollscoil Átha Cliath | The University of Dublin



nature+

Working with nature to provide solutions to
global challenges and ensure sustainability

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Vision

A world where Natural Capital stocks with multiple benefits for the economy, society and businesses are valued, sustainably used, renewed and restored.

Mission

We find new ways to gain and manage sustainable benefits from nature. We undertake research into solutions for the valuation, sustainable use and renewal of Natural Capital underlying ecosystem service supply and benefits. We investigate how natural, social, technological, built and financial capital combine to provide these benefits.

We research new tools and build the knowledge base for sustainable resource use in the circular economy and bioeconomy.

Drivers



- Population Growth
- Climate change
- Globalisation
- Economic Policy

Challenges



- Resource Limitation
- Natural Hazards
- Health
- Society

Solutions



- Sustainable Resource Use
- Nature-Based Solutions
- Education

What is Natural Capital?

Natural capital is the world's stocks of living and non-living resources, including air, soils, water, plants, microbes and animals. From these stocks, flow Ecosystem Goods & Services, these are outputs from nature which have a benefit and value to society.

The Approach

The Natural Capital Approach advocates measurement of impacts and dependencies on natural resources, in order to ensure that management does not erode natural capital stocks, and ensures sustainable flows of ecosystem goods and services into the future.

Goods and
Services

Economic
Opportunity

Natural
Capital



About Us

Nature+ is a multi-disciplinary team of researchers based in the School of Natural Sciences at Trinity College Dublin.

We develop transferable methods for accurately quantifying and managing natural capital, which underpins the flow of goods and services on which economic activities depend. By understanding the feedbacks between natural capital and climate systems, we can design future-proof solutions to ensure economic growth.

Why Work With Us

Based in the School of Natural Sciences, at Trinity College Dublin, Ireland's premier research-led academic institution, the Nature+ team have world-class expertise and research excellence. Our research expertise spans social, ecological, geographical and geological sciences. We explore cutting edge concepts, develop novel tools and applications, and exploit well-established interdisciplinary collaborations, nationally and internationally.



Interdisciplinary and Needs Focused



Why Trinity?

Diverse, robust and stable stocks of natural capital provide goods and services fundamental to production, environmental regulation and human well-being. Climate change and habitat degradation disrupt the flow of these services and ultimately threaten enterprises and livelihoods.

We need to move beyond existing solutions and interventions to mitigate risks from the environment and to the services provided by nature. New nature-based solutions offer opportunities for technological developments to alter and optimise the provision of services.

Tackling challenges requires an interdisciplinary approach, integrating social, economic, political and bio-geo-chemical systems.

“True sustainability needs a paradigm shift in behaviour of producers, consumers and service providers”

Founded in 1592, Trinity College Dublin is the number one university in Ireland, and ranked 88th in the world for the quality of its teaching and research. Knowledge created by Trinity is critical in shaping the education and opportunities we offer our students, and for the economic sustainability of Ireland itself. Through our Innovation and Entrepreneurship strategy Trinity seeks to harness and maximise the societal and economic benefits from all newly generated ideas and technologies.

Researchers in the School of Natural Sciences have received national and international recognition for their work, with €7.6 million of funding secured from European Commission research programmes since 2014, over €11 million from national funders, and €5.8 million from industrial sources. Natural Sciences researchers contribute to SFI Research Centres iCrag and BEACON, and are members of European and global research collaborations.

Nature+ People



Jane Stout

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Ecosystem services, nature-based solutions, natural capital approach



Yvonne Buckley

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Environmental decisions, pest management, ecosystem services, natural capital and climate change impacts



Mary Bourke

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Geomorphology, natural hazards



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Environmental governance: marine, water, energy transitions



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CASE STUDY

01 — Smart Agriculture

Trevor Hodkinson & Matt Saunders

The FAO has estimated that global food production needs to increase by 70% by 2050 to feed a human population of 9.6 billion. It will be difficult to achieve this level of production, given the agricultural land and freshwater requirements this will demand. Degraded ecosystems, pest problems and climate change all challenge global and local production goals.

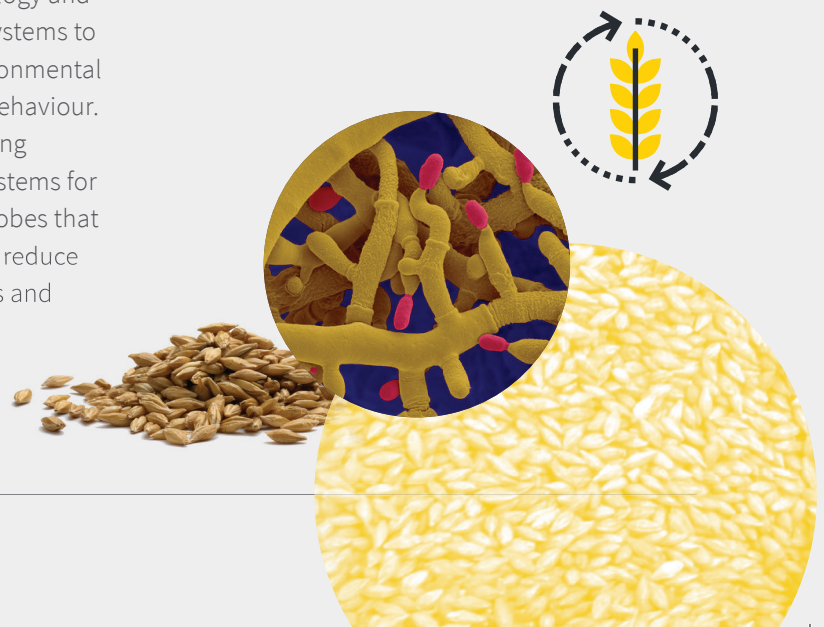
“By working with nature, using smart production systems, we can ensure sustainable food production.”

As an inter-disciplinary research team, we are developing smart agricultural technology and approaches to manage agricultural systems to maximise productivity, improve environmental conditions and influence consumer behaviour.

For example we are developing patented strains and seed delivery systems for endophytes (naturally occurring microbes that enhance crop growth and survival) to reduce agricultural inputs and improve yields and sustainability of farming systems.

Key discoveries to date:

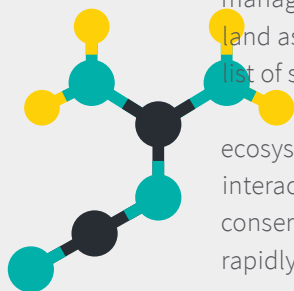
- + *Hyper-diversity in endophytes recovered from wild Irish relatives of barley*
- + *Yield increases and stress resistance recorded over 3 seasons.*
- + *Yields maintained with use of endophytes despite 50% decrease in fertiliser input.*
- + *Yield increased over 2 t/ha for some plots with use of endophytes and grain yield increases of up to 127% compared to controls.*



CASE STUDY

02 — Providing Clean Water

Jeremy Piggott & Ian Donohue



Freshwaters provide essential services to humans (e.g. drinking water, sanitation, irrigation for agriculture) but are one of the world's most degraded and threatened ecosystems. Effective freshwater policy requires managing for multiple human stressors – on land as well as in water – and an ever-growing list of substances of emerging concern.

By understanding how freshwater ecosystems respond to the individual and interactive effect of stressors, we can protect, conserve and even restore freshwaters in a rapidly changing world.

“Multiple stressors affect the ability of freshwater ecosystems to deliver clean water”

For example, we are studying how multiple stressors interact to affect the stability and resilience of freshwater ecosystems and how biodiversity can help to enhance the services provided by freshwater ecosystems to humanity.

Key discoveries to date:

- + *The effects of the nitrification inhibitor DiCyanDiamide (DCD) on aquatic environments*
- + *Agriculturally derived fine sediment is a master stressor in streams and rivers*
- + *Development of next-generation freshwater biological monitoring tools*
- + *Advancing stability-resilience and multiple-stressor theory*
- + *International network of experimental stream mesocosm facilities for multiple-stressor research*



CASE STUDY

03 — Resilience to Natural Hazards

Mary Bourke & Quentin Crowley

Climate change increases the frequency and intensity of natural hazards such as floods, wildfires, and landslides. These hazards impact on the lives and livelihoods of the population, and can incur significant economic costs for property owners, businesses and Governments. We need to improve our understanding and forecasting of natural hazards, while at the same time developing more appropriate responses to extreme events.

“Nature-based methods can help communities build resilience to floods”

For example we are working with communities to build resilience to floods using nature-based methods. Their approach adopts a more holistic understanding of catchment management and flood risk. By better understanding the physical, social and ecological aspects of different catchments, more site-specific and effective interventions can be designed to manage flooding. The potential benefits of this approach are that they foster new and productive collaborations between local communities, scientists, engineers, and local authorities, while

at the same time offsetting the need for more costly and controversial flood risk mitigation strategies.

Key discoveries to date:

- + *Developed innovative technologies for monitoring landscapes and communities during and after extreme events;*
- + *Designed innovative flood modelling techniques capable of incorporating local knowledge and experience of rivers and flooding;*
- + *Worked with communities to co-design and implement strategies for the effective use of nature-based solutions to flood events.*
- + *Developed methods for bringing together local communities, scientists, policy makers and local authorities for more effective catchment management.*



CASE STUDY

04 — Managing for Ecosystem Services

Yvonne Buckley, Jane Stout, Fraser Mitchell, Matt Saunders, Nessa O'Connor & Andrew Jackson

The environment and organisms that make up agricultural systems, grasslands, forests, rivers and urban systems provide us with many products and services including: food, fuel, carbon sequestration, building materials, clean water, climate control, waste processing and pollination as well as health and recreational benefits.

“Multiple services can be provided by the same ecosystem and management of that ecosystem can shift the supply of services.”

We use technical and conceptual advances to enable prediction of ecosystem service supply from different terrestrial, aquatic and marine ecosystems under different management actions. We investigate valuation approaches to provide decision makers with the information they need for investment and process decisions as well as financial and non-financial reporting on natural capital stocks and the ecosystem services they provide. We provide the knowledge base and tools to develop new markets for ecosystem services. We provide scientific advice to industry, civil society and government for the development of new approaches for quantifying and reporting

on natural capital stocks and ecosystem service provision.

Key discoveries to date:

- + *Developed cost effective Nature-Based solutions for biological indicators of freshwater quality*
- + *Designed the use of an ecosystem services “provider group” approach for assessing management effects on ecosystem service supply*
- + *Discovered effects of climate on plant population performance worldwide*



CASE STUDY

05 — Sustainable Blue Economy

Nessa O'Connor, Andrew Jackson, Quentin Crowley & Patrick Bresnihan

Global food security and reducing our reliance on fossil-fuel based energy sources are two of the largest challenges we face as scientists and a society. As an Island nation, we are poised to tackle such challenges building on our ocean wealth but our rudimentary understanding of the processes that underpin the functioning of our marine environment are limiting our ability to harness that wealth. A further challenge is to understand how marine ecosystems will function under changing environmental conditions. This information is essential to accurately predict our capacity to produce bioenergy, food and biomaterials from marine organisms (e.g. seaweed, shellfish). We have experience leading multidisciplinary projects that have produced science-based management plans for aquatic resource management and addressed specific industry needs for the sustainable development of our coastal resources with particular expertise in seaweed and bivalves.

Key discoveries to date:

- + *Developed methods for cultivating seaweed for biofuel*
- + *Management strategies to improve yields of bivalves (mussels, oysters) production*
- + *Designed monitoring tools for implementation of EU environmental legislation in coastal ecosystems*



CASE STUDY

o6 — Nature-based Urban Innovation

Anna Davies, Jane Stout, Marcus Collier, Patrick Bresnihan & Federico Cugurullo

Cities are where most of today's urgent social and environmental challenges occur - rapid climate change, efficient water and waste management, adverse health and well-being, changes in social cohesion and migration patterns. Nature-based solutions can address these challenges and provide opportunities for innovation.

“Nature-based solutions aim to ‘protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits’ (IUCN).”

They are solutions that are inspired and supported by nature that are co-created with urban communities.

We research how nature-based solutions can build resilient as well as greener, healthier cities, leading to a more sustainable living for all. We examine how green roofs and walls, street trees and pocket parks, sustainable drainage and rain gardens can provide a diverse range of natural benefits. These include reducing dust, toxins and noise, sheltering and cooling

property, sinking carbon and attenuating water. We also study how nature-based solutions can provide multifunctional spaces for recreation, fostering well-being, and a host of other social benefits. However, we need to know more about how they can augment or support biodiversity and species conservation, incorporate energy production and waste management, change behaviour, and boost social cohesion.

Key discoveries to date:

- + *open-access interactive SHARECITY100 database of urban ICT-mediated food sharing;*
- + *new methodologies for collaborative workshops on urban food sharing and sustainability;*
- + *development of new approaches for evaluating urban living laboratories;*
- + *Proximity to nature increases lifespan and improves public health*
- + *Recovery from serious illness such as cancer is augmented in natural surroundings*

CASE STUDY

07 — Environmental Monitoring Using Sensors

Jane Stout, Jenny McElwain, Matt Saunders & Mary Bourke

Environmental sensors are becoming cheaper, smaller and have a growing capacity to provide more accurate and highly resolved local environmental data at landscape scales.

Sensor networks

The energy costs of networking environmental sensors is also falling with the development of Low Power Wide Area (LPWA) networking technology. We are using IoT sensor networks to quantify the benefits of Nature-Based Solutions in both urban and rural settings to address questions such as:

- + What is the optimum planting plan on a city street to reduce glare, ameliorate local temperature and humidity?
- + What are the most appropriate tree species to reduce run-off in both rural and urban contexts under future climate change scenarios?
- + How can we better assess and upscale greenhouse gas emissions from natural and managed ecosystems?
- + What is the upper limit of change to the microclimate that nature-based solutions provide?

Biodegradable sensors

We are also researching the development of the ultimate in sustainable and fully biodegradable sensors by trying to better understand the sensing capacity of plants. Plants can sense the local temperature, humidity, light and atmospheric environment at a much finer resolution than any current artificial sensor available on the market.

“We are conducting research which aims to better understand, quantify and harness the sensing capacity of natural-based sensors”

We are using plants in order to detect pollution at trace levels in the indoor environment. We are developing a plant sensor kit for use in experimental climate chambers that are used widely in academia and industry in order to ensure that the climatic conditions programmed into experimental chambers are standardized and calibrated correctly so that all lab-based climate change experiments are rigorously controlled and repeatable.

Responding to disasters

The availability of drone technology has pushed the boundary of how technology can improve our ability to respond to disasters rapidly. Drones capture high resolution images of otherwise inaccessible landscapes so that appropriate rescue assessment can be made.

We collaborate with industry leaders to develop and deploy Unmanned Aerial Vehicles (drones) for measuring and monitoring landscapes and ecosystems. They use the data in natural hazards research, climate change impacts, seasonal-scale ecosystem changes and constructing topographic databases for flood flow modelling.

Terrestrial GHG dynamics

We are using multiple approaches to measure the carbon and greenhouse gas dynamics of terrestrial ecosystems to better determine the impact of climate, land use and management, plant functional type, phenology and disturbance on the mitigation of climate change. Fast-response and low cost sensors are deployed in combination with near-earth and satellite based remote sensing systems and biogeochemical modelling techniques, to enhance the spatial resolution of this data and to better inform land management practices in light of future climatic variability.



CASE STUDY

o8 — Sustainable Supply Chains

Jane Stout

Many raw ingredients used in the manufacture of food, pharmaceutical and cosmetic products derive from plant-based materials. Global trade of these ingredients affects both the livelihoods of the producers, manufacturers and consumers. As does reduced or unsustainable supply.

We are working with both on the ground producers, as well as manufacturers, ensure sustainability of supply chains.

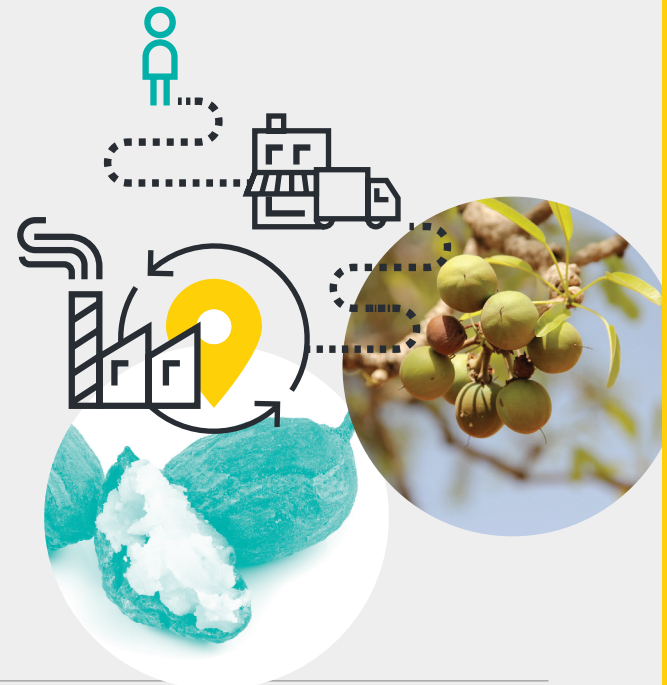
For example, shea butter, derived from the fruit of the shea tree in sub-Saharan Africa, is an important cosmetic, confectionary and pharmaceutical ingredient.

“Shea trees and the habitat in which they grow need to be sustainably managed in order to ensure fruit production.”

Degraded habitats, which do not support vital pollinating bees, may see sharp declines in fruit set. We are determining the local and landscape factors that affect the provision of pollination services by bees in order to inform local communities on best management practices to ensure maximum supply of shea butter.

Key discoveries to date:

- + *Shea is heavily dependent on bees for pollination*
- + *There is insufficient pollination to ensure maximum yield in many sites*
- + *Conservation of habitat to support native bees is urgently required*



How to Get Involved

Nature+ researchers will be happy to discuss research ideas with you. Just get in contact with ideas or questions, and we'll direct you to the researcher with the right expertise to address your issue.

If you already have a connection and want to know how to take it further, then the Trinity Research & Innovation team will be able to let you know all the ways in which we can make that possible.

Funding Mechanisms

Funding for research collaborations between researchers and your organisation come from Science Foundation Ireland, and Enterprise Ireland. This can significantly reduce the cost of a project that you have in mind, or enable new activities that you wouldn't otherwise be able to justify.

Projects can take a variety of forms, but some possibilities are:

- + Working together to develop new and improved products or services
- + Placements for researchers within your organisation
- + Joint training of doctoral researchers
- + Long term high level partnerships between your organisation and Trinity researchers
- + Collaborations can also lead to international consortia, with the possibility to bid for multi-million Euro European funding opportunities, and to access a range of new partners across the continent and beyond.

Who to Contact?

For questions about our work, and how our research can aid your company:

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For questions about opportunities for funding for your business:

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For general queries about research at Trinity College Dublin:

Research Development Office:

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