

Institution: University of Exeter		
Unit of Assessment: UoA 7 Earth Systems and Environmental Sciences		
Title of case study: The value of natural environments for human health: transforming regional, national and international environmental and health policy		
Period when the underpinning research was undertaken: 2011 to present		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Lora Fleming	Professor and Director of European Centre for Environment and Human Health	2011 to present
Tim Taylor	Senior Lecturer	2011 to present
Michael Depledge	Professor in Environment and Human Health	2006 to 2019
Period when the claimed impact occurred: 2015 to present		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact		
<p>Until recently, recognition of the value of the natural environment for human health was lacking in environmental and health policy. Interdisciplinary research at the <i>European Centre for Environment and Human Health</i> based at the University of Exeter has led to a paradigm shift in the integration of health into environmental policy and practice. The research has:</p> <ul style="list-style-type: none"> • influenced the policies and practices of the Convention on Biological Diversity (CBD) and World Health Organisation (WHO), including provision of evidence underpinning ratification of two key CBD decisions on biodiversity and human health • influenced UK environment policy e.g. UK Government investment of >£15m in the natural environment for population health promotion programmes and environmental social prescribing schemes, and • informed local policy and practice on natural environment e.g. by making the case for investment of >£5bn in infrastructure for a green recovery and drawing in European investment of £3.5M in urban Public Open Space in Cornwall for health and biodiversity gain 		
2. Underpinning research		
<p>This case study is based on a decade of research led by interdisciplinary academics at the <i>European Centre for Environment and Human Health</i> ('the Centre'), since 2019 designated as the <i>World Health Organisation (WHO) Collaborating Centre on Natural Environments and Health</i>, at the University of Exeter Medical School. The Centre, established by Depledge and led by Fleming since 2011, has the explicit purpose of revealing the complex links between the environment and human health. Previously, policy relating to the environment, planning and health was not explicit about capitalising on the health and wellbeing benefits from the natural environment nor on how to maximise them; our work has changed this. We have developed strategically a targeted combination of approaches including observational epidemiology, lab-based experimental studies, field experiments, economic analyses, qualitative research, evidence synthesis (including systematic reviews), and policy and practice analyses to build a coherent body of evidence that has demonstrated, quantified and transformed understanding of the benefits to health and well-being from natural environments.</p>		
i) How natural environments can promote health		
<p>We have pioneered the application of systematic review methodologies to environment and health issues and are core members of the UK Centre for the Collaboration for Environmental Evidence.</p>		

Systematic reviews produce novel understandings through formal evidence synthesis methods, such as meta-analysis, and are seen as the highest quality evidence for decision making in health and, increasingly, other disciplines. A key early output exemplifying this decade of research was a 2011 systematic review addressing whether participating in physical activity in outdoor natural environments has greater effects on physical and mental wellbeing than physical activity indoors [3.1]. This was one of the first robust assessments of the state of knowledge on relationships between natural environments and health, which demonstrated that whilst the evidence base was at the time relatively weak, the evidence that did exist was promising. It concluded that *“the paucity of high quality evidence on which to base recommendations...reveals an undoubted need for further research in this area”*. Our later systematic review of the importance of biodiverse environments for health and well-being [3.2] flagged the potential of thinking beyond ‘green space vs grey space’ for health and environment to the mutual benefit of each. This also showed key inconsistencies and weaknesses in the evidence base, and again highlighted needs for high quality, interdisciplinary research to better inform decision-making.

ii) The scale of health economic values and wellbeing benefit of visits to natural environments

In collaboration with Natural England (NE) and Public Health England (PHE), we showed that outdoor physical activity in natural environments delivers an estimated £2.2bn of health benefits to adults in England each year [3.3] (with economic analyses led by Taylor). This study used NE’s unique Monitor of Engagement with the Natural Environment (MENE) data to estimate 1.13bn physically active visits to natural environments per year in England and applied standard health economic approaches to assess the associated health values. Further analysis of MENE [3.4] identified a potential 120-minute threshold for outdoor activity each week to achieve health gains. The study estimated the relationship between actual time spent outdoors in nature (as opposed to residential proximity to green spaces) and self-reported health and subjective wellbeing. Our analysis identified this possible threshold, and the relationship was not explained through the increased physical activity associated with time outdoors. These studies established a more comprehensive set of health-related economic values of natural environments than was previously available, which led to the development of the Greenkeeper tool – an online tool designed to support planning and investment decisions around urban green infrastructure.

iii) Moving to greener neighbourhoods improves health

Our studies using the 18-year British Household Panel Survey were among the first to use robust longitudinal approaches to demonstrate that people moving to greener urban neighbourhoods have subsequent better mental health outcomes, and that positive effects last for at least three years following a move [3.5]. The novel use of long-term, longitudinal data for a large sample of individuals permitted improved causal inference relative to existing, cross-sectional evidence at the time. In particular the approach reduced the likelihood that the greenspace-health association observed is due to selective migration of ‘healthy’ individuals toward greener areas.

iv) Collaborative and embedded research to enhance cross-sectoral policy and practice

Collaborative synthesis and policy-focussed research with Defra, NE and other Governmental partners identified opportunities to transform the new Green Infrastructure Standards for England by promoting the importance to public health of improved green infrastructure. Similarly, collaborative research with PHE and Local Authorities in the South West has informed local government planning, environment and land use policy and delivery by transforming how PHE works with local authorities to deliver health improvement through the provision of green infrastructure. Our collaboration with Public Health England in the Health Protection Research Unit in Environmental Change and Health (*Theme 3: Health and the natural environment* led by Fleming), resulted in numerous publications on both the risks and benefits of natural environments for health. It demonstrated the value of integrating environmental changes and natural environments into local and national UK public health policy [3.6].

This large interdisciplinary body of research has demonstrated that the natural environment plays a crucial role in delivering health and wellbeing benefits. We have shown that the scale and likely causal pathways of these benefits have previously been underestimated and undefined, and the opportunity missed by both health and environment sectors.

3. References to the research

The European Centre for Environment and Human Health has published >120 papers in high-quality, peer-reviewed journals focused on increasing knowledge and awareness of the role of the natural environment in human health and well-being. Below are a selection of key papers (**University of Exeter authors highlighted in bold**) underpinning our impact.

- [3.1] Thompson Coon, J., Boddy, K., Stein, K., Whear, R., Barton, J., **Depledge, M.H.**, 2011. Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environ Sci Technol* 45, 1761-1772. doi:10.1021/es102947t
- [3.2] Lovell, R., Wheeler, B.W., Higgins, S.L., Irvine, K.N., **Depledge, M.H.**, 2014. A systematic review of the health and well-being benefits of biodiverse environments. *J Toxicol Environ Health B Crit Rev* 17, 1-20. doi:10.1080/10937404.2013.856361
- [3.3] White, M.P., Elliott, L.R., **Taylor, T.**, Wheeler, B.W., Spencer, A., Bone, A., **Depledge, M.H.**, **Fleming, L.E.**, 2016. Recreational physical activity in natural environments and implications for health: A population based cross-sectional study in England. *Prev Med* 91, 383-388. doi:10.1016/j.ypmed.2016.08.023
- [3.4] White, M.P., Alcock, I., Grellier, J., Wheeler, B.W., Hartig, T., Warber, S.L., Bone, A., **Depledge, M.H.**, **Fleming, L.E.**, 2019. Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Scientific Reports* 9: 1, 7730. doi:10.1038/s41598-019-44097-3
- [3.5] Alcock, I., White, M.P., Wheeler, B.W., **Fleming, L.E.**, **Depledge, M.H.**, 2014. Longitudinal effects on mental health of moving to greener and less green urban areas. *Environ Sci Technol* 48, 1247-1255. doi:10.1021/es403688w
- [3.6] **Fleming, L.**, Leonardi, G., White, M., Medlock, J., Alcock, I., Macintyre, H., Maguire, K., Nichols, G., Wheeler, B., Morris, G., **Taylor, T.**, Hemming, D., Iacono, G., Gillingham, E., Hansford, K., Heaviside, C., Bone, A., Duarte-Davidson, R., 2018. Beyond Climate Change and Health: Integrating Broader Environmental Change and Natural Environments for Public Health Protection and Promotion in the UK. *Atmosphere* 9: 7, 245. doi:10.3390/atmos9070245

4. Details of the impact

Human health and wellbeing depend on the environment and well-functioning ecosystems. This linkage was historically poorly recognised in both environment and health policy. Research from the Centre has changed policy mind-sets, strategies and practice. Our evidence has strengthened conservation, environmental management and investment policy at scales from local to international by explicitly clarifying the role of natural capital in supporting human health and wellbeing.

Traditionally, environmental policies relating to human health have been dominated by hazards; our evidence means these are now balanced by the recognition of the health and wellbeing benefits of good quality natural environments. Our research impact has been amplified through active engagement and close collaborations with policy bodies who have recognised our expertise and invited participation in a range of expert advisory roles and joint projects.

4.1 Influencing international policy and practice on natural environment and health

Our research has led to changes in international policy and strategy in both the environment and health sectors. Since 2015, we have worked with the Convention on Biological Diversity (CBD) and the World Health Organisation (WHO) Regional Office for Europe on urban greenspace, biodiversity and health. Our 2014 systematic review [3.2] of links between biodiverse environments and 'good' health was a primary resource used to inform the ratification of two key CBD decisions on biodiversity and human health, with a joint CBD/WHO report [5.1]. These decisions invite the 195 nation state signatories, and the European Union, to act on the linkages in developing health and environmental strategies (COP12 decision XII/21; COP13 decision XIII/6) [5.1]. These international decisions set the context for national policy-making, including the UK Government 25 Year Plan for the Environment [5.2a].

Recognition of our research outputs and expertise led to Depledge contributing one of three chapters of the key WHO evidence review underpinning WHO urban greenspace action [5.3]. Researchers at the Centre subsequently attained membership of an Expert Group advising WHO,

ultimately resulting in WHO's "Urban green spaces: a brief for action" for authorities promoting and supporting action for urban greenspaces. The WHO's Urban Health Equity officer said "...*this understanding of what matters is something where Exeter was different to many academic actors. There was a stronger understanding of what does it take on a local level to work on it and fund [green space] to make it functional and operational. This is where Exeter made a difference in terms of how the outputs and the research work were positioned, and how they can be useful to local practitioners.*" [5.4] The WHO report [5.3] and CBD COP Decisions were subsequently cited as key sources in CBD Subsidiary Body on Scientific, Technical and Technological Advice Recommendation XXI/3 *Health and biodiversity* [5.5] encouraging further cross-UN collaboration and enhancing implementation of the Strategic Plan for Biodiversity 2011-2020 and the 2030 Agenda for Sustainable Development through linkage of biodiversity and health. Recognising the significant role of the Centre's research in informing these global processes, in July 2019 it was designated the WHO Collaborating Centre on Natural Environments and Health.

4.2 Influencing national policy on natural environment and health

At the national scale, the Centre's research resulted in a joint report and Departmental briefing that informed and underpinned the Government's position on natural environment and health (published Mar 2017). The report was produced by a collaboration between the Centre, Defra, PHE and related stakeholders, who synthesised existing research-based critical evidence (including from Centre researchers) and conducted primary research. This report and the WHO report [5.3], were the key sources underpinning health aspects of the UK Government 25 Year Plan for the Environment [5.2a]. Consequently, Defra has established policy commitments, including the creation of national standards for Green Infrastructure and the transformation of agricultural subsidies, to a focus on public goods (including health), environmental investments, and large-scale initiatives. Approximately £10m has been committed to these health and nature programmes, reaching significant populations including over 500 schools [5.2a, 5.2b]. Defra's Social Research Advisor explains "*Defra wouldn't be picking up on this agenda if there wasn't some evidence underpinning it... I don't think the evidence would be available to us in the same form if it wasn't for your Centre... There's a major value to society from understanding the health benefits - health costs and benefits are absolutely huge. So, if we can get a better handle on the health costs and benefits linked to the environment, then that's part of a much broader agenda that Defra has realised it should be doing more on*" [5.6].

Our research-based evidence has led to improvements in the environment and has informed public health processes at the national scale, in part through our collaboration with PHE and the Health Protection Research Unit in Environmental Change and Health. Our research findings were used to establish the basis for the value of investing in urban green spaces for population mental health in PHE guidance to local authority planners "Spatial Planning for Health" [5.7]; and in PHE guidance on accessible greenspace, leading to the prominence of health in the new Green Infrastructure standards for England associated with the 25 Year Plan [5.2a]. Our research and collaborations with Defra, PHE and the NHS have contributed to additional Government investment of >£5.5m in social prescribing (prescription of non-clinical therapeutic services and activities outside of the NHS, e.g. conservation volunteer groups) [5.2c]. Together with the £10m investment to help children access the natural environment, this constitutes >£15m in UK government investment.

4.3 Informing local policy and practice on natural environment and health

The Centre's research has led to a range of policy and practice improvements at local scale. Our work directly led to the creation of a commercial tool, Greenkeeper, to evaluate the multiple economic values of urban green infrastructure. Prior to our longitudinal studies [3.5], there was no robust estimation of the magnitude of the positive impact of urban greenspace on population mental health, contributing to the under-valuing of urban nature. This work led directly to our collaboration with Vivid Economics (a climate and energy consultancy now part of the McKinsey group) and Barton Willmore (and independent Planning and Design practice) on the Innovate UK-funded Greenkeeper project. This involved the development and application of our studies of mental health and physical activity values [3.3, 3.5] to incorporate health-related values into the tool. Greenkeeper has already been used for a range of purposes, including in 2020 to support a call from National Trust and Heritage Lottery Fund to press the Government for **£5.5bn green**

infrastructure funding as part of a 'green recovery' to address inequalities in access to nature highlighted by the Covid-19 pandemic [5.8].

At the local scale, research by the Centre has been used to inform decision making and investment to promote the health and well-being of Dorset's population, and reduce pressure on its health and care services. Existing research and green space access mapping, carried out in collaboration with Public Health (PH) Dorset, underpinned the Healthy Places Strategy applied within PH Dorset's Sustainability and Transformation Partnership and Integrated Care System. Their Head of Programmes said "*accessibility mapping has helped to inform the identification of pilot parks...for accessibility enhancement through a blended programme of community engagement and activation, and infrastructure improvements. Research from the European Centre was instrumental in...direct investment by Public Health Dorset of £77,900...to increase engagement with natural environments/greenspaces through enhancements to physical infrastructure and social engagement*" [5.9].

Cornwall Council, under significant financial pressure from austerity, identified a need to recognise the health value as well as biodiversity benefits of almost 2000 parks, amenity and natural open spaces they manage. Collaborative work resulting from the ESRC-funded Beyond Greenspace project [3.5] led to co-produced outputs appended to the Council's Open Space Strategy, and has supported investment in and sustainable management of public open spaces for community health benefit [5.10]. Health evidence input from the Centre contributed to a successful bid led by the Council (with Exeter as a Knowledge Exchange partner) to the European Structural and Investment Fund resulting in a £3.5m green space development project, delivering >35 hectares of improved urban green space quality and accessibility in Cornish towns [5.10].

In summary, our research outputs have directly informed policy and practice at international, national and local scales, and have led to substantive collaborations embedding Exeter researchers within decision-making. This was recognised in 2019 with the designation of the Centre as the *WHO Collaborating Centre on Natural Environments and Health*.

5. Sources to corroborate the impact

5.1. World Health Organization and Secretariat of the Convention on Biological Diversity, 2015. Connecting Global Priorities: Biodiversity and Human Health.

<https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=1785&menu=35>

5.2a. Defra, 2018. A Green Future: Our 25 Year Plan to Improve the Environment. HM Govt, London (page 71). <https://www.gov.uk/government/publications/25-year-environment-plan>; **5.2b.**

<https://www.gov.uk/government/news/gove-kicks-off-year-of-green-action>; **5.2c.**

<https://www.gov.uk/government/news/new-sites-to-test-how-connecting-people-with-nature-can-improve-mental-health>.

5.3. WHO Regional Office for Europe (2016). Urban green spaces and health: a review of evidence. Copenhagen: WHO Regional Office for Europe. <http://www.euro.who.int/en/health-topics/environment-and-health/urban-health/publications/2016/urban-green-spaces-and-health-a-review-of-evidence-2016>.

5.4. WHO Europe (Interview with Technical Officer Urban Health Equity) 13/3/2020

5.5. Convention on Biodiversity, 2017, SBSTTA Recommendations on Health and Biodiversity. <https://www.cbd.int/doc/recommendations/sbstta-21/sbstta-21-rec-03-en.pdf>.

5.6. Defra (Interview with Social Research Adviser) 24/3/2020

5.7. Public Health England (2017) Spatial Planning for Health: An evidence resource for planning and designing healthier places. London: PHE.

<https://www.gov.uk/government/publications/spatial-planning-for-health-evidence-review>

5.8. Greenkeeper (2020) Greenkeeper supported call to Government for £5.5bn Green Infrastructure Funding 6 July 2020 <http://www.greenkeeperuk.co.uk/wp-content/uploads/2020/07/Greenkeeper-Report-for-FPA-Greening-Programme-July-2020-2.pdf>.

5.9. Letter of testimony, Public Health Dorset (Head of Programmes, R & I) 16/9/2020

<http://www.greenkeeperuk.co.uk/2020/07/06/greenkeeper-supported-call-to-government-for-5-5bn-green-infrastructure-funding/>.

5.10. Cornwall Council ESRC IAA form (County Ecologist) 9/5/2017.