CHAPTER 5

Motivating and Sustaining Participation in VGI

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Abstract

Volunteers are the key component in the collection of Volunteered Geographic Information (VGI), so what motivates their participation, what strategies work in recruitment and how sustainability of participation can be achieved are key questions that need to be answered to inform VGI system design and implementation. This chapter reviews studies that have examined these questions and presents the main motivational factors that drive volunteer participation, as determined from empirical research. Some best practices from broader citizen science applications are also presented that may have relevance for VGI initiatives. Finally, a set of case studies from our experiences are used to illustrate how volunteers have been motivated to collect VGI through mapping parties, gamification and working with schools.

Keywords

Motivation, recruitment, participation, incentives, retention

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How to cite this book chapter:

Fritz, S, See, L and Brovelli, M. 2017. Motivating and Sustaining Participation in VGI. In: Foody, G, See, L, Fritz, S, Mooney, P, Olteanu-Raimond, A-M, Fonte, C C and Antoniou, V. (eds.) *Mapping and the Citizen Sensor.* Pp. 93–117. London: Ubiquity Press. DOI: https://doi.org/10.5334/bbf.e.

1 Introduction

Volunteered Geographic Information (VGI; a term originally coined by Goodchild, 2007) has two main components, i.e. the volunteer and the spatial information. Much of the literature on VGI examines either the second component, i.e. the geographic data collected, often in relation to its quality (e.g. Flanagin and Metzger, 2008; Haklay, 2010; Foody et al., 2013; Antoniou and Skopeliti, 2015), or how VGI has been used in different contexts (e.g. Zook et al., 2010; Barrington et al., 2011; Mooney and Corcoran, 2011; Connors et al., 2012). Yet it is the volunteer that is actually at the heart of VGI and the reason why there are many successful examples of it (See et al., 2016; Chapter 2 by See et al., 2017), one in particular being OpenStreetMap (OSM). Thus issues such as attracting and retaining volunteers, and understanding participant motivations and what incentives can be used to attract volunteers, are as important as the spatial information that is collected, particularly in designing new VGI applications. The importance of the volunteer has been recognised in a recent paper by Gómez-Barrón et al. (2016), where the authors consider motivational factors for VGI as a critical part of the participation planning phase in the design of any VGI system.

There are biases observed in participation that are a general characteristic of any application of user-generated content. One of these is referred to as the 1% rule (or the 90:10:1 rule), and states that 90% of the content is provided by only 1% of the users (Nielsen, 2006). Of the remaining users, 9% provide content some of the time while 90% use the content but do not contribute anything. Although these numbers may change slightly from application to application, Nielsen (2006) argues that participation inequality cannot be eliminated. Such inequalities exist even in highly successful collaborative applications such as Wikipedia; for example, He (2012) found that active users have generated around 3.5% of the content of Wikipedia and that this general pattern has not changed over time, while Wikipedia's own statistics for 2016 show that less than 0.5% of content is currently provided by active users (Wikipedia, 2016). Despite the success of OSM, there are also biases in it: Neis and Zielstra (2014) reviewed participation inequality studies for OSM and found that 10% of those registered in 2008 contributed actively while a study in 2010 showed that only 3.5% of volunteers accounted for 98% of the content (Neis et al., 2011).

Given these highly skewed figures, the aim of this chapter is to present ways in which the number of active participants can be increased in order to change the shape of the participation inequality curve (Nielsen, 2006). The starting point is to understand the nature of VGI participants and what motivates their contributions. Through a review of existing studies of VGI motivation, the factors that are relevant to the development of strategies to improve recruitment and to increase the motivation and retention of volunteers in

VGI are outlined. This is followed by a synthesis of some of the best practices from VGI and citizen science experiences. Finally, case studies of VGI are used to highlight different ways in which recruitment, motivation and retention have been tackled.

2 What Motivates Volunteers in VGI?

2.1 The Nature of Volunteers

To help understand volunteer motivations with respect to VGI and how they might differ between participants, it is useful to first understand the nature of the volunteers that take part in VGI. This is usually done by classifying volunteers into types according to factors such as their knowledge of the subject or their degree of participation. Coleman et al. (2009) offer one typology of five types that are situated along a spectrum ranging from Neophytes at one end, who include individuals that have no background in the area but have the time and interest to contribute, to Expert Authorities at the other end, who have considerable experience in mapping technologies and product specifications; in between are Interested Amateurs, Expert Amateurs and Expert Professionals. However, Coleman et al. (2009) argue that this typology is too simplistic for VGI, offering some examples of where the typology breaks down: for example, a Neophyte may have little expertise in the subject area but their local knowledge of an area might mean they can provide valuable contributions that more experienced individuals from other types cannot.

Another typology, which was developed as part of a EuroSDR Workshop, is offered by Heipke (2010). It includes:

- map lovers and experts, who would be happy to provide accurate information when, for example, maps are wrong or information is missing;
- casual mappers such as those from the biking/hiking community;
- media mappers that respond to specific campaigns in bursts of activity such as during mapping parties or post-disaster events;
- passive mappers, e.g. people who provide traffic data via their mobile phone;
- open mappers, e.g. those contributing to initiatives such as OSM;
- and mappers that would be motivated by financial incentives, e.g. through using Amazon's Mechanical Turk.

This typology already provides some insights into possible motivational factors such as interest in the subject or material gain. The open mappers were identified as being the largest group after passive mappers and one that is increasing in size over time. Although their motivations are thought to be altruistic and related to building and using open datasets as a public good (Goodchild, 2007;

Heipke, 2010), the range of motivations driving the group of open mappers is much more complex and nuanced (Budhathoki and Haythornthwaite, 2012), as outlined in the next section.

2.2 Motivational Factors for VGI Participation

Coleman et al. (2009) offer different motivations for participation in VGI that are based on empirical research from Wikipedia and the open source community. These include: altruism; professional or personal interest; intellectual stimulation; protection or enhancement of a personal investment; social reward; enhanced personal reputation; participation providing an outlet for creative and independent self-expression; and pride of place. The idea of local knowledge is captured in pride of place and is relevant to applications such as OSM where mappers more frequently map or update their local areas than areas further afield unless they are driven by mapping parties or humanitarian causes. However, other motivating factors, such as providing an outlet for creative and independent self-expression, may be less relevant to the mapping of features in OSM.

A very comprehensive identification of motivational factors for VGI has been provided by Budhathoki and Haythornthwaite (2012), who reviewed the literature on motivations from three distinct yet relevant domains: volunteerism; leisure; and the generation of knowledge online. The factors were divided into intrinsic motivations, which come directly from the individual; and extrinsic motivations, which come from the outside – such as financial incentives or gaining a positive reputation based on the quality of one's contributions or from peers. The factors are listed in Table 1 and are summarised from the original list that was provided in Budhathoki (2010). They can provide the basis for further investigation into understanding the motivations of participants in any given VGI application.

Budhathoki and Haythornthwaite (2012) used the motivational factors listed in Table 1 as the basis of a survey undertaken with OSM volunteers in order to understand which motivations were the most important for these volunteers. They also differentiated between two types of volunteers, i.e. serious mappers and casual mappers, based on the number of contributions, the length of the contributions or the frequency of contributions. The results of the survey of the 444 OSM volunteers was that two extrinsic factors, i.e. community and the project goal, and the intrinsic factors of unique ethos and altruism were the most important. However, casual mappers ranked unique ethos as more important than serious mappers. Other important factors included the importance of local knowledge (instrumentality and self-efficacy), the freedom to provide information where one wanted, trust in the system and fun. Serious mappers also positively rated learning as a motivation, and in a much stronger manner than casual mappers did. Understanding these motivations can provide strategies

Table 1: Motivational factors for VGI (adapted from Budhathoki, 2010).

Type	Factor	Relation to VGI
Intrinsic	Unique ethos	Maps should be freely available as an open public good
	Learning	Gaining new knowledge about mapping and places
	Personal enrichment	Satisfaction in contributing
	Self-actualisation	Appreciation of talents and skills in mapping and of local knowledge
	Self-expression	Ability to express skills and knowledge of mapping and local areas
	Self-image	Gaining confidence in self through contributions
	Fun	Enjoying the process of contributing and seeing contributions online
	Recreation	Mapping outdoors
	Instrumentality	Providing critical inputs to a map that would otherwise be wrong or missing information
	Self-efficacy	Feeling of being effective through contributions
	Meeting own needs	Filling gaps in spatial information needed for different applications
	Freedom of expression	Ability to choose what information to provide and how
	Altruism	Contributions to a social cause
Extrinsic	Career	Contributions become part of a CV or lead to marketable skills
	Strengthening social relations	Creating strong bonds, e.g. through mapping parties or other socially constructed events
	Project goal	Alignment between goals of the project and those of the contributor
	Community	Being part of a bigger, sustaining community
	Identity	Becoming part of a group, e.g. advancing to an expert group
	Reputation	Recognition from the system or individuals in the community
	Monetary return	Being paid for contributions or making money from the data
	Reciprocity	The idea that if you contribute, others will contribute
	System trust	Will contribute if there is trust in the system
	Networking	Contributing forms networks locally and internationally
	Socio-political	Contributing meets socio-political motivations

to turn casual mappers into more serious ones, e.g. ways that may help build confidence and emphasising the importance and strengths of local knowledge.

In a separate study by Tiwari et al. (2010), a survey of motivations was undertaken with volunteers in OSM and the GISCorps. The top motivational factors in both groups were found to be altruism, personal satisfaction and gaining new geospatial knowledge. Other factors from Table 1 were also chosen, including strengthening of social relationships and fun. Participants were also asked what incentives they would like to receive in order to increase participation. Around one quarter replied that no incentives were needed, while another quarter wanted additional geospatial training. Composto et al. (2016) considered the need to provide something back to the volunteers as a motivator: they examined two VGI initiatives, and found that the one that had more visible impact, i.e. the one that resulted in broken streetlights being reported and fixed, was the one that has had longevity and sustained participation.

3 Best Practices in Volunteer Recruitment, Motivation and Retention

To attract volunteers to contribute to a VGI initiative, there are three key issues to consider:

- What methods should be used to recruit participants?
- How will the volunteers be motivated to contribute given all the different motivational factors that have been identified through empirical research?
- How can participation be maintained in the long term?

Past initiatives have already considered many of these issues, so this section presents different approaches that have been taken in practice. In fact much of the good practice in volunteer recruitment, motivation and retention stems from citizen science initiatives, i.e. the involvement of citizens in scientific research (Bonney et al., 2009). Broader than VGI, citizen science is widespread in areas such as biodiversity monitoring (Hyvoenen et al., 2013; Clavero and Revilla, 2014) and astronomy (Clery, 2011). Although citizen science is not specifically geographic in nature, there are lessons valuable to VGI that have been learned from numerous citizen science projects, some of which are presented below.

3.1 Recruitment

The guidance document written by Tweddle et al. (2012) provides different recruitment strategies for citizen science projects, where the starting point is to determine the target audience, e.g. whether the project is targeted to the general public, to map lovers, to school children, etc. The promotion and recruitment

process can then be tailored towards this group using a range of channels, including email, social media and the press. Experiences from Nature's Notebook, a citizen science project in the USA to collect phenology data (i.e. life stage data) from plants and animals, have shown the necessity to carefully identify target audiences and then to contact them with messages that are focused on explaining the personal benefits of contributing (Crimmins et al., in press). Nature's Notebook had little success when advertising its programme to the general public so instead targeted the members of another citizen science initiative with similarly rigorous protocols for data collection, and this has been a very successful method of recruitment for the project.

Holding a launch event or side event at existing conferences, workshops and festivals can be an effective way of informing potential volunteers about the aims of the project, about why their help is important and about what they will gain from the project. The project goal was ranked highly as a motivator for OSM (Budhathoki and Haythornthwaite, 2012), so communicating this aspect is clearly important for attracting volunteers.

Composto et al. (2016) examined the use of media campaigns to recruit volunteers in two VGI projects. They showed that this is a very effective way of bringing individuals to the website but that contributions decreased rapidly after the intervention, indicating that the use of the press has limited influence over time; thus other methods need to be used in combination with the media to continually stimulate recruitment.

OSM uses mapping parties as a way of recruiting new individuals and providing social contact with other OSM mappers while serving the purpose of increasing map coverage in a particular area (OSM, 2015). An interesting study by Hristova et al. (2013) showed that mapping parties did increase the amount of data collected during the event and did result in greater contributions after the event, generally for light to medium contributors in the short-term and heavy contributors in the longer-term. Mapping parties also retained more experienced users but failed to retain newcomers, possibly because it was more difficult for them to integrate socially in an already established community; thus more focus on integration of novices at these events is recommended, as well as more emphasis on easy-to-use tools and on the fun aspect. Similar events could be organised for other VGI initiatives, using the experience gained by the OSM community in running these events.

Another way of recruiting volunteers is to make explicit links to education, motivating students to take part in VGI initiatives. Some of the current partnerships between mapping agencies and schools are described by Olteanu-Raimond et al. (2017) in Chapter 13 and by Bol et al. (2016). A very successful example of citizen science linking to education is the GLOBE (Global Learning and Observations to Benefit the Environment) Program, which was initiated by Al Gore in 1995. The programme aims to increase environmental awareness by actively involving students in science, including through mapping. Similarly, integrating volunteer service directly into educational programmes is another

effective way to recruit and motivate individuals. There are many examples of this in the conservation arena, such as the Master Naturalist Programs or the Conservation Stewards Programs established in different US states (Van Den Berg et al., 2009) that provide individuals with a certification and require a certain number of volunteer hours, both as part of the certification and to keep the certification once it has been gained. This type of approach could be modified to include mapping as a volunteer activity and could encourage longer term engagement.

3.2 Motivation and Retention

Nielsen (2006) provides some general advice for improving participant equality (i.e. increasing the numbers that actively contribute) in social media and online communities that also has relevance for VGI. The first recommendation is to make it as simple as possible to contribute. This is already implemented in OSM in the sense that users are free to choose what features and in what location they contribute to OSM; furthermore, this was highlighted as one of the main motivators for contributing to OSM in the study by Budhathoki and Haythornthwaite (2012). Part of this recommendation also refers to the design of the site and the ease of use, which can clearly influence participation. The Zooniverse citizen science project has put a considerable amount of effort into the design of its projects and much can be learned from its approach (Prestopnik, n.d.). Zooniverse now offers a platform to host other citizen science projects, allowing new initiatives to benefit from its design principles while also having access to a large community of citizen scientists; new VGI initiatives should consider this option of working with Zooniverse.

Another relevant recommendation from Nielsen (2006) is to make participation part of another activity so that volunteers do not find the act of contributing a burden. Passive data collection from communities such as hikers and bikers or from geotagged repositories are some examples that could be harnessed within VGI applications; alternatively, gamification, or the addition of game mechanics to applications (Deterding, 2012), can lower the burden of participation while adding an element of fun, which is another key motivator for participation in VGI (Budhathoki and Haythornthwaite, 2012; Tiwari et al., 2010). An example of gamification is the Ingress augmented reality game by Google, where players gather spatial information that is then used to update Google Maps as a side task to the main goal of the game, which is to find portals (Carney, 2012). Gamification has also been shown to help motivate participation in a citizen science application such as Project Budburst, which developed the Biotracker app for gathering phenology data: use of technology such as smartphones, coupled with competitive elements such as badges and leaderboards, was shown to appeal to the younger 'Millennial' audience (Bowser et al., 2013). A number of game apps have been built for gathering

OSM data, e.g. AddressHunter, which is a role playing game that also involves adding addresses to the OSM database, and Kort Game, for adding new features to OSM (OSM, 2013).

Motivation is also clearly linked to maintaining participation in the longer term. The use of different incentives can be a powerful way to achieve this. Reputation and confidence building measures can be effective ways to motivate volunteers. The citizen science project iNaturalist, for example, awards different levels of expertise to volunteers, from novice to expert, which recognises their knowledge and degree of contribution. Each observation is also given a stamp of quality, which can build confidence in the contributors, particularly when the observations are considered to be of research grade quality. This follows the advice of Nielsen (2006) to promote high-quality contributions. In Wikipedia, contributors can take on roles with increasing responsibilities within the community, including arbitration and administration (Bryant et al., 2005), which is also a reputation and confidence building measure.

Another incentive is related to the impact of contributions. In OSM, contributors can quickly see their changes on the map, which acts as an important form of visual feedback. Correcting areas and filling in missing information can provide a form of satisfaction that acts as a motivating factor; thus the design of VGI initiatives should include good visual displays (Budhathoki and Haythornthwaite, 2012). Experiences from Nature's Notebook with regards to retention have highlighted the need to provide frequent communication to volunteers, acknowledge the value of their contributions on a regular basis and show that their contributions are being used (Crimmins et al., in press). Nature's Notebook relies heavily on digital communication of various forms, ensuring that the content of the communication is information-rich, including summaries of publications that have used the data, which are communicated in simple language. Finally, the project provides different opportunities for volunteers to participate, which are based on problem solving approaches to keep volunteers engaged over time.

Rewarding volunteers in other ways can also be an effective approach for encouraging and supporting participation. A reward system can be implemented in several different ways; for example, Estes et al. (2016) have used Amazon's Mechanical Turk to do cropland mapping through digitisation of fields for part of South Africa using performance-based micro-payments. Maps with 91% accuracy were produced, and the authors calculated that a detailed cropland map for all of Africa could be created with 2 to 3 million USD and the crowd. Several campaigns have been run using the Geo-Wiki tool for visualisation, validation and crowdsourcing of land cover (Fritz et al., 2012; See et al., 2015), where incentives have ranged from Amazon vouchers to co-authorship on a scientific publication. However, Nielsen (2006) makes the point that participants should not be over-rewarded as this might encourage the most active volunteers to dominate and thereby disincentivise others from contributing.

4 Case Studies

This section describes a set of case studies based on our experiences to illustrate different ways in which volunteers have been motivated to contribute VGI to different applications.

4.1 Mapping Parties

As mentioned previously, mapping parties are intended to map a specific area over a short period of time while introducing newcomers to VGI. This case study describes experiences with two mapping parties that were organised as social events for delegates at the recent FOSS4G (Free and Open Source Software for Geomatics) Europe conference[1], held in July 2015 at the Politecnico di Milano, Como Campus (Figure 1). The first mapping party was a traditional OSM one, while the second focused on indoor mapping. To recruit participants, the mapping party organisers presented their ideas and calls for participation during the opening session of the conference. Information about the events was also communicated over social media, via the official conference website and via OSM in order to attract and sustain participation throughout the conference.

The OSM mapping party was designed and set up by a small number of active OSM contributors who were attending the conference (Mooney et al., 2015); their goal was to collect Points of Interest (POIs) that were missing in Como city. Around 40 participants (roughly 10% of the conference) attended

Fig. 1: Photographs from the mapping parties at the FOSS4G 2015 Europe conference.

and were taught how to collect the data using field papers, which are a specific service to print out OSM maps for annotation in the field. The POIs were then mapped in around 2.5 hours. On the second day of the conference, there was a data upload session that showed the volunteers how to insert their data into the OSM database; this session was too short, so not all data were entered into the database during the event. However, the POIs were monitored after the event and showed an increased mapping over the summer, which is attributed largely to this particular mapping party as local OSM activity in the city is not large. Thus, the mapping party motivated interested individuals by providing them with training and a social, community-based atmosphere in which to collect and upload the data. Given the increase in POIs over the summer, this may have led to some individuals continuing to contribute to OSM.

The second mapping party was focused on indoor mapping, which is something new compared to the more traditional OSM outdoor mapping parties. The main purpose of the event was to raise awareness of the scientific, technical and practical challenges associated with indoor mapping. The IndoorGML standard was used to collect the navigation pathways through rooms and in connecting spaces. The indoor mapping-party received attention from the local television and more than 30 participants took part in the event. Almost all of the mappers generated data, but only some of them contributed to the result, mainly due to technical issues and shortage of time. The overall result was a single, merged navigable graph of two floors of the University building (Figure 2).

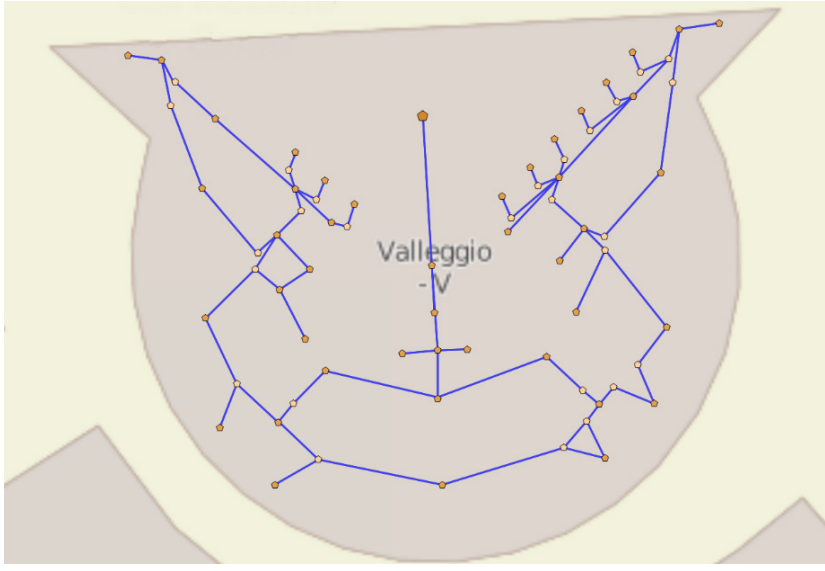


Fig. 2: Screenshot of the merged navigation graph from the participants of the Indoor Mapping Party held at the FOSS4G 2015 Europe Conference.

The indoor mapping party produced positive results as novices learned about the concepts, strategies, problems and tools for mapping indoor spaces while the researchers and developers received feedback on the techniques and tools used during the event.

Overall, the mapping parties were inclusive and friendly experiences and are recommended as side events at future FOSS4G conferences. At both parties, the incentive was the social aspect, i.e. spending time together, learning something new, making a useful social contribution and having fun. An additional incentive was offered, i.e. prizes were given to the top three contributors at the closing ceremony of each event. Thus both mapping parties appealed to a range of intrinsic and extrinsic motivations. Both events were successful in attracting participants, and the OSM mapping party may have led to the recruitment of new participants in OSM that continued to contribute to OSM beyond the actual event. The indoor mapping party was more focused on the learning element as motivator. The main disadvantage associated with both mapping parties was time, e.g. there was insufficient time to complete the uploading of POIs from the paper-based surveys, and this had to be completed by the mapping party staff after the event.

4.2 Gamification

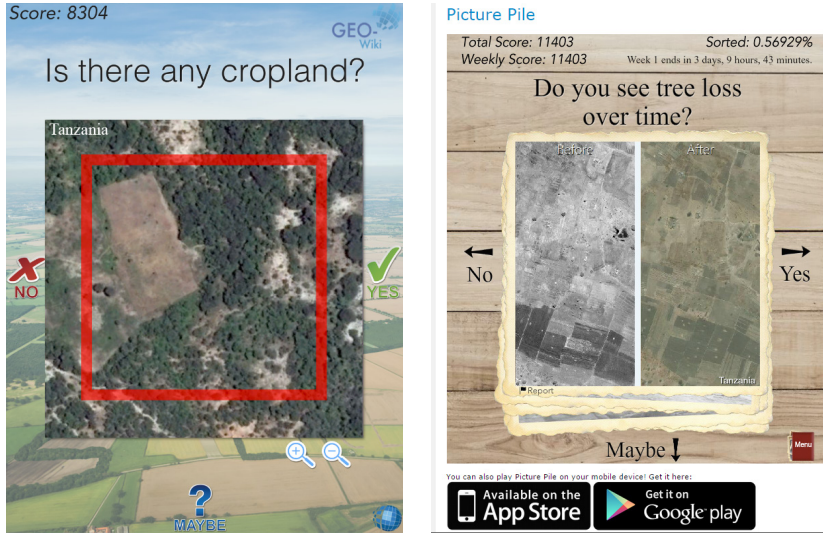
4.2.1 Cropland Capture and Picture Pile

As mentioned previously, a number of Geo-Wiki crowdsourcing campaigns have been organised in the past to collect data on land cover (See et al., 2015). Although these campaigns were successful, we wanted to investigate gamification as a way to attract larger numbers of participants and thereby collect more data to improve global land cover maps. Cropland Capture was the first serious game developed by the Geo-Wiki team as a simplified version of the previous applications. The interface was designed to be mobile as well as desktop-based, running on browsers, smartphones and tablets (for both iOS and Android operating systems). The game was launched in mid-November 2013 and ran until the beginning of May 2014. As part of the game the players were presented with a red rectangle encircling satellite imagery or photographs, as shown in Figure 3a. Players were then asked to determine if there was any evidence of cropland in the image contained within the rectangle. The interface for mobile devices was designed such that players swiped the images into three possible categories: Yes, No or Maybe. For each correct answer, the player received a single point, while one point was deducted for incorrect answers. Correctness was determined through majority agreement, although there was an option to challenge the crowd if the player felt that they had been incorrectly penalised.

Recruitment was through the Geo-Wiki newsletter, a press release, social media and word of mouth. The game received media coverage at two different

occasions during the time it was open, which resulted in a spike in participation; however, participation decreased soon afterwards, similarly to that observed by Composto et al. (2016). The game had a leader board, which was reset each week, and the top three players in terms of the total number of classifications each week were added to a prize draw that took place at the end of the game's six-month period; thus, prizes were one incentive used to motivate the players. The idea of helping science was also a strong message in the game and was meant as an additional motivating factor. In total, more than 4.5 million observations were obtained from more than 3,000 players. A survey of players was undertaken near the end of the game, which revealed that helping science, the competitive element and the beauty of the satellite images were motivating factors for participation.

Picture Pile is the direct successor to Cropland Capture, so the game mechanics are similar. However, Picture Pile was made more generic: the basic concept is that players sort or classify 'piles of pictures', where each pile represents a different task or theme including different land cover types. The idea behind having different tasks in the game is that there will be more variety for the players, which may help to retain them for longer. Another major difference between Picture Pile and Cropland Capture is the added functionality for change detection: in Picture Pile, players are presented with pairs of images from different time periods and asked to look for evidence of change over time, e.g. deforestation (see Figure 3b). Players can also view a map of their contributions and the contributions of others in real-time. Another added feature is the use of more reference data, where the images have been marked up to explain correct



(a) (b)

Fig. 3: (a) Cropland Capture and (b) Picture Pile.

answers. This is used as both feedback and training for the players, which was also intended to provide motivation to participate. Each pile has its own leader board and a chat channel, which makes it very easy for the players and the organisers to communicate with each other as the game progresses.

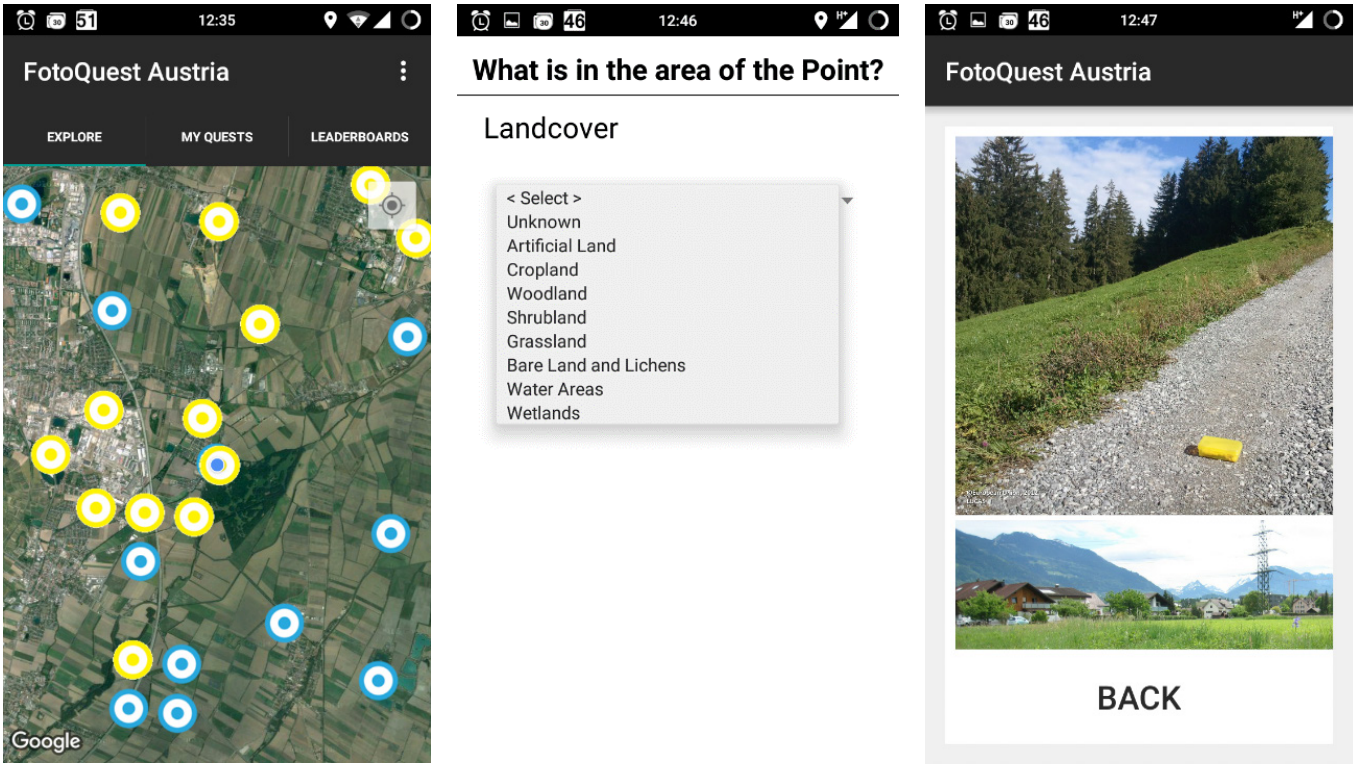
Recruitment strategies were similar to Cropland Capture. The game was launched in November 2015. Almost 4 million pairs of pictures were classified. Other piles will be implemented in the future.

4.2.2 FotoQuest Austria

The second game, called FotoQuest Austria, is quite different in nature from Cropland Capture and Picture Pile: instead of asking the crowd to classify imagery online, the FotoQuest Austria app is focused on getting players to go outside and document the landscape. The game is similar to geocaching except that players do not search for a physical cache. Instead, points are awarded for documenting specific locations shown on the mobile device (see Figure 4). Players are asked to take photographs in four cardinal directions and then classify the land cover and land use based on categories in a classification system developed for the EU LUCAS (Land Use and Cover Area frame Survey) survey. This EU systematic sample is collected by professional surveyors every three years in EU countries for change detection purposes, among other reasons, and therefore provides authoritative data for comparison with the crowd's results. The locations of the LUCAS points for Austria were added to the FotoQuest Austria app along with other locations to ensure sufficient numbers of points for the players to visit.

The app was specifically designed to adhere as closely as possible to the LUCAS protocol, and so only allows photographs to be taken when the user is within a certain distance of the location, the mobile device is not tilted, the compass indicates the correct direction and the horizon matches a line indicated on the app. This was to ensure that the data collected by the players would be of the highest quality possible, but also to make data collection as easy as possible. The app was launched in July 2015 and ran over a three-month period.

Recruitment was via a newsletter, social media and a more traditional media campaign, i.e. a press release was issued and interviews were held with the main television and radio stations in Austria. The app was featured as 'app of the week' in the technology section of the website of Austria's main TV channel and was featured on an afternoon programme which demonstrated how the app worked. In addition to the fun provided by the competitive elements of the game, additional motivators were interacting with the landscape and incentives such as smartphones and tablets, which were awarded at the end of the game. Overall, 2300 quests were undertaken. A second version, which was developed using feedback received from the game, will be launched in 2017.



(a) (b) (c)

Fig. 4: (a) Quests in FotoQuest Austria (b) Classifying land cover (c) Geotagged photograph of the point.

4.2.3 The Land Cover Validation Game

The Land Cover Validation Game is a serious game for validating land cover (Brovelli et al., 2015). Figure 5 shows the user interface, in which players see a reference image of the land under investigation. The task is to classify the 30 m pixel shown within a blue box on the interface. Depending on the answer, the players get points, badges and a ranking on a global leaderboard. The game was introduced at the FOSS4G 2015 Europe Conference and participants played the game during the week of the conference. There were 68 participants engaged for a total of more than 20 hours of gameplay. Overall 1600 pixels were validated. A video[2] summarising the Land Cover Validation Game results was presented at the ESA Earth Observation Open Science event in October 2015. Prizes were offered as additional incentives at the end of the FOSS4G 2015 Europe Conference. The results showed that involving users in a crowdsourcing validation campaign with a gaming incentive can be an effective way to collect data and to resolve disagreements between two conflicting land cover classifications.

4.3 Embedding VGI in Education

4.3.1 Work Training in High Schools

Work training in schools, which is strongly supported by recent school reforms in Italy, combines classroom studies with training in the skills required to

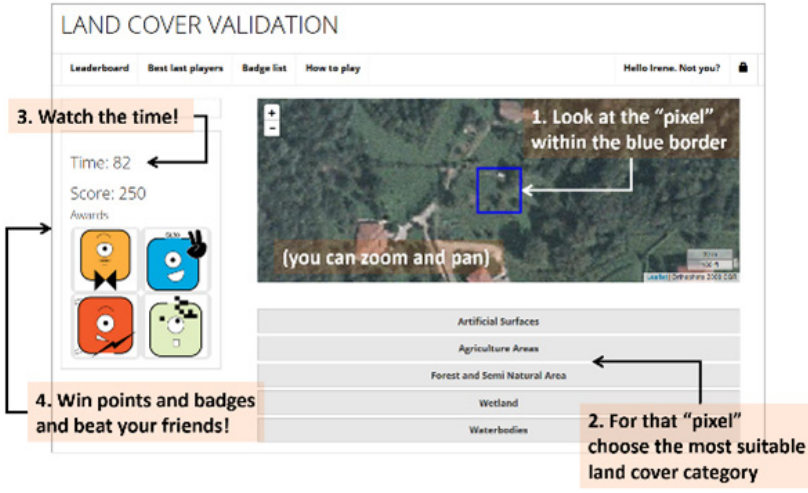


Fig. 5: Land Cover Validation Game interface, with a pixel (blue square box) to be classified (http://bit.ly/foss4game).

make a successful transition from high school to employment, and hence is aimed at students aged 15 and above. Every year since 2013, the Politecnico di Milano has organised a week-long internship for 15–20 students; the incentives for the students to participate are credits towards their course, learning new technologies and the collection of useful VGI. The collection of data is preceded by a MOOC[3] called M'appare il mondo (which is a word play in Italian, as it means 'the world appears to me', but becomes 'mapping the world' if the apostrophe is removed) and instructions on how to create a mobile app to collect the data. This latter step has been done using two applications. The first is the Open Data Kit (ODK), which is a simple, free, open tool for the Android operating system; it is very easy to implement forms in ODK for managing the collection of data, i.e. attributes, photos, videos, audio of the selected features, etc. The second was Geopaparazzi[4], which is another free, user-friendly, open source tool.

During one work training session, the students developed an app to collect data on building amenities, e.g. the presence of ramps and stairs (Figure 6). The results from the data collection exercise were then displayed on a website[5] so that the students could view their contributions online directly (Figure 7), including those features that do not conform to Italian law, simultaneously raising an issue of importance for the public. During another session, students built an app to capture local biodiversity (Figure 8).

In addition to gaining credits, the students learn how to map the world around them and collect data that are of public interest, which are displayed through a WebGIS interface. In the future there are plans to make connections between the data needs of government municipalities and of civil protection agencies and the projects undertaken by the students, which should provide additional motivation to become involved in VGI projects.

4.3.2 Humanitarian MiniMapathons in Elementary Schools

Mapathons, also known as 'armchair' mapping, are events where people come together to do mapping online. Examples are events related to natural disasters and political crises, which are supported and organised by HOT (Humanitarian OSM Team), or events devoted to mapping places that are not yet well mapped or where the most vulnerable people live, e.g. the Missing Maps project. Two MiniMapathons aimed at 10-year-old children from elementary schools were organised by the Geomatics and Earth Observation (GEO) and Hypermedia Open Center (HOC) Labs of the Politecnico di Milano with the support of HOT and Missing Maps. The first event, in which 36 children took part, was organised in Como. The second event, in Milan, saw 212 children participate. Online registration for the second event closed just a few hours after opening, having reached the maximum number of students that could be accommodated in the computer rooms of the Politecnico.

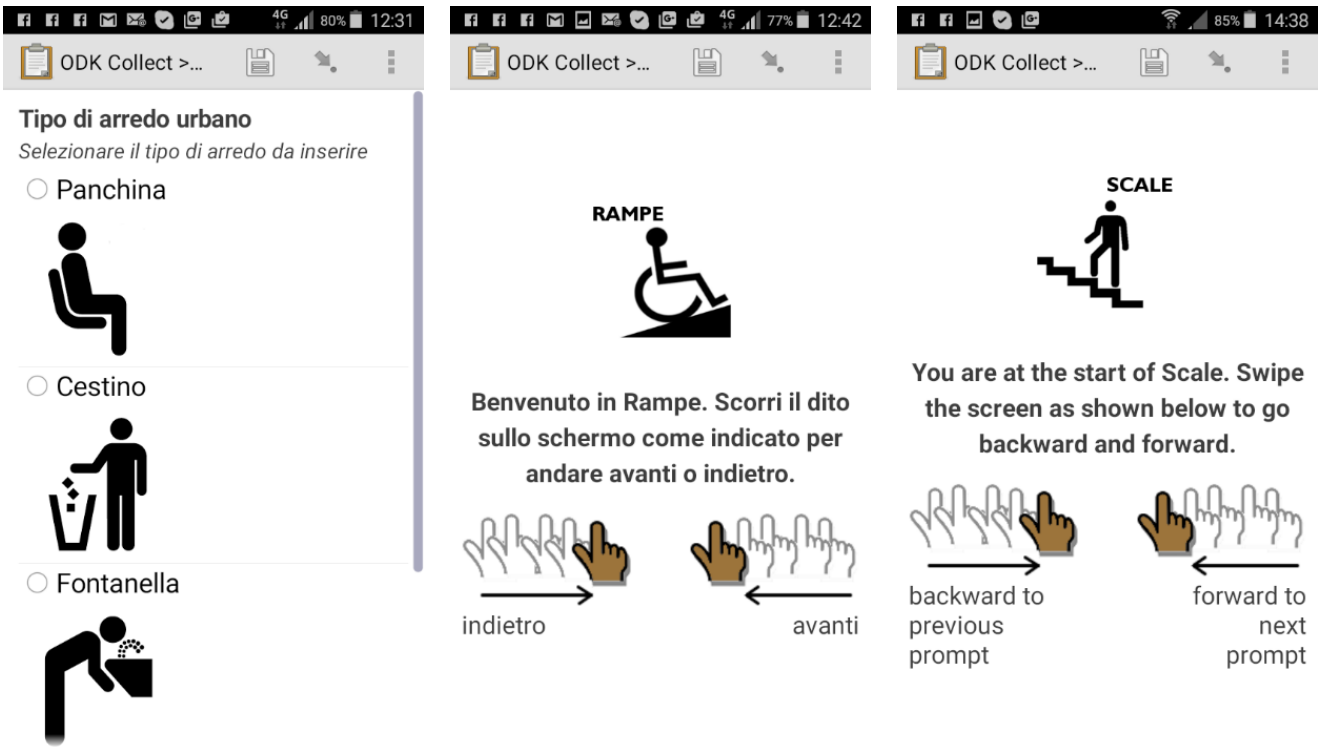


Fig. 6: Example of screenshots from ODK to collect information on building amenities.

Fig. 7: The WebGIS interface showing building amenities in the city.

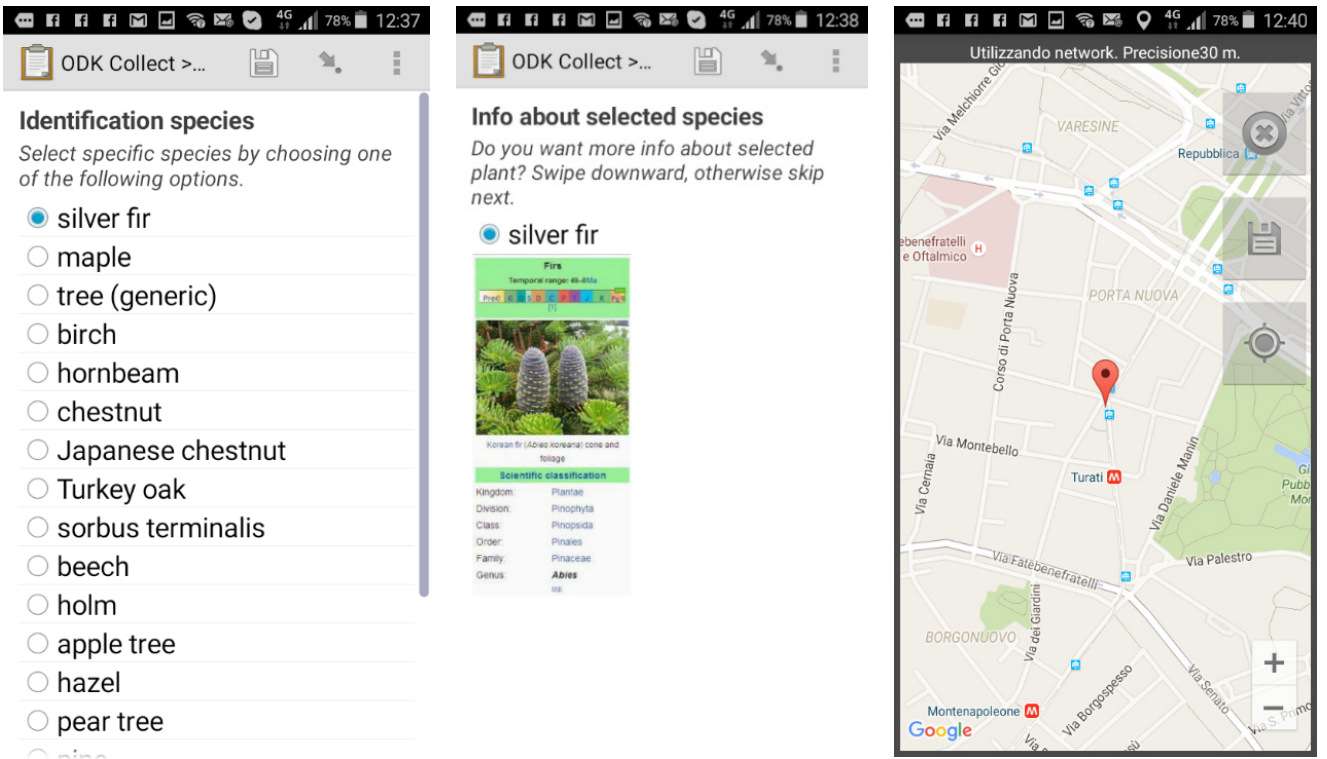


Fig. 8: Examples of screenshots from the ODK forms developed for the biodiversity app (selection of the species, information about the selected species, geolocation).

The purpose of the MiniMapathons was to map buildings in the northernmost part of Swaziland in a project related to malaria elimination. In total 5000 buildings were mapped and the quality was similar to that of adult volunteers' in terms of the shapes digitised and the ability to recognise buildings on the imagery. The teachers of the elementary schools and the children were highly motivated as they saw this as a tangible way of helping people in Swaziland, but at the same time the children acquired competencies in mapping, geometry and informatics. The second incentive for participation was a purely symbolic one, i.e. certificates of participation and baseball caps from Politecnico di Milano. The two events were highly successful and appear to be a good way to transform children into neogeographers and humanitarians and to lead them to contribute VGI for a good cause.

5 Conclusions

The success of VGI is clearly down to the participation of volunteers and of the community that supports the activities related to spatial data collection and mapping. Hence volunteer recruitment, motivation and longer-term retention are key issues when designing and implementing a VGI initiative. A number of studies have looked at typologies for characterising the nature of volunteers and the motivational factors that drive participation. These factors, which were compiled by Budhathoki and Haythornthwaite (2012), represent a comprehensive list of motivations that can be used to further investigate reasons for participation in current VGI initiatives. They can also be used in the design of new applications, drawing upon the findings of Budhathoki and Haythornthwaite (2012) for OSM volunteers. Recommendations and best practice in recruitment, motivation and retention were then provided, drawing upon experiences in the broader field of citizen science. The case studies presented here served to illustrate how recruitment and motivation are considered in a range of different VGI initiatives.

Acknowledgements

This work was supported by the EU FP7-funded ERC grant Crowdland (No. 617754).

Notes

[1] http://europe.foss4g.org/2015
[2] https://www.youtube.com/watch?v=Q0ru1hhDM9Q
[3] https://www.youtube.com/watch?v=1nnfQgMQq4Y
[4] http://geopaparazzi.github.io/geopaparazzi/
[5] http://geomobile.como.polimi.it/Barriere/barriere.html

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