1. **Project title** : Understanding uncertainty in ecosystem service accounting and monitoring

2. **Supervisors with affiliations**

Dr Casey Ryan, Geosciences, University of Edinburgh (Casey.ryan@ed.ac.uk)

Dr Janet Fisher, Geosciences, University of Edinburgh (janet.fisher@ed.ac.uk)

Dr Ina Porras, Sustainable Markets Group, International Institute for Environment and Development (IIED) (ina.porras@iied.org) and Chair of the Plan Vivo Foundation

3. CASE partnership

IIED has indicated willingness to meet the minimum CASE Funding.

4. **Primary supervisor contact email:** Casey.ryan@ed.ac.uk

5. **Project background**

Payments for ecosystem services (PES) are increasingly employed to manage natural resources by linking ecosystem custodians to payment incentives from ecosystem beneficiaries [1]. However, PES has met with mixed success and analyses have identified gaps in how environmental science is applied in such schemes. It is argued that the subtleties and uncertainties of natural science knowledge are often lost as it is translated and applied in PES project design and monitoring, due to other, often socioeconomic, project objectives, and field/budgetary realities [2].

The market for carbon offsets from afforestation/reforestation is one of the most common examples of PES, and is an example where natural and social science need to be reconciled in practice. In addition to providing a global climate service, forest carbon projects (particularly projects in the voluntary carbon market (VCM) e.g. REDD+) are viewed as having potential ecosystem service (ES) and socioeconomic co-benefits at the local level, including biodiversity conservation, watershed protection, improved resilience to climate variability and benefits from cash income. In the context of these PES schemes with multiple objectives, there is a clear need to improve how uncertainties in natural science are applied in ES accounting tools, understand how this interacts with socioeconomic information and analyses, and understand the implications for PES project design and monitoring [3].

By analysing three case studies and using a mixed methodological approach, this PhD project will analyse the treatment of uncertainty in ES accounting tools (focusing primarily on carbon accounting and extending to other ES), analysing the implications for PES project design and monitoring. It will do this by applying a range of ES accounting tools to several PES projects, analysing the uncertainties in the ES quantification, the cost-effectiveness of the methods, and the legitimacy of the tool to the various actors at project level. The case studies are likely to be Plan Vivo carbon projects based in Mexico, Uganda and Mozambique, with which the supervisors have worked in the past.

The ES accounting tools to be applied are: a process-based model developed by Edinburgh University (UoE) for assessing GHG removals (SHAMBA); remote sensing techniques for biomass estimation; and basic field measurement approaches.

6. **Key research questions**

   a) For carbon accounting tools, what are the key areas of uncertainty in the underlying science (e.g. forest and soil science), what are the available approaches to handling this uncertainty (e.g. conservative model parametrisation, sampling intensity), and how does this affect carbon estimation, project design and monitoring in practice?

   b) For environmental co-benefits (e.g. biodiversity or hydrological related services), what are they key areas of uncertainty and how do approaches to handling this uncertainty affect quantification, project design and monitoring of co-benefits?

c) Given this analysis of PES accounting and monitoring tools, what are the trade offs between certainty, cost and local legitimacy? What frameworks can be used to ensure that environmental and social sciences are robustly and cost-effectively integrated and applied in PES project design and monitoring?

7. **Methodology**

The project will start with a critical literature review of the origin of the ES accounting tools and their uncertainties, then examine how they have/will be applied in the case study PES projects, and how they interact with socioeconomic knowledge and analyses in these projects.

The study will then use existing and newly collected field data from the projects and statistical techniques to apply and test each of the monitoring tools and examine available approaches to handling uncertainty in ES quantification. This analysis will test the hypothesis that there are trade-offs between scientific certainty, costs and legitimacy of the accounting tools. These aspects are supported by supervision from CR, IP, and JF respectively.

The study will then work with the VCM PES projects to optimise the use of the accounting tools in PES project design and monitoring, and developing practical, widely applicable frameworks for robust quantification of ES accounting in PES projects

Year 1	Chapter planning, literature review, research skills courses, attendance of appropriate masters degree courses. Meetings with VCM PES projects.
Year 2	Data collection - field data to apply the tools, assess costs, and understand the legitimacy of the tools to different actors. Conference attendance.
Year 3	Data analysis – write up and publication planning

8. **Training**

A comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills. Generic research skills will be provided for presentation, report/paper writing and project management. Technical training to apply the accounting tools (e.g. Python computer programming, remote sensing, field data collection) can be provided to meet the needs of the student.

9. **Requirements**

This award would suit a student with a cross-disciplinary background with qualifications and experience in both social sciences and applied natural science. Experience in conducting independent fieldwork in developing countries would be highly valuable

10. **Further reading or any references referred to in the proposal**

1. Engel, S., S. Pagiola, and S. Wunder, *Designing payments for environmental services in theory and practice: An overview of the issues.* Ecological Economics, 2008. **65**(4): p. 663-674.
2. Naeem, S., et al., *Get the science right when paying for nature's services.* Science, 2015. **347**(6227): p. 2.
3. Benessaiah, K., *Carbon and livelihoods in Post-Kyoto: Assessing voluntary carbon markets.* Ecological Economics, 2012. **77**: p. 1-6.