ICT-enabled citizen science: Where are we and the way forward

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State-of-the-Art Study in Citizen Observatories: Technological Trends, Development Challenges and Research Avenues

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Fostering participation via civic technologies
Background information of the study

- Survey study conducted in 2015 (Aug – Dec)
- Reviewed the last 10 years of participatory sensing literature
- Performed: a systematic literature review + surveys + interviews
- Total of 108 projects studied
- All data is open access at helda portal helda.helsinki.fi/handle/10138/164810
Systematic literature review

- RQ1: What are the trends in citizen repositories/observatories in the world?
- RQ2: What are the practices in citizen repositories/observatories in the world?
- RQ3: What are the current and past initiatives in citizen repositories/observatories in Finland and Europe?
- RQ4: What are the current and past initiatives in citizen repositories/observatories in environmental observation in Finland and Europe?
- RQ5: How to engage citizen?

- IEEE Digital Library
- ACM Digital Library
- Sciencedirect / Scopus
- Web of Science
- Springer Link

- Publication in the last 10 years (1/1/2004 – 31/06/2015)
- Books, papers, technical reports
- Explicit mention of citizen observatories or repositories
- Relevance with respect to research questions
Systematic literature review process

- September
  - Systematic Mapping Study: 107
  - Systematic Literature Review: 415
  - Total: 68307

- November
  - Survey: 12
  - Interviews: 6
  - Total: 453
## Systematic literature review

- Search String A: citizen* AND observ* OR repository* AND environment
- Search String B: citizen* AND engagement* AND environ AND observ*

<table>
<thead>
<tr>
<th>Q1+Q2 (Relevant/Included/Found)</th>
<th>IEEE Digital Library</th>
<th>ACM Digital Library</th>
<th>Science direct</th>
<th>Web of Science</th>
<th>Springer Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18/46/200</td>
<td>18/55/113</td>
<td>19/41/200</td>
<td>3/18/115</td>
<td>12/38/200</td>
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</tbody>
</table>

- (RQ1,RQ3,RQ4) Project title, environmental focus, participation model, domain, focus–domain, country, description, type of data measured, year of start, activeness, contact, website
- (RQ1,RQ5) Stakeholder, activities description, techniques to engage
- (RQ1) IT platform, description, application type, goal, services use, detail IT infrastructure, social media
- (RQ1,RQ2) Problem or limitation, cause, solution proposed
- RQ2,RQ5) Best practice, process
- (RQ1,RQ2) Recommendations
- (RQ1,RQ2) Standard in use, description, issuing institution, website
Background – towards citizen science
ICT enabled citizen science rise

Humans have always been interested in observing phenomenon

1900s Citizen Science Birth

ICT-enabled Citizen Science
Public Participation Across History

1960s
Awareness rising

1970s
Incorporation of local perspectives

1972
Conference on the Human Environment

1980s
Recognition of local knowledge

1990s
Participation as a norm as part of sustainable development

1992
UNCED 92'
In our hands

2000s
Recognition of e-participation

2010s
Rising of ICT-enabled participation (active and passive)
A paradigm shift in governance

- Government
- One-way communication
- Public

- Government
- Two-way communication
- Public

- Government
- Two-way customized communication
- Public
Same practice, different terms

Citizen observatories  2012
Citizen science  1900

Participatory sensing  1990

Participatory GIS  1998
Mobile sensing  2000

Crowdsourcing  2006
Mobile crowdsensing  2010

Opportunistic sensing  2008

Key outcomes from the report
Based on 108 projects
- What, Where, Why, Who, How,
Domains of application

- City management observatories: 25%
- Water, Streams, Snow, Sea observatories: 18%
- Tools for citizen observatories: 8%
- Global Monitoring: 2%
- Disasters Monitoring: 2%
- Species Monitoring: 23%
- Biodiversity Monitoring: 12%
- Air and spectrum monitoring: 10%

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In Europe, 80% of the identified projects have been collecting environmental information – about species, biodiversity, air and spectrum, water, streams, snow, sea, precipitations, climate change – and the remaining 20% have had focus on: cities management, tools for collecting crowd data.
<table>
<thead>
<tr>
<th>Technologies</th>
<th>Best Feature</th>
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</thead>
<tbody>
<tr>
<td>Sensors</td>
<td>Accurate measures, Easy Installation</td>
</tr>
<tr>
<td>Social media</td>
<td>Dynamic, Reflects trends and opinions, Can be used for campaigning</td>
</tr>
<tr>
<td>Mobile Apps</td>
<td>Interactive, Pervasive, Simple</td>
</tr>
<tr>
<td>Surveys</td>
<td>Reliable, Deep, Effort and knowledge required</td>
</tr>
<tr>
<td>Interactive VoiceResponder</td>
<td>Fast and easy to use, Almost universal</td>
</tr>
</tbody>
</table>
Trendy practices

Use citizen observatories to track-solve issues from citizens
- FixMyStreet; SeeClickFix; FixMyArea

Create experts by empowering field observations
- eBird; Great SunFlower; iBats

Large networks based projects
- Galaxyzoo; Waze; Spring Watch

Provide training and recognition
- Fold.it; LAKEWATCH; CURA H2O

Seasonal based observatories
- Spring Watch; Christmas Bird Count
## Stakeholders and Activities

<table>
<thead>
<tr>
<th>Citizen</th>
<th>Academy and Government</th>
<th>Nature Enthusiasts</th>
<th>Families</th>
<th>Developers</th>
</tr>
</thead>
</table>
| - Provide data;  
  - Install sensors or apps that collect background data;  
  - Deploying their own monitoring campaigns. | - Provide data;  
  - Install sensors or apps that collect data;  
  - Deploy their own monitoring projects;  
  - Use result information for decision making;  
  - Research and development. | - Provide data;  
  - Install sensors and apps to collect background data;  
  - Use the data for decision making. | - Provide data;  
  - Install sensors and apps that collect background data;  
  - Use the information for personal decision making | - Research and development |
Who is running the COs

Different types of organizations which are supported by regional grants and networks, government (13%), through local authorities, national commissions/institutions, research units and projects, companies (12%) that run business or research units around the COs topic, research institutes (4%) that are highly focused on observations of different fields, NGOs (2%) which run a particular citizen observatory as their cause (and generate revenues), and charities (2%) that are sustained by multidisciplinary institutions.

Figure 21: Institutions running citizen observatories worldwide

3.4 Challenges, opportunities, best practices and recommendations

Given the ubiquity of mobile devices and the high density of people especially in urban areas, where nearly half of the planet’s population resides [38], citizen science can achieve an unprecedented level of coverage in both space and time for observing events of interest [39]. Although, there are differences in the monitoring across different parts of the world, there is a large number of observatories which share features, practices, and challenges within the two aspects of citizen science: community-based monitoring and community-based management [32].

This chapter, classified the reported challenges and limitations from the identified citizen observatories (108) in 9 categories (Figure 22), which are the following:

1. User Practices (15%): The target stakeholders, are not always ready for start contributing with a citizen observatory. The figure 23, is a word cloud elaborated with the reported issues by the studied observatories.

2. Data Aggregation Issues (7%): This problem, is faced by the observatories that have multiple data formats and data structures which have to be used to extract joint information.
Participation Types
[Cohn 2008; Tangmunarunkit et al. 2015]

**Passive participation:** Also known as opportunistic data collection or passive data. Sensor sampling occurs whenever the state of the device (e.g., geographic location) matches the application’s requirements described in a sensing task (device-centric data collection).

**Active participation:** Also known as participatory data collection or self-reported data. Users are actively involved in the collection process by a prompted experience where the participants decide to record their observations (user-centric data collection).
Why engaging publics matter?

**Operations**

A CO platform without public participation is doomed to fail

**Knowledge**

Publics have intimate knowledge of patterns and anomalies in their communities, enabling them to respond is both empowering and valuable to long term research

Expert assessments can miss important contextual information and need to be tempered by the experiences and knowledge of publics
Motivations (meta clusters)

- Drive to change
- Understand Data Benefits
- Need for Challenges
- Self-Interest Gains
- Social Recognition
Underlying Motivations

- **Be an exceptional citizen**: techniques that award the activeness of a particular citizen as an observer with social recognition in their communities.

- **Citizens Interest based monitoring**: techniques that allow citizens to set up and manage observatory of their own concern.

- **Gamification Strategies**: gamified techniques that involve to incorporate game elements into their applications.

- **Partnership**: techniques that empower city managers to install sensors and apps in their cities, to collect background data about different concern issues.

- **Present Data Benefit**: embraces the discussion with stakeholders, to present them the benefit of the data they will provide.

- **Save Money**: This category focused on creating monetary saving for the users, due to their activeness using a particular observatory.

- **Unify observatories with recreational activities**: use of recreational activities, competitions, learning games and, art campaigns that raise emotional feelings among the stakeholders, while they submit observations.
Palette of Participation

- I launch and run a monitoring initiative because I care about it.
- I decide the monitoring priorities along authorities or scientists and participate actively in the entire process.
- I use an app to avoid areas with pollen because I’m allergic to it. But, I do not contribute to it.
- I contribute to monitoring projects by collecting data.
- I collaborate with authorities or scientist to monitor a phenomenon by collecting data, designing a solution and disseminating the results in my circles.
Challenges

- User Practices (15)
- Data Aggregation Issues (7)
- Technology (5)
- Standardization (4)
- Limited Knowledge (3)
- Limited Resources (3)
- Privacy Issues (1)
- Recognition of Contribution (1)
- Data Accessibility (1)
Common concerns

• Tackling privacy issues and concerns
• Data quality and standards
• Use of proper technologies
• Participation and motivation concerns
Summary

After the report – the show goes on?
Ongoing Research: Temporality of Motivation

• What does motivate people to engage in participatory sensing in environmental monitoring?
• What values underpin the users’ motivations?
• How user motivation changes during a PS initiative?