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Role of Citizen Science and ICTs in Environment Mitigation Measure for Development Projects in India

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Abstract

There are numerous concerns raised to ensure accountability on the part of project proponents of development projects. One of them is to ensure the act of plantation instead of deforestation activity. The Public Interest Litigations (PILs) are filed by various citizen groups, and individual lawyers, at various dates, for various reasons in urban areas. To reply to a multitude of technical queries, the proponent organization entrusted might find it a hindrance to primary responsibility. The assistance of citizens and citizen science to facilitate the mitigation efforts could increase transparency and address the concerns of citizen groups. The involvement of citizen and citizen science could be achieved through participatory and citizen science efforts using technology. The various citizen science projects taken up till now include birds, fireflies, biodiversity, and science education in India. Globally, citizen science initiatives have been applied to various sectors of the environment. The citizen science project uses Information and Communication Technology (ICT) platforms that are created as data sharing platforms, for data collection, engaging citizens in activities, using apps for removing manual work, connecting it to the cloud to avoid confusion in data collection, and repetition of work while doing so. Such initiatives could be extended for citizen concerns for development-led projects wherein numerous PILs are filed to take cognizance of due diligence by the government authorities, required in Environment Management (EMP) efforts in response to Environment Impact Assessment (EIA) for projects. In this study, the methodology comprises secondary literature, published studies and reports. The points of integration and recommendation of this paper lie in identifying places for tree plantation, uploading places of interest details such as picture, location, latitude, longitude, preferred species, volunteering details, and availability for urban development projects. This could assist in the democratization of information and activity about environment management activities.

Keywords: Citizen Science; Urban Development Project; Environment Impact Assessment; Environment Management Plan

Introduction

The perilous impact of development projects on the environment is addressed by mitigation measures. These mitigation measures are regulated under impact assessment and corresponding mitigation measures as mentioned in the environment management plan, which, at times, are not apply to urban and rural areas development projects. The inclusion of citizen science efforts in tracing urban development projects is a feasible exercise. In this paper, the nature of e-citizen science engagement for the environment management planning for development projects is discussed (Romero *et al.*, 2020). Involvement of citizen science initiatives in meeting the requirement of the environment management project is an innovative way of engaging citizens for public service (Gibson *et al.*, 2005). The citizen science initiatives to include citizens in various disciplines of sciences are a set of conscious efforts for public involvement in constructive efforts, assist public agencies, and help make informed choices for an equitable decision-making process (Gibson *et al.*, 2005; Romero *et al.*, 2020). For the citizens, the inclusion process is an exercise to involve them in non-intensive outreach, and learning exercises. It is seen as an enabler for open access, open science, and open data (Morzy *et al.*, 2015). It is seen as promoting knowledge sharing exercise, and an act of cooperation. Although the historical engagement of the public with research extension or support is up for debate, in the more recent, structured, or organized research sector, and the informal associations to work with, the nature of citizens' science collaboration is defined in the way these associations are formed, led and implemented (Tweddle *et al.*, 2012). The debate revolves around questions of integration of citizen science, the democratization of science, overcoming the loss of information due to hierarchies bringing in procedures involved whether it be for better involvement or rather overcoming the loss of information or public opinion or loss of a medium or a platform or a space in organizational structure. The purpose is the opposite as per the current understanding of challenges in citizen science for government-related projects which is for people to get involved, understand, reflect, and suggest on par or as much as possible with government organizations especially when it comes to environment-related measures or sensibilities to be shared by common people. Over the years, the use of technology as an enabling mechanism for citizen science has expanded in its nature of application. The intent is to overcome data quality issues and human resources while working with a large group of datasets and surveys (Fritz *et al.*, 2019). Citizen initiative project ensures data transparency, ease of covering wide or comprehensive data sets, and management of data. The reliability and authenticity of data collected either manually or online are subject to applications for the creation of a database and/or ICT-based tools to collect and monitor databases (Mazumdar *et al.*, 2018). Citizen science has been used as an outreach in the field of floral and faunae survey, biodiversity register, monitoring of select species health such as turtles, sustainable development goals, restoration of lakes, planting and afforestation efforts, geo-hazard management, and water quality (Irwin, 2019). The application of technology has been seen as a way to facilitate the loss of information or communication gap in involving citizens in government projects which is one of the major challenges in citizen science involvement in development projects in India.

Why the citizen involvement is essential and who benefits? Some questions or earlier thoughts on decision-making for citizen science engagement for projects include whether the involvement is transparent, well thought out, and open to taking opinions and viewpoints. The successful projects which do involve citizen science are research initiatives of importance, disseminated for citizen science practices, and highlight success in achieving the objective of the project through citizen science integration appealing to the scientific and social curiosity of the people. This enables the dissemination and integration of information and decision-making. The nature of citizen science initiatives and their

implementation are research dependent, the research parameters, points of contact, and identification of points for suitable engagement of the citizen group with the research community, public agencies, and government stakeholders. Suitable participatory involvement of citizens gives them the agency to contribute (Gibson *et al.*, 2005; Tweddle *et. al.*, 2012; Albagli & Iwama, 2022). The ownership or willingness to participate could stem from personal interest or external project-based motivation. The act of engaging citizens ensures the promotion of scientist-citizens collaborations reduces the gap between academia and citizens and makes exhaustive data collection possible. The concern over the quality or accuracy of data collected by citizens is improving with data collection protocol, and digital means (Namdeo & Koley, 2021). Furthermore, there are means to measure the quality of citizen science data over means such as positionality, temporality, accuracy, completeness, interoperability, and representativeness (Fritz *et al.*, 2019). Here, by using a secondary literature review, published reports, document analysis of PILs, and citizen science initiative database, the paper highlights the possibility of engaging citizen science efforts in urban development projects. The outcome of the paper is to discuss the potential of citizen science in fulfilling environment management plans for development projects such as urban infrastructure or mining projects. To discuss citizen science and its application in development projects the adopted methodology is the use of published literature, reports, and issues of litigation in urban development projects and implementation of management plan for environment coming out of practical experience of association with urban development projects.

Global citizen science initiatives

Origin, Motives, and Outreach

The involvement of citizens in the citizen science program has made it reach a global scale, help gather insights for scientific, and non-scientific objectives, capture innovation in the process and help democratize science (Morzy *et al.* 2015; Sherbinin *et al.*, 2021). There are multiple avenues for citizen science involvement in science and non-science projects. The idea is to involve citizens in projects irrespective of profession and increase the culture of participation in a technology-driven world (Gibson *et al.*, 2005). In the process of the involvement of the citizens in the citizen science projects, has encouraged a sense of belongingness in the community. Through the means of creating awareness and collaboration, citizen science projects have multiplied manyfold over the centuries. From the oldest account, till now, the technological applications are visible for projects on monitoring buffelgrass, plant identification, remote sensing for forest health, agriculture productivity, air, noise, water quality, waste management, queries by farmers, grassroots innovations, health applications, naturalistic observations for collecting crowdsourced data, user experience, data protection, and data validity (Fritz *et al.*, 2019; Boho *et al.*, 2020). The application of citizen science projects has extended from natural sciences to engineering, medicine, education, environment management, and mitigation (Adler *et al.*, 2020). With the rise in technology prowess, the means of connecting information technology with citizen science tools has increased data transparency, and handling of citizen science projects for nature and society (Sherbinin *et al.*, 2021).

Citizen science projects are applied over multiple fields of study and add dimensions of self-reflectiveness (Vohland *et al.*, 2021). The citizen science projects with their steps outlined and objectives decided are implemented using mixed methods online and offline modes of work with the availability and accessibility of project participants (Peter *et al.*, 2021). The involvement of non-experts in the field of citizen science raises questions of data accuracy, therefore evaluation of citizen science projects and feedback mechanisms is important for maintaining transparency and accuracy of the project. One of the ways of maintaining accuracy and transparency is through the introduction of ICTs (Mazumdar *et al.*, 2018). The involvement of citizens in projects comprises choosing a scientific question, forming a team, developing, testing, and refining protocols, data forms, and educational support materials,

recruiting participants, training participants, accepting, editing, displaying, analysing, interpreting data, disseminating results, and measuring the impacts as steps of citizen science projects (Tweddle *et al.*, 2012; Morzy, 2015). Feedback, training, social interaction, incentives, rewards, recognition, and inspiring ability to lead goes a long way in promoting a sense of ownership and participation among citizens (Peter, 2021). The authenticity of the citizen science data is checked with peer and expert verification (Vohland *et al.*, 2021).

Characteristics of Citizen Science Projects

The characteristic of many citizen science projects is to initiate global collaboration for global data and perspective. The projects are contributory, collaborative, co-created, and self-ownership-driven in nature wherein the initiative is either citizen-led or project-led (Morzy, 2015; Haklay, 2021). The oldest and first account of citizens as volunteers for science goes back to the fourteenth century (Morzy, 2015). Since, then, the goal of citizen science is to achieve outcomes for the project, learning for citizens, and making public spaces vibrant, and livable (Memluk, 2013; Wehn *et al.*, 2020). The learning outcome of citizen science is achieved through means of engaging the citizens in acts of scientific pursuits (Haklay, 2021). Volunteerism is seen as the mode of induction for citizens in citizen science projects (Morzy, 2015). The success of a few has inspired multiple citizen science projects over the globe to access knowledge and promote a sense of interconnectedness (Irwin, 2019). While some focus on a participatory approach to monitoring local environment projects, others, focus on increasing naturalistic observations. In addition, citizen science projects work for citizen science and conservation, observatories, innovation management, health, biomedical research, and community-based monitoring (Haklay, 2021). Apart from raising ethical considerations over participation and data management, Adler *et al.* (2020) and Fraisl *et al.* (2022) classified science-based projects for citizen science involvement into observational, participatory, monitoring, and risk aversion in various domains of science, and social science. A few notable examples of citizens' science projects around the globe are in the field of observation, enumeration, accounting, reporting, and monitoring in projects like biodiversity assessment where citizens were involved in monitoring activities, similarly in the case of geohazard and risk management in the United States of America, mining environment in South Africa, water science and quality for data collection in the Netherlands; ornithology, hornbill watch, roadkills in India (Lee, 2019). The application of citizen science in a wide variety of science and engineering projects makes the case for extending the application for development projects in consultation with public authority in India.

Use of ICTs and Citizen Science in Development Projects

Nature of Development Projects

Development projects are a projection of the industrial revolution and meeting human needs. This is more often than not met by engineering natural resources. Though the efforts of mega engineering development projects are examples of technological feat and source of livelihood, they cause environmental damage and affect human health, which was not recognized in the initial years of the Industrial Revolution (Ahluwalia, 1986; Knivella, 2007). The extent of environmental damage ranges from air pollution, soil and water contamination, land degradation, and climate change, whereas, human damage is in the form of lung infection, chronic breathing diseases, waterborne diseases, cancer etc (Ghose and Kundu, 1997; Hendryx, 2008). Along with the damages realized, realizing the need for land acquisition, resettlement of people, employment of people, movement of source, or raw materials, and establishment of requisite infrastructure, the process of industrialization is regulated using a set of permissions, leases, guidelines, terms of reference, environment regulatory and governance laws, environment clearance, environment and social management plans (MoEF&CC,

2020). The legal mandate to ensure environmental and social mitigation measures due to development projects are covered under the environment impact assessment notification of 1994, amended in 2006 and 2014, respectively (MoEF&CC, 2020). Apart from assessing environmental conditions pre-, during, and post-industrial setup, mitigation measures include measures of compensation in either cash or land for resettlement and rehabilitation, afforestation for forestry or timber purposes, and rewilding efforts.

There are various types of development projects. The World Bank describes them as Category A, B, C and F1 based on the significance of impact (World Bank, 2004). These projects extend from the sectors of energy and power, urban development, transportation, health etc. In India, based on the extent of the project, they are classified under two categories: category A and category B. Category A projects are major mineral projects such as coal, infrastructure projects, river and hydroelectric, and thermal projects (MoEF&CC, 2020). The scale of operation and impact is larger and more pervasive as compared to the Category B project. Category B projects include minor mineral projects such as limestone, chlor-alkali, soda ash, and hydropower projects less than 25MW (MoEF&CC, 2020). The centre and state-level approval, screening, and scoping processes, are where these two sets of projects differ from each other. The processes of clearance, leases, permissions, mitigation, operation and management plans are extensive and require technical and human expertise. Apart from fulfilling the current set of guidelines for restoring the environment to as close to previous conditions as possible (MoC, 2013). With these set of standards for the environment improving with the increased awareness about sustainable development goals in India, awareness regarding mitigation and management for development and the environment is a necessity. This is especially true for sectors and projects abandoned and considered paper-intensive, or unsafe for citizens to get involved in. A series of steps to involve citizens in environmental management and mitigation could maintain data transparency, accountability, and implementation for public agencies (Gibson *et al.,* 2005; Romero *et al.*, 2020).

Scope of ICTs and Citizen Science for Environment Mitigation

There are multiple potential points for integrating citizen science efforts in blue-green urban development projects in India (Lekshmi *et al.*, 2021). This could be for observation, scoping, enumerating, monitoring etc. With the use of technology, the number of participation and enthusiasm to be associated with natural and environmental sciences could be vastly increased from the present numbers (Namdeo & Koley, 2021). Citizens' involvement in urban environment projects, development projects, wildlife monitoring, nature education, protected area conservation, and management by involving them through the means of participatory approaches with governing bodies (Gibson 2005; Romero, 2020). ICTs could pave the way for involving citizens. For urban infrastructure projects, ICTs can be used to help citizens identify places for tree plantation, uploading places of interest details such as picture, location, latitude, longitude, preferred species, volunteering details, and availability. Initially from urban infrastructure projects, this could be extended to more intensive or remote sectors such as mining and hydroelectricity and reduce citizen concerns well ahead in terms of resettlement, livelihood, and environment restoration. This set of points of engaging citizens could be achieved with the use of ICTs.

Discussion

Scope of Citizen Science and ICTs in Citizen Science for Development Projects

As discussed, the involvement of citizens in citizen-led projects ensures coverage of mega naturalist projects such as global bird count or identification or monitoring of projects. For citizens, the involvement encourages skills of observation, community outreach, participatory behaviour, furthering policy involvement, retaining the spirit of volunteerism, and inclusion in collaborative

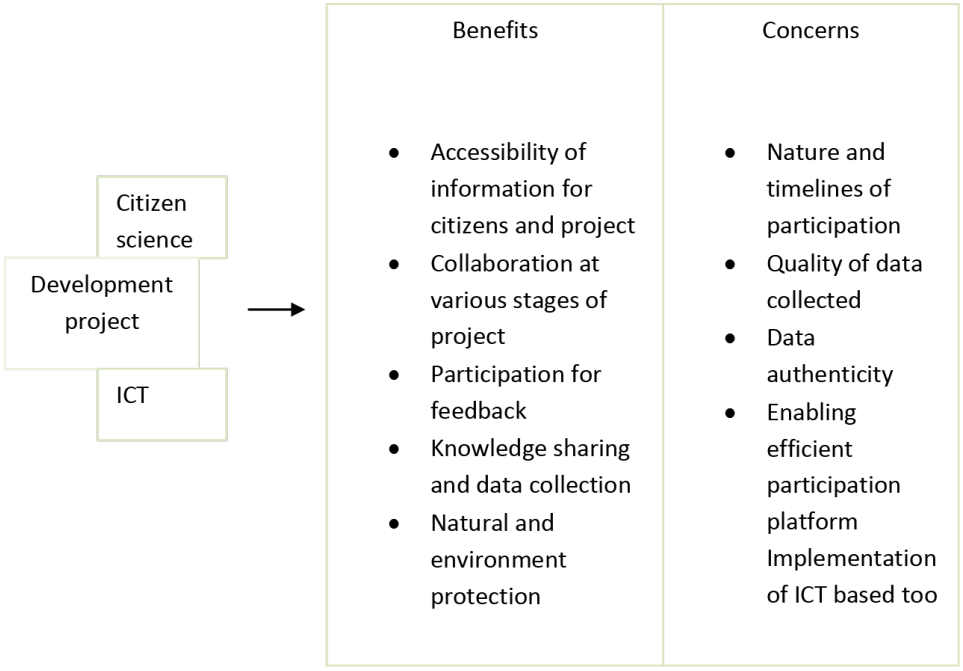

Figure 1: Benefits and concerns of integration citizen science and ICTs into development project.

projects as shown in Figure 1. There are instances of involvement of citizens in environment projects using ICTs such as mapped features, buildings, land cover, northern lights, ocean water colour, phenology, photosynthesis, precipitation, snow depth, soil moisture, forest cover, biomass, water quality, and weather monitoring (Fritz, 2019). Similar ICT-based applications for development projects are possible in India (Namdeo & Koley, 2021). In the case of Namma Metro, the application of ICTs is in creating a platform for mitigation activities under the environment management programme, nominating, and maintaining sites for afforestation, afforestation monitoring activity, neighbourhood citizen science involvement with outreach and education material or extracurricular engagement with school children for environment education, and monitoring; single platform for addressing writ petition related to planting, and constructing activity as indicated in Table 1. Like the Namma Metro, similar initiatives are possible for the other Category 'A' and Category 'B'. This way, the initiatives are participatory and contributory, and fulfil the objectives of citizens' science involvement for outreach and extension for development projects.

Table 1: Integration of citizen science in the EIA and EMP of the development projects.

Stages of development projects	ICT-based citizen activity
Project initiation	Permissions Acquisitions
Environment impact assessment	Baseline development Public hearing
Resettlement and rehabilitation	Land acquisition Compensation in cash or land Livelihood and preservation of traditional knowledge
Environment management plan	Afforestation Afforestation monitoring activity
Corporate social responsibility	Environment education and outreach Community Healthcare Community cleanliness

Benefits and Concerns of ICTs and Citizen Science Initiatives for Development Projects

The means of including citizen science by using ICTs, apps, and technological platforms makes the accessibility to citizens and involvement of citizens a feasible and viable option (Mazumdar *et al.*, 2018; Sherbinin *et al.*, 2021). It benefits offloading some of the tasks of the project proponents, making citizens aware, and getting citizens involved in environment management projects. The concern over the quality and accuracy of data collected using citizen initiatives is overcome using ICT, and a combination of groups of citizens with backgrounds such as educators, technologists, and scientists (Gibson, 2005; Fritz, 2019). Further, by improving the mode of taking feedback, maintaining, and cross-verifying data using ICT concerns over data accuracy could be replaced (Morzy, 2015). The component of feedback is essential for improving data accuracy and the use of ICTs (Adler *et al.*, 2020). The involvement of citizens in citizen science in improving environment management projects in India is essential to reducing fallow lands, improving plantation efficiency, soil, and microbial growth, and overall restoration of the land use diverted or damaged by development projects. Considering the following points for ICT integration might assist in making citizen science beneficial for citizens.

"The only way forward, if we are going to improve the quality of the environment, is to get everybody involved" – Richard Rogers

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