Review of the Natural Environment Research Council Green Infrastructure Innovation Programme

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Contents

EXECUTIVE SUMMARY

This review profiles each of the 13 projects that were granted awards in the Natural Environment Research Council's Green Infrastructure Innovation Programme at the end of 2015. It describes their work and products in the context of the original ambitions of the projects. It is necessarily a partial picture as the majority of the awards have yet to submit their final reports and some do not complete their work until June 2018. The review summarises the project outputs individually and describes the nature of the decision support tools and models being created and their impacts. The review also examines their collective experiences across five cross cutting themes.

It concludes that the projects are all addressing their ambitions and aspirations as expressed in their bids. There are some substantial products arising from the 13 projects including published working tools that are being taken up by the development industry, approaches to citizen-science and credible models for evaluating GI at catchment and city scales. Included in this list are a number of examples of unexpected outcomes and over-delivery. There appear to be few instances of any significant under delivery and where this has occurred lessons have been identified. The review identifies a number of the affinities between the 13 projects, linked by a common purpose or methodology such as creating models and establishing standards, a shared focus on citizen science or the type of the GI they have addressed.

The review sets out a number of reflections and recommendations concerning evidence monitoring and knowledge sharing and how they have helped fill the gaps identified in the NERC sponsored review of GI evidence. It identifies some concerns about the long term value and take-up of decision support tools and also some of the challenges and barriers for tools in making an impact on spatial planning and other decisions. It exposes a gap that has opened up around the provision of guidance on GI for practitioners. The outputs and relationships between the 13 projects suggest there is potential for greater collaboration and enhancing the impacts through the emerging tools in NERC's GI tool-box.

SECTION 1: INTRODUCTION – BACKGROUND, INFORMATION SOURCES, STRUCTURE OF THE REVIEW

The Natural Environment Research Council (NERC) issued a call for bids to its Green Infrastructure Innovation Programme in June 2015. The aim of the call was to *'increase and accelerate the uptake and impact of research that has been funded within the NERC remit by supporting translational and knowledge exchange activity which delivers direct tangible and demonstrable benefits to end users. Funds will be used to support projects which focus upon generating user applicable outputs from past and/or current research that is in the NERC remit and which translates them into outcomes that achieve impact. Since the strength of the relationship between end-users and researchers is often what underpins the likelihood of success of any translational and knowledge exchange activity, it is essential that end-users are involved in both the development and delivery of proposals. They should be engaged by the applicant in the co-creation of the project at the earliest possible point. This should help optimise the sustainability of the project's activities by generating impactful outcomes'*[1]. The evidence needs for Defra, Natural England and the JNCC were also available to applicants.

The call included £150k for short feasibility projects and internships completing before 31 March 2016 as well as for longer term projects of up to £125K at 80% FEC in value. The assessment criteria for the potential impact of the proposals included;

Outcomes and benefits • Potential scale, type and range of impacts arising from the project (these can be direct, for example technology development or job creation, or indirect such as quality of life improvements resulting from better regulation); • The extent to which stakeholders beyond immediate project partners will benefit from activities and outcomes of the project; • Whether the project will result in improvements in innovation; • Whether the science is mature enough to deliver outcomes (the Panel will be questioning if the application is being made to fund research or to achieve impact).

End-user involvement • Demonstration of real commitment, levels of interaction and end-user buy-in (e.g. through involvement in setting project objectives) as outlined in the Letter(s) of Support and also in the contributions made to the project in cash and / or in kind; • Benefits to the end-user as a result of their involvement with the project and benefits to project delivery and achievements as a result of end-user involvement; • Balance of end-users and researchers / academics involved; • Involvement of relevant and / or appropriate end-users: if some are not involved is there a satisfactory explanation as to why not; • The extent to which this interaction may lead to new links between end-users and academics; • The flow of knowledge to one end-user or many may be regarded as of equal benefit – provided that the end-users are appropriate and that important ones have not been overlooked.

Mechanisms for delivery • Appropriateness of the work-plan; can the work proposed be achieved within the time-frame, and with the resources requested; • Range, scope and effectiveness of methods and activity; • Appropriate management in place to ensure best possible success (including relevant staff and systems) • Engagement and involvement of early career scientists and Post-Doctoral Research Assistants; • Appropriateness of funding request and external contributors (in kind and/or cash); • Appropriateness of support provided by host institution.

[1] NERC Green Infrastructure Projects call - Guidance for applicants (NERC, June 2015)

Figure 1: The 13 projects

An Ecosystem Services Approach to Green Infrastructure Partnership Planning (ESS/GIP).
Alex Collins
Period of Award: 1 Jan 2016 - 31 Mar 2016

A national benchmark for green infrastructure (National Benchmark).
Danni Sinnett
Period of Award: 1 Jan 2016 - 28 Feb 2017

Implementing GI approaches to river engineering protection measures (River Engineering).
Jonathan Simm
Period of Award: 1 Feb 2016 - 28 Apr 2017

Solar Park Impacts on Ecosystem Services: a Framework for Best-Practice (SPIES).
Alona Armstrong
Period of Award: 1 Jan 2016 - 30 Jun 2017

A National Scale Model of Green Infrastructure for Water Resources (National Scale Model).
Jim Hall and Mike Simpson
Period of Award: 1 Jan 2016 - 31 Aug 2017

A Decision Framework for Integrated Green Grey Infrastructure (IGGI or IGGIframe).
Larissa Naylor
Period of Award: 1 Apr 2016 - 30 Sep 2017

Assessing the contribution of domestic gardens to urban ecosystem services (Domestic Gardens).
Gina Cavan
Period of Award: 1 Jan 2016 - 31 Dec 2017

Valuing Green Infrastructure Through Tree Assessment TooLs (VITAL).
Philip Wheeler
Period of Award: 1 Jan 2016 - 31 Dec 2017

Injecting a Natural Capital Planning Tool into Green-Blue Infrastructure Management (NCPT).
Oliver Hoelzinger (and Jon Sadler)
Period of Award: 1 Mar 2016 - 28 Feb 2018

Tools For Planning And Evaluating Urban Green Infrastructure - Bicester And Beyond (Bicester & Beyond).
Pam Berry and Alison Smith
Period of Award: 1 Jan 2016 - 28 Feb 2018

Tree Selection for Green Infrastructure (Tree Selection).
Andy Hirons (and Ian Dodd)
Period of Award: 1 Jan 2016 - 30 Mar 2018

Green Growth: Increasing Resilience in Cities Through the Delivery of Green Infrastructure-based Solutions (Green Growth).
Adam Barker
Period of Award: 1 Apr 2016 - 31 Mar 2018

PROSuDs: Providing Real-world Opportunities for Sustainable Drainage Systems (PROSuDs).
John Williams
Period of Award: 1 Jan 2016 - 19 Jun 2018

Sustainability • Long-term updating of data and knowledge, stewardship of databases, models, websites or specific data management tools; • Consideration of end-user demand for the knowledge; is this likely to increase, decrease or remain constant; • How uptake and use by users after the project's end will be ensured and longer term impact will be achieved.

NERC commissioned this Review on 20th July 2017 in order to understand the progress of the 13 projects (see Figure 1) and the Innovation Programme overall. The Review would be used to inform future funding calls and priorities as a result of significant policy and contextual changes for NERC's work. It was understood that the projects would be at different states and stages given their intended completion dates.

1.1 Structure and Evidence Sources

The structure of this report reflects the brief which was agreed with NERC in July. It sets out a summary of the planned ambitions and impacts and the progress of each of the 13 projects followed by a view across the programme within 5 themes. The report identifies a number of common challenges and affinities between the projects, reflecting on opportunities that are emerging and makes a number of recommendations.

The Review has been informed by the following information and evidence sources;

- Abstracts and Planned Impact statements taken from the original project submissions and published on Gateway to Research[2]
- Principal Investigators (PI's) contributions to ResearchFish (March 2017)
- Published final reports, where available.
- Draft and interim reports and published articles and presentations made available by the PI's
- Email correspondence and telephone interviews with Principal Investigators
- Green Infrastructure - Research into Practice; August 2016 [commissioned by Innovation Programmes and Partnerships, Natural Environment Research Council][3].
- Feedback from the work of Prof. Alister Scott, NERC Knowledge Exchange Fellow[4]

[2] http://gtr.rcuk.ac.uk/search/project?term=green+infrastructure&selectedFacets=ZnVuZGVyfE5FUkN8c3RyaW5n,c3RhcnR8MTQ1MTYwNjQwMDAwMF8xNDgzMjI4Nzk5MDU5fHJhbmdl,c3RhcnR8MTQyMDA3MDQwMDAwMF8xNDUxNjA2Mzk5MDU5fHJhbmdl&fields=acp.d,is.t,prod.t,pol.oid,acp.oid,rtp.t,pol.in,prod.i,per.pro.abs,acp.i,col.org,acp.t,is.d,is.oid,cpro.rtpc,prod.d,stp.oid,rtp.i,rdm.oid,rtp.d,col.dept,ff.d,ff.c,col.pc,pub.t,kf.d,dis.t,col.oid,pro.t,per.sn,org.orcidId,per.on,ff.dept,rdm.t,org.n,dis.d,prod.oid,so.cn,dis.i,pro.a,pub.orcidId,pol.gt,rdm.i,rdm.d,so.oid,per.fnsn,per.org.n,per.pro.t,pro.orcidId,pub.a,col.d,per.orcidId,col.c,ip.i,pro.gr,pol.i,so.t,per.fn,col.i,ip.t,ff.oid,stp.i,so.i,cpro.rcpgm,cpro.hlt,col.pic,so.d,ff.t,ip.d,dis.oid,ip.oid,stp.d,rtp.oid,ff.org,kf.oid,stp.t&type=&fetchSize=25&selectedSortableField=score&selectedSortOrder=DESC&page=1

[3] Sinnett, D., Calvert, T., Martyn, N., Williams, K., Burgess, S.,Smith, N. and King, L. (2016) Green infrastructure: Research into practice. NERC Project Report. University of the West of England.

[4] In September 2017, whilst the review was underway, NERC appointed Prof. Alister Scott as a Knowledge Exchange Fellow for a 3-year period 'to help engineer innovative and fit for purpose guidance, processes, tools and resources to better mainstream GI as an asset within policy, delivery and decision making processes in spatial planning'. We have liaised with Prof. Scott and shared some findings and to avoid unnecessary duplication of effort and impact on the time of the project PIs.

SECTION 2: DESCRIPTION OF THE 13 PROJECTS AWARDED FUNDING UNDER THE INNOVATION PROGRAMME

The Natural Environment Research Council (NERC) issued a call for bids to its Green Infrastructure Innovation Programme in June 2015. NERC funded 13 projects through 14 awards having a total value of £1,153,267. The projects commenced in January 2016 or thereafter. These are listed in Table 1 and set out on Grants on the Web [at http://gotw.nerc.ac.uk/list_them.asp?them=Innovation+%2D+GI]. The grants were awarded to 11 universities across England and Scotland and to HR Wallingford Ltd. Principal Investigators from these awarded bodies were joined by Co-investigators from a further 3 universities and the NERC Centre for Ecology and Hydrology. Some of the projects were granted no-cost extensions and these are noted in the individual summaries in Section 6.

Table 1: List of the 13 funded GI Innovation Programme projects

Title, name of Principal Investigator(s) & Researchers contacted and their organisation, dates of the Award and *abbreviations* used in this review
An Ecosystem Services Approach to Green Infrastructure Partnership Planning (*ESS/GIP*). *Alex Collins, Imperial College London, The Centre for Environmental Policy* Period of Award: 1 Jan 2016 - 31 Mar 2016
A national benchmark for green infrastructure (*National Benchmark*). *Danni Sinnett, University of the West of England, Faculty of Environment and Technology* Period of Award: 1 Jan 2016 - 28 Feb 2017
Implementing GI approaches to river engineering protection measures (*River Engineering*). *Jonathan Simm, H R Wallingford Ltd, Floods* Period of Award: 1 Feb 2016 - 28 Apr 2017
Solar Park Impacts on Ecosystem Services: a Framework for Best-Practice (*SPIES*). *Alona Armstrong, Lancaster University, Lancaster Environment Centre and Professor P White, University of York* Period of Award: 1 Jan 2016 - 30 Jun 2017
A National Scale Model of Green Infrastructure for Water Resources (*National Scale Model*). *Jim Hall and Mike Simpson, University of Oxford, Environmental Change Institute SoGE* Period of Award: 1 Jan 2016 - 31 Aug 2017
A Decision Framework for Integrated Green Grey Infrastructure (*IGGI or IGGIframe*). *Larissa Naylor, University of Glasgow, College of Science and Engineering* Period of Award: 1 Apr 2016 - 30 Sep 2017
Assessing the contribution of domestic gardens to urban ecosystem services (*Domestic Gardens*). *Gina Cavan, University of Leicester, Geography (and Manchester Metropolitan University)* Period of Award: 1 Jan 2016 - 31 Dec 2017
Valuing Green Infrastructure Through Tree Assessment TooLs (*VITAL*). *Philip Wheeler, Open University, Environment, Earth & Ecosystems* Period of Award: 1 Jan 2016 - 31 Dec 2017
Injecting a Natural Capital Planning Tool into Green-Blue Infrastructure Management (*NCPT*). *Oliver Hoelzinger and Jon Sadler, University of Birmingham, School of Geography, Earth & Environment Sciences* Period of Award: 1 Mar 2016 - 28 Feb 2018
Tools For Planning And Evaluating Urban Green Infrastructure - Bicester And Beyond (*Bicester & Beyond*). *Pam Berry and Alison Smith, University of Oxford, Environmental Change Institute SoGE* Period of Award: 1 Jan 2016 - 28 Feb 2018
Tree Selection for Green Infrastructure (*Tree Selection*).

Andy Hirons and Ian Dodd, Lancaster University, Lancaster Environment Centre Period of Award: 1 Jan 2016 - 30 Mar 2018
Green Growth: Increasing Resilience in Cities Through the Delivery of Green Infrastructure-based Solutions (*Green Growth*). *Adam Barker, The University of Manchester, Environment, Education and Development* Period of Award: 1 Apr 2016 - 31 Mar 2018
PROSuDS: Providing Real-world Opportunities for Sustainable Drainage Systems (*PROSuDS*). *John Williams, University of Portsmouth, School of Civil Engineering & Surveying* Period of Award: 1 Jan 2016 - 19 Jun 2018

The 13 projects offered to address a diverse range of barriers and opportunities for increasing the impact and delivery of GI and applying NERC and other evidence in practice.

Most of the projects proposed explicitly to create a decision-support tool for planners, engineers, developers and others engaged in the design or delivery of GI policy and schemes. A number of these, in particular the River Engineering and IGGI projects, aimed to directly address regulatory and technical barriers. Two projects, Bicester & Beyond and Green Growth, looked to develop a means of helping people choose the right tool and another proposed to develop a tool that could be used within the context of other tools. In several cases the projects aimed to progress tools developed by previous research by expanding its capabilities or applying it more widely.

Several, for example the National Benchmark and PROSuDS projects, aimed to establish accreditable standards for the quality of GI policy and schemes. Two projects had the intention of directly engaging with citizens through citizen science or creating applications which would be directly useable by communities or local groups. A number suggested that their outputs would be useful to civil society.

In terms of the type of GI being addressed the coverage was quite wide. All referred to multiple benefits and ecosystem services or natural capital being achieved through improved delivery. Three related to water or coastal infrastructure and two were directed at trees and the ecosystem services they provide. Almost all of the proposals made a direct or indirect reference to the development and spatial planning process for the application of their work. The type of research into GI ranged from a detailed investigation of the drought characteristics of trees to the quality of gardens and their impact on GI at the city scale, modelling catchment scale changes to the quality of ecosystem services on development plots, the monetary value of individual trees and the worth of sustainable urban drainage schemes to developers profits. Geographically there was a good spread and many projects proposed case studies or demonstration projects e.g. Manchester (twice), Gloucestershire and Bicester were specifically cited in the bids and, through the engagement of their supporting partners, many projects could suggest that they would test their proposals in real world situations across the UK.

The successful projects varied in their length from 3-4 months to 30 months, with the final projects due to complete in June 2018. NERC kindly commissioned this review on 20th July 2017 for completion by December 2017. At the time of the commission 6 of the 13 projects were due to complete before our deadline and 6 have effectively finished. Several projects were granted no-cost time extensions to their work.

Whilst some projects have finished, their final report will not have been available for this review. Our review is therefore necessarily partial in its coverage of the progress and impacts achieved by the 13 projects. However, the report aims to provide a considered and informal narrative of the progress,

the state of all of the projects and draw some overall conclusions about the Programme and what it has revealed.

SECTION 3: THE REVIEW METHODOLOGY

In order to undertake the review, we drew down information from the original bids approved by NERC and used the Abstract and Planned Impact statements to summarise the original ambitions for each project. We constructed a template for the review process based on the brief agreed with NERC and initially populated this with information from ResearchFish (March 2017) provided by the project Principal Investigators. However, the information provided was at best patchy and often absent; some PI's were clearly more assiduous than others in reporting their progress.

We contacted each of the Principal Investigators to request an update on the progress of their project and asked for copies of reports, publications or other relevant material. This produced a healthy response but it was obvious that to get a fulsome picture, it would be best to conduct a structured telephone interview with each PI. Accordingly we set up interviews throughout September to early December with the PIs. We invited them to respond to a consistent set of questions, though, as we have noted, the projects are at different stages and so the conversations were adapted to the circumstances of each of the projects. Each conversation was written up and a draft provided to the PI's for their comment and agreement. These responses, reports and the other material provided by the projects are the basis for the analysis and commentary that follows.

SECTION 4: CONCLUSIONS, REFLECTIONS AND RECOMMENDATIONS

In this review we have profiled each of the 13 projects in the GI Programme, describing their ambitions, work and products [to date]. We have considered their outputs and experiences across five cross cutting themes, describing the nature of the decision support tools and models being created and their impacts. In the descriptions and themes, we have also identified a number of the affinities and commonalities between the 13 projects.

We can quickly conclude that the projects are all addressing their ambitions and aspirations as expressed in their bids. There appear to be few instances of any significant under delivery and where this has occurred lessons have been identified. Some highlights are set out in Table 2 and Figure 2.

Table 2: Selection of products and outcomes

Project	Some of the products and outcomes
National Benchmark	Building with Nature is the UK's first certification scheme for green infrastructure and has been published at https://www.buildingwithnature.org.uk/ which also has a user guide. Since the launch, the project managers advise that they have already had a flurry of interest from projects around the UK interested in becoming the next wave of Building with Nature certified schemes.
IGGI	The project has a shared framework for the critical success factors with the River Engineering project. The guidance provided by the project has been described as 'invaluable' and that Havant Borough Council is enthused and confident to try enhancements 'as we can now see how they have worked elsewhere and can also appreciate the wider benefits and costs of such measures'.
IGGI/River Engineering	A widely understood shortfall for many projects has been over the availability of credible valuation data for the use of GI. Both the IGGI and River Engineering projects found in particular there is limited or no information because of the lack of long term monitoring of implemented GI schemes. A joint webinar for the IGGI and River Engineering projects was hosted by CIRIA and held in November 2017.
ESS/GIP	Transferability; a purpose of testing was whether the project could design a methodology that others could pick and go; this will be possible but needs some specialist expertise to do this and a number of licencing and corporate data management barriers were met.
PROSuDS	A further challenge has been the difficulty of separating out the added value of SUDs to property values. The project is undertaking some outreach work to residents to understand how they perceive the value.
SPIES	The project has clarified the structure of the solar park industry; there is a long chain of land owner, park owner, asset managers, operational and maintenance companies linked by needs for cost effectiveness and energy production standards. The tool is designed to be part of this process and business model; it enables the developer/local authority to pick management options for ecosystem services.
Tree Selection	The tree species selection guidance is currently being developed in consultation with the nursery industry, which is adjusting nursery availability of species accordingly.

NCPT	At least seven cases studies are anticipated to be available by February 2018 and includes cases in London, Manchester, Oxford, the Black Country, West of England, and the Lake District.
VITAL	The scale of the capture of tree data and records is substantial. From a base of 50k tree records, Treezilla now has 300k and expects to reach 750-800k records by December 2017 as further bulk data from local authorities is uploaded. The project has developed processing code to enable the bulk transfer, which will be an asset for future use of the tool. The research has exposed a dearth of information about urban tree cover, which means there is potentially greater opportunity for further academic research in this area. The project has a confirmed follow-on take up in Wales next year, engaging the extensive network of the National Federation of Women's Institutes in an urban-focussed project 'Planting, Protecting, Promoting Urban Trees'. The WI has drawn down funding from the Heritage Lottery Fund to complement the NERC-funded training currently underway.
National Scale Model	The methodology for assessing the influence of land use [green infrastructure] on catchment response indicators has been developed and a journal paper is in preparation to publish these results. A further journal paper is due to be published shortly which will describe options for long-term national water resource management for Great Britain.
Green Growth	Stakeholders have been keen and buoyant in their enthusiasm to engage in the design process, an openness which has surprised and delighted the researchers. Through the extra work on the stakeholder survey, the refinement of the user typology has taken the project beyond the academic literature; stakeholders' enthusiasm to engage in the design process has become an active co-design process. The proposed typologies recognise the different actors and the variety of scales at which they work. The project has been a key component in securing a follow-on Horizon 2020 grant entitled: GROW GREEN- Green Cities for Climate and Water Resilience, Sustainable Economic Growth, Healthy Citizens and Environment.
Bicester & Beyond	The project has clearly identified an issue with the dearth of immediately useable tools for use by the planning authority. It has gathered a strong database on public participation and the value people assign to local green spaces. Using a Public Participation Geographic Information System (PPGIS) mapping methodology, it has contributed towards filling some of the Cultural Ecosystem Services knowledge gap by capturing new grounded, spatially explicit data about Bicester's GI. This is structured, qualitative data which can support the local authority's policy and decision making processes.
River Engineering	The project has been successfully finished and the report was published on 24th May 2017; *Green approaches in river engineering - supporting implementation of Green Infrastructure***.** The project has developed a decision support framework to support the implementation of Green Infrastructure approaches to river engineering. These GI approaches promote the conservation or recuperation of the natural character of our rivers.
Domestic Gardens	The My Back Yard tool is on-line http://mybackyard.org.uk and available for use by anyone with a UK postcode; the statistical findings are accessible for neighbourhoods in Manchester. The project has re-assessed the level of greenery in gardens at around 50% and, due to scale of the garden asset, this means that green space covers only 48% of the city. The finding has revealed

	the weakness of previous assumptions and methodologies and shown that some areas of the city are not as green as had been anticipated.

There are some wider messages arising as a result of the overall programme, which we set out below. In addition, by considering the affinities and some of the key relationships between the 13 projects - in terms of their challenges and approaches, users and beneficiaries and their focus and spatial application – we can better understand the potential for greater impacts from the tools in the 'GI box' and what may be worthy of further investigation.

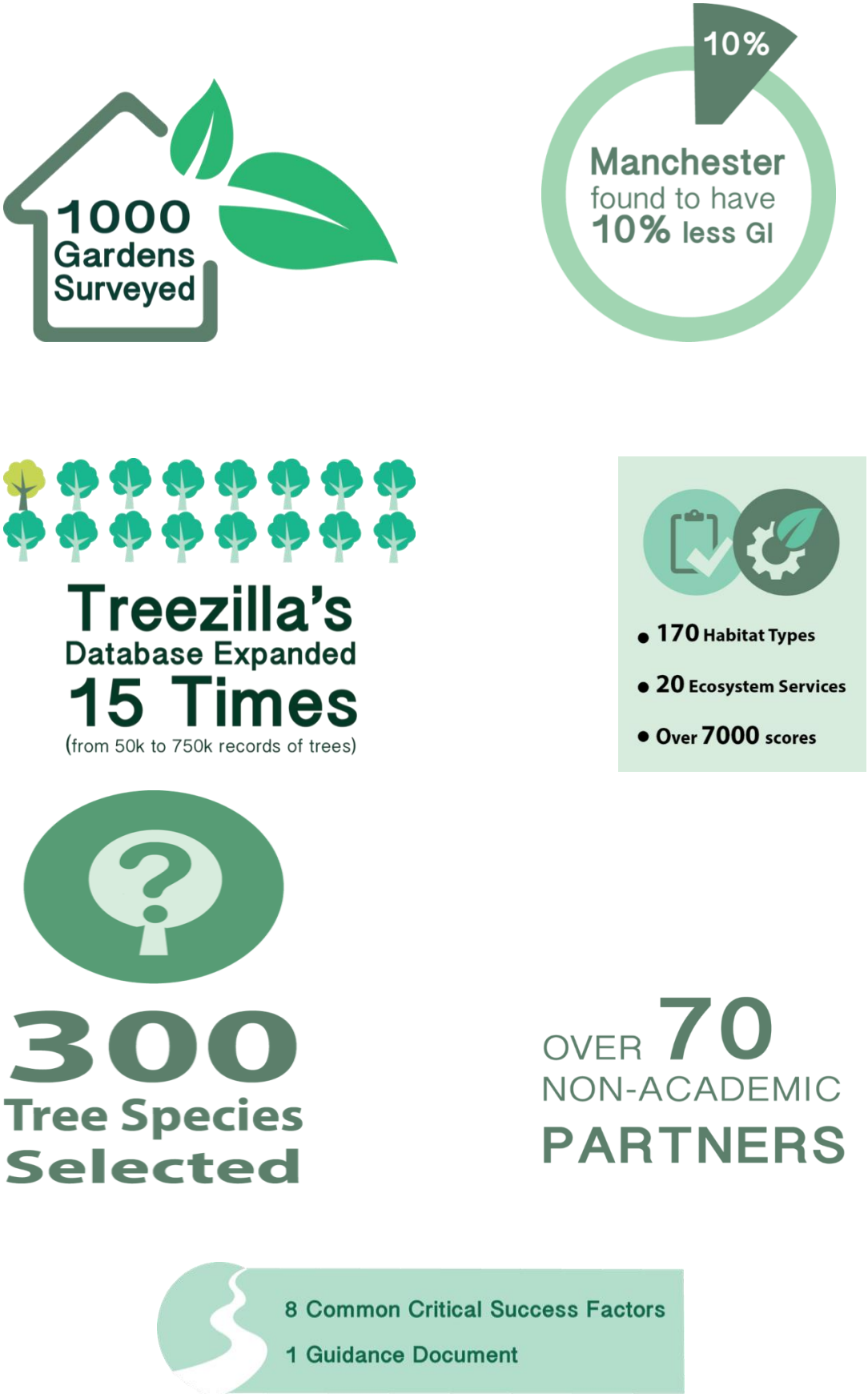
4.1 Addressing evidence gaps identified in the NERC/UWE evidence review

The 13 projects have clearly helped to retrospectively address some of the gaps in knowledge and navigation of the GI evidence as identified by Sinnett et al (2016) on behalf of NERC[5]. This is due to the nature of the criteria set out by NERC for the bids to the GI Programme Call, though, for obvious reasons, the projects have not filled these gaps in a systematic and comprehensive way. We can briefly conclude that;

- The GI knowledge base has been expanded, particularly around the value and qualities of trees in GI schemes and for the potential scoring of the quality of ecosystem services and natural capital;
- A significant amount of expert views and knowledge has been drawn down and shared through the creation of a number of the tools funded by programme;
- The water and coastal environments have new tools to guide professionals towards greener nature based solutions at catchment and site scales;
- Developers, planning authorities and other sectors identified as being missed by the UWE review will have additional and more credible means of delivering better GI outcomes at their disposal in future;
- New transferable models for assessing the quality and services of GI in gardens and catchments have been created which will help create consistent approaches, clearer language and GI standards;
- New approaches to generating citizen science for GI have been created;
- Business as usual approaches to development have been challenged with emerging new good practice using nature based or GI solutions and so helping to change behaviours in a number of professional and industry sectors; and
- A number of the project have generated outputs complementary to the UWE review of evidence and which might be worth bringing together because they have undertaken reviews of their own e.g. literature reviews, reviews of tools and GI typologies for users.

[5] Sinnett, D., Calvert, T., Martyn, N., Williams, K., Burgess, S.,Smith, N. and King, L. (2016) Green infrastructure: Research into practice. NERC Project Report. University of the West of England.

Figure 2: Selected highlights of findings



4.2 Decision support tools for Green Infrastructure

It was clear that there has been a strength and advantage for those projects which began their work from an existing tool or model and so the hard developmental work had been done. The Programme funding for demonstration and development of these tools has allowed them to progress in significant ways. Indeed, a number of the projects have now secured follow-on funding from NERC or other sources to enable them to deliver further. Some of the feedback we received had lamented the lack of on-going support for decision support tools.

We noted that, for a Programme funding a number of projects which aimed to create decision support tools, there was a view expressed on a number of occasions that there are too many tools 'on the market' and that many of these tools are not easily used.

A number of the projects particularly focussed their efforts on tools and models for the UK spatial planning system. These usually had the support of one or more willing representatives of local planning authorities. Outside of these volunteers, there was an assumption that the wider planning system and especially local government would adopt the tool(s) once its value had been proven. This raised a number of questions in conversation with the projects. Would it be used? Is there an appreciation of the limits and constraints faced by planning officers/authorities and how the planning system works? It is clear that the planning system is not infinitely elastic; it doesn't have the capacity to keep adopting new tools and techniques but does need help to address new challenges and absorb new science and evidence.

The solution to this might be multi-fold. It may be partly found in better knowledge exchange or community building or perhaps in improving the understanding of and skills in spatial planning in the academic sector. In a largely centrally controlled but locally delivered planning system, there may be greater merit in providing better guidance for all and we address this 'guidance gap' issue below.

Several other reflections are worth noting. The first is that applying the tools in practice obviously takes time and effort on behalf of the local authority or developer; given that an equal level of development takes place at the small, infill scale it is likely that a good deal of new development may slip under the tools radar unless the local and strategic planning of GI for places is addressed. Better tools or guidance at the strategic as well as the local or site scale may help tackle the problem of cumulative degradation of natural capital and services.

A second point for reflection is the accessibility of the tools by people that are the supposed beneficiaries of their outputs. The Programme has developed, in the main, more sophisticated top-down tools which are technically better and good for negotiating with developers. Those which involved citizen and social science approaches noted the keen interest shown by people in GI and their local 'political' support. The future evolution of GI tools may wish to ensure that usability and accessibility at the local level and empowering of people in the future of their place might be more of a priority.

Third is a reflection on barriers to delivery. Several projects engaged with or targeted developers or industry sectors to better understand their needs and to address these with the provision of niche and specific support. In part these efforts were also to influence behaviours in the professions. The impact of these has yet to be assessed or realised. However, in our conversations it was clear that the projects were engaging with the 'willing' or 'converted' and these representatives often faced a battle within their [usually private sector] organisations to change business approaches toward nature and GI. This suggests that the Programme may be attempting to influence points which are too far down the delivery pipeline to affect real, systemic change. NERC may wish to consider, for example, how it can

affects those decision makers which influence funding sources for development schemes and the subsequent management of GI.

4.3 Role of NERC and others in filling the 'guidance gap' and anticipating future needs

There is clearly a demand for support/guidance to local government and industry to help them to deliver better GI outcomes. Emerging industries (such as solar parks) and new drivers and context changes will obviously also prompt the need for new research and evidence. There is obviously also a wider research and modelling agenda beyond NERC, notably with Defra active in piloting GI-related work linked to its 25 year plan. A number of questions arose during our review in this respect.

Can these new drivers of change be predicted and would some near futures thinking help steer NERC and others to commission relevant research in a more systemic way? Can NERC with other research bodies help GI practitioners get ahead of the curve including an exploration of the value of practitioner-led grey evidence and tools? This may be helped by a wider understanding of the market for tools which reaches beyond academic interests.

In a number of our conversations we also found that there seemed to be a gap in filling this lack of guidance. The GI Programme has been helping to translate GI evidence and research into support tools and models for decision makers but no-one body or sector seemed to own the space. This looks to be a shared space between the research councils/academics, government (local and national), public agencies and industry. Research commissions such as the GI Innovation Programme are valuable but risk falsely addressing a policy, guidance or standards gap that might properly be filled by Government or its agencies.

Several of the projects have demonstrated the value of downloading expertise, grey evidence and knowledge to populate their tools. Projects that are led by the academic sector give a credibility to and help demonstrate the value of the GI products but it may reasonably be asked why this work often needs a NERC grant to do this? Many of the projects have involved statutory agencies and perhaps NERC might explore how these bodies can help do more to create GI as a business as usual proposition. The current 'Ecometric' initiative (led by Natural England) regarding the generation of 'net gain' from development is a positive message in this respect.

4.4 Long term monitoring of impacts and building evidence of what GI works

We note in the individual project summaries some projects have secured follow-on funding whilst others will not be progressed further unless new sources of funding become available. The maintenance and support of tools and their users is closely linked to having a better understanding of what GI approaches and models work. It was a common element of feedback from the researchers that more attention to long term monitoring of schemes on the ground or in the water or on the coast is required.

In some of the projects we reviewed it was clear that responsibility for the tools would be taken on by nominated organisations but in the majority of others this was not readily stated. It was the exception amongst the projects that any addressed long term monitoring and who should take responsibility. There may be solutions in remote sensing and citizen science (some projects mentioned the development of digital applications), especially if linked to the quality of delivery of local services by local government. This could be an area for NERC to consider further if the value of GI is to be properly embedded in business practice.

As an element of the criteria for the award of funds was the sustainability of the proposal - which included aspects such as updating data, stewardship of databases, websites, and end-user demand - NERC may also wish to reflect on the attention paid to this by the awarding panel.

4.5 Affinities across the programme, project collaboration and opportunities

The Programme saw some instances of collaboration e.g. between IGGI and River Engineering, Bicester & Beyond and Tree Selection and, emerging as the review came to a conclusion, between Bicester & Beyond and NCPT. On the face of it there seems to be greater potential to collaborate across the projects and share information; indeed in the course of this review it was possible to make a number of the PIs aware of the work of others on the programme.

This raises the question of whether it would be worthwhile to include community building into the grant award from the outset, to encourage early sharing for the benefit of projects and the programme as a whole. ResearchFish is clearly only intermittently used and so inadequate for this purpose. This requirement could help create an identity for the programme, sharing opportunities, building new and expanded research and skills networks.

NERC may also wish to consider the option of taking this a step further and including in the award process a phase whereby it could identify common research methods and parallel working; with a view to enabling cross-fertilisation, develop added-value and the scope for sharing resources. The feedback from our review would suggest that NERC should consider the advantages of cross disciplinary working, especially economic and social agendas and how behaviour change can be achieved for the better delivery of GI and its benefits.

In looking across the 13 GI projects it is possible to see the complementarity of some to others, for example, the linkages between modelling at a catchment scale to the site based assessments of several tools, down to the operational benefits of GI solutions in particular localities or through the choice of individual species. It is possible that further exploration of these connections could enable NERC to link and 'nest' tools.

Figure 3: An illustration of 4 projects linked through subject matter and methodology

Through the NERC KE Fellow, there will be opportunities to further pool knowledge and information, build the academic community and consider linkages as means of improving the suite of tools and their application, as well as advising on the next generation of research.

Without an exhaustive study into the research approaches and detail of all of the products emerging from the 13 projects, it is hard to provide a definitive picture of their common aspects and relationships. In Table 3 we have attempted to describe some of these to help illustrate some of the shared characteristics and point to some further opportunities.

Table 3: Some of the commonalities across the 13 projects

Category	Common Aspects	Project

Research methodology	Collating expert views	National Benchmark; NCPT; Green Growth
	Collaboration - high level aspects of tool co-designed	IGGI; River Engineering
	Feasibility of 'plug and play' explored for tool in new situation;	ESS/GIP; NCPT
	Application and development of existing tool	ESS/GIP; VITAL; NCPT; Bicester & Beyond; PROSuDS
	Addressing direct monetary value of GI	PROSuDS
	Working with specialised industry	SPIES; Tree Selection
	Citizen science	Domestic Gardens; VITAL
	Strong literature review	Green Growth; Bicester & Beyond
Notable design point	Identified appropriate evidence demands on developer	National Benchmark
	Ensure the applicant has appropriate GI skills	National Benchmark
	Entirely new [and transferable] model created	National Scale Model; Domestic Gardens
	Researching a tool to help others use the right tool	Green Growth; Bicester & Beyond
Barriers/issues	Hard or impossible to get valuation data	IGGI; PROSuDS
	Difficulty gathering case study information	IGGI; PROSuDS
	Corporate/system barriers and/or data availability	ESS/GIP; National Scale Model
	Securing (economic) skills for the research team	PROSuDS
	Changing business context for the industry sector	PROSuDS; SPIES
Key learning points	Accessibility of language, importance of stressing GI benefits to people/society	ESS/GIP; VITAL; Domestic Gardens
	Industry appreciates need for higher standards	SPIES; Tree Selection
	Demand is there for high quality advice/support to inform regulatory compliance	SPIES; Green Growth
	Embed delivery of GI quality in business as usual models wherever possible	SPIES; Tree Selection; Green Growth
	Commitment of identified partners can be variable	NCPT; Bicester & Beyond; IGGI
	Identified 3 climatic zones for GI in the UK; potentially relevant to all GI work	VITAL
	Too many [unusable] toolkits on the market	Bicester & Beyond
	New methodology exposes previous assumptions about types, scale and quality of GI	Domestic Gardens; Green Growth

SECTION 5: ACKNOWLEDGEMENTS AND DISCLAIMER

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The diagrams and illustrations were expertly provided by Niky Szabo of the Faculty of Computing, Engineering and the Built Environment at Birmingham City University. The photographs have been provided courtesy of the National Benchmark Project/Gloucestershire Wildlife Trust.

Needless to say that we have aimed to ensure the highest levels of accuracy and fairness in our review and any errors are solely ours.

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APPENDIX 1: PROGRESS OF THE 13 PROJECTS – A SUMMARY OF CONTENT AND OUTPUTS

This section provides a short description of the aims and purpose of each of the projects and a brief summary of the outputs and content of the completed work or work that is in progress. This is necessarily an abridged description of completed projects and a partial account of the final outputs of projects that are not completed or have yet to report. Links are provided to further material as available and appropriate.

A1.1 A National Benchmark for Green Infrastructure; Dr D Sinnett, University of the West of England, Faculty of Environment and Technology

The project aimed to explicitly fill a gap in applied knowledge by creating a national benchmark or standard of what 'good GI' should be throughout the GI creation process from policy to management on the ground. It proposed to work with end users to create the benchmark and then demonstrate its effectiveness by applying it through demonstration projects. To be freely available to all once published, the project envisaged that the benchmark would be used by and deliver social, economic and environmental benefits to a wide range of producers and consumers of GI. It also expected that it would enable a wider sharing of the knowledge used to create the benchmark. The extent of the agreed project was, as a result of discussions with NERC, curtailed to test the market and the feasibility of applying and refining the work on a benchmark developed locally in Gloucestershire and the West of England [under a Knowledge Transfer Project or KTP] into a national benchmark for GI. Demonstration projects would not be included.

The feasibility review and project was completed and a final report has been submitted. It is detailed in: *Smith, N., Calvert, T., Sinnett, D., Burgess, S. and King, L. (2016) National benchmark for green infrastructure: A feasibility study. Available from: http://eprints.uwe.ac.uk/29514*. The Benchmark project 'Building with Nature – a new benchmark for green infrastructure' is most recently described in 'Planning Our Green Infrastructure' a special issue of the TCPA's journal Town & Country Planning[6].

The feasibility review has concluded that there is a gap to be filled by the development of a national benchmark for GI and would help achieve greater consistency in the provision of successful GI. The review concluded that the benchmark will need to be positioned as offering clear benefits to applicants over and above the existing tools, checklists and guidelines currently in place to support GI. The success of the benchmark was felt to depend on cost, the simplicity and transparency of the assessment process and endorsement by national organisations, governmental bodies and local authorities. The benchmark would need to address a mix of process- and outcome-orientated aspects of GI, particularly the assumption that the key characteristics of GI as a multifunctional network would be a mandatory requirement and ensuring the benchmark was based on a sound understanding of the local context. A number of operational principles were identified through the feasibility review and the five symposia events that were held.

The 'Building with Nature' benchmark has three themes around the services that GI provides for nature conservation, water management and health & well-being. It is a developer-led tool and the standards and associated technical guidance have been informed by experts views from local stakeholders and from across the built environment sector. Development applications were used to

[6] 'Planning Our Green Infrastructure' a special issue of the TCPA's journal Town & Country Planning; October 2017, Vol.86, No.10

assess if the standards are at the right level and that the right type of evidence is required from developers; this was to ensure that it is not so onerous that it will deter developers from using it. The standards were [originally] set at two levels of current practice: 'very good' and 'exemplary' and much of the focus was in ensuring there is greater coherence of the evidence generated across the development project to enable certification. A similar process was being developed for use in policy development, including how the GI strategy will be represented spatially.

The proposal evolved that the developer would be awarded 'candidate status' at the planning and design stage and only given one of the two 'Achieved' or Excellent' awards once the GI had been delivered on the ground. This would address the oft-cited complaint that what is agreed is often not delivered and therefore it can be said that there has been an increase in quality as a result of the Benchmark award. The award itself could be achieved retrospectively through an application, however the preferred means would be to have a trained assessor as part of the project team to advise on the quality assurance of the design to meet standards.

Dr Gemma Jerome (Building with Nature Project Manager) and Simon Spooner (Operations Manager, Gloucester Services) at the launch of Building with Nature

Building with Nature is the UK's first certification scheme for green infrastructure and was formally launched in November at an event attended by over 100 people, including house builders, planners and planning agents, ecological consultants, construction professionals, public health professionals and academics from around the UK. Speakers included David Owen, Chief Executive of GFirst Local Enterprise Partnership; Sarah Scott, Director of Public Health for Gloucestershire; Barry Wyatt, Head of Strategic Planning at Stroud District Council; Ben Rosedale, Director at Environmental Dimension Partnership, and Simon Spooner, Chief Operation Officer at The Westmorland Family. The speakers' contributions on video are here: https://www.amazon.com/clouddrive/share/QTPm6btADVE1vHsG0rmijhYNcDL825uV16xpdO5J4uT and covered by BBC radio: http://www.bbc.co.uk/programmes/p05jqrj7#playt=41m40s (41m40s).

The project has been written-up by Inside Ecology: https://insideecology.com/2017/11/17/building-with-nature-certification-scheme-uk/.

The Building with Nature website is live at https://www.buildingwithnature.org.uk/ which describes how the benchmark works, showcases the five 'early adopters' of the Building with Nature certification mark and provides a User Guide for development and for policy documents.

A1.2 A Decision Framework for Integrated Green Grey Infrastructure (IGGIframe); Dr L Naylor, University of Glasgow, College of Science and Engineering

The IGGI Framework project stated its focus would be on achieving multi-functionality from grey infrastructure to achieve greener urban environments. It proposed to synthesise current best practice into a toolkit of how to apply green infrastructure principles to grey infrastructure. End users would include national agencies, businesses and consultancies who would benefit from having access to harder evidence about the direct and measurable costs and benefits to inform the business case for new investment. It stressed close working and co-designing the project with key partners to assess needs and mutual co-operation with other funded projects (including NERCs River Engineering/Wallingford GI project).

The project has been completed, the report concluded and (following a 3 month no-cost extension) will be launched in December 2017. Twelve months follow-on funding has been awarded from May 2018 to embed the outputs into practice.

The project report describes articles on case studies (showing a range of circumstances) that examine eight critical success factors (CSF) identified by IGGI. The project has a shared framework for the critical success factors with the River Engineering project which is also funded by NERC in this programme. The IGGI report stresses coastal examples to complement the River Engineering project. The eight CSFs have been arranged in a wheel to show their relative importance for each case study. A further 10 'art of the possible' examples have also been considered which analyses the delivered project but did not provide a 'benefits wheel'. The case studies, art of the possible examples and policy links provided in the report can be used to demonstrate the economic, environmental and social benefits that can be gained from adding IGGI measures to projects. They also provide evidence of the policies that have been used as statutory or non-statutory drivers.

The work of the IGGI project is described in Naylor, LA., Kippen, H, Coombes, MA., et al. (2017). Greening the Grey: a framework for integrated green grey infrastructure (IGGI). University of Glasgow report. URL: http://eprints.gla.ac.uk/150672/ . There is also a DOI for one of the applied academic outputs: Naylor, MacArthur, Hampshire et al. Rock armour for birds and their prey: ecological enhancement of coastal engineering Proceedings of the Institution of Civil Engineers, Maritime Engineering http://dx.doi.org/10.1680/jmaen.2016.28 (invited contribution).

A joint webinar for the IGGI and River Engineering projects was hosted by CIRIA and held in November 2017.The IGGI project has generated significant interest in UK infrastructure organisations. One of the SME partners in the project (Arc Consulting) has also benefitted financially from this project, as they are now paid to be involved in the NERC Public Engagement Pilot Project. A new company, Artecology Ltd., has been created as a result which is about innovation in achieving ecological gains, finding new ways to deliver a biologically favourable urban realm.

A1.3 An Ecosystem Services Approach to Green Infrastructure Partnership Planning; Dr A Collins, Imperial College London, the Centre for Environmental Policy

This was the shortest project of the 14 and was aimed at demonstrating the benefits of a previously developed ecosystem services (ESS) mapping approach through four urban demonstration areas (the ESUWE project). Its ambition was to influence the delivery of public services and policy making, including the targeting of investment for most public benefit. Outputs were to include the quantification of the value of services and a standardised approach which would enable judgements about trade-offs, greater interdisciplinary working and communication across a wider range of stakeholders (including the private sector) to achieve shared objectives.

The project was completed on time and the final report delivered; the report was very kindly updated by the PI in August 2017 to inform this review. This project was an ambitious attempt in relatively short time (30 days) to test and translate outputs and methods from the ESUWE project case studies into a new situation. Since the project has been completed for well over a year, the comments below focus on lessons learned, transferability of the approach, its impact and some of the barriers it identified.

Two key lessons were learned. First, that the language being used must be accessible to the non-expert and there needs to be a strong connection with strategic priorities of the adopting organisation. Ecosystem services and natural capital are not readily accepted terms nor understood; using 'benefits' is much easier. Similarly, maps and graphic representations have distinct advantages as sharing methods. The experience in Southampton City Council (SCC) strongly suggested that a link to health and well-being agendas and priorities gained more traction. The project could identify metrics but insufficiently detailed data sets were available to be mapped. This would merit further research and the PI has since started to explore this with OPAL to develop citizen science engagement through smart phone applications to inform the science of using urban parks and their natural qualities for decision makers.

The second was about transferability; a purpose of testing was whether the project could design a methodology that others could pick and go; this will be possible but needs some specialist expertise to do this and a number of licencing and corporate data management barriers were met. Internal stakeholders need to buy-in to the objectives. The project had an initial ambition to identify the value of GI and services but did not eventually allocate financial values. The researchers had reservations about the accuracy and quality of the information that it might reveal. The local authority did not subsequently adopt the tool/findings, mainly it seems due to lack of time and capacity in SCC and some internal barriers. This experience should inform the work of the NERC KE Fellow and it would be worth following up with SCC.

However, the project has generated interest in the approach. The Institute of Environmental Analytics has tried to apply it in Manchester, developing a visual mapping and diagrammatic on-line tool 'Bounty' with the potential to demonstrate the quality of green space in wards. There will also be relevance to other natural capital work in Manchester.

A1.4 PROSuDS: Providing Real-world Opportunities for Sustainable Drainage Systems; Dr J Williams, University of Portsmouth, School of Civil Engineering & Surveying

This project proposed to resolve the lack of standardised valuation guidance for SUDS, which is limiting the full take up of research and evidence of benefits of SUDS. To address the gap, the project will

create best practice guidance and a RICS accredited practice note for calculating the capital costs of SUDS, quantifying the economic values to developments and to explore what other contributions can be sought for off-site benefits. End users would be involved through developers, regulators and SUDS designers. The guidance will help quantity surveyors and developers to accept GI as assets of value and assess the economic case with confidence. The standardised economic case will consider environmental and social externalities and regulators can use the guidance as leverage to achieve multiple environmental benefits.

The project is underway and making good progress. It experienced a late start due to difficulties in recruitment of relevant valuation expertise, leading to the project beginning at the end of June 2016. The tool will be spreadsheet-based and is investigating whether it can be based on the architecture of an existing model. There will be a very clear focus on addressing monetary values and the economics of development and is aimed at use by developers. This has proved to be a bit of a moveable feast as the industry is going through a transition period where SUDS adoption routes are uncertain and various new players are entering the scene.

The first phase has been gathering up data of the whole life costings of constructed SUDs. Site visits continue to identify property values in the context of good SUDs examples though it has proved difficult to find an exemplar site which provides the breadth of information required. A further challenge has been the difficulty of separating out the added value of SUDs to property values. The project is undertaking some outreach work to residents to understand how they perceive the value. The tool will be wrapped up in a package for developers to use in their master plans and development appraisals of sites.

Monetization of the benefits of other services from SUDs is not being attempted in this project. However, the PI observes that they could quantify the process costs of having to redesign a SUDs scheme (say, on the request of the local authority) if these 'externalities' are not considered from the outset by the developer. The value will only be considered in the context of how developers can consider these factors in initial master planning, i.e. commercialisation. It will not estimate a total value that cannot be assigned to added values aspects, except in the context of the "good news" to accompany planning applications etc.

The project is on track to report by June 2018.

A1.5 Solar Park Impacts on Ecosystem Services: a Framework for Best-Practice (SPIES); Dr A Armstrong, Lancaster University, Lancaster Environment Centre and Professor P White, University of York

This project is led by the University of Lancaster in collaboration with the University of York; for administrative purposes it was funded through the award of two grants. The project proposed to develop a practical decision support tool to assess the impact of ground-mounted solar parks on the landscape and the ecosystem services of GI. It aimed to address the gap in current knowledge about impacts and opportunities. The project proposed a five step process for the study involving 11 partners and stressed the engagement of industry stakeholders. The outcomes would particularly inform policy as well as practice, including the construction and management of solar parks for optimal balance of ecosystem services (ESS) and the enhancement of GI. Additional benefits would be the creation of a research and practice network and that the tool would be a means of the UK demonstrating international leadership, with consequent benefits for the solar industry.

The project has been completed on time and on budget, the final report has been submitted to NERC and the tool has been launched with industry partners. The project has secured follow-on funding and its webpage is at www.lancaster.ac.uk/spies

During the first facilitated workshop the mix of commercial and environmental perspectives quickly arrived at a common aim due to the recognition that there was a need for guidance to fill the gap between policy and delivery. The drivers behind this were; variable and inconsistent approaches from different local authorities frustrating developers; companies seeking a standard approach, being able to demonstrate corporate responsibility for future development applications, especially extensions to planning permissions, and recognising that the quality threshold is increasing.

The project has clarified the structure of the solar park industry; there is a long chain of land owner, park owner, asset managers, operational and maintenance companies linked by needs for cost effectiveness and energy production standards. The tool is designed to be part of this process and business model; it enables the developer/local authority to pick management options for ESS, but is generic and so only an informative. The expectation is that it should be used by ecological consultants. Enabling a business as usual approach is important both for the local authority (as is unlikely to be able to enforce it fully as a separate requirement) and the asset management company which needs to demonstrate to the planning authority it has addressed impacts.

The Solar Park industry is clearly still a maturing industry and arguably the most recent example of a challenge to land use and the environment. SPIES is obviously a welcome addition to the toolkit for addressing this challenge, especially as it embeds it into the industry business process. However, the principle of addressing environmental impacts is generic from development and this work suggests that there may be scope for NERC and the regulatory bodies to use this experience to anticipate future industrial challenges and provide the tools these might need to fully embed the quality of the environment in their decision making.

A1.6 Tree Selection for Green Infrastructure; Andy Hirons and Professor IC Dodd, Lancaster University, Lancaster Environment Centre

This project sought to address the lack of guidance for urban planners, landscape architects and other local authority officers on the appropriate selection of tree species within GI schemes. A decision-support tool would be created to enable the selection of a more diverse range of species to match the challenges of urban sites and so help increase the resilience of and future proof GI. End users would be directly involved in identifying needs and the tool would be based upon credible research of tree ecology and physiology and the ESS trees provide. The tool would be informed by commercial perspectives and be refined by knowledge exchange sessions before publication. The bid noted a broader potential to use the model for other GI components.

The project is progressing well. A three month extension has been agreed by NERC and it will be completed by the end of June 2018 with seminars and a launch of the tool scheduled for spring 2018. A guidance document for the Trees and Design Action Group will form one of the major outcomes of the project. In total the guidance will cover the use of around 300 species and currently the lead researcher is working through the time-consuming preparation of each of the tree profiles and collecting photos.

In addition the project has also collaborated on joint research with French and Swedish partners to understand the science and physiology associated with drought stress (as a factor fundamental to tree survival) and this is being translated into four categories in plain English.

These primary data are currently being analysed and will be used to develop papers for publication in academic journals / conferences. The researcher is a co-author of a regular article in the Arboricultural Association ARB Magazine on the 'Plantsman's Choice' which also helps raise awareness of the project. Connections have been made with the Bicester & Beyond project to explore using the TDAG guide to help disseminate some of the Bicester projects' information. The tree species selection guidance is currently being developed in consultation with the nursery industry, which is adjusting nursery availability of species accordingly.

A1.7 Injecting a Natural Capital Planning Tool into Green-Blue Infrastructure Management; Oliver Hoelzinger and Professor J Sadler, University of Birmingham, School of Geography, Earth & Environment Sciences

This project aimed to develop an existing Natural Capital Planning Tool (NCPT; from 2014) to assess the natural capital and ecosystem services provided by G&BI and to incorporate these values and benefits into the UK planning system. It proposed to provide a model for integration and consensus building for providers of G&BI. The project would engage end users through case study partners and national bodies and so be informed by working across different scales and settings. Benefits would accrue to policy makers, businesses, civil society and knowledge brokers. Activity would be structured into three work packages which involved testing the tool, translating it into practice (an extensive set of actions), peer review and publication.

The project is on track to complete on time. There has been some delay and changes to the original project case study partnerships (CSP) but numbers of partners have expanded and it is on track to deliver seven case studies and two knowledge exchange end-user engagement workshops in early 2018. The tool itself is being continuously adapted in light of feedback from the case studies and a guidance document 'Natural Capital Planning Tool Introduction & User Guide' is in preparation. The project reports that it is receiving quite significant external interest; Defra has expressed interest in terms of its proposed 25 year plan.

The tool can be used at a range of scales and the ambition of the project partners was first to test it at a larger scale; there isn't a micro-scale CSP. At least seven cases studies are anticipated to be available by February 2018 and includes cases in London, Manchester, Oxford, the Black Country, West of England, and the Lake District. The new sites have come through following conference presentations by the researcher.

The impact of this range of cases will only be fully understood in the New Year when two end user engagement workshops to translate, review and build commitment will draw together the CSPs to consider how the tool has been used, barriers, lessons learned and impact. These will be hosted by the RTPI and the Business Council for Sustainable Development; the former will emphasise a local government sector perspective and the latter the business case for the tool.

The researcher reports that evidence availability in useable and appropriate formats can be an issue, especially for private sector actors. Whilst local government is obviously expressing an interest in the value of the tool, despite the focus on spatial planning DCLG has yet to get involved in the project.

DCLG is likely to be invited to the end user events. Some NGOs are involved in the case studies but the wider civil society isn't yet involved.

The project aimed to publish via a web portal and now proposes to publish the tool on the Ecosystems Knowledge Exchange Network website. https://ecosystemsknowledge.net/natural-capital-planning-tool-ncpt . This will be by the end of February 2018. In terms of written outputs, a paper with the working title 'Mainstreaming nature's value(s) into spatial planning theory, policy and decision-making in the built environment' is in preparation and a further paper about the NCPT and this project in general is intended.

A1.8 Valuing Green Infrastructure through Tree Assessment TooLs (VITAL); Dr P M Wheeler, Open University, Environment, Earth & Ecosystems

This project aimed to develop a free to use system that allows everyone to understand the value of trees and the ESS they provide. It firstly proposed the improvement of an existing valuation tool and enhanced links to and synergies with another established tool in use, so providing a more powerful suite of tools. End users/partners would be involved in the development and demonstration of the tool. Secondly the tool [Treezilla] would have wider dissemination through the Tree Council's network of members and volunteers. Thirdly, the project would embed a greater wealth of data and knowledge of the tool in end users, with an expectation that this would lead to greater empowerment of citizens to influence environmental decision making.

The project is in an advanced state and progressing well, due to conclude at the end of December 2017. Treezilla: 'the monster map of trees' (www.treezilla.org) was developed by The Open University and adapted by OpenTreeMap to engage citizens in mapping and valuing trees around them. Treezilla calculates ESS benefits across a range of ESS for individual trees. These outputs are based on calculations that require the user to input the species and diameter at breast height (DBH) of the specific tree. These two parameters are used to estimate properties of individual trees such as leaf area, which then permit calculation of an ecosystem service benefit. Treezilla.org provides users with estimated amounts and values per tree for; pollutants removed from the atmosphere, CO2 sequestered and stored, storm water intercepted and energy saved (through reduced needs for heating and air-conditioning due to shade, evapotranspiration and windbreak provided by trees). The benefits are described in monetary values which are based on HM Treasury and other credible sources.

The first objective of the project has been fulfilled; the Treezilla tool is functional and active on line and being evolved in response to use. The second objective of communicating the tool has been actively delivered through engagement with Milton Keynes Parks Trust and 3 local schools, the Tree Council and dissemination of educational material more widely and, shortly, through a collaboration with the Welsh Government, Natural Resources Wales and the Federation of Womens' Institutes in Wales which aims to raise awareness and train several thousand members in 2018. The third ambition to embed the tool and empower citizens is in its formative stages but opportunities are emerging with several local authorities and the Parks Trust.

The scale of the capture of tree data and records is substantial. From a base of 50k tree records, Treezilla now has 300k and expects to reach 750-800k records by December 2017 as further bulk data from local authorities is uploaded. The project has developed processing code to enable the bulk transfer, which will be an asset for future use of the tool. In response to feedback from the Milton

Keynes Parks Trust testing the tool with local people, the project has re-heated an original idea to create applications for mobile devices and these are now in development.

The research has exposed a dearth of information about urban tree cover, which means there is potentially greater opportunity for further academic research in this area. This gap in information may be due to historic practices in local government in collecting and sharing data. The project has highlighted the potential future risk in collating and accessing tree data as local authorities outsource the responsibility for green space and tree management to private companies. Meeting the challenge of translating the OpenTree tool application to create a robust, fit for purpose tool for the UK, required the creation of reference points for UK climatic conditions to ensure accurate valuations of services. The newly identified three climatic zones for the UK could have wider application to other tools and methodologies which assign a value or score to ecosystem services from GI [e.g. relevant to ProSUDS, Tree Selection or NCPT projects].

Treezilla is a citizen science platform that aims to empower individuals to understand the wide range of benefits. The project has established a substantial database and the potential exists if future investment is provided to enable the data to be interrogated by science, policy makers and communities alike.

The tool can be found at www.treezilla.org and readers are encouraged to visit and enter records of trees. A conference paper has been prepared and presented 'Using a citizen science tool to model the health benefits of roadside trees'.

A1.9 A National Scale Model of Green Infrastructure for Water Resources; Professor JW Hall and Mike Simpson, University of Oxford, Environmental Change Institute SoGE

This project aimed to take local experiences and outputs of individual natural resource water management (NRWM) and build a generalised model to identify the costs and benefits of a range of options for new NRWM, including mapped financial and carbon solutions. It proposed to draw on existing knowledge from the UK and overseas to develop a model of the effects of NRWM on water. The model would be applied and tested for the impact of variables such as climate change, population, energy and water demand. The engagement of national stakeholders such as Defra, the Environment Agency and the National Forest Company was highlighted, as was a tie in with a major private sector company.

The project is substantially complete. The methodology for assessing the influence of land use [green infrastructure] on catchment response indicators has been developed and a journal paper is in preparation to publish these results. A further journal paper is due to be published shortly which will describe options for long-term national water resource management for Great Britain.

The 'National Scale Model of Green Infrastructure for Water Resources' project set out to integrate current knowledge on Green Infrastructure at the catchment scale with an existing model of future water resource infrastructure needs for mainland Great Britain. The project was inspired by the research question of how much land use change is needed to make a difference in slowing the flow for flood management. This was a challenge shared by many interested organisations and partners quickly signed up; Environment Agency, WWF, Defra, National Forest Company.

The project was structured into four tasks. Task 1 reviewed the evidence for natural water resource management (NWRM) and the state of art of catchment management. This found and addressed the lack of information on the quantitative benefits of NWRM for hydrology, carbon cost, and land-use

change. The second task developed a generalised model which can identify plausible scenarios based on land use changes. The National Forest was used as a testing ground. Task 3 was aimed at evolving this into a national scale model for 2050 opportunities and the fourth task sought to synthesise with scenarios for future water infrastructure and how a mix of alternative solutions natural and conventional might work. It included work on influence of uncertainties e.g. costs, climate change and on beneficiaries and implications for co-funding.

The project assessed several models before determining a final version. The final model is substantially sound.

The project has developed new tools for the assessment of land use change on water systems and the results stress the heterogeneity of the UK water resource challenge. It mapped outputs of the influence of land use change on hydrology under five scenarios of land use change. The results suggest that catchment management has a moderate, regionally specific role to play in augmenting river flows. However, where it is effective, in areas expecting low to medium growth in water demand, catchment management can be an effective component of a water infrastructure portfolio. This is especially true when the many co-benefits of natural ecosystems are considered, perhaps the most relevant of which are the benefits to water quality and flood protection which have emerged as high priorities for future research and innovation.

The final conclusions are still being discussed although the model did confirm the observations of other projects that there is an association between land use change and flow rates. Further work on the synergies between the two strands of national water resource management and land use change in catchments is underway. The researchers report that the project has also opened up new work areas with the National Infrastructure Commission and the Environmental Change Institute. A network of researchers in this field has been established which is enriching the professional and personal development of the researchers involved.

The language of the bid 'natural resource water management' (NRWM) was EU driven but not recognised by the partners and so it was converted to catchment management. The project met some barriers in getting the co-operation of other organisations to share data; a lesson for encouraging better sharing across institutions. This has suggested to the researchers that further work with greater quantity and quality of data would be important to ensure more robust and sophisticated modelling is possible.

A1.10 Green Growth: Increasing Resilience in Cities Through the Delivery of Green Infrastructure-based Solutions; Dr A Barker, the University of Manchester, Environment, Education and Development

The project proposed to develop and test a means of translating GI research into a practical user interface and so improve the take up of GI implementation. A 'route-map' would integrate GI science into end user organisations in such a way that it would be institutionalised within organisations and help multi-functional GI to become usual in development. Manchester would be the test city. The key benefit would be to provide end-users with both an improved understanding of the barriers and complexities of user uptake of GI and the integration of science into decision making.

This project is on schedule having received a three month no-cost extension for completion in June 2018. It is aiming to create a 'How To' guide for identifying appropriate tools and methods and is being produced in four work packages (WP). WP1 has investigated how GI science is perceived and

understood principally through a literature review. WP2 has reviewed the needs of practitioners and is almost completed following a built environment professional's event. WP3 is beginning to address the barriers and constraints to successful application of GI science and evidence through stakeholder interviews and a practice training event hosted by the UK Green Building Council in March 2018. WP4 will test the outputs from previous WPs toward the 'how to' guide for practitioners.

The literature review has identified a typologies of GI science and this will be part of a published paper. The actual user-focussed typology will be different as the project is taking on stakeholder perceptions of science, translating it to audience and scale as stakeholders found it difficult to identify the relevance of GI science for themselves and synthesise the information.

Barriers to and needs for delivery are emerging [not fully described yet] and some will be addressed in this project whilst others may require further follow-on work. These include; audiences are not sufficiently well described in the science base - it is a simplification to use broad groups (e.g. private vs public sector); the sense of scale is an issue - with a need to express a much stronger sense of a spatial vision for GI; types of science being available - economic valuation of GI is prized but the social and community responsibility agenda, especially health and well-being, was at least as highly considered during WP2 discussions. This seemed to reflect the developers' ambition to demonstrate they were addressing their community obligations as well as creating a marketing message. Towards the bottom of the need for science for developers is climate change, biodiversity.

In October 2017, the project held WP2 Knowledge Exchange Event entitled "Enhancing the delivery of Green Infrastructure: The Experience of Built Environment Professionals" This was a half-day workshop for professionals focusing on several group exercises and a case study based urban design challenge. The emphasis was on mapping needs and identifying opportunities. The outputs (both textual and visual) will inform the WP3 interview surveys. The final part of Work Package 2 has been completed.

Stakeholders have been keen and buoyant in their enthusiasm to engage in the design process, an openness which has surprised and delighted the researchers. Through the extra work on the stakeholder survey, the refinement of the user typology has taken the project beyond the academic literature; stakeholders' enthusiasm to engage in the design process has become an active co-design process. The proposed typologies recognise the different actors and the variety of scales at which they work.

The stakeholders working on the project are often committed advocates of GI already and they require the 'ammunition' to make the case for GI within their organisations. This is because the business model employed by developers (especially house builders) does not encourage design/landscape design inputs. Some stakeholders engaged in the project suggest a stronger regulatory framework with clear parameters would mean better outcomes. Some landowners/development companies express frustration with the GI agenda as it can be interpreted as rewarding more prosperous places and people in higher value locations but in [riskier] lower value places it is not delivered because it is seen as an add-on. The institutional attitude, lack of skills and vision is seen as the barrier.

The urban design sessions on site seemed to reinforce the problem of barriers; they revealed a tendency for stakeholders to identify the reasons why GI solutions could not be implemented rather than to identify creative solutions.

There is a feeling emerging that there are too many toolkits, observing that delivery bodies are confused as to their relevance, unsure of where to go and so don't engage. Underpinning this is an observation that institutional behaviour is a critical factor; current practice is hard-wired into delivery

e.g. reliance on template-style [housing] layouts, prefabricated building techniques etc. This is allied with the role of the market with respect to the environment.

The project is now progressing the interview and workshop components of Work Package 3. The work underway is to consolidate and map the barriers and through scenario-based activity at workshops, consider the routes through these e.g. regulatory solutions, GI levies and taxes, skills development, increased evidence and knowledge.

Part of this is a workshop with the UK Green Building Council. This will be a half-day master class event focusing on integration of GI in development based decision-making. Confirmed keynote speakers include senior staff from Arup, Lend Lease and James Blake Associates. The event will result in the production of a GI 'How to Guide' which will be indicative with scenarios and next steps described.

In addition to yielding academic outputs and enhanced practice based capacity, the project has been a key component in securing a follow-on Horizon 2020 grant entitled: GROW GREEN- Green Cities for Climate and Water Resilience, Sustainable Economic Growth, Healthy Citizens and Environment. The project will centre on the advancement of GI demonstration projects through collaborative partnership between academics, public and private sector actors and third sector interest groups. The project is Manchester-led and there will be a Manchester based demonstration project which will make use of current NERC academic team members and our wider project partners.

A1.11 Tools for Planning and Evaluating Urban Green Infrastructure - Bicester and Beyond; Dr PM Berry and Alison Smith, University of Oxford, Environmental Change Institute SoGE

The Project sought to address the lack of guidance available to GI practitioners in choosing the best tools for their needs. This proposal is driven by the current needs of [end user] Cherwell District Council to integrate GI into new development at Bicester. A number of other local and national stakeholders were named. The University of Oxford and Forest Research would compile the toolbox, apply it to Bicester and then test it in a number of other local authorities. By using the tool, planners, developers and greenspace managers would be able to deliver more benefits and lists these as economic development, health and wellbeing, biodiversity, climate change resilience and social engagement.

The project has fallen a little behind schedule but work is accelerating to ensure completion by the end of February 2018. The toolbox of decision support tools is in preparation; the work so far has revealed a limited (very small) number of useable tools which can be picked up by a planning officer and easily applied.

The project has undertaken database development by compiling numerous different GIS layers to map and evaluate Green Infrastructure in Bicester. These have been obtained from various different sources aiming to use only data that is freely available to local councils and planners; this so that the project will provide guidance showing how other local councils can compile and use similar datasets in their own areas.

The original ambition was to develop a guidebook with a key focus on the needs of Cherwell DC as local planning authority. It is likely to include the EcoServ-GIS Mapping Tool, a National Standard tool (developed by the Scottish Wildlife Trust), the Natural Capital Planning Tool (currently being tested by the project in Bicester and elsewhere) and valuation tools (GI-Val and the BEST SuDS tool).

A key tool will be a land-cover scoring approach for ecosystem services and natural capital which was developed by the researchers in Warwickshire. This tool (being evolved in Bicester) has been created

with stakeholders generating a scored matrix, ground-truthed using extensive literature review information, on the ability of different land-cover types to provide ecosystem services such as flood protection, carbon storage, recreation and habitat for wildlife.

The Bicester natural capital tool differs from the NCPT as it has a simplified version of habitat types (50 to the NCPT's 170) but more ecosystem services (20 compared to 10). The researcher has reviewed the (7000) NCPT scores against knowledge in the literature; whilst the NCPT has many reviewers contributing to its biodiversity scores, it has relatively few or single contributions to scores for many of the other ecosystem services. The researcher is working with NCPT's researcher (Oliver Hölzinger) on the Eco-metric tool for Natural England and will aim to reconcile some of these differences.

The research has revealed some barriers. For example, difficulties getting datasets from developers/consultants and converting data from CAD to GIS formats; a slow response from the local authority in releasing tree data, as well as interruptions in engaging the local authority due to personnel changes within the Council. The project has used a valuation tool supplied by the Mersey Forest (GI-Val) but this required a lot of input data to generate usable information, much of which was not available. Forest Research is attempting to apply the i-Tree and Treezilla tools to value the impacts of trees (e.g. on air quality and carbon storage) but this has been hampered by problems with releasing the local authority tree database.

Two Masters students have deepened the work of the project. One of whom used stakeholder engagement and fieldwork to map the hedgehogs in Bicester and to find out more about which habitats they use, with a view to analysing the connectivity of Bicester. The second has gathered a strong database on public participation and the value people assign to local green spaces. Using a Public Participation Geographic Information System (PPGIS) mapping methodology, it has contributed towards filling some of the Cultural Ecosystem Services knowledge gap by capturing new grounded, spatially explicit data about Bicester's GI. This is structured, qualitative data which can support the local authority's policy and decision making processes. The hedgehog mapping work has provided new evidence for the town and contributed to thinking about the nature of GI networks. For Bicester itself the mapping and scoring work has revealed that there is no real network of green spaces and little or no natural or wild land. Two newsletters dated March and October 2017 have been produced and a GIP Case Study (for the TCPA) and Environmentalist article have been drafted.

The project has clearly identified an issue with the dearth of immediately useable tools for use by the planning authority. Tools are developed because funders are looking for innovation and, once created, they are no longer innovative and so get lost in a 'Death Valley' of unsupported tools. Those that survive are either well-resourced (e.g. through Universities) or commercial and relatively expensive to access (though updated and supported as a result). There is uncertainty as to who has the responsibility for managing the 'guidance gaps' and ensuring that previous investment is not wasted. In addition, the lack of existing guidance on how to optimise planting schemes to maximise air quality benefits (e.g. choice of tree species) has been notable. The work has also revealed an unexpected need for some kind of support tool to help in the operation/management of green infrastructure but is not clear what the solution is for ensuring appropriate governance.

For Bicester itself the mapping and scoring work has revealed that there a limited network of green spaces and little or no natural or wild land [echoed by recent BBC reporting on the absence of wild land in over 140 local authority areas]. According to CORINE satellite data, Cherwell District Council has only 1.2% natural or semi-natural land and 3% urban green space (it is 88% farmland, 8% urban). This makes it difficult to plan meaningful ecological networks.

A1.12 Implementing GI Approaches to River Engineering protection measures; Mr JD Simm, H R Wallingford Ltd, Floods

This project was aimed at resolving some of the procedural, cultural and technical barriers which currently obstruct the application of GI to river engineering protection schemes. It proposed to develop a decision support tool to enable end users and decision makers to select GI engineering options and meet business case, technical and regulatory requirements. It was also envisaged that the tool would be a building block toward a larger GI guidance manual integrating coastal and fluvial GI interventions. In turn this would be a resource for a wider set of stakeholders. A specific reference was made to the potential for integrating with the outcomes of the NERC funded 'A Decision Framework for Integrated Green Grey Infrastructure (IGGIframe)' under this same GI Innovation Programme.

The project has been successfully finished and an overview is available at http://www.hrwallingford.com/projects/green-infrastructure-supporting-green-river-engineering. The report was published on 24th May 2017; ***Green approaches in river engineering - supporting implementation of Green Infrastructure.*** Roca, M. and Escarameia, M. and Gimeno, O. and de Vilder, L. and Simm, J.D. and Horton, B. and Thorne, C. HR Wallingford, Wallingford. ISBN 978-1-898485-16-2 (2017). It can be downloaded at http://eprints.hrwallingford.co.uk/1400/ . It is also available from the CIRIA website at http://www.ciria.org/News/CIRIA_news2/NERC_projects_%E2%80%93_Delivering_Green_Infrastructure_(GI)_in_the_UK.aspx .

The project has developed a decision support framework to support the implementation of Green Infrastructure (GI) approaches to river engineering. GI approaches promote the conservation or recuperation of the natural character of our rivers. They are fundamental to improving the quality, morphology and ecology of rivers as well as contributing to an overall strategy to help people and communities adapt to the impacts of climate change. The development contributes to the change in which river engineering approaches are assessed. It helps users to follow a structured path to consider natural and green approaches first, before considering more traditional hard engineering approaches.

The project addressed three broad objectives; the operational benefits of green infrastructure approaches, the challenges of changing behaviours and attitudes of practitioners and creating a building block for a manual of guidance.

It has achieved what it set out to do in terms of the translation of knowledge to operational practice by creating a decision support framework that works at two levels: the Business case, which provides arguments to support the decision to implement GI approaches, and the Technical Support, which provides technical information to select particular measures. It has identified the success factors that contribute to the success of GI measures and this higher business case level is shared with the IGGI Framework Project. To support the technical information it has collected evidence of a range of case studies to showcase the application of several GI approaches. The decision support framework and the case studies contribute to unlock some of the barriers that prevent and obstruct implementation of GI approaches by supporting asset managers, engineers, decision-makers and other end-users such as regulators and planners to identify the critical success factors that will permit the application of successful GI approaches.

The project developed a number of case studies and these are described in the report. Whilst the original intention was to assess existing evidence sources, the process of describing the case studies relied on extracting valuable grey evidence from operational sources. The project found it difficult to

gather hard evidence of the performance of green infrastructure solutions because the examples did not exist or no long-term monitoring has been undertaken. The PI understands that this evidence and research problem is echoed in recent work by the Environment Agency.

The development of the case studies reiterated the value of drawing down the operational and practitioner experience of implementing schemes and joining this 'grey' evidence to that published in the [incomplete] peer-reviewed literature [on NERC or other funded work] which is necessarily limited. As such the project has created new evidence material and has made it available more widely.

The third initial ambition of this project was to provide a foundation for a guidance document for green river engineering and over-delivered by creating and publishing this guidance. Although it is early days, the signs are encouraging toward the project helping to change behaviours. The Environment Agency has widely circulated the guidance document internally. The research outcomes prompted a discussion about the ownership of the space in which guidance is seen as being required; sitting between industry, academia and policy makers. This due to the lack of funding, government will and process to bridge the policy to delivery gap. This space was seen as hard to fund as it falls between research and practice. The work has reinforced the PI's experience with CIRIA and has demonstrated that practitioners/professionals do not have time to undertake [academic] literature reviews and need ready access to definitive guidance documents.

A1.13 Assessing the contribution of domestic gardens to urban ecosystem services; Dr G Cavan, University of Leicester, Geography and Manchester Metropolitan University

This project aimed to provide a novel citizen science approach to gather data about green infrastructure in domestic gardens and co-develop an action plan to prioritise urban greening solutions in Manchester. It proposed to address data deficiencies through combining people surveys and satellite data which would then be used to model the role of garden vegetation in delivering ecosystem services. Using Manchester as a test bed, the results would inform city-wide GI delivery as well as action at the domestic and neighbourhood scales by the City Council, a charitable housing association and environmental NGOs.

The project has progressed well over the project timeframe, and is nearing completion. The research has been completed and the final report is being finalised and signed off by the project partners. A 3 month extension is being sought from NERC (decision awaited) in order to provide more opportunity for dissemination and consideration by partners. The My Back Yard tool is on-line http://mybackyard.org.uk and available for use by anyone with a UK postcode; the statistical findings are accessible for neighbourhoods in Manchester. The key message of '5 top tips' are also accessible to anyone at the end of the survey.

The first three project objectives have been achieved in full:

1. Development of an innovative citizen science online tool to capture the green infrastructure and associated ecosystem services provided by domestic gardens. This can be viewed at www.mybackyard.org.uk. Over 1000 responses were obtained and processed.
2. Validation and extension of the citizen science database, and developing a domestic garden classification, through application of high-resolution remotely sensed imagery. A GI database has been created for Manchester at ward and Local/Lower Super Output Area level and is available to view on a web map.
3. Quantification of the regulating ecosystem services of domestic gardens at multiple scales (garden-neighbourhood-city) using the outputs from objectives 1 and 2, and existing empirical

models. Maps of cooling and runoff potential have been produced and are available in the online web map database.

The final project objective, due to be completed by mid-end December 2017, is the co-development of an action plan to prioritise planning and investment decisions relating to GI solutions within and beyond domestic gardens and to strengthen the functionality of ecosystems in areas of GI need. Specifically this will include the promotion of actions that increase green space and wildlife in gardens, on the ground garden related projects, policy development, research on gardens and provide training and practical skills relating to gardens. The action plan will fit within partners' existing delivery mechanisms and is currently being signed off by partner organisations. It will then be disseminated.

The project has made a significant finding about the quantity of green space in Manchester. Previously, making the assumption that all gardens are green, GI work had estimated that some 58% of Manchester was green space. The project has re-assessed the level of greenery in gardens at around 50% and, due to scale of the garden asset, this means that green space covers only 48% of the city. The finding has revealed the weakness of previous assumptions and methodologies and shown that some areas of the city are not as green as had been anticipated.

The project started with developing the citizen science online survey tool and 1000 full records were created. 252 of these were verified by a process of digitizing surfaces from aerial imagery and validated the citizen science approach as 79% correct. Further application of high resolution imagery allowed analysis of the surface classes in the gardens and the dataset subsequently combines the citizen science approach with aerial imagery with significant confidence. The database is available to view online (as a web map). This consists of 14 spatial datasets.

The researchers express confidence in the citizen science approach of My Back Yard on its own; its successful application depends on the number of responses, capturing the spread of house types and garden sizes, and where there are gaps, these would need to be filled by on the ground investigation (which was undertaken by investigating high resolution aerial imagery in this project). The returns from Manchester households' mirror-reflected areas of deprivation. As well as the GI-ES survey tool being usable in any location, it would also be possible to take the analysis of a Manchester neighbourhood or ward and, if the house types and garden size are broadly similar, begin to make assumptions of the green cover in gardens in comparable neighbourhoods in other cities.

The impact of gardens on two ecosystem services (using existing tools) has been assessed and described; flooding is particularly relevant to Manchester and urban heating and the need for cooling is emerging as an issue.

If there has been a shortfall, it has been in the promotion of the tool; £5k was allocated for marketing/branding and communicating the tool which focussed on online promotion but this proved not to be sufficient in some areas in Manchester, particularly in more deprived neighbourhoods. However, the focus of this project was to gain a representative sample of house types and garden green space coverage, which was achieved.

Over and above the original bid, the project has investigated a range of social science issues and created social science data which will help a deeper understanding of public attitudes and use of gardens and the services that they provide. This resulted largely due to co-creation of the GI-ES survey with project partners, who were interested in social science issues such as how do people value their gardens, and what do they like/dislike about them.

The key unexpected finding has been that Manchester has significantly less GI resource in its gardens, and therefore across the whole city, than previously assumed. This new information is incredibly valuable to those working on GI policy and delivery, including our project partners, as a call to action and to aid spatially targeting future delivery work.

APPENDIX 2: A VIEW ACROSS THE PROGRAMME - 5 THEMES

This section brings together some of the achievements of the projects and the learning experiences and perspectives of the Principal Investigators (PIs) grouped under 5 themes that are common to all of the 13 projects and of key interest to NERC. They look at key issues within the award criteria; end user and partners, knowledge and evidence in respect of the gaps noted in UWE's 'grey evidence' review; impacts and knowledge sharing of the projects themselves, any significant shortfalls or over delivery and the implications of their work, lessons learned and advice they might offer.

A2.1 Collaboration and the Influence of Partners

The criteria that NERC assigned to their invitation to submit bids for the Call stressed the involvement of end users and partners in the co-design process. All of the project proposals included a number of active partners and usually a wider group of stakeholders. NERC is interested in how successful the engagement of non-academics has been for the success of the project. We asked *'A commentary on the engagement of the non-academic partners cited in the original proposal, including whether new partners were attracted as the project developed? The value of the non-academics and practitioners when engaged in the co-design/delivery, whether the innovation was leading to an iterative process with end users of the work? Have new audiences been identified for the research as a result of contextual changes?'*

All of the projects reported that they had worked closely with non-academic partners. As might be expected some of these partners have been more involved and active than others. In some cases their enthusiasm and commitment has been very strong, whilst in others their involvement has clearly had its limitations. The nature of the engagement with this wide range of partners has varied markedly. For example, the National Scale Model project reported that facilitated discussions with partners at the beginning of the project drew out a good insight into the needs and expectations of partners and helped generate really good contributions. The National Forest Company provided excellent information on pricing matters both in capital and operational expenditure for forestry uses. The project generated new initiatives and collaborations with new partners e.g. The Wildfowl and Wetland Trust with Rezatec (a remote sensing company) and Southern Water. Elsewhere, for example, the ESS/GIP project focussed on engagement by Southampton City Council staff to demonstrate the approach. Their learning experience was that it would have helped to have their earlier involvement in the mapping process in order to help overcome data management and adoption issues within the Council. The project has subsequently generated follow-on pieces of work including the Defra Local Action project in Manchester, which have been identified in the more recent update to the Project's final report.

A number of the projects have relied heavily on drawing down the expertise of many non-academics to help shape the decision support tool or to provide information for the model or tool itself. The National Benchmark (NBM) project held five symposia which engaged with different sets of non-academic partners; three professional institutes and two NGO representative bodies. A number of these were oversubscribed although not as many developers attended as the project might have wanted. A number of other industry bodies [e.g. National Grid and mineral extraction companies] have since expressed an interest in the work.

The symposia clearly showed the value of an in-depth engagement with non-academics/practitioners in scoping the need and content of the Benchmark. The project believes that there could be many applications for the NBM but have heeded the advice from the symposia that it should be developed in a defined, narrow way in the first instance. The closest relationship has been with the

Gloucestershire Wildlife Trust (GWT) and, following the launch and publication of the case studies demonstrating the power of the Benchmark tool, this is ongoing through the GWT's consultancy services. New expressions of interest have emerged during the project, for example, an east London Housing Association has expressed an interest in using the standards to inform a cost-benefit assessment of GI for substantial areas of green spaces in their ownership.

The IGGI Framework and River Engineering projects took a similar approach with partners, using them to shape the architecture of the model and providing critical challenge. The collaborative working relationship meant early agreement was reached to make the high level (business case) of the support framework the same, on which could be attached different points to each step as appropriate thereafter.

At the start the partners worked through their various understandings of the nature of a critical success factor (CSF) e.g. metrics or more qualitative 'what needs to be done to succeed'. The latter became the agreed focus and has the potential to assign quantitative measures if available and credible.

However, both projects found sourcing case study material and data to be time consuming. Other barriers with partners have been experienced; not making skills available, time commitments, commercial confidentiality and also due to partner conservatism around details such as styles of presentation. Despite the engagement of national agencies, such as the Environment Agency, who have begun to disseminate the River Engineering guidance and adopt some of the operational advice from IGGI, there remains no formal commitment as yet to change from business as usual practice.

One of the riverine case studies referred to the actions of land managers [letting cattle access a management scheme]. Although this can be a familiar problem, the partner engagement didn't get into how to address changes of behaviour toward green solutions at these levels. The IGGI project reported that the Institution of Civil Engineers has been very helpful in identifying new partners with an interest in the tool e.g. Havant DC coastal engineers. This helps address gaps found in the UWE evidence review as well. JBA consultants are now considering funding a PhD student to enable monitoring.

Two other projects with common characteristics in their approach with non-academic partners have been Tree Selection and SPIES. Both used focus groups and have worked especially closely with industry partners in developing their tools. Tree Selection got positive inputs to co-design via focus groups from two nurseries (Hilliers, Barcham Trees) as well as the London Tree Officers Group and Kew Gardens. There is continuing support from the nurseries in terms of sponsoring publication.

The focus groups explored in depth the potential content of the tool and identified a large number of traits that could comprise the selection tool; a compromise was reached which concentrated on drought intolerance as a fundamental factor in tree survival in GI schemes (and without which all other services would not accrue). This can be the building block for future evolution of the tool. Hilliers' advised that the tool shouldn't incentivise the import of trees and so increase risks of disease import and reducing resilience.

Aside from the close collaboration between IGGI and River Engineering projects, a relatively rare move for the 13 projects on the Programme has been the linkup between Tree Selection and the Bicester & Beyond GI projects. This has helped Bicester by providing advice on tree selection that might help address air quality issues and avoiding duplication. The tool has been designed to include hyper-links to allow easy connection to other projects to unite research strands, enable ready updating with new evidence or new traits and allow targeted information such as tolerances for air quality.

The project also valued working with the Tree Design Action Group due to their track record of getting advice adopted and the breadth of their members' interests.

The SPIES project is clear that a strength of the tool has been its co-development by a range of stakeholders. The enthusiasm has been extremely high from the initial meeting which attracted partners to the Eden Project (home of one of the partners, the National Solar Centre). Other industry partners included Novus Solar and Good Energy and as awareness has increased the interest from industry has increased, showing high levels of demand. Natural England, National Farmers Union, Wiltshire Council, ADAS, RSPB, Colleymore Farm and Corylus provided other expertise. The NFU was particularly vital in helping make connections with partners. Local authorities have also been linked-in through the Association of Local Government Ecologists. The PI observed that some partners were clearly in this business for the long term but as a relatively new industry, it is still in a state of flux regarding eventual end users and so unclear as to their final engagement through the tool.

Both the Domestic Gardens and VITAL projects worked with local partners, in Manchester and Milton Keynes respectively, to develop and test their tools. The Gardens project reported that partners have been very enthusiastically engaged throughout the project and have helped co-design the GI-ES survey tool, promote the tool, and co-develop the action plan and final report. Many of the citizen-science survey questions originated in the partners desire to understand public attitudes. The PI has used the established Manchester GI Strategy Group as a sounding board to evolve the survey/tool. This group will now be used as the reporting framework for delivery of the final action plan.

Common with other projects the engagement of partner organisations has often been down to the enthusiasm of individuals; the Southway Housing Trust representative leads on GI for the Housing Associations in Manchester and despite budget cuts to implementation and management of GI has maintained active interest throughout.

Enthusiastic representatives of partner organisations can be a strength, bringing resource and expertise. This was also mentioned in respect of the local authority representatives for the ESS/GIP, Bicester & Beyond and SPIES projects. However, it was noted that these colleagues also can be vulnerable to lack of time and support from their parent organisation.

The Milton Keynes Parks Trust has been an enthusiastic and supportive partner for VITAL, testing the tool with local communities. The Tree Council has been active in two ways; disseminating information and knowledge through its extensive network of c5000 Tree Wardens and developing educational materials on Treezilla for schools which will be distributed as part of its usual business; the project research assistant was seconded to the Tree Council for this work.

The act of gathering bulk tree data from local authorities (e.g. Belfast, Birmingham, London, High Peak) and other organisations, has meant that a number of these have begun to engage with the Treezilla tool in new ways. For example, Birmingham City Council is keen to use the tool as a means of maintaining its data and to help engage with its citizens further. High Peak Council is aiming to use the data as part of its ecosystem services assessment of the borough. However, there have been barriers in accessing data from local authorities due to technical and administrative issues.

By helping to co-design and evolve the tool with Milton Keynes Parks Trust and its use in the field, this has exposed the need to develop seamless workflows for users so that they can apply the tool without the need for significant technical knowledge and to reduce errors in data gathering when it is inputted to the system. The development of linked software to capture, locate and upload tree data can be a focus for the next phase of development.

VITAL has reported that the National Federation of Women's Institutes in Wales is now an active new partner in the project, partly as a result of organisational changes within their partner Natural Resources Wales and partly as they have drawn down lottery funding to roll out the tool.

The NCPT project has reported good engagement from local government partners, some originally cited have dropped off the project but these have been replaced by other willing volunteers as knowledge of the tool and the project has spread. Contact with consultancies has largely been through local authorities. The non-academic partners have been crucial in assembling a database with some 7500 different scores for ecosystem services and land uses. Not all are fully detailed as they have been informed by only a few expert opinions but there is still reasonable confidence in the strength of the indicators.

A significant issue in the possible use of the tool is the amount of time that any local authority has available to apply the tool but feedback from partners to date suggests that this has not been a fundamental barrier. Their feedback has been continuous with one significant change being that cultural ecosystem service scores have been extended to include future population densities in the vicinity of a development site.

The project noted that four types of stakeholders are involved as principal players in this knowledge exchange work: policy-makers, businesses, civil society and 'knowledge brokers / social entrepreneurs'. A number of new case study local authority partners have come forward during the life of the project although no new categories of partners have been attracted to date. Aside from the Wildlife Trust involvement in the Black Country project, there appears to be a gap in the involvement of civil society in the development of the tool e.g. there is no case study partner at Neighbourhood Plan scale. The tool does include scope for local variation when scoring a site/development, so some or all local value may be picked up in a technical manner. The project end user events planned in early 2018 may wish to explore the relationship between beneficiaries and stakeholders.

Bicester & Beyond has developed a similar scoring system to the NCPT (indeed they are collaborating on Natural England's 'Ecometric' project to align their approaches and scoring). Bicester listed 12 non-academic organisations plus the Green Infrastructure Partnership as stakeholders; Bioregional and the District Council have been a particular positive force in the project. Constraints on their time inputs have hampered the co-design process but they have been well engaged. The 'nature partners' have been well represented but the project notes that it has been difficult to engage developers and landscape architects. Co-design with non-academics and practitioners has been an essential part of the process and has been done in an iterative manner, but due to time constraints this has been more limited so far than originally intended. The plan is to focus more on this in the last few months of the project. As the project has advanced, a number of the local organisations and individuals with attachment to local green spaces have been asked to be kept informed of the project.

The Green Growth project was an initiative that came from outside of the University and this culture of encouraging and facilitating external input has been continued by the academic team. The core group of stakeholders uses their extensive network to draw in skills and expertise from across the city/region. More specific support came from Business in the Community which hosted 'seeing is believing' sessions that have helped to develop a co-design approach. The City Council leads on the associated EU funded project, so helping drive forward this work.

The PROSuDS research project is undertaken by a team of experts in SUDS, costing, valuation, innovation and sustainability at University of Portsmouth supported by a number of non-academic partners including professional bodies, practitioners and developers, policy makers, regulators such

as the Royal Institution of Chartered Surveyors (RICS), Hampshire County Council (HCC), Southern Water, First Wessex, Atkins, Grainger, Mayer Brown, the Environment Agency and CIRIA. The project has also drawn insights on valuation from developers, on the development context and how the process works. They have, however, observe to have found it harder than anticipated to access information and expertise from the specialist field of quantity surveying; perhaps a trait of the profession is that it is not used to giving up time free of charge?

A2.2 Evidence gaps and knowledge sharing

Following the confirmation of the 13 GI projects at the end of 2015, the Natural Environment Research Council separately commissioned the University of West of England to undertake a review[7] of how the evidence base for Green Infrastructure (GI) is being translated into practice.

Their study first reviewed 'grey literature' to identify the evidence related to the benefits of GI to biodiversity, ecosystem services and where these have been monetised. A series of case studies was also presented covering a range of GI projects, geographical areas and intended outcomes. They, and the evidence base, demonstrated that there are numerous excellent examples of GI research and practice happening across the UK. There were also gaps in the knowledge and evidence available. Second, in order to gain further insight into GI practices and their relationship with academic research, two events in May 2016 brought together the GI community of research, policy and practice. These explored the patterns in access and use of grey literature and academic evidence, the disciplines and sectors that are underrepresented across research and practice, the role of different organisations and networks in sharing evidence and good practice and the needs of the GI community in terms of research and knowledge exchange. It found an overload of evidence from both academia and those responsible for grey literature and practitioners are struggling to navigate their way through this. It also found that the evidence is not reaching out to all the sectors and disciplines.

Clearly none of the projects could be expected to retrospectively address the problems of these knowledge gaps and navigation through the evidence. However, we took the opportunity to take a quick reading of the work of the projects as to whether they were incidentally helping to provide solutions. We asked *'Are any of the gaps identified in the 2016 NERC GI 'grey evidence' review being filled?'* and split this into (a) Addressing the gaps in knowledge and evidence and (b) Addressing navigation and sharing knowledge. This is what we found.

A2.2.1 Addressing the gaps in knowledge and evidence

Many of the projects started with the aim of utilising existing evidence sources and had no ambition to generate new evidence or knowledge. Where new knowledge was created, its type and scale depended on the prime purpose of the project, usually to inform the development of the decision support tool. Those projects that had specified a geographic application for their work have clearly helped generate local data and other products. For example, ESS/GIP in Southampton (maps of city-wide and urban ecosystem services), Domestic Gardens (GI coverage and two regulatory ecosystem services across Manchester's gardens) and Bicester and Beyond (which described the distribution of hedgehogs across the town). These have provided a particular type of new database. Others, such as the NCPT, National Benchmark, IGGI and River Engineering (and likely PROSuDS) are generating a set

[7] Green Infrastructure - Research into Practice (August 2016); Danielle Sinnett, Tom Calvert, Natalie Martyn, Katie Williams, Sarah Burgess, Nick Smith and Louise King, Centre for Sustainable Planning and Environments, University of the West of England, Bristol.

of case studies for particular places and covering a wider set of GI, services and natural capital; their more significant impact is likely to be in how this is being used in sharing knowledge.

One or two of the projects have managed to bring together knowledge which will have long term benefit for research. For example, the production of the National Scale Model (of GI for Water Resources) has gathered and synthesised a significant amount of existing evidence and information relating to water management at catchment and national level. This will be available for future modelling work.

In a similar vein, the IGGI project has helped increase the knowledge base on marine or 'salty' B&GI to inform policy development. Like River Engineering and PROSuDS, the project is engaging with the need for increasing the knowledge of engineers and surveyors, to help change practice and behaviours in the professions and their institutions.

The VITAL project is gathering together a great deal of existing information about trees and so new information on this element of GI is now being added to the Treezilla database. The tool allows this information to be converted to a monetary value for a number of [pre-determined, due to the origins of the tool] specified ecosystem services, including carbon capture. Outdoor learning experiences are being extended through the testing and dissemination of the tool but these have not been evaluated.

Two of the projects – Bicester & Beyond and the Domestic Gardens - are realising unexpected amounts of social science data; their citizen science and public participation work has generated a good insight into the value held by the community of domestic and local green spaces and their cultural and other services.

The Tree Selection tool, however, is doing what it aimed to do by filling gaps in knowledge and evidence related to the use of trees in GI. The research supports a tool which will provide information on trees and their characteristics in terms of drought tolerance, enabling them to be chosen for SUDs, reducing losses and maintenance costs and in turn maintaining the value to the developer and the community. As an online tool, it could create a platform for community use and increased knowledge of and engagement in the environment; indeed the strength of this tool would be in providing detailed information and advice and supporting the delivery of GI under more generic tools, such as Domestic Gardens, Bicester and Green Growth.

The PROSuDS tool will add to knowledge for the development industry in addressing the role of GI as a regulatory service for water management and flooding but in an entirely economic sense. This is the main tool in the programme which is directly hoping to fill the gap in valuing ecosystem services and natural capital from development experiences and case studies.

A2.2.2 Addressing navigation and sharing knowledge

Given that the majority of the projects are concerned with decision support tools, it would be surprising if they did not help to resolve some of the challenges arising from helping practitioners navigate their way through the GI evidence base. Similarly, the purpose of the Programme was to help embed GI research and evidence into delivery in new ways and tended to favour projects that would be aimed at sectors currently not receiving this support. There was also a stress on the projects to involve end users in the research; this is dealt with more fully elsewhere in this section.

Projects that have prioritised planners and the development process include ESS/GIP, NCPT, Bicester and Beyond, Green Growth, PROSuDS, National Benchmark and, as such, these all focus on urban areas noted as being neglected by UWE's review.

The ESS/GIP's ecosystem service maps were tailored for the local authority in Southampton and the project identified visual language which made the concepts of ESS and NC more accessible. The approach has been picked up by others, notably the Institute of Environmental Analytics in developing the Bounty tool for Manchester. BOUNTY – Benefits of Urban Nature to You - is a Defra Local Action Project to communicate information and data on the benefits provided by environmental infrastructure and natural capital and highlight where there is scope for improvements. This aims to enable residents, local authority officers, developers and policy makers to work together on a level playing field. This aim of empowering citizens through better access to environmental information is shared by the VITAL project.

The National Benchmark (NBM) is bringing together an understanding of the appropriate type and level of evidence on GI that is required [to meet standards]. By its very nature the Benchmark will also create a consistent use of language and quality. In particular it has attempted to engage with some of the sectors previously being under-represented in GI work; the professional institutes including RICS and RTPI and has teased out interest from at least parts of the development industry. By being developer-focussed, the NBM is taking an end-user position and the feasibility study has helped determine the market for the NBM.

The tool is to be used for shaping development policy and applications, so will have an urban focus and addresses nature conservation, water management (quality and quantity) and health and wellbeing and covers some ecosystem services; others in the core standards include climate adaptation and air quality management.

Other projects, such as SPIES and PROSuDS, have been specifically aimed at and working with industry partners, which were highlighted as a gap by the evidence review. The River Engineering and IGGI projects both gathered significant amounts of grey evidence for practical use by their industry partners, organised it into consistent forms and did this through engaging industry end users. The Tree Selection tool has focussed on working with commercial nurseries but the end product will clearly have wider value for local authorities and communities wanting to design trees into their GI. Through the use of plain language and as a one-stop selection tool, it will inform these decision-makers who are not expert professional horticulturists or landscape designers.

The Domestic Gardens and Bicester & Beyond projects have both developed information on the cultural value of GI which will be shared with their local partners. The Treezilla tool (VITAL project) has the potential to be very far reaching through local schools, the Women's Institute in Wales and the Tree Council nationwide. The tool is clearly accessible to relevant sectors and end users, though will need to be promoted; work to enhance the interrogation of the data in the model will enable this further. The tool creates a common language for describing the value of trees and the economic benefits are rooted in recognised sources (e.g. from HM Treasury, the Stern Report).

Sharing knowledge has been a significant part of the NCPT and Bicester project tools; the experience and knowledge of numerous experts and specialists has been brought together in one place for a specific application. This is accessible to some of those sectors (e.g. local authorities, developers, planners) the evidence review identified as not being targeted. The tools do not set a standard but do provide metrics for decision makers to do this in the context of the policy ambitions of net gain (or no net loss) and may help the evolution of local standards. As with all tools, they may help create a consistent language for the application of GI in development contexts if it is picked up by many users. Urban areas are more explicitly addressed as it is a tool designed for the spatial planning process.

Both the Bicester & Beyond and the Green Growth tools have the ambition to be a tool for tools, respectively aiming to provide navigation through the large quantity of potential decision support mechanisms and a way through the maze of GI science and evidence by producing a 'how to' guide. The PROSuDS tool is similarly reaching out to property professionals as a valuation tool relevant to their role on the development process. If house builders and others can be convinced, the aspiration is that the tool will help set the standard for delivering SUDs that will provide other environmental and ecosystem services. All three are usefully focussed on the development sector, identified as a gap in the evidence review.

A2.3 Impacts and Knowledge Sharing

We asked: *Understanding what dissemination of any findings has occurred and in what form? Whether there has been any measurable [immediate] impact from the research findings? Next steps e.g. whether commitments have been made to apply the project outcomes in the future?* This is what we found.

The four completed projects have made their reports including any decision making tools available on line and have generally been active in disseminating their findings. A number of the projects, including some which are still in progress, have been described in the previously noted October special issue of the TCPA's Town & Country Planning journal.

The ESS/GIP project was one of the earliest finishers and was active in disseminating its work through addressing conferences and through the Institute of Environmental Analytics on-line tool is in active use informing the Bounty tool work in Manchester. The project (tool) impact on its test authority Southampton City Council was not wholly successful but lessons were identified on the need to address internal barriers.

A more recently completed project, the National Benchmark (NBM), has undertaken a formal launch. 'Building with Nature', the UK's first certification scheme for green infrastructure, was launched at Gloucester Services (Southbound) - a motorway service area on the M5 www.gloucesterservices.com – in November. Over 100 people attended the event, including house builders, planners and planning agents, ecological consultants, construction professionals, public health professionals and academics from around the UK. This showcased the five 'early adopters' of the Building with Nature certification mark. Speakers included David Owen, Chief Executive of First Local Enterprise Partnership; Sarah Scott, Director of Public Health for Gloucestershire; Barry Wyatt, Head of Strategic Planning at Stroud District Council; Ben Rosedale, Director at Environmental Dimension Partnership, and Simon Spooner, Chief Operation Officer at The Westmorland Family; on video here: https://www.amazon.com/clouddrive/share/QTPm6btADVE1vHsG0rmijhYNcDL825uV16xpdO5J4uT . And coverage on BBC radio is at http://www.bbc.co.uk/programmes/p05jqrj7#playt=41m40s (41m40s).

A write up of the project has been published in Inside Ecology: https://insideecology.com/2017/11/17/building-with-nature-certification-scheme-uk/. One case study - Elderberry Walk – was covered in the Guardian: https://www.theguardian.com/tv-and-radio/2017/sep/04/grand-designs-presenter-kevin-mccloud-seeks-to-raise-50m-to-build-600-homes-a-year . Prior to the launch, the project's presentation to the Building Prosperous Cities national conference in London generated agreement to fund/undertake demonstration projects in Scotland out-with the NERC project and these are applying the NBM feasibility study findings. Results from these will be available over the next year.

The finished product has been published at https://www.buildingwithnature.org.uk/ which also has a user guide. Since the launch, the project managers advise that they have already had a flurry of

interest from projects around the UK interested in becoming the next wave of Building with Nature certified schemes.

Two projects, River Engineering and the IGGI Framework have collaborated from the outset and they have continued this practice in disseminating their findings. CIRIA hosted a joint webinar to a wide audience of academics and practitioners in November 2017. It is early days to assess the impact of their findings on regulators and designers of GI (green-grey) schemes but the work is seen as highly relevant by the Environment Agency and some of the solutions identified by the two projects are finding their way into operational activity. However, there are no formal commitments from EA or other regulators to using the guidance.

The River Engineering guidance mentions a number of constructors which have developed a niche in delivering GI solutions and who will benefit from the guidance. More widely, it is unlikely that traditional 'grey' constructors will easily adopt GI approaches given that grey and green solutions require different business models because of their different construction and post-construction requirements in managing structures, plant species etc. Additionally, green solutions strongly imply that they will work with natural morphological processes. The researchers think we might see a merging of business models and deliverers within the industry as the use of green and grey-green solutions become more common.

Some of the projects are having an impact in their immediate area (see Figure 4) as they have worked with local partners and it is clear that the outputs from the projects are beginning to have an influence. Havant Borough Council Coastal Environmental Project engineers have recently approach the IGGI PI to help them prioritise selection of enhancement measures on a Flood & Coastal Erosion Risk Management scheme that is in the detailed design stage. The guidance provided to the project has been described as 'invaluable' and that Havant is enthused and confident to try enhancements 'as we can now see how they have worked elsewhere and can also appreciate the wider benefits and costs of such measures'. Further research avenues are also being explored.

Scottish Natural Heritage are also intending to use the outcomes of the IGGI project at its 'Sharing Good Practice: Design with Nature event on 21 February 2018. The event will be focussed on integrated, multifunctional GI in urban design, planning and delivery, aimed at planners, designers, architects, developers, local authorities/public sector, house builders/social housing providers etc. The idea is that it is very much solutions-oriented on policy, strategic and project levels. IGGI has been granted NERC Innovation follow-on funding and this may help realise the potential of the green-grey approaches.

A similar interim conclusion might be drawn from the SPIES work in that the Solar Park industry is keen to draw upon good practice but the impact has yet to be fully assessed. The industry is, however, a relatively new and still maturing sector and the potential for rapid uptake of the guidance emerging from this project could be relatively high. The impact on policy and practice will be furthered through the follow-on project starting in 2018 when it is tested in a commercial environment and an impact case study is described.

It would be true to state that, across all the projects, as yet there are few firm commitments to implementing and maintaining the tools for the long term. Some of those projects nearing completion hold a promise for this but for academic and some obvious practical reasons have been reluctant to share their findings to date. For example, the National Scale Model project has developed a working model for assessing land use options for catchment management and whilst not yet confident of its conclusions, Defra is reported to be very interested in the outcomes.

Many of the projects have delivered conference papers and have prepared or are proposing journal papers. A smaller number, such as the VITAL, Bicester and the Gardens project have developed citizen science approaches and worked with communities or local organisations. In Milton Keynes, VITAL has disseminated information on Treezilla through schools and will do so more widely throughout the schools sector via the Tree Council. The project has a confirmed follow-on take up in Wales next year, engaging the extensive network of the National Federation of Women's Institutes in an urban-focussed project 'Planting, Protecting, Promoting Urban Trees'. The WI has drawn down funding from the Heritage Lottery Fund to complement the NERC-funded training currently underway. In terms of evidence, this work may help ground truth urban canopy data created some years ago.

Figure 4: Some projects are also delivering an impact locally

Treezilla built upon and evolved an existing methodology and tool and the benefits of having this advantage have been echoed in the NCPT project, which has succeeded in attracting additional interest from external stakeholders to trial and test a well-defined tool. The original case study partners have changed but new ones have doubled their number. This interest has been partly down to the numerous presentations made at conferences and workshops, opportunities generated by the increased activity nationally in exploring natural capital and GI solutions through the spatial planning system. Other opportunities to apply the tool beyond the testing phase will likely be identified at end user events in early 2018.

The Tree Selection decision support tool is also bringing to bear expert advice on the qualities of Green Infrastructure, in this case tree species. In all it brings together science and evidence related to 300

tree species in one tool and will link these to place and to ecosystem service delivery. The developmental work has involved specific industry end users, the commercial nurseries which will supply developers and local authorities. By focussing on one aspect of GI it is presenting more hard science than other guidance tools in the programme, by defining certain (drought related stress) traits, standards and a consistent language for the use of 300 species of trees in GI. It is also doing this in a strong commercial context; Hilliers and Barcham have expressed interest in enabling the tool being made available on-line. There is a risk that the tool might seem like a nursery catalogue and so issues also arise about doing this through other nurseries. The project will discuss with NERC the appropriate approach toward accessing this data and possible commercial opportunities. Beyond the industry sector, the Trees Design Action Group network will act as an amplifier for the use of the tool especially in development related locations. The seminars and launch events proposed in spring 2018 may provide an opportunity to use practical case studies to illustrate the power of the tool. Tree Selection could easily be seen as a tool which fits within the context provided by other decision support tools.

The Green Growth project is one of a number which have not yet disseminated its findings although drafts of papers and survey material were willingly shared for the purposes of this review. The NERC funding for this project has however already been influential in leading to a successful bid for a larger EU funded Horizon 2020 'Grow Green' project which will take forward the work over the next 5 years through demonstration of using nature based solutions. This project may further help illustrate how various toolkits can be integrated and will result on GI interventions in 3 front runner cities. In the case of Manchester, this will be green space provision as part of regeneration of the West Gorton area of Manchester, which scores highly on urban deprivation. The grant income will total over €12m with €841,300 accruing to the University of Manchester and some €1.3m for West Gorton itself. Manchester CC is the project lead and part of an emerging narrative of GI partnership working in Manchester.

The project would not have happened without the NERC study as the driver to get partners working together to think about GI barriers. There is a new www site for the project, which is still being populated: http://growgreenproject.eu/

The PROSuDS project is expected to complete in June 2018 and so too early to disseminate outputs, though it is possible that it will begin to share findings after December 2017. The tool is reaching out to property professionals as a valuation tool relevant to their role in the development process. Like a number of the projects in the GI Programme, it is worth recognising that project partners are generally enlightened already; attempts to directly engage with the volume house-building industry in PROSuDS fell on deaf ears. The eventual impact would be through RICS endorsement of a practice standard.

Although yet to complete, the Bicester and Beyond project has published a significant amount of information via two newsletters, in March and October 2017, plus write ups of the public participation, ecological networks and hedgehog survey work. An article has been published in The Environmentalist and a case study formed part of the TCPA's October publication on 'Planning green and prosperous place – principles for success'. It is too early yet to identify impacts but the project has been providing Cherwell District Council (CDC) outputs from the land use scores and maps and is awaiting their response. It will inform the local plan process in the district and, though the project sometimes finds it hard to tease out from CDC their exact requirements, the Council as co-developer in the project is committed to using the toolbox and project outputs in their spatial planning work.

The Domestic Gardens project is to undertake the bulk of its dissemination work through three workshops planned in the first quarter of 2018. These will be aimed first at Councillors and local leaders with a launch event in February and as part of the Greater Manchester Green Summit in

March. The My Back Yard tool is on-line and accessible to all. The findings on the scale and quality of Gardens as GI have been shared with partners and they are now firming up their commitments to an Action Plan. The research is enabling partners to target their actions in the city more clearly. For example, the Lancashire Wildlife Trust is launching a 'garden project' in 2018 and Manchester City of Trees has committed to planting a tree for every man, woman and child in the city. Manchester City Council will use the project outcomes to inform their review of the city's Green Infrastructure Strategy, including a specific section and policy on gardens.

The project will generate two or possibly three academic articles. The first will address the design of the tool and the combination of citizen science and remote sensing. The second will likely investigate the citizen science data which shows the value and extent of the green space and ecosystem service data alongside house types, tenure, age of occupants etc. The third will address the social science data to understand public attitudes and use of gardens, the services that they provide. Like Bicester & Beyond, which had the benefit of 2 Master's students undertaking research, the project is also inspiring a number of student dissertations. A substantial number of citizens have already pledged to implement improvements to their gardens and these pledges are being supported by partners (e.g. through providing trees, receiving copies of the project report).

A2.4 Shortfalls, over-delivery and gaps

The review did not aim to undertake a forensic interrogation into or to make judgements about the projects; the review is more 'reading the gas meter' than an 'Ofsted'. However, no project runs perfectly and understanding lessons from what didn't work or what succeeded beyond expectations can be informative. In conversation with the PIs we asked '*Understanding whether there has been a shortfall or over-delivery on the expectations of the award, including the GI coverage of the call? Whether the research projects have unearthed gaps or any unexpected findings and their prospective value?* This is what we found.

Some of the projects, such as the ESS/GIP and Bicester & Beyond, were motivated by translating their research and tools for the benefit of specified practitioner partners. The aim was to directly inform their practice. The ESS/GIP efforts in shaping the work of Southampton City Council did not result in the ESUWE approach being embedded as business as usual within the authority. It did reveal a number of barriers to applying the approach. These included issues of expertise, language and capability. Each local authority is likely to have different approaches to the adoption and management of mapping (ESS) data as part of corporate data management systems. Corporate attitudes and inertia to change might be a barrier worth a more generic investigation by NERC.

A number of projects – Bicester & Beyond, National Benchmark (Building with Nature), NCPT, Tree Selection included – have worked up, tested or demonstrated existing decision support tools. These have shown the value of NERC funding taking forward and developing existing research. In the case of the National Benchmark tool it has enabled a successful launch of the product and take up by partners and stakeholders outwith the original bid. The NCPT tool similarly looks to have captured the imagination of a wider range of demonstrator bodies than first envisaged, even though some of the original partners dropped away due to practical reasons. The National Benchmark project unearthed an unexpected appetite by its partners to undertake five year checks to maintain the NBM which is encouraging, given the feedback from a number of projects that long term monitoring of GI solutions is difficult to secure.

The PROSuDS project has separately looked to an opportunity [at the time of writing] to use the architecture of an existing design/costing tool for SUDs through HR Wallingford. This will avoid the need for the project to create a new platform and so help reduce risk of error, need for testing etc.

The initial ambition of the River Engineering project was to provide a foundation for a guidance document for green river engineering. It has over-delivered by creating and publishing this guidance. The project developed a number of case studies and these are described in the report. Whilst the original intention was to assess existing evidence sources, the process of describing the case studies relied on extracting valuable grey evidence from operational sources. As such the project also created new evidence material and has made it available more widely. The generation of unexpected new evidence sources is a success shared by others such as the Gardens, Bicester & Beyond and VITAL projects.

The SPIES project also found rich evidence sources, revealing an industry which has yet to mature its business model whilst appreciating that it needs ways of addressing the environmental context in which it works. The project has clarified that some industry/consultancy research has been undertaken on solar parks and consequently the evidence was of variable quality and lacking academic rigour.

The PROSuDS project has also had to negotiate industry changes. Context shifts and uncertainty have been created following the dropping of the Flood and Water Management Act in 2015 [which would have helped create a standard for SUDs]. There are now a number of routes to achieving SUDs and consequently much ambiguity in understanding the long term economics around SUDs creation and management. This might include, for example, funding models via a resident's levy or commuted sums and local authority needs to understand the varied management requirements, benefits and risks of grey and green components. This has increased the need for the tool but made it a more complex business environment for its creation. This suggests that there could be merit in NERC and its agency partners anticipating future industry trends and the needs of sectors to help them embed GI into business as usual models.

The outputs of some of the projects have attracted the interest of unexpected partners as they seek to understand the value of GI or nature based solutions. The National Infrastructure Commission is, for example, keen to explore the application of the National Scale Model. There have also been some 'softer' additional benefits arising out of the projects; the National Scale Model work has helped to develop research networks and contributed to the personal development of researchers involved, demonstrating the benefits of multi-disciplinary working and understanding the challenges faced by practitioners in changing behaviours to favour alternative GI-driven solutions in the Green Growth project.

The IGGI Framework has created an aid to get decision-makers get beyond the point of agreement to the green alternative approach. A 'high level' approach was chosen because it found there is no possibility of creating a 'plug and play' tool which can simply be adopted in all cases; each scheme is unique and requires individual data/evidence accordingly. However, the data within the tool as developed can give a credible flavour of the strength of the green alternatives. The case studies show marginal costs and benefits which can be scaled-up.

In this sense the IGGI project, like the NCPT and the Bicester scoring tool, is answering the challenge made at the programme 'Information Day' held by NERC before bids were submitted, that practitioners wanted to have tools which could give local results for the benefits of GI. Expert scoring for GI and ecosystem services has been created for the NCPT and Bicester tools and can be applied

across a variety of locations but there is some way to go before there is a consistent methodology and reliable scoring at a range of scales. Natural England's work on creating an 'Ecometric' for assessing net gain for ecosystem services may help resolve this challenge. The IGGI coastal work has been on vertical defences which throws doubt on the appropriateness of comparable data as most GI schemes have been for flat surfaces. There were also differences between the nature of riverine and coastal schemes; the coastal examples added resilience and other benefits rather than replacing structural components. For the IGGI project this means it has had to describe comparisons of process between the business as usual and the green-grey alternative, rather than hard costings and values. A widely understood shortfall for many projects has been over the availability of credible valuation data for the use of GI. Both the IGGI and River Engineering projects found in particular there is limited or no information because of the lack of long term monitoring of implemented GI schemes.

The limitations of relatively small funds for this GI programme have been exposed in a number of projects. These have not prevented the outputs being delivered but researchers have found that their ambitions expressed in the bid have in some cases overestimated what they could achieve. For example, the Domestic Gardens project created a significant database of citizen science returns with a representative sample of house types and garden green space but the promotional budget was insufficient to generate returns from the more deprived areas of Manchester.

However the Domestic Gardens project delivered in a significant way over and above the original bid. The project has investigated a range of social science issues and created social science data which will help a deeper understanding of public attitudes and use of gardens and the services that they provide. This arose largely due to co-creation of the GI-ES survey with project partners, who were interested in social science issues such as how people value their gardens and what they like/dislike about them.

Thanks to the unexpected efforts of post-graduate students, the Bicester & Beyond project has also gathered a strong database on public participation and the value people assign to local green spaces. This is structured, qualitative data which can support the local authority's policy and decision making processes.

The Gardens project has, somewhat unexpectedly, found that Manchester has significantly less GI resource in its gardens and therefore across the whole city, than previously assumed. This new information is incredibly valuable to those working on GI policy and delivery as a call to action and to aid spatial targeting of future delivery work. Bicester's hedgehog mapping work – again thanks to postgraduate work - has provided more data than originally envisaged with new evidence for the town. It has reinforced CORINE satellite data; Cherwell District Council has only 1.2% natural or semi-natural land and 3% urban green space (it is 88% farmland, 8% urban). This makes it difficult to plan meaningful ecological networks with such a sparse distribution of existing habitats.

The tools being developed through the Programme clearly address GI at a variety of scales and some, such as River Engineering and IGGI, have generated new valuable evidence through case studies. The Domestic Gardens and VITAL projects have gathered information at a very local – 1000 garden records and 750k tree records – scale which has significantly increased the accessibility of GI information to decision makers.

The Bicester & Beyond project has clearly identified an issue with the availability of usable tools. Tools are developed because funders are looking for innovation and, once created, they are no longer innovative and so get lost in a 'Death Valley' of unsupported tools. Those that survive are either well-resourced (e.g. through Universities) or commercial and relatively expensive to access (though are

updated and supported as a result). There is uncertainty as to who has the responsibility for managing the 'guidance gaps' and ensuring that tools are established as best practice and that previous investment is not wasted. This message is echoed by PI's working on other projects in the programme and we cover it more fully elsewhere in the Implications section below and Conclusions.

The Green Growth project shared a similar success as the Domestic Gardens project in benefitting from stakeholders enthusiasm to engage and be active in a co-design process. Through the extra work on the stakeholder survey, the refinement of the user typology for GI has taken the project beyond the academic literature. The proposed typologies now recognise the different actors and the variety of scales at which they work.

A2.5 Implications, lessons learned and advice

NERC was keen to learn from the programme and get feedback on what might be appropriate for future funding. In addition to the conclusions we could draw from our other lines of enquiry, we asked for advice about the form of subject matter and high value methodologies for GI that could be worth investment. We asked*: Identify if there has been any advice emerging for future NERC grant programmes, including significant research gaps or duplications that have arisen? Which, if any, particular research and knowledge exchange methodologies have proved themselves most valuable and effective? Headline (only) reflections on the programme and the mechanism of the awards plus any other feedback through an open format invitation.* The following comments are highlights taken from the discussions held with PIs.

A2.5.1 Areas of research worthy of new or further investment

The project leads were clearly enthused by their progress and could all see area opportunities for future investment or gaps that could be filled. Given that the programme was all about innovation and ways of making an impact with emerging an untried approaches, it would have been surprising if this was not the case. Of course, some of these suggestions may already be the subject of active investigation.

A number of the suggestions and comments were directed at the gaps around practitioner needs and long term evidence to prove the value of GI solutions;

- NERC should continue funding of the research projects that join the evidence in academic literature with practitioner experiences if it is to meet the needs of industry looking for accessible and credible guidance on which it can rely. Additionally, more is needed on long term monitoring (LTM) of GI solutions. This [GI] area of research is a busy space at the moment and NERC should consider the idea of funding smaller follow-on projects with end users to assure impact.
- The relationship between policy and research needs to be considered more carefully; with an industry which is rapidly evolving, there is too big a gap between national planning policy, the local plan and development management levels. Research and evidence can help fill this gap.
- Funding for further real-world testing of the model would allow fuller exploitation of the model and sound base which has been created.
- There is a need for future funding which can be applied to monitoring and evaluation of success and improve the understanding of what works. Developer led schemes could provide sites and 'in kind' support to do this but funding is unlikely to come from developers for any outcomes apart from biodiversity – one of the benchmark standards includes provision for

monitoring wildlife – particularly for health and wellbeing as these studies are very expensive.

- Long term monitoring will remain an issue; whilst solar parks are still too new, one of the partners is undertaking LTM across 12 sites to build knowledge and evidence and a 'living lab' solar park is being considered. This will help take the evidence base past generic sources.
- Funding/support for long term monitoring of success or failure of tools delivery on the ground should be considered.

Other suggestions considered how investment could be targeted at currently underrated subjects. Some were very specific, others of greater breadth;

- Is there scope to have a big innovation fund? In particular, to identify the multi-functional outcomes [that are not covered by silo research finding]. This could be used to understand the trade-offs between aspects of GI and help people address the complexity of different outcomes and test the assumptions currently being made.
- Research on the links between health and GI and especially predictive modelling would be of significant help.
- Research that provides confidence in the valuation of ecosystem services is required.
- NERC could consider more emphasis on 'salty' or marine projects as there is a policy gap. Generating the costs for 'big green' solutions vs grey solutions revealed a demand for this information
- Gardens are an under-studied aspect of GI and as a large spatial asset of any city have an enormous impact as well as potential.
- A deeper understanding of what urban nature and networks should be about given the risk of the rapid pace of development overtaking the ability of local authorities to protect green infrastructure and the services and benefits required by people.
- Further work required on the translation of metrics to UK climates with a need to learn from other climate zones to understand the value better, including anticipation of future UK climate conditions given often long lead in time for industry in supplying tree species.

A couple of comments suggested NERC and other research councils could collaborate across their remits;

- From a scientific perspective, NERC might wish to consider how it can further support the exploration of hard science at the city scale. In particular, in ways that help people use information for their own purposes and empowerment.
- The Treezilla project has gathered large numbers of records and created a significant database which is open and accessible. However, it cannot be readily interrogated so that blocks of data can be exported to be analysed and used by scientists and communities alike. NERC could work with the OU (and others) to ensure the development of the tool(s) to make it (them) open to enquiry and ensure that the evidence and science can inform from the bottom-up as well as the top-down.
- NERC could usefully look across into ESPRC areas of interest to identify potential value of cross-fertilisation of programmes and ideas.

There was a recognition that some or many decision tools now lie dormant and investment in action to keep these tools in use should be considered;

- NERC may wish to consider the availability of follow-on funding to maintain the tool in future. This may be simply care and maintenance (e.g. updating links) or possibly more substantial reviews. Can the tool developers and users be brought together to share experience?
- Could NERC consider how it can validate and then help government and others mandate the use of the tool?
- A gathering together of the box of decision support tools across the whole of the NERC remit would be valuable; with consideration as to how these can be tested with users, managed, updated and supported for easy use.
- Valuation tools to help assign monetary value to GI are much in demand from users, but existing tools such as GI-Val need a lot of data gathering and regular updating.
- Success of the [Tree Selection] tool will be in levels of adoption and impact in changing choices of trees in GI; evaluating this, providing feedback will be crucial for long term credibility that delivery has occurred. Sources of data will exist through the industry nurseries and small amounts of NERC funding could facilitate the co-ordination of this feedback and evolution of the tool. Possibly fund a comparative study of a GI scheme using the tool against one not applying the tool.

A number of ideas recognised that behaviour change will be fundamental to successful application of GI approaches;

- Addressing institutional and behavioural challenges and barriers to innovation and change, affecting the role of finance and drivers of design; combining social and environmental science.
- Further work to understand the roles of networks of actors and facilitating access; this is perhaps an action for the KE Fellow?
- NERC may wish to consider the potential risk of the loss of evidence and information where local authorities outsource the responsibility for GI to private companies.

A2.5.2 Effective and valuable methodologies

The summaries of the individual projects give an indication of how they are succeeding or have succeeded. The following comments were worthy of particular mention by the PIs.

NERC's stress on collaboration and early engagement of stakeholders and end users was validated;

- The collaboration between River Engineering and IGGI and End User involvement were commended for creating more usable outcomes.
- Engagement of the end users was crucial; this suggested a demand driven value for the tool.
- Working with large groups of local stakeholders for co-design was particularly beneficial.
- Mixed workshop with project partners looking at identifying problems and goals followed by bilateral meetings to find specific partner requirements and opportunities for collaboration
- Active facilitation of connections by the NFU helped establish credibility with industry partners.
- Working with the GI Strategy stakeholders in the city has also proved valuable.

- The literature review was an extensive assessment of key benchmarking schemes to inform the study and the symposia were obviously fundamental in shaping the nature of the benchmark itself.

A number of comments identified what engaged wider audiences;

- The research methodology effectively combined citizen science data with satellite imagery, verifying the data capture approach whilst engaging and educating the public at the same time.
- The use of maps and other visual representations have been shown to be critical in explaining the value of ESS to non-expert audiences. Making available the information from the project in a visual and accessible manner has proved popular
- The availability of local data sets, alignment with corporate data management systems and expertise remain crucial to the success of the approach.
- Visibility through media work and use of social media engendered interest

The following comments suggest that crossing inter-disciplinary boundaries has significant merit;

- The social science data is proving extremely worthwhile with partners; NERC could consider this cross-disciplinary benefit further e.g. by looking across into ESPRC areas of interest to identify potential value of cross-fertilisation of programmes and ideas.
- The valuation data provides a clear description of the economic benefits of trees for places and communities. This ought to provide an opportunity to link evidence across tools and places where work is underway elsewhere such as the natural capital accounting pilot in Manchester or to inform tools that provide scoring for the value/benefits of GI (e.g. the NCPT).
- The mix of the team of physical and social scientists has been a positive factor in generating a multi-skilled groups and expanding expectations. The visioning and 'seeing is believing' sessions were very valuable. The academic team found the enthusiasm of the stakeholders encouraging and that by 'standing back' the power dynamic of the project group allowed for greater co-production.

A2.5.3 Advice for NERC's way of working

No-one had much in the way of criticism of the way NERC ran the Programme and the compliments for NERC ranked equally with suggestions for improvement;

- The project has only been developed because of the Innovation Fund.
- The project appreciated NERC's flexible attitude toward small amounts of sub-contracting to allow facilitation by local organisations
- We are very appreciative of receiving the award.

Inevitably there were some comments about funding and timescales;

- Enhanced funding for expenditure (such as T&S) could turn this kind of project into a more attractive proposition for researchers e.g. as a one year post-doctoral position.
- The project had to cover local authority expenses to attend the meetings due to their cost restraints. Funding for partners to overcome their constraints in contributing to the project would be helpful e.g. honoraria for voluntary groups, or paying for time spent providing data.

- Quicker, shorter lead in times for approving the funding would have allowed the host organisation to plan and organise academic staffing more effectively.
- The timescales and funding of the programme were too short and small for generating papers and the academic part of the jigsaw.
- NERC may wish to be less ambitious about early starting dates when the award has only just been decided.
- NERC might consider lengthening timescales for projects to enable them to meet the high expectations of quality of outcomes.
- Limited budget couldn't cover the cost of graphic design; now seeking sponsorship and/or perhaps further funding from NERC.

A number of suggestions were about the approval and administrative processes;

- On reflection the project was very ambitious and the award process could possibly recognise this in future, by advising on funding and timescales that would be anticipated inferred by the scale and scope of the bid.
- It seemed that late-on in the run up to the deadline for this call, NERC looked to have changed the terms for engaging with external partners, which was a little disruptive.
- The administration of transferring the leadership of the project from the original lead university (due to PI staff changes) to its successor took some time and could have been more quickly resolved.
- Some concern about the value for money accruing to NERC because of the limitation of only funding via an HEI; the singular expertise for this project and funding had to be channelled through a University, that the on-costs taken from the project may be considered significant and reduce the spend available for the work. It also potentially reduces the flexibility for engaging practitioners.
- More communication across the projects within the GI programme would have potentially been valuable.