UKEOF
ENVIRONMENTAL OBSERVATION FRAMEWORK

Citizen Science & Environmental Monitoring: Evaluating Opportunities, Costs and Benefits

Citizen science has great potential as a tool for environmental monitoring. Volunteers already make a valuable contribution by monitoring various environmental attributes, and there is interest from many agencies, including governmental bodies in the UK, in increasing the use of citizen science.

Until now there has been no readily-available advice on how to make a quantitative evaluation of the opportunities, costs and benefits of taking a citizen science approach. In this project* we sought to assess current volunteer involvement in environmental monitoring activities supported by the UK public sector, and to develop a framework based on our findings to help others evaluate the costs, benefits and opportunities of taking a citizen science approach.

Making decisions on when to invest in citizen science requires information on its costs and benefits (both financial and non-monetised). A range of different methods can be used to undertake such an evaluation, including methods that can account for direct and indirect costs and benefits, including those that are not monetised.

We implemented four of these methods in a tool to enable users to evaluate the costs and benefits of citizen science for particular activities. This tool is freely available to download and use.

Authors
R.J.P. Blaney & A.C.V. Philippe
WRc plc
G.D. Jones,
Fera Science Ltd
M.J.O. Pocock,
Centre for Ecology & Hydrology

** Full report and evaluation tool available at www.ukeof.org.uk: Blaney, R.J.P., Jones G.D., Philippe, A.C.V., Pocock, M.J.O. (2016)* Citizen Science and Environmental Monitoring: Towards a Methodology for Evaluating Opportunities, Costs and Benefits. *Final Report on behalf of UKEOF. WRc, Fera Science, Centre for Ecology & Hydrology.*

Credit: L. Carvalho, CEH

Background

There is a long history of volunteer involvement in monitoring the environment, especially in the UK. This volunteer involvement, i.e. citizen science, can complement, augment or even replace monitoring by contracted professionals. There is a need to understand more fully the potential for citizen science to support environmental monitoring programmes, and how we can evaluate the relative costs and benefits of different approaches. Between September 2015 and March 2016 a project team from WRc, Centre for Ecology & Hydrology (CEH) and Fera was commissioned by UKEOF to develop an evaluation framework for employing citizen science in environmental monitoring.

Findings

1. Current approaches to citizen science in UK governmental bodies

Interest in citizen science is increasing, but taking a citizen science approach is not free; its costs can be substantial and it can vary considerably in its cost-effectiveness depending on how it is implemented. Citizen science has the potential to provide a wider range of benefits than simply the data collected, such as increasing public engagement or in helping to detect rare events. We assessed the current state of, and attitudes towards, citizen science in key environmental public bodies in the UK through a targetted staff survey and found that:

- Most organisations' approaches to evaluating citizen science is embryonic (suggesting that there is considerable potential for it to develop).
- Citizen science is already widely-used to monitor some environmental attributes, especially non-marine biodiversity, alien invasive species, weather and climate, and protected sites. For these, some respondents considered that citizen science was already an essential component of their organisation's monitoring activities. Citizen science is less widely-used to monitor other environmental attributes.
- The most important opportunities provided by citizen science included:
  - more/better data (e.g. greater spatial coverage of records),
  - being able to undertake public engagement with science and the environment,
  - increased cost effectiveness (or lower cost) compared to monitoring by professionals.
- The greatest barriers for the use of citizen science were regarded as:
  - concerns about data quality,
  - lack of control in the monitoring (potentially leading to spatial bias, inadequate recording, and loss of authority in the results),
  - activities can be unsuitable for volunteers (e.g. due to access restrictions),
  - lack of funding, resources, skills and experience in the organisation
- Few respondents considered that lack of interest by potential volunteers was an important barrier. However, it is important to consider volunteer recruitment and retention when planning new activities.
- Many of the costs and benefits of citizen science are known or can be estimated. However, staff and IT costs, which are direct costs, tend to be better known than other (more indirect) costs. Overall, though, we found that costs are rarely collated or used to evaluate the use of citizen science.

2. Evaluation of citizen science

In the context of resource constraints in the public sector and the need for efficiency and transparency, evaluating citizen science approaches is essential, and can be undertaken to meet different objectives:

- to compare the outcomes from citizen science (for research, monitoring or public engagement) with alternative approaches
- to make a case for funding the development of citizen science activities
- to justify continued investment in citizen science

However, whilst there is much information on best practice in citizen science, there was no readily-available advice for evaluating the costs and benefits of citizen science. This project sought to fill this gap.

3. Developing a framework to evaluate citizen science

From a long list of economic methodologies, we concluded that four approaches were most suitable to evaluate citizen science approaches for environmental monitoring. No single method was suitable in all circumstances so we devised a framework that employs all four approaches (including evaluating some non-monetised costs and benefits).

The four methods are:

- **Return On Investment** (ROI) which solely considers the financial aspects to assess the value an organisation receives from their investment in volunteers.
- **Cost-Benefit Analysis** (CBA) which considers costs and benefits of an approach (e.g. citizen science, or monitoring by professionals) to society as a whole, rather than just to the organisation, and includes non-monetary costs and benefits where a value can be estimated. The costs and benefits are summed in order to determine whether the costs or benefits predominate.
- **Cost-Effectiveness Analysis** (CEA) which compares the relative costs to the outcomes (effects) of two or more options (e.g. comparing contracted monitoring with a citizen science approach). It is most useful when the outcomes of the option are the same, or where constraints prevent the use of a cost-benefit analysis.
- **Multi-Criteria Analysis** (MCA) which is a structured approach to determine the relative preference for different options based on evaluation indicators. Unlike a cost-benefit analysis, the measurement of indicators need not be in monetary terms. It relies on expert judgement to evaluate non-monetary costs and benefits.

These can be used to indicate the value of undertaking citizen science (ROI and CBA), or to indicate the value of citizen science compared to an alternative e.g. professional monitoring (CEA), including the use of qualitative indicators, such as raising public awareness (MCA).

Fully qualitative approaches can also be used for evaluation, e.g. to assess outcomes for participants, but are generally used post-implementation rather than for evaluating the potential of a particular approach.

4. A tool for evaluation of the use of citizen science

We developed a framework based on these four evaluation methodologies and implmented them in a freely-available tool, which we tested with several case studies. The tool consists of:

- Initial screening questions to assess the feasibility of using citizen science.
- A decision framework to help users decide which of the four evaluation approaches is most suitable.
- A facility to enter costs and benefits. These can either be calculated or estimated values, or qualitative assessments (for the multi-criteria analysis).
- A presentation of the results from the four different evaluation approaches.

The tool is populated with default values, including some 'difficult-to-quantify' values such as benefits to participants' health and well-being. These defaults can be adjusted by the user, but further research is required to gain a better estimate of such values.

The tool can be used for evaluating citizen science as a new standalone activity, or as an activity to replace or augment existing monitoring and research. It can be applied to activities being run by, or commissioned by, an organisation.

Recommendations

- Individual citizen science activities should be rigorously evaluated at key points in the life of the activity (including during the inception and planning stages). All such evaluations should be planned in advance.
- Those undertaking evaluation of citizen science activities should share their findings with other project organisers (within and between organisations). This includes whether the evaluation in the planning phase of activities supports citizen science or supports it over an alternative, such as monitoring by contracted professionals.
- Organisations should undertake a formal risk assessment for the development of citizen science, particularly where it might replace existing long-term or mandated monitoring by professionals.
- Better evaluation of the 'difficult-to-quantify' benefits of citizen science should be a focus for further research. It would be useful to create a database of citizen science benefit values from existing research.
- The spreadsheet evaluation tool should be viewed as 'under development'. Any results should be carefully considered before being used to support decision-making. The authors and funders cannot accept any responsibility for decisions made with the results of the spreadsheet evaluation tool.

ACKNOWLEDGEMENTS

We thank UKEOF Citizen Science working group for their support and guidance during this project and the representatives from the government agencies who contributed their time and expertise to the survey. We thank those who trialled the use of the evaluation tool in the case studies; their feedback helped improve its functioning and confirmed its potential in assessing the viability of citizen science monitoring.

UKEOF
ENVIRONMENTAL OBSERVATION FRAMEWORK

UKEOF works to improve coordination of the observational evidence needed to understand and manage the changing natural environment. It is a partnership of public sector organisations with an interest in using and providing evidence from environmental observations. Contact us at office@ukeof.org.uk

UKEOF PARTNERS

Department for the Environment , Food and Rural Affairs, Department of Energy and Climate Change, Economic and Social Research Council, Environment Agency, Forestry Commission, Joint Nature Conservation Committee, Met Office, Natural England, Natural Environment Research Council, Natural Resources Wales, Northern Ireland Environment Agency, Scottish Environment Protection Agency, Scottish Natural Heritage, The Scottish Government, UK Space Agency, Welsh Research Environment Hub, Welsh Government.

WRc is an independent consultancy, operating across the Water, Environment, Gas, and Waste & Resource Management sectors. Working across sectors WRc strives to share learning, and work in a collaborative way. WRc builds on a legacy stretching back over 90 years, with 120 expert members of staff based in the main office and testing facility in Swindon. WRc works throughout the UK, as well as globally, to provide innovative solutions that enable clients to meet the challenges of the future. Clients include utility and manufacturing companies, trade organisations, government departments and public bodies, NGOs, universities, the European Commission and the World Bank.

Fera Science Limited (Fera) is a translational science business, employing more than 500 people, including 350 scientists at the National Agri-food Innovation Campus near York. Fera (formerly the Food and Environment Research Agency) is a national and international centre of excellence for interdisciplinary investigation and problem solving across plant and bee health, crop protection, sustainable agriculture, food and feed quality and chemical safety in the environment. It turns expertise and innovation into ways to support and develop a sustainable food chain, a healthy natural environment, and to protect the global community from biological and chemical risks. Its vision is to be the global provider of leading edge scientific solutions, evidence and advice across the agri-food chain.

Centre for Ecology & Hydrology (CEH) is the UK's centre of excellence for integrated research in terrestrial and freshwater ecosystems and their interaction with the atmosphere. As part of the Natural Environment Research Council, CEH provides national capability based on innovative, independent and interdisciplinary science and long-term environmental monitoring. CEH also has a long history of supporting volunteers undertaking recording, especially through the Biological Records Centre (established in 1964) and using the data as a unique resource to assess the impacts of environmental change. CEH has produced influential guides on the use and development of citizen science.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

www.ukeof.org.uk

@UKEnvObs

This guide can be freely distributed in its original form for non-commercial purposes. Please feel free to forward it to anyone you think will be inserted. All content is copyrighted and no images or sections of text can be extracted elsewhere without first obtaining permission from UKEOF.

Published 2016