

Knowledge Transfer & Innovation Fund (KTIF) SG Final Report Template

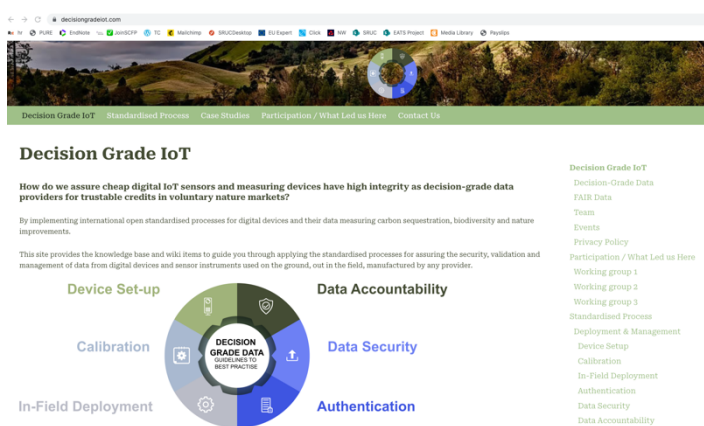
1. PROJECT TITLE/APPLICANT

1.1 Trustable IoT Sensors - KTIF/008/2022

1.2 Overview of the lead facilitating organisation

Scotland's Rural College (SRUC) delivered the project, and facilitated the project's partners (Oyster Highland/Cyberlock and SAOS) and pilot sites (Tulloch Farms, Fordoun, Laurencekirk; and Titaboutie Farm, Coull, Tarland; SRUC's Hill & Mountain Research Centre at Kirkton & Auchtertyre Farms; Lauriston Farm, Edinburgh; and RSPB's Glencripesdale reserve, Morvern). SRUC has a long history dating back over 115 years of support to farming and rural industries and is now working towards University status. As a large, modern, and multi-disciplinary organisation with over 1,300 staff, it has a concentration of skills and resources that are unique in the UK. It provides advanced education and training, research and development; advisory and consultancy work on an extensive range of subjects but with particular emphasis on the natural economy including food, land, environment, biodiversity, circular economy and business management.

2. EXECUTIVE SUMMARY

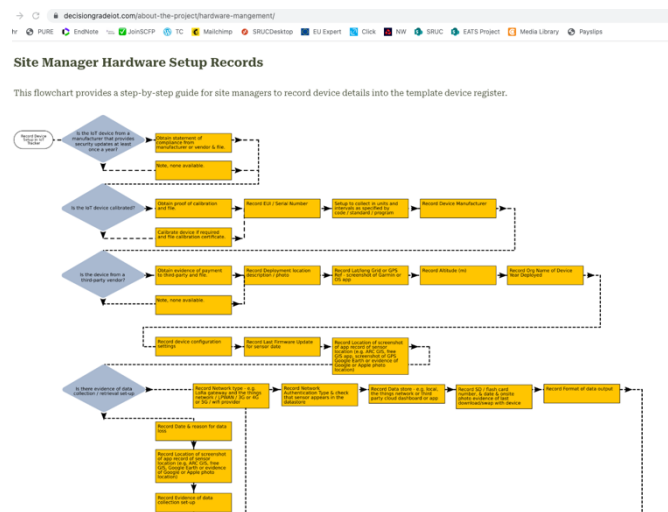


At <https://decisiongradeiot.com>, we have published the outcomes of this innovation project – work with the sector to co-develop a set of open source standardised processes for assuring digital IoT (internet of things) devices and their data that measure carbon sequestration, biodiversity and nature improvements.

The project used action research as an iterative process with

practitioners using IoT devices on Scottish farms and a remote nature reserve. The project has built a knowledge base and wiki to guide any farmer, land manager or ranger, or any third party setting up devices on their behalf, through applying the standardised processes for assuring the security, validation and management of data from digital devices and sensor instruments used on the ground, out in the field, manufactured by any provider.

Tested in-the-field templates and pro-formas have been designed to support robust data collection about devices' set-up, calibration, and deployment, and the data authentication and security.



This will ensure that both government and financial organisations can test the validity and veracity of data inputs from IoT devices, and be assured of the trustability of the raw data and data analysed through softwares from IoT and digital measuring devices.

The innovation project was delivered by a core team of researchers and digital device and web specialists, and cybersecurity experts. They worked on the ground at project partners' pilot sites. A wider working group of 35 stakeholders advised the project through online workshops. The co-design and action research activity ran between 20.07.2022 – 31.03.2023. However, due to running out of time after staff illness and changes, the knowledge exchange part of the project did not achieve much of the communications plan, The case study video is planned and being filmed in April 2023 with FAS, and the work was presented at 2 national conferences (CIEEM '22 and MASTS '23), and was discussed at ScotSecure '23.

The impact of the innovation will be realised through the KTIF grant starting work that the Natural Environment Research Council recognised as important to fund in 2023 with a grant of £172k. The NERC project includes some further testing of the openly published standardised processes this summer, and case studies of organisations applying them will be worked up as part of this project too, enabling knowledge exchange then.

Working with practitioners to iterate our ideas on the standardised processes was extremely valuable, bringing pragmatism and practical ideas to the project. Working with cybersecurity experts brought up-to-date practice on data security and governance. However, an unexpected feedback was that digital devices can be seen as poisonous in natural environments. Further research could consider how to make robust nature-friendly digital devices - without batteries and plastics, and with more biodegradable materials.

3. PROJECT DESCRIPTION

3.1 Summary background of the project

Cheap and practical IoT sensors and measurement devices such as digital camera traps, echo meters and audio moths can measure biodiversity baselines and improvements in a landscape. However, the IoT sensors and digital measuring devices lacked credibility as comparable, trustable data sources. This is because there is no consistent or standardised process for authenticating, calibrating and validating them, nor guaranteeing their cybersecurity, as each device manufacturer has differing methods and bespoke measurement units. In 2021, IoT attacks rose 50% in just six months, due to configuration flaws (configuration, calibration and validation issues) and cryptographic key flaws (authentication and security issues). This currently weakens sensors' and digital measurement devices' viability as creators of decision-grade data. This is likely to cause investors in biodiversity net gain projects to demand more expensive methods of proving biodiversity improvement, instead making the projects financially non-viable for farmers and land managers. This issue can be solved by writing standardised processes for configuring, calibrating, validating, authenticating and securing IoT sensors.

To deliver private investment in nature at scale, high-integrity ecosystem markets are needed that can provide assurances to investors, natural resource managers and the public that investment is delivering permanent and additional ecosystem services to society that would not have been possible without private investment. To quantify additional benefits, projects typically measure changes in ecosystem services in relation to a baseline. However, collection of empirical data in the field is time-consuming and expensive, and reliable proxies

have only been developed for a small number of ecosystem services. This is a problem because to be operational, ecosystem markets need decision-grade data that is cost-effective enough to avoid over-inflating prices.

In 2021, Project Co-ordinator Dr Rudman convened Trustable Credit (see trustablecredit.com), now a stakeholder group of 35 organisations from farm to finance, which worked together to agree the problems around decision grade data from IoT sensors and digital devices that measure biodiversity: including the lack of authentication and calibration processes which affect the trustability of their data, and their lack of cybersecurity. Developing standardised processes for device authentication, calibration and cybersecurity solves these issues.

Pilot sites already or about to be hosting IoT and digital measuring devices, in a range of differently connected locations, will test and feedback on the practical application of standardised processes. These were SAOS demonstration farms at Tulloch Farms, Fordoun, Laurencekirk; and Titaboutie Farm, Coull, Tarland; SRUC's Hill & Mountain Research Centre at Kirkton & Auchtertyre rural Farms; Lauriston Farm, Edinburgh; and RSPB's Glencripesdale rainforest reserve, a remote site in Morvern.

The deployments were overseen by a core team of researchers and digital device and web specialists, and cybersecurity experts. They worked on the ground at project partners' pilot sites. A wider working group of 35 stakeholders advised the project through online workshops. The activity ran between 20.07.2022 – 31.03.2023.

It was interesting to conceptualise processes for cheap digital device set-up, calibration, in-field deployment, security and authentication with both land-based practitioners and cybersecurity experts. The digital experts learnt what would be pragmatic and possible for land managers to achieve in remote outdoors locations. Land-based practitioners learnt about more robust general ICT practices with the devices in-field, and back at the office.

4. FINANCE

4.1 £62,832 total awarded.

4.2 Detail of spend

SRUC core team budget on project development, management and partnership development was mainly spent. The subcontract to John Gillies our cybersecurity expert was fully spent. We extended £4,000 spend to subcontractor SAOS from SRUC's budget as they were able to deliver the website when SRUC could not after losing a core team member.

4.3 Note on underspend

Due to running out of time, the project did not achieve much of the communications plan, although the case study video is planned and being filmed in April 2023, and the work was presented at 2 national conferences (CIEEM and MASTS), and was discussed at ScotSecure.

Only a small amount of Publicity activity cost is therefore claimed. C. £20k of scheduled project management T&S costs are also not claimed for the same reason.

5. PROJECT AIMS/OBJECTIVES

5.1 Aims and objectives

- To co-develop standardised processes for biodiversity measuring IoT sensors, digital devices and their software applications. This will ensure that both government and financial organisations can test the validity and veracity of inputs, and trustability of security certificates from softwares and IoT and digital measuring devices. The standardised processes will be drafted, then tested in pilot sites with different connectivity qualities, improved following feedback from pilots and review from the project's wider stakeholders and thereafter, made available - open source - to all, globally.
- To test the ease of application of the standardised processes on IoT sensors and digital measurement devices deployed in different landscapes and levels of connectedness: at SAOS Aberdeenshire demonstration farms (rural) and SRUC's Hill & Mountain research centre (rural/remote), Lauriston Farm (urban), RSPB's Glencripesdale Estate (remote). Iterate and improve the standardised processes for practical application ease, and decision-grade data robustness, following the gathering feedback from their application at a range of pilot locations with varying landscapes and levels of connectedness.
- Review the drafts with a wider group of 35 stakeholders, and European biodiversity measurement networks such as EuropaBON, TNFD.
- Publish the standardised processes open source and free, and formalise them into the natural economy sector in the UK.

6. PROJECT OUTCOMES

6.1 Aims and Objectives

We wanted to create a set of open source standardised processes for IoT sensors and digital devices that measure and triangulate biodiversity baselines and improvements.

- Enabling farmers and land managers to create decision grade data about the biodiversity ecosystem services they provide, and
- giving them opportunities to sell biodiversity net gain ecosystem projects into natural capital markets.

These were to be piloted at research sites and demonstration farms already set up with sensors and staff with experience of them, and co-developed with a working group of 35+ organisations that have come together around the issues in the last year, plus Scottish experts.

6.2 Milestones

Timeline and Milestones achieved

| Activity | July | August | September | October | November | December | January 2023 | February | March |
|--|--|--------------------|--------------------------|-----------------------------|----------------------------------|--------------------|--------------------|--|---------------------------------------|
| Kick off & oversight meetings with operational team | Kick off meeting | Monitoring meeting | Monitoring meeting | Monitoring meeting | Monitoring meeting | Monitoring meeting | Monitoring meeting | Monitoring meeting | Evaluation meeting |
| Co-develop Draft 1 of standardised processes | Writing | Reviewing | | | | | | | |
| Test Draft 1 implementation at 5 pilot sites | | | H&MRC and Glencripesdale | SAOS farms & Lauriston farm | | | | | |
| Gather feedback on practicality from pilot sites | | | | H&MRC and Glencripesdale | SAOS farms & Lauriston farm | | | | |
| Co-develop Draft 2 | | | | | | Re-writes | | | |
| Test Draft 2 implementation at 5 pilot sites | | | | | | | | SAOS farms & Lauriston farm | H&MRC and Glencripesdale |
| Trustable Credit working group comments on Draft 1 & 2 | | | | | Draft 1 comments | | | | |
| Video creation of how to apply the standardised processes to different sensors and measurement devices | | | | | | | | | Plan video filming editing and launch |
| Wiki website for open source standardised processes | | | | | | | | Set up | Plan launch |
| Dissemination and Press and PR activities | News to SG and Trustable Credit of KTIF investment | | | | Presentation at CIEEM conference | | | ScotSecure - SBRC and NCSC connections | Presentati on at MASTS conferenc e |

7. LESSONS LEARNED

7.1 Issues/Challenges

Team members were out sick for long periods in December 2022, when we had initially hoped to publish the standardised processes following the testing at pilot sites in October and feedback from the wider group of 35 stakeholders in November.

Then in January 2023, SRUC lost a key team member who was building the digital resources, and had to arrange for SAOS to take over the delivery of the public facing wiki website. This delayed us by another month, but the new wiki website at <https://decisiongradeiot.com/> was delivered by project deadline of 31st March, and continues to be developed as a living site for the NERC funded project (see 7.2).

7.2 Impacts

On farm and reserve testing of the standardised processes led to rationalisation and iteration of them. This iteration was then tested with the wider Trustable Credit group and Scottish Nature Finance Pioneers network. Their feedback is reflected in the final published version.

Publication of this is at <https://decisiongradeiot.com/>.

The Natural Environment Research Council (NERC) awarded Hannah Rudman £172k in 2023 as PI of “[Integrating finance and biodiversity for a nature positive future](#).” This action research project will feature the Lauriston Farm and RSPB Glencripesdale reserve case study videos, and will test the standardised processes, as published in March 2023 at decisiongradeiot.com, at further sites measuring biodiversity in summer 2023.

Case study video filming by FAS team has been booked, with the NERC grant continuing the action research and knowledge transfer work.

7.3 What would you do differently

The project was too rushed, starting late. Then knowledge exchange (KE) activities were not achieved due to illness, and losing team members in 2023 ahead of the March deadline. Although innovation projects often benefit from rapid development, this one suffered from ambitious timescales in that there was no contingency for slippage, and we ended up not completing all KE activity. We completed the innovation activity within the timeframe.

8. COMMUNICATION & ENGAGEMENT

8.1 Overview of Communications and Engagement

- Partner deployments following the standardised processes were achieved at all SRUC and SAOS farms, Lauriston Farm and at the RSPB Glencripesdale reserve.
- Final Trustable Credit working group dissemination and feedback session was held online, in partnership with the Scottish Nature Finance Pioneers network, on 29th November 2022.
- First engagements with Scottish Business Resilience Centre and National Cybersecurity Centre were made in December 2022, and consolidated at ScotSecure conference, Feb 2023.
- The project and standardised processes were presented at the Chartered Institute of Ecology and Environmental Management's (CIEEM)'s Autumn Conference, October 2022, and at the Marine Alliance for Science and Technology for Scotland (MASTS) March 2023 conference.

8.2 FAS Engagement

The FAS video team will be filming about the standardised processes supporting the digital biodiversity baseline measurement at Lauriston Farm on 25th April 2023. Thereafter, a video case study will be edited to share on decisiongradeiot.com. Whether the film is shared on the FAS website is to be decided by the producers.

The communications plan has mainly not been delivered yet, and therefore is not claimed for.

9. KEY FINDINGS & RECOMMENDATIONS

9.1 Analysis and discussion

It was interesting to conceptualise processes for cheap digital device set-up, calibration, in-field deployment, security and authentication with both land-based practitioners and cybersecurity experts. The digital experts learnt what would be pragmatic and possible for land managers to achieve in remote outdoors locations. Land-based practitioners learnt about more robust general ICT practices with the devices in-field, and back at the office.

Whilst the processes improved the quality and interoperability and security of data, they complicated the start of projects with extra technical and administrative steps of the type not much appreciated by the land-based practitioners, however, the working group included verifiers and auditors who really liked these aspects, and assured the practitioners of their value in creating nature restoration projects for new financial opportunities as well as their innate ecological benefits.

Digital best practice (locating devices on GPS map layers in apps) was achievable, but not necessarily always at site, where power and connectivity were daily issues. Data collection, analysis and management and governance mechanisms remained highly dependent on manual intervention. Automation of this through network connectivity was not guaranteed due to the power and connectivity issues. Satellite broadband and 5G antennae would improve rural locations' connections where LoRaWAN is not cost-effective.

A key issue that arose working with nature lovers, whether they were farmers, ecologists, rangers or volunteers, was that they were concerned about the plastic and poisonous materials (in batteries and circuit boards) contained in the digital devices that were being put out in natural landscapes where animals lived. An important development here would be to invent slowly biodegradable and non-poisonous devices.

10. CONCLUSION

The innovation project was achieved, but ran late due to illness and staff changes meaning that the knowledge exchange aspects were not achieved at the scale we had originally envisaged. We have not claimed for this part of the project.

The impact of the innovation will be realised through the KTIF grant starting work that the Natural Environment Research Council recognised as important to fund in 2023 with a grant of £172k. The NERC project includes some further testing of the openly published standardised processes this summer, and case studies of organisations applying them will be worked up as part of this project too, enabling knowledge exchange then.

Working with practitioners to iterate our ideas on the standardised processes was extremely valuable, bringing pragmatism and practical ideas to the project. Working with cybersecurity experts brought up-to-date practice on data security and governance. However, an unexpected feedback was that digital devices can be seen as poisonous in natural environments. Further research could consider how to make robust digital devices without batteries and plastics, and with more biodegradable materials.

11. ANNEXES/APPENDICES

All supporting explanatory, how to and proforma documents which support the standardised processes are all available online in open source format - at: <https://decisiongradedata.com>

KTIF Secretariat
Agricultural Policy
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