COBWEB PROJECT

Final publishable summary report

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1. Executive summary

COBWEB was a research project that succeeded in its goal of developing a generic crowdsourcing infrastructure platform and toolkit that could be used in multiple scenarios generating data of sufficient quality to be used by policymakers. At the end of the project, different components comprising the platform are at different Technology Readiness Levels (TRL); with some high TRL outputs being open sourced, eg, Fieldtrip Open.

Achieving an understanding of how citizen science can be harnessed in the service of societal goals is important. There is a veritable deluge of data being generated by citizens and some of that data is useful (or can be made useful) for environmental decision making. Perhaps more importantly, the technology is creating opportunities for greater citizen involvement in environmental decision making. For example, it has been observed that realising the UN's Sustainable Development Goals will require massive citizen support. COBWEB made a contribution, most significantly in the following areas: standardisation, quality control, security/privacy and use of the UN's World Network of Biosphere Reserves (WNBR).

A new Open Geospatial Consortium (OGC) Citizen Science Working Group has been established and looks set to become a key forum for advancing related global interoperability issues. COBWEB's Sensor Web Enablement for Citizen Science (SWE4CS) initiative is a first step in the standardisation process and led the way in developing a harmonised information model for exchanging CS data and addressing semantic interoperability issues. The high TRL access management federation approach advocated by COBWEB for managing privacy and security has had impact on GEOSS and is being used by followon projects. Quality control continues to be a major concern for initiatives dealing with crowdsourced data; COBWEB pioneered a web services chaining approach that allows great flexibility in the processes applied in response to the multitude of different circumstances under which such data is collected. This too is being further developed by followon projects.

Using a unique co-design approach, COBWEB concentrated on mobilising citizens within Biosphere Reserves. We found the WNBR to be an excellent (and underused) resource for this kind of research project; where access to an already incentivised and organised pool of citizens enthusiastic about the sustainable development agenda is a definite advantage.

Having a government involved as a full partner in the project also proved to be an advantage; COBWEB benefited from direct communication channels with bodies responsible for setting and delivering policy relating to environmental data. This impact continues post project as Welsh Government is sustaining the COBWEB platform for a period in support of environmental decision making and policy.

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2. Summary description of project context and objectives

2.1 Project context

Key context for COBWEB was the huge upsurge in the availability of mobile devices of increasing sophistication with concomitant increase in the volume of citizen sourced data. The big challenges were, and remain, how to make these data useful for better decision making while harnessing citizen enthusiasm and technology in the service of societal goals. In some areas, COBWEB made some significant advances which are being leveraged post-project by various initiatives, including Citizen Observatory related followon projects funded under H2020 SC5-17-2015: *Demonstrating the concept of 'Citizen Observatories'*.

COBWEB was predicated upon UNESCO's World Network of Biosphere Reserves (WNBR) and the original proposal referenced the UN's Millennium Development Goals. Over the period of the project, the Sustainable Development Goals (SDG) were published, including a clear statement referencing the importance of geographic information. The UN's Man and Biosphere programme responded by aligning with the SDG's as did multiple other public authorities at all levels. COBWEB also responded appropriately and consideration of the SDG's informed several aspects of the work in the latter stages of the project.

The chief expected impact from COBWEB may be summarised as enabling greater citizen influence in environmental governance. The project set out to use a small number of Biospheres in Wales, Greece and Germany as representative testbeds for developing and validating the technology developed. In the process, we developed a unique co-design approach to respond to community priorities, mobilise citizens and help gauge the effectiveness of the WNBR concept. This aligned with a general shift towards co-design/co-creation and encouragement of greater citizen involvement in environmental decision making. Welsh Government was a full partner in the project and contributed substantially towards understanding the shifting context in respect of environmental policy development and delivery. They continue to support the deployment of the COBWEB platform in mobilising citizen's associations post-project.

Standards were an important organising principle for COBWEB from the start and formed much of the context for the work undertaken. Over the period of the project, semantic web standards underpinning the open data movement continued to gain traction. These standards are designed to make it possible to link data and make clear exact meanings of concepts used, but can represent a challenge in terms of compatibility with more traditional open geospatial interoperability standards. The open source toolkit (Fieldtrip Open[1]) COBWEB created can publish data in various

[1] http://fieldtrip.edina.ac.uk/

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formats depending upon what is required, eg, INSPIRE specific schema, linked data, GEOJson, or Sensor Web Enablement for Citizen Science (SWE4CS). The latter is a potentially important contribution from COBWEB towards improving interoperability. Originally conceived as a standard for publishing citizen science data into the Global Earth Global Earth Observation System of Systems (GEOSS) and published as an OGC Discussion Paper - *Standardized Information Models to Optimize Exchange, Reusability and Comparability of Citizen Science Data*[2] - SWE4CS has broad applicability and is a significant first step on the standardisation ladder.

Linking with authoritative data from initiatives such as the Infrastructure for Spatial Information in Europe (INSPIRE) directive and GEOSS is part of a broader movement within the citizen sourced data community towards leveraging the wealth of related data from different sources for different purposes. COBWEB's main contributions were in conflation/fusion with Spatial Data Infrastructure (SDI) initiatives like INSPIRE for display or analysis purposes, conflation with data from sensors, and Quality Assurance (QA).

An overarching problem in Citizen Science is that large quantities of data are being created but exist in silos. Useable standards either don't exist, are neglected, poorly understood or tooling is unavailable. In terms of standardising approaches to citizen sourced data, it is still relatively early days and this is reflected in the different Technology Readiness Levels (TRLs) of outputs from research projects such as COBWEB. SWE4CS for example, is at an intermediate TRL. Similarly, the standards based web services chaining approach to QA pioneered by COBWEB allows great flexibility. Data from increasingly diverse sources can be brought to bear and tailored processes applied, customised as necessary, to meet the individual needs of the huge variety of different Use Cases encountered in the Citizen Science space.

The access management federation approach advocated by COBWEB for managing privacy and security is high TRL and is likely to have continuing impact. This is because of the continued lack of a widely accepted, robust, practical way of securely sharing valuable data across administrative domains. The requirement to be able to securely share (with a high level of assurance) in a genuinely interoperable way controlled data such as the location of endangered species, and the associated need to maintain individual privacy, is a constant in the volunteered geographic information, crowdsourcing, citizen science context within which COBWEB was executed.

[2] https://portal.opengeospatial.org/files/?artifact_id=70328

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2.2 Project objectives

The following list of key objectives was compiled by considering the original project proposal and the reality of the project as it was executed over its four year lifetime:

- Research and develop a “generic crowdsourcing infrastructure platform” manifested as a toolkit which could be downloaded and used in multiple scenarios.
- The citizen observatory platform should be capable of integrating a wide variety of different information sources such as physical sensors embedded in the environment, cyber sensors leveraging online data, or social sensors leveraging social media streams.
- Explore the potential for integrating the platform into Biosphere information systems and evaluating the use of the WNBR as an integral part of projects like COBWEB, which require active cooperation of citizens and citizen groups.
- Address the question: how can the business of government be improved using citizen science data, empowering citizens, and enabling contributions towards better environmental governance in keeping with policy aims?
- Address policy objectives at a local, national, European or global level as appropriate.
- Show how citizen sourced data can help realise the benefits of existing investment in Spatial Data Infrastructure (SDI) initiatives such as INSPIRE and GEOSS
- Improve interoperability through adherence to open standards and by using the processes of the standards defining organisations where appropriate
- To meet real world needs and address community priorities in a flexible way, demonstrate the solution working in three pilot case study areas:
    1. Creation and validation of data products from Earth Observation data
    2. Biological monitoring
    3. Flooding

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3. Description of main S&T results

The following description of the main Science and Technology results is based on a paper[3] written by the COBWEB consortium in the final year of the project.

The COBWEB project provides open source tooling which can be downloaded , configured and modified if necessary to enable citizen observatories – infrastructure which enables citizens to use their own mobile devices to make observations across a wide range of different citizen science scenarios. The platform developed and described below is generic, extensible and powerful enough to accommodate sophisticated requirements arising from a broad range of stakeholders across different sectors, yet sufficiently flexible to enable non-experts to create and use mobile applications which meet their needs.

It should be noted that COBWEB was a research project. As such, the various components described below are at different levels of technical maturity ranging from Technology Readiness Level (TRL) 4 (validated in laboratory) to TRL 9 (actual system proven in operational environment). The TRL scale is used as a tool for decision making on research and development investments at the EU level and has been developed to enable assessment and comparison of technologies in respect of maturity.

COBWEB provides high TRL tooling for collecting new data and, where possible, the software developed leverages and complements existing well established high TRL open source projects such as those in the OSGeo[4] suite. COBWEB has also conducted research (low TRL) into the use of other crowdsourced data, for example, from social media streams and sensors, for both quality assuring and enriching observations. The latter is an example of the benefits of leveraging SDI as standards are critical for relating and combining (the terms fusion and conflation are also used) spatial data from various sources.

3.1 System design through stakeholder engagement and co-design

COBWEB commenced with a process of requirements gathering for a system that would enable citizens in the Dyfi Biosphere Reserve area in Wales to collect data in the 3 pilot case study areas as introduced above. Requirements were initially gathered through a process of desk study reviewing existing systems and structured interviews. The latter started with citizen groups located within the Biosphere Reserve and were widened and further refined through broader stakeholder

[3] http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/view/406/393

[4] http://www.osgeo.org/uk

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engagement; in particular with groups associated with environmental governance and stewardship.

In parallel, a process of rapid prototyping software development was entered into with the intention of creating software that demonstrated the feasibility of meeting identified requirements and surfacing issues and challenges. Once we had reached the requisite level of software maturity, to further assess the viability of the proposed solution and better understand the needs of the citizen, COBWEB then engaged in a period of structured co-design activity.

3.1.1 Co-Design

Co-design happens where "participants are invited to cooperate with designers, researchers and developers during an innovation process[5]". A unique approach, of broad social science interest, was developed and piloted under COBWEB. Seven citizen groups active in the Dyfi Biosphere Reserve in mid-Wales were commissioned through an open tendering process to help gather requirements and validate our concept of a citizen observatory by mobilising citizens (usually volunteers) to go out in the field to collect data (Table 1).

Table 1: Summary of main Co-Design sub-project activity

Citizen Group	Collecting Information on	COBWEB Champion
Cardigan Bay Marine Wildlife Centre	Marine megafauna, e.g. dolphins, porpoise, seals	Aberystwyth University
Coetiroedd Dyfi Woodlands	Variety of different woodland species (flora and fauna)	Ecodyfi
Penparcau Community Forum	Variety of species with a focus on butterflies and larval food plants	Environment Systems Ltd
RSPB (Royal Society for the Protection of Birds)	Habitat (salt marsh and peat bog) reversion processes	Aberystwyth University
Snowdonia National Park Authority	Invasive species (Japanese Knotweed)	Welsh Government
The Outward Bound Trust	Variety of species	Aberystwyth University
Ysgol Bro Hyddgen	Variety of species	University of Edinburgh

The invitation to tender was issued via the Dyfi Biosphere Reserve and COBWEB websites and resulted in a strong response from the community within the Biosphere Reserve expressing a desire to work with an unexpectedly (from the project consortiums perspective) rich set of environmental phenomena. This generated a diverse set of requirements and may be interpreted as evidence of the Biosphere

[5] https://en.wikipedia.org/wiki/Participatory_design

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Reserve mechanisms successfully working to help meet the sustainable development agenda in the context of a research project which needs to mobilise citizens.

Each citizen group proposal was analysed and refined in respect of what it could offer the project, e.g. research potential, policy implications, technical challenges, ethical implications, etc. The result of the co-design process was a challenging set of technical requirements to guide system design, based on real user needs, and the opportunity to predicate further research on real world requirements.

The seven co-design sub-projects were programme managed by COBWEB partner Ecodyfi (the delivery arm of the Dyfi Biosphere Reserve partnership) with each sub-project allocated a 'champion' (Table 1) from within the project. A Steering Group with representation across the COBWEB consortium was established to coordinate and ensure consistency. Throughout the 2015 and 2016 field seasons the seven co-design partners listed above had, between them, over a thousand people collecting data during fieldtrips of varying duration and frequency that they organised. This is a significant number of people considering that the Dyfi Biosphere Reserve area is mostly rural.

Regular workshops, interviews, participation in, and feedback from, the fieldtrips facilitated understanding throughout. Concentrating on the experience gained by the wide variety of users using the software and access to these users, the consortium used the field data and the intelligence flowing back from the interactions with the citizens and co-design partners to refine and improve the concept and system design.

Some lessons learned: the difficulty of enabling communication between scientists and 'ordinary' citizens to facilitate dialogue on sometimes obscure scientific concepts should not be underestimated. Interviews with volunteers participating in a project that can claim to be working towards better environmental governance (having Welsh Government as a partner on the project was important) proved to be a strong motivator. A particular challenge of this kind of co-design activity is the need to continually manage expectations - it was emphasised repeatedly to the sub-project leads and volunteers that they were participating in a research project which was testing and validating our concept of a citizen observatory; the components of which are at various TRL's with research and development continuing in parallel. Significant technical support had to be allocated to respond quickly to prevent disillusionment with failing software.

Participants responded with enthusiasm to software releases where they could see the issues they identified being addressed and their ideas implemented. One of the outcomes has been establishment of an enthusiastic partner network interested in further work. The role of the Biosphere Reserve concept in facilitating scientific research aligned with the sustainable development agenda, eg, the UN's

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Sustainable Development Goals, was widely appreciated, particularly by the seven co-design partner organisations.

3.2 COBWEB Workflow

As can be seen from Figure 1 (an illustration of the overall workflow underpinning COBWEB), the concept of surveys is central to COBWEB. A survey represents the context for a group of citizens going out into the field with one or more tasks over a period of time in a certain area. It constitutes a set of forms, workflows (business processing rules applying to observations) and datasets, all of which may be adjusted as the needs of a particular survey dictate.

COBWEB has found that, depending upon exact circumstances and the amount of control required, several key roles may be identified (Table 2) in order to enact surveys. These roles are of broad applicability, although, depending upon circumstances, they may overlap.

Table 2: Key Actors and Roles

Actor	Role
Principal Investigator	Sponsor for a specific crowdsourcing campaign.
Project Coordinator	Lead from the perspective of the community carrying out the task
Administrator	Maintains instance of the COBWEB system. Where the software has been installed to meet the needs of a particular organisation.
Survey Manager	Defines, sets up surveys and invites citizens where appropriate
Quality Reviewer	Configures quality assurance processes in accordance with needs of the sponsor
Citizen	Individuals participating in collecting data. May be known or anonymous (see section 3.3.2 for different kinds of surveys: public, registered or private)
Consumer	Potentially a large range of actors interested in results
Publisher	Actors with the authority and capability of making crowdsourcing results available
Semantics Expert	Individuals that link information to survey terms to help explain their meaning

COBWEB set out with the aim of being generic; the same software can be used to enable observations on a wide variety of environmental parameters. This is important as it frees organisations from the need for expensive and difficult to source expertise every time a change in Citizen Science initiative is required - it is not necessary to have to keep engineering new Apps. Reusing the same well written software also improves the chances that interoperability standards are being adhered to.

Surveys are authored by the 'Survey Manager' in order to meet specific requirements. When doing so and if required, the 'Quality Reviewer' liaises with the sponsor to ensure that quality control processes are established that meet their

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needs and which generates sufficient metadata to enable 'fit for purpose' decisions to be made by consumers, ie, is the data being described by the metadata suitable, appropriate and of sufficient quality for the envisaged use.

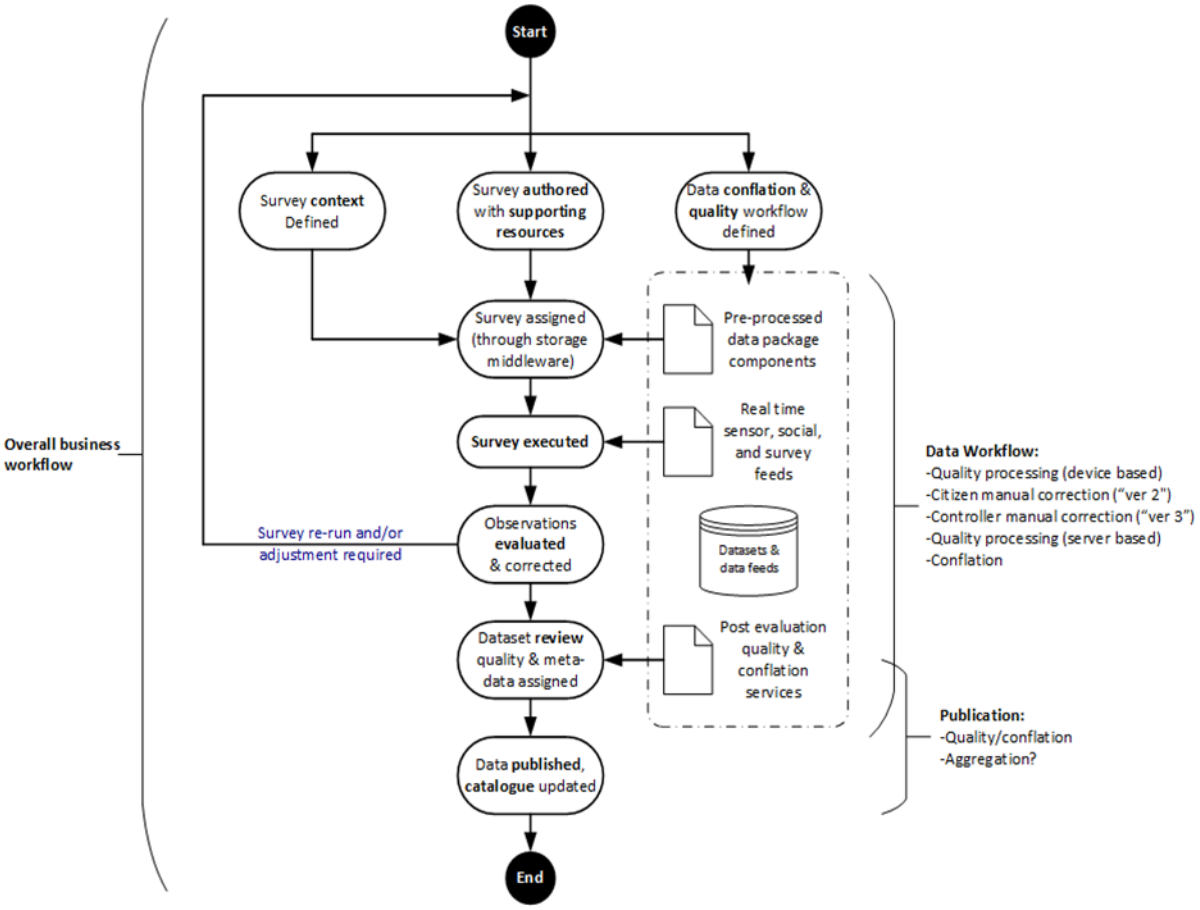

Figure 1: The COBWEB Workflow

Quality control may require diverse input (see section 3.3.6 below). For example; it may be advantageous or necessary to have data from a variety of sensors; these in turn can be a combination of physical sensors embedded in the environment, cyber sensors leveraging online data, or social sensors leveraging social media streams (see section 3.3.7). Similarly, it may be desirable to configure access to authoritative data from SDI type initiatives such as GEOSS, INSPIRE network services and national SDI's. This may be necessary for conflation purposes (relating and combining spatial data from various sources); as part of quality control or to assist with visualising the results.

3.3 Architecture

The system architecture (Figure 2) necessary to support the above was developed through a combination of rapid prototyping and new software builds informed by requirements derived through co-design activities and other methods of stakeholder

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engagement. The architecture consists of the following key components: portal website, generic application designer, apps, storage middleware, quality assurance and conflation, sensor networks, whilst also implementing access control and privacy, and open standards. It is a strength of COBWEB that the components we have developed embed within an architecture that uses existing open source projects. This provides flexibility to adapt to the myriad scenarios under which solutions may be developed in respect of capturing citizen sourced data, it also creates potential for additional community support and improved sustainability.

3.3.1 Portal Website

These are the main points of entry to COBWEB instances, providing access to the functionality documented in the sections below. In the simplest case, this is where users login and request to join selected surveys. An example is currently integrated with the Dyfi Biosphere Reserve website for demonstration purposes. Once users have contributed observations via their mobile device, results are available for visualisation via the portal using Web Map Services (WMS), Web Feature Services (WFS) or Sensor Observation Services (SOS).

At the heart of the portal is the latest version (3.0) of GeoNetwork, extended under COBWEB to facilitate typical citizen science scenarios. GeoNetwork is an open source catalogue application offering resource registration capabilities and the ability to expose those resources for discovery by others via a number of standards, most notably those of ISO/TC 211[6] (ISO Technical Committee – Geographic information/Geomatics) and the Open Geospatial Consortium[7] (OGC), e.g. the OGC Catalogue Services for the Web (CSW) standard. Metadata can be exported to other standards such as Dublin core, DCAT[8] (Data Catalog Vocabulary), and schema.org[9].

Survey discovery: After having been created at the portal website (Figure 2), surveys can be discovered by any interested parties via the portal. Making surveys discoverable using accepted and widely used open standards helps avoid waste, duplication, assists with recruiting volunteers and facilitates research and development in the field.

[6] http://www.isotc211.org/

[7] http://www.opengeospatial.org/

[8] https://www.w3.org/TR/vocab-dcat/

[9] http://schema.org/

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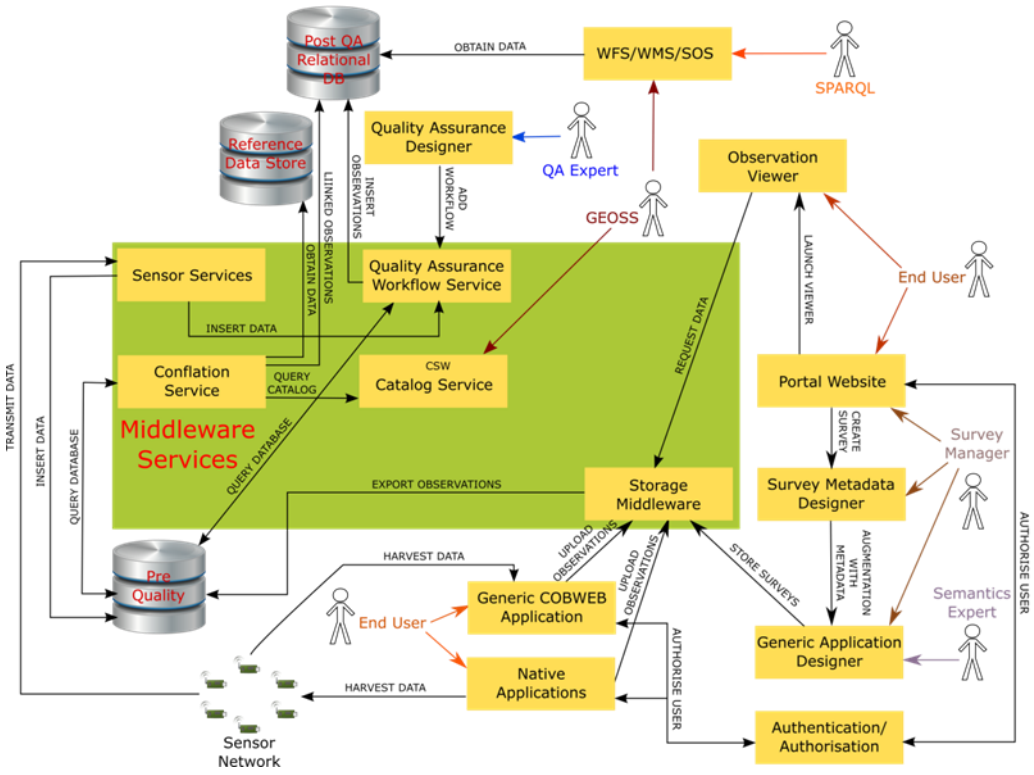

Figure 2: An overview of the COBWEB architecture, and the high level interactions between components

Data discovery: Making citizen science data discoverable online, within communities like GEOSS and INSPIRE, represents a more significant challenge than project or survey discovery. Note there are strong overlaps with the work underway developing a harmonised common data model (see section 3.4) and assessing data quality (see section 3.3.6).

Key citizen science data discovery related questions addressed include:

- *What level of aggregation is used to determine quality: dataset or feature level?*

  Many user groups were interested in datasets as a whole ('what is the spatial distribution of that species'). Other users may be interested in selected features (meaning abstractions of real world phenomena – buildings, rivers, plants, animals) and want to put questions such as 'when did that particular observation of the species of interest occur'. Quality in COBWEB was therefor determined at both the feature and dataset level.

- *How is the quality of datasets and/or features represented?*

  Quality varies at the feature level, e.g., different observations in the same survey may be of different quality, it may be less certain that a particular species has been observed even though the observer is the same. Quality is therefor best

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represented as part of the data and we recommend storing quality elements as part of the data.

- *Is dataset quality assessed by aggregating the quality level of each of the observations in the dataset?*

  COBWEB decided that there were circumstances under which it made sense to both store quality information at the individual feature level, and aggregate, where necessary, at the dataset level for rapid assessment. The ability to visualise quality cartographically may be useful in many circumstances.

- *What schema is being used?*

  The technical solution developed by COBWEB is flexible and enables publication of metadata and data to various schemas. For metadata the iso19139 and iso19157 schemas are used, but they can be exported on request to Dublin Core, DCAT or schema.org . For aggregation at the dataset level, the generic SWE4CS model was proposed and developed (see section 3.4), which allows extension to include any external ontologies.

3.3.2 Access control and privacy

Citizens can participate in COBWEB surveys anonymously (for reasons of privacy and data sharing this can be desirable) or they can register by providing identity information to user management systems integrated with the portal. Whether they do so or not depends on the survey; three kinds of surveys are distinguished in COBWEB:

1. Public survey. Any user, anonymous or registered, can join and contribute.
2. Registered survey. Only registered users can see the survey in the portal listings and contribute. An example of where this might be required is where the identity of the user making the observation is being used as a proxy for the quality of the observation, e.g., where the observer is expert in the field of study and recognized as such by the project coordinator and/or the principal investigator.
3. Private survey. **Invited** registered users only.

The need for the three kinds of surveys listed above and different levels of control over who can participate in surveys was identified early in the design process. Initial stakeholder engagement revealed a desire to be able to make and share observations of protected species. Therefor, where such species are implicated, we identified a requirement to be able to control access to sensitive data; for example, species protected under the UK Wildlife and Countryside Act or listed in the Natural Resources Wales Sensitive Species List.

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It is not desirable or permitted to make publically available over the web detailed information on the location of these species without any access control. Conversely, these are often the most valuable data for consideration in environmental monitoring, and exactly the kind of information most needed for management and policy purposes.

The need for a reusable, well understood, high TRL, solution to security interoperability (sharing restricted data using standards across organizational boundaries) is a common SDI requirement. Throughout the extensive stakeholder engagement conducted by COBWEB, we found this requirement recurring over and over again in citizen science scenarios. The corollary, existing solutions that do not take security (interoperable or not) into account is also commonplace. The private survey concept developed by COBWEB is a powerful feature of the platform.

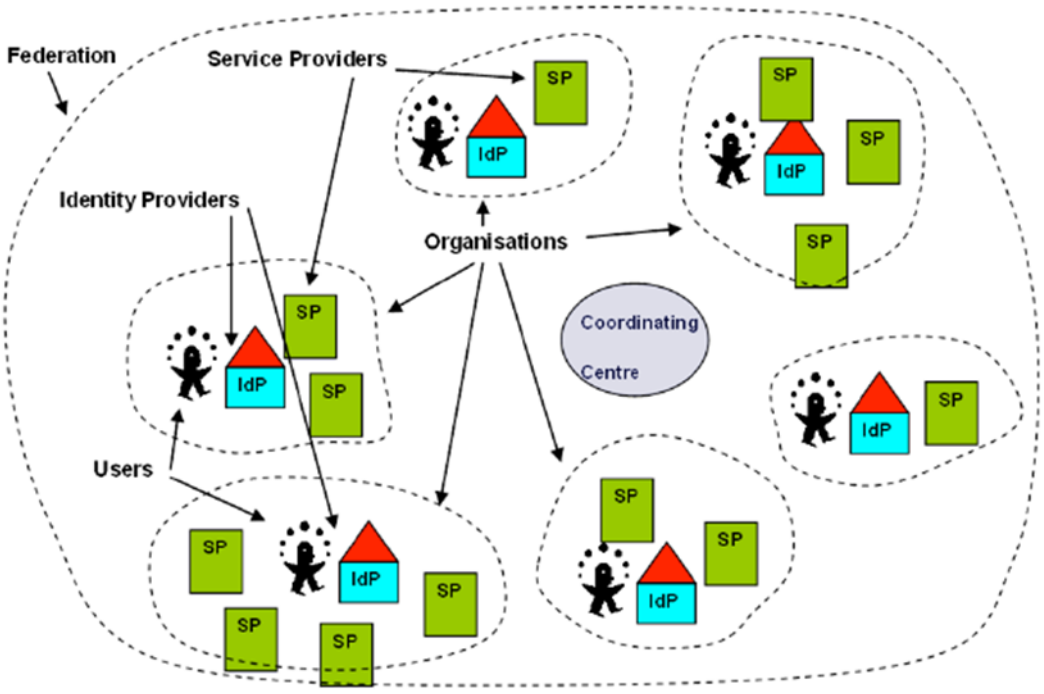

Figure 3: Key Roles within a Typical SAML Access Management Federation

In addition to data security, concomitant questions of privacy were also a requirement within COBWEB. It is essential to enable users to register using personal information so that decisions concerning what they are authorised to access and contribute towards can be made. In the current citizen science landscape, identity information is also frequently used for quality assurance purposes and verifying observations.

Based upon the OASIS Security Assertion Markup Language (SAML) standard, the key advantages of the approach illustrated in Fig 3 are that it is a proven, high TRL,

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industry strength solution that allows Single Sign On (SSO) to protected web based resources across administrative domains. Users can login using their familiar organisational credentials (presented via a SAML Identity Provider (IdP)) and then access protected resources (typically OGC web services in SDI scenarios) presented as SAML Service Providers (SP). Users only need to login once (SSO) and can then access multiple protected resources in the federation, providing they are suitably authorised.

Fine grained authorisation decisions, controlling exactly what information particular parties are authorised to access, is established based upon attributes of the users and the actions on resources they want to carry out. The OGC's GeoXACML standard, which extends the OASIS eXtensible Access Control Markup Language (XACML) to enforce geo-specific constraints, is another mature standard with high TRL guarantee. In COBWEB different levels of access were enforced to ensure the privacy of citizens that collected information and also the wellbeing of the observed species.

For the COBWEB framework, this means that surveys can be configured which access both unprotected and protected data sources, e.g., for conflation and/or quality assurance purposes. Private surveys can be setup which enable citizens to collect and share protected data with public authorities in compliance with both data protection and wildlife protection legislation. Public authorities can leverage the full benefits of interoperability, for example, by sharing sensitive data across organisational boundaries with authorised individuals using protected OGC web services. Potentially all citizen sourced data, sensitive or not, can be accessed without recourse to non-interoperable, one-off, bespoke security point solutions or mechanisms such as anonymisation, obfuscation, reduction of spatial resolution, etc.

3.3.3 Generic application designer

For each community, there was at least one 'Survey Manager' whose privileges entitle them to setup and create surveys. COBWEB employs a hybrid App approach enabling survey managers to build custom data collection forms using the generic application designer component of the portal website. Forms designed at the portal can then be synchronised with the generic COBWEB application on individual users mobile devices. The generic and extensible application designer supported a wide variety of form elements to cater for a broad range of user requirements.

Similar framework approaches to creating citizen science projects are not uncommon as exemplified by initiatives such as Open Data Kit, Indicia and EpiConnect amongst others. Some of the aspects that help distinguish COBWEB are its flexible and powerful approach to automating quality control using multiple inputs, use of an interoperable security solution and adherence to open standards wherever possible.

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3.3.4 Mobile applications (Apps)

The generic Application solution offered the citizens the ability to install onto their mobile device, and login using an appropriate identity provider (Figure 3). The citizen then has the ability to either contribute to a directly available survey (public or registered) or a private survey which they have been invited to by the Survey Manager. The citizen would then be presented with the form designed by the Survey Manager, allowing them to participate in data collection with or without network coverage.

In addition to this, the generic capability described above was complemented by functionality allowing the cacheing of high quality basemapping on individual handsets for use in areas of poor or no network coverage. The background mapping used by COBWEB in the UK has been created using a variety of open products (mostly OpenStreetMap and Ordnance Survey Open Data Products) cartographically optimised for zooming in and out on mobile devices in both urban and rural areas. In the latter phases of the project, where we transferred technology developed in the UK to Greece and Germany, we discovered that it is difficult to replicate the rich open map stack available in the UK across Europe.

To demonstrate the effective 'separation of concerns' in the architecture, and how the COBWEB framework can be used in scenarios where lower level access to inbuilt mobile device functionality is required, a native Application (Figure 2) in the flooding thematic area case study area was also developed. This uses the same interface as the generic application for communicating with the 'Storage Middleware'.

3.3.5 Storage Middleware

Storage Middleware is a central component of the COBWEB architecture used for managing survey schemas and exporting geospatial observations to the desired encodings, e.g. KML (Keyhole Markup Language), Geopackage, Shapefile, GeoJSON, CSV, etc. By synchronising all stored information with a relational database (the pre-quality PostGIS database in Figure 2) export of data via OGC Web Services (WMS/WFS) is supported.

Observations were received from the App. As long as Oauth v2 authorisation was supported, the Storage Middleware component provided a generic REST-based API accessed storage compatibility layer on top of a range of cloud based providers (Google Drive, Dropbox, etc.) or physical storage media where local storage was required.

3.3.6 Quality assurance and conflation

Since the emergence of citizen science as a means of supporting scientific research, data quality has been considered an important issue for data use. Quality assurance accordingly plays an important role for the analysis of data obtained from citizen science and for the set-up of citizen science projects. It is commonly agreed that unknown data quality makes citizen science data of limited use. COBWEB's

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approach to quality assurance was twofold: first, a number of quality measures were determined based on the variety of data provided by crowdsourcing activities, observations from the co-design projects, sensor feeds and social media; secondly, a means to express those measures in observation metadata was provided. This also included an approach to link and conflate observations with relevant external datasets on the Web.

To allow for a customizable and dynamic quality assurance, remaining independent from actual citizen science projects, COBWEB used a standards based web service chaining approach (the QA Workflow Service in Figure 2 above), and thus enabled survey designers to adapt and adjust the quality assurance process to their needs. This generic approach on QA is necessary, because the relevance of specific quality control processes is usually highly use case dependent. The solution extended a pre-existing typology of quality assessment types to seven categories (or pillars) covering a range of specific quality controls generating quality metadata elements (table 3).

Table 3: The 7 pillars of Quality Controls in Citizen Science

Pillar number & name	**Pillar description**
1.LBS-Positioning	Location, position and accuracy: *Location-Based-Services focusing on the position of the user of the targeted feature (if any), local condition or constraints, e.g. authoritative polygon, navigation, routing, etc.*
2.Cleaning	Verification, erroneous entries, mistakes, malicious entries: *Erroneous, true mistakes, intentional mistakes, removals, corrections are checked for the position and for the attributes. Feedback mechanism can be an important part of this pillar if the mistakes can be corrected.*
3.Automatic Validation	Simple checks, topology relations and attribute ranges: *Carries further the cleaning aspects by validating potential good contribution. This aim is more positive than with cleaning and may keep as outlier a given captured data rather discarding it.*
4.Authoritative Data Comparison	Comparison of submitted observations with authoritative data: *Either on attributes or position performs statistical test, (fuzzy) logic rule based test qualifying the data captured or reversely qualifies the authoritative data. Knowledge of the metadata of the authoritative data is paramount.*
5.Model-Based Validation	Utilising statistical and behavioural models: *Extends pillar 4 testing to modelled data coming e.g. physical models, behavioural models, other user contributed data within the same context. This may use intensively fuzzy logics and interactions with the user within a feedback mechanism of interactive surveying. (if some tests will be similar to pillar 4 the outcome in quality elements can be different)*

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6. Big/Linked Data Analysis	Data mining techniques and utilising social media outputs: *Extends pillar 5 testing to using various social media data or related data sources within a linked data framework. Tests are driven by a more correlative paradigm than in previous pillars.*
7.Semantic Harmonisation	Conformance enrichment and harmonisation in relation to existing ontologies: *Level of discrepancy of the data captured to existing ontology or crowd agreement is transformed into data quality information. In the meantime data transformation to meet harmonisation can take place.*

The implementation of the quality assurance process is based on the Business Process Model and Notation (BPMN) and OGC Web Processing Service (WPS) standards. This combination allows for the definition and dynamic binding of atomic quality control processes, encapsulated by WPS interfaces, to be used in a workflow environment. Therefore, the JBPM suite (workflow editor and workflow engine) has been customized to work with OGC services and has been integrated as a component of the COBWEB portal. Thus, each survey manager has the authority to create quality assurance workflows for their particular survey.

Capabilities to link and conflate citizen science observations with external data are designed and implemented to 1) assist the quality assurance process and 2) infer spatial information from the identified spatial data relations. Since all conflation processes are also offered via the OGC WPS interface, seamless integration and use by the workflow engine was assured. Currently, identified links of an observation can be attached as additional attributes or stored as RDF (Resource Description Framework) in a Linked Data store. Whereas the first option is primarily used to enrich and validate observations, the latter option allows for the reasoning on spatial data relations using semantic web techniques, in particular by the application of SPARQL (SPARQL Protocol and RDF Query Language) queries.

3.3.7 Sensor networks

Though data collection from mobile devices was fundamental to the generic COBWEB framework, a variety of sensor platforms, monitoring multiple environmental parameters, within the Dyfi Biosphere Reserve testbed area, have been deployed. These sensor networks have been developed mainly as a result of dialogue between research scientists working on COBWEB and the co-design partners.

There are two ways by which sensor data can be incorporated into the storage middleware:

1. Automated sensing. The physical sensors embedded in the environment are augmented with telemetry capabilities that enable them to operate in an

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autonomous manner, without human intervention, in transmitting data to a base station.

2. Participatory sensing. Data collection by citizen participating in surveys when in close proximity to suitably equipped sensors. The survey participant's mobile device connects directly to the sensor using short range communication and the citizen physically relays the data back to a position where the data can be uploaded to the COBWEB servers

Physical sensors: Both participatory and automated approaches were researched and developed within COBWEB. Some of the Wasp Motes listed in table 4 were used for participatory sensing. Surveys were configured such that when a citizen came within range of one of the Wasp Motes, it was discovered by the citizen's mobile device. When an observation was made, the mobile communicates with the sensor via the Bluetooth LE standard and the environmental parameters of interest were simultaneously captured. Such data can be used in quality control or to otherwise supplement the metadata associated with that observation.

Table 4. Sensors deployed in COBWEB

Sensor type	Measuring
In-Situ sensors	water depth levels, pressure (mBar), pressure (PSI), temperature
Wasp Motes	water depth levels, salinity (g/kg)
Davis Weather stations	various meteorological parameters
phone-based sensors	ambient temperature (C), pressure (mbar), accelerometer readings (radians)

The In-Situ and Davis Weather station sensors captured data automatically and transmitted back to the COBWEB servers. Data from the In-Situ sensors was used in association with habitat reversion at co-design partner RSPB's Yns-Hir reserve. Data from the weather stations are being used in educational scenarios with co-design partner Ysgol Bro Hyddgen and to investigate pollinator scenarios with co-design partner Penparcau Community Forum. In the pollinator scenarios, citizens go out on a regular basis to record observations of butterflies and their larval foodplants around Penparcau in the Dyfi Biosphere Reserve. The data recorded includes plant/butterfly species, plant coverage, butterfly activity, and habitat information.

Weather data (temperature, wind speed etc.), from weather stations, sited in strategic locations, is used in a Twitter alert service to send tweets to citizens following a dedicated Twitter account to encourage participants to go out and collect data when the weather is suitable for butterfly activity. The weather data is also used post-data collection to validate and add value to the observations.

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When collecting data within the field, sensors on board the user's mobile device are harnessed to provide additional information. For example, accelerometers values are recorded when the user is taking photographs to enable the line of sight to be determined - useful for various quality assurance purposes. It should be noted that the generic COBWEB App accesses this functionality via a Cordova plug-in while the native flooding App obtains the data directly from the sensor.

Cyber sensing: This form of sensing refers to the harvesting of online geotagged sensor data from a variety of sources through different web-based API's. In COBWEB, the approach has been demonstrated using data accessed through the Shoothill[10] (UK river levels) and Weather Underground[11] (network of personal weather stations) API's.

There are two ways (Figure 2) in which sensor data were associated with surveys within COBWEB. In the case of participatory sensed data, sensor data are included as part of the survey data and exported to the pre-quality database via the storage middleware in the usual manner. Otherwise, for both cyber and physical sensors, the data were stored directly in the pre-quality database either by sensor nodes transmitting the data in the case of physical sensors or by the harvester in the case of cyber sensors.

Social sensors: Leveraging social media streams. In COBWEB, research and development has concentrated on the use of Twitter and Flickr API's. Data from both social media platforms are acquired by two methods.

1. Bounding boxes for Biosphere Reserves are used to monitor and capture any social media postings within these areas.

2. Keywords are used to identify relevant postings worldwide.

Once social media postings have been captured they are stored in a database and are available for viewing at the portal or potentially for use within a Quality Assurance workflow.

3.4 Standards and Spatial Data Infrastructures

COBWEB aimed to maximise technical interoperability by the use of standards wherever appropriate - the sections above make multiple references to standards from several standards defining organisations such as, OGC (discovering and publishing data), ISO/TC 211 (metadata and quality information), OASIS (access control) and W3C (semantic web).

[10] https://www.shoothill.com/our-api/

[11] https://www.wunderground.com/weather/api/

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All the citizen observatory's developed under the FP7 call which funded COBWEB were required to make data collected available within the GEOSS without restriction.

Publishing data into SDI-like initiatives such as GEOSS was addressed using a cooperative approach based mainly on the processes of the OGC. For example: the project contributed to three OGC led GEOSS Architecture Implementation Pilots; five ad hoc Citizen Science meetings were organised by COBWEB during OGC Technical Committee meetings over the duration of the project, resulting in the formation of a fully constituted Citizen Science Domain Working Group.

One of the main results was the publication of the OGC Discussion Paper *'Standardized Information Models to Optimize Exchange, Reusability and Comparability of Citizen Science Data'*. These are the first steps on the standardisation ladder, progressing through formation of a standards working group to eventual publication of an agreed international standard. Broad community uptake of a harmonised common information model applicable to a wide range of citizen science scenarios would be a valuable contribution towards being able to share and future proof the value of data collected. Data compliant with this information model can be discovered and accessed through standardised web interfaces, e.g., OGC web services, and integrated with SDI's as most, if not all, SDI's are based on open geospatial interoperability standards.

Two approaches to creation of a harmonised data model were explored within COBWEB: First, the definition of an application profile by specialising the Observations and Measurements (O&M), SensorML and SweCommon information models. Second, the definition of an O&M, SensorML and SweCommon encodings best practices to allow more efficient reuse of existing components.

Semantic interoperability is a major concern, especially considering the growth in the open data movement and use of semantic web standards. Semantics is concerned with attaching unambiguous meaning to terms and concepts, typically, using ontologies (formal models describing semantics). In the citizen science domain, as in others, this is very important as understanding exactly what was observed and in which context is essential to making the data comprehensible; both for the immediate use, by others and in the future. The ability to share data, reuse, integrate and compare is often compromised by a lack of semantic interoperability. As would be expected in a research project whose main objective is developing a generic infrastructure that aims to satisfy requirements across as broad a range as possible of the multitude of potential citizen science scenarios, semantics was an area of intense research and development interest in COBWEB. The approach described below is documented in the OGC Discussion Paper referenced above.

In terms of the COBWEB workflow (Figure 1), semantics could be introduced at various stages, but the best place to introduce semantics is when the survey context is defined. At this point, the goals of the project should be clear, and if not, then it is

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time well spent clarifying exactly what is expected to be observed and to what extent exact definitions can be incorporated. Ideally, the Survey Manager would liaise with the Principal Investigator and possibly also the Quality Reviewer and other experts as appropriate, to incorporate sufficient semantics to ensure that the information generated by the survey is of maximum usefulness to end Consumers.

During the Sept 2016 OGC Technical Committee meeting, a live demonstration of the 'Interoperability Profiles (IP)' approach developed under COBWEB was given, demonstrating the projects rigour in effectively delivering semantic interoperability. Using this method, the Survey Manager selects (or creates) an IP during survey design; the IP provides unambiguous references to authoritative definitions of concepts being used in the survey, in this case, it was a link to the relevant standards entry (biodiversity standard Darwin Core terms) defining the invasive species Japanese Knotweed. As a consequence of using this IP during survey creation, every time an observation of a Knotweed was made using this COBWEB survey, the data then contained references to the authoritative definition thereby ensuring semantic interoperability.

Note that this approach is independent of, and does not affect, serialisation options; the Citizen Science application profile enables encoding as XML (Extensible Markup Language), GeoJSON or linked data. The observations and raw data are of primary interest, various levels of processed or aggregated data may be required at different times depending upon circumstances. All types of observations are supported; including raw observations and those which are derived or result from subsequent quality assurance or conflation processing. A provenance model is included to provide information on the history of each observation.

Of course, widespread adoption and use of this approach presupposes that the relevant semantic resources have endpoints and are internet addressable using semantic web standards, that IP's have been created and that the approach has received widespread community uptake. This is far from the case; however, the low TRL approach described above demonstrably works, can and is being used as a platform to stimulate further discussion, research and development.

4. Potential impact

COBWEB conducted research into the feasibility of creating a common generic framework for mobile device apps for use in citizen science for environmental monitoring, using the UNESCO World Network of Biosphere Reserves as a testbed. We have demonstrated that, in principle, it is possible and brings multiple benefits when starting from a position where the importance of interoperability and flexibility is paramount. This stands in contrast to the current proliferation of Citizen Science Apps generating silos of data.

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Specifically, it has been shown that creating a generic solution to automating quality control and assurance, which is sufficiently flexible to address the huge range of potential scenarios, is beneficial to the reuse of citizen science data. Further development would result in the ability to make very large volumes of data useable, and is an area of active ongoing research.

Similarly, COBWEB has contributed to the understanding that further research and development is needed to address whether it is possible to create an easily useable framework which is sufficiently flexible to allow a broad range of different kinds of familiar semantic resources to be employed in designing surveys before citizens go into the field. Without this, despite post-processing server-side, continued problems associated with a lack of semantic interoperability may be anticipated.

Despite perceived complexity and proliferation, the use of open interoperability standards still presents the most realistic chance of preventing the waste of resources and reuse opportunities inherent in creating silos of data locked into proprietary solutions. In the citizen science domain, as in other domains that leverage SDI, the lack of a widely adopted solution to security interoperability is again apparent as a major barrier. At the technical level, COBWEB has shown that access management federations work; progressing this relies upon action at the organisational, legal and political level – outwith the scope of COBWEB.

However, standardisation efforts should continue and adherence be required to help realise investment in SDI type initiatives such as GEOSS.

COBWEB has had significant potential impact in highlighting that, if agreement can be reached on a harmonised common information model, with sufficient community support, most, if not all, crowdsourced, citizen science type data could be made compliant with the developing standardisation efforts initiated under COBWEB. The immediate prize would be a boost to the usefulness of these data by reducing integration costs and enabling the myriad of potential consumers of such data to exploit existing standards based tooling and develop new standards based solutions on top. COBWEB has also contributed to the understanding that the long term curation value of holding citizen sourced data at the observation level of granularity compliant with a well thought out, agreed and documented information model is to maximise potential future access and re-use.

The amount of citizen sourced environmental data will continue to increase dramatically and clearly has the potential to be of use for policy formation and delivery in respect of environmental decision making. At the global scale, towards the end of 2015, the UN adopted the 2030 Agenda for Sustainable Development, this included a set of 17 Sustainable Development Goals (SDG) to end poverty, fight inequality and injustice, and tackle climate change by 2030. The importance of geospatial information in monitoring progress with SDG targets is explicitly recognised in clause 76 of the official resolution (United Nations, 2015). It may be

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argued that citizen sourced geospatial information has a potentially important contribution towards realising the SDG's worthy of significant further research.

In this respect, based on experiences in COBWEB, we would recommend increased focus on the UNESCO World Network of Biosphere Reserves (WNBR) as a testbed for sustainability science related research and development. This is particularly appropriate as at the 2016 Fourth World Congress of Biosphere Reserves, the UN's Man and Biosphere Programme resolutely aligned the WNBR with the SDG's in the resulting Lima Action Plan[12].

Using co-design processes and consortia such as those employed in COBWEB, WNBR mechanisms can be leveraged to more easily mobilise sufficient numbers of enthusiastic citizens in order to help realise meaningful outcomes based on real world needs.

The COBWEB framework solution described above is complex and significant further work is required to present only the required level of complexity, depending upon circumstances, when required. Integrating all the components (at different TRL's) to create an actual system proven in an operational environment (TRL 9) was beyond the scope of this research project.

4.1 Main dissemination activities and exploitation of results

With the direct involvement of OGCE on COBWEB as a full partner, the use of interoperability standards has always been central to the project and will be key to exploitation of project results. Towards the end of this four year project, in June 2016, COBWEB sponsored the OGC Technical Committee (TC) meeting in Dublin. The project was highly visible and was represented multiple times during the week, including a half day 'COBWEB Summit' entirely dedicated to those aspects of the project within the scope of a standards defining organisation.

An ad hoc Citizen Science meeting was also held during the TC week; this was the fourth of five ad hoc meetings organised by COBWEB at TC's held over the course of the project at various locations around the globe: Barcelona, Sydney, Washington, Dublin and Orlando.

The culmination of this discussion and community consultation came at the Sept 2016 Orlando TC when the charter for the new Citizen Science Domain Working Group (DWG) was voted on and approved, as was the release of the OGC Discussion Paper *'Standardized Information Models to Optimize Exchange, Reusability and Comparability of Citizen Science Data'* (published March 2017).

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12 http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/Lima_Action_Plan_en_final.pdf

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COBWEB led on all the above and is explicitly acknowledged as doing so, project representatives in Orlando concluded by giving a live proof-of-concept demonstration of the documented approach in action.

At the time of writing, the work described above has already had impact and is a milestone in the standardisation of citizen sourced data. Several recently funded Horizon 2020 projects referenced the work in their proposals and are exploiting COBWEB results; this includes NextGEOSS and all four projects funded under H2020 SC5-17-2015: *Demonstrating the concept of 'Citizen Observatories'* - the latter was evident at the Brussels cluster meeting attended by the author in Nov 2016. Indications are that the OGC Citizen Science DWG will continue to be an important global forum for discussing common approaches to interoperability challenges in the citizen sourced data domain.

Longer term, the work may lead to the formation of a Standards Working Group and eventually a full international standard with broad uptake. As noted above, the potential impact of this is great; vast amounts of potentially valuable citizen sourced data are currently being locked in silos and opportunities are being lost now and will continue to be in the future because adherence to a well thought out data model is not happening. Whether an accepted standard emerges via the OGC route or not is dependent upon multiple different factors now outside the influence of COBWEB, although the COBWEB coordinator hopes to positively influence this as the current European co-chair of the new Citizen Science DWG.

Various other aspects of COBWEB have also filtered through into new projects. One of the H2020 SC5-17-2015 projects – LandSense, is reusing elements of the COBWEB approach to **Quality Assurance (QA)** and security.

As noted above, a major criticism of citizen sourced data is that it is often of insufficient quality to be of use for the kinds of scenarios typical of policy formation and delivery. The situation is compounded by the current lack of automated QA methods and bottlenecks caused by reliance upon experts visually checking the quality of submitted observations. Raising the TRL of the highly flexible standards based web services chaining approach, developed under COBWEB, to the point where it could be used in production to automate QA and add appropriate metrics to observation metadata would be valuable indeed.

The situation with the access management federation approach used for **security** and privacy in COBWEB is different. This is already proven to be high TRL, key components are, in some cases, eg, SAML based access management federations in the academic sector, already in use by literally millions round the globe. The barriers to widespread uptake are not technical; they are political, organisational and financial. Long term impact will depend upon whether other solutions to sharing data across administrative domains using interoperability standards emerge, or whether the lack of a widely accepted approach increases uptake. Over the lifetime of the

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project, COBWEB used the regular GEOSS Architecture Implementation Pilots to disseminate our knowledge of this area - current indications are that the lack of a widely adopted interoperable security solution continues to be an issue.

Another key dissemination channel used for summarising and communicating project results was the scientific paper *'Citizen OBservatory WEB (COBWEB): A Generic Infrastructure Platform to Facilitate the Collection of Citizen Science data for Environmental Monitoring'* published in a special Citizen Science edition of the Joint Research Centres (JRC) International Journal of Spatial Data Infrastructures Research. Writing this paper in the final year of the project coincided with the special edition and JRC hosting a two day workshop (data and service infrastructures for Citizen Science) during Jan 2016 of a global grouping centred around the European Citizen Science Association focussed on interoperability of Citizen Science data. JRC subsequently agreed to be charter members of the new OGC Citizen Science DWG.

Other core dissemination activities communicating results towards the end of the project were a COBWEB article intended for a more general audience in the widely distributed Impact magazine[13] and, with greater novelty value, the comic book: *Crowd Power: the COBWEB Guide to Citizen Science*, available off the COBWEB website[14]. Here you can also find a short documentary video comprised of interviews with key project personnel recorded during the final consortium meeting in Sept 2016[15].

From the outset, COBWEB committed to open standards, open data and open source software. In the last quarter of the project, effort was expended in open sourcing those high TRL outputs that the consortium considered to have the greatest exploitation potential. This resulted in the creation of **Fieldtrip Open[16]** as a separate entity with an existence beyond the end of COBWEB.

Fieldtrip Open is comprised mainly of the generic COBWEB App, the survey designer and the middleware. It is fully documented and extensible allowing the incorporation of quality control processes and additional controls as required. Observations can be published in a variety of different formats/schemas and made available via OGC web services. The intention is that the software can be used with other well known open source geospatial projects, eg, GeoNetwork, that it forms the

[13] http://www.ingentaconnect.com/content/sil/impact/2017/00002017/00000003/art00007

[14] https://cobwebproject.eu/news/promotional-materials

[15] https://cobwebproject.eu/news/publications/videos-0

[16] http://fieldtrip.edina.ac.uk/

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basis for multiple initiatives and that those benefiting contribute back to the codebase to create a viable sustained open source community.

In March 2017, the prospect of the latter happening received a boost through the Welsh Government's awarding the year long Welsh Citizen Observatory Pilot (WCOP) contract to a subset of the COBWEB consortium. WCOP was created to sustain the existence of the COBWEB infrastructure as deployed in the Dyfi Biosphere Reserve to allow further opportunities to influence citizen science projects to adopt more mature data collection and management strategies and to demonstrate the benefits of standards based technology and open data models for government. The focus for WCOP will be on projects identified by Welsh Government as having the greatest impact in terms of environmental decision making and policy. Because the software is generic, flexible and does not require software engineering expertise to create surveys, the expectation is that it will also continue to be used by a variety of community groups, including those involved in co-design during the execution of COBWEB.

The Commission's investment in COBWEB has clearly had an impact, this is particularly evident in how citizen involvement using new technology in environmental governance is viewed in Wales. This may be taken as additional evidence of the benefit of having direct involvement of government bodies in large collaborative research projects that aim to have policy impact. As Welsh Government is a devolved administration, exploitation of COBWEB results by the public sector to realise policy objectives is having impact, and will continue to have impact, not only in Wales, but across the UK through national fora such as the UK Environmental Observation Framework.

5. Address of project public website

https://cobwebproject.eu/

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Annex A – An impression of COBWEB

The following annex provides an impression of COBWEB over the project lifetime by illustrating and promoting the work in the form of selected photos, videos, press cuttings, etc.

Kick Off Meeting, Edinburgh – November 2012

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Press cutting: Herald Scotland – Dec 2012

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Apps aim to help conservation fight

Monday 24 December 2012

Scottish researchers are leading an international project to preserve areas of cultural or environmental significance such as the mythological home of the Greek gods.

Mount Olympus is one of the sites earmarked for a conservation project that will encourage members of the public to document environmental changes using personal cameras and smartphones.

Edinburgh University researchers will develop mobile apps to help tourists observe wildlife populations, plant species and rising water levels in special "biosphere reserves" identified by world conservation body Unesco.

The scheme, named The Cobweb Project, will encourage input from visitors to Mount Olympus, the highest peak in Greece, which ancient societies believed was the home of their gods, as well as sites in Greece, Germany and the Dyfi valley in Mid Wales.

The project is supported by a consortium of 13 partners from five European countries: UK, Germany, Greece, the Netherlands and Ireland. Cobweb Project coordinator Chris Higgins, of Edinburgh University's Edina national data centre, said: "Biosphere reserves are beautiful areas with people living in them who want to keep them that way. Using smartphone technology to get people more involved in decision-making is a hot research area.

"Empowering people and improving information flow is vital to addressing environmental issues."

Funding for the project comes from the EU's FP 7 Programme, which is designed to respond to Europe's employment needs, competitiveness and quality of life.

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BBC – Jan 2013

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BBC VOCAB

Hafan Gwleidyddiaeth Gogledd-Ddwyrain Gogledd-Orllewin Canolbarth De-Ddwyrain De-Orllewin Wales News

14 Ionawr 2013 Diweddarwyd 11:16

Cynllun gwyddonol ym Miosffer Dyfi i helpu atal llifogydd?

Mae cynllun ar y gweill sy'n golygu y gall pobl gasglu gwybodaeth ar eu ffonau clyfar fydd yn helpu ymchwil gwyddonol.

Bydd gwarchodfa Biosffer Dyfi, sy'n cynnwys rhannau o Geredigion, Gwynedd a Phowys, yn rhan o brosiect COBWEB sy'n werth £7 miliwn dros bedair blynedd.

Y nod yw casglu gwybodaeth fel risg llifogydd a chynefinoedd bywyd gwyllt ond ni fydd pobl yn cael cymryd rhan am o leiaf flwyddyn.

Bydd pobl yn gallu defnyddio ffonau clyfar i gasglu gwybodaeth

Mae rhaglenni ffonau yn cael eu datblygu ar hyn o bryd.

Yn ôl Partneriaeth Biosffer Dyfi ym Machynlleth, fe ddylai'r cynllun wella'r modelau sy'n proffwydo'r lleoedd sy'n debygol o gael llifogydd.

Ardaloedd prawf

Sail y prosiect yw Rhwydwaith Gwarchodfeydd Biosffer y Byd UNESCO ac mae ardaloedd prawf mewn gwarchodfeydd yng Nghymru, yr Almaen a Groeg.

Prifysgol Caeredin sy'n arwain y prosiect ac yn y consortiwm mae 13 o bartneriaid o bump o wladwriaethau Ewrop: Y DU, Yr Almaen, Groeg, Yr Iseldiroedd ac Iwerddon.

Dywedodd Chris Higgins, Cydlynydd Prosiect COBWEB: "Mae gwarchodfeydd Biosffer yn ardaloedd lle mae pobl am i'w hardal aros yn hardd.

"Mae defnyddio technoleg ffonau clyfar fel bod dinasyddion yn rhan o benderfyniadau yn faes ymchwil cyffrous.

'Grym i bobl'

"Rhaid rhoi grym i bobl a gwella llif gwybodaeth er mwyn mynd i'r afael ag ystod o broblemau amgylcheddol."

Straeon Perthnasol

'Labordy ymchwil'

Hwb o £2.5m i dwristiaeth

Cydweithio er lles yr amgylchedd

Prif Straeon

Gwasanaeth iechyd: Rhagor o gwynion

Staffio mamolaeth yn bryder i ACau

Ailgynnau ail ffwrnais Port Talbot

Cytundeb rhyngwladol i greu swyddi

Prisiau tai yn cynyddu yng Nghymru NEWYDD

Pigion

Cofeb i'r Cymry fu farw yn Fflandrys?

Dywed ymgyrchwyr fod angen cymorth ariannol gan Lywodraeth Cymru er mwyn sicrhau bod cofeb yn cael ei chodi yn Fflandrys i goffáu'r holl Gymry a fu farw yn ystod y Rhyfel Byd Cyntaf.

Parêd Gŵyl Dewi

Dr Meredydd Evans fydd Tywysydd cyntaf parêd blynyddol i ddathlu Dydd Gŵyl Dewi.

Rali i gofio Tryweryn

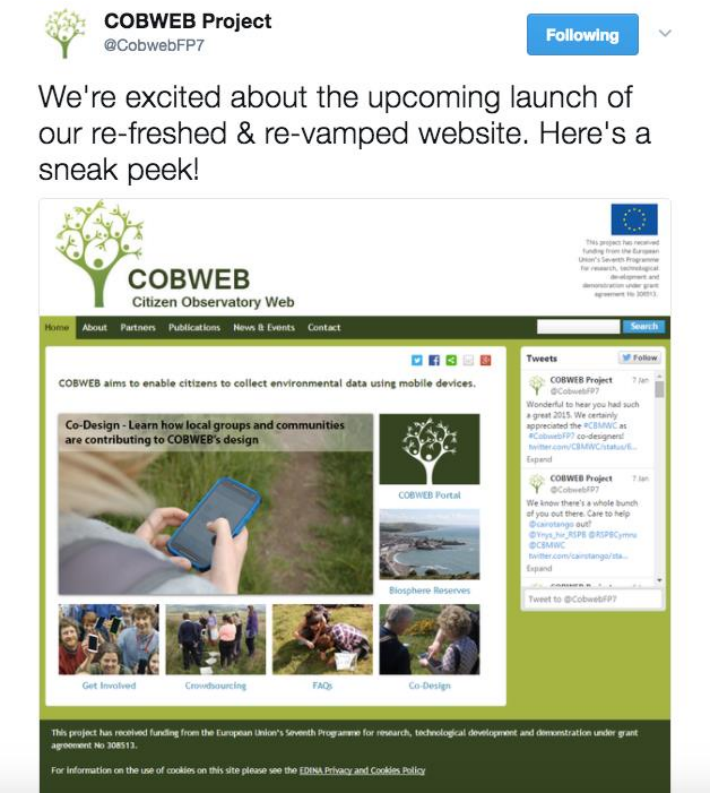
Rali ger Llyn Celyn 50 mlynedd ers i Fudiad Amddiffyn Cymru osod dyfais ffrwydrol mewn trosglwyddydd ar y safle.

Cofio'r Cawr Addfwyn

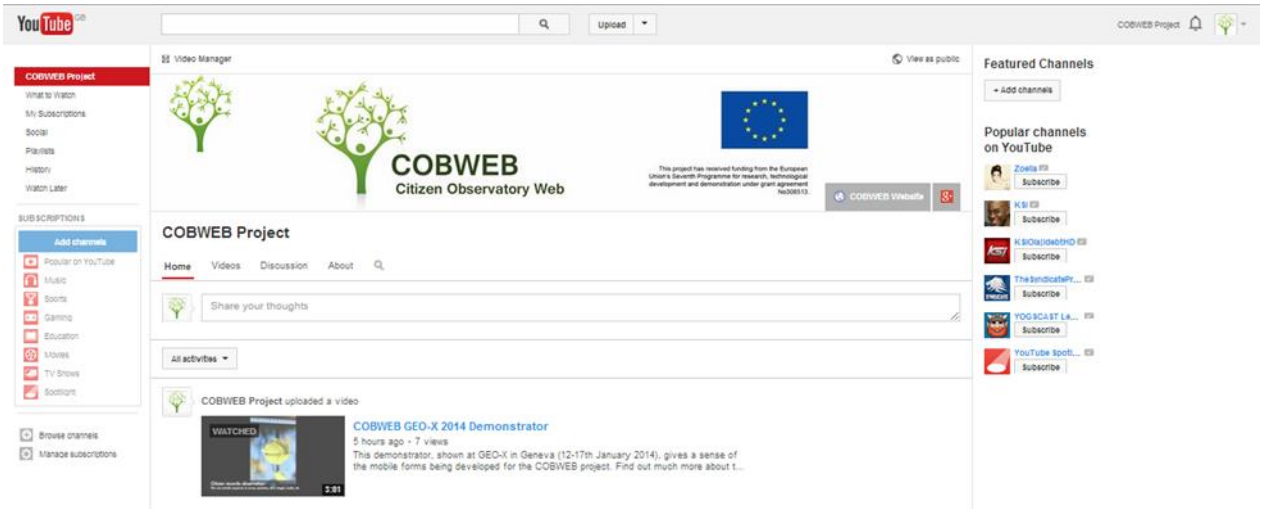
Bydd John Charles yn ymddangos ar stamp newydd y Post Brenhinol i nodi 150 mlynedd ers creu rheolau'r gêm bêl-droed.

COBWEB Website – from Jan 2013 (refreshed Jan 2016)

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513



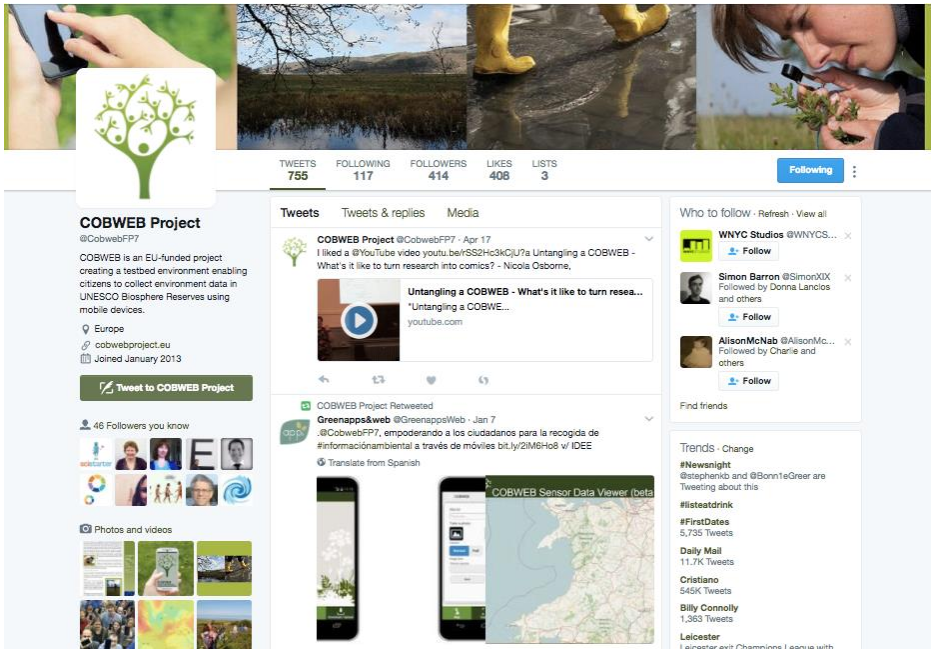
COBWEB YouTube Channel – from Jan 2013



COBWEB Twitter – from Jan 2013

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

View of @cobwebfp7 presence as of April 2017:



This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Example tweets from and about COBWEB including:

Ysgol Bro Hyddgen
@BroHyddgen
Follow

Yr 10 working hard collecting data and testing apps for #Cobwebfp7 and #RSPB
2:12 PM - 16 Jun 2015
4 1

Ysgol Llangynfelyn
@YGLlangynfelyn
Follow

Gweithio'n galed/working hard on the COBWEB project @Ynys_hir_RSPB @Natures_Voice @CobwebFP7
7:24 PM - 30 Apr 2015
2

CBMWC News
@CBMWC
Follow

Survey this morning with Dolphin Survey Boat Trips - opportunity to test the @CobwebFP7 app #citizenscience
6:36 PM - 27 May 2015
1 1

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Citizens' Observatories Coordination Workshop, Brussels – January 2013

Design Forum, Consortium Meeting in Dyfi Biosphere Reserve – May 2013

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Work Package 2 Meetings in Greece – October 2013

Speakers Corner, GEO X, Geneva – January 2014

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Janez Potočnik, the European Commissioner for the Environment at the EC Citizens' Observatories stand, Geo X, Geneva – January 2014

Press cutting: GeoConnexion Article – Mar 2014

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Dyfi Co-Design Workshop, Y Plas, Machynlleth – May 2014

AGILE 2014 Workshop – June 2014

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

8th GEO European Projects Workshop, Athens – June 2014

RSPSoc Conference, Aberystwyth, Sept 2014

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

COBWEB Flyers – from Nov 2013

Printed/online in Welsh/English; English/French; English/German; and English/Greek.

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Citizen Observatory Conference- Live Demo, Brussels, Dec 2014

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

COBWEB Co-Design Kickoff Meeting, Machynlleth, Apr 2014

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

COBWEB Newsletters – from late 2014

A total of seven COBWEB newsletters were published, with most translated into both Welsh and Greek. Some indicative screenshots are included below.

The latest Newsletter from the COBWEB Project.

View this email in your browser

COBWEB
Citizen Observatory Web

COBWEB Newsletter #7
Sharing our successes

The COBWEB team share their highlights and findings as the project comes to an end.

COBWEB: Citizens OBservatory WEB project has been creating a platform to enable citizens within UNESCO Biosphere Reserves to collect environmental data using mobile devices.

In this issue (our last long form newsletter for the project), we will be sharing some of our highlights from the last four years, sharing the latest updates and resources for you to access and use, and sharing our hopes and plans for the future.

If you would like to find out more about any aspect of the project please do get in touch. You will find contact details for the COBWEB team as well as a link to download project resources at the end of the newsletter.

Crowd Power: the COBWEB Guide to Citizen Science

New (free) comic book shares best practice and the story of the project

We have recently been working with writers and artists at BHP Comics to create a new comic book which provides an introduction to citizen science and an overview of the COBWEB: Citizen Observatory Web project and the

The latest Newsletter from the COBWEB Project.

View this email in your browser

COBWEB
Citizen Observatory Web

COBWEB Newsletter #4

Find out what COBWEB has been up to in recent months!

COBWEB: Citizens OBservatory WEB is a project which is creating a platform to enable citizens within UNESCO Biosphere Reserves to collect environmental data using mobile devices.

In this issue, we highlight COBWEB Co-Design project activities in the 2015 field season, and where COBWEB has been out and about the last few months.

As ever, if you would like to get involved with any aspect of the project please do get in touch. You will find contact details for the COBWEB team as well as a link to download project leaflets and flyers at the end of the newsletter.

Fresh New Look for COBWEB

The COBWEB website has been revitalised with new content and a fresh new look. With up-to-date information on our Dyfi Biosphere co-design projects, SWE4CitizenScience, our partners, and the Biosphere Reserves working with COBWEB, there's a wealth of new information about who we are and what COBWEB is all about.

Check out the website and tell us what you think!

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Το νέο ενημερωτικό φυλλάδιο του προγράμματος COBWEB.

View this email in your browser

COBWEB
Citizen Observatory Web

COBWEB Ενημερωτικό Δελτίο #4

Ενημερωθείτε για τις δράσεις του COBWEB τους τελευταίους μήνες!

Το **COBWEB** (Citizens **OB**servatory **WEB**) - Διαδικτυακό Παρατηρητήριο Πολιτών είναι το πρόγραμμα, μέσω του οποίου δημιουργείται μια πλατφόρμα εισαγωγής περιβαλλοντικών δεδομένων από πολίτες, μέσω κινητών συσκευών. Περιοχές αναφοράς είναι οι περιοχές του δικτύου Αποθεμάτων Βιόσφαιρας της UNESCO.

Σε αυτό το τεύχος, δίνουμε έμφαση στις δράσεις που υλοποιήθηκαν στο πεδίο, στο πλαίσιο των έργων συν-σχεδιασμού (co-design projects) του COBWEB για το 2015, καθώς και στις δράσεις εκπροσώπησης του προγράμματος σε πλήθος εκδηλώσεων.

Όπως πάντα, εάν ενδιαφέρεστε να συμμετέχετε στο πρόγραμμα COBWEB επικοινωνήστε μαζί μας. Στοιχεία επικοινωνίας, καθώς και ένα σύνδεσμο, για να κατεβάσετε φυλλάδια του προγράμματος, θα βρείτε στο τέλος του ενημερωτικού δελτίου.

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

INSPIRE - Geospatial World Forum, Lisbon, May 2015

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

9th GEO European Projects Workshop, Copenhagen, June 2015

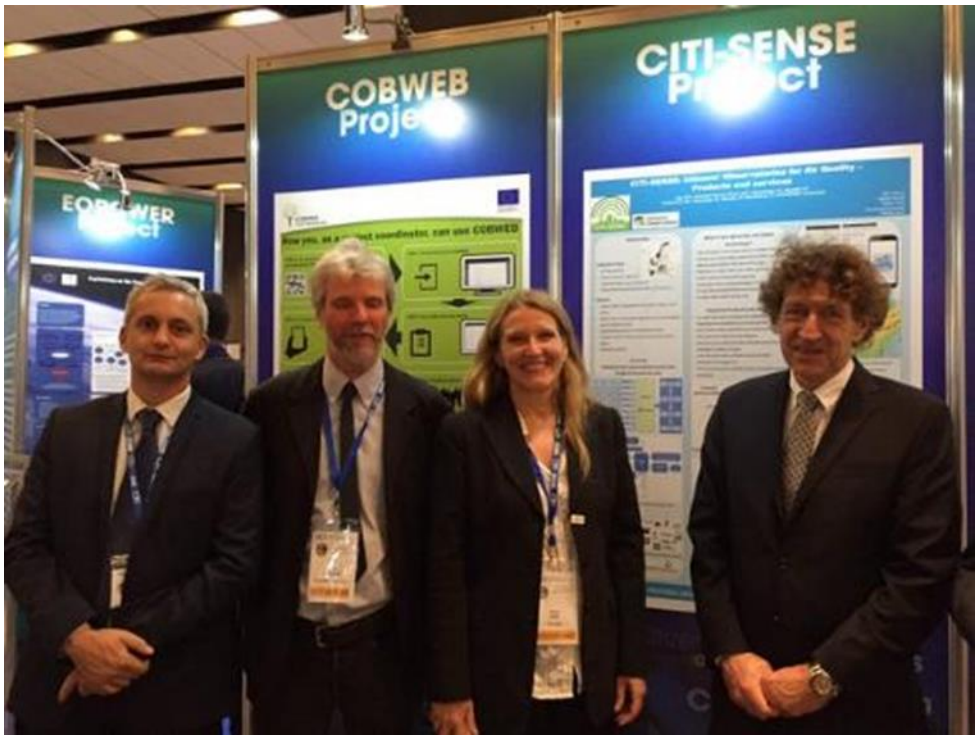
Social4Social
@S4Snet
Follow

Introducing @CobwebFP7 - codesign process and data collection by citizens to protect environment
10:58 AM - 15 Jun 2015

OGC Technical Committee, Sydney, Australia, Nov 2015

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

GEO-XII Plenary & Mexico City Ministerial Summit, Nov 2015



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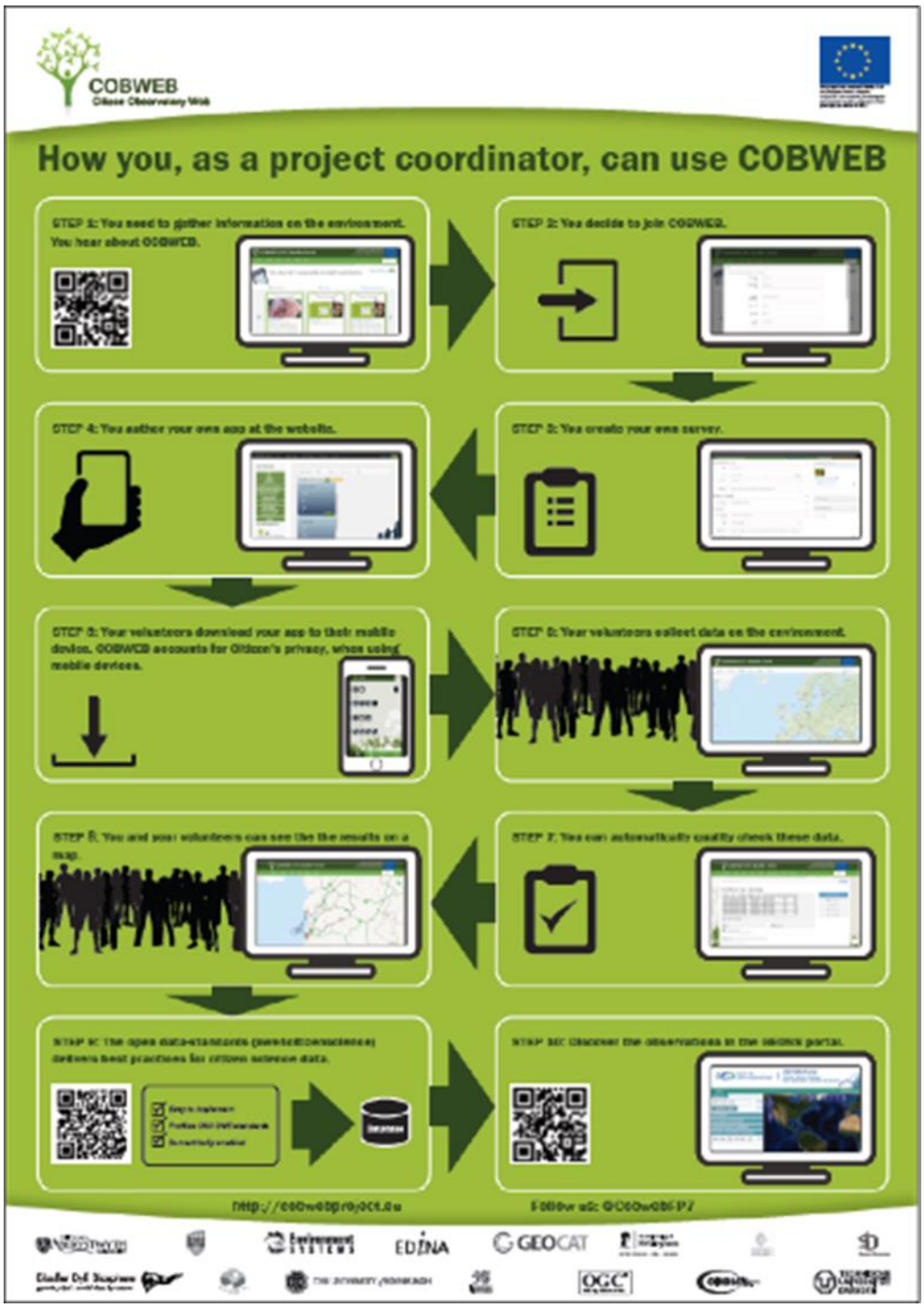
Non-technical COBWEB Poster

Displayed at the ECSA General Assembly Oct 2015 and EU Stand, GEO XII Nov 2015



This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

RSPB Co-design sub-project, sensor deployment, Jan 2016

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Press cutting: Science Node – March 2016

COBWEB and quotes from Chris Higgins (UEDIN) appeared in the article "Is citizen science living up to the standard", published on 23rd March 2016: https://sciencenode.org/feature/is-citizen-science-living-up-to-the-standard.php.

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Is citizen science living up to the standard?

The US National Science Foundation (NSF) -supported Data and Metadata Working Group will improve discoverability and continue to bring citizen scientists into the ranks of respectability.

Speed read

- Volunteer-powered science resides in a state of ambivalence.
- Standardizing citizen science data and metadata will enhance discoverability and legitimacy.
- Citizen scientists offer another safeguard when regulatory agencies fail.

Posted on 23 MAR, 2016

Lance Farrell
Managing Editor

Share this story

Republish

Tags

National Science Foundation (NSF)
European Commission
citizen science
crowdsourcing

We've been following the advent of citizen science for some time now at the Science Node. Citizen science has come a long way, and to improve its reach and efficiency, the US National Science Foundation (NSF) -supported Citizen Science Association (CSA) recently created a Data and Metadata Working Group (DMWG). If all goes as hoped, citizen science will come out of the shadows and continue to join the ranks of respectability enjoyed by traditional scientific research practices.

When most of us think of science in practice, we probably envision a white-coated, bespectacled senior scientist delegating field research to apprentice researchers (i.e. graduate students). These fledgling scientists port their observations and samples back to the lab, where fully credentialed researchers verify, clean, and analyze the data. Findings are eventually forwarded on to the public in the form of peer-reviewed publications.

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

World Congress of Biosphere Reserves, Lima, Peru, Mar 2016

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Meeting with the Management Body of Mount Parnon and Moustos Wetland Natura 2000 site, Athens, Greece, May 2016

European Citizen Science Association conference, Berlin, Germany, May 2016

cobwebfp7 Following

sciencekompass, smnfilm, stellare, the_conscious_collective, opalnature, morningmentor and **yvesmulkers** like this 47w

cobwebfp7 Cobweb attended the #EuropeanCitizenScienceAssociation (#ECSA) conference in Berlin, Germany, last week. The venue was KulturBrauerei, an old brewery, and made for an interesting location.
Cobweb chaired 'Data, metadata, quality and visualisation of citizen science data' with a focus on acquisition of observation data through sensors and apps. Taking into consideration the observations themselves and how they are stored, shared, processed and visualised.
Image taken by COBWEB partner Paul van Genuchten
More information on the COBWEB project can be found on our website http://cobwebproject.au
#CitizenScience #OpenData

Add a comment...

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

OGC Technical Committee meeting, Dublin, Ireland, June 2016

School trip, Mount Olympus Biosphere Reserve, Greece, July 2016

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Wadden Sea National Park survey, Nordeney, Germany, Aug 2016

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

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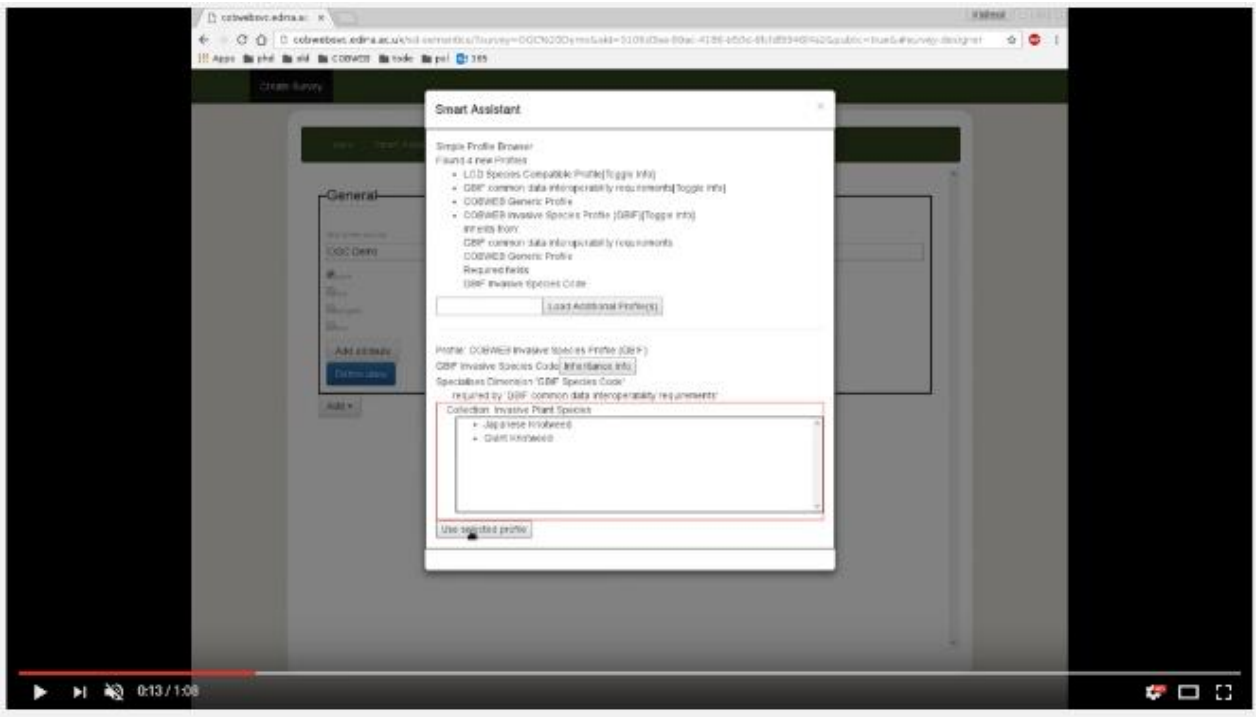
OGC Technical Committee meeting, Orlando, USA, Sept 2016

A live demonstration of survey creation with semantics software, was given at the inaugural meeting of the OGC Citizen Science Domain Working Group during the Orlando Technical Committee meeting. A video of this demo is available at: https://www.youtube.com/watch?v=l66CAm9LC1U (see image below).



Release of the COBWEB led OGC Discussion Paper *'Standardized Information Models to Optimize Exchange, Reusability and Comparability of Citizen Science Data'* (https://portal.opengeospatial.org/files/?artifact_id=70328) was voted on and agreed at the new Citizen Science Domain Working Group.

COBWEB Videos

A series of commissioned videos capturing COBWEB Use Cases in the context of the co-design projects. Released in 2015 and 2016.

Validating land cover using COBWEB

Available at: https://www.youtube.com/watch?v=CvYhLTqdGY4

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

What is COBWEB?

Available at: https://www.youtube.com/watch?v=fFI-NrSX9ws

A documentary, giving an overview of the whole COBWEB project, was commissioned from Beyongolia Productions, and published in November 2016: https://www.youtube.com/watch?v=gTMGOpcvNHs

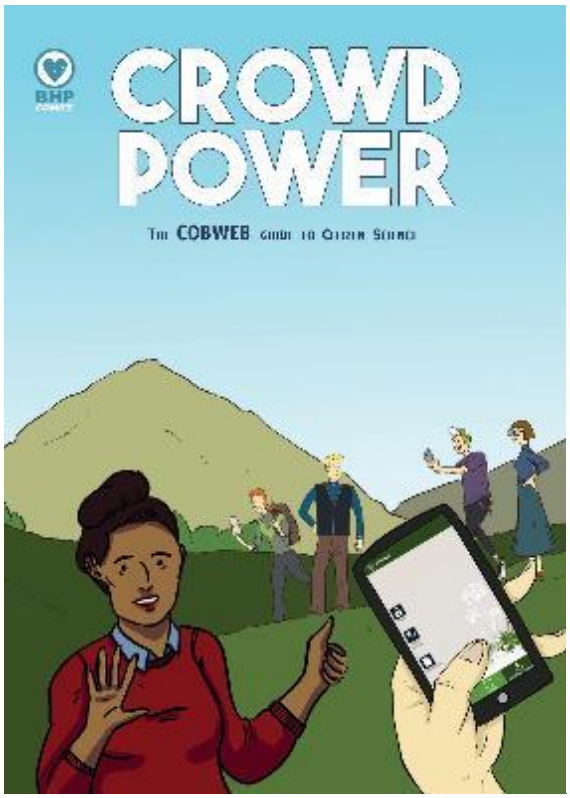
This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Crowd Power: The COBWEB Guide to Citizen Science – November 2016

This comic book, commissioned and co-edited by the COBWEB project, gives an introduction to citizen science as part of an overview of COBWEB and the achievements and technical progress made during the project. Distributed at various events through a print run of 1000 A4 copies, published by Black Hearted Press Ltd. Also available as a globally available digital (PDF) version.

Credits: Sha Nazir and Kirsty Hunter Art with Clare Forrest, Kirk Kristofferson, Jack Lothian and Nicola Osborne. EDINA, COBWEB: Citizen Observatory Web project and (BHP Comics) Black Hearted Press Ltd., 2016 . ISBN: 978-1-910775-07-3

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513



This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Fieldtrip Open Website – from Sept 2016

In order to promote and disseminate the open source software created during COBWEB – including the associated Github repositories, a new Fieldtrip Open website was launched in autumn 2016: http://fieldtrip.edina.ac.uk/

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308513

Press cutting: Impact: Pathways to Innovation – Mar 2017

Article, “COBWEB, Citizen Observatory Web, FP7” in this outreach publication with both digital and Print editions: https://doi.org/10.21820/23987073.2017.3.17

This project has received funding from the European Union’s Seventh Programme for research, technological development and demonstration under grant agreement No 308513