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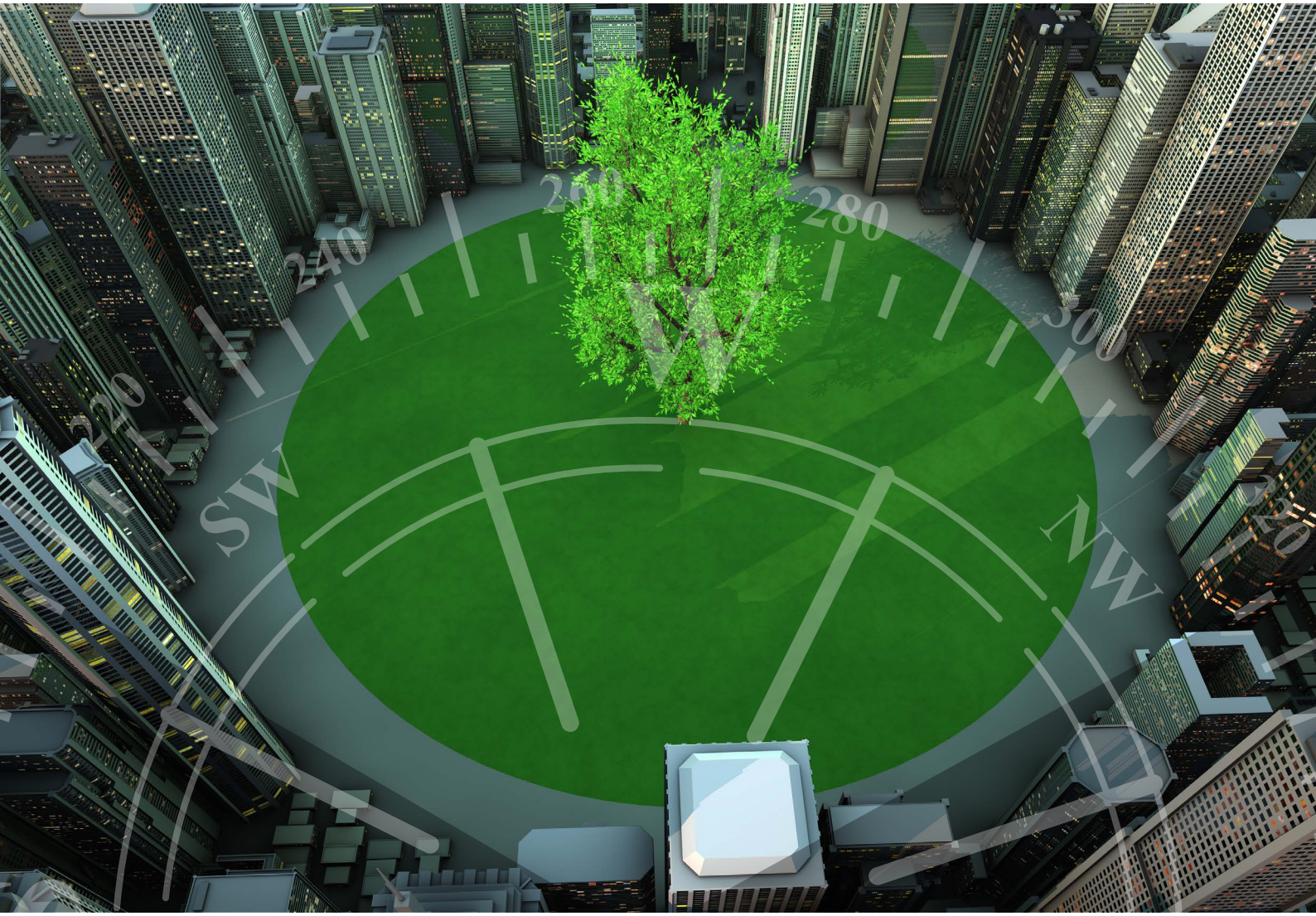
November 2015

Planning for Sustainable Land-Use: The Natural Capital Planning Tool (NCPT) Project



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Planning for Sustainable Land-Use: The Natural Capital Planning Tool (NCPT) Project

Report for Royal Institution of Chartered Surveyors

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Study sponsored by :

The RICS Research Trust, a registered charity established by RICS in 1955 to support research and education in the field of surveying.

Published by the Royal Institution of Chartered Surveyors (RICS)
RICS, Parliament Square, London SW1P 3AD
www.rics.org

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Executive Summary

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The purpose of this research project was to devise a reliable and industry acceptable assessment methodology based on ecosystem services to better assess and manage the long-term impacts of proposed major developments and plans on natural capital and ecosystem services.

The aim was to develop a fit-for-purpose tool which allows the indicative but systematic assessment of ecosystem services in a planning context. The assessment would determine the maximum potential outcomes for natural capital from the Masterplan stage through to a 25 year post-development period, and with the expressed intention of returning a net positive for natural capital over this timeline; so enhancing human well-being and biodiversity value alike.

The net result of this study is presented here as the Natural Capital Planning Tool (NCPT).

Background

The world faces significant population growth within the next few decades with increasing urbanisation as more and more people live in cities. Globally, the population living in urban areas is projected to gain 2.6 billion by 2050 (United Nations 2012), or c70% of people on the planet. In the UK the population is projected to grow by almost 10 million within the next 20 years. This necessitates the development of additional housing, services and associated infrastructure to accommodate new inhabitants.

Population growth is associated with many opportunities and advantages but development can also have negative impacts on the environment, the economy and people's wellbeing. The land-use changes that come with development can put significant additional pressure on natural capital and the ecosystem services. Ecosystem services are "*the benefits people obtain from ecosystems*" (Millennium Ecosystem Assessment 2005) and many ecosystem services in the UK are already in a degraded and/or declining status (UK NEA 2011). The pressure on ecosystems can be exacerbated if development takes place in the wrong places or if not considered holistically in terms of maximizing the economic, social and environmental benefits.

Land-use changes due to development can impact on the extent and ability of green infrastructure and ecosystems to provide ecosystem services such as space for recreation, the mitigation of flooding events and air quality regulation; all of them including their associated health and wellbeing benefits. This means that the provision of ecosystem services including their wide benefits to people's wellbeing cannot be taken for granted and needs to be actively planned, managed and protected.

The crucial importance to protect and enhance ecosystem services has for example been highlighted by the UK Government's National Planning Policy Framework (2012): "*The planning system should contribute to and enhance the natural and local environment by […] recognising the wider benefits of ecosystem services*." (DCLG 2012).

But so far the government has not equipped developers and planning authorities with the necessary practical tools to assess and manage these benefits at the project scale which hinders them from implementing such strategic guidance. At the moment, the planning system in England and in much (if not all) of the rest of the world is not systematically accounting for and managing the impact of development and inherent land-use changes on natural capital and ecosystem services.

HM Government's Natural Environment White Paper states that "*Planning has a key role in securing a sustainable future. However, the current system […] is failing to achieve the kind of integrated and informed decision-making that is needed to support sustainable land use.*" (HM Government 2011). This research project – the development of Natural Capital Planning Tool (NCPT) – aimed to tackle exactly this issue.

Acknowledging the complexity within ecosystem services research and the many gaps in the scientific evidence the Project Team did not aim to develop a perfect tool that generates 100% accurate outcomes; but to give the target audience, mainly developers and planning authorities, something to hand that can be easily applied in practice and that generates proxy values indicating the direction and magnitude of development impacts on ecosystem services. A key objective was that use of the tool would require no previous expert knowledge.

Methods

Development work has been undertaken by a core Project Team comprising representatives from Birmingham City Council, CEEP (Consultancy for Environmental Economics and Policy) and the UK Business Council for Sustainable Development – UK BCSD (the UK branch of the World Business Council for Sustainable Development).

A Multi-Criteria Decision Analysis (MCDA) framework was chosen for the development of the NCPT. Because the target audience is not expected to have the level of expertise and time to individually assess the impact of development on ecosystem services the scoring of features used in the framework (e.g. the ecosystem services performance of different land-use options) has been undertaken by expert Task Groups.

Ten different Task Groups, one for each ecosystem service recognised by the NCPT, were established at the beginning of the Project. These Task Groups were composed of experts from academia and relevant governmental institutions as well as practitioners; e.g. from third sector organisations, local authorities and businesses. Altogether, the Project Team was able to recruit 45 Task Group members for this Project.

The first activity of each Task Group was to select a set of feasible indicators to assess each ecosystem service. For this purpose a list of potential indicators (which have been identified as part of a literature review and work undertaken in an earlier pilot project) was shared with each Task Group.

Task Group members were asked to prioritise the most important indicators for assessing the ecosystem service in a planning context and to select a final set of indicators for the NCPT. They were also given the opportunity to challenge or propose alternative indicators.

Because the published scientific evidence to assess ecosystem services is imperfect and reveals many gaps, the impact of e.g. land-use changes and other indicators on ecosystem services was mainly based on expert judgment. In most cases Task Group members were presented with indicator features (e.g. different land-use types) and were then asked to apply indicative scores (e.g. the biodiversity values of different land-use types) to each feature. However, they were only asked to apply scores/values where they felt comfortable doing so/where their main expertise lay. The aggregated scoring results were then shared with the group again to allow a review and to confirm or challenge the outcomes. Indicators and scores have then been integrated into the NCPT which means that the tool application does not demand specific expertise about ecosystem services from the user.

In addition to these Task Groups a Project Steering Group was established at the start of the Project. The main purpose of the Steering Group was to oversee and review Project progress and to endorse the outcomes and research findings. The Steering Group included business and local authority representation (as potential future users of the tool), representatives from relevant governmental bodies such as the Environment Agency and Natural England, representation from academia and third sector organisations, and initially Frankfurt City Council as an international partner.

Results: The Natural Capital Planning Tool (NCPT)

The main outcome of this Project was the development of an assessment tool rather than the assessment of a specific development. The Natural Capital Planning Tool (NCPT) enables the indicative but systematic assessment of the impact of proposed developments and plans on natural capital and ecosystem services. Ten different ecosystem services can be assessed by the tool with an assessment timescale of 25 years.

Only easily accessible data sources have been utilised to inform the NCPT. To minimise the time and resource commitment when applying the NCPT the tool user only has to enter a range of simple Input Level Indicators (ILIs) such as the area of actual and proposed land-use types or population density statistics for that area. The NCPT then

automatically translates these ILIs into Assessment Level Indicators (ALIs) such as changes to the biodiversity value of a site due to land-use changes. The translation of ILIs into ALIs is based on the scores applied by the Task Group members.

The result is an ecosystem services impact value which is calculated for each assessed ecosystem service. After applying weightings designed to make different ecosystem services comparable the NCPT calculates an Ecosystem Service Impact Score (ESIS) indicating the direction and the magnitude of the impact on each ecosystem service.

The tool also calculates a Development Impact Score (DIS) where all ESIS are aggregated to a single score from -10 (indicating a negative impact on ecosystem services) to +10 (indicating a positive impact on ecosystem services). Furthermore the NCPT allows comparing different design options for a proposed development site to see which option has the best performance in terms of ecosystem services impacts. Figure 1 summarises the framework and functionally of the NCPT.

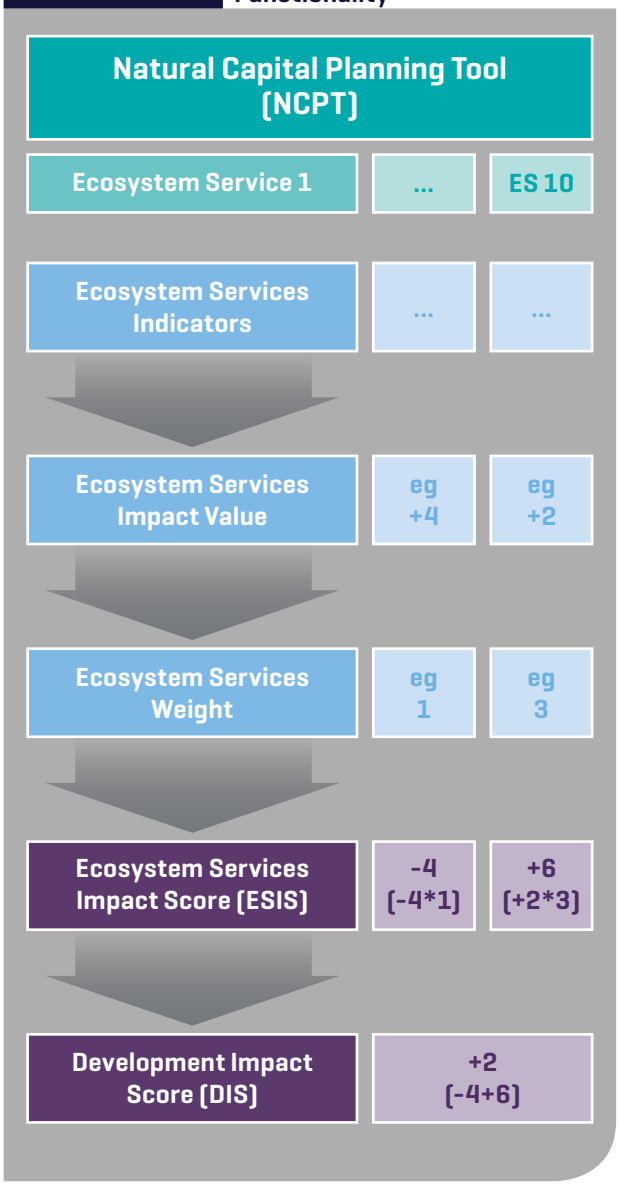
If a proposed development has a poor ecosystem services performance then the NCPT outlines different design strategies to improve the impact. This information includes references to relevant policy documents and links to further guidance on how to improve the design of a development in order to improve its impact on ecosystem services and natural capital. The tool user can then re-run the tool with the updated design options and see how this changes the tool outcomes, i.e. the final Development Impact Score.

The functionality and usability of the NCPT has been successfully tested in three different case studies:

- Birmingham City Council for a mayor urban housing development in Birmingham
- The Environment Agency on a Flood Alleviation Scheme in Rugeley, Staffordshire
- Skanska on the re-development of their manufacturing facilities in Doncaster.

The purpose of these case studies was to trial the tool under 'real-world' circumstances and to gather feedback about the tool applicability and usefulness; and the strategic potential of the tool in the future. Feedback from the case study applications was used to further update and improve the NCPT.

Figure 1 NCPT Framework and Functionality



Conclusions & Recommendations

The research project has shown that expert and stakeholder knowledge can be used successfully to inform a 'fit-for-purpose' tool which can systematically assess the impacts of Masterplan proposals and potential developments on natural capital and ecosystem services. There is overall agreement across the involved stakeholders that the Natural Capital Planning Tool (NCPT) can provide a very valuable additional information source to assess, monitor and manage the impact of proposed plans and developments on natural capital and ecosystem services in a holistic way; acknowledging that these outcomes are indicative rather than the proven outcome.

The NCPT is seen by all partners involved as a stepping stone towards integrated management of natural capital and ecosystem services in a planning context – something that has not been mainstreamed to date.

The case study trials have revealed that assessments using the NCPT offer a valuable additional perspective on development impacts; beyond the 'tick-box thinking' prevalent in planning however, to amend data requirements for developers and corresponding consultancies so that relevant data is available in a 'ready-to-use' format.

The NCPT also offers a wide range for opportunities for further development and for its application and implementation in different contexts. In the future the NCPT can be improved so that for example scores and values are based on a broader sample size of experts and to link the tool indicators better to existing assessments such as an Environmental Impact Assessment or a Flood Risk Assessment.

The NCPT as presented here has been developed specifically for England. This is mainly due to the fact that ecosystem services and natural capital are not adopted concepts elsewhere at present; therefore the vital local information would not be available to inform the NCPT process in other locations. For example our research identified from discussions with our European partner City, Frankfurt, that relevant policy discussions were still underway. However, as these broader concepts become more widely adopted, then the current format of the NCPT could easily be adapted to suit other countries.

There is also the potential to develop more local or regional NCPT versions to make use of additional information sources which are not consistently available at the national level; such as implementing Local Biodiversity Action Plans. Furthermore an Ecosystem Services Monitoring System (ESMS) could be developed to collect and aggregate the outcomes of NCPT assessments to monitor and assess cumulative changes to ecosystem services e.g. at the city or county scale.

The Steering Group believe that the NCPT could also serve as basis for Ecosystem Services Offsetting (ESO) schemes. One criticism of biodiversity offsetting is that it does not account for the full range of ecosystem services and therefore the overall impact on human wellbeing.

The NCPT applies a scoring and valuation system which is quite similar to existing biodiversity offsetting schemes. However, an Ecosystem Services Offsetting (ESO) scheme based on the NCPT would not just allow offsetting biodiversity values but also other ecosystem services values such as recreation and climate regulation. In principle therefore, the design of the NCPT allows for the incorporation of Biodiversity Offsetting values should the Government or the Local Authority in question agree to its adoption.

1.0 Introduction & Project Aims

Image source: Paolo Bona / Shutterstock.com

The main aim of this research project was to develop a Natural Capital Planning Tool (NCPT) to better assess and manage the long-term impacts of proposed developments and their plans (such as a master plan) on natural capital and ecosystem services; in order to maximise the potential benefits for people and wildlife in an industry acceptable yet sustainable way. Particular emphasis has been given to the demands of the target audience, planners and developers, by developing a 'fit-for-purpose' tool that can be applied without specific ecosystem services expertise.

The Project has been undertaken by core Project Team comprising representatives from Birmingham City Council, CEEP (Consultancy for Environmental Economics and Policy) and the UK Business Council for Sustainable Development – UK BCSD (the UK branch of the World Business Council for Sustainable Development). However input from policy and industry experts and practitioners and from users was considered to be essential and a Project Steering Group with representation from a range of stakeholders was established to oversee the Project and to validate the outcomes.

1.1 Introduction & Background

1.1.1 Drivers of Land-use Changes and its Impact on Natural Capital and Ecosystem Services

In the United Kingdom and worldwide the population is growing and urbanisation is increasing with now more people living in urban areas than in rural areas. The world population is projected to increase by almost 1 billion by 2025 and nearly 2.5 billion by 2050 (United Nations 2013); with urban populations due to grow the fastest. Globally, the population living in urban areas is projected to gain 2.6 billion, expanding from 3.6 billion in 2011 to 6.3 billion by 2050 (United Nations 2012).

The UK has the fastest population growth in Europe and is projected to grow by almost 10 million within the next 20 years. Birmingham's population, for example, is projected to grow by around 150,000 between 2011 and 2031. This necessitates the development of additional housing, services and associated infrastructure – all constrained by the city boundary. It has been estimated that the number of households in the city will grow by more than 80,000 by 2031.[1] This scale of development will be reflected across many local authorities over the same timescale.

Notwithstanding the many opportunities and advantages associated with such growth, developments can also have negative impacts on the environment, the economy and people's wellbeing more generally. New developments can put significant additional pressure on the natural capital itself and the ecosystem services that flow from it.

Natural capital can be defined as "*the stock of natural ecosystems that yields a flow of valuable ecosystem goods or services into the future*" (Costanza 2008). A less technical definition has recently been proposed by the Natural Capital Committee where natural capital is defined as "the elements of nature that directly and indirectly produce value or benefits to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions" (Eftec 2015). A commonly used definition for ecosystem services is "*the benefits people obtain from ecosystems*" (Millennium Ecosystem Assessment 2005). The protection and enhancement of natural capital stocks is crucial for securing a sustainable flow of ecosystem services in the future.

Land-use changes due to development can impact on the extent and ability of natural capital to provide ecosystem services such as space for recreation, the mitigation of flooding events and air quality regulation; all of them including their associated health and wellbeing benefits. Such ecosystem services are very valuable and essential to maintaining a high quality of life – in cities and elsewhere. The UK National Ecosystem Assessment (2011) has found that many ecosystems in UK cities, but also on the countryside, are already in degraded and/or declining status (UK NEA 2011). This means that the provision of ecosystem services including their wider benefits to people's wellbeing cannot be taken for granted and needs to be actively managed and protected.

One of the main drivers of natural capital and ecosystem services degradation is land-use change caused by development (Bastian et al. 2012; Hölzinger et al. 2014). Because natural capital is not often traded on markets it lacks a market price which can lead to its undervaluation and presents an incentive for its over-exploitation. The projected population growth and urbanization is likely to increase the pressure on natural capital and ecosystem services. The expected population growth also means that the demand for ecosystem services such as recreational opportunities increases. So in a 'business-as-usual' scenario we can assume that on the one hand the provision of ecosystem services will decline whilst the demand for ecosystem services increases. This is, by definition, an unsustainable development path and so is likely to endanger the wellbeing of future generations if no action is taken now.

1.1.2 Demand and Barriers for Assessment Tools

The crucial value of ecosystem services has been assessed at the global (Millennium Ecosystem Assessment 2005), national (UK NEA 2011) and city scale (Hölzinger et al. 2013). The crucial importance to protect and enhance ecosystem services has for example been highlighted by the UK Government's National Planning Policy Framework (2012): "*The planning system should contribute to and enhance the natural and local environment by […] recognising the wider benefits of ecosystem services*" (DCLG 2012). But so far the government has not equipped developers and planning authorities with the necessary practical tools to assess and manage these benefits, which hinders them from implementing such strategic guidance.

Implementing the value of natural capital and ecosystem services into spatial planning and land-use management is not a new idea and has certainly attracted research interest (See e.g. de Groot et al. 2010). We can see from the literature that scientists call for the implementation of ecosystem services and natural capital values into spatial planning and land-use management (Raymond et al. 2009; Hermann 2011; Koschke et al. 2012; Bastian et al. 2012). The need for software tools has also been highlighted (Egoh et al. 2007). However, within academia the assessment of ecosystem services in a planning context usually focuses on the conceptual framework, project-specific research and issues of implementation more generally rather than developing tools and systematically implementing and mainstreaming ecosystem services values into site-specific assessments.

The systematic assessment of ecosystem services and natural capital within the scope of a development project can be very challenging and faces a range of barriers. It is arguable that one main reason for this lack of implementation is that relevant evidence, e.g. from national assessments of ecosystem services, is hard to assimilate and to take up at the local and site scale where most planning decisions take place. Such planning decisions have a considerable impact on land-use changes, and therefore on ecosystems, and ultimately on the provision of ecosystem services benefiting human wellbeing. The current difficulty is that the global or national ecosystem assessments cannot easily be transferred to the local scale; as such evidence cannot easily be downscaled or adjusted to be useful for the specific local context of the policy area (Hölzinger et al. 2014).

Another barrier is that ecosystem services thinking and its dedicated terminology can be very complex and developers and planning authorities are often not familiar with the concept and related methodical approaches.

1 Population projection information provided by the UK Office for National Statistics (ONS).

Also, developers and their agents do not always have ecosystem services expertise available in-house. The same applies for many planning authorities. In 2011 only about 40 per cent of English local authorities had an in-house ecologist and in 2007 planning officers only received ecological advice for just over 50 per cent of their planning cases[2] (Parliamentary Office of Science & Technology 2013). It should also be mentioned that such ecologists are often specialized in biodiversity issues rather than the wider range of ecosystem services. This limits their ability to assess and judge the impact of proposed development projects on ecosystem services and to compare related values and their inherent impacts on human wellbeing with other benefits such as new households or jobs created.

Even if developers and planning authorities are equipped with the necessary expertise they often lack of resources and time to undertake a holistic in-depth analysis of ecosystem services impacts. Because of the complexity of the topic and the wide range of potentially relevant datasets and resources it is often difficult (1) to gather and analyse relevant data (if available), (2) to translate such data into useful indicators, and (3) to meaningfully aggregate and interpret the findings. Even if site-specific assessments are available elsewhere it can be very challenging to replicate such studies for the policy site (Scolozzi et al. 2012).

There are tools available which can assess the impact of land-use changes on natural capital and ecosystem services values including the Natural Capital Asset Check which was recently developed as part of the National Ecosystem Assessment Follow-On (NEAFO) research project funded by the UK government (Dickie et al. 2014). Further tools that could be used for such an assessment include Social Cost-Benefit Analysis and Multi-Criteria Decision Analysis (See Scott et al. 2014 for an overview).

However, such detailed assessments are resource intensive and therefore difficult to fund at the site scale – e.g. for a development site or a master plan. The application of such tools is also very demanding in terms of the expertise required and the time commitment. At the moment, the planning system in England and in much (if not all) of the rest of the world is not systematically accounting for the impact of development and inherent land-use changes on natural capital and ecosystem services. A fit-for-purpose tool that generates proxy values for such assessments not only provides a valuable opportunity to fill this gap; but could also become an acceptable and workable industry standard.

In order to validate these findings the NCPT Project Team undertook a more detailed literature review and approached Frankfurt Municipality - via the twinning arrangements that exist between Frankfurt and Birmingham. As a 'Sister-City' Birmingham was keen to share thoughts on the design of the planning tool and to receive international feedback. The municipal officers at Frankfurt undertook an initial assessment of the tool and concluded that they were not 'authorized' to proceed with a test in their City.

The Humboldt Institute of Berlin University has just published in 2015 a review of how national planning policies in Germany, Austria, Sweden and North America, are in a position to absorb the relatively new science of ecosystem services. The Institute's findings were that the German planning system was not yet ready, but could be amended to absorb a progression towards taking an ecosystems approach (Hansen et al. 2015).

2 Figures are based on a sample.

The planning team in Frankfurt were keeping abreast of this study. Their position was that the NCPT may well have a very useful place in Germany in years to come, once the national legislation has been appropriately amended – as has already been the case in England with publication of the National Planning Policy Framework (DCLG 2012) But until that time there was no mechanism for the planning team at Frankfurt to engage with – to test such a tool.

The literature suggests that a tool which systematically assesses the impact of development and inherent land-use changes on natural capital and ecosystem services has not been developed yet (Chan et al. 2006; Egoh et al. 2007; Paetzold et al. 2010). Birmingham City Council has also contacted its global Biophilic Cities Network partner cities with the response that a similar tool has not been used yet but there is interest in testing the Natural Capital Planning Tool and to explore opportunities for the future.

During the course of the Project the Team was contacted by a number of interested parties including a Local Authority in the Netherlands which was in the early stages of considering this type of approach.

Assessing these impacts is an important step towards integrated ecosystem services and natural capital management and decision-making because '*what gets measured gets managed*'.

Without assessing the impact of planning and development on natural capital and ecosystem services, planning authorities and governmental institutions will not be able to set the right incentives to protect and enhance these valuable resources and therefore ensure sustainable land-use.

HM Government's Natural Environment White Paper states that "*The Government expects the planning system to deliver the homes, business, infrastructure and thriving local places that the country needs, while protecting and enhancing the natural and historic environment. Planning has a key role in securing a sustainable future. However, the current system […] is failing to achieve the kind of integrated and informed decision-making that is needed to support sustainable land-use.*" (HM Government 2011). This research project – the development of a Natural Capital Planning Tool (NCPT) – aimed to tackle exactly this issue and was a direct reaction to the Government's call for integrated and informed decision-making in planning; acknowledging the high value of ecosystem services to people's wellbeing.

1.2 Aims & Objectives of this Research Project

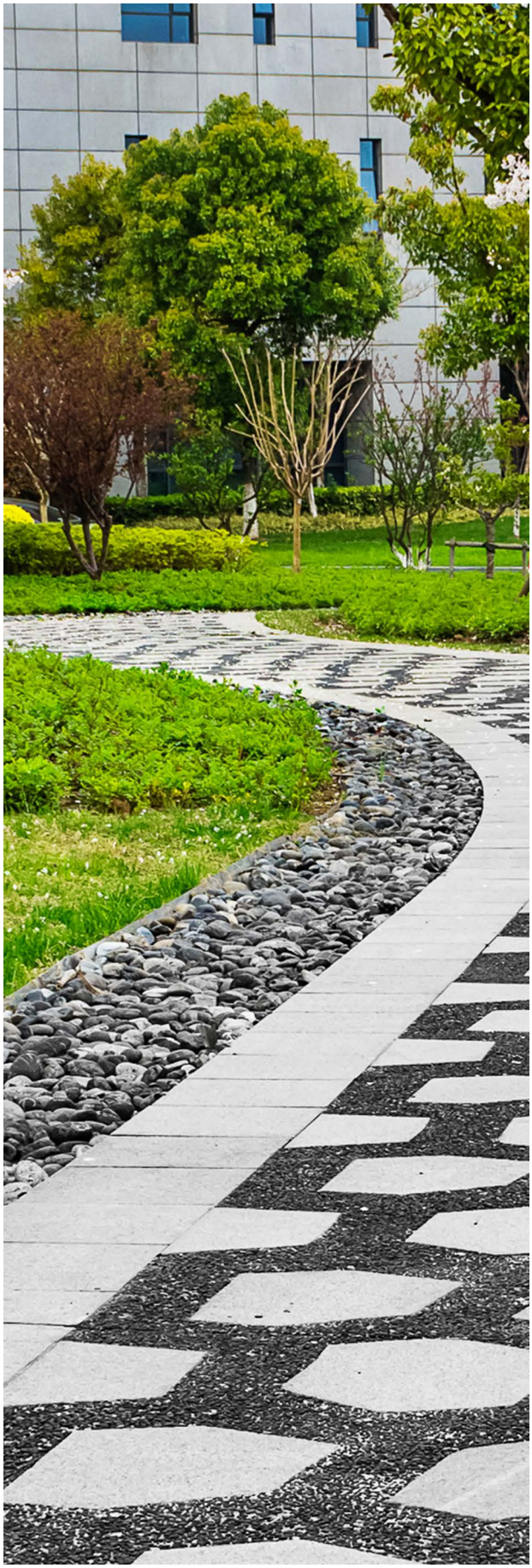
The main aim of this research project was to overcome most of the barriers as outlined above by developing a fit-for-purpose tool which allows the indicative but systematic and holistic assessment of ecosystem services impacts in a planning context.

Objectives:

- The development of an excel-based Natural Capital Planning Tool (NCPT) allowing non-specialists to assess the impact of proposed developments and inherent land-use changes on ecosystem services.
- Acknowledging resource and time constrains of planning authorities and developers it was important that the application of the NCPT would not impose an unreasonable additional effort on the tool user. The Project Team saw this as a crucial point with respect to the 'real world' impact of the tool. In our view there is no point of developing a tool that generates perfect outcomes if the application of the tool is so complex, time consuming and costly that no one can actually apply it in practice. Therefore it was necessary to limit the effort of the tool user to a practical minimum.
- Because the potential tool users are not always ecosystem services specialists and frequently have to make decisions under high time pressure the outcomes of the tool should be simple and easy to interpret; but still meaningful. Therefore the NCPT should be designed so that a single score indicates if the overall impact of the (proposed) development or plan on ecosystem services is positive or negative; and what the magnitude of this impact is. However, the tool should also allow more detailed interpretation for each assessed ecosystem service and provide initial guidance on how to improve impacts on specific ecosystem services through sustainable design options.
- The NCPT should be applicable to a wide range of developments and plans rather than just focussing on large-scale developments. Such a focus would have the advantage that additional information sources such as a Flood Risk Assessment are more often generated as part of the planning process. However, when assessed cumulatively also small-scale developments can cause significant natural capital degradation and loss; e.g. by 'creeping' into the greenspaces of cities. The NCPT has been so designed to capture the more incremental impacts of small developments such as a single dwelling or a front garden development.

- Because the availability, quality and format of datasets varies significantly across countries the NCPT has been developed to assess developments in England only. This scale has been chosen because in England many datasets and indicators are provided in a consistent format and following consistent methods. This does not mean that future tool versions cannot be developed for other countries or even for specific regions or local authorities to make use of additional data sources and indicators available at those scales.
- There is a trade-off between accuracy of tool outcomes and applicability of the tool. The Project Steering Group saw it as very important to find a good balance between limiting data input requirements and complexity of the tool on the one hand and the accuracy of the tool outcomes on the other. To meet this requirement the tool works with average values which can be applied quickly and with limited demands in terms of data-input and interpretation by the tool user. However, the tool should also allow the adjustment of scores to account for site-specific circumstances which cannot be incorporated into the average scores. The limitations and caveats should be directly acknowledged within the tool.
- Ecosystems often need a long time until they develop their full potential for providing ecosystem services which would make a long assessment timescale of decades or centuries preferable. Developers and local authorities, however, often work against comparatively short timescales of few years e.g. in accordance with development plans or driven by short-term economic incentives. Therefore it is important to define a pragmatic hence meaningful assessment timescale for the NCPT and to account for ecosystem services value changes over time; e.g. when comparing newly created ecosystems and mature ecosystems. As a compromise an assessment timescale of 25 years was chosen which is also in line with the timescale of many local plans.
- It was important for the Project Steering Group to develop a transparent and evidence based tool rather than a 'black box' tool where it is not possible to review the link from entered data to the outcomes. Therefore the tool has been designed so that the user can see how the inputted data is reflected in the tool outcomes.
- The accessibility of the tool to the user is vital. Therefore the NCPT should be tested together with case study partners to improve its applicability and to assess the usefulness of the tool in different contexts. This process has allowed us to gather valuable feedback on the future potential of using the NCPT.
- Last but not least it was our objective to contribute to ecosystem services science by offering a new approach and framework to assess and value natural capital and ecosystem services in a planning context. This refers to the NCPT itself; but also to the process of selecting indicators and arriving at values for these indicators making use of expert and stakeholder knowledge.

Overall the development of the NCPT aimed to offer a great opportunity to better manage, protect and enhance natural capital and ecosystem services as part of the planning process which can ultimately benefit sustainable land-use, human health and wellbeing, and society as a whole.



2.0 Methods

The Natural Capital Planning Tool enables the assessment of the impact of development and land-use changes across 10 different ecosystem services and is based on a Multi-Criteria Decision Analysis (MCDA) framework. For each assessed ecosystem service a set of feasible indicators has been identified. Because of the gaps in the published scientific literature an expert-knowledge based approach has been taken to establish values to features; e.g. for ecosystem services provided by different land-use types.

2.1 Previous Work

The development of the NCPT builds upon a former research project which was funded by the Government's Department for Environment, Food and Rural Affairs (Defra) with additional support provided by industrial partners. A so called Natural Capital City Tool (NCCT) was developed as the main outcome of that project in 2014.

The purpose of the NCCT was to introduce a structured framework and mechanism for planners and developers to assess the impact of development on the provision of ecosystem services. The NCCT was very much a prototype to prove the worth of assessing ecosystem services values in a planning context but was demanding in terms of the level of expertise and information inputting required by the tool user.

To apply the NCCT the user needed a certain level of expertise in ecosystem services research because indicators and values were based on the knowledge and judgement of the user. This project significantly advanced the workability and applicability of the tool as the Natural Capital Planning Tool (NCPT). The purpose of the NCPT is to introduce a simplified and automated mechanism for planners and developers demanding no specific ecosystem services expertise of the tool user.

The scope of the former NCCT project extended to an assessment framework and a list of ecosystem services to be assessed. This has been used as the basis for developing the new NCPT.

2.2 Project Scope

Acknowledging the high complexity of ecosystem services research and the many gaps in the scientific evidence the Project Steering Group did not aim to develop a perfect tool that generates 100% accurate outcomes; but to give the target audience something to hand that can be easily applied in practice and that generates proxy values indicating the direction and magnitude of development impacts on ecosystem services.

Within recent decades natural capital and ecosystem services research has become an important concept. This is an interdisciplinary area of research and the number of relevant publications, indicators and methods is vast and further evidence is added almost on a daily basis. It was clear from the beginning that within scope of this Project it would not be possible to identify and incorporate all relevant evidence to create a 'world-tool' for all possible circumstances. Therefore the scope of the research was restricted to a workable range of ecosystem services and indicators to be used in the assessment.

When developing the former NCCT a workshop was held to identify the key indicators. The project group was presented with a comprehensive list of ecosystem services which could potentially be assessed by the tool. The list of ecosystem services was based on the framework of the National Ecosystem Assessment (UK NEA 2011). To reduce the complexity of the assessment and also of the tool itself this rather long list needed to be narrowed down to a workable version. Therefore the workshop attendees were asked to select those ecosystem services that were seen to be most important to be assessed in a planning context. Table 2.1 shows the final list of ecosystem services that were selected to be assessed by the tool.

2.3 Stakeholder Involvement

Stakeholders have been involved for the duration of the Project. The Project Steering Group was established at the start of the programme. The main purpose of the Steering Group was to oversee and review the project progress and to endorse the outcomes and research findings. Its members were recruited through the existing networks of the core Project Team and built upon the group involved with the NCCT project. The process was overseen by UK BCSD.

The Steering Group comprised 13 members and included business and local authority representation as potential future users of the tool; representatives from relevant governmental bodies such as the Environment Agency and Natural England; representation from academia and third sector organisations; and initially Frankfurt City Council as international partner. A full list of Steering Group members, including affiliations, is included in Appendix 1 (Section 7.1).

The Steering Group met three times over the course of the Project. It agreed on the methodological approach to be taken, ensured the quality and validity of the NCPT design and other Project outcomes, as well as a review findings (both Interim and Final), and arranged the testing of the tool at case study sites. At its last meeting in April 2015 it was also agreed that the Group would be retained after the formal project ends to explore future opportunities for tool dissemination, development and implementation.

Table 2.1 Assessed Ecosystem Services

	Ecosystem service	Example
1	**Harvested products**	Impact on the production of food, timber and other products harvested from ecosystems
2	**Biodiversity**	Impact on habitat composition and connectivity
3	**Aesthetic values**	Impact on the visual amenity of a site
4	**Recreation**	Impact on the availability and accessibility of public greenspace
5	**Water quality regulation**	Impact on water quality improving vegetation
6	**Flood risk regulation**	impact of vegetation on water storage capacities and water run-off
7	**Air quality regulation**	Impact on vegetation contributing to air quality
8	**Local climate regulation**	Impact on cooling vegetation reducing the Urban Heat Island Effect (UHIE) – climate change adaptation
9	**Global climate regulation**	Effect on carbon stored in soil & vegetation – climate change mitigation
10	**Soil contamination***	Impact on risks to human health and groundwater

Note: *Within scope of the NCCT development this ecosystem service was labelled as 'soil quality'. This has been changed to 'soil contamination' because factors such as soil productivity for agriculture have already been factored in within the ecosystem service harvested products. In a strict definition 'soil contamination' may not be labelled as ecosystem service but for consistency reasons and to improve the readability of the report 'soil contamination' is treated as ecosystem service.

Table 2.2 Task Group Members

	Task Group	Members
1	**Harvested products**	6
2	**Biodiversity**	12
3	**Aesthetic values**	7
4	**Recreation**	7
5	**Water quality regulation**	8
6	**Flood risk regulation**	6
7	**Air quality regulation**	4
8	**Local climate regulation**	8
9	**Global climate regulation**	8
10	**Soil contamination**	6

Over and above the Steering Group specialist Task Groups were established. The Project Team has, with support of the Steering Group, invited members to join 10 different Task Groups, each one of them to assess the impact of planning and development on one of the selected 10 ecosystem services. Task Groups were composed of experts from academia and relevant governmental institutions as well as practitioners; e.g. from third sector organisations, local authorities and businesses. See Appendix 1 (Section 7.1) for a full list of Task Group members including their affiliations.

Altogether the Project Team was able to recruit 45 Task Group members. Table 2.2 below shows how many members joined each group. It should be noted that some individuals joined more than one Task Group.

The main activity for each Task Group was to select a set of feasible indicators to inform the assessment of each ecosystem service, to identify data and information sources to inform the indicators, and to participate in a scoring exercise to establish ecosystem services related scores to features; e.g. different land-use options (see Section 2.5 for further details).

2.4 Methodological Approach & Assessment Framework

2.4.1 Methodological Approach

A Multi-Criteria Decision Analysis (MCDA) framework was chosen to support the development of the NCPT. MCDA is a structured approach designed to integrate and evaluate multiple (and often heterogeneous) dimensions and criteria of a decision (Scott et al. 2014). In MCDA it is common to ascertain scores or weights to different features or impacts of a decision. These scores or weights are commonly arrived at by an individual assessor or by a group of assessors (See e.g. Hölzinger et al. 2014 for an overview).

Because the target audience for the NCPT, i.e. developers and planners, often do not have the necessary level of expertise to assess the impact of development and land-use changes across a range of ecosystem services (by applying scores) the scoring of features (e.g. the ecosystem services value of different land-use types) was undertaken by the Task Groups.

This process can be clarified using the example of biodiversity values of different habitat types. In a common MCDA (and also the former NCCT) the planner or developer would have to:

1. Assess how land-use would change due to a proposed development
2. Establish a score reflecting the biodiversity value of the former as well as the latter land-use (pre- and post-development)
3. Calculate a score for the biodiversity value gain or loss for all land-use changes combined
4. Establish weightings for the indicator 'biodiversity value' itself to be able to compare and established ascertained values for other biodiversity indicators such as connectivity as well as values for other ecosystem services
5. Repeat the same steps for other biodiversity-related indicators as well as all indicators for all other ecosystem services and
6. Aggregate all the scores to arrive at a final score for the proposed development.

When applying the NCPT the developer or planner only has to enter what the actual and the proposed future land-use type is. Scores and weightings have already been assigned by the expert Task Group and the NCPT automatically calculates and aggregates the outcomes. This has to be repeated for other indicators as well but many input-level indicators inform several assessment-level indicators which reduces the overall effort of the tool user. This process is explained in detail in Section 2.5.

2.4.2 NCPT Assessment Framework

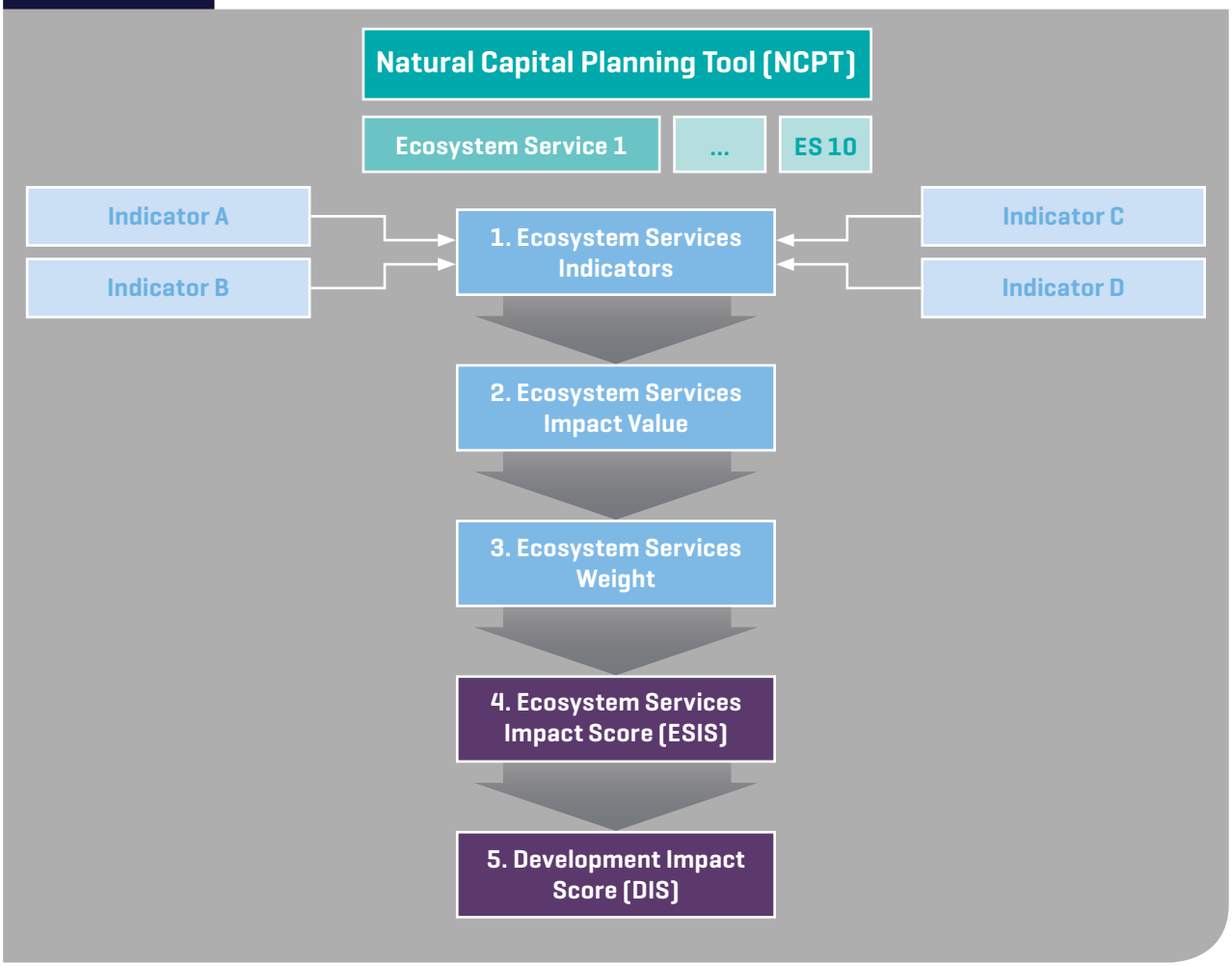
Figure 2.1 shows the assessment framework for the NCPT.

In Step 1 a set of feasible indicators has been defined for each ecosystem service. The selection of indicators was based on the availability of datasets to inform the indicators and how meaningful these indicators are to assess the value of ecosystem services changes due to land-use changes. The different attributes for each indicator have pre-defined scores which were established by each of the Task Groups (e.g. a per-hectare biodiversity value for each land-use type).

The features (e.g. area of actual and proposed land-use) need to be entered into the tool by the tool user. This process must be replicated for each indicator. There are up to four different indicators for each assessed ecosystem service. For each ecosystem service (ES 1 to 10) these scores are then aggregated based on multiplicators or weights which have also been defined by the Task Groups. The result of this aggregation process provides the Ecosystem Service Impact Value (Step 2).

In Step 3 these Ecosystem Service Impact Values are weighted to make the impact on different ecosystem services comparable. It was agreed at the third Steering Group meeting that all assessed ecosystem services should have equal weight. However, the tool is designed so that alternative weightings could be implemented quickly in the future. The result (Step 4) is an Ecosystem Service Impact Score (ESIS). The ESIS is one of the main tool outcomes and shows the impact of the proposed development on each assessed ecosystem services. To arrive at a single Development Impact Score (DIS) all ESISs for each ecosystem service are aggregated by adding up scores and re-calculating them to a -10 to 10 scale (Step 5). The DIS is the main outcome of the NCPT and indicates the overall impact of the proposed development on all assessed ecosystem services together.

Figure 2.1 NCPT Assessment Framework



2.4.3 NCPT Land-use Classification Framework

As the NCPT focuses on the assessment of land-use changes it is not surprising that many indicators relate to land-use types. Therefore it was very important to work with a comprehensive land-use classification framework. Unfortunately a fit-for-purpose land-use classification framework suitable for the NCPT did not exist and had to be developed as part of the Project.

The Project Team, with the support from selected Steering Group members and representatives from the Birmingham City Council planning team, established a comprehensive NCPT land-use classification framework. The framework is based on the Joint Nature Conservation Committee (JNCC) Phase 1 habitat survey and classification framework (JNCC 2010). The JNCC framework is often used when surveying and mapping habitats in the UK. This framework has been combined with the list of UK Biodiversity Action Plan (BAP) Priority Habitats (BRIG 2007) to give more detail to the framework especially in respect to biodiversity values. Furthermore additional categories such as 'buildings covered with green roof' have been added to the framework. Some original JNCC categories have also been left out when overlaps occur or to reduce the overall complexity of the framework.

It can be seen in Table 2.3 that each habitat category has a unique code. Each broad habitat category (A) has a range of sub-categories (A.2) which themselves may have further sub-categories (A.1.1) and so on. The original JNCC Phase 1 codes all end on a number (except top-level broad habitat classes). When BAP Priority Habitats (blue in Table 2.3) or other habitats/land-uses (purple) were added to the list the code does not end with a number (e.g. A1.1) but with a letter (e.g. A.1.1.1.a). Because the different classification systems are not directly comparable some habitat categories may overlap. The tool user is always asked to select the category that best matches the existing/proposed land-use. For the full NCPT Land-use Classification Framework see Appendix B (Section 7.2).

Table 2.3 NCPT Land-use Classification Framework (Extract)

A	Woodland and scrub
A.1	Woodland
A.1.a	Lowland beech and yew woodland (UK BAP Priority Habitat)
A.1.b	Wet woodland (UK BAP Priority Habitat)
A.1.1	Broadleaved woodland
A.1.1.1	Broadleaved woodland – semi-natural
A.1.1.1a	Broadleaved ancient semi-natural woodland (ASNW)
A.1.1.1b	Upland birchwoods (UK BAP Priority Habitat)
A.1.1.1c	Other broadleaved woodland – semi-natural
A.1.1.1	Broadleaved woodland – plantation
...	

2.5 Indicator Selection & Scoring Exercise

Two key features of the NCPT's development were the indicator selection and the scoring exercise. For both elements the Task Groups played a significant role in this process. Figure 2.3 shows the NCPT framework including Task Group contributions. For each assessed ecosystem service, and therefore each Task Group, this process followed a similar process with five subsequent steps.

Step 1: Indicator identification

For each assessed ecosystem services a preliminary literature review was undertaken to identify potential indicators to assess the impact of development and land-use changes. Sometimes task group members helped to identify feasible indicators. Because ecosystem services are usually not directly assessed by existing indicators and assessment methods we classified indicators into Input Level Indicators (ILIs) and Assessment Level Indicators (ALIs).

The ILIs are those indicators which the tool user has to enter into the NCPT. They include for example land-use changes, soil type or socio-economic data such as population density. However, such information usually does not directly indicate the effect on ecosystem services. Therefore ILIs needed to be 'translated' into ALIs which directly indicate the impact on ecosystem services and natural capital. When assessing for example flood risk regulation an ILI would be the land-use change and an ALI would be the water storage capacity/water run-off of vegetation associated with each land-use. Which ILIs inform which ALIs and which ALIs are used to assess which ecosystem services is indicated by the arrows in Figure 2.3.

Figure 2.2 NCPT Assessment Framework and Task Group Contributions

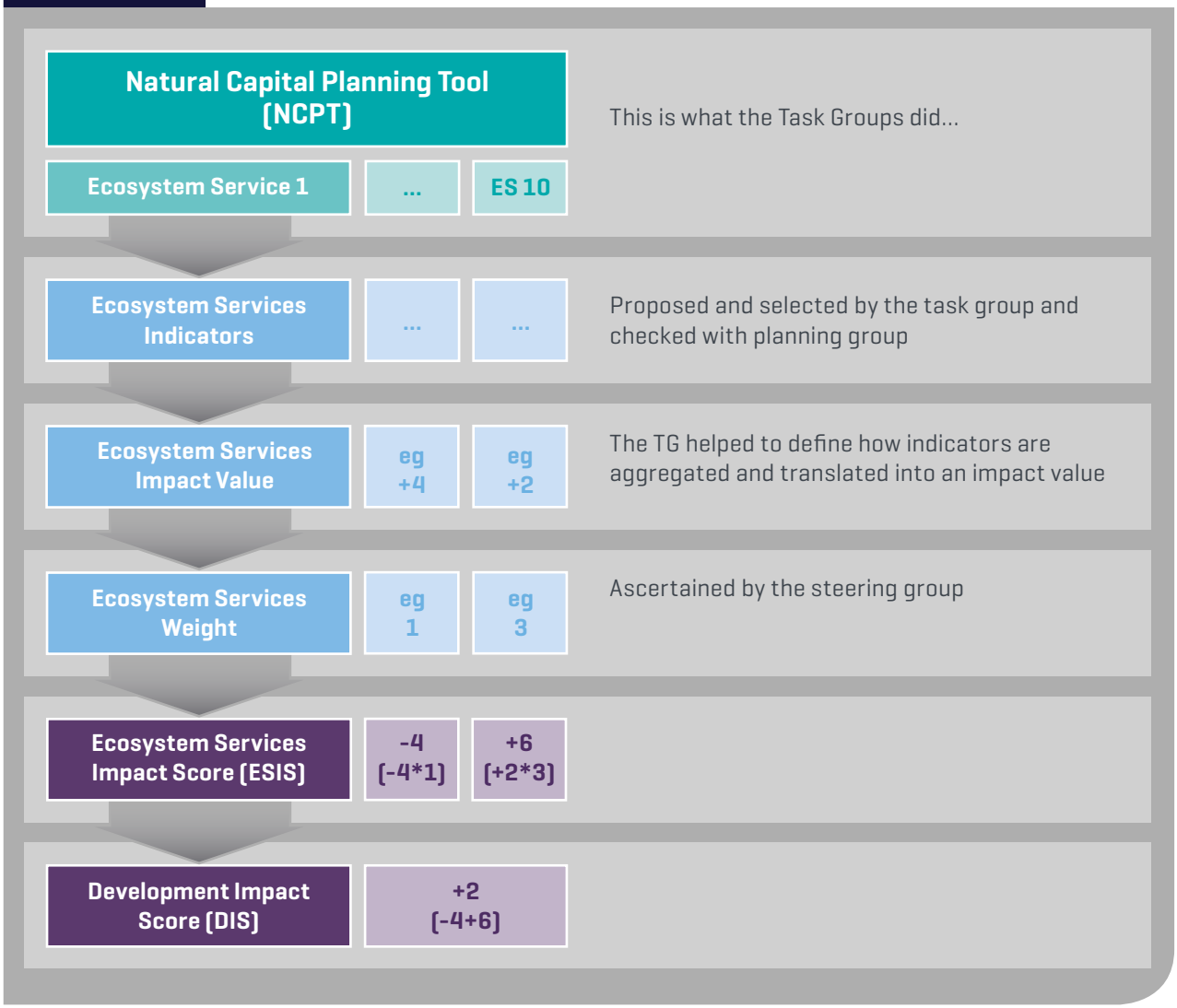
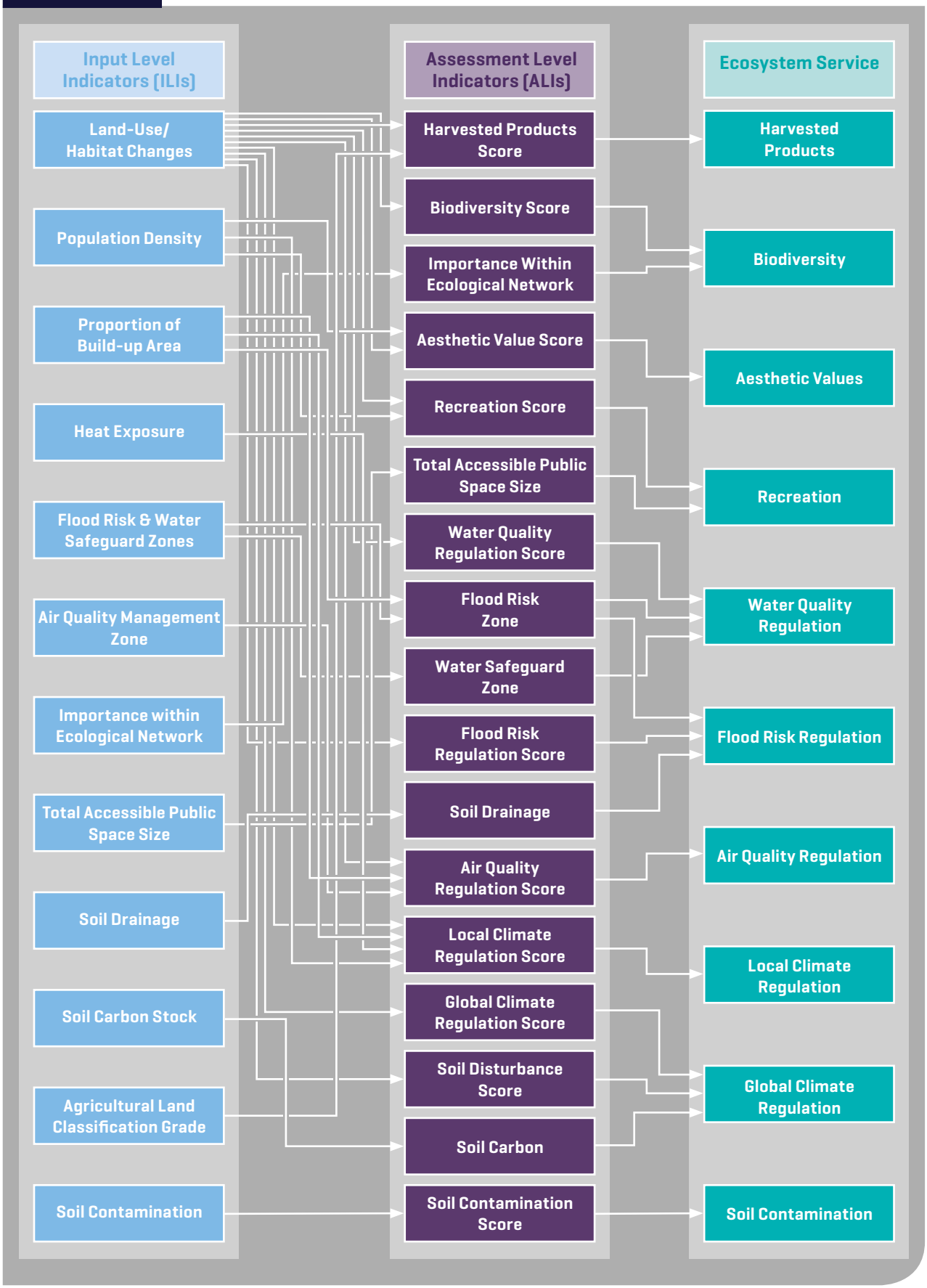


Figure 2.3 Relationship between ILIs, ALIs and Ecosystem Services



Because it was of crucial importance that the NCPT can be applied using existing and readily available datasets (e.g. available as part of the planning process) each potential ILI has been checked with a representative from Birmingham City Council Planning Team and ruled out for the tool if not readily available. Because different information sources are available for different plans and developments, e.g. for some proposals an Environmental Impact Assessment (EIA) is available and for others not, the selected indicators are those that are available for most plans and developments. However, sometimes meaningful indicators have been selected which are only available for larger developments. In that case average proxy values have been applied for smaller developments where this information is absent.

Altogether almost 60 potential indicators were identified which could potentially have informed the NCPT. Some of them were ruled out after consultations with the planning team. For the remaining indicators a short description on why the indicator has been selected, how and where relevant information can be assessed, which assumptions apply, and if the indicator reflects the supply of or demand for ecosystem services was outlined. A brief explanation of how the ILI could be translated into an ALI was also given. This information was provided for the Task Groups in Step two.

Step 2: Indicator selection

The first action of each Task Group was to select a set of feasible indicators which could be used to assess their ecosystem service. For this purpose a list of potential indicators (from Step 1) was shared with each Task Group via email. To limit the complexity of the tool – but also the input requirements and time commitment of the tool users – a limited number of indicators was selected. Each ecosystem service had a maximum of four indicators.

When the initial number of proposed indicators exceeded four, the Task Group was asked to participate in a short voting exercise. Members were asked to apply a score for each pre-selected indicator where a higher score showed that the indicator is more important when assessing the ecosystem service in a planning context. Task Group members were also given the opportunity to propose alternative indicators or to challenge indicators in case they felt that the indicator may be inappropriate or misleading for assessing each ecosystem service.

Because some individuals joined only one Task Group (specialists) and some joined several task groups (generalists) a weighting system was applied to the scoring exercise (and all other scoring exercises) to ensure that some individuals joining many Task Groups would not have a disproportionally strong impact on the Project outcomes. If an individual joined just one Task Group a 100% weight was applied to their scores. If an individual joined two Task Groups a 50% weight was applied for each task group and so on.

Four indicators were seen as the maximum manageable amount for each ecosystem services. This has been agreed at the first Steering Group meeting. If the list of proposed indicators did not exceed the limit of four indicators the voting exercise was bypassed, but Task Group members were still given the opportunity to comment, challenge and propose alternative indicators.

Step 3: Indicator confirmation

In the next step a final set of up to four indicators was shared with the Task Groups. In most of the cases this set of indicators was based on the scoring exercise from Step 2 where only those indicators with the highest voting result were adopted. But sometimes, e.g. when new or alternative indicators have been proposed, when new data became available in the meanwhile, or when discussions resulted in excluding a specific indicator because it was not suitable to inform the assessment or because relevant data is not available, these indicators have been included/excluded without repeating the voting exercise from Step 2.

The pre-selected list of indicators was shared with each Task Group together with a short outline where a method for translating the ILIs into the ALIs was proposed. The Task Group members were asked to review and comment on selected indicators and proposed methods- with the aim to seek agreement across the membership. Members were also asked to flag up additional evidence that could inform the indicators.

Step 4: Scoring exercise

Because the published scientific evidence to assess ecosystem services is imperfect and reveals many gaps the translation from ILIs into ALIs was mainly based on expert judgment. In most cases Task Group members were presented with ILI features (e.g. the NCPT land-use classification framework) and were then asked to establish indicative ALI scores (e.g. the biodiversity values of each land-use type). However they were only asked to establish scores/values where they felt comfortable doing so/where their main expertise lies.

For this exercise an excel spreadsheet was circulated via email explaining the purpose and rules of the scoring exercise. Typically the excel sheet included the NCPT land-use classification list and Task Group members were asked to select scores from a drop-down menu, or to select an average, a minimum and a maximum score for each land-use option.

Figure 2.3 **Screenshot of Biodiversity Scoring Exercise Excel Sheet**

		Indicative biodiversity value scores					
		Existing habitat			New Habitat		
		Average	Min	Max	Average	Min	Max
A	Woodland and scrub	3	3	4	2	2	3
A.1	Woodland	Please Select	Please Select	Please Select	Please Select	Please Select	Please Select
A.1.a	Lowland beech and yew woodland (UK BAP Priority Habitat)	3	3	3	2	2	2
A.1.b	Wet woodland (UK BAP Priority Habitat)	3	3	4	2	1	3
A.1.1	Broadleaved woodland	Please Select	Please Select	Please Select	Please Select	Please Select	Please Select
A.1.1.1	Broadleaved woodland - semi-natural	3	3	3	2	2	2
A.1.1.1.a	Broadleaved ancient semi-natural woodland (ASNW)	3	3	4	2	1	3
A.1.1.1.b	Upland birchwoods (UK BAP Priority Habitat)	3	3	3	2	2	2
A.1.1.1.c	Other broadleaved woodland - semi-natural	2	2	2	2	2	2
A.1.1.2	Broadleaved woodland - plantation	2	2	2	2	2	2
A.1.1.2.a	Broadleaved plantation on ancient woodland site (PAWS)	3	3	3	2	2	2
A.1.1.2.b	Traditional Orchards (UK BAP Priority Habitat)	2	3	4	2	1	3
A.1.1.2.c	Other broadleaved woodland - plantation	2	2	2	2	2	2
A.1.1.a	Upland mixed ashwoods (UK BAP Priority Habitat)	3	3	3	2	2	2
A.1.1.b	Upland oakwood (UK BAP Priority Habitat)	3	3	3	2	2	2

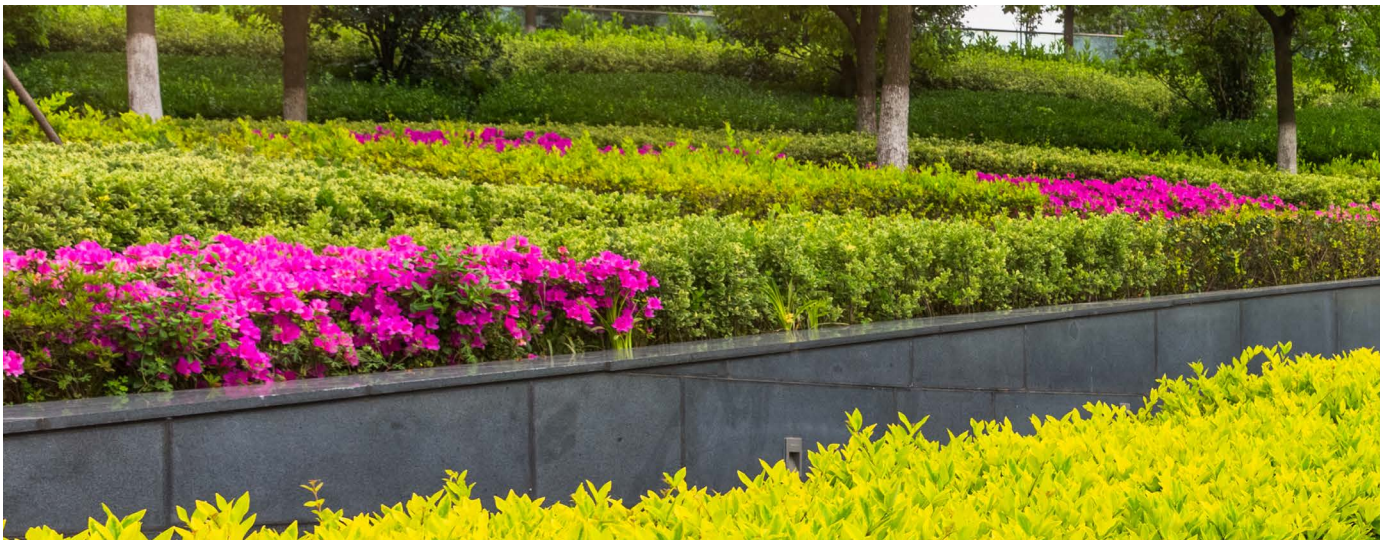
The average score is the proposed score allocated to the ecosystem services value of a specific land-use. The minimum and maximum scores define thresholds within which the tool user can adjust the score to account for circumstances not factored in into the indicator. A specific land-use type, for example, may have an average biodiversity score of 3 – but if that habitat is in particularly good management and of very high quality – then the tool user has the opportunity to adjust the score e.g. to 4.

Figure 2.3 shows a screenshot of a scoring exercise sheet for biodiversity. To factor in the impact of the maturity level of habitats on biodiversity values the exercise has been split into 'existing habitats' and 'new habitats'. The scores for the latter are given for a 25 year timescale after the habitat has been created.

Step 5: Scoring confirmation

After the completed excel sheets were returned the scores of all Task Group members were aggregated applying the individual weights (see Step 2). The aggregated scoring results were shared with the Task Group again to allow a review and to confirm or challenge the outcomes.

Task Group members were able to change scores if they thought a score was way off target and if they could justify the change. If that was the case the proposed changes, including justification, were again shared with the whole group to be confirmed. All Task Group members had a veto-right so if a group member did not agree with a changed score then the original aggregated score was adopted. The result was a final set of scored indicators for each of the 10 assessed ecosystem services which have then been implemented in the NCPT.



2.6 Caveats and Limitations of this Approach

The methodical approach chosen for the development of the NCPT is experimental. This was determined by the nature of this research project – especially reducing the high complexity of ecosystem services research to a manageable but still meaningful level together with the gaps in the scientific evidence.

For each assessed ecosystem service a broad range of potential indicators and assessment methods was available. Within the scope of this Project only a limited set of indicators could have been implemented which reduces the complexity and data requirements of the tool but also the accuracy of the outcomes. For the assessment of global climate regulation services, for example, very sophisticated models are used to calculate the inventory of greenhouse gases of the Land-Use, Land-Use Change and Forestry sector (LULUCF) of the United Nations Framework Convention on Climate Change (UNFCCC). The NCPT applies simplified models which means that outcomes are less accurate and therefore cannot incorporate all aspects of an ecosystem services impact.

Several datasets and indicators were proposed by Task Group members that could improve the accuracy of the tool outcomes. However these indicators could not always be adopted because (1) datasets to inform these indicators were difficult to access or only accessible for specific audiences; (2) datasets would need extensive and time-consuming manipulation or interpretation to be useful to inform the NCPT; and (3) data was only available at specific locations but not at the national level.

Furthermore values are based on expert knowledge and are founded on a science base that still reveals many gaps as not all aspects of natural capital and ecosystem services are sufficiently well understood. It should be noted that some of the values established are based on the opinion of one single expert, and this may bias some outcomes even if all scores have been reviewed and endorsed by the relevant Task Groups.

Also, the main expertise of many Task Group members is for land-use types occurring in the Midlands so when applying the tool in other English regions the findings should be taken with additional care. When the NCPT was tested at case study sites (see Section 4) the established scores were not called into question as they broadly met the expectations. However, because some scores are only based on the opinion of one/few Task Group members some scores may need adjustment in the future.

It should also be noted that not all Task Group members participated in all steps of the indicator selection and scoring exercise. Several members stated that they were not certain about the scores they established and that these should be treated as 'best guesses'. For these reasons tool outcomes should be treated as purely indicative. The NCPT is a supplementary information source available to a range of interested parties and non-experts to help assess the impact of proposed developments and plans on natural capital and ecosystem services and is not designed to replace other elements to be considered for a planning decision such as an Environmental Impact Assessment or a Flood Risk Assessment.

The supplementary nature of the NCPT means in practice that even if the outcome of the assessment is positive, all other planning application requirements for any proposed development would need to be fulfilled. The development team intends to further develop and improve the tool in the future which may cause adjustments to indicators and scores. Some potential improvements identified throughout the development and testing process are outlined in Section 5.2.

3.0 Results

The main outcome of this Project is an excel-based tool allowing to assess the impact of developments on natural capital – NCPT. The tool allows a user to systematically assess the impact of proposed developments and plans on natural capital and ecosystem services over an assessment timescale of 25 years.

The main audiences for the NCPT are planners, developers and related consultants. However, the NCPT has also the potential to become an industry standard and is therefore relevant to national governmental institutions and to RICS. The research also has academic value and will contribute to our knowledge about assessing ecosystems in a planning context.

The operation of the NCPT is set out below using a fictitious development example.[4]

Start

When opening the NCPT the user will see a start page with a narrative outlining some background information and explaining the main purpose and functions of the tool. Instead of providing an external guide, the guidance has been integrated into the tool itself to allow easy access and application by providing relevant information where required. See Section 7.3.1 for a screenshot of the start page.

Step 1: Indicator entry

The user can then navigate to the 'indicators' section to begin the assessment.

First the user will be asked to enter some general information about her/himself and the assessed development. The user will then be asked to enter a range of Input Level Indicators (ILIs). These ILIs often inform several Assessment Level Indicators (ALIs). The user only has to enter each ILI once and the NCPT automatically uses this information to inform the different ALIs which are automatically calculated (see Figure 2.3 for how ILIs and ALIs are linked). Every indicator shown is linked to the ecosystem services informed by the ILI (see Figure 3.1).

Figure 3.2 below shows how land-use changes are entered into the tool. It is always explained in a narrative where to find relevant data and how to access data (see Section 7.3.2). This needs to be repeated for a range of ILIs until all relevant information is entered.

Figure 3.1 Link between Indicator and Ecosystem Services (Population Density)

4. Population Density										
Indicator informs the following ecosystem services:	*Harvested Products*	*Biodiversity*	***Aesthetic Values***	***Recreation***	*Water Quality Regulation*	*Flood Risk Regulation*	*Air Quality Regulation*	***Local Climate Regulation***	*Global Climate Regulation*	*Soil Contamination*

Figure 3.2 Entry Table for Land-use Changes

Area reference	Pre-development land-use/habitat type	Post-development land-use/habitat type	Area	Unit	Average width in m	Area in ha
LUC01	B.6 Poor semi-improved grassland	J.3.6.d Buildings - Other	500.00	m² (area)		0.05
LUC02	B.6 Poor semi-improved grassland	J.3.6.b Buildings - area covered with brown roof	500.00	m² (area)		0.05
LUC03	B.6 Poor semi-improved grassland	J.3.e Gardens	1000.00	m² (area)		0.10
LUC04	B.6 Poor semi-improved grassland	J.3.a Streets	100.00	m (linear)	7.00	0.07
LUC05	J.a Open mosaic habitats on previously developed land	A.1.1.1.c Other broadleaved woodland - semi-natural	1.00	ha (area)		1.00
LUC06	J.a Open mosaic habitats on previously developed land	A.3 Parkland/scattered trees	1.00	ha (area)		1.00
LUC07	J.a Open mosaic habitats on previously developed land	J.1.2 Amenity grassland	2.00	ha (area)		2.00
LUC08	J.a Open mosaic habitats on previously developed land	G.1.d Ponds (UK BAP Priority Habitat)	0.50	ha (area)		0.50
LUC09	Please select	Please select	Enter	ha (area)		0.00
LUC10	Please select	Please select	Enter	ha (area)		0.00
					Total area of land-use changes:	4.77

4 Please note that this example is for demonstrating purposes only in has no relation to any of the case studies.

Figure 3.3 Review and Adjustment of Scores (Overview)

A	B		C	D	E		F	G	H	I	J	K
Area reference	Land-use/habitat type pre- and post development		Area in ha	Biodiversity score of land-use/habitat				Importance within ecological network		Impact Value		Justification for score adjustment (if applicable)
				Average	Min	Max	Applied	Importance	Multiplier	Adjusted	Unadj.	
LUC01	Pre-dev.	B.6 Poor semi-improved grassland	0.05	2	1	3	2	LOW	1.0	-0.0		
	Post-dev.	J.3.6.d Buildings - Other	0.05	1	0	1	1	LOW	1.0			
LUC02	Pre-dev.	B.6 Poor semi-improved grassland	0.05	2	1	3	2	LOW	1.0	0.0		
	Post-dev.	J.3.6.b Buildings - area covered with brown roof	0.05	2	1	2	2	LOW	1.0			
LUC03	Pre-dev.	B.6 Poor semi-improved grassland	0.10	2	1	3	2	LOW	1.0	0.0		
	Post-dev.	J.3.e Gardens	0.10	2	1	2	2	LOW	1.0			
LUC04	Pre-dev.	B.6 Poor semi-improved grassland	0.07	2	1	3	2	LOW	1.0	-0.1		
	Post-dev.	J.3.a Streets	0.07	1	0	1	1	LOW	1.0			
LUC05	Pre-dev.	J.a Open mosaic habitats on previously developed land	1.00	3	2	3	2	MEDIUM	2.0	0.0	-1.7	Habitat is of poor quality/management
	Post-dev.	A.1.1.1.c Other broadleaved woodland - semi-natural	1.00	2	1	2	2	MEDIUM	2.0			
LUC06	Pre-dev.	J.a Open mosaic habitats on previously developed land	1.00	3	2	3	2	MEDIUM	2.0	0.0	-1.7	See above
	Post-dev.	A.3 Parkland/scattered trees	1.00	2	1	2	2	MEDIUM	2.0			
LUC07	Pre-dev.	J.a Open mosaic habitats on previously developed land	2.00	3	2	3	2	MEDIUM	2.0	-5.2	-8.6	See above
	Post-dev.	J.1.2 Amenity grassland	2.00	1	1	1	1	LOW	1.0			
LUC08	Pre-dev.	J.a Open mosaic habitats on previously developed land	0.50	3	2	3	2	MEDIUM	2.0	+0.9	0.0	See avove
	Post-dev.	G.1.d Ponds (UK BAP Priority Habitat)	0.50	3	2	3	3	MEDIUM	2.0			
									Total Biodiversity Impact Value: *Sum of all Impact Values above*	-4.4	-12.2	
									Per-hectare Biodiversity Impact Value: *'Total Biodiversity Impact Value' divided by the total area where land-use changes are proposed*	-0.9	-2.6	
									Ecosystem Services Weight: *Relative weight of this ecosystem service compared to other ecosystem services*	1		
									Ecosystem Services Impact Score: *'Per-hectare Biodiversity Impact Value' multiplied by the 'Ecosystem Services Weight'*	-0.9	-2.6	

Figure 3.4 Review and Adjustment of Scores

D	E			F	G	H	I	J	K
Biodiversity score of land-use/habitat					Importance within ecological network		Impact Value		Justification for score adjustment (if applicable)
Average	Min	Max		Applied	Importance	Multiplier	Adjusted	Unadj.	
2	1	3		2	LOW	1.0	-0.0		
1	0	1		1	LOW	1.0			
2	1	3		2	LOW	1.0	0.0		
2	1	2		2	LOW	1.0			
2	1	3		2	LOW	1.0	0.0		
2	1	2		2	LOW	1.0			
2	1	3		2	LOW	1.0	-0.1		
1	0	1		1	LOW	1.0			
3	2	3		2	MEDIUM	2.0	0.0	-1.7	Habitat is of poor quality/management
2	1	2		2	MEDIUM	2.0			
3	2	3		2	MEDIUM	2.0	0.0	-1.7	See above
2	1	2		2	MEDIUM	2.0			
3	2	3		2	MEDIUM	2.0	-5.2	-8.6	See above
1	1	1		1	LOW	1.0			
3	2	3		2	MEDIUM	2.0	+0.9	0.0	See avove
3	2	3		3	MEDIUM	2.0			
							Total Biodiversity Impact Value: *Sum of all Impact Values above*	-4.4	-12.2	
							Per-hectare Biodiversity Impact Value: *ded by the total area where land-use changes are proposed*	-0.9	-2.6	
							Ecosystem Services Weight: *his ecosystem service compared to other ecosystem services*	1		

Step 2: Score review and adjustment

In Step 2 the user has the opportunity to review and if necessary adjust scores for each assessed ecosystem service. Figure 3.3 shows an overview of how biodiversity scores are presented and how they can be adjusted. Figure 3.4 shows the same example but focussing on the scores only. Each section of the NCPT contains a short narrative explaining what the different elements of the table mean and how scores are calculated (see also Section 7.3.3).

Columns A to C (shown in red) help to identify the assessed land-use change. Column D shows the average biodiversity score for each land-use. These scores have been established by the Task Group members for each land-use/habitat type and are automatically linked by the NCPT.

By default the applied score (column F) equals the average score (column D). However, the user has the opportunity to adjust scores acknowledging that not all possible circumstances could have been incorporated into the NCPT. In the development of NCPT the Task Group members also defined the threshold values within which the adjusted scores should fall (column E). To allow a quick and transparent review of all score adjustments the NCPT always highlights adjusted scores. If they fall within the defined thresholds the score is highlighted in yellow (as can be seen in column F). If the applied score falls outside the threshold values it would be highlighted in red. If adjustments are made during the assessment the user will also be asked to enter a reason/justification for the adjustment (column K).

The NCPT automatically calculates an impact value for each land use change and an aggregated value for all land-use changes together (column I). For biodiversity the impact value is based on the difference between the land-use biodiversity score pre- and post-development (column F) and a multiplier which depends on the importance within the ecological network of habitats (column H). If scores have been adjusted by the tool user then the NCPT will also show the impact value applying the average score in column J to allow a transparent review of the impact of score adjustments. The final 'Ecosystem Services Impact Score' (ESIS) is based on the aggregated average per-ha impact value. A similar approach is taken to calculate an ESIS for all 10 assessed ecosystem services.

Step 3: Results

The main tool outcome is an Ecosystem Service Impact Score (ESIS) indicating the direction and the magnitude of the impact. The tool also calculates a Development Impact Score (DIS) where all ESIS are aggregated to a single score from -10 (indicating a negative impact on ecosystem services) to +10 (indicating a positive impact on ecosystem services). Figure 3.5 shows how these scores are presented in the NCPT. Again, the unadjusted scores are also shown to allow a transparent review.

Figure 3.5 shows the average scores per hectare. The NCPT also contains a table showing the impact for the whole assessed area of land-use changes as a total. This information can be used to aggregate impacts across development sites – for example to monitor development impacts on ecosystem services at a city scale. The results section of the NCPT also contains a narrative outlining how findings should be interpreted. Furthermore it allows the tool user and the relevant planning authority to make comments so allowing for further discussion- centering on the outcomes from the Tool. (see also Section 7.3.4).

Step 4: Design strategies

The main purpose of the NCPT is not just to monitor impacts but also to guide a developer to improve the overall performance of a development. For this purpose the NCPT also contains a section 'design strategies'. This section provides information and recommendations of key policy documents including the National Planning Policy Framework (DCLG 2012) and offers links to guidance documents that can help to improve the design of the development with respect to ecosystem services. The whole 'design strategies' section can be reviewed in Section 7.3.5. The tool also contains a section 'Methods and Caveats' that summarises its limitations as outlined in Section 2.6 of this report.

Figure 3.5 **Presentation of NCPT Results**

Development Impact Score
Average Per-Hectare

Ecosystem Service	Adjusted Scores	Unadj. Scores
1. Harvested Products	+1.6	-2.2
2. Biodiversity	-0.9	-2.6
3. Aesthetic Values	+2.4	+2.4
4. Recreation	+3.9	+3.9
5. Water Quality Regulation	-1.1	-1.1
6. Flood Risk Regulation	+1.2	+1.2
7. Air Quality Regulation	-1.4	-1.4
8. Local Climate Regulation	+1.8	+1.8
9. Global Climate Regulation	-0.2	-0.2
10. Soil Contamination	+0.0	+0.0
Development Impact Score	+0.7	+0.2

4.0 Case Studies

To test the NCPT under 'real-world' circumstances three case studies were conducted as part of this research Project.

The NCPT was tested by Steering Group partners on:

- A major urban housing development in Birmingham,
- A Flood Alleviation Scheme in Rugeley, Staffordshire,
- The re-development of a manufacturing facility in Doncaster in northern England.

Additional initial trials and reviews have been undertaken by external partners (see Section 4.4). The main purpose was to gather feedback about the applicability and (strategic) potential of the NCPT. This information helped to further improve and update the fin al version of the tool.

The case studies are summarised below.

4.1 Birmingham's Langley Sustainable Urban Extension (Birmingham City Council)

4.1.1 Case Study Overview

Birmingham expects a strong population growth requiring 89,000 new households within the next two decades which necessitates the development of additional housing and associated infrastructure. Whilst development on brownfield sites is prioritised, the Council is also proposing to develop on part of former Birmingham's Green Belt. This is one of the most significant developments planned for the City in a generation, aiming to achieve approximately 6,000 new dwellings.

A masterplan will be prepared for the 'Sustainable Urban Extension' (SUE), which is located west of the A38 at Langley in the north-east of Birmingham (see Figure 4.1). The site is dominated by land in agricultural use but also contains smaller patches of e.g. semi-natural broadleaved woodland. According to the Birmingham Development Plan, the Langley SUE aims to achieve the highest standards of design and sustainability and a network of green spaces including a green corridor to New Hall Valley Country Park (Birmingham City Council 2013).

4.1.2 NCPT Application and Outcomes

Birmingham City Council is 'testing' the Natural Capital Planning Tool (NCPT) on its proposed Sustainable Urban Extension. As this development is replacing agricultural land in the main – the Council has a very ambitious target to achieve a net positive outcome for natural capital.

An initial test on part of a draft concept option has been undertaken. Users reported that it was very encouraging how relatively easy it was to apply the NCPT – with no 'expert' knowledge required – as that has now been built into the tool itself.

The Council is happy with the usability of the tool and the outcome as it will help to give more clarity about the overall impact of the development. It is also believed that the NCPT can be used to influence the masterplanning process to achieve a truly sustainable development.

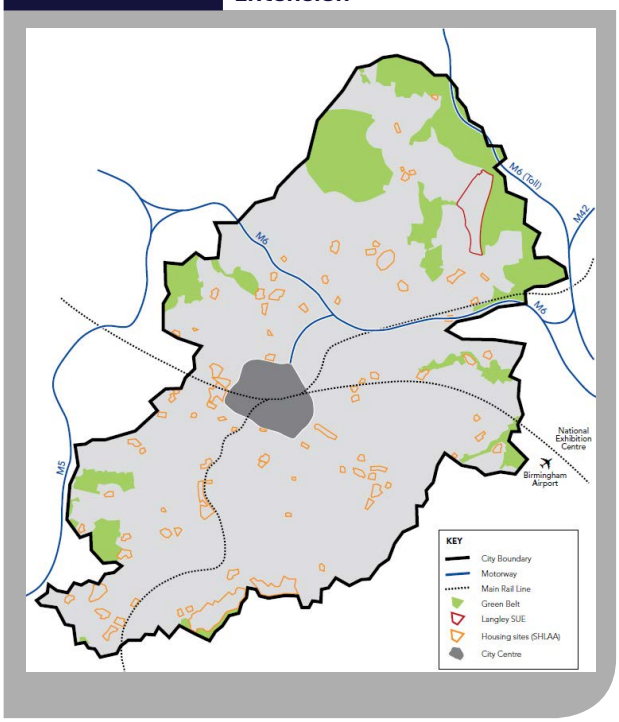
4.1.3 Feedback

Nick Grayson (Climate Change and Sustainability Manager, Birmingham City Council):

"What this case study application shows is that the NCPT does have real merit – in the 'real world'. To be able to use the science behind ecosystem services and natural capital as a totally new assessment methodology for developments provides a very clear steer as to just how hard any new green and blue infrastructure has to work, to deliver a positive result. This goes beyond the no net loss of biodiversity, which is where current understanding sits. It also shows that it is possible to re-design the development layout and adjust the final quality of the green and blue infrastructure to achieve that end. This will not only deliver immediate environmental benefits, but lock-in long-term economic, social, and health and wellbeing benefits.

This early trial has provided sufficient confidence to progress this process on to the preferred masterplan and to work closely with both the masterplanning consultants and developers, on achieving desired outcomes without affecting the development viability."

Figure 4.1 **Langley Sustainable Urban Extension**



4.2 Rugeley Flood Alleviation Scheme (Environment Agency)

4.2.1 Case Study Overview

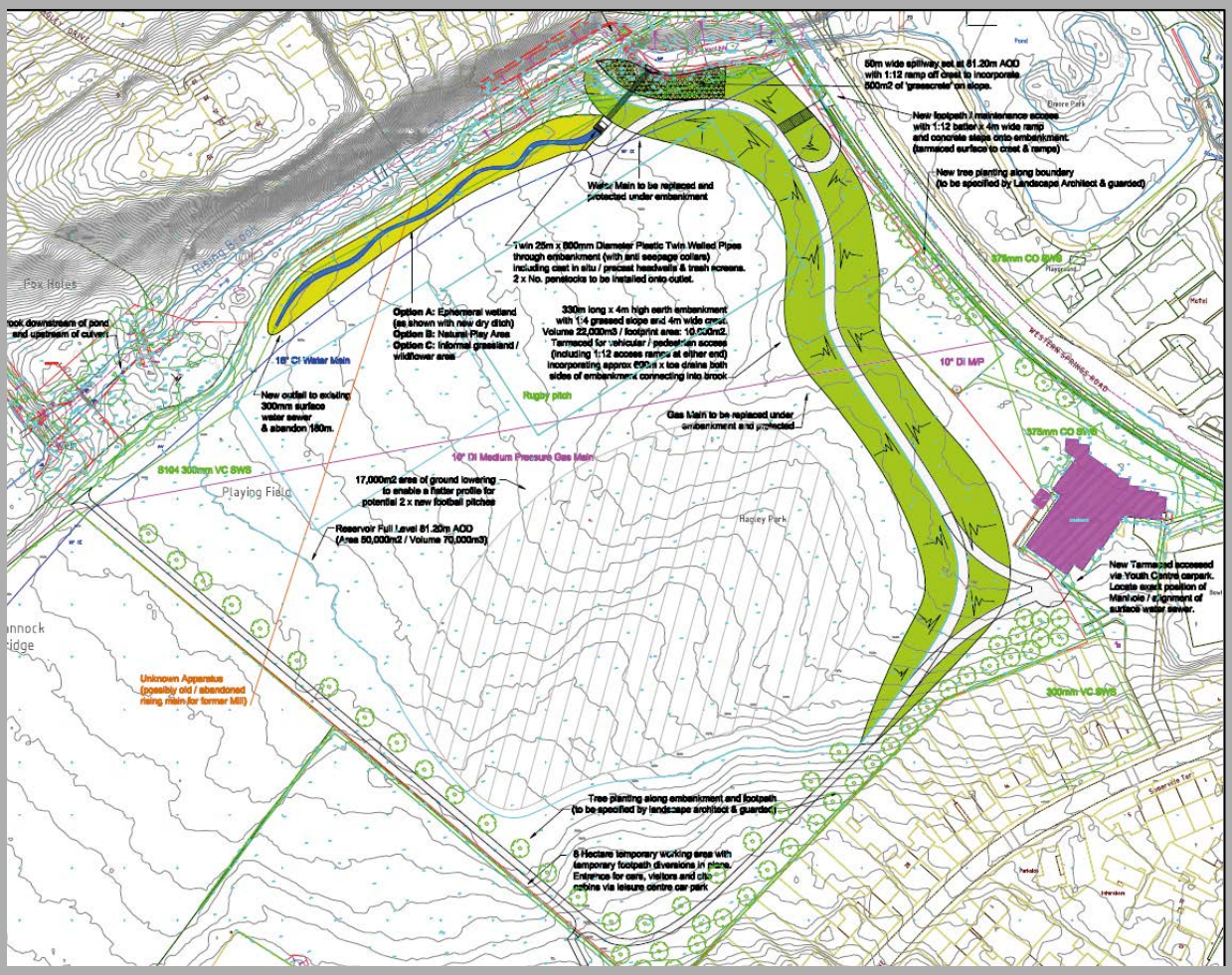
The Environment Agency has provided significant support for the NCPT development. Amongst other contributions the Environment Agency tested the NCPT for two outline designs of a planned Flood Alleviation Scheme (FAS) in Rugeley, Staffordshire.

The purpose of the Rugeley FAS is to create a water storage area to hold back flood water and significantly reduce the risk of flooding to Rugeley. The Rising Brook becomes culverted to the east of Rugeley town centre before entering the River Trent. Although the Brook did not frequently flood the town centre in the past – a modelling study carried out by the Environment Agency in 2014 showed that a large part of the town centre is located in a 1 in 100 year flood plain.

The risk of flooding to the town centre will be significantly reduced by creating a storage area on playing fields adjoining the Rising Brook before it enters the culvert. The project is planned to start in spring/summer of 2016 and will take about 5 months to complete. Part of the playing field will be lowered and material used to construct an embankment. The Environment Agency is currently looking at the viability of the scheme and two draft flood storage outline designs have been assessed using the NCPT to provide additional information about the wider impact on ecosystem services and to test the NCPT.

The tool assessor from the Environment Agency, Tim Pickering, familiarised himself by applying the NCPT to a different very simple flood scheme before without assistance. The tool has then been used to assess the two design options. Design option 2 is outlined in Figure 4.2. The tool assessor has been assisted by the developer of the NCPT.

Figure 4.2 **Rugeley FAS Design Option 2**



Source: © Crown copyright and database rights 2015. Ordnance Survey 100024198

The main challenge in preparation for the tool application was to obtain accurate land use area values as this was not available in a ready-to-use format. This took about half a day using Geographic Information System (GIS) software for both design options together. Applying the tool itself was reported to be quite self-explanatory with the guidance provided in the NCPT and the assessment took about half a day for both options.

As the NCPT did not account for topography changes some scores for the flood risk regulating service were adjusted in the 'scores' sheet to better account for the created additional flood storage capacity of the schemes. Currently the NCPT does not access changes to topography as such detailed information is not usually available as part of the planning process. Other values and scores were within expectations.

It was also reported that the adjustment of the scores may be challenging with only a rudimentary understanding of the ecosystem services concept. The outcomes of the assessment can be reviewed in Figure 4.3. As the purpose of this case study application was to test the tool applicability rather than the assessment itself no explanation of the outcomes is given.

4.2.3 Feedback

Tim Pickering (Environment Planning Specialist, Environment Agency):

"The Environment Agency states in its corporate plan that it will take an integrated approach to work in catchments and implement a programme to embed the ecosystem approach and ecosystem services assessments in our work and hence it has an interest in tools like the NCPT. A large proportion of our major construction schemes tend to be for flood risk management which do not automatically result in land use change (i.e. same land use but more capacity to store water). Where this is the case the NCPT may not register much difference. We would need to weigh up the benefit of this result against the effort of applying the tool in the first place. Notwithstanding the NCPT does necessitate consideration of ecosystem services and most importantly puts them in context with the locality, which is most illuminating. From an Environment Agency perspective there is certainly a value in using the NCPT in cases where significant land-use changes occur (e.g. for larger-scale flood/biodiversity projects). I would hope to be able to incorporate the NCPT into EA ecosystem services training events."

Figure 4.3 NCPT Outcomes for Rugeley FAS Design Option 2

Development Impact Score
Average Per-Hectare

Ecosystem Service	Adjusted Scores	Unadj. Scores
1. Harvested Products	+1.2	+1.2
2. Biodiversity	+0.1	+0.1
3. Aesthetic Values	+0.2	+0.2
4. Recreation	+0.0	+0.0
5. Water Quality Regulation	-0.0	-0.1
6. Flood Risk Regulation	+4.2	+0.7
7. Air Quality Regulation	+0.9	+0.9
8. Local Climate Regulation	+0.5	+0.5
9. Global Climate Regulation	-0.4	-0.4
10. Soil Contamination	+0.0	+0.0
Development Impact Score	+0.7	+0.3

4.3 Bentley Works Development (Skanska)

4.3.1 Case Study Overview

Bentley Works is Skanska UK's engineering and manufacturing facility situated 3 km north of Doncaster, South Yorkshire. The 7.5 hectare site has been used by the company for over a century and was in need of redevelopment and modernisation. Skanska redeveloped Bentley Works into a state-of-the-art facility to provide high quality engineering, manufacturing and pre-fabrication services for various Skanska operating units working throughout the construction industry.

Skanska was the developer and main contractor for the US$18 million Bentley Works redevelopment and modernisation scheme. The project involved the demolition of the existing office and workshop buildings, and construction of a modern 1,800 m^2 two-story office building and a 3,135 m^2 fabrication and machine workshop. An existing workshop building was refurbished, along with an existing 112 m^2 paint shop building. The project was completed in March 2015.

Whilst the main purpose of the re-development was to improve the environmental performance of the site applying engineering measures such as achieving net zero primary energy, avoiding hazardous materials and minimising water usage, the re-development also included green infrastructure improvements.

Post development the site now includes more landscaping including a variety of locally relevant species, green roofing, a grass swale and a green wall, all with the purpose to promote biodiversity, reduce the local risk of flooding by creating Sustainable Drainage Systems (SUDS), and to provide a pleasant and green environment for its employees.

4.3.2 NCPT Application and Outcomes

Skanska tested the NCPT at Bentley on completion of the site works. The development is an office and industrial facility and it was encouraging that the tool showed that a positive benefit was achieved by adding a relatively small area of green infrastructure on to the site.

Non-experts in natural capital used the NCPT and found it straightforward, quick and easy to use and it also gave them a better appreciation of how the creation of natural capital can impact on a development.

Skanska and the Project Team are now looking to use the NCPT to assess the impact on some linear projects that are currently being undertaken at the site, at both the design and completion stage.

4.3.3 Feedback

Nigel Sagar (Senior Sustainability Manager, Skanska):

"We understand the importance of implementing Green Infrastructure on our sites to deliver positive long term benefits. The NCPT provides a method of being able to assess quickly the potential outcomes of these enhancements, as well as highlighting where we may be currently lacking the data required in order to make such assessments. It has potential for application at the design phase to enable designers to predict the outcome of different features.

The NCPT assessment we have undertaken at Bentley will also link into the post occupancy evaluation work that we are undertaking there as part of our involvement in the World Green Building Council project on Health, Wellbeing and Productivity in Buildings."

4.4 Feedback from Other Project Partners

An initial review of the NCPT has been undertaken by Tim Sunderland, Principal Specialist in Economics at Natural England. He says:

"Land-use change is an important driver in changing ecosystem services, but the value of this change is not normally included in appraisal. This leads to the undervaluation and loss of ecosystem services. Including them in appraisals is very challenging due to gaps and uncertainties in the evidence base, and the amount of locally specific information that needs collecting. The Natural Capital Planning Tool provides a welcome 'first pass' or interim assessment of the value of ecosystem service change, which may support decision-making or flag the need for further research. In future iterations it would benefit from greater transparency about the data driving the model and greater guidance as to how to interpret the results."

Another initial practical test of the NCPT has been undertaken by Naomi Perry, Planning Policy Officer at East Staffordshire Borough Council. She says:

"Overall the NCPT is well developed with clear instructions. It did take a while to capture some of the required information. That is not necessarily a problem in the longer term but might put people off in the first instance. The tool requires a lot of information about the development in terms of area of land-use changes which is usually not available to planning authorities in a 'ready-to-use' format. At the moment many authorities do not have the capacity to manipulate land-use data as part of their daily work. However, if the tool became embedded within authorities this information requirement could be captured early in the application process which would ease the application of the NCPT."

Sarah Bentley, Environmental Advice Manager at Staffordshire County Council says:

"In 2013 Staffordshire County Council, through the Staffordshire & Stoke Local Nature Partnership and supported by Natural England, Forestry Commission and Staffordshire Wildlife Trust, commissioned an Ecosystems Assessment to better understand the value of the natural environment. This identified a capitalised value of over £7 billion for the ecosystem services where a valuation methodology exists – the real value will be much higher. This emphasises the considerable contribution the natural environment makes – something often overlooked in decision making. As a county council we are keen to further develop our understanding of natural capital and how we can use the ecosystems approach to inform our work. Ecosystems Assessments can be a difficult and complex task, particularly for non-specialists. To fully integrate the Ecosystems Approach we need tools to help apply it to real situations in a straightforward way. The Natural Capital Planning Tool offers a mechanism to assess the impact of potential development schemes on natural capital and to help identify ways to mitigate that impact. We have therefore been keen to support its development and are keen to explore how we can use it."

5.0 Conclusions & Recommendations

5.1 Conclusions

The research project has shown that through careful use of expert and stakeholder knowledge, a 'fit-for-purpose' tool can be developed which can systematically assess the impact of plans and developments on natural capital and ecosystem services. There was overall agreement across involved stakeholders that the Natural Capital Planning Tool (NCPT) can provide a very valuable additional information source to assess, monitor and manage the impact of proposed plans and developments on both natural capital and ecosystem services in a holistic way; acknowledging that these outcomes are indicative rather than proven outcomes.

The NCPT is seen by almost all partners involved as a stepping stone towards the integrated management of natural capital and ecosystem services in a planning context – something that has not been mainstreamed to date.

All Steering Group members have endorsed the NCPT and agreed to retain the Steering Group to explore future opportunities for tool promotion, development and implementation.

Our initial work with the Municipality of Frankfurt and investigations with other European networks and the Biophilic Cities partners has indicated that this form of impact assessment is of interest but remains at a relatively early stage. The research for the development of the NCPT undertaken in this Project has therefore been innovative.

Many interested parties have been identified, including local authorities, members of the global Biophilic Cities Network and Utrecht City Council (Netherlands): the latter has shown a great deal of interest in testing the tool further and to explore opportunities for its implementation in the future.

The case study trials have revealed that assessments using the NCPT offer a valuable additional perspective beyond the 'tick-box thinking' prevalent in current planning decision-making practice. To mainstream the NCPT it would be necessary, however, to amend data requirements for developers and corresponding consultancies so that relevant data is available in a 'ready-to-use' format.

Another requirement would be to establish a basic knowledge about the ecosystem services concept and natural capital within planning authorities, developers and relevant consultancies; not just at the management level and within specialised divisions but also at the officer level.

To implement the NCPT at a broader scale it would also be necessary to offer some assistance and to periodically update the NCPT e.g. to repair broken links or to incorporate new data sources as they become available. It would also help to develop special versions of the tool to best match the demands of local authorities and agencies (e.g. in terms of data availability and requirements) to apply the NCPT most effectively and efficiently.

The Project Team would like to encourage more local authorities and developers to test the tool in practice and to adopt the NCPT for assessing developments and plans and to help inform their planning decisions.

The development of the NCPT should not be seen as a one-off project. The tool offers a wide range of opportunities for future development and for its application and implementation for related purposes.

5.2 Recommendations

Refinement and improvement of indicators and values

Within scope of this Project we had to limit the complexity of the tool to a single workable version. In the future the Project Steering Group hopes to be able to:

- Further develop and refine the tool so that for example scores and values are based on a broader sample size of experts.
- Link the tool indicators better to existing assessments such as an Environmental Impact Assessment or a Flood Risk Assessment so that the outcomes of these information sources, if available, can directly inform the tool indicators. The preparation of such assessments may need to meet some additional requirements to meaningfully inform future NCPT versions.

Local and International NCPT versions

The current version of the NCPT has been developed specifically for England. This is mainly because information sources are very diverse across countries in terms of availability, accessibility, format and applied methodologies. The general functionality of the NCPT, however, is transferable which means that NCPT versions could be developed for any country or area. This would require the re-design of the NCPT to only include indicators which are available for that specific area. Some scores may also need to be adjusted to account for such differences as in the biodiversity values because different species and habitats are under threat.

There is also a potential to develop local or regional NCPT versions to make use of additional information sources which are not available at the national level. In Birmingham, for example, substantial research on the Urban Heat Island Effect (UHIE) has been undertaken (see e.g. Tomlinson 2009). A result of this research is a map indicating the Urban Heat Island Magnitude across the city which would generally be suitable to inform the ecosystem service local climate regulation of the NCPT. But because this advanced information is only available for Birmingham but not for other areas in England this indicator could not be included in the current NCPT version as it sought to be applicable everywhere in England.

A Birmingham-specific NCPT version would be needed to incorporate such advanced information sources. Local tool versions could also account for Local Biodiversity Action Plans (LBAP) to inform biodiversity indicators.

In addition, the ease of use of the NCPT could be improved by for example only including land-use types occurring in that local area rather than referring to a much longer national land-use classification framework.

Ecosystem Services Monitoring System (ESMS)

The NCPT outcomes are calculated in a consistent format which allows aggregation e.g. at the local authority level. At the moment changes to ecosystem services values over time are not systematically monitored and assessed in the UK (UK NEA 2011) and presumably worldwide. An Ecosystem Services Monitoring System (ESMS) could be developed to collect and aggregate the outcomes of NCPT assessments to monitor and assess changes to ecosystem services e.g. at a city scale. This information could be very valuable to inform for example natural capital accounting systems or more generally environmental decision-making at the local and national level as it would show the direction and magnitude of natural and ecosystem services changes including cumulative impacts.

Ecosystem Services Offsetting (ESO)

The NCPT could also serve as basis for Ecosystem Services Offsetting (ESO) schemes. Biodiversity offsetting schemes are commonly based on a scoring system. The scores are used to calculate how much biodiversity value is lost due to land-use change on one site and therefore needs to be offset at a different site. One criticism of biodiversity offsetting is that it does not account for the full range of ecosystem services and therefore the impact on human wellbeing.

Even if the biodiversity value of a lost habitat is offset elsewhere to the same value that does not mean that other services such as greenspace recreational opportunities or flood risk regulation services are also offset to a similar extent. In a biodiversity offsetting scheme such values are not considered and a successful biodiversity offsetting project may still result in a significant loss of other ecosystem services. This may for example happen when an area of accessible urban greenspace in areas with limited greenspace, is lost or reduced and is then offset in a rural area outside of the urban centre.

The NCPT applies a scoring and valuation system which is quite similar to existing biodiversity offsetting schemes. However, an Ecosystem Services Offsetting (ESO) scheme based on the NCPT would not just allow for the offsetting of biodiversity values but also other ecosystem services values which could be seen as a significant advantage compared to existing biodiversity offsetting schemes. Linkages have already been made with an equivalent assessment scheme developed by Warwickshire County Council. The Project Steering Group is keen to explore these and other opportunities in the future provided that additional funding becomes available.

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7.0 Appendices

7.1 Appendix A: List of Steering & Task Group Members

All task- and steering group members are listed in alphabetic order.

Steering Group Members

Chris Baggott, Birmingham City Council

Sarah Bentley, Staffordshire County Council

Amanda Craig, Natural England

Jane Findlay, Fira

Nick Grayson, Birmingham City Council

Thomas Hartmanshenn, Frankfurt City Council

Oliver Holzinger, CEEP

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Jeremy Parker, Fira

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Jon Sadler, University of Birmingham

Nigel Sagar, Skanska

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Tim Sunderland, Natural England

Ruth Waters, Natural England

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Richard Bassett, University of Birmingham

Steve Bloomfield, Worcestershire Wildlife Trust

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Susan Lee, University of Birmingham

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Rachel Melvin, Staffordshire County Council

Justin Milward, Woodland Trust

Simon Needle, Birmingham City Council

Chris Parry, Birmingham & Black Country Local Nature Partnership

Tippala Gamage Perera, University of Birmingham

Tim Pickering, Environment Agency

John Porter, Birmingham City Council

Gary Rogerson, Skanska

Gina Rowe, Warwickshire Wildlife Trust

Jon Sadler, University of Birmingham

Nigel Sagar, Skanska

Lee Southall, Birmingham City Council

Xiaonan Tang, University of Birmingham

Sam Todd, Environment Agency

Vicky West, Forestry Commission

Martyn Wilson, Worcestershire County Council

Harriet Wood, Small Woods

Lucy Wood, Worcestershire Wildlife Trust

Julian Wright, Environment Agency

7.2 Appendix B: NCPT Land-Use Classification Framework

Table 7.2 NCPT Land-use Classification Framework (Extract)

A	Woodland and scrub
A.1	Woodland
A.1.a	Lowland beech and yew woodland (UK BAP Priority Habitat)
A.1.b	Wet woodland (UK BAP Priority Habitat)
A.1.1	Broadleaved woodland
A.1.1.1	Broadleaved woodland – semi-natural
A.1.1.1.a	Broadleaved ancient semi-natural woodland (ASNW)
A.1.1.1.b	Upland birchwoods (UK BAP Priority Habitat)
A.1.1.1.c	Other broadleaved woodland – semi-natural
A.1.1.2	Broadleaved woodland – plantation
A.1.1.2.a	Broadleaved plantation on ancient woodland site (PAWS)
A.1.1.2.b	Traditional Orchards (UK BAP Priority Habitat)
A.1.1.2.c	Other broadleaved woodland – plantation
A.1.1.a	Upland mixed ashwoods (UK BAP Priority Habitat)
A.1.1.b	Upland oakwood (UK BAP Priority Habitat)
A.1.2	Coniferous woodland
A.1.2.1	Coniferous woodland – semi-natural
A.1.2.1.a	Coniferous ancient semi-natural woodland (ASNW)
A.1.2.1.b	Other coniferous woodland – semi-natural
A.1.2.2	Coniferous woodland – plantation
A.1.2.2.a	Coniferous plantation on ancient woodland site (PAWS)
A.1.2.2.b	Other coniferous woodland – plantation
A.1.3	Mixed woodland
A.1.3.a	Lowland mixed deciduous woodland (UK BAP Priority Habitat)
A.1.3.1	Mixed woodland – semi-natural
A.1.3.1.a	Mixed ancient semi-natural woodland (ASNW)
A.1.3.1.b	Native pine woodlands (UK BAP Priority Habitat)
A.1.3.1.c	Other mixed woodland – semi-natural
A.1.3.2	Mixed woodland – plantation
A.1.3.2.a	Mixed plantation on ancient woodland site (PAWS)
A.1.3.2.b	Other mixed woodland – plantation
A.2	Scrub
A.3	Parkland/scattered trees
A.3.a	Wood-pastures and parkland (UK BAP Priority Habitat)

continued

continued

A.3.1	Broadleaved Parkland/scattered trees
A.3.2	Coniferous Parkland/scattered trees
A.3.3	Mixed Parkland/scattered trees
A.4	Recently felled woodland
B	**Grassland and marsh**
B.1	Acid grassland
B.1.a	Lowland dry acid grassland (UK BAP Priority Habitat)
B.1.b	Other acid grassland
B.2	Neutral grassland
B.2.a	Lowland meadow (UK BAP Priority Habitat)
B.2.b	Upland hay meadow (UK BAP Priority Habitat)
B.2.c	Other neutral grassland
B.3	Calcareous grassland
B.3.a	Lowland calcareous grassland (UK BAP Priority Habitat)
B.3.b	Upland calcareous grassland (UK BAP Priority Habitat)
B.4	Improved grassland
B.5	Marsh/marshy grassland
B.5.a	Coastal and floodplain grazing marsh (UK BAP Priority Habitat)
B.5.b	Other marsh/marshy grassland
B.6	Poor semi-improved grassland
B.a	Purple moor grass and rush pastures (UK BAP Priority Habitat)
C	**Tall herb and fen**
C.1	Bracken
C.2	Upland species-rich ledges
C.3	Other tall herb and fern (ruderal and non-ruderal)
D	**Heathland**
D.a	Lowland heathland (UK BAP Priority Habitat)
D.b	Upland heathland (UK BAP Priority Habitat)
D.c	Other heathland
D.d	Mountain heaths and willow scrub (UK BAP Priority Habitat)
D.e	Lowland heathland/dry acid grassland mix (assumption: 50% each) (UK BAP PH)
D.f	Other Heathland/acid grassland mix (assumption: 50% each)
E	**Mire**
E.1	Bog
E.1.a	Blanket bog (UK BAP Priority Habitat)
E.1.b	Lowland raised bog (UK BAP Priority Habitat)
E.1.c	Other bog

continued

continued

E.2	Flush and spring
E.3	Fen
E.3.a	Lowland fens (UK BAP Priority Habitat)
E.3.b	Other fens
E.a	Upland flushes, fens and swamps (UK BAP Priority Habitat)
E.4	Peat – bare
F	**Swamp, marginal and inundation**
F.1	Swamp
F.1.a	Reedbeds (UK BAP Priority Habitat)
F.1.b	Other Swamp
F.2	Marginal and inundation
G	**Open water**
G.1	Standing water
G.1.1	Standing water – eutrophic (UK BAP Priority Habitat)
G.1.a	Canals (tool will allow free width entry)
G.1.b	Reservoirs
G.1.c	Lakes
G.1.c.a	Mesotrophic lakes (UK BAP Priority Habitat)
G.1.c.b	Oligotrophic and dystrophic lakes (UK BAP Priority Habitat)
G.1.c.c	Other lakes
G.1.d	Ponds (UK BAP Priority Habitat) (tool will allow free width entry)
G.1.e	Aquifer fed naturally fluctuating water bodies (UK BAP Priority Habitat)
G.2	Running water (tool will allow free width entry)
G.2.a	Rivers (UK BAP Priority Habitat) (tool will allow free width entry)
G.2.b	Streams (tool will allow free width entry)
H	**Coastland**
H.1	Intertidal
H.1.1	Intertidal – mud/sand
H.1.1.a	Intertidal mudflats (UK BAP Priority Habitat)
H.1.1.b	Other intertidal – mud/sand
H.1.2	Intertidal – shingles/cobbles
H.1.3	Intertidal – boulders/rocks
H.2	Saltmarsh
H.2.a	Coastal saltmarsh (UK BAP Priority Habitat)
H.2.b	Other saltmarsh
H.3	Shingle above high tide mark
H.3.a	Coastal vegetated shingle (UK BAP Priority Habitat)

continued

continued

H.3.b	Other shingle above high tide mark
H.4	Boulders/rocks above high tide mark
H.5	Strandline vegetation
H.6	Sand dune
H.6.a	Coastal sand dunes (UK BAP Priority Habitat)
H.6.b	Other sand dune
H.8	Maritime cliff and slope (UK BAP Priority Habitat)
H.a	Saline lagoons (UK BAP Priority Habitat)
I	**Exposure and waste**
I.a	Calaminarian grasslands (UK BAP Priority Habitat)
I.b	Inland rock outcrop and scree habitats (UK BAP Priority Habitat)
I.1	Natural rock exposure and waste
I.1.1	Inland cliff
I.1.2	Scree
I.1.3	Limestone pavement (UK BAP Priority Habitat)
I.1.4	Other rock exposure
I.1.5	Cave
I.2	Artificial rock exposure and waste
I.2.1	Quarry
I.2.2	Spoil
I.2.3	Mine
I.2.4	Refuse-tip
J	**Miscellaneous**
J.a	Open mosaic habitats on previously developed land (UK BAP Priority Habitat)
J.1	Cultivated/disturbed land
J.1.1	Cultivated/disturbed land – arable
J.1.1.a	Arable fields
J.1.1.b	Arable field margins (UK BAP Priority Habitat)
J.1.1.c	Horticulture
J.1.1.c.a	Allotments
J.1.1.c.b	Other horticulture
J.1.2	Cultivated/disturbed land - amenity grassland
J.1.3	Cultivated/disturbed land - ephemeral/short perennial
J.1.4	Introduced shrub
J.2	Boundaries & Hedges
J.2.a	Hedgerows
J.2.a.a	Hedgerows (UK BAP Priority Habitat)

continued

continued

J.2.a.b	Other hedgerows
J.2.5	Wall (assumption: 0.5m average width when mapped as linear feature)
J.2.6	Dry ditch (assumption: 1.5m average width when linear feature)
J.2.8	Earth bank (assumption: 1.5m average width when linear feature)
J.3	Built-up areas
J.3.4	Caravan site
J.3.5	Artificial sea wall
J.3.6	Buildings
J.3.6.a	Buildings - area covered with green roof
J.3.6.b	Buildings - area covered with brown roof
J.3.6.c	Buildings - green walls (assumption: average width 0.5m if linear feat.)
J.3.6.d	Buildings – Other
J.3.a	Streets
J.3.b	Street tree and other trees in paved areas
J.3.c	Paved areas (e.g. car parks)
J.3.e	Gardens
J.4	Bare ground

7.3 Appendix C: NCPT Screenshots

A fictive example development has been used to explain the tool functionality (see Section 3 of the main report).

Figure 7.3.1 NCPT Screenshot – Start

NCPT Natural Capital Planning Tool England Version 0.9.0 START Development Fictive Example Development

Thanks for choosing the Natural Capital Planning Tool (NCPT) for assessing your plan or development. Please read the information provided on this sheet (and all other sheets in this file) carefully!

1. Introduction

The main aim of this research project was to develop a Natural Capital Planning Tool (NCPT) to better assess and manage the long-term impacts of proposed developments and plans on natural capital and ecosystem services; in order to maximise the available multiple benefits.

Notwithstanding many opportunities and advantages, development can also have negative impacts on people's wellbeing. New developments can put significant additional pressure on natural capital and the ecosystem services it provides. Ecosystem services are the benefits people obtain from ecosystems (Millennium Ecosystem Assessment 2005). Many ecosystem services in the UK are already in degraded and/or declining status (UK NEA 2011).

Land-use changes due to development can impact on the extent and ability of green infrastructure to provide ecosystem services such as space for recreation, the mitigation of flooding events or air quality regulation; all of them including their associated health and wellbeing benefits. The crucial importance to protect and enhance ecosystem services has for example been highlighted by the UK Government's National Planning Policy Framework (NPPF): *"The planning system should contribute to and enhance the natural and local environment by [...] recognising the wider benefits of ecosystem services."* (DCLG 2012). Further references of the NPPF to specific ecosystem services are outlined in the 'Design Strategies' tab. The NCPT allows to assess the impact of land-use changes on 10 different ecosystem services:

Ecosystem service	Example
1. Harvested products	Impact on the production of food and timber
2. Biodiversity	Impact on Biodiversity Action Plan (BAP) priority habitats and habitat connectivity
3. Aesthetic values	Impact on the visual amenity of a site
4. Recreation	Impact on the availability and accessibility of public greenspace
5. Water quality regulation	Impact on water quality improving vegetation
6. Flood risk regulation	Impact of vegetation on water storage capacities and water run-off
7. Air quality regulation	Impact on vegetation contributing to air quality
8. Local Climate regulation	Impact on cooling vegetation reducing the Urban Heat Island Effect (UHIE) – climate change adaptation
9. Global climate regulation	Effect on carbon stored in soil & vegetation – climate change mitigation
10. Soil contamination	Impact on risks to human health due to soil contamination

2. Disclaimer & Copyright

The tool developers decline all responsibility for errors or deficiencies in the database or software or in the documentation accompanying it, for program maintenance and upgrading as well as for any damage that may arise from them. The tool developers also decline any responsibility for updating the data and assume no responsibility for errors and omissions in the data provided.

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Please note that most values are based on expert knowledge as the published evidence is incomplete. Therefore all tool outcomes and scores/values should be treated as indicative only. Additional care should be taken when the tool is used outside the Midlands as many experts have their main expertise on land-uses occurring in the Midlands. The 'Caveats & Limitations' sheet provides more detailed information. Please get in touch with the tool developer (see below) in case you have further questions.

Figure 7.3.1 **NCPT Screenshot – Start**

3. Navigation & Application

The NCPT contains different sheets. To navigate through the sheets click on the tabs (usually shown below). If not all tabs are visible then use the arrows to navigate through the menu. Please note that the 'SCORES' and 'RESULTS' tab will be added after returning the completed file (see below).

START | INDICATORS | SCORES | RESULTS | Feedback | Design Strategies | Methods & Caveats | Land-use List | References

The assessment works like this:

1. To start the assessment click on the 'INDICATORS' tab. Here you will need to enter a range of indicators such as land-use changes.
2. After you completed the 'INDICATORS' sheet you will need to send this excel file to oliver.h@ceep-online.co.uk
   Your entries will be automatically translated into scores and values. Usually within 1-2 working days you will receive an updated file which contains additional 'SCORES' and 'RESULTS' sheets. Please note that you will not be able to make changes to your entries in the 'INDICATORS' sheet after you sent us the file. If you need to make changes in the 'INDICATORS' sheet then you will have to send the file again (changes you made in the 'SCORES' and 'RESULTS' sheet may be lost).
3. In the 'SCORES' sheet you will be be given the opportunity to review and adjust the scores and values associated with your indicator entries.
4. The 'RESULTS' sheet summarises the assessment outcomes and allows you to make comments. The outcome will be a score for each assessed ecosystem service as well as for all ecosystem services combined indicating the direction and magnitude of the impact of the proposed development.
5. The 'Feedback' sheet gives you the opportunity to flag up for example broken link, errors in calculations or typos. We would also welcome general feedback about the NCPT and its usability.

The tool also contains further sheets which provide you with additional information but you will not need to make entries.

The 'Design Strategies' sheet introduces you to some evidence and literature to give you ideas on how to improve the impact of your development on natural capital and ecosystem services.

The 'Methods & Caveats' sheet gives you more detail about methodology applied when developing the NCPT as well as the caveats and limitations that should be acknowledged when assessing the tool outcomes.

The 'Land-use List' shows all land-use types/habitats to chose from in the 'INDICATORS' sheet. This may help you to find the applicable land-use type more quickly.

The 'References' sheet contains full references of all literature stated in this tool.

4. About

The NCPT has been developed by the Consultancy for Environmental Economics & Policy (CEEP) in partnership with the UK Business Council for Sustainable Development (UK BCSD) and Birmingham City Council. Funding for this research project has been provided by the Royal Institution of Chartered Surveyors (RICS) Research Trust. The development of a former tool (on which the NCPT is partially based) has been funded by the Department for Environment, Food & Rural Affairs (Defra).

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ceep Consultancy for Environmental Economics & Policy

Business Council for Sustainable Development United Kingdom

Birmingham City Council

Figure 7.3.2 NCPT Screenshot – Indicators: Population Density

4. Population Density

Indicator informs the following ecosystem services:	*Harvested Products*	*Biodiversity*	***Aesthetic Values***	***Recreation***	*Water Quality Regulation*	*Flood Risk Regulation*	*Air Quality Regulation*	***Local Climate Regulation***	*Global Climate Regulation*	*Soil Contamination*

The population density is an important indicator for the demand for ecosystem services such as recreation or local climate regulation. Please enter the population density at Lower Super Output Area (LSOA) in the table below. If you do not have the relevant statistics available then follow the steps below to

1. Go to the ONS Neighbourhood Statistics Portal: https://neighbourhood.statistics.gov.uk/dissemination/

2. If you do not know the LSOA(s) or postcode of your development site click on '**Map Viewer**'. Click on the tab '**Display**' and tick the box next to '**Lower SO Areas 2011**'. Then zoom in until you can see the name of the LSOA(s) of your development site.

3. Enter the LSOA name or postcode on the main page, tick the box next to '**Lower Layer Super Output Area**' and click '**Search**'.

4. Identify the correct LSOA and enter it in the table below.

5. Select '**People and Society: Population and Migration**'.

6. Select '**Population Density, 2011 (QS102EW) (2011)**' and enter the value for '**Density (Number of Persons per Hectare) (Persons)**' of the LSOA in the table below.

7. Go back to the '**Population and Migration**' page and select '**Age Structure, 2011 (KS102EW) (2011)**'

8. Enter the relevant % values (not count!) of the LSOA in the table below.

If the development site falls within more than one LSOA then repeat the steps above for all relevant LSOAs (LSOA B etc.).

	LSOA A *(mandatory)*	LSOA B *(optional)*	LSOA C *(optional)*	LSOA D *(optional)*	Average for all LSOA(s)
Lower Layer Super Output Area (LSOA) name/reference:	**XYZ**				
Population density (Number of Persons per Hectare):	**2000.0**				**2000.0**
Age 0 to 4 (in %)	**5.0%**				
Age 75 to 84 (in %)	**2.0%**				
Age 85 to 89 (in %)	**2.0%**				
Age 90 and Over (in %)	**1.0%**				
Age 0 to 4 & 75+ (in %)	10.0%	0.0%	0.0%	0.0%	
Population density (age 0 to 4 & 75+ per Hectare)	200.0	0.0	0.0	0.0	**200.0**

Development note
A local NCPT version could be developed where only the LSOA name/reference needs to be selected from a drop-down menu and the values will be generated automatically. This would also include more up to date population estimates (post-census). If you're interested in such a local NCPT version then please contact the tool developer.

Figure 7.3.3 **NCPT Screenshot – Scores: Biodiversity**

2. Biodiversity

The table below shows the Biodiversity Impact Value of all proposed land-use changes calculated by the NCPT. You have the opportunity to adjust values. The different columns, which entry options you have and how values are calculated is explained here:

Biodiversity score of land-use/habitat	**Average**	All biodiversity scores are per-hectare scores. These scores are based on the usual/common maturity, management practice, quality, etc. of that habitat. It is based on the average value over 25 years post development. This is the score that should apply in most circumstances.
	Applied	In case the habitat is/will be particularly good/poor in terms of maturity, management, quality, etc. then you can adjust the score by selecting an alternative score from the drop-down menu. However, this should be the exception and you will need to justify your change in the corresponding field. Changes should be supported by evidence. Please note that the score indicates the average biodiversity value over 25 years post development. If you e.g. increase a score because of particularly good habitat management/quality then you should state how this is secured throughout the next 25 years.
	Min/Max	This is a minimum/maximum threshold for the applied score. If you choose an applied score that falls outside these thresholds then the cell will turn red which means that you should select a different score.
Importance within ecological network	**Importance**	The importance within the ecological network can be 'LOW', 'MEDIUM' or 'HIGH' and depend on size and connectivity based on your entries in the 'Indicator Entry' tab. See Section 8 in 'Indicator Entry' for more information.
	Multiplier	Each importance ('LOW', 'MEDIUM' or 'HIGH') has a multiplier attached. This multiplier is multiplied by the biodiversity score to arrive at the impact value.
Impact Value	**Adjusted**	The adjusted impact value is based on multiplying the per-ha biodiversity score by the ecological network multiplier for each land-use (pre- and post development). The pre-development score is then subtracted from the post-development score. The result is multiplied by the area in ha and re-scaled so will not match the calculation.
	Unadjusted	When adjustments have been made to the biodiversity score then the unadjusted score is also stated to flag up how adjustments change the outcomes of the assessment.

Area reference	Land-use/habitat type pre- and post development		Area in ha	Biodiversity score of land-use/habitat				Importance within ecological network		Impact Value	
				Average	Min	Max	Applied	Importance	Multiplier	Adjusted	Unadj.
LUC01	Pre-dev.	**B.6 Poor semi-improved grassland**	0.05	2	1	3	**2**	LOW	1.0	**-0.0**	
	Post-dev.	**J.3.6.d Buildings - Other**	0.05	1	0	1	**1**	LOW	1.0		
LUC02	Pre-dev.	**B.6 Poor semi-improved grassland**	0.05	2	1	3	**2**	LOW	1.0	**0.0**	
	Post-dev.	**J.3.6.b Buildings - area covered with brown roof**	0.05	2	1	2	**2**	LOW	1.0		
LUC03	Pre-dev.	**B.6 Poor semi-improved grassland**	0.10	2	1	3	**2**	LOW	1.0	**0.0**	
	Post-dev.	**J.3.e Gardens**	0.10	2	1	2	**2**	LOW	1.0		
LUC04	Pre-dev.	**B.6 Poor semi-improved grassland**	0.07	2	1	3	**2**	LOW	1.0	**-0.1**	
	Post-dev.	**J.3.a Streets**	0.07	1	0	1	**1**	LOW	1.0		
LUC05	Pre-dev.	**J.a Open mosaic habitats on previously developed land**	1.00	3	2	3	**2**	MEDIUM	2.0	**0.0**	-1.7
	Post-dev.	**A.1.1.1.c Other broadleaved woodland - semi-natural**	1.00	2	1	2	**2**	MEDIUM	2.0		
LUC06	Pre-dev.	**J.a Open mosaic habitats on previously developed land**	1.00	3	2	3	**2**	MEDIUM	2.0	**0.0**	-1.7
	Post-dev.	**A.3 Parkland/scattered trees**	1.00	2	1	2	**2**	MEDIUM	2.0		
LUC07	Pre-dev.	**J.a Open mosaic habitats on previously developed land**	2.00	3	2	3	**2**	MEDIUM	2.0	**-5.2**	-8.6
	Post-dev.	**J.1.2 Amenity grassland**	2.00	1	1	1	**1**	LOW	1.0		
LUC08	Pre-dev.	**J.a Open mosaic habitats on previously developed land**	0.50	3	2	3	**2**	MEDIUM	2.0	**+0.9**	0.0
	Post-dev.	**G.1.d Ponds (UK BAP Priority Habitat)**	0.50	3	2	3	**3**	MEDIUM	2.0		
									Total Biodiversity Impact Value: *Sum of all Impact Values above*	**-4.4**	-12.2
									Per-hectare Biodiversity Impact Value: *'Total Biodiversity Impact Value' divided by the total area where land-use changes are proposed*	-0.9	-2.6
									Ecosystem Services Weight: *Relative weight of this ecosystem service compared to other ecosystem services*	1	
									Ecosystem Services Impact Score: *'Per-hectare Biodiversity Impact Value' multiplied by the 'Ecosystem Services Weight'*	**-0.9**	-2.6

Figure 7.3.4 NCPT Screenshot – Results

NCPT Natural Capital Planning Tool England Version 0.9.0 **RESULTS** Development **Fictive Example Development**

Here you can find a summary as well as a more detailed breakdown of the results including opportunities for commenting. If scores are unsatisfactory then you may consider the guidance provided in the 'Design Strategies' tab when re-designing your plan.

1. Summary

Below you can see the Ecosystem Services Impact Score (ESIS) for each assessed ecosystem service as well as the overall Development Impact Score (DIS) aggregated across all ecosystem services. All scores in the blue table are on a scale from -10 to +10 where a negative ESIS (DIS) indicates a negative overall impact of the development on that ecosystem service (all 10 assessed ecosystem services) over an assessment timescale of 25 years. Please note that in many cases the full scale (-10 to +10) cannot be exhausted for a specific development. This is because many indicators are based on national statistics and if a development does e.g. not fall within an area with the highest population density in England then related ecosystem services such as recreation cannot score the maximum (positive or negative) score.

The purple table indicates the total impact of the development on ecosystem services over a 25 year timescale. These are the per-ha scores from the blue table multiplied by the total area of land-use changes. In case scores have been adjusted in the 'SCORES' tab then the tables below will also show the unadjusted scores in an extra column to show how score adjustments have changed the outcomes of the assessment. A more detailed table including opportunities for commenting can be found further below.

Development Impact Score
Average Per-Hectare

Ecosystem Service	Adjusted Scores	Unadj. Scores
1. Harvested Products	+1.6	-2.2
2. Biodiversity	-0.9	-2.6
3. Aesthetic Values	+2.4	+2.4
4. Recreation	+3.9	+3.9
5. Water Quality Regulation	-1.1	-1.1
6. Flood Risk Regulation	+1.2	+1.2
7. Air Quality Regulation	-1.4	-1.4
8. Local Climate Regulation	+1.8	+1.8
9. Global Climate Regulation	-0.2	-0.2
10. Soil Contamination	+0.0	+0.0
Development Impact Score	+0.7	+0.2

Development Impact Score
Total for 4.8 Ha of Assessed Land-use Changes

Ecosystem Service	Adjusted Scores	Unadj. Scores
1. Harvested Products	+7.5	-10.5
2. Biodiversity	-4.4	-12.2
3. Aesthetic Values	+11.3	+11.3
4. Recreation	+18.7	+18.7
5. Water Quality Regulation	-5.4	-5.4
6. Flood Risk Regulation	+5.8	+5.8
7. Air Quality Regulation	-6.6	-6.6
8. Local Climate Regulation	+8.5	+8.5
9. Global Climate Regulation	-0.7	-0.7
10. Soil Contamination	+0.0	+0.0
Development Impact Score	+3.5	+0.9

Tool outcomes should be treated as purely indicative. The NCPT is a supplementary information source to assess the impact of proposed developments and plans on natural capital and ecosystem services and is not designed to replace other elements to be considered for a planning decision. See 'Methods & Caveats' tab for more information.

Figure 7.3.4 NCPT Screenshot – Results

2. Detailed Results

Below you have the opportunity to comment on each ESIS as well as the DIS e.g. to justify unintended outcomes or to flag up issues that are not incorporated into the tool.

	Average per-ha ESIS/DIS		Total ESIS/DIS	
	Adjusted Scores	Unadj. Scores	Adjusted Scores	Unadj. Scores
1. Harvested Products	+1.6	-2.2	+7.5	-10.5
2. Biodiversity	-0.9	-2.6	-4.4	-12.2
3. Aesthetic Values	+2.4	+2.4	+11.3	+11.3
4. Recreation	+3.9	+3.9	+18.7	+18.7
5. Water Quality Regulation	-1.1	-1.1	-5.4	-5.4
6. Flood Risk Regulation	+1.2	+1.2	+5.8	+5.8
7. Air Quality Regulation	-1.4	-1.4	-6.6	-6.6
8. Local Climate Regulation	+1.8	+1.8	+8.5	+8.5
9. Global Climate Regulation	-0.2	-0.2	-0.7	-0.7
10. Soil Contamination	+0.0	+0.0	+0.0	+0.0
Development Impact Score	+0.7	+0.2	+3.5	+0.9

Comments & Clarifications	
By Developer	By Planning Authority

General Comments/Statement by Developer

General Comments/Statement by Planning Authority

Figure 7.3.5 NCPT Screenshot – Design Strategies

NCPT Natural Capital Planning Tool England Version 0.9.0 **Design Strategies** Development **Fictive Example Development**

The National Planning Policy Framework (NPPF) refers to all of the 10 ecosystem services assessed by the NCPT - directly or indirectly. Below, for each ecosystem service you can find some relevant sections of the NPPF as well as some initial guidance you may want to consider when (re)designing your plan or development. This may help you to improve the overall impact on ecosystem services.

1. Harvested Products

The NPPF states that *"local planning authorities should take into account the economic and other benefits of the best and most versatile agricultural land [ALC grade 1, 2 and 3a]. Where significant development of agricultural land is demonstrated to be necessary, local planning authorities should seek to use areas of poorer quality land in preference to that of a higher quality."* (DCLG, 2012, p. 26)

Apart from protecting the most versatile land for agriculture the sustainable management of agricultural land is vital to produce multiple ecosystem services. Intensive management practices of agricultural land can for example result in disbenefits e.g. to biodiversity or water quality (UK NEA, 2011). Some guidance on sustainable farming practices can be found here:
https://www.gov.uk/browse/business/farming/farming-and-the-environment

2. Biodiversity

The NPPF states that *"The planning system should contribute to and enhance the natural and local environment by minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures"* and that *"if significant harm resulting from a development cannot be avoided (through locating on an alternative site with less harmful impacts), adequately mitigated, or, as a last resort, compensated for, then planning permission should be refused."* Furthermore the NPPF stresses that *"opportunities to incorporate biodiversity in and around developments should be encouraged."* (DCLG, 2012, pp. 25-28)

When designing a plan or development for biodiversity benefits the Lawton Review 'Making Space for Nature' (Lawton, J. et al., 2010) and England's Biodiversity 2020 Strategy (Defra, 2011) may be the starting point for guidance on how to plan and manage ecosystems for wildlife. You can download both publications as well as further information from:
https://www.gov.uk/government/policies/protecting-biodiversity-and-ecosystems-at-home-and-abroad

3. Aesthetic Values

The NPPF states that *"planning should [...] always seek to secure high quality design and a good standard of amenity for all existing and future occupants of land and buildings" and that "plans should allocate land with the least environmental or amenity value..."* (DCLG, 2012, pp. 5 & 26)

The aesthetical, visual and cultural value of ecosystems is difficult to grasp but there is a vast amount of evidence showing for example that environmental settings are of crucial importance for mental health. Further information about such values can be found in Chapter 16 of the UK National Ecosystem Assessment (UK NEA, 2011) which can be downloaded here:
http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx

4. Recreation

The NPPF states that *"to deliver the social, recreational and cultural facilities and services the community needs, planning policies and decisions should guard against the unnecessary loss of valued facilities and services, particularly where this would reduce the community's ability to meet its day-to-day needs"* as *"Access to high quality open spaces and opportunities for sport and recreation can make an important contribution to the health and well-being of communities."* (DCLG, 2012, pp. 17-18)

When planning for natural recreational opportunities the publication 'Nature Nearby - Accessible Natural Greenspace Guidance' (Natural England, 2010) may be of interest. But it should be mentioned that also sites below 2 ha of size can be very valuable for recreational purposes. Important is that natural greenspace is provided close to where people live. The guidance can be downloaded from:
http://publications.naturalengland.org.uk/publication/40004

5. Water Quality Regulation

The NPPF states that *"The planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to {...} unacceptable levels of [...] water or noise pollution..."* (DCLG, 2012, p. 26)

Green vegetation can play an important role in regulating water quality. Intensive management of agricultural land for example can have negative effects on water quality. Chapter 14 of the UK National Ecosystem Assessment (UK NEA, 2011) offers more information and initial guidance on how ecosystems can be managed to protect and improve water quality:
http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx

Figure 7.3.5 **NCPT Screenshot – Design Strategies**

6. Flood Risk Regulation

"Local Plans should apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change, by [...] safeguarding land from development that is required for current and future flood management [and] using opportunities offered by new development to reduce the causes and impacts of flooding." (DCLG, 2012, p. 23)

Sustainable Drainage Systems (SuDS) offer a great opportunity in managing flood-risk as part of the planning and development design. They are often a cost-effective alternative to engineered flood-defence and offer a wide range of additional ecosystem services such as biodiversity or recreational opportunities. The SuDS Manual (Ciria, 2007) provides detailed guidance on SuDS design. The impacts of climate change should also always be factored in when planning for flood risk. The Environment Agency recommends to allow for additional climate change related rainfall intensity, peak river flow etc.

Ciria SuDS Manual (free download after registration):	http://www.ciria.org/Resources/Free_publications/the_suds_manual.aspx
EA Climate Change Allowances for Planners:	https://www.gov.uk/government/publications/flood-and-coastal-risk-guidance-climate-change-allowances

7. Air Quality Regulation

The NPPF states that *"planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas."* (DCLG, 2012, p. 29)

The location and species of trees in particular can strongly effect on local air quality. The Woodland Trust published a discussion paper with some initial guidance on how to plan and manage trees for air quality regulation purposes (Woodland Trust, 2012). The paper can be downloaded from: http://www.woodlandtrust.org.uk/publications/2012/04/urban-air-quality/

8. Local Climate Regulation

The NPPF states that *"Local Plans should take account of climate change over the longer term, including [...] changes to biodiversity and landscape. New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure."* (DCLG, 2012, p. 23)

Green infrastructure can have a significant cooling effect in urban areas reducing the Urban Heat Island Effect (UHIE). Forest Research published the evidence note 'Green infrastructure and the urban heat island' with some initial information and guidance. The research note 'Air temperature regulation by urban trees and green infrastructure' (Doick, K. & Hutchings, T., 2013) and the study 'Reducing urban heat risk' (Arup, 2014) provide further guidance.

FR Green infrastructure and the urban heat island	http://www.forestry.gov.uk/pdf/urgp_evidence_note_004_Heat_amelioration.pdf/$file/urgp_evidence_note_004_Heat_amelioration.pdf
FR Air temperature regulation by urban trees and GI	http://www.forestry.gov.uk/pdf/FCRN012.pdf/$FILE/FCRN012.pdf
Arup Reducing urban heat risk	http://publications.arup.com/Publications/R/Reducing_urban_heat_risk.aspx

9. Global Climate Regulation

The NPPF states that *"local planning authorities should set out the strategic priorities for the area in the Local Plan. This should include strategic policies to deliver climate change mitigation..."* (DCLG, 2012, p. 38)

Green infrastructure and corresponding soils sequester and store large amounts of carbon mitigating global warming. Especially land-use changes and the management of soils have a strong effect on the amount of carbon stored. Some initial information is provided in the Forestry Commission information note 'Forests, Carbon and Climate Change: the UK Contribution' (Broadmeadow, M. & Matthews, R., 2003). Also interesting in this context when accounting for carbon gains/losses may be the Woodland Carbon Code.

FC Forests, Carbon and Climate Change	http://www.forestry.gov.uk/pdf/fcin048.pdf/$FILE/fcin048.pdf
Woodland Carbon Code	http://www.forestry.gov.uk/carboncode

10. Soil Contamination

The NPPF states that *"where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner."* and that *"in preparing Local Plans, local planning authorities should set out environmental criteria, in line with the policies in this Framework, against which planning applications will be assessed so as to ensure that permitted operations do not have unacceptable adverse impacts on the natural and historic environment or human health, including from migration of contamination from the site..."* (DCLG, 2012, pp. 28 & 33)

Woodland and trees may play an important role in remediation of contaminated land. The Forestry Commission publication 'The Opportunities for Woodland on Contaminated Land' (Hutchings, T., 2002) provides more information. The information note can be downloaded from: http://www.forestry.gov.uk/pdf/fcin44.pdf/$file/fcin44.pdf

General guidance on how to manage soil contamination can be found here: https://www.gov.uk/government/collections/land-contamination-technical-guidance

8.0 Acknowledgements

The Project Team would like to thank all individuals being involved in the Steering Group, specialist Task Groups and case study partners for their commitment and valuable contributions to this project.

In particular we would like to thank Steering Group members for overseeing the project and reviewing and endorsing the outcomes (in alphabetic order): **Chris Baggott** (Birmingham City Council), **Sarah Bentley** (Staffordshire County Council), **Amanda Craig** (Natural England), **Diane Crowe** (Carillion plc), **Thomas Hartmanshenn** (Frankfurt City Council), **Jeremy Parker** (Fira), **Chris Parry** (Birmingham & Black Country LNP), **Tim Pickering** (Environment Agency), **Jon Sadler** (University of Birmingham), **Nigel Sagar** (Skanska), **Alister Scott** (Birmingham City University), and **Tim Sunderland**, Natural England.

The Project Team would also like to thank to all expert and stakeholder Task Group members for their participation in the scoring exercises which were of crucial importance for the success of this Project (in alphabetic order): **Mike Ashmore** (University of York), **Julia Banbury** (Staffordshire County Council), **Emily Barker** (Worcestershire County Council), **Richard Bassett** (University of Birmingham), **Steve Bloomfield** (Worcestershire Wildlife Trust), **William Bloss** (University of Birmingham), **Richard Brandsma** (Environment Agency), **Paul Burns** (Birmingham City Council), **Xiaoming Cai** (University of Birmingham), **Ewan Calcott** (Forestry Commission), **Sara Carvalho** (EcoRecord), **Jamie Cooper** (Staffordshire County Council), **Ron Corstanje** (Cranfield University), **Ali Glaisher** (Staffordshire County Council), **Alex Hale** (Environment Agency), **James Hale** (University of Birmingham), **Michael Hardman** (University of Salford), **Joe Hayden** (Birmingham City Council), **Julie Holloway** (Natural England), **Dan Van der Horst** (University of Edinburgh), **Safieh Javadinejad** (University of Birmingham), **Cédric Laizé** (Centre for Ecology & Hydrology), **Susan Lee** (University of Birmingham), **Alex McDonald** (Environment Agency), **Ruth Meek** (Environment Agency), **Rachel Melvin** (Staffordshire County Council), **Justin Milward** (Woodland Trust), **Simon Needle** (Birmingham City Council), **Chris Parry** (Birmingham & Black Country Local Nature Partnership), **Tippala Gamage Perera** (University of Birmingham), **Tim Pickering** (Environment Agency), **John Porter** (Birmingham City Council), **Gary Rogerson** (Skanska), **Gina Rowe** (Warwickshire Wildlife Trust), **Jon Sadler** (University of Birmingham), **Nigel Sagar** (Skanska), **Lee Southall** (Birmingham City Council), **Tim Sunderland** (Natural England), Xiaonan Tang (University of Birmingham), **Sam Todd** (Environment Agency), **Vicky West** (Forestry Commission), **Martyn Wilson** (Worcestershire County Council), **Harriet Wood** (Small Woods), **Lucy Wood** (Worcestershire Wildlife Trust) and **Julian Wright** (Environment Agency).

Last but not least we would also thank our case study partners for testing the tool at case study sites (in alphabetic order of organisation): **Nicola Farrin** & **Uyen-Phan Han** (Birmingham City Council), **Tim Pickering** (Environment Agency) and **Clare Day**, **Lizzie Rendell** & **Nigel Sagar** (Skanska).

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