Citizens observatories for effective Earth observations: the WeSenseIt approach

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Citizen observatories for effective Earth observations: the WeSenseIt Approach

Suvodeep Mazumdar, Vita Lanfranchi, Neil Ireson, Stuart Wrigley, Clara Bagnasco, Uta Wehn, Rosalind McDonagh, Michele Ferri, Simon McCarthy, Hendrik Huwald and Fabio Ciravegna describe how “citizen observatories” have been created with the help of new technology to allow the public to collaborate with authorities and organisations in day to day and emergency water management issues.

The WeSenseIt project defines citizen observatories as “A method, an environment and an infrastructure supporting an information ecosystem for communities and citizens, as well as emergency operators and policymakers, for discussion, monitoring and intervention on situations, places and events”1. A collaborative approach has been taken to develop solutions that involve an exchange of information and expertise from all participants and where the focus is on arriving at practical solutions with a clear vision and direction. This has created a shared ownership scheme, and shifts power to the process itself rather than remaining within authorities, developers or decision-makers. The project’s emphasis is on delivering highly innovative technologies to support citizens, communities and authorities in developing a real-time situation awareness while ensuring all stakeholders play their part. Implementation has been through a combination of crowdsourcing, custom applications and dedicated web portals designed to foster collaboration, and which has created a shared knowledge base that facilitates decision-making processes and engages with communities.

A variety of information can be provided by citizens and communities in an emergency, explicit sensors (people actively contributing information via mobile and online systems through participatory crowdsourcing), and implicit sensors (people sharing information via social media, opportunistically crowdsourced to identify critical relevant information). A variety of applications and systems have been developed in the project to address each type of information need and stakeholder.

**Citizens as Sensors**

Real-time high quality sensors provide “live” ground information on the current environmental conditions of a locality, and hence are critical to the understanding of areas of interest. Data from sensors are processed in a variety of ways and made available to decision makers as visualisations, predictive analyses or real-time alerts and triggers. All of these approaches together help inform decision makers of the existing and predicted conditions at specific locations. High precision sensors are highly expensive, need constant maintenance and are static, but can provide high volumes of data regarding areas that have been previously determined to be of interest. However, with the rapidly evolving environmental conditions and landscapes, critical areas of interest can be dynamic and different areas in cities can be of interest at different times. This challenge has been addressed by the development and deployment of low-cost sensor technology, as well as maintaining communication between citizens and the authorities.

A variety of information can be provided by citizens and key to their participatory role is the large scale installation of low cost analogue devices across wide geographical areas. Examples of such devices are water depth gauge boards and snow depth gauge boards, which need to be manually ‘read’ by counting clear numerical markings on the boards. They are relatively cheap to manufacture, require very little maintenance and can be installed at a large number of locations such as, rivers, canals, locks, waterways and so on. Citizens can quickly visually read the gauge boards and provide the information to the authorities via a smartphone or desktop application (app). In addition to the visual observation of analogue sensors, the WeSenseIt project has also developed several low cost electronic sensors using Raspberry Pi and Arduino platforms. These have been developed as small mobile devices which can provide data on local air temperature, barometric pressure, light levels as well as estimating water course pressure, traffic, snow depth, water level and key to their participatory role is the large scale installation of low cost analogue devices across wide geographical areas. Examples of such devices are water depth gauge boards and snow depth gauge boards, which need to be manually ‘read’ by counting clear numerical markings on the boards. They are relatively cheap to manufacture, require very little maintenance and can be installed at a large number of locations such as, rivers, canals, locks, waterways and so on. Citizens can quickly visually read the gauge boards and provide the information to the authorities via a smartphone or desktop application (app). In addition to the visual observation of analogue sensors, the WeSenseIt project has also developed several low cost electronic sensors using Raspberry Pi and Arduino platforms. These have been developed as small mobile devices which can provide data on local air temperature, barometric pressure, light levels as well as estimating water course pressure, traffic, snow depth, water level and...
Citizen Technologies for Data Collection

Citizens and communities participate in two ways: explicitly by providing information via mobile and online portals that were developed in the project, and implicitly by using social media platforms, opportunistically sourced to provide an assessment of evolving situations. Explicit data collection is undertaken by participatory sensing, where citizens are encouraged to report if they observe anything of relevance. Two dedicated WeSenseIt mobile applications have been developed during the lifetime of the project, which have been provided to citizens and to community volunteers (for example, civil protection volunteers). While conducting their daily activities, a citizen or a volunteer can inform authorities of any concern and can transmit the information via the smartphone app (Figure 3 left), which is submitted to the WeSenseIt data hub. At the same time, owing to evolving situations, if decision makers identify locations that are of interest (for example, reports of a river being flooded or roadways disrupted), they can highlight such areas (geofences) on an online interface (Figure 3 right), which is automatically fed into the smartphone app. Upon entering any of such geofences, a notification will be triggered to the user, prompting for critical information; the user can then quickly provide any observational data. Authorities can similarly highlight areas of interest that can trigger alerts to users if they enter those areas that are deemed “at-risk” or “in danger” to request them to be safe and exit the area at their earliest opportunity. Being in such areas can also provide essential information for authorities, however, the very nature of emergencies provides their own challenges for citizens to communicate.

To improve the support to emergency services, WeSenseIt developed an app that creates a direct video channel between citizens and authorities in order to reduce the risk of inaccurate responses.1 This system, called “Eyes on the Ground”, is a real-time live platform (Figure 4) that provides a flexible way for operators and decision makers to view an area from the control room, but still allows communication with citizens. A conversation between citizens and authorities can be initiated in several ways – a citizen can choose to contact the authorities at their command and control centre to explain an emergency scenario. Alternatively, depending on the need for information upon receipt of a report, authorities can contact citizens via a mobile app or text message. Finally, entering a dangerous geofence can trigger a request for communication via messages containing a URL. Upon clicking the URL, the mobile automatically starts streaming a live video feed to the control room. The control room operator can provide instructions to the citizen on any immediate actions needed or even move them to a different location to provide a different view. This helps provide the control room with views of affected areas, so an appropriate response can be organised in times of emergencies.

Citizens as Decision Maker

As discussed previously, citizens have multiple roles as data providers - however, with the democratisation of public policies, decisions can be made with true conviction when citizen data is included in the decision making processes. This requires citizens to have access to the data decision-makers use, so they can be more informed about situations in their regions of interest. A variety of data sources are hence provided to citizens such as weather and tide data, citizen generated reports, high precision weather station and sensor data, low cost sensors and social media. The data is presented in multiple ways - an initial home screen (Figure 5, Section 1-3) provides detailed information on subjects most relevant to typical user communities. For example, weather forecasts, flood warnings, official news reports, and citizen generated flood risk data, are pieces of information that users need to be immediately concerned with; any impending concerns can be identified from such information. Additionally, a “community wall” provides access to historical images previously uploaded by members of the community. This section provides ways for communities to remember past events which were significant in the lives of their communities for example, historical flooding events, or community charity events.

Citizens can choose to delve into more detail if they desire by accessing the raw data provided from the sensors (explicit or implicit). A map displays all the sensors at their current locations and clicking on each one provides historical sensor data. Users can also subscribe to each sensor (Figure 5, Section 3a), and set conditions to trigger alerts to notify them of any urgent readings (for example, if the river level is greater than five metres). Using a large amount of information can help citizens take better decisions regarding their personal activities as well as their community life. For example, immediately understanding the presence and locations of flood risks helps them plan their daily routes for walking, help citizens and communities be prepared for impending emergencies, as well as organise and coordinate rescue efforts by authorities and disaster response teams.

Lessons Learnt

The role of citizens in citizen observatories is key - not just as mere data providers or consumers, but as participants in a broader initiative and collective effort.
In the current project as well as previous projects, the technological development process has been driven by the need for active citizen involvement to build a better understanding of their environment, their communities, and how to collaboratively develop solutions and take decisions to improve water management and governance.

One of the practical issues identified related to the installation of sensors was the remote location and nature of sensors. They are typically located in harsh environments and as a result, often need regular maintenance and revisits. Such environments are also prone to seasonal variations and may be difficult to reach at times. Figure 6 shows the challenging locations sensors may need to be installed in. Growth of vegetation, bird droppings, and loose foliage can block the sensor areas. Citizen volunteers are often unable to perform complex troubleshooting, and as a result, the availability and physical presence of support staff is essential. Volunteer communities also have a wide range of technological requirements that may evolve over the scope of the project since engagements of communities are dynamic (with respect to volunteer members’ time, as well as technical needs and preferences). Furthermore, physical sensors require a reliable source of power in order to ensure a consistent stream of data is generated. Depending on the type of sensor and the amount of power required, this can be often challenging – batteries require constant monitoring and replacement while electricity and power lines are not always readily available and accessible. Solar panels, on the other hand are affected by weather conditions and obstruction by foliage and overgrowth (as seen in Figure 6). This is an important consideration that needs to be addressed, in order to ensure a continued and engaged participation from citizen communities.

During the lifetime of the project, all stakeholders and participants expressed concern regarding the longer term sustainability of Citizen Observatories. In addition to making available tools and technologies developed within the project as freely available open source code, several avenues are also being explored, such as identifying exploitation opportunities, providing post-project technical support, as well as code and data sharing initiatives with other citizen science and crowdsourcing projects.

The WeSenseIt project is in its final stages now, and the technologies developed are currently undergoing evaluation. The results are expected to provide a rich set of findings and a lot of interesting results, particularly in the way citizen and communities can work together to build a greater understanding of their local environment, their communities, as well as collaboratively developing solutions and taking decisions to improve water management and governance.

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