

## **Defra Group “Statement of Need” - Strategic Priorities Fund Constructing a Digital Environment Programme**

This statement outlines the Defra group’s needs that could be supported by ‘Constructing a Digital Environment’ demonstrator projects. It aims to facilitate dialogue with bidders in proposal co-design.

### **Initial Points of Contact for enquiries relating to these needs:**

- **Core Defra- Giles Golshetti** - Giles.Golshetti@defra.gov.uk
- **Joint Nature Conservation Committee - Niki Newton** Niki.Newton@jncc.gov.uk
- **Natural England - Andy Nisbet**- Andy.Nisbet@naturalengland.org.uk
- **Forestry Commission – Ian Tubby** Ian.Tubby@forestrycommission.gov.uk
- **Environment Agency - Neil Veitch**- neil.veitch@environment-agency.gov.uk

### **CROSS-CUTTING NEEDS:**

**Digital twins for the natural or built environment** - The use of digital twins (i.e. models which mimic reality) can be a useful means of ensuring the robustness of decision making. Research is needed to explore the development of digital twins for the environment in areas such as flooding and coastal erosion. Digital twinning could also extend to exploring the relationships between forestry and agriculture and energy.

**Initial PoC-** Giles Golshetti, Ian Tubby

**Citizen Science** - Citizen Science is an important part of data collection; however, there are often gaps in terms of geographical coverage and in the consistency of the data collection. Investigations are needed on how technology can address these gaps. Also, how we can encourage more citizen science including by using technology to decrease participant burden and simplify the collection and submission of data by networks of volunteers.

**Initial PoC-** Giles Golshetti, Niki Newton

**Internet of Things for Defra - A Demonstrator for the Future** - Defra group activities include a significant amount of remote working and use a wide range of instrumentation to collect digital information about the environment. Data is used for many purposes and include air quality monitoring; flood forecasting; and water quality monitoring. Many sensing devices are on separate networks so there is a need to explore whether modern communications technologies could provide step-change improvements in efficiency and effectiveness.

Such large-scale transformation presents a variety of inter-connected challenges, ranging from overall scope to detailed technical standards, which could be addressed through the development of a practical demonstrator, which included Defra's environmental applications. To support Defra's policies and procedures a demonstrator would need to: be based on a common platform; use open standards; and include genuine plug and play. Ideally, the demonstrator would showcase new science and technologies and also integrate legacy networks, instrumentation and sensing devices where necessary.

**Initial PoC-** Giles Golshetti, Neil Veitch

**Operational Telemetry - Withdrawal of PSTN** - Defra Group organisations, particularly the Environment Agency are facing the withdrawal of the Public Switched Telephone Network (PSTN) analogue networking services in 2025. The Environment Agency currently has the largest number of PSTN lines in Defra Group that form part of the telemetry network. These support various services - particularly real-time flood forecasting - over existing analogue lines.

It is estimated that hundreds of monitoring stations in remote locations will not have a replacement solution to PSTN services in place by 2025. The principal reasons are:

- Insufficient power to support new digital services
- Insufficient mobile network coverage
- Resilience & fall back requirements

A demonstration of solution(s) is sought, which will address this issue and so enable ongoing and integrated communication with all of the monitoring stations. managed by Defra Group.

**Initial PoC-** Neil Veitch

**Broad Scale, Long Term Evidence Integration** - The Environment Agency is working closely with Core Defra in developing "Sentinel Evidence for Decision Making (EDM)": a systems-based evidence initiative and capability to provide a holistic understanding of our environment. It will support decision making for the delivery of Defra's 25 Year Environment Plan and enable better understanding and reporting on the state of (and changes to) our environment at a broad scale. This understanding will be based on evidence from multiple sources, and will include social as well as physical evidence. At the heart of the EA's evidence will be a new surveillance monitoring network, using the Generalised Random Tessellation Stratified (GRTS) method. Using Sentinel EDM, the plan is to integrate GRTS data with other sources of evidence to create a more complete picture of our environment.

However, we face real challenges in developing this and seek to work with the research community to provide solutions. For example,

- How can we integrate citizen science that has very different data standards with the GRTS data and other national data sets?
- How can we combine evidence from different models and maintain an understanding of uncertainty?
- How can we automate this as much as possible?
- How do we future proof this to allow for future innovations in monitoring?

**Initial PoC-** Neil Veitch

**Futures/Horizon Scanning-** how can we draw on predictive capabilities (e.g. drawing on AI, data science), social media (e.g. sentiment/semantic analysis) and collective intelligence (i.e., crowdsourcing forecasts) to help understand long term strategic trends and driving forces of change from across the socio-political (including geopolitical), environmental, and technological spectrums. Secondly, how can we exploit developments in immersive technology, narratology and cognitive neuroscience to ensure futures insights are made relevant against present day pressures?

**Initial PoC-** Giles Golshetti

### **THEMATIC NEEDS:**

#### **Enhanced Air Quality Monitoring**

- **Monitoring Services** - The Environment Agency has responsibility for delivering the government's annual £6M air quality monitoring services. This includes managing contractors to deploy and maintain equipment and to quality control and assure data from around 300 monitoring stations across the UK.

Over 100 monitoring stations are in the UK's Automatic Urban and Rural Network (AURN) which monitors tropospheric pollutants that are potentially harmful to human

health. The information produced is of high quality and used by the Defra group for reporting, modelling and informing policy.

However, the geographical coverage of monitoring sites is limited by the cost of installations. Defra and the Environment Agency are therefore seeking innovative approaches and methods for the acquisition of air quality data at a higher spatial resolution. The data output will need to be of known quality and suitable to support analysis and reporting at a national level.

**Initial PoC-** Giles Golshetti, Neil Veitch

- **Environmental quality** –We need to improve our understanding of the impacts of widespread pressures on the environment. We could monitor air quality and noise using low cost sensors which would greatly improve our understanding of how these pressures vary over space and time, eg real time data on temperature, air quality in urban areas and green spaces. How does this relate to health, where are the environmentally best areas of an urban environment for health and how does that change in real time?

**Initial PoC:** Andy Nisbet

### **Flood Risk**

- **Predictive analytics for ‘just-in-time’ maintenance of low-utilisation flood risk assets** - Maintenance work on fixed flood defences is identified and prioritised based on a visual inspection of condition. However flooding is, by its very nature, a rare event. As a consequence, assets are loaded infrequently and actual data on performance is limited. Predictive techniques developed and deployed in process industries are unable to be used in such low-utilisation settings. Remote and in-situ sensing combined with powerful statistical analysis could offer a chance to move to a more pro-active approach to maintenance.

**Initial PoC-** Giles Golshetti, Neil Veitch

- **Integrating data using a linked data model: Demonstrate the approach and benefits in a real life case study** - Research is required to explore how digital technologies (e.g. Machine Learning, Big Data) can be utilized in flood risk management, along with linked data models. Digital technologies can help to discover new data sources and new techniques to store, analyse and present data along with other benefits and opportunities not previously considered.

**Initial PoC-** Giles Golshetti, Neil Veitch

- **Flood Forecasting** - There is a challenge in developing data and communications that enable and empower people to prepare and become more resilient to flooding. Technologies (e.g. Internet of Things or Artificial Intelligence) are needed to help interpret real time imagery from drones, car sat-nav systems, social media or other sources, during extreme rainfall. Translation of data, science and behavioural insights are also needed to produce trusted, locally specific information that the public and businesses can source, trust, tailor to their own needs and use to reduce the economic and social impacts of flooding.

**Initial PoC-** Giles Golshetti, Neil Veitch

## Plant Health and Biosecurity

- **Digital Treescapes** - Host data on treescapes is often inconsistent, originating from different methodologies (including sample plots, citizen science etc.) and tends to focus on woodland areas. How can these datasets be pulled together to form a holistic landscape and can technology bridge the gaps (urban trees, small copses, individual trees in rural areas)? Could sensors be developed and placed on sentinel trees in order to detect disease and could this technology be incorporated into the aforementioned landscape to allow a quick response to pest/disease issues?

**Initial PoC-** Giles Golshetti, Ian Tubby

- **Early Warning (EWS) System** - Fera/Defra are developing a system that would automatically monitor key risk factors and generate alerts when the risk to the UK's biosecurity is heightened. This system takes in to account the different intrinsic risks associated with different countries and the risks around different commodities. One area for additional development is around predicting risks (e.g. geopolitical) which have the potential to disrupt trade, commodities movements and production/supply routes with possible knock on effects for biosecurity. Open source data (drawing on social media, predictive analytics) make predicting and assessing geopolitical risk possible, which the EWS could draw in.

**Initial PoC-** Giles Golshetti

- **Pests and Diseases in Forestry** - There is a need to investigate the possibility of using data from agriculture to predict outbreaks of pest and diseases in forestry. Monitoring of insect pests and diseases associated with cereals, oilseeds and potatoes is carried out routinely. Data collected can help inform farmers of when best to use control measures. One area for exploration is whether this data can predict when forestry pests such as *Elatobium abietinum* (spruce aphid) or *Dendroctonus micans* are more likely to cause damage.

**Initial PoC-** Ian Tubby

## Soils

- **Soil Health** - The 25 Year Environment Plan (25YEP) aims to improve the approach to soil management and improve soils health, including developing a soil health index, in order to support the sustainable use and management of land. A current research project is developing a monitoring framework, integrating multiple data sources at the appropriate scales (local, regional, and national from in-situ measurements and remote sensing) to answer key soil health policy questions. The results of the project will also inform the development of appropriate soil metrics for measuring 25YEP outcomes and a new Environmental Land Management (ELM) system. The next phase is to set up a monitoring programme utilising the outputs of the project. This programme will enable us to monitor the impact of policies (such as ELM) on soil health, requiring data at the appropriate scales. A digital, integrated approach is needed to meet our soil health aims. This could be extended to forestry to better understanding of health of forest soil before and after harvesting operation and also provide information on carbon flux

**Initial PoC-** Giles Golshetti, Ian Tubby

## **Environmental Net Gain**

- **Net Gain** - The 25 Year Environment Plan (25YEP) sets a commitment to embed an 'environmental net gain' principle for development, aiming to leave the natural environment in a measurably better state.

Developing and harnessing the digital environment (e.g. sensor network, earth observation, storage) is crucial to support policy delivery (e.g. spatial planning) and ongoing monitoring (e.g. changes in habitat extent and other natural capital assets), at a local and national level. To date, Natural England and JNCC have been involved in producing 'Living Maps' by utilising Earth Observation to develop detailed maps of habitat type, extent and location, and will continue to develop these to align with future policy needs.

In addition, a publicly available and regularly updated habitat register of compensatory habitat sites will be established. It will show where habitat is being created, how much and of what type, as well as what development it is offsetting. The register sits at the nexus of policy delivery (e.g. preventing use of the same offset for multiple developments) and monitoring (e.g. has biodiversity net gain been achieved at different spatial scales?), so there is an opportunity to consider how digital solutions could enable the efficient collection and storage of data whilst maximising the opportunities for analysis and monitoring, especially in combination with other datasets.

These could include other geospatial datasets relating to land cover and habitat change, species distribution, designated sites, location and type of development (e.g. postcode, planning or Ordnance Survey data), socio-economic data and land transactions (e.g. land registry). There are also lessons to be learned from the evaluation of existing public-environmental data interfaces or existing examples of public and enforcement agency monitoring of biodiversity compensation or habitat restoration projects.

**Initial PoC-** primarily Giles Golshetti. Ian Tubby, Niki Newton, Andy Nisbet also

## **Net zero and land use**

- Using data from existing field scale solar arrays, wind turbines, and forest and crop growth models to establish what the optimal land use is to mitigate climate change via generation of low emission heat and power, production of renewable materials and carbon sequestration in different parts of the UK. Developing cost benefit models that show economic return to investors and land owners in the presence and absence of subsidy.
- The national forest inventory provides a snap shot of standing volume of timber but year on year increment and growth is not monitored. Can meteorological data and data from agriculture including the RPA Crop Map for England (CROME), crops yields and characteristics of crops (e.g. protein content) be used to model annual increment of different tree species in different parts of the country? This would help give us a better understanding in the annual variation of the forest carbon sink and could help us increase sequestration rates and protect carbon stocks.

**Initial PoC-** Ian Tubby

## **Food/Farming**

- **Farming/Land Management** - a model is needed which allows a link to be made between data on farm/holding characteristics (location, special/geographical, financial,

management practice, social network involvement) and local environmental outcome data (water quality, soil, biodiversity), to help better understand the factors which influence land/farm management and the impact of different land management on the environment. The key issue with this is data sensitivity and ensuring farms/land managers remain anonymous, along with being able to accurately link data collected from different surveys.

#### **Initial PoC –Giles Golshetti**

- **Trees** - the Forestry Commission is looking to develop a better understanding of on-farm planting of trees to maximise environmental benefit e.g. reducing nitrogen or phosphate run off and other diffuse pollution and mitigating climate change.

#### **Initial PoC- Ian Tubby**

- **Climate change resilience** – Evidence suggests some tree species are coming into leaf earlier as the climate changes. Combining data collected from Earth Observation with data collected in the field, the rate and impact of this change could be investigated on a landscape scale. Results could inform species choice decisions made by managers restocking woodlands following harvest or to replace diseased trees (e.g. ash dieback). Results could extend our understanding of how climate change will alter the provision of ecosystem services by woodlands (including water regulation, carbon sequestration and biodiversity).

#### **Initial PoC- Ian Tubby**

- **Increasing productivity in forestry.** The UK is the second largest timber importer in the world, sourcing 80% of the timber it consumes from overseas. Many previously managed woodlands in England have fallen out of production. A lack of management can exacerbate problems caused by new plant diseases and climate change. Improved use of Earth Observation data, forest inventory data and data on local markets for woodfuel and timber could help increase productivity and coordinate forestry operations on a landscape scale. In turn this could increase the quality of woodland habitat and increase resilience to climate change, pests and disease.

#### **Initial PoC- Ian Tubby**

- **Agricultural compliance monitoring** - EA is looking to improve collection of farm data and analysis to support guidance and interventions to support farmers. This could involve Geomatics to develop working algorithms for measuring compliance for Farming Rules for Water. Other approaches include using drone surveys of target catchments to assess risks to water from agriculture and help farmers identify investment priorities under Catchment Sensitive Farming

#### **Initial PoC- Neil Veitch**

#### **Water**

- **Long-term planning of water quality in our environment** - The challenge of restoring water sites to as close to a natural state as possible, along with improving water and flood resilience, is increased by a combination of climate change and population growth. Defra requires better usability of water quality monitoring data to improve water quality in different catchments. This includes using our existing data to identify which interventions are having the most impact on improving water quality, are

reversing the deterioration of groundwater, and reducing emissions of harmful substances,

**Initial PoC:** Giles Golshetti and Neil Veitch

- **Agent based modelling for water** - Research is required to understand the impacts of the behaviours of water users (individuals, homes and businesses) and links to policy decisions on reducing water use. This includes using existing data to create an agent based model representing the key stakeholder groups involved in using water, their actions/behaviours and the resulting impact on water use. This will improve future policy design by allowing comparison of the options through modelling and simulation of different possible policy interventions. This will also help to uncover any unforeseen interactions between different policies using a numerical model that can be used to understand the impacts of policy across the water system.

**Initial PoC:** Giles Golshetti and Neil Veitch

### **Biodiversity and Monitoring**

- **Automatic sensor networks** - Development of sensors is required for the automatic detection and recording of wildlife (e.g. bird song, bats, and invertebrates) in species surveys and site monitoring, which could be left in specific locations (as passive sensors) or carried around when surveying and then computer analysed. Example applications include:
  - JNCC is currently working with the Bat Conservation Trust to develop a potential new national bat monitoring programme using passive acoustic surveys, which presents challenges and potential opportunities. **Initial PoC:** Niki Newton
  - Large areas of blanket bog are being restored to benefit biodiversity, carbon storage and water quality. Networked, low cost sensors could be used to monitor water levels and soil/peat wetness to improve our understanding of the hydrology and ecology of these areas, the effectiveness of management/restoration activities, and fire risk. **Initial PoC:** Andy Nisbet
- **Enhancing volunteer networks** - JNCC work in partnership with NGOs and research organisations to mobilise thousands of volunteers to collect information on biodiversity. There are gaps in data collection, both taxonomic and geographic. How can the digital environment be enhanced to support and grow the numbers of volunteers who are a vital network of environmental sensors? How can we increase the accessibility of data at multiple scales by the volunteers who collect the data, as well as by decision makers?

**Initial PoC:** Niki Newton

- **People and nature** - There is a need for networked, smart counters embedded in gateposts, etc. to provide better information on how people access the natural environment (possibly focusing on National Nature Reserves). There may also be scope to use apps to aid in our understanding of how people engage with the natural environment and what they value.

**Initial PoC:** Andy Nisbet

- **Virtual reality (VR) to enhance the data we collect on the natural environment** - Could the digital environment be used to construct VR to enhance the way people interact with the environment? Can we use VR to enable greater access to the natural

environment? Can we pair a volunteer who is recording birds with someone using VR to classify habitat management?

**Initial PoC:** Niki Newton