New Technologies for Environmental Monitoring

Workshop Report

24th September 2013

Scottish Government
Victoria Quay,
Edinburgh

Acknowledgements

We would like to acknowledge the hard work of the UKEOF secretariat in organising and running this workshop. We are grateful to the Scottish Government for hosting the day, and to Scott Boyd and his team for their work.

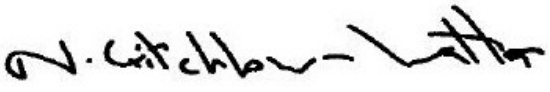
Foreword

There has been a fundamental shift in the capability, accessibility and ubiquity of modern technology; for instance, 70% of the UK's population now own a Smartphone. These new technologies present huge opportunities for people to monitor their immediate environment and radically change how we understand, protect and improve the environment.

This workshop was set up in response to the need of agencies to better understand the landscape of innovative technology, and identify how we can make more effective and efficient use of it. The talks and panel discussions were inspiring and informative, and all the feedback received has been overwhelmingly positive. Hopefully, this workshop report will enable organisations to take the key issues and recommendations, and use them to improve environmental monitoring.

I am grateful to UKEOF for organising this workshop, which is a powerful example of how joint working through the UKEOF can help us deliver our individual objectives.

Nathan Critchlow-Watton



Principal Scientist
Scottish Environment Protection Agency

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Executive Summary

Fifty three people representing twenty seven organisations from across academia, public, private and the third sector attended the 'New Technologies for Environmental Monitoring' workshop in Edinburgh on Tuesday 24th September 2013, jointly hosted by the UK Environmental Observation Framework (UKEOF), Scottish Environment Protection Agency (SEPA), and CAMERAS (Co-ordinated Agenda for Marine, Environment and Rural Affairs Science).

Workshop Aims

The joint workshop was organised to bring together members of the observation community to:

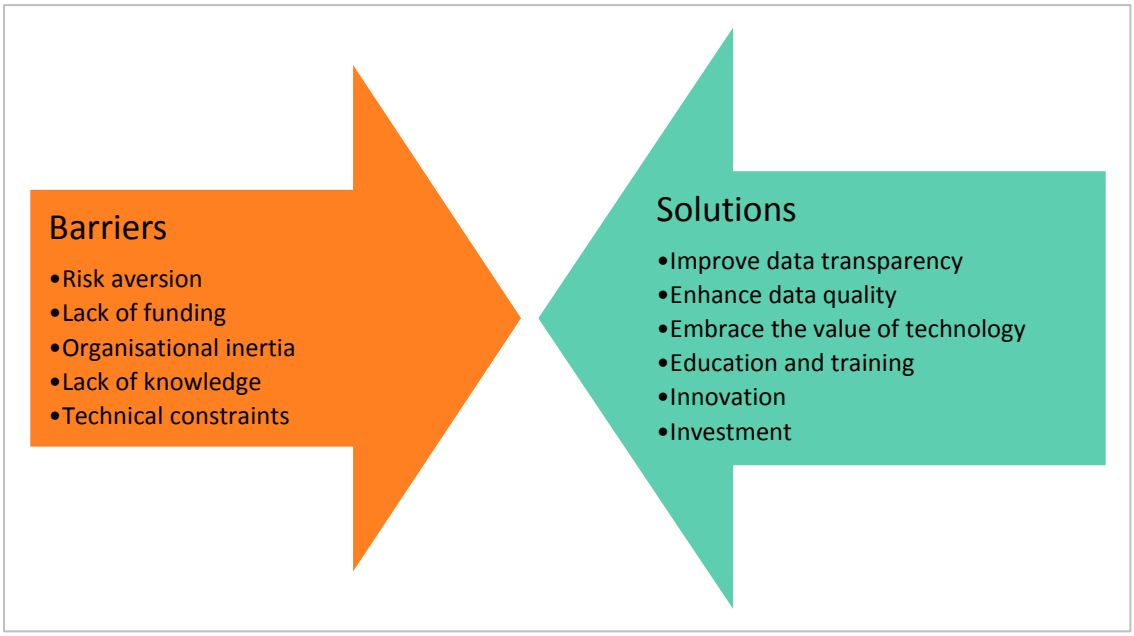
- Summarise recent advances in personal environmental monitoring technologies and low cost data gathering devices
- Explore how existing technologies could be applied to different areas of monitoring
- Consider how emerging technologies could improve environmental monitoring
- Explore the need to develop new technologies for efficient monitoring.

Key Messages

The key messages from the workshop were:

1. Organisations should aspire to be more innovative, less risk averse and more ready to invest in emerging monitoring technology to deliver efficiency savings, operational improvements and an improved understanding of the environment (Figure 1).
2. New technologies are already being used for monitoring a diverse range of environmental variables in air, water and land.
3. Development of new and more effective environmental monitoring technologies is happening at a fast pace. Hack-a-thons can be a creative and productive way of collaborating with individuals with different interests, experience and expertise.
4. Risk aversion and lack of funding within and across organisations were identified as the most common barriers to the uptake of innovative environmental monitoring technologies.
5. One of the main perceived risks is of variability in the quality of data that are collected.
6. Within organisations there can be a lack of visibility/engagement with innovative technologies, and a paucity of the necessary skills for their development.
7. Greater use of new technologies can be encouraged by making data open and available and increasing the transparency of meta-data.

Figure 1 Summary of Barriers and Solutions for the Uptake of New Technologies in Environmental Monitoring Organisations



Next Steps

Arising from discussions at the workshop and building on the feedback from participants, the recommended next steps are presented for consideration and further development by the organisations involved.

- It is recommended that a review of high value environmental monitoring technologies be carried out to inform and guide the choices of developers and users for particular scientific approaches.

- Concerns surrounding the quality of data collected by environmental monitoring technologies could be addressed by producing a peer-reviewed paper on best practice data sampling, verification and management strategies.

- In response to the apparent paucity of knowledge, it is recommended that a profile of training courses on the development, use and uptake of new technologies are carried out within environmental monitoring organisations. Training could be aimed at:
  (a) high level decision-makers;
  (b) data custodians; and
  (c) internal developers.

- Based on the overwhelmingly positive reception to this workshop, UKEOF should consider holding similar workshops with the aim of promoting innovation to encourage more efficient and effective environmental monitoring and observation activities at the UK level.

1. Introduction

1.1 Background

Parallel discussions within SEPA and the Data Advisory Group (DAG) on the need to better understand the implications and potential of innovative environmental monitoring led to the UKEOF secretariat agreeing to organise a workshop on the topic.

This was developed in a partnership between UK Environmental Observation Framework (UKEOF), Scottish Environment Protection Agency (SEPA), and CAMERAS (Co-ordinated Agenda for Marine, Environment and Rural Affairs Science), with Scottish Government providing the venue.

Fifty three people attended the workshop from twenty seven different organisations in the public, private, academic and voluntary spheres representing England, Northern Ireland, Scotland, Wales, and the UK as a whole. Attendees are listed in Annex 1.

1.2 Workshop Aims

The joint workshop was organised to bring together members of the observation community to:

- Summarise recent advances in personal environmental monitoring technologies and low cost data gathering devices
- Explore how existing technologies could be applied to different areas of monitoring
- Consider how emerging technologies could improve environmental monitoring
- Explore the need to develop new technologies for efficient monitoring.

2. Key Messages

The following key messages emerged from the workshop presentations, discussions and breakout sessions.

1. Organisations should aspire to be more innovative, less risk averse and more ready to invest in in emerging monitoring technology to deliver efficiency savings and operational improvements.
2. New technologies are being used for monitoring a diverse range of environmental variables in air, water and land.
3. Development of new and more effective environmental monitoring technologies is happening at a fast pace. Hack-a-thons can be a creative and productive way of collaborating with individuals with different interests, experience and expertise.
4. Risk aversion and lack of funding within and across organisations were identified as the most common barriers to the uptake of innovative environmental monitoring technologies.
5. One of the main perceived risks is of variability in the quality of data that are collected.
6. Within organisations there can be a lack of visibility/engagement with innovative technologies, and a paucity of the necessary skills for their development
7. Greater use of new technologies can be encouraged by making data open and available and increasing the transparency of meta-data.

3. Summary of the Day

The workshop began with a series of presentations which focused on social media and crowd sourcing, and air pollution monitoring and assessment. Speakers presented case studies of the development and application of personal monitoring technologies for a variety of environmental variables, demonstrating how their use can increase the amount and types of data that can be collected. The afternoon session followed the theme 'new technologies: new challenges'. Presentations covered the principles of good data management and app development. After both sets of presentations, workshop attendees were invited to ask the speakers questions relating to their presentations. A detailed description of the presentations and the panel question and answer sessions are available in sections 5 and 6. The presentations themselves can be found on the UKEOF website. The Agenda for the day is in Annex 2.

4. Discussion

Workshop attendees were presented with four questions posed on poster boards around the room and were asked to respond to each one in turn by adding their comments on Post-it notes:

- What barriers have you come across in your organisation for using this type of technology?
- What steps do you think could be taken to encourage greater use of new technologies for environmental monitoring?
- Have you identified anything from the workshop that you could potentially use or will follow up on?
- Are you aware of other examples of personal environmental monitoring technologies?

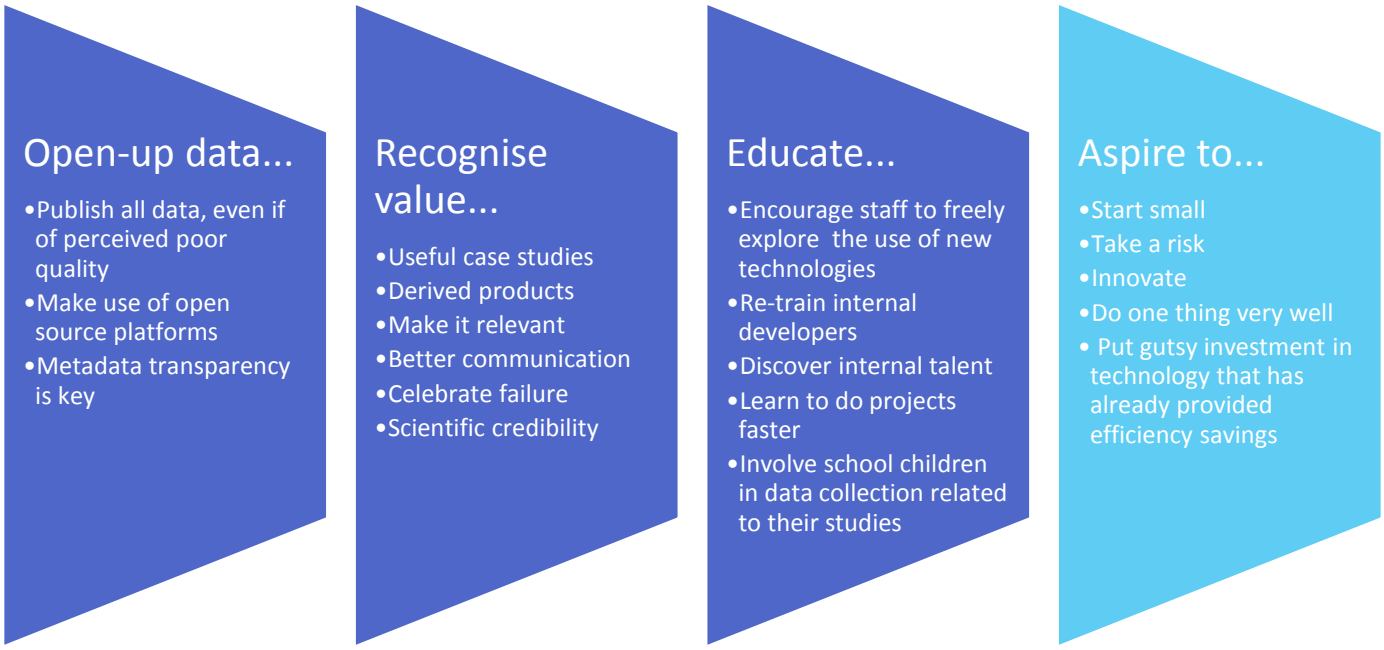
A discussion session followed that was led by four rapporteurs who reported back on each of the questions.

4.1 There was acknowledgement of several different barriers and constraints to the uptake of new technologies within and across organisations (Figure 2). Attendee comments were grouped into six categories with the highest number of points relating to 'risk aversion' and 'lack of funding'. An important factor preventing organisations from using new technologies is distrust in the quality of data that is produced. 'Fear of failure' was a barrier discussed later in the session as something that organisations should instead embrace, learn from and share with others. Funding for the development and use of new technologies is often restricted by an organisation's historical investment. Substantial funding 'up front' to kick-start a project is also hard to come by.

4.2 The group provided some valuable suggestions of how greater use of new technologies could be encouraged (Figure 3). One of the key themes from the workshop was the importance of making data open and available, including underlying meta-data which should be transparent. Attendees proposed that organisations should recognise the value that new technologies can bring, including scientific credibility, as long as the right methodologies and data verification strategies are chosen. 'Lack of knowledge' can be overcome through education, by allowing staff more time to research the use of new technologies and re-training internal developers to keep up with technological advancements. Attendees also offered some inspiring advisory statements.

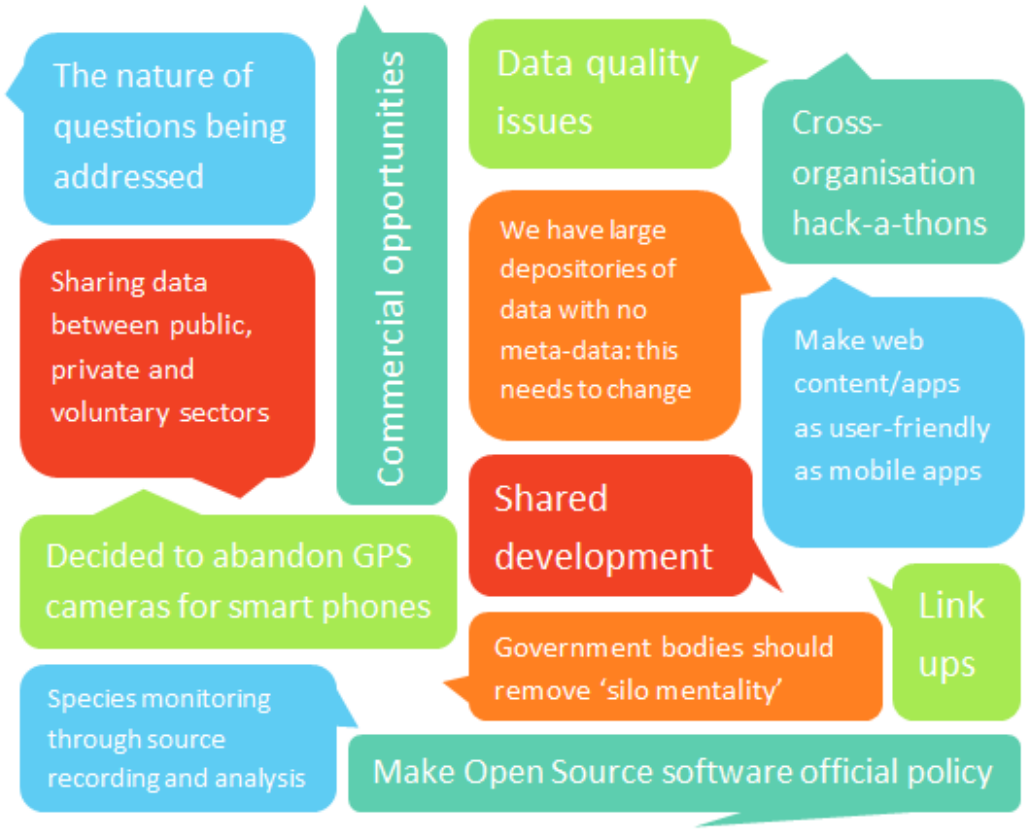
Figure 2 Barriers to using new technologies within organisations

Figure 3 What steps could be taken to encourage greater use of new technology?



4.3 Figure 4 gives an indication of the impact of the workshop, as it shows a range of things that attendees said they will use and follow-up on in future. These included development opportunities and new linkages with organisations; new ideas and knowledge of alternative technologies. The workshop made stakeholders aware of the current research and policy landscape surrounding new technologies for environmental monitoring and the salient issues to be tackled.

Figure 4 Have you identified anything from the workshop that you will use or follow up?



Box 1: Environmental monitoring products

- Lapka: A personal environment monitor app for iPhones. Sensors allow you to measure and monitor variables in your surrounding environment.
- WiMoto: A series of tiny, rugged, wireless sensors that connect to your smartphone via Bluetooth, enabling you to remotely monitor the environment in your home and garden.

Box 2: Environmental monitoring projects using new technologies

- The Centre of Expertise for Water's (CREW) report *'Innovations on aquatic monitoring'* highlights examples of where personal monitors have the potential to be, or currently are, being used.
- SEPA's Diffuse Pollution Farm Assessment: end-to-end mobile data capture and reporting system.
- SNH's SWIFT project: Site Condition Monitoring and Site Check on protected areas using mobile devices that provide background information, field data capture, spatial data and photographs , and upload to corporate repositories.
- Weather Underground: a network of personal weather station recording basic weather information such as wind speed and temperature every two seconds.
- Met Office's Weather Observations Website (WOW) crowd-sourcing platform.

4.4 Workshop attendees identified a number of additional examples of new technologies for environmental monitoring, covering a range of environmental variables (figure 5). Attendees also provided examples of environmental monitoring products currently on the market (Box 1) and projects underway which are using personal monitoring technologies (Box 2).

Figure 5 Other examples of personal environmental monitoring technologies

5. Morning session: Social Media and Crowd Sourcing, Air pollution Monitoring and Assessment

Nathan Critchlow-Watton, (Principal Scientist, SEPA and UKEOF Management Group member), welcomed attendees to Victoria Quay and introduced the aims of the workshop. Six presentations followed, grouped around the themes of social media and crowd sourcing, and air pollution monitoring and assessment. All presentations are available on the UKEOF website.

5.1 Environmental hack-a-thons

Simon Redding (Environment Agency) gave a whistle-stop tour of his experience of environmental hack-a-thons, both as a participant and an organiser. Getting together a group of interested people with divergent interests, expertise and experiences (inside and outside of work) usually results in some unexpected and innovative approaches to a particular problem. Simon emphasised that the people who solve an issue often had no previous idea that a particular problem existed, and this fresh approach is the main benefit from bringing different groups of people together.. There is always some level of risk (will anything useful come out? Will it be a disaster and damage our reputation?), but with

sufficient advance planning and guidance on the day (use a guide; give out prizes and treats; make sure the challenge is clear) this can be minimised.

5.2 Soil testing kit project – collecting and managing soil data on a global scale

Selena Georgiou (Growers Nation/ Met Office) described using a 24 hour hack-a-thon to develop an achievable, low cost, wireless, self-powered, maintenance-free, soil testing device, with:

- WiFi enabled communications that can upload data automatically without need for a phone, and;
- 2G/ 3G enabled communications to allow unattended data uploads wherever there is mobile reception.

The aim of this device was to produce data to feed into a prototype 'Grow Your Own' app, to answer the questions:

- **What** produce can I grow where I live?
- **When** should I sow/ plant/ harvest it?
- **How** should I sow/ plant/ harvest it?

Teams from Google and the Met Office worked to together to achieve a basic, working prototype by the end of the 24 hour session, which with further development should result in a low-cost, fit-for-purpose device. There was a steep learning curve, but the experience was really positive and Selena encouraged others to have ago and take the (minimal) risk for (high) potential benefit.

5.3 Naturelocator – The BatMobile and other apps

Dave Kilbey explained that the Naturelocator team at University of Bristol works with researchers and organisations to engage the public with data collection to:

- design bespoke smartphone applications, for example using crowd sourced data;
- innovate to take the technology in new directions;
- provide data visualisation tools to enhance feedback.

Leafwatch Tracker, Plant Tracker and Sealife Tracker have all been developed by Dave's team, and are used to harness the public's enthusiasm for citizen science. For example, Plant tracker (a collaboration between Environment Agency, NERC Centre for Ecology and Hydrology (CEH) and University of Bristol) is used to identify the location of invasive, non-native plant species such as Himalayan balsam in order to eradicate them from a location. This saves time and money for all the organisations involved, and gives a sense of satisfaction and 'making a difference' to participating citizens.

Naturelocator's Batmobile project is a collaboration with CEH and University College London to test the feasibility of developing an app capable of automatically identifying the UK's bat species from their ultrasonic calls. Dave talked through the particular challenges of working with bats (it's dark; we can't hear their calls; they move quickly), demonstrated the progress so far with this work, and the next steps needed to get a fit-for-purpose app – in this case, the need to work with a bat bio-acoustic specialist. This approach is now being developed for use by other projects where the target species is identified primarily by its call, for example the New Forest cicada project.

5.4 Monitoring air quality: small sensors start to show their capabilities

Rod Jones (University of Cambridge) introduced his work with the Sensor Networks for Air Quality at Heathrow Airport project ('SNAQ Heathrow'). This work explores methods to quantify emissions from aircraft at Heathrow airport, and compares the current approach of using a small number of very accurate, precise measurements, with an alternative approach using a much larger number of less accurate/lower quality measurements. The complexities of particulate movements, linked to many factors including weather, are significant and a detailed analysis is needed to clarify the observed patterns. It is anticipated that the knowledge gained from this detailed research will enable data to be collected by a series of

minaturised/hand-held monitoring devices, rather than from a few hugely expensive 'stations'. This has significant applications and money saving implications worldwide.

5.5 iSPEX – measuring aerosols with mobile technology

Hester Volten (Netherlands Environmental Assessment Agency) introduced the work of the iSPEX team, and demonstrated how clipping on a simple add-on and adding a plastic film to the screen to a standard iPhone can change it into a scientific instrument to measure atmospheric aerosols. A better knowledge of the distribution of aerosols (i.e. small suspended particles) in the earth's atmosphere is relevant to many aspects of our lives, as aerosols affect our health. For example, aerosols exacerbate asthma, can prevent aeroplanes from flying safely (e.g. due to volcanic ash in the atmosphere), and form one of the large unknowns in our climate change predictions (the error bars on climate change predictions are primarily due to the unknown impact of aerosols).

Originating as a satellite prototype developed by astronomers to measure dust in space, the technology has been modified and reduced in size (and cost) by the iSPEX project for use on the ground. This has the added benefit of providing calibration for the satellite data recorded by the astronomy programme.

Winning a national science communications prize in 2012 enabled the team to progress from a prototype stage to launching a national citizen science experiment. Ten thousand iPhones with iSPEX add-ons were distributed to volunteers around The Netherlands, and when weather conditions were optimum (blue skies across the country), recorders were alerted to take measurements. These mass-recording, citizen science events (8th July, 5th September) provided excellent sets of data to test the technology and received enthusiastic publicity both locally and nationally. Volunteers recently received a social science questionnaire asking about their experiences of taking part, which will enable the iSPEX team to maximise the benefits of participating for volunteers in the future.

5.6 Panel Q&A: Social media, crowd sourcing, monitoring and assessment

Questions were invited for speakers from the morning sessions, and the following issues were discussed:

iSPEX:

- Although iPhones have only 30% of the smartphone market in The Netherlands, their uniformity makes it feasible to develop physical modifications to enable mass citizen science participation. Samsung (the most popular Android phones) holds about 60% of the market and individual phones are cheaper, but the range of shapes and sizes, and varying location of the camera on different models, makes it impractical to develop a 'one size fits all' approach.
- Spectral data translates into information about aerosol particle size, which can be used to infer composition.
- Additional data on calibration is required before the iSPEX team can be clear about the minimum number of measurements needed to produce useful information about atmospheric aerosols.
- Being realistic about what volunteers can (and cannot) achieve boosts participants' satisfaction with a citizen science experience.

Hack-a-thons:

- Hack-a-thons have a clear set of rules, which include an agreement to 'leave the idea in the room', i.e. don't steal and patent the outputs. You must trust the participants and do all you can to enable them to focus on the task (for example, providing useable data, logistics, and clear objectives). Hack-a-thons are not usually limited to a particular sector (such as the public sector) as this maximises the benefits from unexpected encounters. However, this has been done (for example, within the Met Office and Department for Business, Innovation and Skills).

- A hack-a-thon needs a 'hook' to lure professional software designers to participate – a prize, or the opportunity for new business, for example.
- An exciting hack-a-thon 'Planet Earth Global Sustainability Jam' is coming up on 22 – 24th November. For more information go to: http://www.globalsustainabilityjam.org/ .

NatureLocator:

- Bird song has so many variations and levels of complexity (including mimicry) and can be confounded by background noise, all of which make it unlikely that a viable app could be developed.
- Standard bat detectors can't be adapted with a plug-in, as the full spectrum of a call is needed by the Nature Locator app.
- If data gathered by PlantTracker were to be open source, other organisations might follow NatureLocator's lead; however such a decision about sharing intellectual property needs an open debate.
- If the principles of the BatMobile project could be adapted to enable automatic recording (i.e. remove the expense of needing a person to hold the device, even if low precision data are collected) it would be really useful for monitoring.

6. Afternoon session: New technologies: new challenges

The Chair of the UKEOF Data Advisory Group, Stefan Carlyle welcomed the group back and introduced the afternoon session. While there is a great deal of hype surrounding the use of, for example, smart phone apps to improve monitoring and visualisation of data, this cannot happen if (a) monitoring data is poor quality and (b) a business planning approach is taken to the introduction of new technologies. The focus of the afternoon session was therefore on these two key aspects of innovation in environmental observation management.

6.1 How do we manage the data deluge: the principles of good data management

Dave Morris (CEFAS and UKEOF Data Advisory Group member) gave an entertaining round-up of the risks of data overload, and summarised the benefits of implementing good data management. Dave flagged up two recent UKEOF publications as particularly useful: 'Guide to citizen science' and 'Principles of good data management'.

From Dave's experiences at Cefas of curating data (Cefas holds over 40Tbytes of data), he distilled the following points:

- Just because you (and your 'citizens') can measure something (collecting a lot of data, everywhere, all the time) doesn't mean you should.
- If you must, think hard, plan ahead
- Just because the source is 'free' and 'amateur' doesn't mean you don't have to curate the data properly, including security, access, use and licences
- Doing things to data/metadata retrospectively is bad (and expensive)
- Metadata helps you get things right
- Data without metadata is worse than useless, so get metadata generated automatically where you can;
- Lineage is essential for high quality data.

6.2 Turning unique capability into a unique app

Nick Thorne, Director of Winchester Innovation, gave a fascinating insight into the development of a mobile phone app from the software developers' perspective. Nick described the requisite business management stages of the development of 'anyTide', an innovative app for accurately predicting tides at any location around the UK. He described the stages and obstacles of software design, technology and developing effective user

interfaces. He pointed out that very few apps made available on the iTunes App Store, for example, make their developers any money. Instead, the industry relies on funding for bespoke business apps, typically covering financial accounting, time recording, expenses, travel, etc. These contracts may be much more complex than commissioning organisations appreciate, and require skilled people with a demonstrable track record. They are often much less costly compared with a systems development approach to performing similar functions, in some instances by as much as 1:10.

6.3 Panel Q&A

Questions were invited for speakers from the afternoon session, and the following issues were discussed:

- iPhones are of much higher specification than most android phones, so are more powerful as mobile monitoring devices and for citizen science applications.
- While only 30% of new mobile phones are iPhones, 60% of scientists use iPhones.
- Although there is an increasing move towards citizen science projects, curation of data really would be best done by organisations, as it is time consuming, expensive, and has legal implications. In recognition of this some data repositories are government funded specifically to keep data safe for a long time.
- Many scientists have limited skills in data handling and sharing, and may not sufficiently appreciate the need to facilitate sharing by keeping raw data safe and curated, with a known lineage and descriptive metadata.
- It is best not to store data in excel or access databases, as they are difficult (non-automated) to share.

7. Next Steps

Based on an assessment of points made during the workshop and feedback given by participants, a number of follow-up actions are recommended:

- It is recommended that a review of high value environmental monitoring technologies should be carried out to inform and guide the choices of developers and users for particular scientific approaches.

- Concerns surrounding the quality of data collected by environmental monitoring technologies could be addressed by producing a peer-reviewed paper on best practice data sampling, verification and management strategies.

- In response to the apparent paucity of knowledge, it is recommended that a profile of training courses on the development, use and uptake of new technologies are carried out within environmental monitoring organisations. Training could be aimed at:
    (a) high level decision-makers;
    (b) data custodians; and
    (c) internal developers.

- Based on the overwhelmingly positive reception to this workshop, UKEOF should consider holding similar workshops with the aim of promoting innovation to encourage more efficient and effective environmental monitoring and observation activities at the UK level.

8. Conclusion

The New Technologies for Environmental Monitoring workshop has been a valuable learning exercise for both the attendees and organisers of the event. Not only did the workshop provide a platform for knowledge sharing and networking, it brought together representatives from different sectors and devolved administrations in an effective manner to provide a perspective from the UK level. Feedback was very positive, with seventy six per cent of workshop attendees reporting that their expectations were fully met (Annex 3). The hosts agreed that this model should be applied to developing future workshops of this kind, to promote innovation to encourage more efficient and effective environmental monitoring and observation activities.

Annex 1- Attendee List

Name	**Organisation**
Matt Aitkinhead	James Hutton Institute
David Allen	Natural Resources Wales
DK Arvind	University of Edinburgh
Tim Ashelford	Defra
Helen Beadman	UKEOF
Patrick Bell	British Geological Survey (NERC)
Jonathan Bowes	SEPA
Mike Brown	Centre for Ecology and Hydrology (NERC)
Claire Campbell	SEPA
Alan Cameron	Scottish Natural Heritage
Stefan Carlyle	Environment Agency
Mark Caulfield	Scottish Natural Heritage
Savania Chinamaringa	Defra
Jodie Clarke	UKEOF
Nathan Critchlow-Watton	SEPA
Ben Ditchburn	Forestry Commission
Karen Dobbie	SEPA
Nigel Donald	NI Environment Agency
Bob Downes	SEPA
Willie Duncan	SEPA
Colin Frizzell	NI Environment Agency
Debbie Garft	Scottish Government
Selena Georgiou	Met Office
Colin Gray	SEPA
Lindsay Green	SEPA
Robert Grew	Environment Agency
Sophie Isaacs	UKEOF
Ben Jackson	SEPA
Stevie Jarron	Conservation Volunteers
Geoff Johnson	NBN
Roderic Jones	University of Cambridge
Liam Kelly	Scottish Government
Dave Kilbey	University of Bristol

Barnaby Letheren	Natural Resources Wales
Donald MacLeod	UK Astronomy Technology Centre
Sandra Marks	Scottish Government
Scot Mathieson	SEPA
David Morris	CEFAS
Peter O'Hare	EDINA/University of Edinburgh
Keith Porter	Natural England
Deborah Proctor	Joint Nature Conservation Committee
Simon Redding	Environment Agency
John Redshaw	SEPA
James Reid	EDINA/University of Edinburgh
Stefan Reis	Centre for Ecology and Hydrology (NERC)
Kerry Riddell	Conservation Volunteers
Zoe Russell	Scottish Natural Heritage
Marian Scott	University of Glasgow
Janet Shepherd	SEPA
Conor Smyth	EDINA/University of Edinburgh
Susanne Steinle	Centre for Ecology and Hydrology (NERC)
Duncan Stewart	SEPA
Andrew Thompson	Natural England
Nick Thorne	Winchester Innovation
Philip Trembath	Centre for Ecology and Hydrology (NERC)
Liz Tucker	Defra
Andrea Turner	UKEOF
Amber Vater	NERC
Hester Volten	National Institute for Public Health and the Environment (The Netherlands)
Dave Watson	SEPA
Lesley Whyte	SEPA
Sian Williams	
Peter Winstanley	Scottish Government

Annex 2 - Workshop Agenda

Time	Item	Lead
Chair: Nathan Critchlow-Watton, Scottish Environment Protection Agency		
09:30	Welcome & aims	Chair
Social media & crowd sourcing		
09:40	Environmental hack-a-thons	Environment Agency: Simon Redding
09:55	Soil testing kit project – collecting and managing soil data on a global scale	Growers Nation/ Met Office: Selena Georgiou
10:20	Naturelocator – The BatMobile and other apps	University of Bristol: Dave Kilbey
10:45 Refreshment break		
Air pollution monitoring and assessment		
11:05	Monitoring air quality: small sensors start to show their capabilities	University of Cambridge: Rod Jones
11:35	iSPEX – measuring aerosols with mobile technology	Netherlands Environmental Assessment Agency: Hester Volten
12:05	Panel Q&A: Social media, crowd sourcing, monitoring and assessment	Chair
12:35 Lunch		
Chair: Stefan Carlyle, Environment Agency and DAG Chair		
New technologies: new challenges		
13:15	How do we manage the data deluge: the principles of good data management	CEFAS: Dave Morris
13:35	Turning unique capability into a unique app	Winchester Innovation: Nick Thorne
13:55	Panel Q&A	
14:15	Introduction to discussion session 'New challenges to implementing personal monitoring technologies'	Chair
14:25 Refreshment break and delegate participation session		
15:00	Feedback session	Rapporteurs
15:20	Wrap-up	Chair
15:30	**Close**	

New Technologies for Environmental Monitoring
24th September 2013, Victoria Quay, Edinburgh

Workshop Evaluation

Introduction
A total of 53 people attended the workshop, from 27 organisations representing Scotland, England, Wales, Northern Ireland and the UK as a whole. Feedback forms were circulated during the afternoon break and emailed to participants after the event (other than those who submitted a named form on the day). The information below summarises the 29 responses received. Headings are the same as those used on the feedback form.

For this workshop, how did you rate (please tick):

	Excellent		↔		Poor	n/a
Venue	8	**13**	7	1	0	0
General organisation	**16**	13	0	0	0	0
Relevance to your job	**11**	**11**	6	1	0	0
Opportunity for discussion	**13**	10	4	1	0	0
Social media and crowd sourcing session	12	**14**	0	0	0	3
Air pollution monitoring and assessment	**15**	12	1	0	0	1
Panel Q & A (morning sessions)	9	**16**	3	1	0	0
New technologies: new challenges	9	**13**	5	1	0	1
Panel Q & A (afternoon session)	6	**13**	9	0	0	1
Participation session	8	11	4	2	0	4

*(Values in **bold** denote the highest score; shaded values denote the highest paired score)*

Feedback on each section of the workshop was overwhelmingly positive, with all aspects and speakers rated by the vast majority of people as either excellent or good. Morning and afternoon sessions were equally well received, and the general organisation was particularly appreciated by participants. The afternoon Panel Q&A session had a slightly lower rating than other sessions, but as this constituted only two speakers (compared to five in the morning Q&A) this would be expected to spark less interest.

What were you hoping to get out of the workshop?
Participants were interested in broadening their knowledge, finding out about developments of mobile technologies/applications and exploring the opportunities these would offer to their organisations. The opportunity to network with people from a wide range of organisations motivated many of the participants.

How well were your expectations met?
Expectations were fully met for the vast majority of respondents (22 people, 76%), all other respondents had their expectations partially met.

Is there anything else we could have usefully included?
The following suggestions were received, grouped into two broad categories.

Sharing experience and good practice:

- Catalogue of technologies different agencies have tried and how they got on with them;
- A discussion about potential projects and collaboration opportunities;
- Consideration of how to deal with data quality issues (how robust are citizen science data?), implications for monitoring strategies/methodologies;
- More focus on tools and technology (currently available and being developed) that could be adapted – we have very limited capacity to develop technology in-house;

Topics for a future workshop:

- Linked data;
- More hardware/software;
- Monitoring of people's perception and physiological conditions, and their relationship to app data;
- Demos of various mobile devices in use, to accompany mobile apps.
- Presentation of SEPA mobile project;
- Facilitated work-shopping around specific ideas – this would need a pre-process to come up with ideas for discussion (Delphi type approach);
- More on things for those without smartphones;
- More discussion time;
- Posters.

How might circulated information be used?
All participants agreed that they would circulate information about the workshop to colleagues, with most people anticipating that this would be for general interest and background information. A small number thought that the information gained would be used to input into internal strategy and/or policy development, in addition to sharing and discussing best practice with colleagues. Several participants suggested that the workshop could encourage colleagues/organisations currently hesitating about whether/how to embrace new technologies.

Additional comments
The following additional comments were received, suggesting activities that UKEOF and partners might consider. Could UKEOF:

- do a review of (and promote) high value apps? – So many available and overload…
- develop best practice examples of integration of citizen science volunteers and professionals to deliver a defined outcome;
- follow up on the some really strong common themes from today and ensure this information goes to the right people;
- organise a longer conference/workshop;
- set up a cross-functional/organisational initiative;

- follow up by profiling attendees into sub-groups or forums of shared interests/work areas/experiences/organisations?

The following points were also raised:

- we need Government to support infrastructure and support for citizen science – lower cost data but need investment and support;
- the talks which focused on tools to help citizen science become easier and more accessible thereby increasing the amount and quality of information available were particularly interesting;
- the range of delegates was really good which gave some great networking opportunities;
- Edinburgh is a little inaccessible which meant missing some of the discussion and talks in the latter part of the afternoon.