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REFEREED PAPER

A Shared Perspective for PGIS and VGI

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This paper reviews persistent principles of participation processes. On the basis of a review of recent interrogations of the (Public) Participatory Geographic Information Systems (P)PGIS and Volunteered Geographic Information (VGI) approaches, a summary of five prevailing principles in participatory spatial information handling is presented. We investigate these five principles that are common to (P)PGIS and VGI on the basis of a framework of two dimensions that govern the participatory use of spatial information from the perspective of people and society. This framework is presented as a shared perspective of (P)PGIS and VGI and illustrates that, although both share many of these same principles, the ways in which these principles are approached are highly diverse. The paper ends with a future outlook in which we discuss the inter-connected memes of potential technological futures, the signification of localness in 'local spatial knowledge', and the ramifications of ethical tenets by which PGIS and VGI can strengthen each other as two sides of the same coin.

Keywords: participatory geographic information systems, volunteered geographic information, Geoweb, local spatial knowledge, participatory practice

PGIS HAPPENED AND ALONG CAME VGI

A decade has passed since the last major reflection on the development of (Public) Participatory Geographic Information Systems (PPGIS/PGIS) as a practice, which took place at the 'Mapping for Change' conference in Nairobi in July 2005. The conceptual ideas and the concrete experiences articulated at that event made it clear that PGIS/PPGIS had been brought from a useful collection of tools towards a more holistic practice. Subsequently, the practice has further evolved, but meanwhile, the new approach of Volunteered Geographic Information (VGI) has emerged to challenge PGIS in terms of speed, scale, and representativeness. Such alternatives to PGIS which utilize complementary materials and applications from the Geoweb are seen to be more dynamic, and more collaborative, in a sense that potentially there can be broader more comprehensive 'produsing' (Coleman *et al*., 2009) involvement from the audience.

A quickscan on the commonalities between PGIS and VGI finds: a core intention to capture people's valuable (often non-documented) spatial knowledge; privileging non-authoritative sources of information and knowledge of the common people in line with user-generated content (UGC), Citizen Science, and countermapping; promoting stronger narratives of agency in the public domain, for citizens to feel more included and valued; and, garnering efficiency, that is more information for less cost. What are very different between PGIS and VGI are: ownership in terms of access, dissemination, and use of collated knowledge, and thus empowerment opportunities; depth and richness vis-à-vis speed and range of knowledge inputs; and, the stage at which the generated knowledge is aggregated, i.e. at source for PGIS, and, at destination for VGI.

This paper is centred on the two approaches of PGIS and VGI; we assess the salient positives and negatives of both and the synergies and contradictions between them. We have reviewed a range of materials in PGIS and VGI to formulate a 'reflection on the future of PGIS' and its practice within the new reality of VGI.

PERSISTENT PRINCIPLES IN PARTICIPATION PROCESSES

Several persistent principles have shaped the way in which participatory approaches have been used for generating and

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developing local spatial knowledge (LSK) over half a century and which especially PGIS practice (with the emphasis on the 'P') has employed over two decades (Abbot *et al*., 1998; Chambers, 1983, 1994b, 2006; Corbett *et al*., 2006; Verplanke, 2008). We discuss the most salient of these principles in the next sections according to the principles of access, ownership, trust, validation, and application. These principles form a logical structure for participatory approaches, starting with careful community engagement and elicitation of local knowledge to ensure its documentation and preservation, and also to ensure the knowledge is employed to good use for and by the community and does not remain idle in a repository.

PGIS/PPGIS

We consider PGIS and PPGIS to be practices of great similarity which were initially a merger of Participatory Learning and Action (PLA) methods with geographic information technologies. PPGIS developed largely in the global North (Obermeyer, 1998) while PGIS has found more practice in the global South (Chambers, 1994a; Rambaldi *et al*., 2006a, 2006b; Sieber, 2006). There are arguments that PGIS is more concerned with the techniques, methods, procedures practical practices of working with LSK of local people, whereas PPGIS is more about the social and political processes of participatory planning (and management), and less about the actual methods used (Brown and Kyttä, 2014; Rambaldi *et al*., 2006b; Tulloch, 2008; Tulloch and Shapiro, 2003). PGIS practice is geared towards community empowerment through tailored, demand-driven and user-friendly applications of these geospatial technologies. Good practice in PGIS is flexible and adapts to different socio-cultural and biophysical environments, relying on the combination of 'expert' skills with local knowledge. In contrast to traditional GIS applications, PGIS ideally places the control of access and use of socially or culturally sensitive spatial data in the hands of the communities who generate it (Rambaldi *et al*., 2006b). But any overview of the thousands of examples shows that in practice this distinction is irrelevant (McCall, 2016). These practices emerged in their own rights with an emphasis on active local participation, LSK, local ownership of PGIS processes and outputs, and on pushing for local empowerment (McCall *et al*., 2015). PGIS (from here on, we refer to PGIS as a term for both PPGIS and PGIS) aims to represent local people's spatial knowledge by geographical information products – most commonly, maps – that can facilitate informed and inclusive participatory decision-making processes and support communication and community advocacy.

But, there are maps … and maps. Authoritative maps: produced by national mapping agencies; Collaborative maps: produced usually on the Geoweb, by dispersed individuals though sharing common objectives; and Participatory maps produced by people having a common purpose, sharing a pool of knowledge in a given territory; and usually working together (physically) when generating data or making a map (Corbett, 2013; Rambaldi, 2013).

A brief history of PGIS

From the 1960s, participatory planning processes frequently made use of participatory mapping and other participatory spatial information collection tools using local inputs such as through face-to-face interactions in map-making workshops. The feasibility of applying GIS tools to local group mapping exercises in a more participatory way has been discussed since the earliest days of GIS development in the 1980–1990s, centring on whether GIS could be used by local peoples to 'give them power to influence decisions' (Corbett *et al*., 2006; Pickles, 1995; Poole, 1995; Rundstrom, 1995; Schuurman, 2000). PGIS practice has been championed by those who criticize classical GIS for being rigid and disembodied, over-emphasizing a positivist mode of thinking and focusing on technical solutions while forgetting about the human stories behind the data (Elwood, 2006; McCall, 2004). PGIS approaches are therefore context-, demand- and issue-driven, and aim for community (knowledge holders) empowerment as a higher purpose than the technology usage.

During the 1990s, the PGIS community made use of Participatory Action Research (Whyte, 1991) and PLA and combined the approach with mapping and geo-information[1] (Robinson and Sawicki, 1996; Robinson *et al*., 1994). These applications, using spatial information in problem-solving at the household or community levels, were complemented with locally known and understood methods of scientific thinking and experimentation to support participation and sustainable rural livelihoods. In the USA, a loud call for 'participatorizing' GIS was heard during this period (Weiner *et al*., 2002).

A shift in the approaches of PGIS, shifting to applying geo-information technologies in the global south, where participatory practices were already existing, was highlighted in the 'Mapping for Change' conference held in Nairobi in 2005 (Chambers, 2005; Corbett *et al*., 2006; Poole, 2006; Rambaldi *et al*., 2006a). Major platforms and media for PGIS practice have since been the IAPAD[2] portal, the linked electronic discussion group ppgis.net[3] (Rambaldi *et al*., 2006a), and the Training Kit on Participatory Spatial Information, Management, and Communication[4]. In 2013, the Mapping for Change meeting was followed up by a Symposium entitled 'the Future of PGIS' in Enschede, The Netherlands (Fagerholm, 2013; Haklay, 2013b; Harvey, 2013a; McCall, 2013; Orta Martinez, 2013; Rambaldi, 2013).

A brief history of VGI

The concept of VGI came from practitioners, users, and researchers in GI Science who were more interested in the information itself than in whether it was a participatory process that created and used it. In a general GI Science framework, VGI is more about application and large data (Sieber and Haklay, 2015; Tulloch, 2008) while PGIS is more about processes and outcomes. The rise of VGI is an overarching term for the set of approaches, systems, and modalities for gathering and organizing citizens' local (spatial) knowledge, including UGC systems, Web 2.0, and the Geoweb (Goodchild, 2007a; McCall *et al*., 2015; Sui *et al*., 2013a; Xu and Nyerges, 2016).

Current terminology and conceptualizations in VGI are imprecise, though there are key distinctions between *volunteered* (known and activated) or contributed information, and *opportunistic* (which may be known-but-passive, or

unknown, unpermitted) involvement (Harvey, 2013b); and distinctions between unidirectional provision of citizens' data, and information flows which are interactive, whether as feedback or dialogue flows. There are two foundation themes of the VGI explosion, which have developed separately, but are also intertwined.

(a) Citizen science and people's participation – Knowledge from outside the academy, outside of 'authoritative information', the post-modernist drive for more of people's participation in planning, design, policy, and, everything. The value, reality and social significance slowly being accorded to lay people's phenomenological and technical knowledge. This popular *vulgar knowledge* formation is alternative, critical, often in conflict with authoritative information, but it is not necessarily spatial information. Conceptualizations within this theme are UGC and volunteered citizens' information, and citizen journalism – none of which necessarily have anything to do with *scientific knowledge*, although the material contained might be 'scientific'.

(b) Then, adding GIS and adding the Web (and geo-referencing) – the rapid technological advances in handling, dissecting and utilizing geospatial information in GI science and technology. The term WebGIS summarizes the broader social and cultural implications of what are specifically technical extensions of conventional GIS technologies and systems, such as: mash-ups, web GIS, Cybercartography, geotagging, and locative media. These all have broad implications for Citizen Science and other UGC in knowledge frames.

There is a concern that, to some degree, the terms 'participation' and 'collaboration' have been misused in the VGI literature to describe mass granular contributions where the balance of benefits is usually with the data aggregators. This is because VGI is conceptualized more through the advances and accessibility of technology and open data. VGI has become prominent in occasions of 'momentary engagement' by third parties (international development agencies, emergency services, etc.) especially relevant to crisis situations and humanitarian disasters.

Open online mapping as a manifestation of VGI using Google Maps, Google Earth or OpenStreetMap (OSM) have created mapping masses, individuals, and communities that have access to spatial data otherwise only available to an elite group of surveyors and government officials. This has been facilitated by a decreasing cost of geographic information technologies and mobile data exchange, increasingly user-friendly interfaces, increasing Internet penetration and use of mobile devices in developing countries. This is contemporaneous with development in the field of citizen science and the shifts in what is acceptable as 'authoritative knowledge' as in Citizen Science, people from outside research institutions generate content, including spatial information, to contribute to a growing scientific knowledge base (Connors *et al*., 2012; Elwood, 2008a; Fung and Warren, 2011; Goodchild, 2007b; Haklay, 2013a; Liebenberg, 2013; McCall *et al*., 2015; Shilton, 2010; Verplanke, 2013; Xu and Nyerges, 2016).

PRINCIPLES OF PGIS AND VGI

This paper challenges the five persistent principles (Table 1) by outlining their strengths and weaknesses for both PGIS and VGI. To do this, we shall relate them (in Table 2) to two dimensions by which people and society achieve both generation and *use of data* and *use of methods*. The strengths and weaknesses of PGIS and VGI have been reviewed from research and practitioner literature in order to determine factors significant to the future of PGIS practice.

The paper takes a critical look at the five principles – how PGIS and VGI approaches deal with *access* and (intellectual) *ownership* (and authorship) of knowledge and information (Orta Martinez, 2013; Rambaldi, 2013); how *trust* is handled (Haklay, 2013a; McCall *et al*., 2015; Rambaldi *et al*., 2006a); and *validation* and *application* of the acquired knowledge. For both validation and access, there should be ethical attention to stakeholder interaction and the capturing of local context (Fagerholm, 2013; Harvey, 2013a). Furthermore, there are issues of tools and knowledge dissemination which are also related to training, the transparency of the tools, and effectiveness of their processes.

Before proceeding, however, we first need to look at *purpose*. Significant differences emerge between PGIS and VGI in the purposes which drive employment of the two approaches. The idea of purpose establishes a degree of distinction between PGIS and VGI, important to later reviewing the principles.

Purpose in PGIS and VGI

PGIS aims to improve the quality of planning through a participatory approach and facilitate inter-generational knowledge exchange and dialogue with disadvantaged communities and their leaders. Community cohesion and actual engagement in implementing follow-up actions identified in the process. In terms of information sources, PGIS widens the notion of the participating knowledge holders to include 'the public' and, particularly, marginalized groups. PGIS involves local communities in the creation of spatial information and geocoded knowledge to be fed into the GIS and in the elaboration of this information in spatial decision-making. A purpose of generating information through a PGIS process and participatory mapping is thus directly related to a community[5] enhancing its own understanding and contacts with its environment by mutually developing new dimensions of awareness about their surroundings.

VGI is intended to create, collect, validate, analyse, and disseminate geographic data contributed voluntarily by individuals (Elwood, 2008d; Goodchild, 2007b, 2008; Miscione *et al*., 2011; Tulloch, 2008) who do not necessarily know each other or have any kin or social relationship. VGI is based more on contribution and communication of information than on participation. In terms of purposes of exchanging information, VGI is based on a usually one-way flow of information while implementing an (external) activity, rather than on co-operation. This is partially due to its intrinsic individualism. This is apparent from the disconnect between the knowledge-holders who contributed the data and the persons who will use these for analysis. VGI employed as collective

Table 1. The principles of participatory approaches as observed in PGIS

Issues of	Principles
• Preservation of LSK about local cultures • Strengthening of local identity • Enhancing/generating empowerment • Inclusiveness of voices in a community	Access, ownership
• Acknowledging the authorship and legitimizing the ownership of LSK • Safety and security concerns in using or disseminating LSK	Trust
• The knowledge acquired is relevant to local people's needs • Employability of LSK and information • Development of local capacity	Validation, application

effort is usually associated with crowdsourcing or externally decided joint activities (Xu and Nyerges, 2016). As information is contributed via Collaborative maps into a real world which is outside the control of the knowledge-holders, VGI can lend itself to further applications not linked to the original purpose for which the information was contributed. VGI is more focused on dispersal and does not focus on convergence, the 'full' Integration of problem identification, priority-setting, and design of the activities, as well as jointly carried out implementation. PGIS is based strongly on collaborative activities and convergence, – and thus potentially strengthening to the purpose of empowerment (McCall, 2003; McCall and Dunn, 2012)

Access and ownership

One of the most significant and valuable contributions of PGIS is that it elicits and validates local (including indigenous) spatial knowledge which is rarely available on Authoritative maps. PGIS practice has an advantage because it can take local knowledge and perceptions into account, such as, perceptive information on local use of space, including feelings towards place and related social cultural values (Feick and Roche, 2013). Processes of spatial (environmental) change can be observed, and in particular, how stakeholders deal with that change – thus, historical knowledge and understanding is vital, and is well-articulated within PGIS processes (McCall, 2003; McCall and Dunn, 2012). Much culturally- or socially sensitive information is, however, not readily available, it is present 'beneath the surface' and can only be elicited, if appropriate, through the slow build-up of mutual trust. By eliciting local knowledge and perceptions a community can piece together a knowledge base of otherwise scattered puzzle elements. Tacit spatial knowledge can emerge from these efforts to acquire a more complete picture of the local situation, its history and the perception local people have of place and space. Community identity is strengthened through the understanding that the collective community knowledge is as relevant for the community itself as for the outside world (Rambaldi, 2010).

Participatory practice revolves around a model which aims to be sensitive to exclusion and disempowerment (Chambers, 2006) by focusing on social values and principles in the elicitation of knowledge, dissemination of analysis, and observation by the participants. This way the practice is directed to the process of empowerment, leading to the creation of a strengthened identity and increased community cohesiveness with respect to shared concerns and aspirations, visualized in a sustainable equi-accessible knowledge base of the LSK. Therefore, some of the most important principles for generated geo-information and all related outputs of PGIS practice are, that the information is accessible, available, and open to all members of the community (knowledge holders) and selectively to the outside world, taking into account all the ethical considerations.

In VGI ownership is limited because those controlling the volunteered data *de facto* decide what to make public, when, how, and where, while the original contributors have no or only limited say on this. In PGIS, access takes into account the local aspects of the enabling environment for civil society to make information available. Local customs and power relations, however, also have repercussions on the control over data. Access to data means that information can be shared publicly to provide a broader view on local issues, and as such it provides a principle of application of LSK that promotes its integration into the planning processes. If participatory processes in PGIS neither increase the diffusion of selected knowledge nor make it accessible, there is no valorization possible and LSK can lose its credibility.

What *information should be shared*? Who should decide which data should be shared and which should be kept confidential? How can information be accessed? What

Table 2. The shared and competing perspectives of PGIS and VGI on the five principles

PEOPLE & SOCIETY ACHIEVE:	… DATA THROUGH:	… METHODS THROUGH:
ACCESS TO …	openness	inclusiveness and complexity
OWNERSHIP OF …	process and attribution	technology and training
TRUST IN …	accuracy and precision	feedback and usability
VALIDATION OF …	quality	application and results
APPLICATION OF …	use	purpose

restrictions on access or dissemination are in place? These access and ownership issues are all the subject of ethical principles. Because the concern with ethics is one of the prime areas of attention within PGIS, this has resulted in relevant guidelines (Flanagin and Metzger, 2008; Rambaldi *et al*., 2006a; Zook and Graham, 2007). Internal validation and acceptance is a strength in PGIS because the local context of collection and use enables the information to be checked by the participating actors. This is related to the development of social capital which further strengthens the legitimacy of Information and sets the foundation of informed decision-making and commitment.

Trust

In participatory approaches much depends on the capacity of people to start a bottom-up process and execute the tasks required in the process. The existing capacity determines to what extent training is required. It is also related to the strength and awareness of cultural identity. In the end, the local capacity within society will be a determinant of how much empowerment will be gained and to what extent institutional capacity is strengthened. Facilitating participants is a very challenging task but deep and sincere involvement is usually required to gain trust with a community. Trust is what facilitators need when they facilitate interaction between communities and outsiders. Interaction with government agents in particular adds another layer of complexity as this type of stakeholder has a set of objectives that often distinctly differs from that of other participants (Scott, 1998). Empowerment in this context means the abilities that result from a process (e.g. participatory mapping) that enable people to make choices and take actions on their own behalf with self-confidence, from a position of economic, political, and social strength, to change the status quo and influence change. Empowerment could also be seen as a process comprising a range of activities – from individual self-assertion to collective resistance, protest, and mobilization – that challenge existing power relations. Communities are empowered greatly when they can propose and defend their plans vis-à-vis government officials. For individuals and groups where class, caste, ethnicity, and gender determine their access to resources and power, their empowerment begins when they not only recognize the systemic forces that oppress them, but also act to change existing power relationships. Empowerment, therefore, is a process aimed at changing the nature and direction of systemic forces which marginalize women and other disadvantaged sectors in a given context (adapted from Veneklasen and Miller (2007)).

Accuracy is often simplistically attributed as being a strength of VGI because it is assumed that technology-literate people adopt this practice, and the practice uses more technologically advanced tools that have default settings for ensuring measurement and precision. In reality of course the people using social media online are not by definition technologically literate and average users have no background knowledge on locational accuracy. Trust in the accuracy of this data might be misplaced. But trust in accuracy in PGIS is also not straightforward. PGIS scores higher on representational accuracy albeit in a more qualitative representation. In PGIS, it is not usually a high priority to present spatial accuracy (or rather, locational *precision*) with a precise figure, but this should be (more than) compensated for by the elaborate contextual descriptions of location and features, and by the consensus of the participants that the information is a valid representation of their interpretation of the situation (representational accuracy) (McCall, 2006). Within PGIS, the insistence on spatial precision is balanced against the context and people's understanding. It is the responsible, engaged facilitation within PGIS that turns representational accuracy into a strength. In PGIS practice, validation is supported during the process of data generation by the peer group of knowledge holders – with their face value at stake, there is usually a social pressure for data input to be as accurate and as relevant as possible. Within VGI the locational precision is supported by technology and tool operation. Representational accuracy, however, is given less prominence, though sometimes there are procedures of validation by an external moderator – which may in itself introduce a new bias or error.

Validation and usability

In terms of validation, the significance of data in PGIS and VGI is primarily that spatial information has distinct characteristics pertaining to its locatability (Verplanke, 2013) and timing. Therefore, issues such as the appropriate degree of accuracy, precision, and quality of the location information are of importance. Data are a very broad term, and in this context it also covers the quantity of information available and the way it is made available. Much of the global discussion on data use in the Geoweb has to deal with the concept of Open Data. The openness of data is of strategic importance to both the practices of VGI and PGIS. Openness feeds back to the principle of access. These principles are clearly linked as there can be no validation without access.

The practice of PGIS is by design and practice a slow, careful, and reiterative process. In some cases, however, as in many post-disaster situations, the urgency of acquiring up-to-date information overrides the benefits of slowly acquired context and depth of local knowledge. For the purpose of disaster response this makes the information usable. More technology-driven methods of data collection allow for faster information collection from usually a larger, or less confined, geographic space. VGI has both speed and breadth – the purpose of VGI is to collate data relatively quickly from a large audience, and many developers have created applications for it in private enterprise. Applications use platforms like OSM as basis to collect VGI with a form of collaboration to create a high quality and easily accessible repository of topographic knowledge of events around the world (Flanagin and Metzger, 2008; Haklay, 2010; Hall *et al*., 2010; Neis *et al*., 2013). The most information-rich examples of OSM maps that are available,[6] however, have been constructed from facilitated participatory mapping exercises in which community building and local capacity development were part of the PGIS purpose.

In VGI, online communication is fast, relatively cheap, and crosses physical boundaries easily. Access to the Internet allows the inclusion of stakeholders who in a traditional participatory approach might be excluded, for

example in remote land areas or archipelagos where people cannot congregate easily. VGI moreover has shown that it can bind communities on a much larger scale and, particularly in disaster responses, tremendous impact has been achieved (Caquard, 2013; Meier, 2012; Wridt *et al*., 2014). In this context, we note that PGIS and VGI possess complementary strengths in communication which can be mutually beneficial for people and society.

Accessibility to information is less of a problem in the Geoweb although it is dependent on those controlling the platform. The problem is the abundance of data, which paradoxically restricts the application to construct context-relevant information (Elwood, 2008b, 2008c; Sui *et al*., 2013b; Vajjhala, 2005; Weiner *et al*., 2002). The relation between application and the principle of validation is also clear. An issue with the obstructive capacity of data abundance is the difficulty to validate data in the Geoweb. Not knowing which data to choose is probably as bad as not being able to access good data. This is exacerbated in the lack of agreed and unified standards for this available online data. On the one hand, unified standardization is required for the purposes of big data analysis. On the other hand, this diversity of sources and data constructs reflects the context richness of the data that ideally would be tracked and preserved, because it would disappear through standardization; one size usually does not fit all.

Methods and tools – although the individual tools adopted in PGIS – are generally straightforward, the implementation of a proper practice is a complex process because it is not limited to the act of inputting geo-coded data but goes far beyond. This complexity has direct implications on the time required for participatory action. In both VGI and PGIS relevant stakeholders can be reached, informed, and involved using many different methods and tools.

The PGIS approach is proactive in seeking out and recognizing the complexity of the local context as presented by communities and PGIS methods consequently adapt to this. Focus is given to a sequence of community mobilization workshops, legend development, data collection, mapping exercises, data management, and editing to arrive at an information synthesis and making further use of the resulting outputs. VGI on the other hand thrives on technical and remote technologies to input, store, and process data, detached from local context if the information is used at different scales. Due to the interaction and direct contact with the community and the need to provide feedback, the PGIS process takes much longer than VGI. It is an intrinsically time-demanding method dependent on external factors, particularly when governments and bureaucracies are involved and follow-up actions included.

Both VGI and PGIS in this context rely heavily on *communication*, but in VGI it is a focus on electronic communication and social media to reach a large audience or achieve a significant response as efficiently as possible, thus emphasizing communication as a 'means' to the 'ends' of many participants. In PGIS it is more communication 'towards an end'. Communication is a purpose by itself depending more on who is reached by the feedback in order to satisfy validation. Feedback is considered significant in VGI because it is a reciprocal part of open data ethics – it is more '*feedout*' than 'feedback'. Information shared for the purpose of public dissemination should be quickly accessible to the general public in cases where aggregated information is regurgitated not only to the original data contributors. As a result, the VGI process is speedy compared to PGIS and therefore more applicable to situations that require immediate intervention (Xu and Nyerges, 2016).

Community fieldwork implies deployment of technical and human resources, such as computer and data collection devices and travel and accommodation of facilitators and knowledge holders. As many communities have limited resources the choice of appropriate technology is an issue. Satellite or aerial imagery – usually imagery from Bing or Google Earth – is employed, and Internet and mobile telecoms are needed. Time is money, therefore in technology-rich environments the quick and relatively cheap – and easily replicable – approaches of VGI appeal to limited budgets and to limited time frames. PGIS takes intrinsically more time for a properly executed practice, leaving the cost of an exercise usually higher and difficult to forecast. On the other hand, PGIS methods allow the collection of a huge amount of diverse data sets from different participants on diverse topics, even if it takes a longer time. This diversity and the potential deviations mean it is essential to have a clearly formulated purpose and intensive facilitation to choose the right set of methods and tools.

Fortunately the *technology required for both approaches is becoming more ubiquitous,* simpler, and much cheaper. In both cases, the methods chosen for collecting information have consequences for the time spent on training. VGI usually depends on technology already used by individuals, and within PGIS the technology is usually adapted to the local capacity so as to require only limited training (Verplanke, 2004). The introduction of digital technology in participatory approaches has paradoxically both widened and closed the digital divide at the same time. Access to new technology has empowered people in developing countries, but some members of communities are still excluded from its use by poverty, access to networks, or other reasons. Basic cell phone use is rapidly becoming ubiquitous. According to water.org[7] more people have a mobile phone than a toilet (ITU, 2015; JMP, 2015) and the use of smartphones is penetrating rapidly in the global south. The digital divide which used to be between the community and the outside world is now shaping power relations within the community.

From the analysis of the five principles we can conclude what is common and what is distinguishable between PGIS and VGI. Table 2 shows this from the perspectives of two dimensions – the data being generated and used and the methods being applied. These are set against the principles that govern the social use of spatial information (LSK), originally in PGIS. It is clear that VGI and PGIS share many of these same principles, but the ways in which these principles are approached in the methods used and in the data handling are highly diverse. Each cell in Table 2 reveals paradoxes when comparing the characteristics. For example, the difference with regard to 'achieving validation of data through quality' is obvious for both PGIS and VGI; there is no right or wrong implied here. Whereas for VGI, validation is achieved largely through volume ('breadth'), for PGIS, it is achieved through context richness ('depth'). The objectives are similar in both cases and may or may not be achieved, but

they employ very distinct criteria of validity. PGIS and VGI clearly occupy different sides of the same coin.

REFLECTIONS ON THE FUTURE OF PGIS IN A VGI WORLD

In terms of the technological progress of communities, low-tech approaches as deployed in PGIS are likely to remain in the near term even while the use of VGI will increase. It will be some years before the 'last billion' are connected to the Internet (Negroponte, 2014) when, presumably, information *can* be shared from any place on the planet, and VGI *can* provide the quick and easy access to local spatial information. Still only about 10% of the connected population supply *any* information, and beyond this there is the 1% rule (1% of online contributors provide 90% of the content (McConnell and Huba, 2006; Nielsen, 2006)). OSM studies (Heipke, 2010; Neis *et al*., 2013; Stephens, 2013) show that the percentage of geo-information contributors is often much lower and is gender-biased. There are few indications this will change dramatically with the connection of that last billion people. What role is there for PGIS in such a connected society? We interrogate this in terms of the interconnected memes of potential technological futures, the signification of localness in 'LSK', and the ramifications of ethical tenets in PGIS and VGI.

Tech futures

How likely is PGIS to become technology-dominated because of the growing pervasiveness of tools such as in the Public Laboratory for Open Technology and Science?[8] The Public Lab toolbox currently has a broad range of non-technical methods suitable to places with limited resources, but in the near future the facilitators of participatory processes will become more time-pressured and more tech-savvy. A challenge then will be for PGIS facilitators (opting for higher-tech tools to speed up data collection and impress community leaders) to uphold the inclusiveness of the process when not all community members have access to the technology. In the next decade, standardized geo-information will be creatable from LSK. Application program interface development and interoperability of software is improving at such a rate to be able to include almost any type of information in a geo-database. The procedures, algorithms, and filters are hardly keeping pace with the spectacular rise in data availability. Certainly human processing – both social and individual – is not able to digest VGI-type big data streams, in as thorough and critical a manner as do the small groups of committed individuals working in participatory (PGIS) exercises. Will future software be better able to distil local context from an even larger data pool constructed from VGI?

Localness

Whereas global accessibility, currency, and on-demand-ness drive VGI, the distinguishing strengths of PGIS lie in its purposefulness, flexibility, focusable responsiveness, and localness. Will these keep PGIS in demand? Many of humanity's problems handled on a daily basis are about the local environment, be it the neighbourhood, town or village. Effective employment of LSK depends on the ability to connect the spatial data to local situations and practices. 'Location is everything' from an economic locatability perspective, but understanding *why* a feature exists in a place requires more than buffer analysis and proximity algorithms. 'Consumer profiling' based on online behaviour gathered from social media or mobile communications achieves this contextual understanding through sheer data volume. When a big data pool forms around a specific place, algorithms are able to model the local context and people's behaviour quite accurately. But currently most big data are urbanized and lack geographical coverage to extrapolate for remoter rural locations. While the city is no longer too diverse to be modelled with big data (e.g. Facebook profiling), the information about rural areas is too thinly spread, spatially, and demographically. As long as the appropriate, sufficient density of LSK cannot be supplied through VGI, PGIS practice will be needed to support local planning. The need for local context in information demands (slow) community engagement and good contact facilitation in eliciting LSK. This can be seen as a constraint for VGI because it reflects the high priority placed on the locatability and provenance of spatial information.

Ethics

Research into VGI usage (Goodchild, 2007a; Haklay, 2013c; Stephens, 2013) shows that factors supporting involvement in VGI are mainly human/socio-cultural, including time availability, access to technology, gender, social background, and self-confidence. With the unprecedented growth of data from sensors, including human sensors working through VGI, the main obstacles shaping the access and use of LSK are the ethics of participatory practices. Greater access to, and supply of, VGI will not improve the depth of knowledge or insight into local contexts, and not necessarily, even the breadth of inputs. It might instead bias LSK identification and flows towards the most active and connected members in the community. This is already a recognized issue with PGIS and other participatory processes which are open to 'elite capture' and manipulation. Another challenge to the PGIS 'slow, small, and intense' approach comes from the ubiquity of cheap sensors; there is a concern that only evidence backed up with instrumental information (e.g. bodycams providing images with GPS and time stamp) will be considered suitable by higher authority decision-makers. Ethical facilitation is needed to guide the ownership and confidentiality of LSK in a connected world where this knowledge and the metadata of its distribution are increasingly valued (only) for their direct marketing potential. PGIS offers rich, culturally sensitive and situated LSK, and it is essential to maintain the value of this knowledge against the challenge of big data (VGI) being treated as more 'scientific'.

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land use conflicts are at play. His research work is concentrating around PGIS/PPGIS (Participatory Mapping and GIS), VGI , and Citizen Science and the role this plays in the interaction between Policy-makers, Planners, and Citizens.

BIOGRAPHICAL NOTES

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Notes

1 Participatory cartography and Cybercartography spread during the late 1990s as part of a new pluralist eclecticism and creativity regarding participatory methodologies, while other developments and concepts towards the same goals, and often sharing methods and tools, are GIS/2, Neogeography, Qualitative GIS, and *cartografia social* (Chambers, 2006; Taylor, 2006).
2 www.iapad.org.
3 www.ppgis.net.
4 http://pgis-tk-en.cta.int/.
5 We define a community as one or more social groups occupying, accessing and using a geographically defined area and the resources found there.
6 www.ramanihuria.org.
7 Facts about water and sanitation: http://water.org/water-crisis/water-sanitation-facts/ on 30th July 2016.
8 https://publiclab.org/. Public Lab is a community where people can learn how to investigate environmental concerns using inexpensive DIY techniques.

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