TOTAL TURNKEY SOLUTION FOR SWACHH BHARAT ABHIYAN (SBA): A CITIZEN CENTRIC APPROACH FOR GOVERNANCE

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ABSTRACT: Citizen Science came into existence as an extension of much needed computing resources and information collection for large scientific data processing. Due to increasing accessibility and affordability of internet and mobile devices, it has given impetus to citizen science with direct participation in public administration and decision making for monitoring natural resources, tracking environment degradations etc. as valuable information provider. An attempt has been made towards Clean India mission to develop citizen centric governance approach for information collection, monitoring, status updates and feedback mechanism. The work demonstrates how the citizen science and geo-processing capabilities with mobile computing can be used in citizen centric e-governance. We have built the total turnkey solution for Swachh Bharat Abhiyaan (SBA). The solution has full cycle of waste management services. It has three major component *Citizen App* & *Service App (Android based)* and *Dashboard (web-enabled)*. The citizen app has components for geotagged visible waste information collection, dustbin location information dissemination with routing module and real-time service life cycle monitoring. The complementary service App is for the field staff of civic bodies. It has components to locate and provide optimum route for catering cleaning services. It also has capability to report additional reinforcement and status updates for rendering each service request. The third component of the solution for monitoring and logistics management is a web enabled dashboard. The dashboard has business intelligent based analytical reporting of service requests status, priority area identification, and optimum route determination for vehicle logistic management. The study has been implemented in Dehradun city, Uttarakhand and got executed with the support of universities and government institutes. Henceforth the total turnkey solution demonstrates the role of citizen participation for large scale data collection and real time vulnerability mapping to improve decision making.

1. INTRODUCTION

Waste management is a very serious problem in most countries including India and it leads to various health problems and many other issues. Civic bodies, the agency responsible for the same have various challenges like limited manpower, limited machination, unauthorized dumping location, lack of information on vehicle routing/planning and separating & managing biodegradable/ non-biodegradable waste. Hence public awareness and participation is very much essential to achieve the targets set by the SBA initiatives. Furthermore Geospatial Technology can be a real game changer in this aspect as it allows capturing, monitoring and visualizing geotagged garbage locations and allows performing various GIS analysis like optimal route determination for cleaning, identifying hotspot areas etc. Such tools and functionalities will help the local civic bodies in managing their resources in optimal manner and save fuel cost etc.

With the advancements and convergence of technologies (Information and communication technologies (ICT)), especially the Internet and mobile technology has further assisted people to participate and support government endeavours. With the availability of the location sensors (GPS) and camera on-board the mobile devices has enabled citizen to collect geotagged data along with field photograph. In today's scenario, citizens play an important role by working as "sensors" (Citizen as Sensors (Goodchild, 2007)) helping government/institutions by collecting and analysing data. The classic example of people involvement in a large scale project is Wikipedia "the free encyclopedia" (www.wikipedia.org), wherein volunteers create and edit the content. Similarly in geospatial domain we have OpenStreetMap project where volunteers are contributing in the mapping of the whole world (www.openstreetmap.org).

Citizen science nowadays have become a valuable and important approach, wherein scientific data for understanding the underlying phenomenon could be collected by volunteers/non-specialist within a quick possible time. Citizen Science, basically refers to non-professional acting as volunteers supporting the activities involved in a scientific project ranging from data collection to analysis including data dissemination (Arias de Reyna & Simoes, 2016).Citizen Science, basically refers to non-professional acting as volunteers supporting the activities involved in a scientific project ranging from data collection to analysis including data dissemination. Citizen Science is being used worldwide for policy advocacy, e-government, and e-democracy (Shirky, 2008). It was also found extremely useful in recent disasters like Haiti earthquake, 2010 (Zook, Graham, Shelton, & Gorman, 2010) and the Nepal earthquake 2015 (Dittus, Quattrone, & Capra, 2017) assisting rescue and relief efforts. Not all the citizen science projects are of geographic in nature. Hence in the citizen science, the projects which are of geographic nature wherein volunteers helps in data collection/analysis etc. come under the gamut of "Geographical Citizen Science". (Haklay, 2013) has also given the classification scheme

and that is based on the depth of the engagement of the volunteer and their participation in the citizen science project (Figure 1).

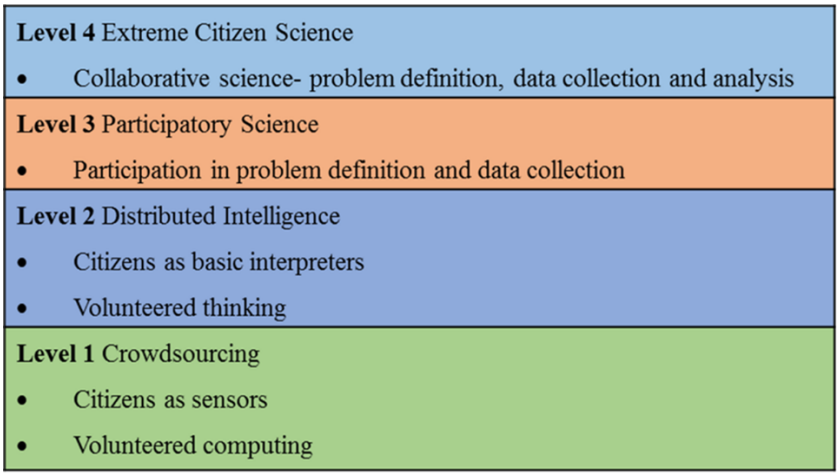

Figure 1: Levels of participation in citizen science project. Source: (Haklay, 2013)

2. CITIZEN SCIENCE BASED SWACHH BHARAT TURNKEY SOLUTION

The Swachh Bharat Abhiyaan (SBA) or Clean India Campaign was formerly launched by Indian Prime Minister, Mr. Narendra Modi on the eve of 2nd October 2014, the birth anniversary of Mahatma Gandhi. SBA re-emphasized and put the focus on sanitation (the basic requirement) with the aim to achieve universal sanitation thereby achieving "Swachh Bharat" by the year 2019 which could be the best tribute on the occasion of the 150th Birth Anniversary of Mahatma Gandhi (Ministry of Drinking Water & Sanitation, 2010).

To support the above initiative Indian Institute of Remote Sensing, a Unit of Indian Space Research Organisation has designed & developed a complete turnkey solution for Swachh Bharat Abhiyaan, which is geo-enabled and is based on the citizen science approach. The solution allows public participation by encouraging locals to report geotagged garbage complaints in and around their locality/city. The solution consists of three different applications, two mobile App(s) and one web application namely (Figure 2):

- **Citizen App** for reporting the garbage locations,
- **Web based dashboard** for visualization, reporting, user/vehicle management, job assignment and GIS based optimize route determination and
- **Service (Cleaner) App** for garbage redressal.

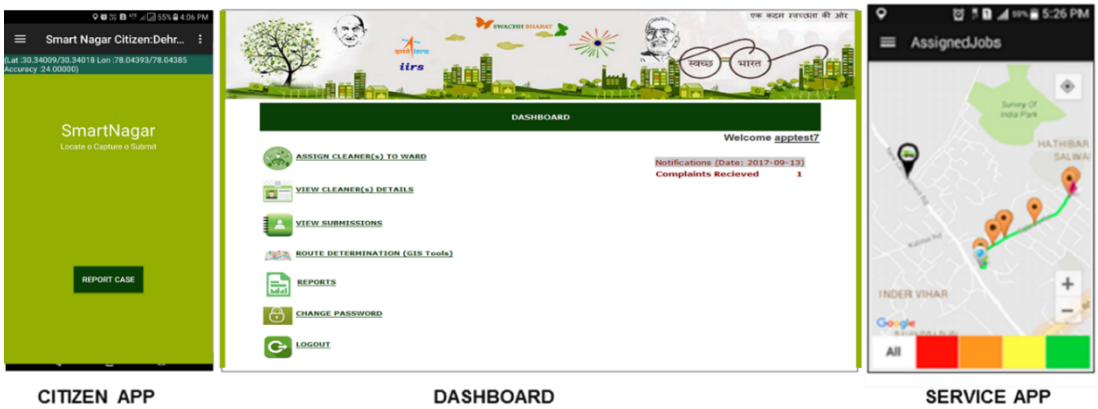

Figure 2: SBA Turnkey Solution Components

(1) Citizen App- is an Android based mobile application, which enables a citizen to report garbage related complaints. To report a location, the citizen needs to geotag the location using on-board GPS on the Android mobile phone, take the photograph of the garbage and fill details like type of garbage & brief description and submit. Citizens can also view the authorized dumping sites (Dumper Placer (DP) and Compact Placer (CP)) of the civic bodies.

(2) **Web based dashboard**- The citizen App work along with the Web based Dashboard application where all the data resides in the spatial database. Dashboard application consists of following modules namely Login, User-management, Vehicle-management, Job Assignment, Routing and Reporting.

(3) **Service App-** is an Android based mobile application designed for the cleaners and allows them to handle the tasks in efficient manner. Application uses geo-fencing (Pongpaichet, Singh, Jain, & Pentland, 2013) based service enablement technique to respond to the service request. This supports accountability by ensuring that the service provider has reached and attempted the complaint. Further it also helps the supervisor to monitor & measure the performance of workforce.

Success Story- Solution Implementation

The complete system was put to use during Oct 2, 2016 (the birth anniversary of Mahatma Gandhi) which is also celebrated as Swachh Bharat Day. Over 1000 participants from 4 Universities and 9 government institutes in the Dehradun participated in this exercise. A total of 3268 garbage locations were geotagged using the citizen mobile App On Aug 27, 2016 within a short time of 5 hours (0800-1300 hrs.). Earth Observation will have limited use in this area, hence crowdsourcing approach was a big game changer enabling collecting such a huge amount of geotagged garbage locations in a mission mode. The cleaning operation through Android based 'Service App' was carried out (Figure 3).

Figure 3: Field photographs of usage of the mobile application for the collection and redressal of the reported garbage locations.

For the same first the Web Based Dashboard was used for job assignment and optimal path identification using the routing module. IIRS organized workshop in each university during Aug 20-26 , 2016 to demonstrate the complete solution along with apprising the usage of the Citizen App which was used during the Aug 27 , 2016 by the participating students. During the workshop participants were also briefed about the predefined routes they need to follow for geotagging the garbage locations. The screenshot of the Web Based Dashboard application at IIRS server showing the points (garbage complaints) reported is shown in Figure 4.

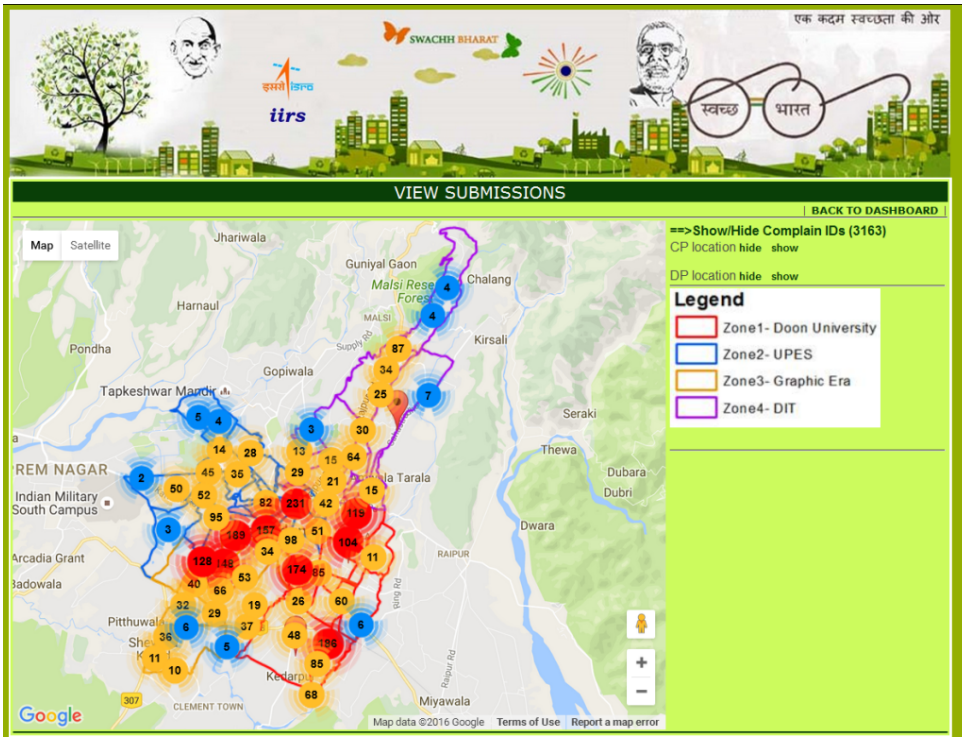

Figure 4: Web Dashboard- Showing complaints using clustering method

The geospatial solution was formally released by Dr. Krishan Kant Paul, H.E. the Governor, Uttarakhand on Oct 4, 2016 at Rajbhawan, Dehradun (Figure 5).

Figure 5: Release of Geospatial Solution by Dr. Krishan Kant Paul, H.E. the Governor, Uttarakhand

3. Knowledge Based Classification using Citizen Science Approach

The geotagged garbage related points contributed by the students in the above exercise were further classified using the knowledge based approach. Again using the citizen science principles (Level 2- Citizens as basic interpreters) the points collected were further classified into following categories by involving the Post Graduate (PG) Students of IIRS.

- Commercial
- Natural
- Public- Open
- Public- CP/DP Spillover
- Public- Spillover
- Public- Waterbody Residential

A total 100 IIRS PG students participated in this activity. To help the students to classify the image, web based application was developed (Figure 5). The student by looking at the image and with the help of sample images provided, could classify each random point into one of the above mentioned categories. All images were classified into defined categories by the students within an hour.

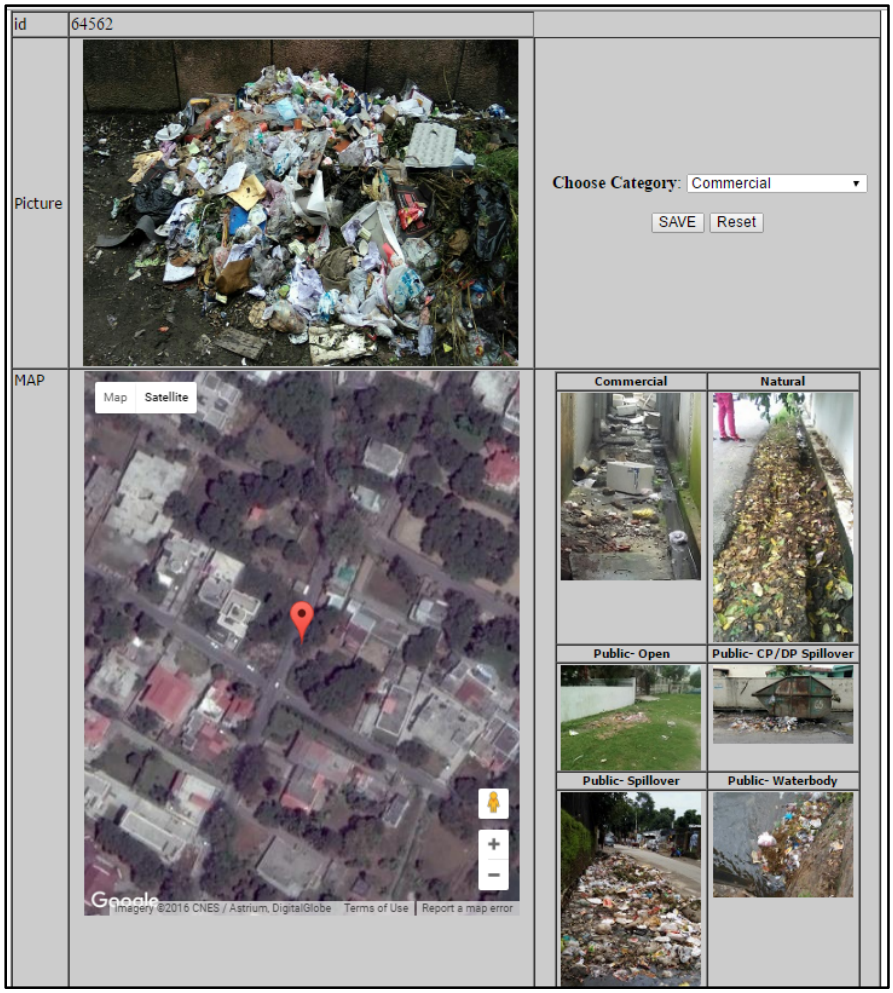

Figure 5 Web application for knowledge based classification

Figure 6 summarizes the points classified into various categories.

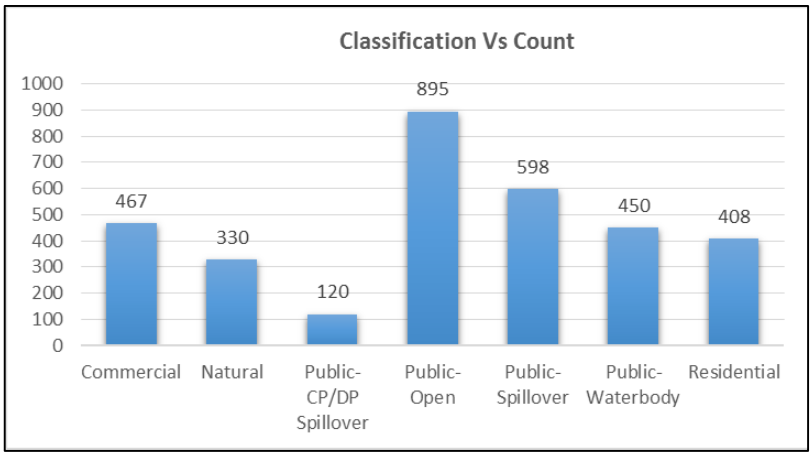

Figure 6. Classification statistics of crowdsourced collected garbage points

Subsequently the GIS based spatial analysis of all the geotagged points was carried w.r.t. the respective wards. The vulnerability map was derived considering ward wise point density. Five zones of different density were classified on the basis of point density viz. very low, low, medium, high and very high as shown in Figure 7. In some of the wards, the points were not taken due to forest cover, high altitude, and inaccessibility and time constraints. Wards with high and very high vulnerability are listed below in table 1:

Table1: Vulnerability assessment of the collected garbage data.

Sl. No.	Vulnerability Category	Wards
1.	Very High	Kali Mandir Marg Race Course (S) Gandhi Gram Ritha Mandi Lakhi Bagh
2.	High	Arya Nagar Chukkuwala Clock Tower Nehru Colony Patel Nagar (W) Mahadevi Kanya Pathsala Race Course (N) Tilak Road Bharmpuri Dronapuri

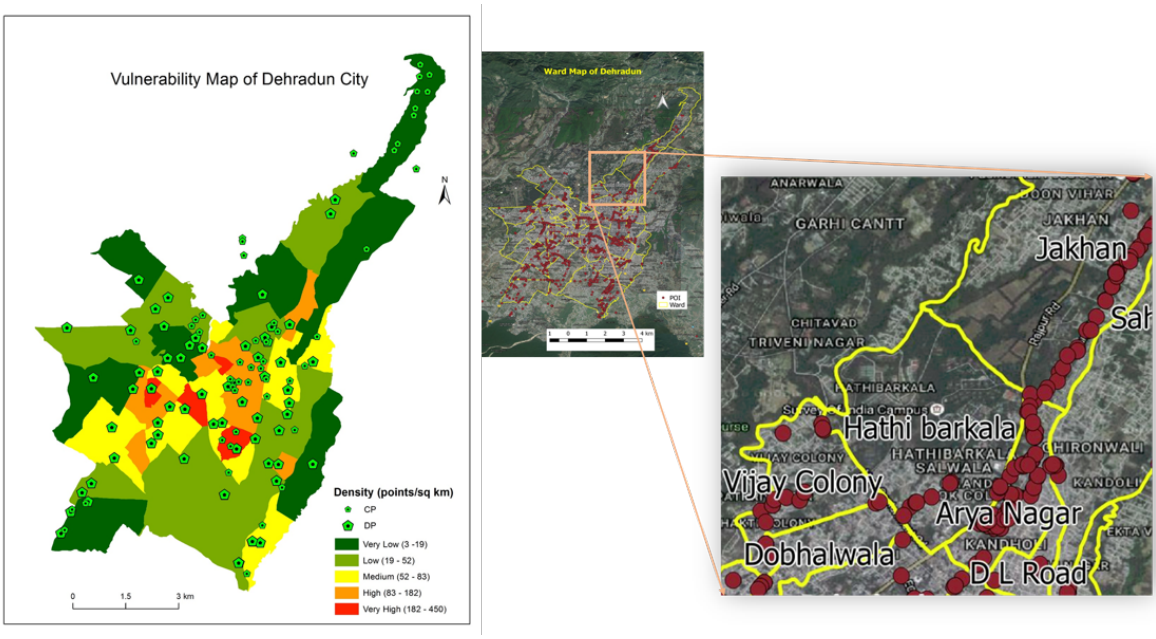

Figure 6: Ward wise vulnerability map and ward boundaries map overlaid over satellite image with reported garbage location in Dehradun City

4. CONCLUSION

The geospatial enabled turnkey solution for SBA is a generic application that could be utilized for various cities of India. All the three components are very user-friendly thereby eliminating any learning process. Moreover it clearly demonstrate the usefulness of public participation in the national initiative like Swachh Bharat Abhiyaan through garbage reporting around their locality using geospatial enabled mobile apps. Further this application also ensures the

accountability, transparency and timely services to the local citizens on the part of civic bodies. It can also assist in identifying the areas which are frequently reported (hotspot areas) so that necessary enforcement and awareness activities could be planned. Further through citizen science approach, complex tasks like classifying garbage complaints based on uploaded image using knowledge based classification can be undertaken in very quick time.

REFERENCES

Arias de Reyna, M., & Simoes, J. (2016). Empowering citizen science through free and open source GIS. *Open Geospatial Data, Software and Standards*, *1*(1), 7. https://doi.org/10.1186/s40965-016-0008-x

Dittus, M., Quattrone, G., & Capra, L. (2017). Mass participation during emergency response: event-centric crowd-sourcing in humanitarian mapping.

Goodchild, M. F. (2007). Citizens as sensors: the world of volunteered geography. *GeoJournal*, *69*(4), 211–221. https://doi.org/10.1007/s10708-007-9111-y

Haklay, M. (2013). Citizen Science and Volunteered Geographic Information: Overview and Typology of Participation. In *Crowdsourcing Geographic Knowledge* (pp. 105–122). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-4587-2_7

Pongpaichet, S., Singh, V. K., Jain, R., & Pentland, A. (Sandy). (2013). Situation Fencing: Making Geo-fencing Personal and Dynamic. In *Proceedings of the 1st ACM International Workshop on Personal Data Meets Distributed Multimedia* (pp. 3–10). New York, NY, USA: ACM. https://doi.org/10.1145/2509352.2509401

Shirky, C. (2008). *Here comes everybody : the power of organizing without organizations*. Penguin Press.

Zook, M., Graham, M., Shelton, T., & Gorman, S. (2010). Volunteered Geographic Information and Crowdsourcing Disaster Relief: A Case Study of the Haitian Earthquake. *World Medical & Health Policy*, *2*(2), 6–32. https://doi.org/10.2202/1948-4682.1069