2020

Participatory Mapping, E-Participation, and E-Governance: Applications in Environmental Policy

Pragati Rawat
Slippery Rock University

Juita-Elena (Wie) Yusuf
Old Dominion University, jyusuf@odu.edu

Original Publication Citation

Rawat, P., & Yusuf, J.-E. W. (2020). Participatory mapping, e-participation, and e-governance: Applications in environmental policy. In N.V. Mali (Ed.), *Leveraging digital innovation for governance, public administration and citizen services: Emerging research and opportunities* (pp. 147-175). IGI Global. https://doi.org/10.4018/978-1-5225-5412-7.ch007

Chapter 7
Participatory Mapping, E-Participation, and E-Governance:
Applications in Environmental Policy

Pragati Rawat
https://orcid.org/0000-0002-7347-3584
Slippery Rock University, USA

Juita-Elena (Wie) Yusuf
https://orcid.org/0000-0003-3599-1417
Old Dominion University, USA

ABSTRACT

This chapter focuses on participatory mapping as an e-governance tool to facilitate public participation. Public participation is a key component of democratic governance, and there is a growing reliance on digital government tools such as the internet and social networking sites and geographic information systems (GIS). This chapter focuses on public engagement using information and communication technology, namely participatory mapping, known by a variety of terms such as participatory GIS (PGIS), public participation GIS (PPGIS), and voluntary GIS. While the analysis involves use of participatory mapping related to environmental issues, the chapter brings together seminal work from various fields of citizen engagement and participatory mapping. The idea is to create one common narrative for scholars and practitioners, bringing together various terminologies, practices, and studies in participatory mapping in the environmental arena that offers a beginner's frame of reference.

DOI: 10.4018/978-1-5225-5412-7.ch007

INTRODUCTION

Governments at all levels are increasingly adopting citizen engagement in governing decisions (UN, 2014). Environmental issues are among the issues that have been considered too technical to be understood by the average person, but there continues to be support for public participation in environmental decision making (Crow & Stevens, 2012). While different approaches have been used for citizen engagement in environmental issues, participatory mapping has gained popularity. The purpose of this chapter is to locate and organize participatory mapping in the broader field of public participation and e-government, and discuss the various participatory mapping approaches using information and communication technology (ICT), organizing them under the umbrella term e-participatory mapping.

The literature on participatory mapping and public participation is vast and spans multiple policy areas such as environmental policy, urban planning, sustainable development, e-government, and geographical information systems (GIS), in addition to encompassing multiple techniques, approaches, and technologies used. This chapter presents a structured review by synthesizing the literature, with the aim of developing an understanding of e-participatory mapping as an e-governance tool for public participation. The idea is to create one common narrative for scholars and practitioners by compiling various terminologies, practices, and studies that offers a beginner's frame of reference. The focus is on e-participatory mapping, since ICT is becoming an inevitable part of the public participation process in both developed and developing countries.

ENVIRONMENTAL ISSUES AND PARTICIPATION

Environmental issues are concerned with human actions that affect the biosphere, including species, habitats, or landscapes. Environmental policy is aimed at governing the relationship between humans and their natural environment. Decisions regarding technical issues such as the environment are generally thought to be best left in the hands of experts and scientists (Rowe & Frewer, 2000). Environmental policy is the definitive example of technocratic policymaking (Fischer, 2000), as the technical nature of environmental policy makes it difficult for the average citizen to comprehend (Crow & Stevens, 2012). Yet, growth in citizen science suggests that citizens are interested in science and complex topics (Crow & Stevens, 2012; Dickinson et al. 2012; Brown & Donovan, 2014).

Environmental problems are complex and dynamic, leading the policy field to embrace diverse sources of knowledge and values, and embed participation in environmental decision making (Reed, 2008). For example, the United Nations

Framework Convention on Climate Change (UNFCCC) calls on member countries to implement educational and public awareness programs, provide public access to information, and seek public participation in addressing climate change and its effects (1992). ICTs, including GIS technologies, are widely used to support public participation in environmental issues (Al-Kodmany, 2002; Bojórquez -Tapia, Diaz-Mondragón, & Ezcurra, 2001; Gonzalez et al., 2008; Jordan & Shreshtha, 2000; Kingston, Carver, Evans, & Turton, 2000).

Public Participation

Public participation refers to the involvement of the public in policy making activities on a regular and ongoing basis (Lukensmeyer & Torres, 2006). It involves a range of activities such as public sharing of government information and activities, consulting with the public on policy issues, and involving them in decision making (UN, 2008; UN, 2014; Smith, 1983). Smith (1983) defines public participation as procedures for consulting, involving, and informing those affected by a decision in the decision-making process. "Authentic participation," defined as "deep and continuous involvement" that potentially allow participants to affect the situation (King, Feltey, & Susel, 1998, p. 320), can be achieved with targeted public information, active solicitation of public opinion, delegation of decision-making authority to the public, and opportunities for citizens to exercise their knowledge in policy and program development (Rowe & Frewer, 2000; Lukensmeyer & Torres, 2006).

Public participation is a democratic ideal (Rowe & Frewer, 2000) that gained importance when trust in government decreased and the demand for public accountability increased (Parr & Gates, 1989; King et al., 1998). It is considered especially useful in areas that lack official, continuous, and local data, and for effective collaboration between scientists, the community, and policy decision makers (Andrade & Szlafsztein, 2015). Public administrators have come to realize the importance of public participation for effective decision making and increased citizen buy-in (Burby, 2003; King et al., 1998; Webler, 1999). Yet, the same administrators may block participation efforts that challenge the status quo (King et al., 1998). Clear identification of relevant interest groups and stakeholders is critical for enabling participation (Brown, Adger, & Tompkins, 2002). However, some scholars are skeptical that more participation means more democracy (Parry & Moyser, 1994). Concerns have been raised about who decides the agenda for participation, whether participants are representative of the larger population, if participation impacts decision making, and the legitimacy of such decision-making activities (McLaverty, 2011; Parry & Moyser, 1994; Verba, Schlozman, Brady, and Nie, 1993).

Individuals who receive information and are encouraged to engage are more likely to increase their engagement (Lewandowski & Oberhauser, 2015). In hazard mitigation planning, having targeted plans, coordinating these plans with broader community concerns, connecting them to more immediate quality of life concerns, and preparing small area plans so that residents can relate to these as issues impacting their own neighborhood, will help planners obtain citizen input and support (Godschalk, Brody, & Burby, 2003).

Public participation in environmental issues generally involves two types of discourse between the government and the public. One type involves problem solving that seeks agreement among diverse interests to decide a course of action, and the other type involves sensemaking to overcome technical dominance, build understanding and overcome dissent (Hamilton & Wills-Toker, 2006). Various approaches have been used to enable public participation in environmental issues (e.g. Davies, Selin, Gano, & Pereira, 2012; Gray et al., 2015). Examples include focus groups, open meetings, informal questionnaires, facilitated discussions, ranking exercises, and policy mapping tools (Brown et al., 2002; Brown, Few, Tompkins, Tsimplis, & Sortti, 2005; Few, Brown, & Tompkins, 2007). While multiple approaches and tools are used for public participation in environmental studies, the current review is focused on participatory mapping, which has gained popularity in the field.

Participatory mapping is any participation-based method for generating and recording spatial data (Vajjhala, 2005). Participatory mapping emerged around the 1990s (Chambers, 1994), concurrently with the advent of the Internet and World Wide Web. ICT and Web-based applications have since gained momentum as a platform for public participation. The next section discusses the use of ICT in public participation and connects it to participatory mapping.

Role of ICT: E- Government, E-Participation, and GIS

E-government, defined as the "public sector use of the Internet and other digital devices to deliver services, information, and democracy itself" (West, 2005, p. 1), includes ICT use "for the provision of information and public services to the people" (UN, 2014, p.61) and "that improves citizen access to government information, services and expertise to ensure citizen participation in, and satisfaction with the government process" (United Nations and the American Society for Public Administration, as cited in Moon, 2002, p. 425). E-participation is defined as "the process of engaging citizens through ICTs in policy and decision-making in order to make public administration participatory, inclusive, collaborative and deliberative for intrinsic and instrumental ends" (UN, 2014, p.61). E-participation is integral to e-government's purpose and utilizes e-government infrastructure for public participation activities. Some models of e-government incorporate e-participation as an advanced stage of e-government

(Hiller & Belanger, 2001; West, 2005; Marchionini, Samet, & Brandt, 2003), one that is in need of greater effort from the government and is the least developed in practice (Hiller & Belanger, 2001; Moon, 2002).

E-participation can be conducted over a variety of platforms such as via phone, email, and Web 2.0 tools like social networking sites (e.g., Facebook, Twitter, and YouTube) and other internet-based tools (Delli Carpini, Cook, & Jacobs, 2004; Fredericks & Marcus, 2013; Tolbert & Mossberger, 2006; Mossberger, Tolbert, & McNeal, 2008). One online participatory tool claimed to have far-reaching consequences is the mapping application (Tulloch, 2007). Online mapping interfaces have become sufficiently user-friendly to allow amateurs to participate in decision making and present their ideas in meaningful ways (Tulloch, 2007; Ganapati, 2011). The Internet has encouraged citizen science by enabling personal e-devices such as computers, mobile phones, and global positioning system (GPS) receivers to work as scientific instruments that citizen scientists can use to make observations (McCall, Martinez, & Verplanke, 2015). GIS has evolved in three phases from desktop GIS to Web GIS to geo-spatial Web 2.0 platforms (Ganapati, 2010). Web GIS is developed specifically for the Web to communicate real-time data (McCall et al., 2015). Google Earth, an example of a Web 2.0 geospatial application, allows user uploading of captions, photo images, videos, audio, links, and metadata that can be geo-tagged (McCall et al., 2015).

PARTICIPATORY MAPPING

Participatory mapping is any process where individuals share in the creation of a map (Goodchild, 2007). It emerged as one of the techniques of participatory rural appraisal (PRA) and includes activities such as sketch mapping, scale mapping, and transect walking (Chambers, 1994). The working hypothesis behind participatory mapping is that local people have mental maps that can be drawn as a way to convey information through spatial representation (Chambers, 1994). In recent years, participatory mapping has been used in a variety of fields such as health (Lowe, Gaudion, McGinley, & Kew, 2014; Skinner, Hanning, & Tsuji, 2006), urban planning (Kim, 2015; Smith & Jenkins, 2015) and migration (Lingel, 2011).

Participatory mapping methods vary from using sticks, dirt, and paper to highly technical Internet crowdsourcing, GIS, and 3-D modeling (Corbett, 2009). Ground maps, sketch maps (or paper maps) are simple, inexpensive and not technology dependent, but are static and not geo-referenced (IFAD, 2009; IPAD, 2009). Mapping using GPS and multimedia maps linking digital video, photos and text with maps have the advantage of storing data in digital format but can be expensive and require user training (IFAD, 2009). Aerial and remote sensing is effective for mapping large, difficult to reach areas but is very expensive and may not be easily accessible (IFAD, 2009). Online maps have the advantage of being inexpensive and compatible with GIS, but have limited functionality and require computer access and software (IPAD, 2009). Geospatial software such as ArcGIS are interactive, flexible, and thorough, but require expert intervention and can be costly (IPAD, 2009).

Participatory mapping is an unconventional alternative for collecting spatial data for large landscape areas (Beverly, Uto, Wilkes, & Bothwell, 2008). It helps situate local observations in the wider geographic context, and has potential for exploring human dimensions of environmental issues and examining local perspectives and priorities (Joyce & Canessa, 2009). Local knowledge is considered unique, reflective of local identity and encompasses the manifestation of cultural values placed on land and place in imprecise, emotional, and holistic terms (Hoole & Berkes, 2010; Levine & Feinholz, 2015), but that may not fit neatly into a spatial format. Furthermore, exact spatial boundaries using participatory mapping are generally difficult and public administrations may question the validity of anecdotal information obtained from local community members (Levine & Feinholz, 2015).

Participatory mapping puts human experiences into a spatial context, and is a process-driven, vibrant and vital way of knowing that fosters deliberation in complex science system (Tschakert et al., 2016). The mapping process is considered more important than the resulting map because it provides an opportunity for participants to engage in new ways, learn from each other, and share concerns held by different stakeholder groups (Levine & Feinholz, 2015). At the same time, participatory mapping is criticized for its dualistic approach to power and culture, and for reifying material and discursive forms of domination pervasive in the Western culture (Sletto, 2009).

In the area of environmental issues, participatory mapping has been used in monitoring, reporting, and verifying environmental policies and problems. Examples include applications that focus on natural resource management (Hoole & Berkes, 2010; Lubis & Langston, 2015), environmental degradation (Chagumaira, Rurinda, Nezomba, Mtambanengwe, & Mapfumo, 2016), and human-nature interactions (Cocks, Dold, & Vetter, 2012; Woodhouse, Mills, McGowan, & Milner-Gulland, 2015). Other applications have addressed issues of ecosystem management (Andrade & Szlafsztein, 2015), disasters and adaptation (Kaul & Thornton, 2014; Levine & Feinholz, 2015), ecotourism (Chakrabarty, 2011), and marine spatial planning (Stelzenmüller, Lee, South, Foden, & Rogers, 2013).

ICT supports every phase of participatory mapping, such as in data collection and processing, data search and presentation, data validation, and community building that consists of advocacy activities and sharing of views and information (Gouveia & Fonseca, 2008). This chapter combines all ICT-based participatory mapping techniques and organizes them under the umbrella term of e-participatory mapping.

Participatory Mapping, GIS and E-Participatory Mapping

GIS is a core ICT tool that can facilitate e-government processes and public participation (Ganapati, 2010; Kingston et al., 2000; Tulloch, 2007). GIS has the ability to visually represent numerous aspects of a location collectively and precisely, but this ability is not sufficient for public participation (Vajjhala, 2005). Technological advancements in GIS have progressively improved GIS accessibility for ordinary citizens (Ganapati, 2011). GIS, coupled with 3D visualization, allows governments to manage assets and perform day-to-day operations, collaborate, and develop and implement sustainable solutions (Bergeron, Barbara, & Stiller, 2010). These developments, combined with decreasing computer costs, low-cost GPS, and open data access over the Internet, have led to community-based organizations and individuals utilizing GIS in community initiatives (Corbett et al., 2006). The ability of GIS to synthesize a wide variety of data including spatial representations has made it an essential planning tool (Vajjhala, 2005). Simultaneously, participatory mapping has emerged as a participatory method for collecting spatial data, but one that is time-consuming and generates unwieldy information (Vajjhala, 2005). Due to the complementary nature of GIS and participatory mapping, scholars have integrated the two approaches (e.g. Craig, Harris, & Weiner, 2002; Mapedza, Wright, & Fawcett, 2003; Mbile, DeGrande, & Okon, 2003; Robiglio, Mala, & Diaw, 2003; Vajjhala, 2005; Weiner & Harris, 2003) into what can be called e-participatory mapping.

E-participatory mapping has been used to promote inclusive decision making in environmental issues (Vajjhala, 2005). Examples include mapping environmental changes (Aswani, Vaccaro, Abernethy, Albert, & Pablo, 2015), documenting landscape-related knowledge (Barlindhaug & Corbett, 2014), planning sustainable infrastructure development (Forrester & Snell, 2007), and mapping land use and land cover change (Bauer, 2009; Garrard et al., 2016; Malek & Boerboom, 2015). Across these studies, multiple terms are used in the literature to refer to e-participatory mapping approaches, including participatory GIS, public participation GIS, voluntary GIS, community GIS, bottom-up GIS, qualitative GIS, and grassroots mapping.

FOUR APPROACHES TO E-PARTICIPATORY MAPPING

Four approaches to e-participatory mapping feature prominently in the environmental literature: participatory GIS, public participation GIS, voluntary GIS, and human sensors. This section introduces and discusses these approaches.

Participatory GIS (PGIS)

The integration of GIS technology and community initiatives has led to participatory GIS (PGIS) that uses geo-spatial information as a vehicle for interaction, discussion, and analysis in support of advocacy and decision making (Corbett et al., 2006). The practice of PGIS developed out of participatory approaches that combine a range of geo-spatial tools and methods such as aerial photographs, sketch maps, satellite imagery, participatory 3D models, and GPS "to represent peoples' spatial knowledge in the forms of virtual or physical, 2 or 3 dimensional maps used as interactive vehicles for spatial learning, discussion, information exchange, analysis, decision making and advocacy" (Rambaldi, Kwaku Kyem, Mbile, McCall, & Weiner, 2006, p.2).

PGIS begins with the preliminary appraisal stage that includes gathering information (such as existing policies, GIS datasets, imagery and maps), identifying and understanding stakeholders, and building relationships necessary for collaborative partnerships (Baldwin, Mahon, & McConney, 2013; Pozzebon, Tello Rozas, & Aguilar Delgado, 2015). Stakeholders are identified and selected based on interest in or knowledge of the issue, or based on results of stakeholder assessment exercises that obtain information on demographics, livelihood, use of resources, and environmental practices.

Mapping exercises are carried out with stakeholders to document local spatial knowledge (Baldwin et al., 2013). The mapping exercise can be carried out with individuals or small groups using interviews or focus groups (Baldwin et al., 2013; Asare-Kyei, Forkuor, & Venus, 2015; Pozzebon et al., 2015; Bracken et al., 2016; Cinderby, Snell, & Forrester, 2008; Pozzebon et al., 2015), during formal or informal meetings, using brainstorming sessions (McBride et al., 2017), by recording oral history (Cullen, 2015) or by taking a walk in the area (Pozzebon et al., 2015; Sletto, Muñoz, Strange, Donoso, & Thomen, 2010). Often the first round of mapping exercise is used to create a base-map and subsequent exercises used to add details such as identifying distribution of resources and areas of threat (Baldwin et al., 2013; Cullen, 2015). In other applications, the first mapping cycle can be aimed at identifying the pre-existing issue or historical occurrence of events such as floods, and the second iteration to identify where solutions must be implemented (Bracken et al., 2016). Sometimes initial base maps are created by the researchers themselves and are then further refined using community input (Sletto et. al., 2010).

Mapping and stakeholder assessment data are translated into GIS by scanning, geo-referencing, and digitizing the resulting maps (Baldwin et al., 2013; Cullen, 2015). Some studies use validation exercises with a wider community (Bracken et al., 2016; Cinderby et al., 2008; Sletto et. al., 2010) to refine and finalize the map. This stage of PGIS may include discussion on issues such as relevant geospatial data types or visualization techniques, supplementary end products, and means of accessing data (Baldwin et al., 2013; Cinderby et al., 2008). The final stage involves use of the PGIS products such as for assessing coastal vulnerability, identifying areas of concern for planning or environmental protection, and obtaining stakeholders' evaluation of the PGIS process and products (Baldwin et al., 2013; Cinderby et al., 2008; Cullen, 2015; Jordan & Shrestha, 1998).

PGIS has been found to be effective at co-producing knowledge by eliciting high quality local experiential knowledge compatible with experts' knowledge and generating products that are understood by locals. Simultaneously, PGIS promotes spatial learning and builds capacity to access and use information produced by a variety of stakeholders through processes that generate positive emotions and bonding among participants, ultimately empowering disadvantaged groups (Balderas Torres, Santos Acuña, & Canto Vergara, 2014; Baldwin & Oxenford, 2014; Bracken et al., 2016; Cinderby et al., 2008; Cullen, 2015; McBride et al., 2017; Rambaldi et al., 2006; Young & Gilmore, 2013).

Public Participatory GIS (PPGIS)

Public participatory GIS (PPGIS) is an innovative GIS-based decision-making system that integrates GIS with the Internet, encourages public participation, and seeks to empower communities and individuals by integrating local knowledge into decision making (Weiner & Harris, 2003). Although there is ambiguity in the terms PGIS and PPGIS, scholars have attempted to clarify the distinction between the two. First, PGIS has its roots in participatory approaches used in rural areas of developing countries while PPGIS is generally applied in developed countries (Brown, 2012; Brown & Kyttä, 2014; Dunn, 2007; Tulloch, 2008; Rambaldi et al. 2006). PGIS applications generally use purposive sampling and do not require digital mapping technology (Brown, 2012; Brown & Kyttä, 2014), while PPGIS uses random sampling techniques and digital mapping with high quality spatial data as a major objective (Schlossberg & Shuford, 2005; Brown & Kyttä, 2014; Brown & Fagerholm, 2015).

Brown (2012) analyzed 17 PPGIS studies in the areas of environmental and regional planning, and found that all used random sampling of the general public. The representativeness of the sample impacts the attributes and preferences identified in PPGIS (Brown, 2012; Brown, Kelly, & Whitall, 2014). It is argued that without the component of random sampling, PPGIS will not improve the quality of public participation (Brown et al., 2014), as there can be variations in spatial results by community.

Data collection can take multiple forms, such as using online surveys (Brown & Donovan, 2013; Pocewicz, Nielsen-Pincus, Brown, & Schnitzer, 2012; Beverly et al., 2008). Multiple mapping methods have been used in PPGIS, ranging from paper maps with markers, pen, or sticker dots; participatory 3-dimensional modeling where participants create 3D models; to digital and Internet-based applications such as Google Maps (Brown, 2012; Leon et al., 2015; Gaillard, Hore, & Cadag; 2015; Cadag & Gaillard, 2012). In Internet PPGIS, a website is created that allows participants to enter textual and spatial information such as by using an online map interface (Brown & Weber, 2013; Brown & Donovan, 2013; Brown et.al., 2014; Fonji, Larivee, & Taff, 2014).

As a decision-making tool PPGIS is considered a transparent alternative especially for complex issues such as those related to the environment (Drew, 2003). PPGIS helps decision-making agencies to spatially identify community values (Brown, 2012), integrate complex spatial information and local knowledge into solutions and decisions, and empower local stakeholders in decision making (Sieber, 2006). PPGIS has been used in the field of environmental and regional planning in countries such as the U.S., Canada, New Zealand, and Australia. These include forest and landscape planning (Brown & Donovan, 2013; Thompson, Prokopy, Floress, & Weinkauf, 2011); conservation (Brown & Weber, 2013); and forest and land management (Brown et al., 2014; Beverly et al., 2008).

Public agencies have only minimally adopted PPGIS beyond initial trials (Brown, 2012). Furthermore, despite the emphasis on random sampling, many studies have been found to use systematic, convenience or voluntary samples (Brown, 2012; Fonji et al., 2014; Thompson et al., 2011). Even PPGIS projects using random sampling have been critiqued for having a biased sample with older, educated, and higher-income male participants (Brown et al., 2014), but Brown (2012) argues that it can still produce results that differ from those obtained by governmental organizations or interest groups. While PPGIS generally requires high quality spatial information and digital data, Pocewicz et al. (2012) found that traditional paper-based PPGIS surveys resulted in a higher response rate and greater participation compared to an Internet survey. Furthermore, web-based GIS is criticized for lacking the important face-to-face PPGIS intermediaries and exacerbates skill gaps of different participant groups (Wong & Chua, 2000).

PPGIS has been promoted more by academicians than by the government and it is difficult to find a bureaucratic champion for a PPGIS project (Brown, 2012). There are several reasons for this. First, PPGIS is resource intensive and implementing it in resource-poor communities, especially those with limited access to computers and the Internet, is not very feasible (Weiner & Harris, 2003). Second, use of PPGIS is largely hampered by institutional reasons and not technical reasons (Ganapati, 2011). Agency capacity (financial, technical, and personnel), lack of agency experience in engaging the public, unsupportive organizational culture, and regulatory review requirements are barriers to participatory methods such as PPGIS (Barndt, 1998; Brown, 2012; Ganapati, 2011). Asymmetrical power and political relationships may further result in unequal participation in and support for PPGIS efforts (Laituri 2003; Sieber, 2006). For example, public agencies may withdraw support for PPGIS if the results appear to legitimize public opposition (Brown, 2012). Environmental and industry stakeholders may also be reluctant as they do not always have a control over the outcomes of the PPGIS (Brown, 2012).

Voluntary GIS (VGIS)

Voluntary GIS (VGIS) is a term introduced by Goodchild (2007) to refer to approaches where individuals, untrained in geography or cartography, voluntarily provide geographic data by harnessing new Internet technologies such as bi-directional collaborative Web 2.0 tools. Although there are similarities between PPGIS and VGIS, in PPGIS an individual may be accessing a dataset about a location as a participant in public policy decision making, while in VGIS the individual may be creating a spatial dataset about a location regardless of the policy or decision (Tulloch, 2008). On the other hand, Brown et al. (2014) argue that in the Web 2.0 environment the differences may be more semantic than real.

VGIS, rather than being based on scientific knowledge, is driven by user-generated content, information volunteered by citizens, and citizen journalism that generates the popular knowledge that can be in conflict with authoritative knowledge (McCall et al., 2015, p. 793). VGIS platforms consist of internet- and GIS-enabled devices, and is driven by technological advancements such as mashups, dynamic GIS, cybercartography and geotagging (McCall et al., 2015). An example is OpenStreetMap that started with the goal of creating a free digital map of the world using volunteer participants to collect information that is then stored in a central database and distributed in multiple digital formats using the Web (Haklay, 2010). Volunteered information can be disseminated over the Internet using applications such as My Maps and Wikimapia (Goodchild & Glennon, 2010; McCall et al., 2015).

Although VGIS is based on the same premise as PGIS or PPGIS – that local people have knowledge of their environment and socio-economic conditions – scholars claim that VGIS is generating so much information far more rapidly and at lower cost through crowdsourcing (Goodchild & Glennon, 2010; Tulloch, 2008) that it undermines the practices of participatory GIS that are limited, slower, and on a smaller scale (McCall et al., 2015). During times of emergency, government agencies are particularly stretched with limited staff and resources, and citizens' eyes and ears can be utilized to assist emergency managers and other residents (Goodchild & Glennon, 2010). VGIS augments existing data and can generate early warning signs, in addition to creating a more informed and educated public and promoting cooperation between agencies and citizens (Gouveia & Fonseca, 2008).

The challenges of VGIS are that its actors are unknown, operating under no institutional or legal framework, and following non-transparent processes that can negatively affect information credibility (Goodchild & Glennon, 2010; Gouveia & Fonseca, 2008; McCall et al., 2015). VGIS efforts are often isolated, ad-hoc initiatives and the level of commitment of the volunteers is unknown (Gouveia & Fonseca, 2008). The degree of participation is low compared to PGIS and the flow of information is usually one-way, restricting any interaction (McCall et al., 2015). In addition, the data produced using VGIS is unlikely to be rich in information (McCall et al., 2015), and there is an ongoing debate on whether crowdsourced data results in crowd wisdom (McCall et al., 2015; Haklay, 2010). Nevertheless, some scholars believe in the quality of VGIS data as it is more current and complete compared to authoritatively-produced data (Goodchild & Glennon, 2010; Haklay, 2010). In fact, Jokar Arsanjani, Helbich, Bakillah, Hagenauer, and Zipf (2013) compare collaboratively-collected free VGIS data of land use patterns with European Environmental Agency data and find above 76 percent agreement between the two.

Human Sensors

The term *human sensors* overlaps with PGIS, PPGIS, and VGIS. The human sensor web is defined as a publicly-available web that people (humans) with mobile phones or tablets (the human sensors) use to share information and report issues by enabling their mobile devices to record quantitative and qualitative parameters (Georgiadou, Budhathoki, & Nedovic-Budic, 2011; Meo, Roglia, & Bottino, 2012). Human sensors are the individuals, particularly mobile phone and social media users, who act as a distributed data collection network. ICT developments in terms of increased computational power, storage, miniaturization, multiplicity of communication channels, and remote sensing have promoted new approaches to environmental monitoring via human sensors (Gouveia & Fonseca, 2008).

Society today faces new kinds of threats such as from various manmade and natural disasters. These require effective communication, such as those provided using GIS and the Internet with humans as sensors, that starts before the disaster takes place and remains long after it subsides. Laituri and Kodrich (2008) argue that online communities (such as those related to disaster response) can efficiently upload and disseminate information to create an interactive information exchange. The images and text posted by these virtual communities help create a sense of urgency and foster a sense of community (Laituri & Kodrich, 2008). McCall et al. (2015) describe a research project in Zanzibar aimed at developing a human sensor web for water supply information. Citizens were asked to report water shortages through short message service (SMS) texts sent to a special reporting telephone number. A local internet provider relayed the text messages and uploaded them to an online accessible map.

There are challenges in application of human sensors. These include establishing methodologies for user registration and data collection, recognizing variations in the precision of devices used for data collection, user training requirements, recruitment of new volunteers, and maintenance of existing volunteers (Gouveia & Fonseca, 2008). The digital divide can also affect data collection that underpin the human sensors network. For example, in the Zanzibar water supply case study, the women were the ones who collected water but the men were the ones who possessed mobile phones (McCall et al., 2015). Sometimes the local culture can also create a hindrance. In the Zanzibar culture people were highly respectful of elders. This culture discouraged them from sending short text messages without context, but the human sensor web was not designed to extract information from long strings of text messages (McCall et al., 2015).

Issues, Controversies, and Problems

There are several challenges of and barriers to participatory mapping, including issues of accessibility due to the digital divide, inequity in empowerment of participants, conflicts amongst participants, lack of community support, and lack of a supporting institutional framework (Gouveia & Fonseca, 2008; Norris, 2014). Laws and policies further shape the broad conditions of who participates, how information is communicated, and who has access to data (Brown & Donovan, 2014; Ganapati, 2011). Lack of effective administrative mechanisms and structures hinder the outcomes of the initiatives from being incorporated into mainstream decision-making processes (IFAD, 2009).

There are also challenges associated with the four types of e-participatory mapping. Contextual issues such as linguistic and cultural factors, low participation rates, representativeness of the sample, citizen perceptions of and trust in government, and the digital divide are common concerns. Where public agencies are required to pursue e-participatory mapping, the major issues largely revolve around institutional reluctance to adopt the methodologies, and lack of resources such as technical and personnel capabilities. The credibility and richness of data, and the uncertainty of participation may also mar e-participatory mapping initiatives where individuals are voluntarily providing information. Furthermore, despite all efforts, the knowledge generated from such efforts cannot be expected to replace expert knowledge.

Another issue that stands out is the inconsistent use of the four categories of e-participatory mapping approaches throughout the literature. The literature review underpinning the discussion presented in this chapter found that, even though there are attempts at demarcating the various e-participatory mapping exercises (such as

PGIS, PPGIS, and VGIS), in practice, not all scholars follow the rules or attempt to categorize their research into one of the categories. Some researchers simply refer to participatory mapping and GIS, broadly, in their methodology rather than being more specific such as by calling it PGIS or PPGIS. For example, Brown et al.'s (2014) study identify the research by Beverly et al.'s (2008) as using PPGIS, but the original authors themselves use the general term of participatory mapping and not PPGIS. On the other hand, despite random sampling being a key feature of PPGIS, Fonji et al. (2014) only use voluntary participants in what they identify as an application of PPGIS.

PGIS and PPGIS are also noted by some scholars to be different according to the developed vs. developing nations dichotomy. However, this distinction is not consistently evident in actual application. For example, PPGIS studies have been conducted in developing nations such as Sri Lanka (Alagan & Aladuwaka, 2012), and PGIS studies have been conducted in developed countries such as the UK (Bracken et al., 2016; Cinderby et al., 2008). Further overlap can be seen using the example of the e-participatory mapping study by Fonji et al.'s (2014). This study shows characteristic of PGIS in that it has a strong educational component, and characteristics of PPGIS in the use of a dedicated systems architecture for data upload and collection for a specific and pre-identified purpose. At the same time, mapping participants were volunteers who monitored their environment using GPS devices, placing their study somewhere within the VGIS and human sensors categories.

SOLUTIONS AND RECOMMENDATIONS

Technology resource requirements and reluctance by public agencies to adopt e-participatory mapping methodologies pose challenges for e-participatory mapping. However, the complexity of environmental problems and the emphasis on stakeholder engagement, in parallel with increasing access to the Internet and software and hardware development, make e-participatory mapping an irresistible option in the future. Supporting institutional infrastructure, such as recommendations and guidelines to agencies for using e-participatory mapping, training and skill development initiatives for agency personnel and stakeholders, greater availability and accessibility of technology infrastructure, and transparent processes for reducing information asymmetry and building citizen trust are required for meaningful participation.

FUTURE RESEARCH

In the PGIS category, future research is called for to answer questions such as whether the mapping projects changed the way the communities represent themselves to the state and how to leverage participatory research to support marginalized stakeholders in policy decision making (Norris, 2014). The participation rates in PPGIS surveys have been low and Brown (2012) argues that PPGIS practitioners need to find ways to reverse the declining participation trends. Studies claim that paper-based map surveys result in higher response rates and greater mapping participation than Internet-based survey methods (Pocewicz et al. 2012), which is problematic for achieving PPGIS' goal of high quality digital spatial data. Thus, an effective method to increase participation using PPGIS while simultaneously maintain the quality of the spatial data needs to be identified (Brown, 2012). Future research should also examine public receptivity to alternate mapping using top-down, bottom-up or integrated approaches (Brown & Weber, 2013). Advancing knowledge in VGIS may require incorporating knowledge from the participatory, feminist and critical GIS approach, as well as drawing from multiple disciplines such as GIScience, cognition, and human-computer interaction (Elwood, 2008; Kwan, 2002; Boschmann & Cubbon, 2014; Cullen, 2015). Future research should focus on use of free and open source software for crowdsourced data and collective problem solving (Gajbe, Shankar, & Rodriguez, 2014), and take advantage of open source solutions and development in mobile GIS for establishing standards and protocols for data collection and seamless data exchange, new data exchange networks, and licensing arrangements to facilitate use of software and data (Laituri & Kodrich, 2008). Future work is also suggested on human sensors to improve the quality of metadata, to improve the quality of the tag categories, and to reduce record duplications (Meo et al., 2012).

CONCLUSION

This chapter situates e-participatory mapping as an e-governance tool to facilitate public participation. The discussion uses the umbrella term of e-participatory mapping to refer to all participatory mapping activities using ICT such as GIS, the Internet, and mobile technology. Various approaches of e-participatory mapping used in the field of environmental policy, including PGIS, PPGIS, VGIS, and human sensors, are explored. By bringing together the discussion of various terminologies, practices, and studies in participatory mapping, and approaches used in e-participatory mapping in the environmental policy domain, the chapter creates a single narrative for scholars and practitioners to serve as a beginner's frame of reference for those interested in embracing e-participatory mapping as an e-governance tool. Despite various challenges, e-participatory mapping is an important tool for public participation, policy implementation, and public management. A database with participatory georeferenced data can facilitate decision making on policy issues. Advancements in ICT and the possibility of generating large amount of crowdsourced data such as through VGIS and human sensors makes public participation in mapping spatial data inevitable in the future.

REFERENCES

Al-Kodmany, K. (2002). GIS and the artist: Shaping the image of a neighbourhood in participatory environmental design. In D. Weiner, T. M. Harris, & W. J. Craig (Eds.), *Community participation and geographic information systems* (pp. 320–329). London: Taylor and Francis. doi:10.1201/9780203469484.ch24

Alagan, R., & Aladuwaka, S. (2012). Innovative public participatory GIS methodologies adopted to deal with the social impact assessment process challenges: A Sri Lankan experience. *URISA Journal*, *24*(2), 19–32.

Andrade, M., & Szlafsztein, C. (2015). Community participation in flood mapping in the Amazon through interdisciplinary methods. *Natural Hazards*, *78*(3), 1491–1500. doi:10.100711069-015-1782-y

Asare-Kyei, D., Forkuor, G., & Venus, V. (2015). Modeling flood hazard zones at the sub-district level with the rational model integrated with GIS and remote sensing approaches. *Water (Basel)*, *7*(7), 3531–3564. doi:10.3390/w7073531

Aswani, S., Vaccaro, I., Abernethy, K., Albert, S., & Pablo, J. (2015). Can perceptions of environmental and climate change in island communities assist in adaptation planning locally? *Environmental Management*, *56*(6), 1487–1501. doi:10.100700267-015-0572-3 PMID:26142887

Balderas Torres, A., Santos Acuña, L. A., & Canto Vergara, J. M. (2014). Integrating CBM into land-use based mitigation actions implemented by local communities. *Forests*, *5*(12), 3295–3326. doi:10.3390/f5123295

Baldwin, K., Mahon, R., & McConney, P. (2013). Participatory GIS for strengthening transboundary marine governance in SIDS. *Natural Resources Forum*, *37*(4), 257–268. doi:10.1111/1477-8947.12029

Baldwin, K., & Oxenford, H. A. (2014). A Participatory approach to marine habitat mapping in the Grenadine Islands. *Coastal Management*, *42*(1), 36–58. doi:10.1080/08920753.2013.863725

Barlindhaug, S., & Corbett, J. (2014). Living a long way from home: Communicating land-related knowledge in dispersed indigenous communities, an alternative approach. *Acta Borealia*, *31*(1), 1–24. doi:10.1080/08003831.2014.904619

Barndt, M. (1998). Public participation GIS—Barriers to implementation. *Cartography and Geographic Information Systems*, *25*(2), 105–112. doi:10.1559/152304098782594607

Bauer, K. (2009). On the politics and the possibilities of participatory mapping and GIS: Using spatial technologies to study common property and land use change among pastoralists in Central Tibet. *Cultural Geographies*, *16*(2), 229–252. doi:10.1177/1474474008101518

Bergeron, S. J., Barbara, L. M., & Stiller, A. (2010). Digital city initiatives for small municipalities and rural areas and their role in solid waste management. *Journal of Solid Waste Technology Management*, *36*(3), 918–926.

Beverly, J., Uto, K., Wilkes, J., & Bothwell, P. (2008). Assessing spatial attributes of forest landscape values: An internet-based participatory mapping approach. *Canadian Journal of Forest Research*, *38*(2), 289–303. doi:10.1139/X07-149

Bojórquez-Tapia, L. A., Diaz-Mondragón, S., & Ezcurra, E. (2001). GIS-based approach for participatory decision making and land suitability assessment. *International Journal of Geographical Information Science*, *15*(2), 129–151. doi:10.1080/13658810010005534

Boschmann, E., & Cubbon, E. (2014). Sketch maps and qualitative GIS: Using cartographies of individual spatial narratives in geographic research. *The Professional Geographer*, *66*(2), 236–248. doi:10.1080/00330124.2013.781490

Bracken, L., Oughton, J., Donaldson, E., Cook, A., Forrester, B., Spray, C., ... Bissett, N. (2016). Flood risk management, an approach to managing cross-border hazards. *Natural Hazards*, *82*(S2), 217–240. doi:10.100711069-016-2284-2

Brown, G. (2012). Public participation GIS (PPGIS) for regional and environmental planning: Reflections on a decade of empirical research. *Journal of the Urban and Regional Information Systems Association / URISA*, *24*(2), 7–18.

Brown, G., & Donovan, S. (2014). Measuring change in place values for environmental and natural resource planning using public participation GIS (PPGIS): Results and challenges for longitudinal research. *Society & Natural Resources*, *27*(1), 36–54. doi:10.1080/08941920.2013.840023

Brown, G., & Fagerholm, N. (2015). Empirical PPGIS/PGIS mapping of ecosystem services: A review and evaluation. *Ecosystem Services*, *13*, 119–133. doi:10.1016/j.ecoser.2014.10.007

Brown, G., Kelly, M., & Whitall, D. (2014). Which 'public'? Sampling effects in public participation GIS (PPGIS) and volunteered geographic information (VGI) systems for public lands management. *Journal of Environmental Planning and Management*, *57*(1-2), 190–214. doi:10.1080/09640568.2012.741045

Brown, G., & Kyttä, M. (2014). Key issues and research priorities for public participation GIS (PPGIS): A synthesis based on empirical research. *Applied Geography (Sevenoaks, England)*, *46*, 122–136. doi:10.1016/j.apgeog.2013.11.004

Brown, G., & Weber, D. (2013). A place-based approach to conservation management using public participation GIS (PPGIS). *Journal of Environmental Planning and Management*, *56*(4), 455–473. doi:10.1080/09640568.2012.685628

Brown, G. G., & Donovan, S. (2013). Escaping the national forest planning quagmire: Using public participation GIS to assess acceptable national forest use. *Journal of Forestry*, *111*(2), 115–125. doi:10.5849/jof.12-087

Brown, K., Adger, W. N., & Tompkins, E. L. (2002). *Making waves: Integrating coastal conservation and development*. London: Routledge.

Brown, K., Few, R., Tompkins, E. L., Tsimplis, M., & Sortti, M. (2005). *Responding to climate change: Inclusive and integrated coastal analysis*. Tyndall Centre Technical Report 24.

Burby, R. J. (2003). Making plans that matter: Citizen involvement and government action. *Journal of the American Planning Association*, *69*(1), 33–49. doi:10.1080/01944360308976292

Cadag, J. R. D., & Gaillard, J. C. (2012). Integrating knowledge and actions in disaster risk reduction: The contribution of participatory mapping. *Area*, *44*(1), 100–109. doi:10.1111/j.1475-4762.2011.01065.x

Chagumaira, C., Rurinda, J., Nezomba, H., Mtambanengwe, F., & Mapfumo, P. (2016). Use patterns of natural resources supporting livelihoods of smallholder communities and implications for climate change adaptation in Zimbabwe. *Environment, Development and Sustainability*, *18*(1), 237–255. doi:10.100710668-015-9637-y

Chakrabarty, A. (2011). Ecotourism development and security restructuring: A GIS based planning for peaceful dissuasion of anarchism in forest provinces of India. *Procedia: Social and Behavioral Sciences, 21*, 108–115. doi:10.1016/j.sbspro.2011.07.006

Chambers, R. (1994). The origins and practice of participatory rural appraisal. *World Development, 22*(7), 953–969. doi:10.1016/0305-750X(94)90141-4

Cinderby, S., Snell, C., & Forrester, J. (2008). Participatory GIS and its application in governance: The example of air quality and the implications for noise pollution. *Local Environment, 13*(4), 309–320. doi:10.1080/13549830701803265

Cocks, M. L., Dold, T., & Vetter, S. (2012). 'God is my forest' - Xhosa cultural values provide untapped opportunities for conservation. *South African Journal of Science, 108*(5/6), 1–8. doi:10.4102ajs.v108i5/6.880

Corbett, J. (2009). *Good practices in participatory mapping: A review prepared for the International Fund for Agricultural Development (IFAD).* Retrieved 29th July from http://agris.fao.org/agris-search/search.do?recordID=GB2013201933

Corbett, J., Rambaldi, G., Kyem, P., Weiner, D., Olson, R., Muchemi, J., ... Chambers, R. (2006). Overview: Mapping for Change – the emergence of a new practice. *Participatory Learning and Action, 54*, 13–19.

Craig, W., Harris, T., & Weiner, D. (2002). *Community participation and geographic information systems*. London: Taylor and Francis.

Crow, D. A., & Stevens, J. R. (2012). Citizen engagement in local environmental policy: Information, mobilization, and media. In H. L. Schachter (Ed.), *State of citizen participation in America* (pp. 131–162). Charlotte, NC: Information Age Publishing.

Cullen, A. (2015). Making sense of claims across institutional divides: Critical PGIS and mapping customary land in Timor-Leste. *The Australian Geographer, 46*(4), 473–490. doi:10.1080/00049182.2015.1080344

Davies, S. R., Selin, C., Gano, G., & Pereira, Â. G. (2012). Citizen engagement and urban change: Three case studies of material deliberation. *Cities (London, England), 29*(3), 51–357.

Delli Carpini, M. X., Cook, F. L., & Jacobs, L. R. (2004). Public deliberation, discursive participation, and citizen engagement: A review of the empirical literature. *Annual Review of Political Science, 7*(1), 315–344. doi:10.1146/annurev.polisci.7.121003.091630

Dickinson, J. L., Shirk, J., Bonter, D., Bonney, R., Crain, R. L., Martin, J., ... Purcell, K. (2012). The current state of citizen science as a tool for ecological research and public engagement. *Frontiers in Ecology and the Environment, 10*(6), 291–297. doi:10.1890/110236

Drew, C.H. (2003). Transparency – Considerations for PPGIS research and development. *URISA Journal, 15*, 73-78.

Dunn, C. (2007). Participatory GIS -- A people's GIS? *Progress in Human Geography, 31*(5), 616–637. doi:10.1177/0309132507081493

Elwood, S. (2008). Volunteered geographic information: Future research directions motivated by critical, participatory, and feminist GIS. *GeoJournal, 72*(3), 173–183. doi:10.100710708-008-9186-0

Few, R., Brown, K., & Tompkins, E. L. (2007). Public participation and climate change adaptation: Avoiding the illusion of inclusion. *Climate Policy, 7*(1), 46–59. doi:10.3763/cpol.2007.0704

Fischer, F. (2000). *Citizens, experts, and the environment: The politics of local knowledge*. Durham, NC: Duke University Press. doi:10.1215/9780822380283

Fonji, S., Larrivee, M., & Taff, G. (2014). Public Participation GIS (PPGIS) for regional mapping and environmental awareness. *Journal of Geographic Information System, 6*(2), 135–149. doi:10.4236/jgis.2014.62015

Forrester, J., & Snell, C. (2007). Planning inclusive and sustainable urban regeneration: Balancing a visitor-based economy with local needs in the city of York, UK. *Journal of Urban Renewal and Regeneration, 1*(1), 69–82.

Fredericks, J. F., & Foth, M. (2013). Augmenting public participation: Enhancing planning outcomes through the use of social media and web 2.0. *Australian Plants, 50*(3), 244–256. doi:10.1080/07293682.2012.748083

Gaillard, J. C., Hore, K., & Cadag, J. R. D. (2015). Participatory mapping for disaster risk reduction: A review. *Globe, 76*, 31–38.

Gajbe, A., Shankar, A., & Rodriguez, S. (2014). Virtual coast guard: An open and crowdsourced GIS portal for stewardship of India's coast. *Transactions in GIS, 18*(4), 544–554. doi:10.1111/tgis.12066

Ganapati, S. (2010). *Using geographic information systems to increase citizen engagement*. Washington, DC: IBM Center for the Business of Government. Abstract retrieved on 12th November 2016 from http://faculty.cbpp.uaa.alaska.edu/afgjp/padm601%20fall%202010/GIS.pdf

Ganapati, S. (2011). Uses of public participation geographic information systems applications in e-government. *Public Administration Review, 71*(3), 425–434. doi:10.1111/j.1540-6210.2011.02226.x

Garrard, R., Kohler, T., Price, M. F., Byers, A. C., Sherpa, A. R., & Maharjan, G. R. (2016). Land use and land cover change in Sagarmatha National Park, a world heritage site in the Himalayas of Eastern Nepal. *Mountain Research and Development, 36*(3), 299–310. doi:10.1659/MRD-JOURNAL-D-15-00005.1

Georgiadou, Y., Budhathoki, N. R., & Nedovic-Budic, Z. (2011). An exploration of SDI and volunteered geographic information in Africa. In Z. Nedovic-Budic, J. Crompvoets, & Y. Georgiadou (Eds.), *Spatial data infrastructure in context: North and South* (pp. 203–218). Boca Raton, FL: CRC Press.

Godschalk, D. R., Brody, S., & Burby, R. (2003). Public participation in natural hazard mitigation policy formation: Challenges for comprehensive planning. *Journal of Environmental Planning and Management, 46*(5), 733–754. doi:10.1080/0964056032000138463

González, A., Gilmer, A., Foley, R., Sweeney, J., & Fry, J. (2008). Technology-aided participative methods in environmental assessment: An international perspective. *Computers, Environment and Urban Systems, 32*(4), 303–316. doi:10.1016/j.compenvurbsys.2008.02.001

Goodchild, M., & Glennon, J. (2010). Crowdsourcing geographic information for disaster response: A research frontier. *International Journal of Digital Earth, 3*(3), 231–241. doi:10.1080/17538941003759255

Goodchild, M. F. (2007). Citizens as sensors: The world of volunteered geography. *GeoJournal, 69*(4), 211–221. doi:10.100710708-007-9111-y

Gouveia, C., & Fonseca, A. (2008). New approaches to environmental monitoring: The use of ICT to explore volunteered geographic information. *GeoJournal, 72*(3), 185–197. doi:10.100710708-008-9183-3

Gray, S. A., Gray, S., De Kok, J. L., Helfgott, A. E. R., O'Dwyer, B., Jordan, R., & Nyaki, A. (2015). Using fuzzy cognitive mapping as a participatory approach to analyze change, preferred states, and perceived resilience of social-ecological systems. *Ecology and Society, 20*(2), 186–199. doi:10.5751/ES-07396-200211

Haklay, M. (2010). How good is volunteered geographical information? A comparative study of OpenStreetMap and ordnance survey datasets. *Environment and Planning. B, Planning & Design, 37*(4), 682–703. doi:10.1068/b35097

Hamilton, J. D., & Wills-Toker, C. (2006). Reconceptualizing dialogue in environmental public participation. *Policy Studies Journal: the Journal of the Policy Studies Organization, 34*(4), 755–775. doi:10.1111/j.1541-0072.2006.00200.x

Hiller, J. S., & Bélanger, F. (2001). Privacy strategies for electronic government. In M. A. Abramson & G. E. Means (Eds.), *E-government 2001* (pp. 162–198). Lanham, MD: Rowman & Littlefield.

Hoole, A., & Berkes, F. (2010). Breaking down fences: Recoupling social–ecological systems for biodiversity conservation in Namibia. *Geoforum, 41*(2), 304–317. doi:10.1016/j.geoforum.2009.10.009

Integrated Approaches to Participatory Development (IPAD). (2009). *Participatory mapping*. Retrieved 21st January 2016 at https://coast.noaa.gov/digitalcoast/_/pdf/participatory-mapping.pdf?redirect=301ocm

International Fund for Agricultural Development (IFAD). (2009). *Good practices in participatory mapping*. Retrieved 6th January 2016 from http://www.ifad.org/pub/map/pm_web.pdf

Jokar Arsanjani, J., Helbich, M., Bakillah, M., Hagenauer, J., & Zipf, A. (2013). Toward mapping land-use patterns from volunteered geographic information. *International Journal of Geographical Information Science, 27*(12), 2264–2278. doi:10.1080/13658816.2013.800871

Jordan, G., & Shrestha, B. (2000). *A participatory GIS for community forestry user groups in Nepal: Putting people before the technology. Participatory learning and action notes 39*. International Institute for Environment and Development.

Jordan, G. H., & Shrestha, B. (1998). *Integrating geomatics and participatory techniques for community forest management: Case studies from the Yarsha Khola watershed, Dolakha district*. Nepal: ICIMOD.

Joyce, A., & Canessa, R. (2009). Spatial and temporal changes in access rights to shellfish resources in British Columbia. *Coastal Management, 37*(6), 585–616. doi:10.1080/08920750903097517

Kaul, V., & Thornton, T. (2014). Resilience and adaptation to extremes in a changing Himalayan environment. *Regional Environmental Change, 14*(2), 683–698. doi:10.100710113-013-0526-3

Kim, A. M. (2015). Critical cartography 2.0: From "participatory mapping" to authored visualizations of power and people. *Landscape and Urban Planning, 142*, 215–225. doi:10.1016/j.landurbplan.2015.07.012

King, C. S., Feltey, K. M., & Susel, B. (1998). The question of participation: Toward authentic public participation in public administration. *Public Administration Review, 58*(4), 317–326. doi:10.2307/977561

Kingston, R., Carver, S., Evans, A., & Turton, I. (2000). Web-based public participation geographical information systems: An aid to local environmental decision-making. *Computers, Environment and Urban Systems, 24*(2), 109–125. doi:10.1016/S0198-9715(99)00049-6

Kwan, M. (2002). Feminist visualization: Re-envisioning GIS as a method in feminist geographic research. *Annals of the Association of American Geographers, 92*(4), 645–661. doi:10.1111/1467-8306.00309

Laituri, M. (2003). The issue of access: An assessment guide for evaluating public participation geographic information science case studies. *URISA Journal, 15*, 25–32.

Laituri, M., & Kodrich, K. (2008). Online disaster response community: People as sensors of high magnitude disasters using internet GIS. *Sensors (Basel), 8*(5), 3037–3055. doi:10.33908053037 PMID:27879864

Leon, J. X., Hardcastle, J., James, R., Albert, S., Kereseka, J., & Woodroffe, C. D. (2015). Supporting local and traditional knowledge with science for adaptation to climate change: Lessons learned from participatory three-dimensional modeling in BoeBoe, Solomon Islands. *Coastal Management, 43*(4), 424–438. doi:10.1080/08920753.2015.1046808

Levine, A. S., & Feinholz, C. L. (2015). Participatory GIS to inform coral reef ecosystem management: Mapping human coastal and ocean uses in Hawaii. *Applied Geography (Sevenoaks, England), 59*, 60–69. doi:10.1016/j.apgeog.2014.12.004

Lewandowski, E. J., & Oberhauser, K. S. (2015). Butterfly citizen scientists in the United States increase their engagement in conservation. *Biological Conservation, 208*, 106–112. doi:10.1016/j.biocon.2015.07.029

Lingel, J. (2011). Information tactics of immigrants in urban environments. *Information Research, 16*(4). Available at http://InformationR.net/ir/16-4/paper500.html

Lowe, C., Gaudion, K., McGinley, C., & Kew, A. (2014). Designing living environments with adults with autism. *Tizard Learning Disability Review, 19*(2), 63–72. doi:10.1108/TLDR-01-2013-0002

Lubis, M. I., & Langston, J. D. (2015). Understanding landscape change using participatory mapping and geographic information systems: Case study in North Sulawesi, Indonesia. *Procedia Environmental Sciences*, *24*, 206–214. doi:10.1016/j.proenv.2015.03.027

Lukensmeyer, C. J., & Torres, L. H. (2006). *Public deliberation: A manager's guide to citizen engagement.* Retrieved 24th January 2016 from https://www.whitehouse.gov/files/documents/ostp/opengov_inbox/ibmpubdelib.pdf

Malek, Ž., & Boerboom, L. (2015). Participatory scenario development to address potential impacts of land use change: An example from the Italian Alps. *Mountain Research and Development*, *35*(2), 126–138. doi:10.1659/MRD-JOURNAL-D-14-00082.1

Mapedza, F., Wright, J., & Fawcett, R. (2003). An investigation of land cover change in Mafungautsi forest, Zimbabwe, using GIS and participatory mapping. *Applied Geography (Sevenoaks, England)*, *23*(1), 1–21. doi:10.1016/S0143-6228(02)00070-X

Marchionini, G., Samet, H., & Brandt, L. (2003). Digital government. *Association for Computing Machinery. Communications of the ACM*, *46*(1), 24–27.

Mbile, P., DeGrande, A., & Okon, D. (2003). Integrating participatory resource mapping and geographic information systems in forest conservation and natural resources management in Cameroon: A methodological guide. *EJISDC*, *14*(2), 1–11.

McBride, B., Sanchez-Trigueros, F., Carver, S., Watson, A., Stumpff, L., Matt, R., & Borrie, W. (2017). Participatory geographic information systems as an organizational platform for the integration of traditional and scientific knowledge in contemporary fire and fuels management. *Journal of Forestry*, *115*(1), 43–50. doi:10.5849/jof.14-147

McCall, M. K., Martinez, J., & Verplanke, J. (2015). Shifting boundaries of volunteered geographic information systems and modalities: Learning from PGIS. *ACME: An International E-Journal for Critical Geographies*, *14*(3), 791–826.

McLaverty, P. (2011). Participation. In M. Bevir (Ed.), *The SAGE handbook of governance* (pp. 1–30). London: Sage. doi:10.4135/9781446200964.n26

Meo, R., Roglia, E., & Bottino, A. (2012). The exploitation of data from remote and human sensors for environment monitoring in the SMAT Project. *Sensors*, *12*(12), 17504-17535.

Moon, M. J. (2002). The evolution of e-government among municipalities: Rhetoric or reality? *Public Administration Review, 62*(4), 424–433. doi:10.1111/0033-3352.00196

Mossberger, K., Tolbert, C. J., & McNeal, R. S. (2008). *Digital citizenship: The internet, society, and participation*. Cambridge, MA: MIT Press.

Norris, T. B. (2014). Bridging the great divide: State, civil society, and 'participatory' conservation mapping in a resource extraction zone. *Applied Geography (Sevenoaks, England), 54*, 262–274. doi:10.1016/j.apgeog.2014.05.016

Parr, J., & Gates, C. (1989). Assessing community interest and gathering community support. In International City Management Association (Eds.), Partnerships in local governance: Effective council-manager relations. Washington, DC: International City Management Association.

Parry, G., & Moyser, G. (1994). More participation, more democracy? In D. Beetham (Ed.), *Defining and Measuring Democracy* (pp. 44–62). London: Sage.

Pocewicz, A., Nielsen-Pincus, M., Brown, G., & Schnitzer, R. (2012). An evaluation of internet versus paper-based methods for public participation geographic information systems (PPGIS). *Transactions in GIS, 16*(1), 39–53. doi:10.1111/j.1467-9671.2011.01287.x

Pozzebon, M., Tello Rozas, S., & Aguilar Delgado, N. (2015). Use and consequences of participatory GIS in a Mexican municipality: Applying a multilevel framework. *Uso y consecuencias de un SIG participativo en un município mexicano: aplicando un modelo multinivel, 55*(3), 290-303.

Rambaldi, G., Kwaku Kyem, A. P., Mbile, P., McCall, M., & Weiner, D. (2006). Participatory Spatial Information Management and Communication in Developing Countries. *EJISDC, 25*(1), 1-9. Retrieved from http://www.ejisdc.org/ojs/include/getdoc.php?id=246&article=263&mode=pdf

Reed, M. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation, 141*(10), 2417–2431. doi:10.1016/j.biocon.2008.07.014

Robiglio, V., Mala, W. A., & Diaw, C. M. (2003). Mapping landscapes: Integrating GIS and social science methods to model human-nature relationships in Southern Cameroon. *Small-scale Forest Economics. Management and Policy, 2*(2), 171–184.

Rowe, G., & Frewer, L. J. (2000). Public participation methods: A framework for evaluation. *Science, Technology & Human Values, 25*(1), 3–29. doi:10.1177/016224390002500101

Schlossberg, M., & Shuford, E. (2005). Delineating 'public' and 'participation' in PPGIS. *URISA, 16*, 15–26.

Sieber, R. (2006). Public participation geographic information systems: A literature review and framework. *Annals of the Association of American Geographers, 96*(3), 491–507. doi:10.1111/j.1467-8306.2006.00702.x

Skinner, K., Hanning, R. M., & Tsuji, L. J. S. (2006). Barriers and supports for healthy eating and physical activity for First Nation youths in northern Canada. *International Journal of Circumpolar Health, 65*(2), 148–161. doi:10.3402/ijch.v65i2.18095 PMID:16711466

Sletto, B. (2009). 'Indigenous people don't have boundaries': Reborderings, fire management, and productions of authenticities in indigenous landscapes. *Cultural Geographies, 16*(2), 253–277. doi:10.1177/1474474008101519

Sletto, B., Muñoz, S., Strange, S. M., Donoso, R. E., & Thomen, M. (2010). El Rincón de los Olvidados: Participatory GIS, experiential learning and critical pedagogy in Santo Domingo, Dominican Republic. *Journal of Latin American Geography, 9*(3), 111–135. doi:10.1353/lag.2010.0022

Smith, H., & Jenkins, P. (2015). Trans-disciplinary research and strategic urban expansion planning in a context of weak institutional capacity: Case study of Huambo, Angola. *Habitat International, 46*, 244–251. doi:10.1016/j.habitatint.2014.10.006

Smith, L. G. (1983). *Impact assessment and sustainable resource management.* Harlow, UK: Longman.

Stelzenmüller, V., Lee, J., South, A., Foden, J., & Rogers, S. I. (2013). Practical tools to support marine spatial planning: A review and some prototype tools. *Marine Policy, 38*, 214–227. doi:10.1016/j.marpol.2012.05.038

Thompson, A., Prokopy, L., Floress, K., & Weinkauf, D. (2011). A method for incorporating community priorities into GIS: Challenges, choices, and directions for landscape planners. *Landscape Journal: Design, Planning, and Management of the Land, 30*(2), 299–312. doi:10.3368/lj.30.2.299

Tolbert, C. J., & Mossberger, K. (2006). The Effects of e-government on trust and confidence in government. *Public Administration Review, 66*(3), 354–369. doi:10.1111/j.1540-6210.2006.00594.x

Tschakert, P., Ricciardi, V., Smithwick, E., Machado, M., Ferring, D., Hausermann, H., & Bug, L. (2016). Situated knowledge of pathogenic landscapes in Ghana: Understanding the emergence of Buruli ulcer through qualitative analysis. *Social Science & Medicine*, *150*, 160–171. doi:10.1016/j.socscimed.2015.12.005 PMID:26761375

Tulloch, D. L. (2007). Many, many maps: Empowerment and online participatory mapping. *First Monday*, *12*(2). doi:10.5210/fm.v12i2.1620

Tulloch, D. L. (2008). Is VGI participation? From vernal pools to video games. *GeoJournal*, *72*(3/4), 161–171. doi:10.100710708-008-9185-1

UN. (2008). *World public sector report*. Retrieved 21st January 2016 from http://www.unpan.org/Directories/UNPublicAdministrationGlossary/tabid/928/language/en-US/Default.aspx#

UNFCCC. (1992). *UN convention on climate change*. Available at https://unfccc.int/resource/docs/convkp/conveng.pdf

United Nations (UN). (2014). *E-Government survey 2014*. Retrieved 11th October 2015 from, http://unpan3.un.org/egovkb/Portals/egovkb/Documents/un/2014-Survey/E-Gov_Complete_Survey-2014.pdf

Vajjhala, S. P. (2005). *Integrating GIS and participatory mapping in community development planning*. Paper for the ESRI International User Conference, Sustainable Development and Humanitarian Affairs Track, San Diego, CA.

Verba, S., Schlozman, K., Brady, H., & Nie, N. H. (1993). Citizen activity: Who participates? What do they say? *The American Political Science Review*, *87*(2), 303–318. doi:10.2307/2939042

Webler, T. (1999). The craft and theory of public participation: A dialectical process. *Journal of Risk Research*, 2(1), 55–71. doi:10.1080/136698799376989

Weiner, D., & Harris, T. M. (2003). Community-integrated GIS for land reform in South Africa. *Journal of the Urban and Regional Information Systems Association / URISA*, *15*(2), 61–73.

West, D. (2005). *Digital government: Technology and public sector performance (Safari tech books online)*. Princeton, NJ: Princeton University Press.

Wong, S., & Chua, Y. (2000). Data intermediation and beyond: Issues for web-based PPGIS. *Cartographica*, *38*(3/4), 63–80.

Woodhouse, E., Mills, M., McGowan, P., & Milner-Gulland, E. (2015). Religious relationships with the environment in a Tibetan rural community: Interactions and contrasts with popular notions of indigenous environmentalism. *Human Ecology: an Interdisciplinary Journal, 43*(2), 295–307. doi:10.100710745-015-9742-4 PMID:25983377

Young, J. C., & Gilmore, M. P. (2013). The spatial politics of affect and emotion in participatory GIS. *Annals of the Association of American Geographers, 103*(4), 808–823. doi:10.1080/00045608.2012.707596

ADDITIONAL READING

Chambers, R. (1997). *Whose reality counts? Putting the first last.* London: Intermediate Technology. doi:10.3362/9781780440453

Flanagin, A., & Metzger, J. (2008). The credibility of volunteered geographic information. *GeoJournal, 72*(3), 137–148. doi:10.100710708-008-9188-y

Gould, W., & White, R. R. (1986). *Mental maps* (2nd ed.). Boston: Allen & Unwin.

Haklay, M., & Tob6n, C. (2003). Usability evaluation and PPGIS: Towards a user-centred design approach. *International Journal of Geographical Information Science, 17*(6), 577–592. doi:10.1080/1365881031000114107

Pickles, J. (1995). *Ground truth: The social implications of geographic information systems (mappings).* New York: Guilford Press.

Renn, O., Webler, T., & Wiedemenn, P. (1995). *Fairness and competence in citizen participation: Evaluating methods of environmental discourse.* Dordrecht, The Netherlands: Kluwer Academic Publishers. doi:10.1007/978-94-011-0131-8

Sui, D., Elwood, S., & Goodchild, Ml. (2012). *Crowdsourcing geographic knowledge.* Dordrecht: Springer.

Surowiecki, J. (2004). *The wisdom of crowds: Why the many are smarter than the few and how collective. wisdom shapes business, economies, societies, and nations* (1st ed.). New York: Doubleday.

KEY TERMS AND DEFINITIONS

E-Government: Use of information and communication technology for delivery of government services.

E-Participation: Use of ITCT for engaging the public in policy making activities.

E-Participatory Mapping: E-governance tool for public participation that utilizes ICT to engage the public in participatory mapping activities.

Geographic Information Systems (GIS): A set of information technology tools to collect, store, analyze, and display spatial information.

Human Sensors: General publics' use of ICT tools for sensing and sharing data relevant for policy making.

Information and Communication Technology (ICT): Range of hardware and software associated with communication of information using digital data.

Participatory GIS (PGIS): Participatory mapping activities involving the use of GIS technology. It is associated with use of purposive samples and focus on empowerment of indigenous people.

Participatory Mapping: Activities that involve the general public in map-making activities.

Public Participation: Engagement of the general public in policy-making activities. It includes activities such as sharing of government information, seeking comments on issues and policies, and using public inputs in decision making.

Public Participation GIS (PPGIS): Participatory mapping activities using GIS and the Internet. It relies on random sampling and focuses on high data quality.

Voluntary GIS (VGIS): Participatory mapping where the public voluntarily provides spatial data using ICT tools.