

Back to Office report – Study tour Taiwan

25/9/2026



Table of contents

Executive Summary	3
1. Feitsui Site, Taiwan Chang-Term Social Ecological Research (LTSER)	4
2. LTSER Changhua: Long-Term Socio-Ecological Research for Sustainable Coastal Futures	6
3. Taiwan LTSER International Conference: Knowledge to Action	11
4. Acknowledgements	14
5. References	15
6. Annex 1 Presentation to National Changhua University of Education	16
7. Annex 2 Presentation to Taiwan LTSER International Conference	32
8. Annex 3 Session Proposal to ILTER OSM Meeting	43

Executive Summary

This back-to-office report summarises a visit by Dr Jan Dick (UKCEH) to Taiwan from 14-21 September 2026 at the invitation of Prof Teng-Chui Liu, National Taiwan Normal University (tclin@ntnu.edu.tw) and colleagues from the Taiwanese Long-Term Socio-Ecological Research (LTSER) Network. During the visit, Dr Dick delivered a keynote presentation entitled “*Knowledge to Action*” at the first annual meeting of the Taiwan LTSER Network (front cover) and engaged with researchers and stakeholders across the network to strengthen international collaboration, exchange knowledge, and explore future opportunities for socio-ecological research and partnership.

Itinerary Dr. Jan Dick’s visit Taiwan 14-21 Sept 2026

Date	Itinerary	Location
9/14	Depart Scotland	Edinburgh
9/15	Arrive in Taiwan	Taoyuan/Taipei
9/16	Visit to the Feitsui Site, Taiwan Chang-Term Social Ecological Research (LTSEr)	TaipeiV
9/17	Visit to the Changhua Site, Taiwan LTSEr; Seminar at the Department of Geography, National Changhua University of Education, Taiwan	Changhua
9/18	Attend the LTSEr K to A Workshop and deliver a keynote/special lecture	Wanli, New Taipei City
9/19	Attend the LTSEr K to A Workshop and participate in discussions	Wanli, New Taipei City
9/20	Meeting/Discussion with the LTSEr team; Depart from Taiwan	Taipei
9/21	Arrive Scotland	Edinburgh

Taiwan's Long-Term Social-Ecological Research (LTSEr) program is a national initiative funded by the National Science and Technology Council (NSTC) to monitor and manage interlinked environmental and human systems for sustainability. The network merges top-down criteria (mandating transdisciplinary teams of natural and social scientists) with bottom-up site proposals from researchers.

The visit to the Feitsui LTSEr site demonstrated how long-term socio-ecological research is supporting evidence-based management of a critical water catchment that supplies drinking water to around five million people in Taipei. To protect water quality, government policies restrict the expansion of tea plantations and prohibit new housing or tourist developments. While these measures safeguard ecosystem services, they also limit local economic opportunities, contributing to an ageing population and the outmigration of younger residents. The LTSEr team is conducting intensive research on water quality and greenhouse gas emissions under different tea plantation management regimes, assessing the effects of varying fertiliser and pesticide inputs to identify more sustainable land management options (section 1).

The visit to the Changhua LTSEr site highlighted research examining the effects of wind turbine development on coastal dune dynamics and clam production, particularly where shifting sands influence local livelihoods. Researchers also described the social challenges facing the region, including population decline and increasing numbers of abandoned homesteads. During the visit, Dr Jan Dick delivered a seminar to students in the Geography Department at National Changhua University of Education (Annex 1), focusing on the opportunities, technical challenges, and ethical considerations associated with digital technologies. The presentation emphasised the importance of Responsible Research and Innovation (RRI) to ensure that digital tools are developed and applied in ways that are ethical, transparent, inclusive, and responsive to societal needs (Section 2, Annex 1)

The Taiwan LTSER International Conference, *Knowledge to Action*, was held on 18-19 September 2026 at the CT Greenbay Hot-Spring Hotel in Wanli District, New Taipei City. The meeting brought together representatives from all seven Taiwanese LTSER platforms, who presented their research in Mandarin with welcome translation support provided by Prof Teng-Chui Liu and Marco Chen (gxcmarco@gmail.com). Dr Jan Dick delivered a keynote presentation entitled *From Data to Impact* (Annex 2), which was simultaneously translated by a professional interpreter. To maximise accessibility, the key messages from each presentation slide were translated into Chinese as used in Taiwan using Microsoft 365 Copilot and subsequently reviewed by Prof Teng-Chui Liu. These measures were particularly valuable given that approximately 20% of attendees were estimated to have limited English proficiency (Section 3, Annex 2).

The conference provided an excellent opportunity for knowledge exchange across the Taiwanese LTSER network and stimulated discussion on future international collaboration. In particular, the forthcoming International Long-Term Ecological Research (ILTER) conference in Argentina in March 2027 was identified as an important platform for showcasing the innovative research and societal impact being delivered by the Taiwanese LTSER sites (Annex 3).

1. Feitsui Site, Taiwan

Chang-Term Social Ecological Research (LTSER)

The visit to the Feitsui LTSER site highlighted the importance of long-term socio-ecological research in supporting the sustainable management of one of Taiwan's most significant water catchments. The Feitsui watershed, centred on the Feitsui Reservoir in northern Taiwan, is a predominantly forested subtropical landscape that supplies drinking water to approximately 5-6 million people in the Greater Taipei metropolitan area. Researchers explained that, because of the critical importance of maintaining water quality, the Taiwanese government has implemented strict regulations that prohibit the expansion of tea plantations and prevent new construction within the catchment. The site integrates biophysical and social research, including studies of water resources, stakeholder governance, and social-ecological relationships. A major focus of the research programme is the generation of decision-ready evidence on the environmental impacts of tea cultivation. Through intensive monitoring of runoff from tea plantations managed under a range of production systems, from intensive conventional practices to organic management, researchers are assessing the effects of different fertiliser and pesticide regimes on water quality and greenhouse emissions from soil. This work provides an important scientific evidence base for balancing agricultural livelihoods with the long-term protection of a vital ecosystem service.



Feitsui study site showing typical landscape and river, in the company of Prof Teng-Chiu Lin, Prof Jr-Chuan Huang (River) and Dr. Li-Chin Lee.



Shu-Chuan Cheng serving award winning green and black tea, grown on her farm, which is the site of flux towers and soil measurements.

2. LTSER Changhua: Long-Term Socio-Ecological Research for Sustainable Coastal Futures

The LTSER Changhua platform was established to understand and monitor the long-term interactions between society and the environment along Taiwan's rapidly changing west coast. The region faces multiple challenges, including urbanisation, industrial development, aquaculture, groundwater extraction, land subsidence, pollution, biodiversity loss, climate change, and the impacts of renewable energy expansion. Through long-term socio-ecological observation and data collection, the platform provides an evidence base for understanding ecosystem change, human wellbeing, and sustainable governance. Its research supports decision-making on environmental management, coastal resilience, and Taiwan's energy transition while promoting the sustainable development of coastal communities and ecosystems.

The team (Table 1 <https://ltsertwchanghua.org/about/researcher>) showcased their work on the changing landscape and ecosystem of Changhua's coastal area, highlighting the influence of coastal dune dynamics on clam production relative to the building of a new wind farm. A walk around the area showcased the abandoned homesteads, the Seaside Skywalk which allows people to enjoy the landscapes of the mangrove forest and wetland ecology up close. The role of the planted mangrove forest on the local biodiversity and local recreation was highlighted.

Table 1 Team at LTSER Changhua platform who explained some of their work to Dr Jan Dick

Name	Role	email
Wang Su-Fen	Professor of Geography, National Changhua University of Education	sfwang@cc.ncue.edu.tw
Song Yu-Ling	Professor of Geography, National Changhua University of Education	yuling@cc.ncue.edu.tw

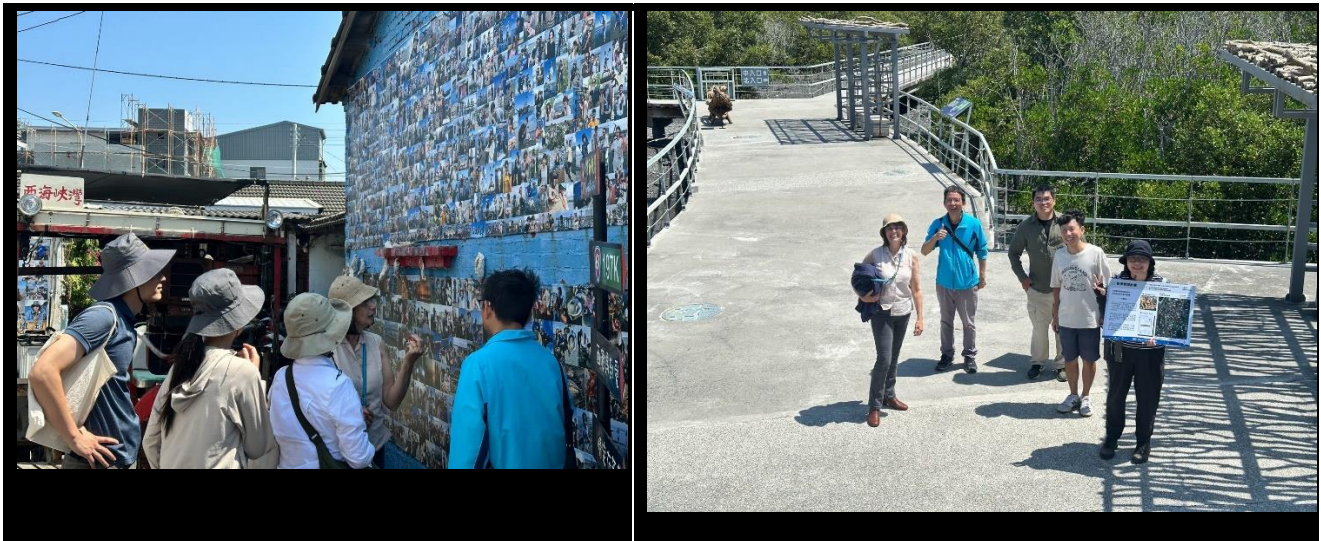
Chen Yi-Qing	Associate Professor, Department of Geography, National Changhua University of Education	yichinchen@cc.ncue.edu.tw
Chi Heng-Chang	Associate Professor, Department of Geography, National Changhua University of Education	hcchi@cc.ncue.edu.tw
Zeng Guang-Yu	Team researchers	brucetz1229@gmail.com
Pei-Chen Yang	Team Researcher	b9120504@gmail.com
You-Ting Liao	Team Researcher	tsubasa830@gmail.com
Wei-Chi Lin	Team Researcher	
Kun-Lin Li	Team Researcher	



Group of students and staff of Changhua in transport to tidal clam farms and explaining their research



Group of students and staff of Changhua on the shifting dunes



Group of students and staff of Changhua showcasing a local tourist business and the tourist walkway (Seaside Skywalk opened in 2021).



The Fangyuan mangrove forest spans nearly 30 hectares, primarily featuring black mangroves (*Avicennia marina*) and kandelia mangroves (*Kandelia obovata*). Researchers are assessing the influence on the local biodiversity <https://tourism.chcg.gov.tw/AttractionsContent.aspx?id=679&chk=96613160-5163-41b9-9273-7e69e88dc184&l=EN>

Dr Jan Dick gave a lecture to students of the geography department focused on responsible research and innovation (Annex 1).



*People
Nature
Better Futures*

Dr. Jan Dick
UK Centre for Ecology & Hydrology (UKCEH)
英國生態與水文中心

SPECIAL LECTURE

**Exploring Digital Worlds:
Models, Shadows and Twins,
Shaping the Future Responsibly.**

探索數位世界：從模型、映像到孿生，
形塑負責任的未來

2026年
9月17日 (星期四)
14:20 - 15:10

聲洋館三樓
沒課窩

Dr. Jan Dick 是英國生態與水文中心的資深科學家，長期領導跨領域研究，專注於長期觀測站中的人文社會與自然系統耦合。她具有社會學與社會生態學背景，擅長將權益關係人參與融入，深入探討自然與社會相互依賴的各種理論與實務層面。本次演講將結合其深厚的社會生態學研究與觀察，探討模型、數位映像與數位孿生在引領未來永續與決策上的關鍵角色。

MODELS
模型
for understanding

SHADOWS
映像
to reveal change

TWINS
孿生
for a better tomorrow

*Connected
Landscapes
Thriving Together*

*Science
for People,
Nature and a
Sustainable Tomorrow*

PEOPLE | LANDSCAPES | DATA | SOLUTIONS | RESILIENT FUTURES

Poster created to advertise the invited talk to the Geography Department of the National Changhua University of Education 17 Sept 2026



Student questioning Dr Jan Dick following the lecture and Prof Chen Yiqing presenting Dr Jan Dick with a thank you gift



Students and Staff of Geography Department of the National Changhua University of Education 17 Sept 2026

The students delivered the images shown in this report:

<https://drive.google.com/drive/folders/15Rs81HQhabC0OGdER9cygFHTJOThbGv1>
(photo)

<https://drive.google.com/file/d/1732w3UFjrUd-qcfLy-rhoqQRc3sOvBMn/view?usp=sharing>
(video)

<https://www.facebook.com/share/p/1JcWkxoSm7/?mibextid=wwXlfr>
(FB University of Changhua University of Education, Department of Geography)

3. Taiwan LTSER International Conference: Knowledge to Action

The Taiwan LTSER International Conference: Knowledge to Action (K2A) was held on 18-19 September 2026 at the CT Greenbay Hot-Spring Hotel, Wanli District, New Taipei City. The conference explored how long-term research findings, environmental observations, and transdisciplinary knowledge can be translated into actions that are accessible, relevant, and useful to society. Approximately 80 participants attended, representing the natural sciences, humanities and social sciences, government agencies, local organisations, and prospective data users. Through presentations, discussions, and informal knowledge exchange, participants examined how long-term socio-ecological research can help address contemporary sustainability challenges and strengthen connections between research and practice.

The evening poster session was particularly valuable. The posters provided a greater level of detail than was possible within the formal presentations, and presenters were highly approachable and enthusiastic in discussing their work. Communication was facilitated by the excellent English spoken by poster presenters, allowing extensive discussion and exchange of ideas. In addition to research posters, several displays highlighted developments in research data management, open science practices, and the activities of the Taiwan Sustainability Hub.

The conference was organised by Lila (Wan-Chen) Chung, Chief Executive Officer of the Taiwan Sustainability Hub, an initiative supported by the National Science and Technology Council (NSTC) of Taiwan. The Hub is based within the Centre for Condensed Matter Science, National Taiwan University, Taipei, and plays an important role in promoting data stewardship, interdisciplinary collaboration, and the translation of research knowledge into societal impact.



Dr Jan Dick giving a keynote address at the Taiwan LTSER International Conference: Knowledge to Action, 19 Sept 2026



Taiwan LTSER International Conference: Knowledge to Action

September 18–19, 2026 | CT Greenbay Hot-Spring Hotel, 1 Haijing Road, Wanli District, New Taipei City — Yingxi Hall & Rongyao Hall

September 18, 2026

Time	Min.	Session / Topic	Speaker / Presenter	Chair
12:40-13:00	20	Check-in		
13:00-13:15	15	Opening Remarks		Prof. Teng-Chiu Lin National Taiwan Normal University, Department of Life Science
13:15-13:45	20 + 10	Keynote <i>Knowledge to Action in Long-Term Social-Ecological Research</i> Q&A	Prof. Hsing-Sheng Tai Department of Natural Resources and Environmental Studies, National Dong Hwa University	Prof. Teng-Chiu Lin
13:45-14:25	20 + 20	Keynote <i>How is long-term socio-ecological research organised in the emerging European Research Infrastructure eLTER to promote inter- and transdisciplinary knowledge integration?</i> Q&A	Mag. Dr. Veronika Gaube (online) Eisenwurzen LTSER Platform; Institute of Social Ecology (SEC), BOKU University, Austria	Prof. Teng-Chiu Lin
14:25-14:40	15	Group Photo & Communication Break		

Time	Min.	Session / Topic	Speaker / Presenter	Chair
14:40-16:05	15 × 3 + 40	Site Presentations — Coastal & Island Systems • LTSER Changhua • LTSER SW Coast • LTSER Lyudao • Q&A	Changhua: Prof., Su-Fen Wang (Department of Geography, National Changhua University of Education) SW Coast: Research Fellow, Meng-Hsien Chen (Department of Oceanography, National Sun Yat-Sen University) Lyudao: Research Fellow, Chao-Lun Allen Chen (Biodiversity Research Center, Academia Sinica)	Prof. Teng-Chiu Lin
16:05-16:15	10	Health Break		
16:15-17:25	15 × 2 + 40	Site Presentations — Satoyama & Satoumi • LTSER Feitsui • LTSER Hualien • Q&A	Feitsui: Prof., Jr-Chuan Huang (Department of Geography, National Taiwan University) Hualien: Prof., Yu-Yun Chen (Department of Natural Resources and Environmental Studies, National Dong Hwa University)	Prof. Teng-Chiu Lin
17:30-18:00	20	Poster Setup		
17:30-19:00		Check-in		
18:00-19:00	60	Dinner		
19:00-20:30	90	Poster Session		

Taiwan LTSER International Conference: Knowledge to Action

September 18–19, 2026 | CT Greenbay Hot-Spring Hotel, 1 Haijing Road, Wanli District, New Taipei City — Yingxi Hall & Rongyao Hall

September 19, 2026

Time	Min.	Session / Topic	Speaker / Presenter	Chair
07:00-09:30		Breakfast		
09:30-09:40	10	Check-in		
09:40-10:10	20 + 10	Keynote <i>From data to impact: Translating LTSER science into local and global impact.</i> Q&A	Dr. Jan Dick Cairngorms LTSER Platform; UK Centre for Ecology & Hydrology (UKCEH)	Prof. Teng-Chiu Lin
10:10-11:20	15 + 15 + 40	Site Presentations — Indigenous Peoples • LTSER Alishan • LTSER Fengbin • Q&A	Alishan: Prof., Guo-Ching Weng (Institute of Wildlife Conservation, National Pingtung University of Science and Technology) Fengbin: Assoc. Prof., Umin Itei Tanohila (Department of Ethnic Relations and Cultures, National Dong Hwa University)	Prof. Da-Wei Kuan Department of Ethnology, National Chengchi University
11:20-11:30	10	Health Break		
11:30-12:20	50	Panel Discussion — From Aspirations to Reality: Internal Reflections Changhua Site • Alishan Site • Hualien Site • SW Coast Site • Fengbin Site • Feitsui Site • Lyudao Site • Indigenous Peoples Research Project • Q&A	Site representatives	Prof. Teng-Chiu Lin
12:20-13:30	70	Lunch		

4. Acknowledgements

The author is deeply indebted to Professor Teng-Chui Liu for the outstanding organisation of this visit and to the staff named in this report and across all seven LTSER sites for their generous hospitality and for so clearly explaining the scientific research undertaken at their respective sites. The author would like to extend special thanks to Marco Chen and his friend Hsin Pei Lu for their thoughtful support and hospitality, ensuring my comfort and welfare throughout the visit while providing a wonderful introduction to the cultural heritage and attractions of Taipei. The author is also grateful to the staff of the NTNU Campus Hotel (also known as the NTNU Guest House), run by the National Taiwan Normal University School of Continuing Education, where she stayed; it is located at No. 129, Section 1, Heping East Road, Da'an District, Taipei City.

The author is also indebted to the funders of the work showcased in the presentations (Annex 1 and 2). These insights would not have been possible without the long-term investment provided by UKCEH National Capability funding from the Natural Environment Research Council award NE/Y006208/1 and NatureScot which help sustain the UK Environmental Change Network site and wider socio-ecological monitoring in the Cairngorms LTSER. The development of the recreational model was funded by the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no 308428 and followed by European Union's Horizon Europe research and innovation programme under Grant Agreement No 101057437, BioDT, while the work of the SPEAK project was supported by the Natural Environment Research Council – Growing Shoots Partnership and application co-creation bursary, NE/Y005805/1. The work on the Drought Risk-to-Vegetation tool which delivered the Open Knowledge pipeline was funded by the Natural Environment Research Council as part of the NC for Global Challenges programme (NE/X006247/1) delivering National Capability.

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6. Annex 1 Presentation to National Changhua University of Education

PowerPoints slides to Students at the Department of Geography, National Changhua University of Education, Taiwan. The presentation by Jan Dick explores the evolution from Digital Models to Digital Shadows and Digital Twins, highlighting how these technologies can support environmental decision-making while adhering to Responsible Research and Innovation (RRI) principles.

The presentation explains the progression from:

- **Digital Models:** static or manually updated representations.
- **Digital Shadows:** real-time, one-way data transfer from physical systems to digital systems.
- **Digital Twins:** real-time, two-way interaction between physical and digital systems often enabling simulation, prediction and optimisation

The presentation demonstrates how environmental science is evolving from static models toward interactive digital twins that integrate data, models, stakeholders and decision-makers. Through examples including drought-risk assessment, water quality management and nature-based wellbeing, it shows that successful digital twins require not only technical capability but also transparency, stakeholder engagement, governance and responsible innovation.

Exploring Digital Worlds: Models, Shadows and Twins – Shaping the Future Responsibly.

Jan Dick

16/09/2026

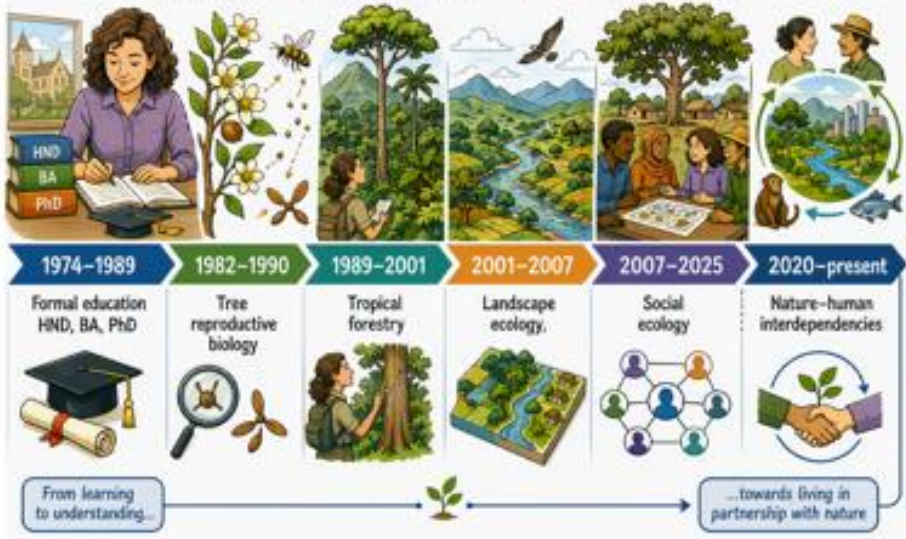
 UKCEH

Our planet.
Decoded.

UKCEH 2

Background

Career evolution of Dr Jan Dick



1974–1989	1982–1990	1989–2001	2001–2007	2007–2025	2020–present
Formal education HND, BA, PhD	Tree reproductive biology	Tropical forestry	Landscape ecology	Social ecology	Nature-human interdependencies
From learning to understanding...					...towards living in partnership with nature

Image AI generated (Midjourney)

UKCEH 3

I am employed by UK Centre For Ecology and Hydrology in the Biodiversity and Land Use section

Thriving Nature and Resilient Societies



- Sustainable food systems, land use and energy transitions
- Biodiversity recovery through scaled whole system approaches
- Evidence to enable decisions in the face of uncertainty for environmental risk and policy
- Resilient ecosystems for society and nature
- Reduced impacts of invasive species and disease

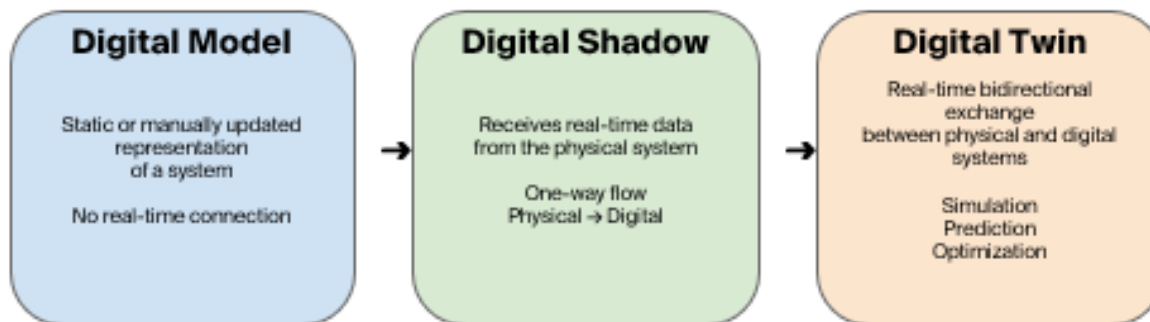
Taken from Biodiversity and land use BLUprint 2030

The presentation started with background slides giving an overview of Dr Jan Dick's career evolution and current research portfolio.

What's the difference?

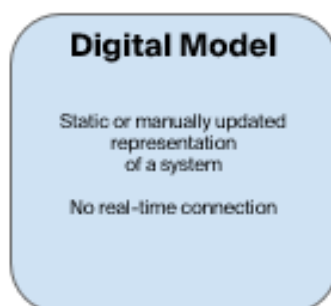
Digital Model → Digital Shadow → Digital Twin

Increasing integration, automation and decision support



The presentation explains the progression from: Digital Models, Digital Shadows and Digital Twins and leads the audience along the evolutionary journey highlighting responsible research and innovation

Responsible Research and Innovation



As an example a UKCEH-developed open-source model was used.

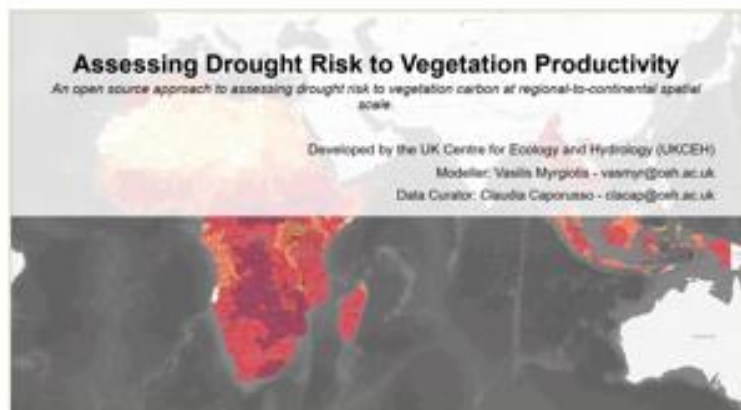
It estimates drought-induced reductions in vegetation productivity, using:

- Land cover data
- Net Primary Productivity (NPP)
- Drought indices (SPEI)

The following slides are taken from the storyboard which describes the model in lay terms

Digital Model - Drought-risk-to-vegetation Tool following an OK Pipeline

Open-source algorithm estimating drought-induced risk to annual vegetation productivity, used as a proxy for atmospheric carbon removals thus, climate change mitigation capacity. The model integrates globally available open-source datasets, including satellite-derived land cover, net primary productivity (NPP), and meteorological drought indices since 2000.



Risk = Vulnerability x Probability

Where:

Vulnerability (of NPP to drought) is the difference between NPP under drought conditions and NPP under non-drought conditions during the examined period

Probability (of drought) is the frequency of drought occurrence in the examined period

Background

Global efforts to mitigate climate change rely on greenhouse gas emissions reporting, but the land use sector presents a significant challenge.

Its complexity stems from (i) the diversity of land uses and practices worldwide and (ii) land use vulnerability to climate change, which affect land productivity.




B

From Challenges to Solutions

These dual challenges create uncertainty and compromise the transparency and comparability of national climate action plans.

This work addresses the issue by focusing on:

- A critical part of the carbon cycle: vegetation productivity
- A key source of uncertainty: drought





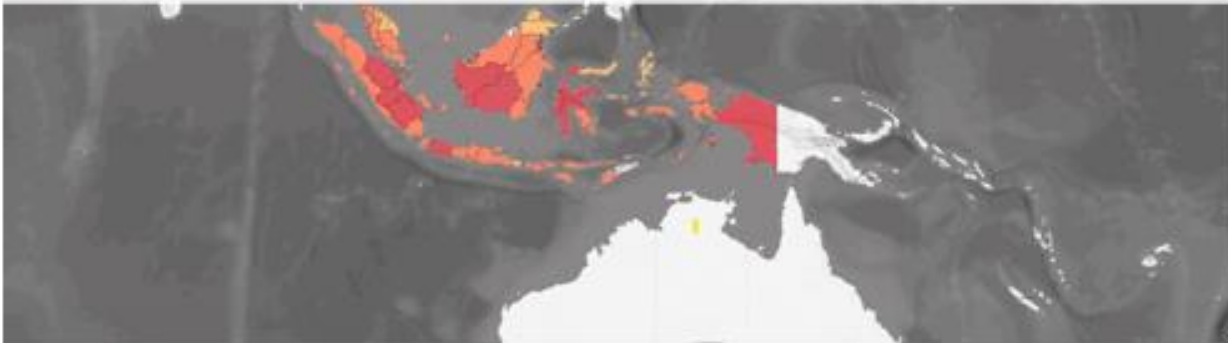

9

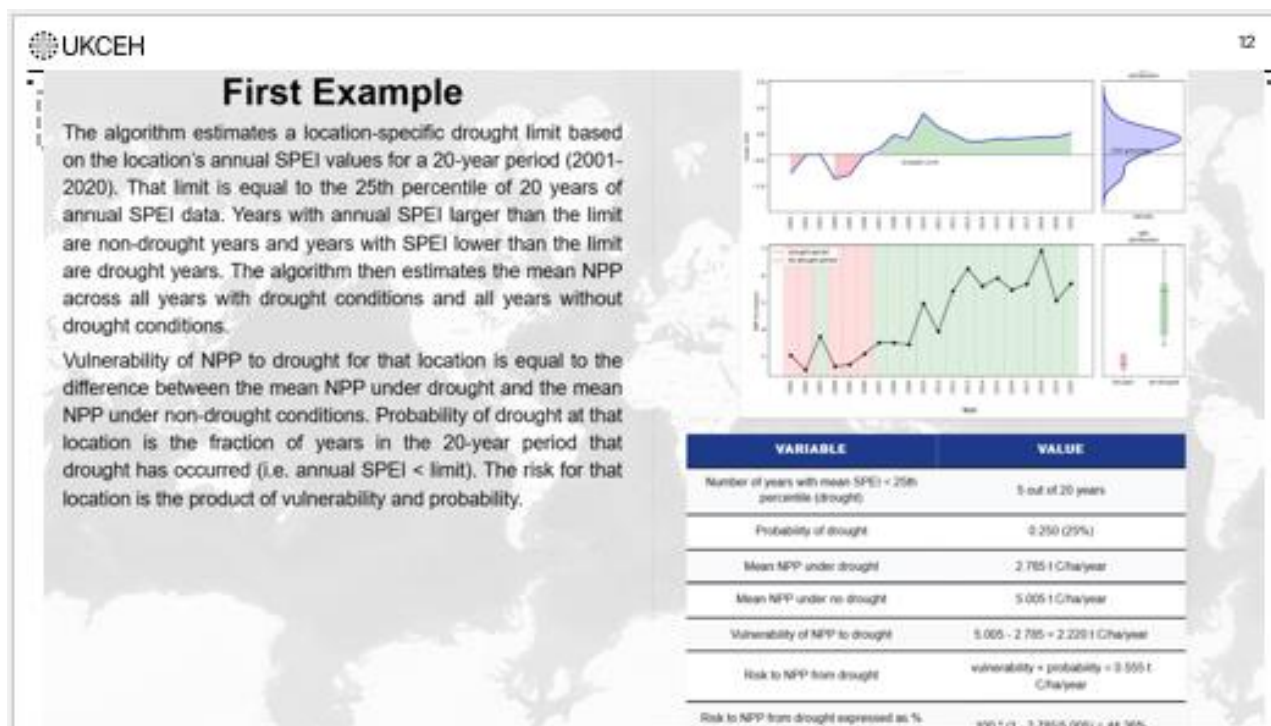
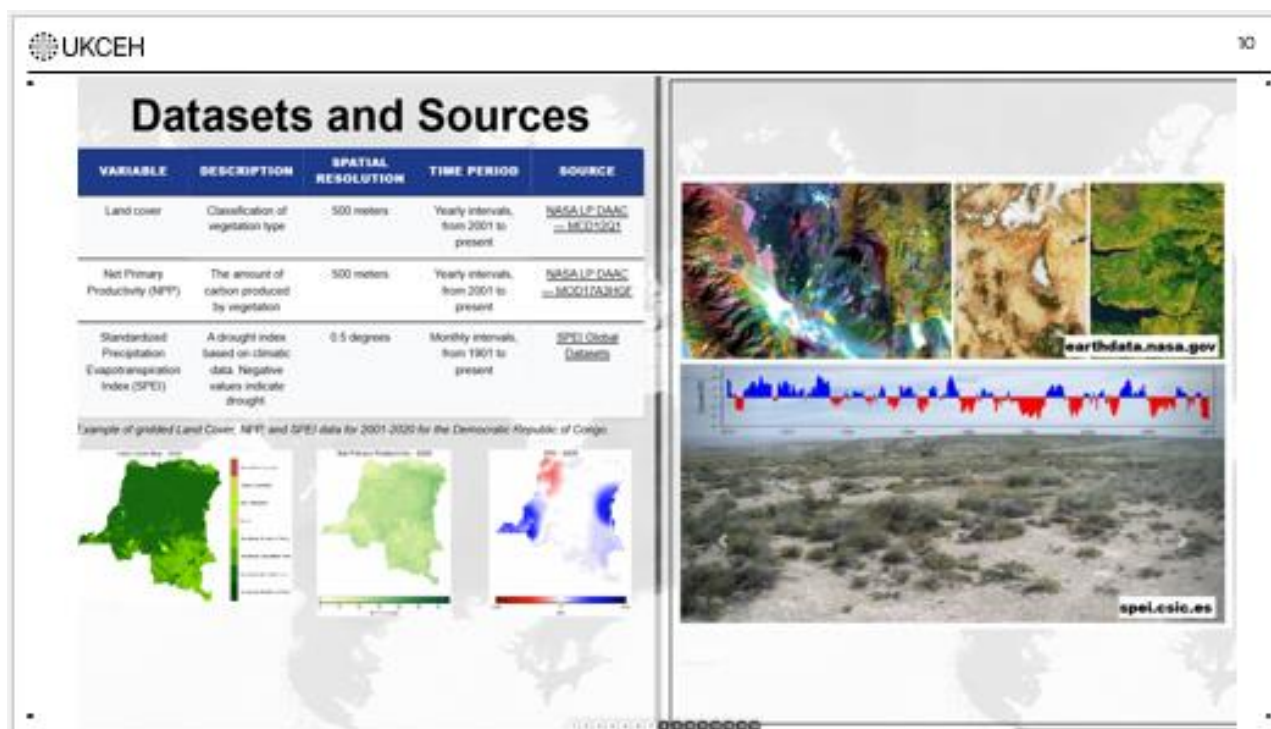
Methodology

We developed an algorithm that integrates spatial data on :

1. The physical material present on the Earth's surface such as vegetation types, water bodies, bare ground, built areas i.e. Land Cover (LC) data
2. How much carbon vegetation removes from the atmosphere annually i.e. Net Primary Productivity (NPP) data
3. An index that quantifies drought severity i.e. the Standardized Precipitation Evapotranspiration Index (SPEI) data

The algorithm uses this information to estimate the risk posed by drought to annual carbon assimilation by vegetation at a 500m spatial resolution





UKCEH 13

SUMMARY OF METHODS AND PARTICIPATION

We employed a mixed-methods approach comprising:

- 1 Two regional stakeholder workshops**
(West Africa, Southeast Asia)
held in March 2026
11 attendees
- 2 Anonymous feedback collected via an online form**
linked from the storyboard
(November 2025 - Mid-May 2026)
- 3 Semi-structured interviews with early expert adopters**
(December 2025 - February 2026)
4 respondents

In total **over 20 responses** were received, but it is not possible to say if these were unique individuals as the survey responses were anonymous.

We received ethical approval from the institutional Human Research Ethics Committee (HREC0075) of the corresponding author's organisation.

The drought tool was deployed using an **Open Knowledge (OK) Pipeline**, co-developed with stakeholders including:

- Methodological storyboard
- Public dashboard
- Open-source code

UKCEH 14

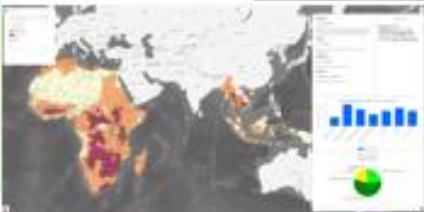
Making the model accessible

Our OK pipeline deployment strategy includes:

- A storyboard documenting rationale and methodology
- A public dashboard aggregating indicators for all administrative units in Africa and Southeast Asia with associated tutorial and
- Open code distributed via an institutional toolbox



Tutorial



Dashboard



Environmental Data Science Toolbox

Governance statement



Storyboard



Dashboard



Open Code

Open Knowledge pipeline

Stakeholder feedback highlighted the need for clear guidance on appropriate and inappropriate use, prompting the inclusion of governance statements and limitations to avoid misuse.

 UKCEH
 15

Users called for explicit guidance on appropriate and inappropriate tool use to ensure openness supports responsible decision-making and avoids misuse, so we added the following to the Storyboard

Limitations

Land use change is not included in the current analysis. Reductions in net primary production (NPP) are attributed solely to drought without consideration of the effects of land cover change or other factors (e.g. fire, pests).

Additionally, the risk metric does not capture drought impacts extending beyond the year in which drought occurs. This fact can affect the calculation of vulnerability for certain areas/pixels.

There are areas/pixels for which mean NPP during drought years is higher than mean NPP during non-drought years. In such pixels vulnerability takes a negative value and risk to NPP is equal to zero.

The algorithm does not provide uncertainty estimates because the underlying datasets lack them.

This OK Pipeline should not be used as the sole evidentiary basis for regulatory enforcement.

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 16

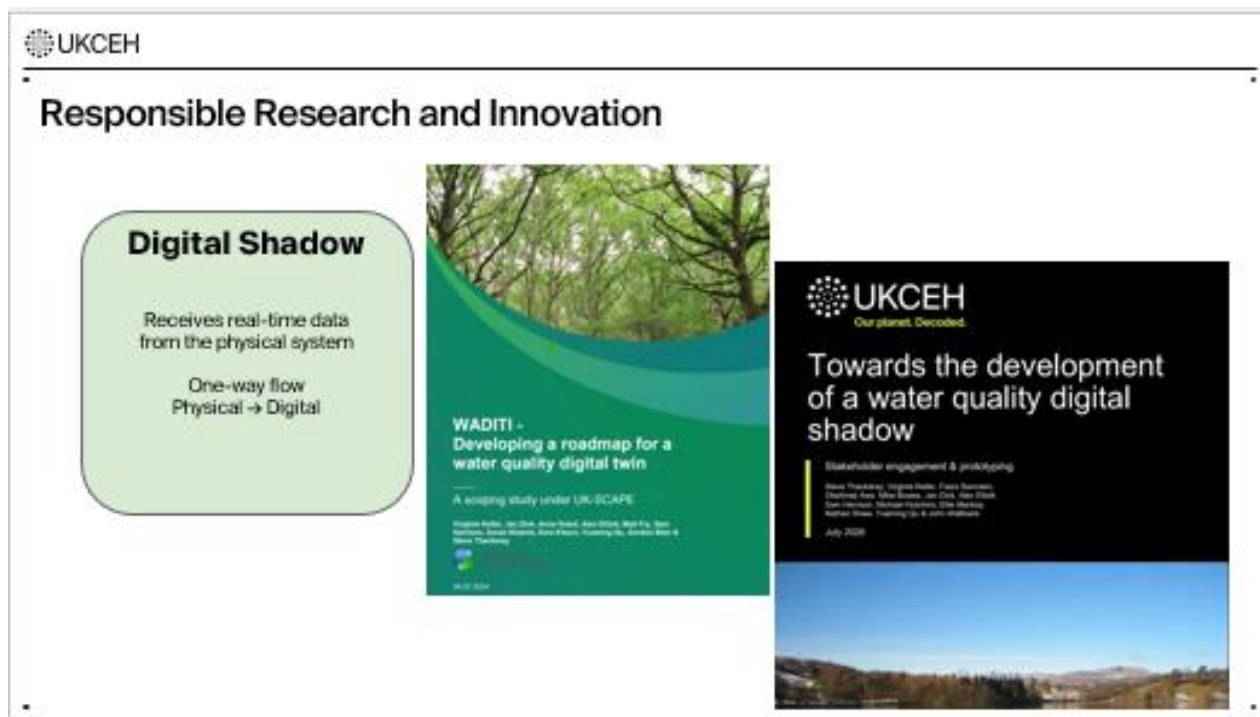
Access to the Outputs and Feedback

This environmental tool follows an **Open Knowledge (OK)** pipeline comprising:

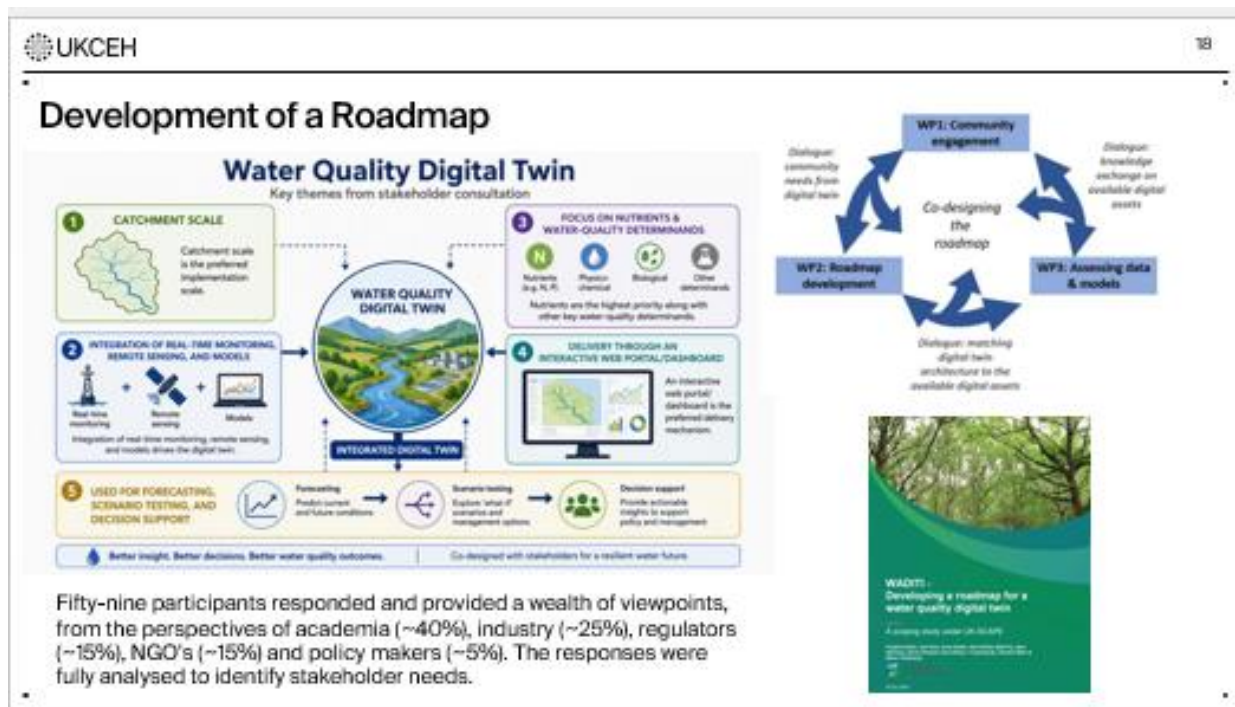
1. An accessible methodological narrative (this storyboard) and a short tutorial:
[Watch the tutorial](#)
2. A decision-supporting analytical interface:
[Explore the dashboard](#)
3. Openly available code in Python:
[The algorithm code available as a Jupyter Notebook](#)

We are keen to improve this tool and would welcome your anonymous feedback:
[Complete the questionnaire](#)

The OK pipeline can be accessed via these QR codes or (i) a storyboard documenting rationale and methodology ([MapX Storyboard](#)); (ii) a public decision-facing dashboard ([MapX geospatial data platform \(UNEP/GRID Geneva\)](#)), with associated tutorial (https://youtu.be/Q_lV53-zQf8); and (iii) open code distributed via an institutional toolbox ([UKCEH Environmental Data Science Toolbox](#)),

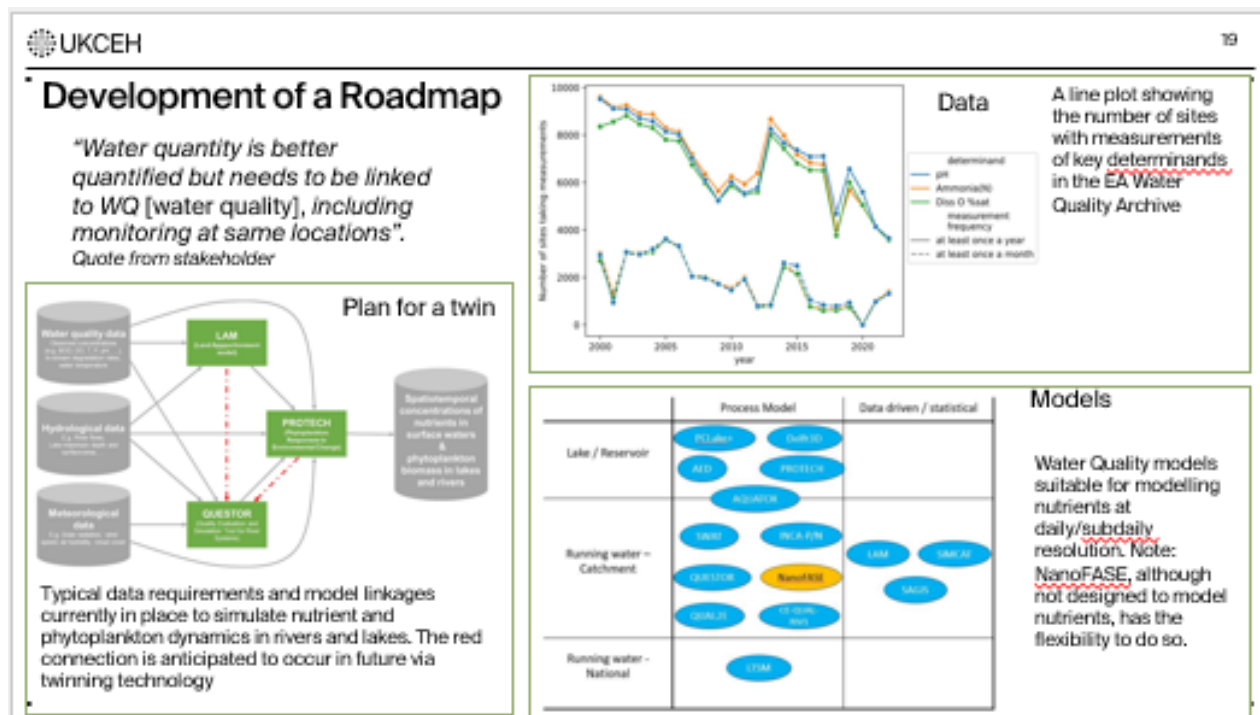


The presentation describes UKCEH's work towards a Water Quality Digital Shadow and future Digital Twin, each step delivered as an open access report.

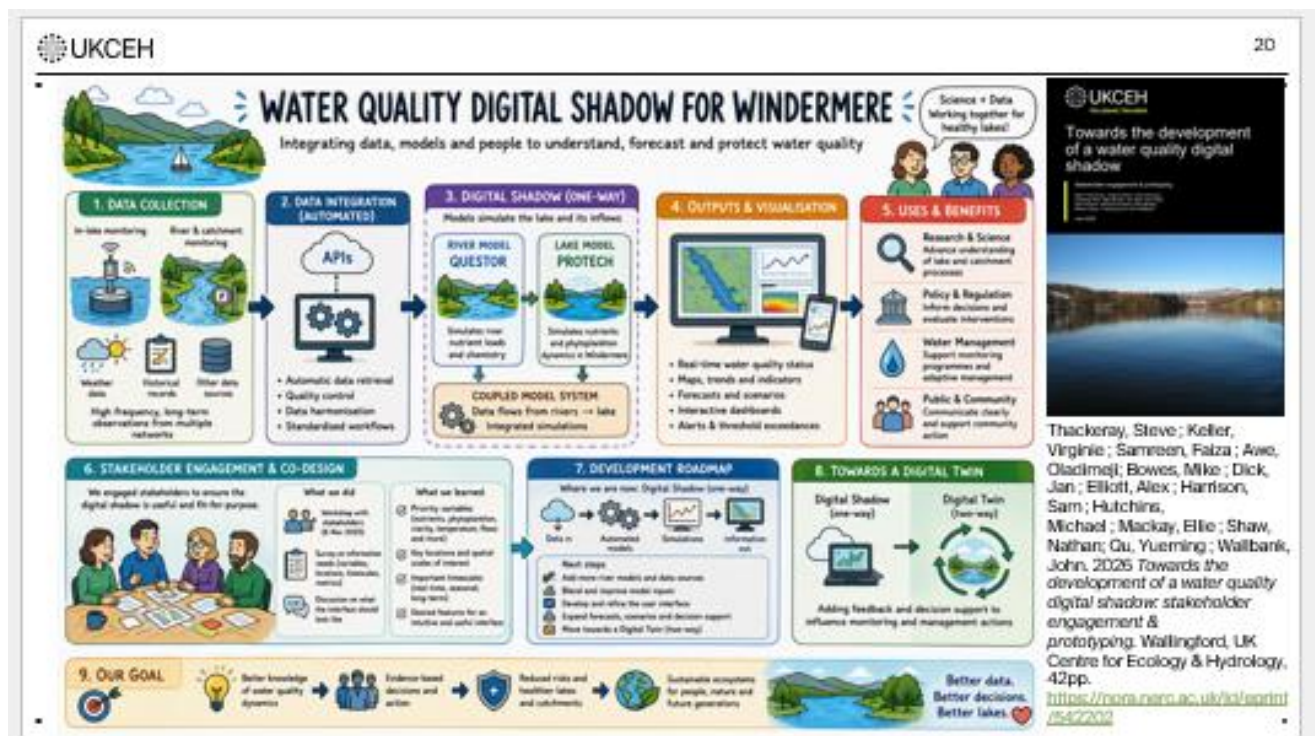


Stakeholder engagement involving 59 participants from academia, industry, regulators, NGOs and policy communities identified priorities including:

- Catchment-scale modelling
- Integration of monitoring, sensors and models
- Nutrient and water-quality forecasting
- Interactive dashboards for decision support



Data sources and available models were collated and a roadmap was co-designed to guide future development.



A follow-on project delivered a water quality digital shadow. Two open access reports detail the journey and following the creation of a digital shadow in two years further funding is being sought to create a full digital twin.


21

Responsible Research and Innovation

Digital Twin

Real-time bidirectional
exchange
between physical and digital
systems

Simulation
Prediction
Optimization

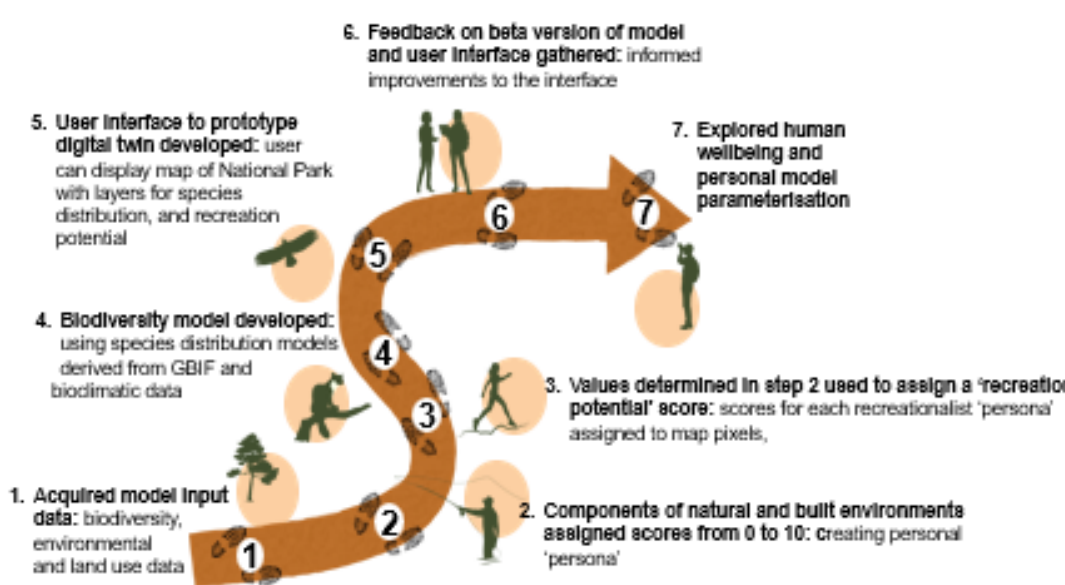
A major case study demonstrates the development of a Nature-Based Wellbeing Digital Twin that combines:

- Biodiversity models
- Environmental and land-use data
- Recreation potential modelling
- User-defined recreational preferences ("personas")

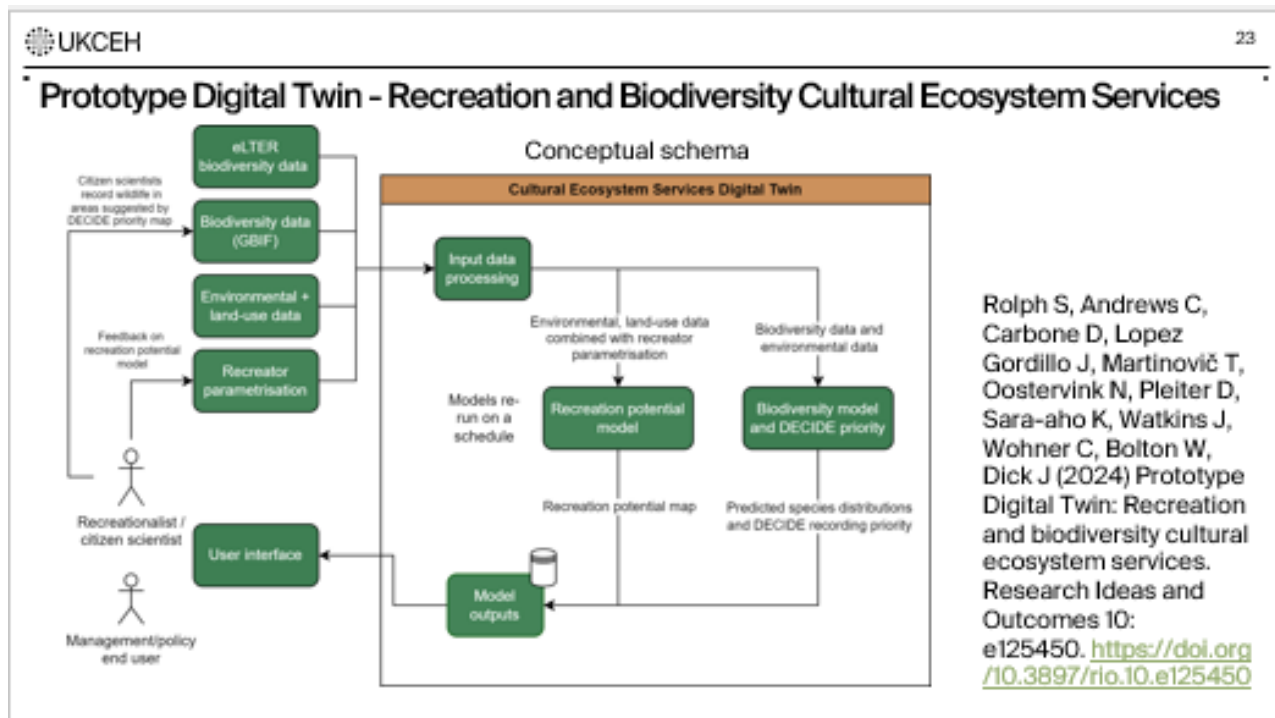
The prototype digital twin allows users to explore how different environmental conditions affect biodiversity experiences and recreational opportunities.


22

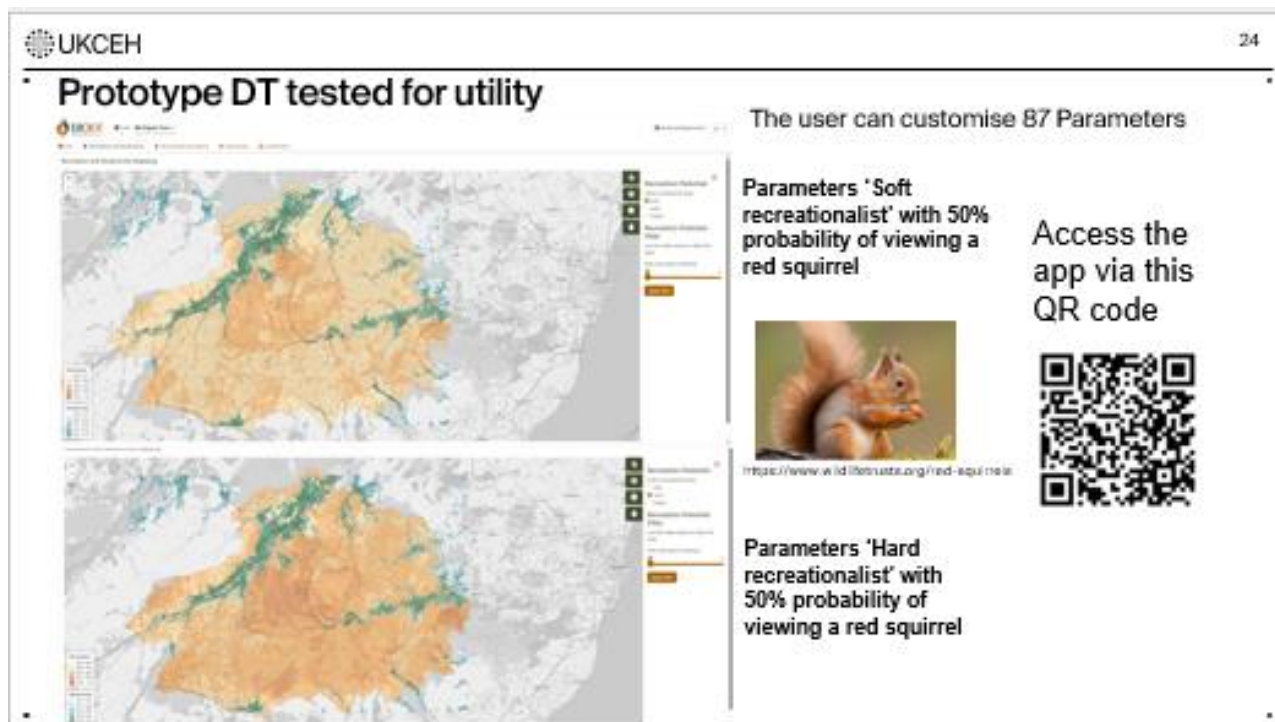
Our journey to create a Nature-Based Wellbeing Digital Twin



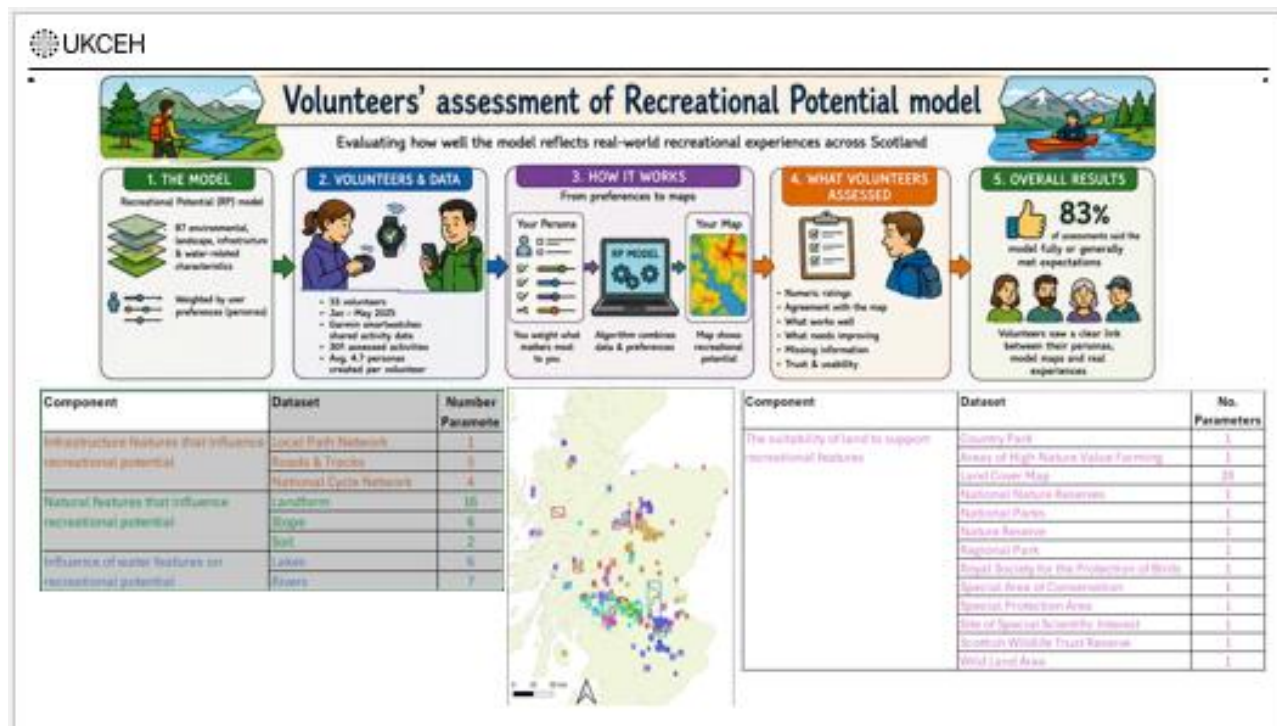
1. Acquired model input data: biodiversity, environmental and land use data
2. Components of natural and built environments assigned scores from 0 to 10: creating personal 'personas'
3. Values determined in step 2 used to assign a 'recreation potential' score: scores for each recreationalist 'persona' assigned to map pixels,
4. Biodiversity model developed: using species distribution models derived from GBIF and bioclimatic data
5. User interface to prototype digital twin developed: user can display map of National Park with layers for species distribution, and recreation potential
6. Feedback on beta version of model and user interface gathered: informed improvements to the interface
7. Explored human wellbeing and personal model parameterisation



The original idea of encouraging citizens to explore regions where biodiversity was predicted to occur and through citizen science programs such as iRecord report sightings thus updating the digital twin was using the DECIDE model was unfortunately beyond the capability of this project. However, the recreational potential with the probability of seeing biodiversity was implemented. Further work enabled users to parameterise the model for the whole of Scotland not just the Cairngorms National Park (LTSER platform).



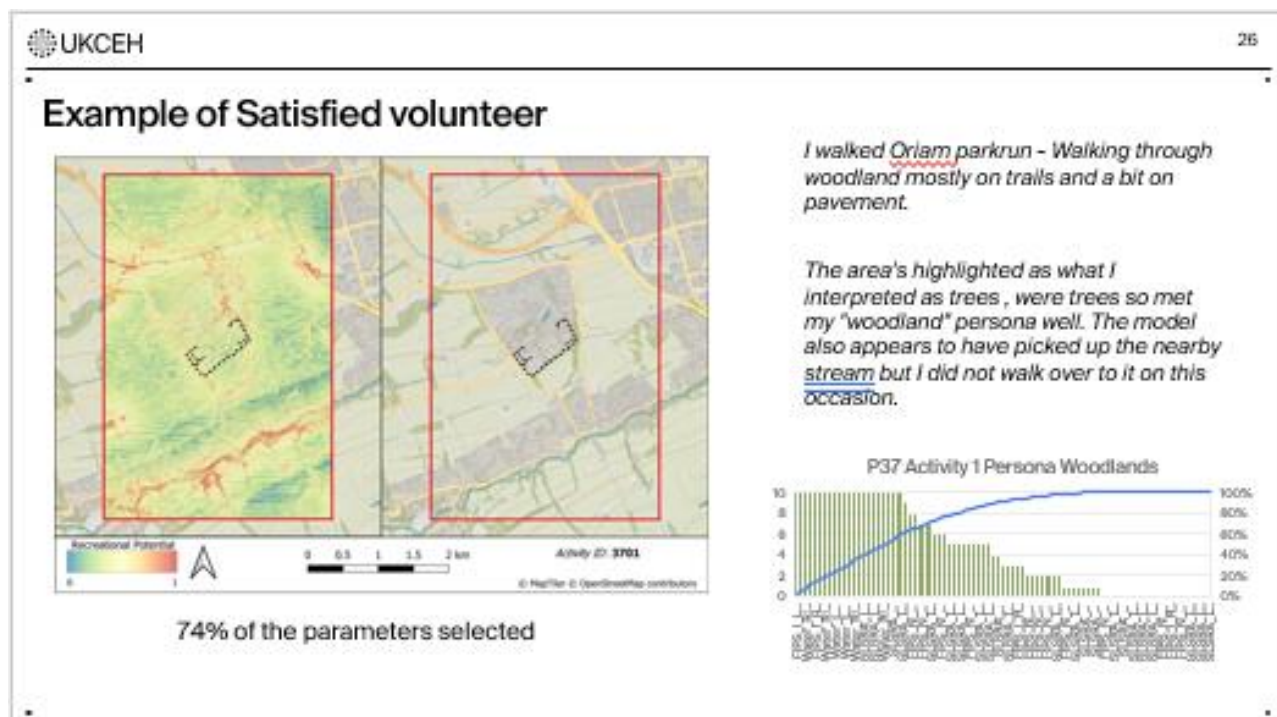
An interactive interface was delivered – here the difference between a hard and soft recreationalist is shown with the probability of viewing a red squirrel

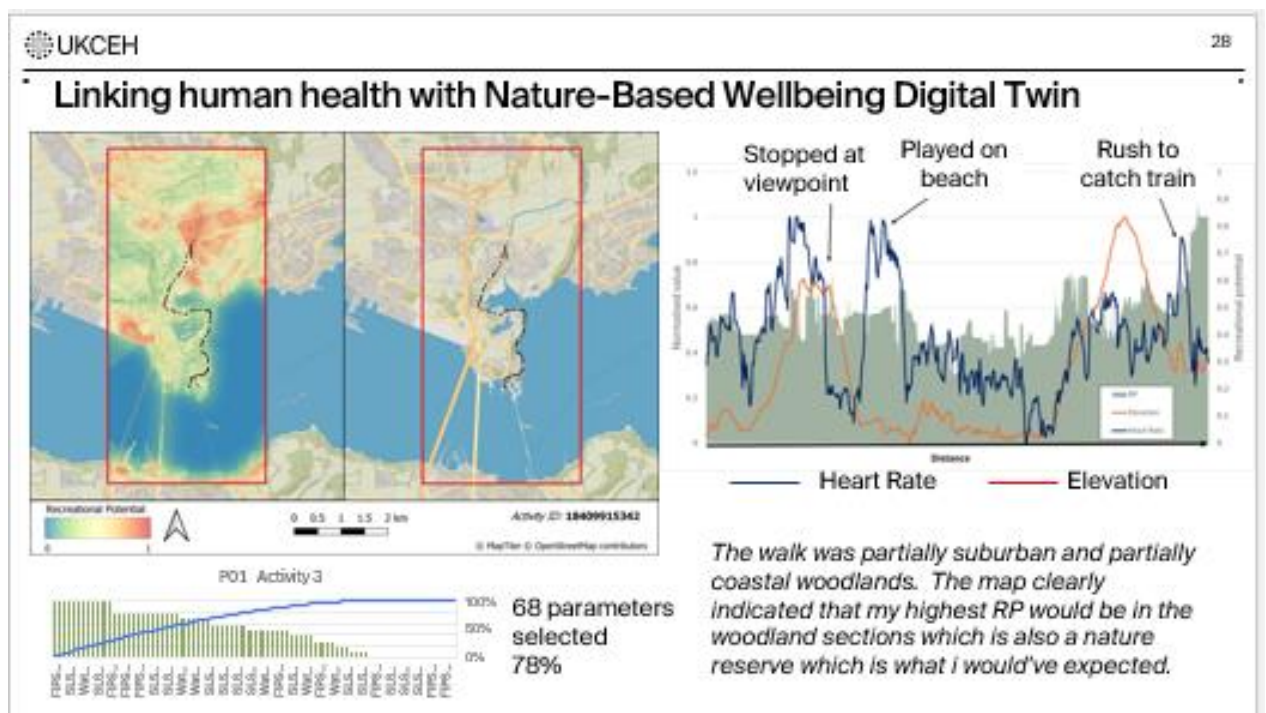
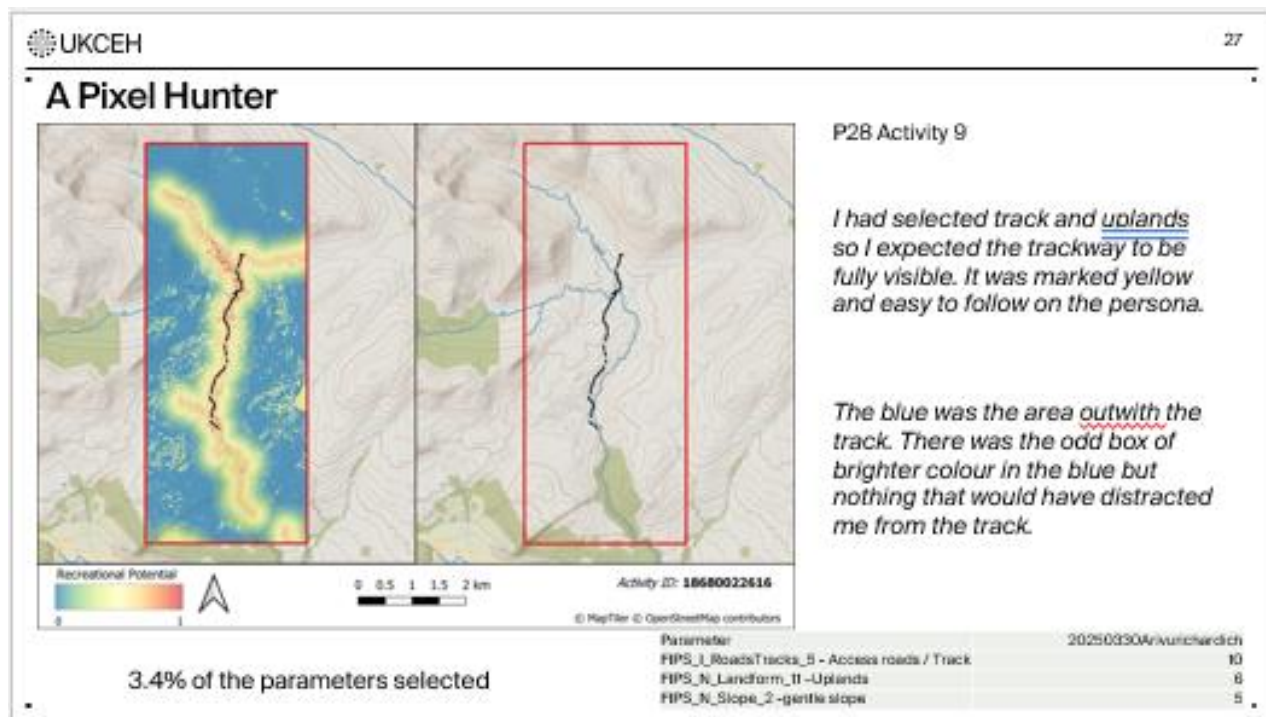


The prototype was evaluated using volunteer assessments equipped with smartwatch which delivered GPS data.

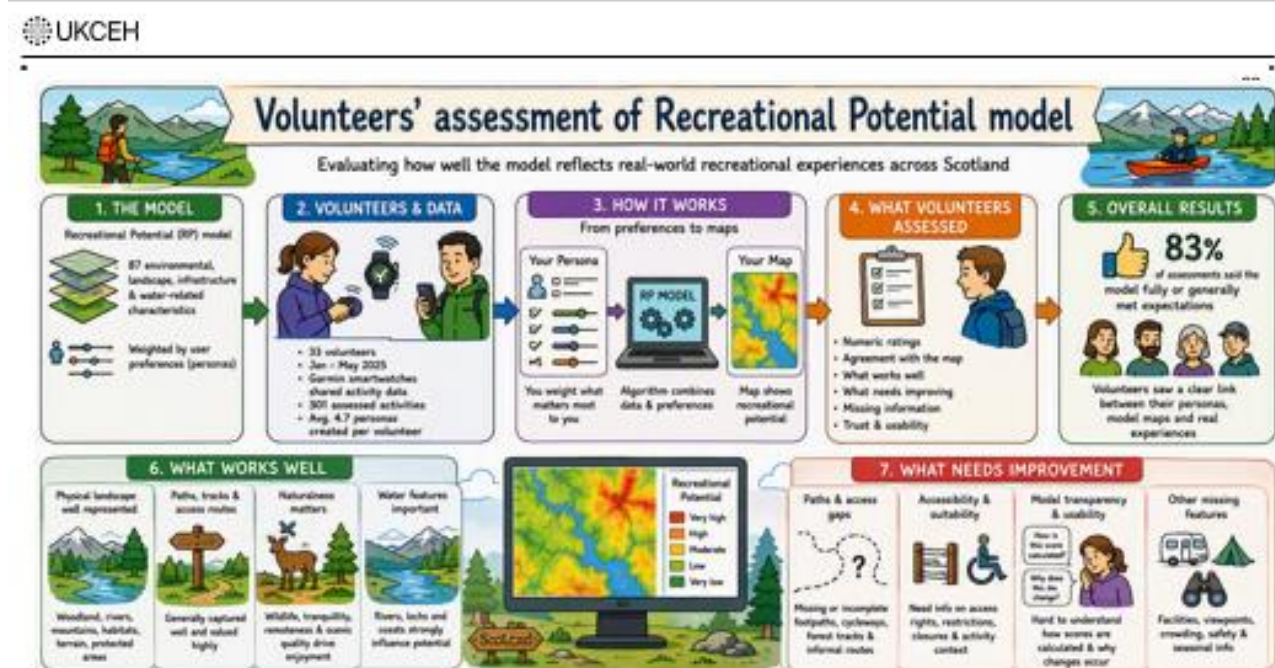
Key findings included:

- Users could customise 87 parameters to reflect their recreational preferences.
- Volunteer assessments indicated strong agreement between model outputs and real-world experiences.
- The system showed promise for linking recreation, biodiversity and human wellbeing.

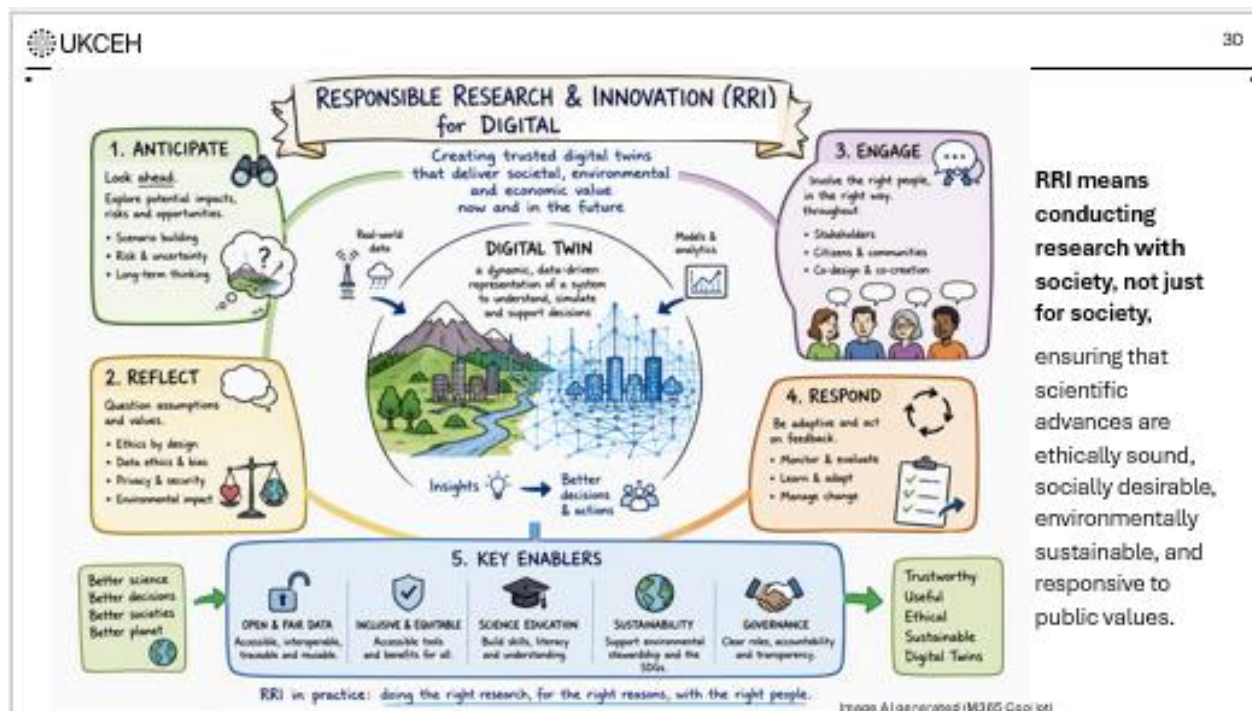




The study showed that understanding human well-being was not simple. The graph shows a volunteer walking and as the elevation increases so does his heart rate but because he played football with his child on the beach his heart rate also increased on the flat.



From 33 participants who collectively conducted 301 recreational activities 83% assessed the model as fully or generally meeting their expectations. Improvements generally focused on aspects which were not in the model e.g. toilets, car parks, cafes, and gave important suggestions for improvements.



RRI means conducting research with society, not just for society, ensuring that scientific advances are ethically sound, socially desirable, environmentally sustainable, and responsive to public values.

A central theme throughout the presentation is that: Research should be conducted with society, not just for society, ensuring that scientific advances are ethically sound, socially desirable, environmentally sustainable and responsive to public values

Thank you.

For more information
please contact:

Jand@ceh.ac.uk



Our planet.
Decoded.



7. Annex 2 Presentation to Taiwan LTSER International Conference

The presentation, “**From Data to Impact: Translating LTSER Science into Local and Global Impact**”, presented to the Taiwan LTSER International Conference: Knowledge to Action, 19 Sept 2026. Using examples from the Cairngorms LTSER, shows that impact arises through co-produced knowledge, long-term stakeholder engagement, trust building and sustained collaboration. Scientific outputs such as publications and models are important for scientific impact, but societal impact is achieved when research influences policy, management and behaviour. Researchers often do not have the right to make policy their influence is on the next user, the policy maker. The presentation highlights the importance of understanding stakeholder needs, developing trusted relationships and creating networks that extend influence beyond individual sites. Its central message is that Knowledge + Trust = Impact.

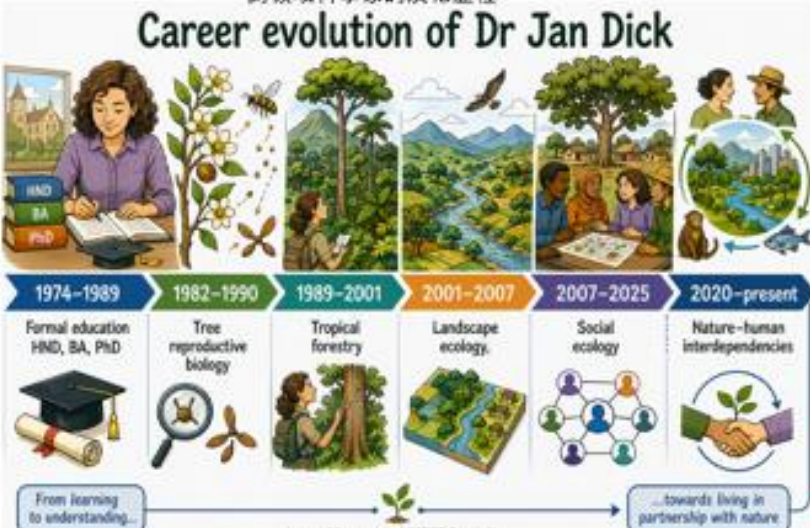


UKCEH [FROM DATA TO IMPACT] 2

Evolution of a transdisciplinary Scientist

跨領域科學家的演化歷程

Career evolution of Dr Jan Dick



Initially trained as a natural scientist but later learnt social science methods - LTSER science needs both

原本是一位自然科學家，但後來學習了社會科學研究方法：長期社會生態研究（LTSER）科學家需要同時具備這兩方面的能力

I work in Cairngorms LTSER chaired by Cairngorms National Park Authority - a public sector government agency

在蘇格蘭高爾斯社會生態研究平台（Cairngorms LTSER）工作，由蘇格蘭高爾斯國家公園管理局（政府公部門機構）主持

From learning to understanding... (Image AI generated (Midjourney)) ...towards living in partnership with nature

UKCEH [PRESENTATION TITLE] 3

I am employed by UK Centre For Ecology and Hydrology in the Biodiversity and Land Use section

Thriving Nature and Resilient Societies



Sustainable food systems, land use and energy transitions

Biodiversity recovery through scaled whole system approaches

Evidence to enable decisions in the face of uncertainty for environmental risk and policy

Resilient ecosystems for society and nature

Reduced impacts of invasive species and disease

我受聘於英國生態與水文中心（UK Centre for Ecology & Hydrology, UKCEH），隸屬於生物多樣性與土地利用研究部門

我們由 125 位科學家組成的團隊，共同致力於推動自然繁榮、社會韌性

Taken from Biodiversity and land use BLUprint 2030

The presentation started with background on the presenter and highlighted the need for natural and social scientists in an LTSE platform.



[FROM DATA TO IMPACT] 4

What is impact?

科學貢獻與影響力?

Scientific / Academic Impact
Advances in knowledge
Citations and scholarly use of deliverables
New methods and theories
Research capacity building

什麼是影響力?

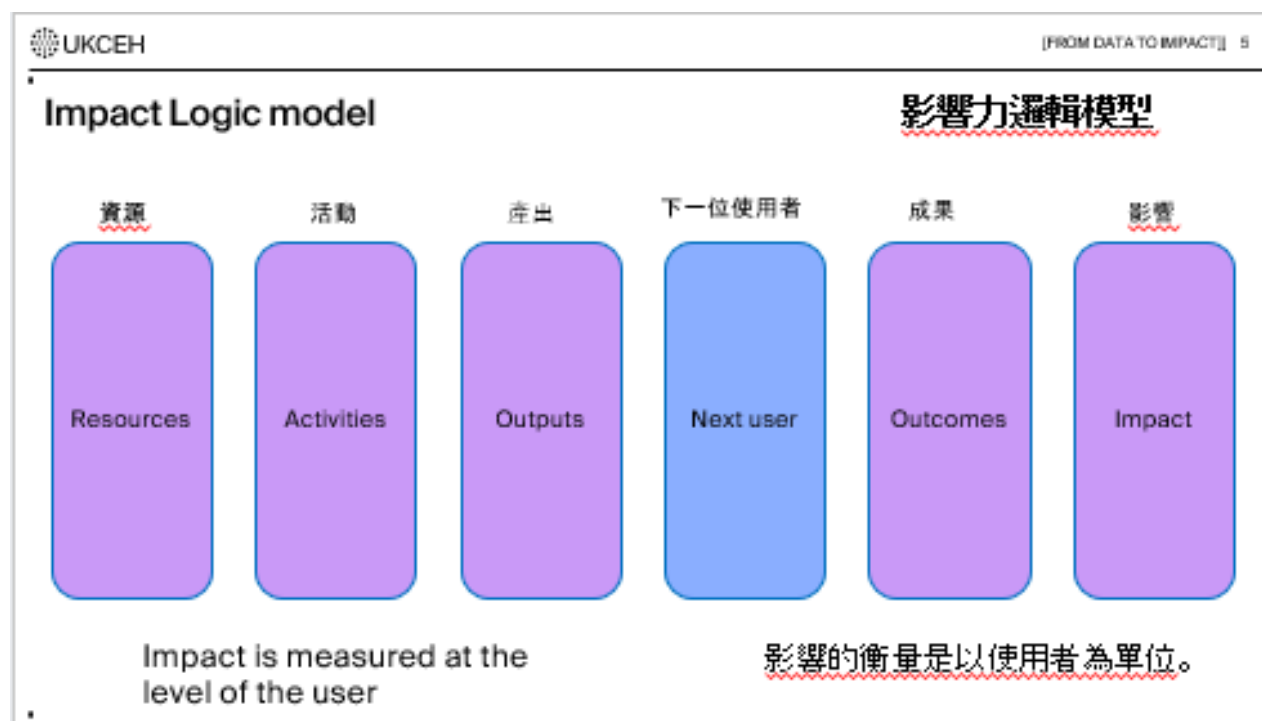
什麼是社會影響力?

Societal impact
Changes in policy, practice or behaviour
Environmental, economic, social, health benefits
Improved management governance or decision making
Real-world outcomes beyond academia

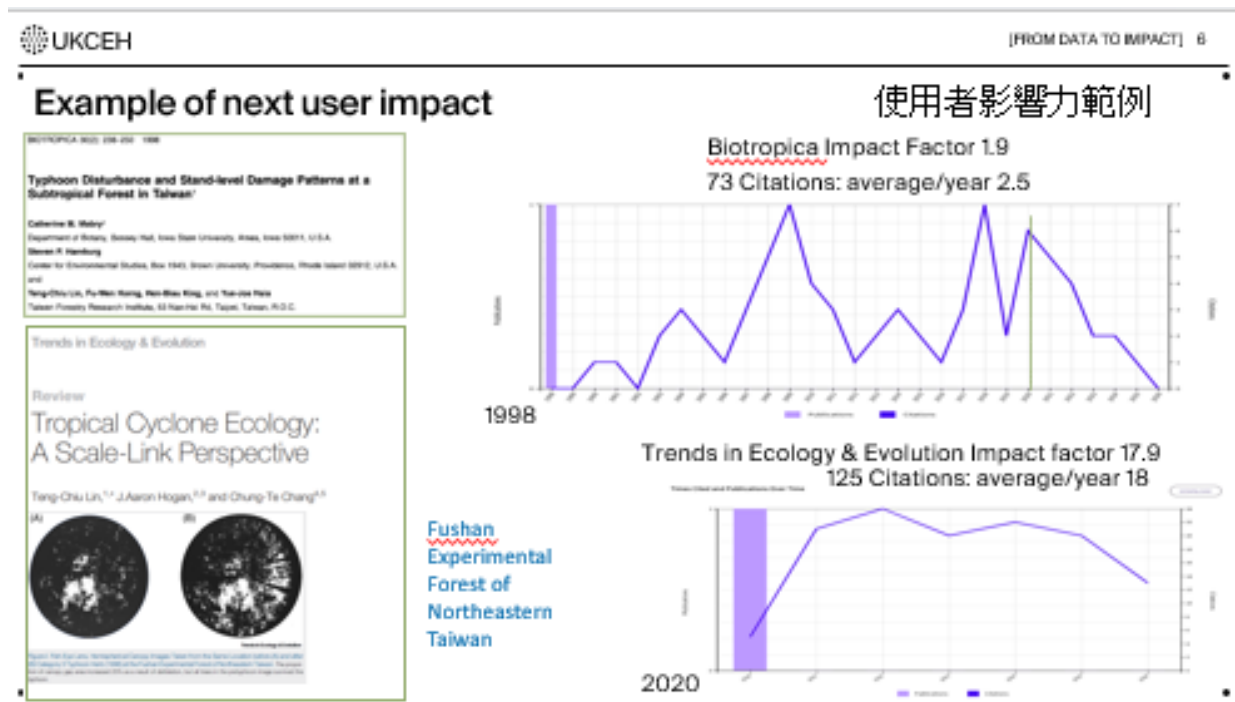
Significance – degree to which the impact has enabled, enriched influenced informed or changed the performance of policies, practices, products, services, cultural understanding, awareness or well-being of the beneficiaries

Reach is the extend, spread, breadth and/or diversity of the beneficiaries of the impact – often numbers publications, citations, datasets, models, tools, number students

The presentation distinguishes between: **Scientific impact** and **Societal impact** and describes impact using two dimensions: **Significance**: how much change or influence occurred and **Reach**: how many people or organisations benefitted.



A central argument is that impact is measured through what users do with research outputs rather than through the research itself.



The top paper was published in a low impact journal but without that paper the later high impact paper could not have been written. It is important to understand the long-term nature of impact.



The presentation proposes four mechanisms through which LTSER platforms generate impact:

1. Shaping the type and use of knowledge
2. Enabling long-term iterative engagement
3. Influencing real decisions through trust
4. Generating impact beyond the local platform

1. Shaping the type and use of knowledge

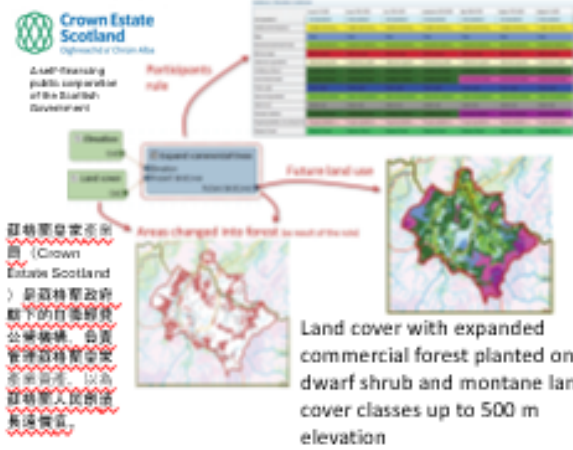
1. 形塑知識的類型與應用方式



1. Three complementary forms of knowledge are identified:

- Instrumental knowledge ("doing")
- Conceptual knowledge ("understanding")
- Strategic knowledge ("shaping the future")

Testing a software tool to identify where trees could possibly be planted – not aiming at instrumental knowledge



Crown Estate Scotland
Highland & Orkney

Land planning public consultation of the Scottish Government

Participatory rule

Future land use

Areas changed into forest as a result of rule

Land cover with expanded commercial forest planted on dwarf shrub and montane land cover classes up to 500 m elevation

蘇格蘭皇家不動產 (Crown Estate Scotland)
蘇格蘭政府轄下的自營經營公營機構，負責管理蘇格蘭皇家資產管理，以高蘇格蘭人民的財產系統管理。

By not aiming at instrumental knowledge, it allowed concentration on facts e.g. where trees could grow – it defused the polarised situation

不以追求工具性知識為目標，使討論能專注於樹木適合生長的位置，進而緩和了意見分歧與對立

Comment by: National Park Officer at workshop

The ability to see conflict areas helps to decide on future decisions and change



國家公園管理人員意見

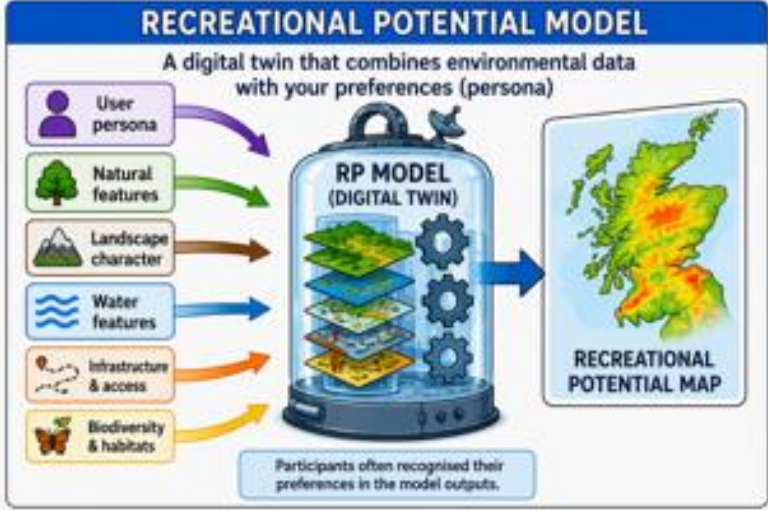
Dick, J., Verweij, P., Carman, E., Rodela, R. and Andrews, C., 2017. Testing the ecosystem service cascade framework and QUICKScan software tool in the context of land use planning in Glenelg Estate Scotland. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 19(2), pp.10-25.

The presentation uses a Scottish tree-planting planning exercise to show how focusing on facts and shared understanding can reduce conflict among stakeholders and improve dialogue

 UKCEH

[FROM DATA TO IMPACT] 10

2. Enabling iterative long-term engagement



RECREATIONAL POTENTIAL MODEL

A digital twin that combines environmental data with your preferences (persona)

RP MODEL (DIGITAL TWIN)

RECREATIONAL POTENTIAL MAP

Participants often recognised their preferences in the model outputs.

2. 形塑知識的類型與應用方式

Using the recreational potential model as an example of long-term iterative engagement

以休閒潛力模型為例，展現長期且反覆迭代的參與過程

A major determinant of impact in the Cairngorms LTSE is the value of sustained engagement over many years. Using the Cairngorms recreational potential model as an example, the presentation shows how, stakeholders identified a management challenge.

 UKCEH

[FROM DATA TO IMPACT] 11

To have impact you need a problem to solve 要產生影響力，首先必須有一個需要解決的問題

Tourism accounts for 30% of the economy (GVA) and 43% of employment. The park was awarded the EUROPARC Federation charter for Sustainable Tourism in Protected Areas in early 2000's and has used the federation's five principles to practically manage and develop tourism in the area.

The [2017 verifier's evaluation report](#) highlights the positive improvements but also comments on the need for a deeper knowledge about the recreational potential of the whole Cairngorms National Park to inform visitors and so reduce the high concentration of visitors in certain places and times.





觀光產業占當地經濟總產值（GVA）的30%，並提供43%的就業機會。該國家公園於2000年代初獲頒EUROPARC聯盟（EUROPARC Federation）「保護區永續觀光憲章」（Charter for Sustainable Tourism in Protected Areas），並運用該聯盟提出的五項原則，作為當地觀光管理與發展的實務指導方針。



The research must be of societal importance to enable research to have societal impact.



[FROM DATA TO IMPACT] 12

The science has evolved over time

OpenNESS Project 2012-2017

Zulian, G., Stange, E., Woods, H., Carvalho, L., Dick, J., Andrews, C., Baró, F., Vizzolani, P., Barton, D.N., Nowel, M. and Rusch, G.M., 2018. Practical application of spatial ecosystem service models to aid decision support. *Ecosystem Services*, 29, pp.465-480. <https://doi.org/10.1016/j.ecoser.2017.11.005>

Funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no 308428, **OpenNESS Project** (Operationalisation of Natural Capital and Ecosystem Services: From Concepts to Real-world Applications) (www.openness-project.eu)

BioDT project 2022-2025

Rolph, S., Andrews, C., Carbone, D., Gordillo, J.L., Marínović, T., Oostervink, N., Pleiter, D., Watkins, J., Wohner, C., Bolton, W. and Dick, J., 2024. Prototype Digital Twin: Recreation and biodiversity cultural ecosystem services. *Research Ideas and Outcomes*, 10, p.e125450. <https://doi.org/10.3897/rio.10.e125450>

Funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement No 101057437 (BioDT project, <https://doi.org/10.3030/101057437>)

SPEAK project 2024-2025

We are very grateful to all the participants of the SPEAK project which this output is based on including: Alastair Leaver, Alice MacSporran, Brian Cassidy, Chris Pollock, David Giles, Jean Cowie, Joanna Gillatt, Justyna Olszewska, Laura Taylor, Maddi Bunker, Rebecca MacLennan, S Mayes, Shaila Rao, Steve MacKinnon and Tom Gebbie, Active Stirling. We are equally grateful to an additional 18 participants who preferred to remain anonymous.

Funded by Natural Environment Research Council – Growing Shoots Partnership and application co-creation bursary. NE/Y005805/1 _Growing Shoots

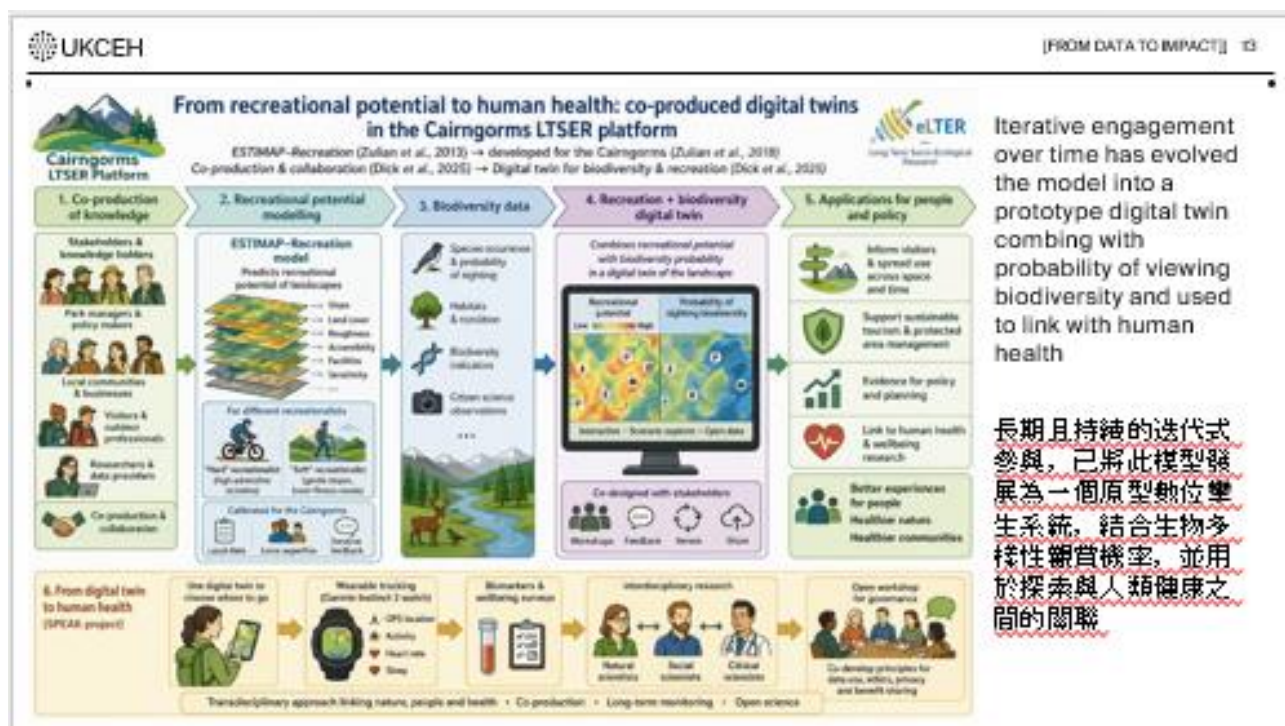
1989 -LTER **2013 -LTSER** **2026**

UK National Capability Funding plus three rounds of EU infrastructure funding eLTER and INTERACT





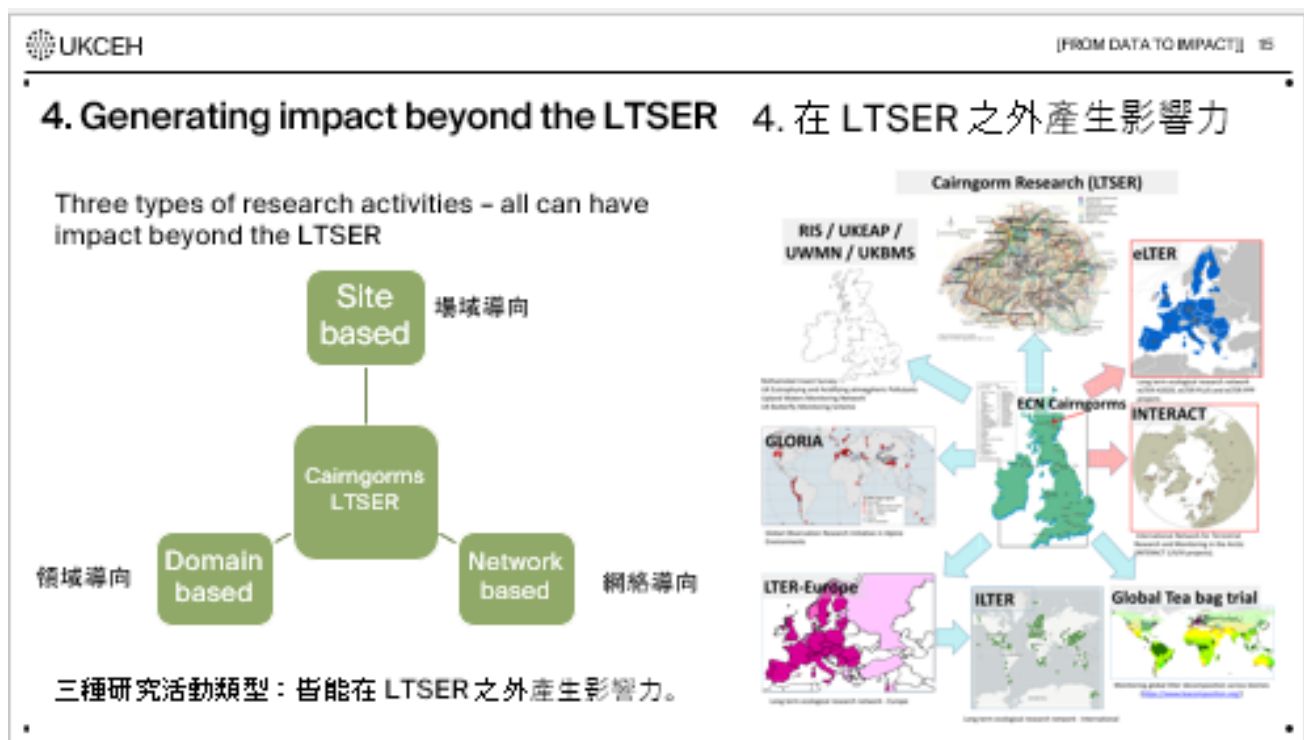
Researchers and users worked together to design the tools often beyond the normal 3-5 year research project life-cycle.



Model evolved over time which was necessary to advance the science but also to attract follow-on funding.



Continuous participation improved trust and relevance, an while the scientific knowledge presented by the team was not the only deciding factor in this example the officer agreed the data had helped to decide the location of a proposed car park which maximised human recreation while protecting an iconic bird species and agreed the wording in the academic paper cited.



The impact of an LTSER platform can be considered on three axis. The Cairngorms LTER site provides data to a range of networks and projects (blue arrows networks, pink arrows infrastructure projects)

 UKCEH

[FROM DATA TO IMPACT]

Network based - Academic Impact

凱恩戈姆山脈 (Cairngorms) 的 GLORIA 監測樣區，是遍布歐洲各地監測網絡的一部分，幫助我們了解氣候變遷如何重塑山地生態系。

Hauschert, J. et al., 2026. Widespread thermophilization but weak link to climate warming in Europe's summit plant communities. *Nature Ecology & Evolution*, pp.3-34.
<https://www.nature.com/articles/s43552-026-03581-5>

Vannote, T. et al., 2026. Widespread shrubification on European mountain summits. *Global Change Biology*, 32(3), e70786. DOI: 10.1111/gcb.70786

Wessely, J. et al., 2026. Rising plant extinction rates on European mountain summits. *Science*. DOI: 10.1126/science.ade2974

Yue, K. et al., 2026. Contrasting thermophilization among forests, grasslands and alpine summits. *Nature*, 653(8115), pp.765-769.
<https://www.nature.com/articles/s43586-026-06622-7>

20 多年高山監測揭示的氣候變遷訊息



Example of high academic impact but not societal impact

 UKCEH

[PRESENTATION TITLE] 17

Network based - Societal Impact

Social media a pathway to societal impact

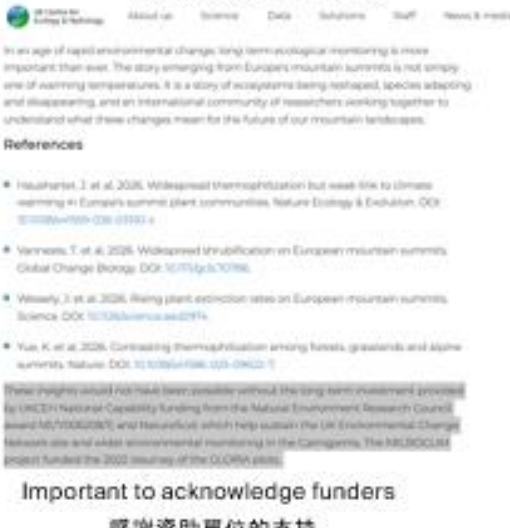


Social media increases the **reach** of your science, but remember societal impact is the measurable change in people, policy, practice

社群媒體能擴大科學研究成果的觸及範圍，但請記住，社會影響力是指人們、政策與實務上的可衡量改變。

網絡導向的社會影響力

社群媒體促進社會影響力



Important to acknowledge funders
感謝資助單位的支持

The presentation notes that social media can improve the reach of science and act as a pathway towards impact, but true societal impact requires measurable changes in practice, policy or behaviour

Site based



This study combined modelling plus focused walking interviews - the where and what type of knowledge combined with the why people want to recreate in nature

本研究結合了模型分析與焦點式步行訪談 (walking interviews)，將「人們在哪裡進行休閒活動」以及「從事哪些休閒活動」的空間資訊，與「人們為什麼想要親近自然、在自然環境中進行休閒活動」的深層動機結合起來。

Check, J., Andrews, G., Orenstein, D., Telf-Soler, Y. and Zelen, G. 2002 A mixed-methods approach to analyse recreational values and implications for management of protected areas: a case study of Catecombe National Park, UK. *Ecosystem Services* 58. [http://dx.doi.org/10.1016/S0924-6460\(02\)00149-0](http://dx.doi.org/10.1016/S0924-6460(02)00149-0)

Example of site based academic impact

Domain based



Operationalisation of
Natural Capital and
Ecosystem Services:
From Concepts to Real-
world Applications
(OpenNESS - EU funded
project)

知識 + 參與 + 信任 = 影響力

27 case studies

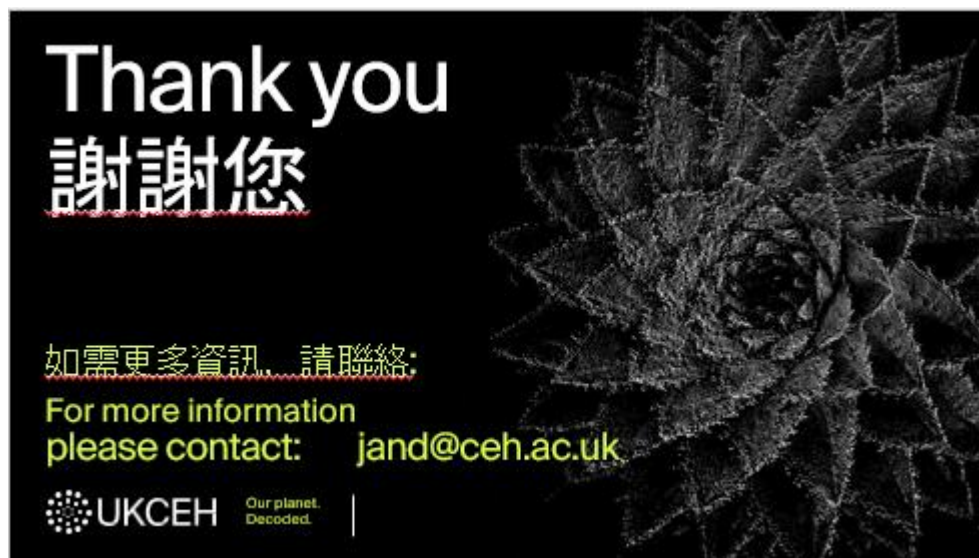
紐恩戈姆高地國家公園案例研究：自然資本與生態系統服務的實務化應用：從概念走向真實世界的應用（OpenNESS－歐盟資助計畫）

[illegible]

Example of domain based academic impact (ecosystem services)



The presentation argues that the greatest impacts of LTSER research emerge not from data alone, but through long-term co-production, rightsholders and stakeholder participation, trust building, and sustained engagement. Research infrastructures such as LTSER platforms provide the conditions needed to transform scientific knowledge into better decisions, healthier ecosystems, stronger communities and wider societal benefit



8. Annex 3 Session

Proposal to ILTER OSM Meeting

Place-based research infrastructures, impact, and pathways toward sustainability transformations: Measuring change, evaluating success, and negotiating the role of science

Proposal for session at the ILTER OSM Meeting, 2027 – Bariloche, Argentina

Submitted by Daniel Orenstein and Jan Dick (others welcomed!)

For more than three decades, Long-Term Ecological Research (LTER) networks have integrated multiple disciplines and local knowledge to understand social-ecological systems and inform sustainable management and policy. Long-Term Social-Ecological Research (LTSER) platforms, urban LTER sites, and related place-based research infrastructures may do more than document change: they may generate scientific and societal impacts and contribute to sustainability transformations involving fundamental changes in values, priorities, institutions, relationships, and practices.

Yet there is limited empirical evidence showing what impacts these activities generate or whether, and through what mechanisms, research infrastructures contribute to transformative change. Project impacts can be assessed against stated goals and objectives, but transformation may also emerge through subtler and more systemic processes, including learning, relationship-building, shifts in perspectives, strengthened capacities, and the accumulation of changes across institutions and scales. These processes are often long-term, nonlinear, and difficult to attribute to a particular intervention. Policy or management changes may constitute important impacts without demonstrating that a broader transformation has occurred.

Evaluating these contributions therefore requires attention to both project impacts and wider processes of change. Goals, indicators, baselines, and, where possible, counterfactuals can help determine whether projects achieved their objectives. Evidence may include ecological and socioeconomic indicators; changes in policy, management, governance, and institutions; and qualitative accounts of changing values, relationships, capacities, and practices. Other contributions may be indirect, emergent, or distributed across actors and institutions and may be better understood through process tracing and stakeholder interpretation. Long-term research is especially valuable for identifying delayed and unexpected outcomes and tracing how changes persist, interact, and accumulate over time.

Evaluation is also inseparable from questions of power, values, and purpose. Assessment criteria embody assumptions about valuable knowledge and desirable change and may influence how research is conducted. Stakeholders may hold different, sometimes conflicting, visions of success, requiring indicators and targets to be co-produced while acknowledging disagreement, trade-offs, and unequal distributions of benefits and costs. Scientists must likewise negotiate their roles as researchers, facilitators, knowledge partners, and potential advocates, and consider how these roles affect credibility, trust, equity, and respect for locally defined priorities.

The session will bring together empirical case studies, comparative analyses, and methodological contributions addressing four questions:

- How can project impacts be identified and monitored, and how can their contributions to longer-term processes of change be understood?
- How should success be defined and assessed when stakeholders differ in their priorities, values, and desired outcomes?
- How should scientists negotiate their roles in facilitating or advocating for transformative change?
- Under what conditions, and through what mechanisms, can long-term research infrastructures contribute to broader societal transformation?

We welcome contributions on LTSER platforms, urban LTER sites, nature-based solutions, knowledge co-production, and other forms of place-based transdisciplinary research. We particularly encourage longitudinal and retrospective studies, including cases in which anticipated impacts or transformations did not occur; comparisons across cultural, institutional, and geographic contexts; co-produced evaluation frameworks; and analyses combining ecological, social, and governance outcomes. Contributions examining less readily measured processes, such as learning, relationship-building, capacity development, and shifts in perspectives or practices, are also encouraged.

The session aims to develop a more critical empirical understanding of what changes, how impacts and broader processes can be assessed and interpreted, what research infrastructures contribute, and how scientists can participate responsibly. It will also inform a proposed special collection in *Case Studies in the Environment* (University of California Press), open to session participants and the wider international community



**For more information
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[LEARN MORE]
ceh.ac.uk

[FOLLOW US]
[@uk_ceh](https://twitter.com/uk_ceh)

