# A characterization of Volunteered Geographic Information

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## ABSTRACT

This paper characterizes the Volunteered Geographic Information (VGI) phenomenon and explores comprehensively its relation with SDI. The SDI component view is used as common framework for describing the main characteristics of VGI and as framework for exploring VGI and SDI relation. Openstreetmap, Wikiloc, 360.org, Wikimapia and Eye on earth are evaluated to indentify general characteristics of VGI initiatives and discuss differences and similarities between VGI and SDI. Despite differences between VGI and SDI similarities can be identified. Characteristics of all SDI components have been identified in the VGI case studies.

## 1. INTRODUCTION

Traditionally geographic data are captured by well trained specialists using state of the art technology. Land survey, photogrammety, remote sensing, sensor networks, are examples of methods used to capture data about social and environmental phenomena above, on, or under the Earth's surface. Recent developments like Web 2.0 platforms, GPS enabled cell phones and sensor technology make capturing of geographic data no longer the exclusive domain of well trained professionals, but opens new possibilities for involvement of citizens (Craglia, 2008). Every human is able to capture geographic information about social and environmental phenomena, perhaps facilitated by simple aids as GPS and other means to take measurements of environmental variables. Internet provides the means to upload those observations and share it with other users (Goodchild, 2007b).

Interactive platforms such as Google Maps or Microsoft's Bing maps make it possible for nearly anyone with an Internet connection to disseminate their own maps and geographic information (Elwood, 2008; Turner, 2007). They have sparked an exponential growth in user-generated geographically referenced content (Rinner, 2008; Hecht, 2010). Many examples already exist of platforms where geographic information can be published and made available by and for user communities. Wikimapia [1] and Openstreetmap [2] are examples of such platforms. Citizens actively capture own thematic geographic referenced observation and make it available on the web. Information about place of interests, bird species, GPS tracking of bike and hiking routes are examples of this user generated content. Usually the content consists of description of places or phenomena or information collected by technical devices, e.g. GPS tracking. This ways of data capturing require that the user actively acts to capture data and upload it on the Web to share it with others.

The term "Volunteered Geographic Information" (VGI) was coined by Goodchild (2007b) to describe user generated geographic information. According to Goodchild (2007b) VGI combines

elements from: Web 2.0, collective intelligence and neogeography. Other authors also refer to Web 2.0 developments and citizens gathering and disseminating their observations and geographic knowledge to describe volunteered geographic information (see e.g. Craglia, 2007; Elwood, 2008; Flanagin, 2008; Sui, 2008; Coleman, 2009). New research challenges have been identified to explore the technological, social, and political opportunities, limitations, and implications of VGI (see e.g. Kuhn, 2007; Elwood, 2008; Sui, 2008).

Several authors have begun to explore the convergence between VGI and Spatial Data Infrastructures (SDIs). Goodchild (2007a) argues that VGI fits in the model of an SDI, facilitating exchange of geographic information between individuals in a community. Budhathoki (2008) argues that SDI conceptual foundation will still be valid and apparatuses of SDI´s, such as metadata, standards, interoperability, policy, and organization will be useful in a VGI context as well, but that assumptions of SDI´s need to be reconceptualised to enable SDIs to accommodate VGI. In the reconceptualised SDI non-professional users are allowed to produce and share GI, and participate actively in the production process, creating VGI. Furthermore when SDI and VGI converge SDIs will have a broader audience, more real time data need to be included and validation and quality assurance process will be different (Craglia, 2007). Harmonization of SDI and VGI can, in fact, create a very rich and fertile middle ground between these two (Budhathoki, 2008). Suggested is to explore the utility of long-standing experiences with SDIs for understanding VGI issues (Elwood, 2008). However, there has been little empirical investigation analyzing the VGI phenomenon and to explore VGI and SDI convergence.

The objective of this paper is to characterize the VGI phenomenon and explore comprehensively its relation with SDI. Our method, described in section 2, is based on using the SDI component view as common framework for describing the main characteristics of VGI and as framework for exploring VGI and SDI relation. In section 3 the results of the characterization of five VGI case studies are presented. In section 4 identified VGI general characteristics are discussed and VGI and SDI characteristics are compared.

## 2. METHOD

### 2.1 Framework of comparison

To systematically compare VGI and SDI a comprehensive framework for comparison is needed. Assuming that VGI fits in the conceptual model of an SDI, as argued by Goodchild (2007a) and others, we use the conceptual model of Rajabifard, et al (2002). This model identifies five core components of an SDI 1) policy; 2) access networks; 3) technical standards; 4) data and 5) people (including partnerships) interacting with each other (see figure 1). Those core components can be used to comprehensively frame and describe SDI characteristics.

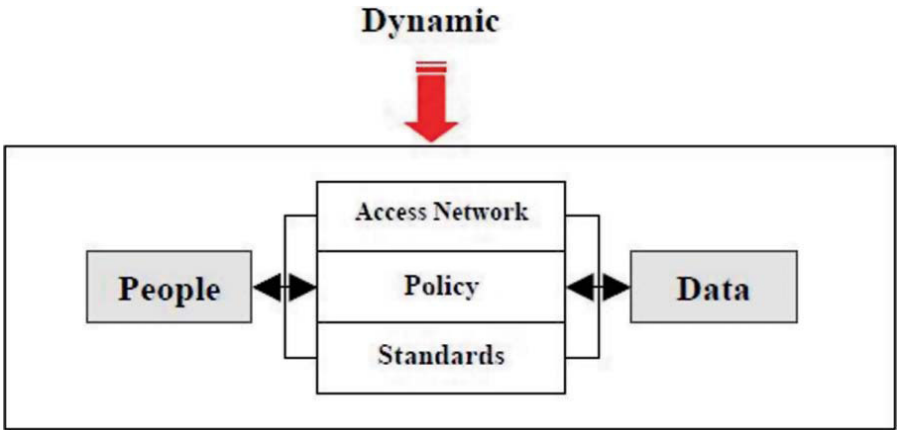


***Figure 1:*** Nature and relation between SDI components (Rajabifard, et al, 2002).

The core components have previously been used by Crompvoets (2004) as comprehensive frame to describe the development of national clearinghouses. For each component a set of characteristics has been described which seem to be suitable to describe emerging phenomena in a SDI framework Furthermore both clearinghouses and VGI websites are web portals facilitating spatial data discovery, access and services. Based on the Crompvoets (2004) methodology and an additional review of VGI literature describing general characteristics of VGI (e.g. Goodchild, 2007b; Budhathoki, 2008; Elwood, 2008) for each SDI component a set of characteristics has been defined to characterize VGI.

Based on the results of an analysis of five VGI case studies general characteristics of VGI have been described using the SDI component view. Subsequently those characteristics are compared with SDI characteristics using the SDI components as comprehensive frame.

## 2.2 Description of the SDI components

To characterize clearinghouses Crompvoets (2004) selected twelve characteristics on basis of the criteria: ease of measurement by web survey, objective character, and clear presentation of the five components. We use the same selection criteria and the general description of the different SDI components of Crompvoets (2004) as basis for our selection. However, the clearinghouse characteristics have been adapted and selected VGI characteristics are more focused on the web 2.0 and VGI context, identified from our literature review. In our analysis thirteen characteristics are used to describe VGI with presentation of all SDI components. In table 1 the thirteen characteristics are presented, described and grouped by the five SDI components.

| Nr. | Name | Description | SDI component |
|---|---|---|---|
| 1 | User registration | Registration to contribute required | Policy |
| 2 | Application Programming Interface | E.g. Google Maps, Bing Maps or others | Access Network |
| 3 | Available services | Availability of download and upload service | Access Network |
| 4 | Standard described | Data standards described | Standards |
| 5 | Number of user uploads | Total number of contributions uploaded | Data |
| 6 | Data types | Point, Line, Polygon | Data |
| 7 | Most recently produced dataset | Last update/contribution to the website | Data |
| 8 | Thematic focus | Focus or specific theme user community | Data |
| 9 | Geographic extent | e.g. Worldwide, Europe, national, local | Data |
| 10 | VGI and official data combined | Website offers as well VGI as official data | Data |
| 11 | Registered users | Number of users registered on the website | People |
| 12 | Website visitors per day | Number of unique visitors per day | People |
| 13 | Web references | Number of unique sites linking to the site | People |

***Table 1:*** The thirteen characteristics to describe VGI grouped by SDI component**.**

### 2.3 Case studies and data collection

Our analysis is based on a characterization of five VGI case studies. We assume that those five case studies are sufficient to explore general VGI characteristics. The case studies selected are: 1)

Openstreetmap [2], 2) 360.org [3], 3) Wikiloc [4], 4) Eye on earth [5], and 5) Wikimapia [1]. Those five case studies are all VGI platform with large and active communities and an international focus, but with a slightly different thematic focus. Other platforms were considered, such as Birdwatch UK [6], Globoamazonia [7] and Natuurkalender [8], but had limitations in e.g. languages, accessibility or didn't have much content.

Most information to describe those websites in terms of VGI characterization was available. Therefore they provide a good basis for an explorative characterization. In order to collect the data the website was visited, including the sections for uploading data, user guides and discussion boards and news. The information has been collected in January 2010.

Additional information that couldn't be directly retrieved from the case study website about the number website visits per day was estimated using an average of the web tools statbrain [9] and webinfostats [10]. The number of web references was estimated using alexa [11]. This information was collected 25 and 26 of January 2010.

## 3. RESULTS OF THE CHARACTERIZATION OF FIVE VGI CASE STUDIES

Table 2 gives an overview of the analysis of the five case studies, measuring thirteen characteristics. For each SDI component (policy, access, network, standards, data and people) the results are further analyzed and discussed.

| | Openstreet-map | Wikiloc | 360.org | Wikimapia | Eye on earth |
|---|---|---|---|---|---|
| **Policy** | | | | | |
| **User registra-tion (1)** | Yes | Yes | Partly | Partly | No |
| **Access network** | | | | | |
| **Application Programming Interface (2)** | Own OSM API | Google Maps | Google Maps | Google Maps | Bing maps |
| **Available services (3)** | Download and Upload | Download and Upload | Download and Upload | Upload | Upload |
| **Standards** | | | | | |
| **Standards described (4)** | Map features and values | Standard format | Standard data form | Map features | Standard data form |

| | | | | | |
|---|---|---|---|---|---|
| **Data** | | | | | |
| **Number of user uploads (5)** | 1.949.859.482 | 136.635 | *300-500 per day* | 11.748.660 | 64.000 (estimated) |
| **Data types (6)** | Points, lines, polygons | Points and lines | Points | Points, lines, polygons | Points |
| **Most recently produced data set (7)** | Less than one hour | Less than one hour | Less than one hour | Less than one hour | Not available |
| **Thematic focus (8)** | General | Outdoor activities | Weather | General | Environment |
| **Geographic extent (9)** | Worldwide | Worldwide | Worldwide | Worldwide | Europe |
| **VGI and official data combined (10)** | Yes | No | Yes | No | Yes |
| **People** | | | | | |
| **Registered users (11)** | 208.553 | 108607 | 7500 (estimated) | 650.000 | Not available |
| **Website visitors per day (12)** | 39.495 | 7.954 | 1.449 | 1.068.210 | 101 |
| **Web references (13)** | 4118 | 345 | 39 | 6961 | 64 |

***Table 2*:** Characterization of five VGI case studies using thirteen characteristics grouped by SDI component.

### 3.1 Policy

To contribute to Wikiloc and Openstreetmap user registration is required. Registration gives more rights to contributors of Wikimapia and 360.org, but also without registration it is possible to contribute to those two platforms. Eye on earth has no registration system and is open to everybody to contribute. Wikiloc, Wikimapia and Openstreetmap give the right to registered users to give direct

comments on contributions of others and the possibility to contact them, e.g. in case of incorrect information. Wikimapia and Openstreetmap also give the right to registered users to edit contributions of others.

### 3.2 Access network

All five platforms use a map viewer to present the geographic content. Those map viewers can be used to search for location and pan and zoom on the map. Search results are immediately displayed on the map. Wikiloc, Wikimapia and 360.org are based on the Google Maps API, Eye on earth on the Microsoft Bing maps API. The Openstreetmap community has developed its own API based on opensource software.

The Openstreetmap, Wikiloc and 360.org access networks facilitate download of data to use it in another application or (mobile) device. All platforms offer services to publish and upload data.

### 3.3 Standards

Users contributing data to 360.org and Eye on earth need to fill in a standards form with predefined data attributes. Wikimapia and Openstreetmap have predefined map features like rail way or water way. Openstreet map has also recommended values for the map features like river, stream for map feature water ways. Wikiloc uses as standard format GPX for all its contributions.

### 3.4 Data

Openstreetmap, Wikimapia and Wikiloc have the highest number of user uploads ranging from almost 2 billion (track points, nodes and ways) in Openstreetmap to almost 150 thousand routes in Wikiloc. The number of user uploads of 360.org and Eye on earth were estimated as lower. The last update of four case studies websites was less then on hour ago at the moment of website visit. For Eye on earth no information about the most recent produced data set could be obtained. Each platform has an own focus or specific theme. Wikimapia and Openstreetmap are more general platforms. Wikiloc, eye on earth and 360.org cover a specific theme. The case studies have all a worldwide geographic extent, except for Eye on earth where only European data is included. Openstreetmap, eye on earth and 360.org combine VGI with data from other sources and present it together. Wikiloc and Wikimapia present only VGI.

### 3.5 People

Wikimapia is the case study with the biggest user base. It has the most visited website, more than 1 million visitors per day, and the highest number of registered users. The number of visitors per day of Eye on earth is estimated the lowest, but this might be due to the fact that the number of visitors was difficult to estimate due to use of different URLs to access the website.

## 4. VOLUNTEERED GEOGRAPHIC INFORMATION AND SPATIAL DATA INFRASTRUCTURES

In this section general characteristics of VGI are described based on the results of our case study analysis. Those characteristics are compared with SDI component characteristics and differences and similarities are identified.

### 4.1 General characteristics of Volunteered Geographic Information

Based on the analysis of the VGI case studies general characteristics of VGI can be described using the five SDI components as comprehensive framework. 1) Policies and guidelines are defined by communities of registered users. Registered users can interact with other users and comment and edit content of others users. 2) Access networks in the case studies are bidirectional. They can be used to search, view and download data, but also to publish and upload content. 3) Standards are described for the data content, e.g. for data attributes and feature types. They are specific for each case study. 4) Data content is limited to a specific focus or theme. The case studies focus on displaying data published or uploaded by the user own community. 5) People VGI has a broad user base, many users are registered and actively contribute data and the websites have many visitors per day.

Our analysis describes general characteristics of VGI, but VGI doesn't have a hard boundary. The case study eye on earth has no registration system of users and interaction of users in a community, but it has the other characteristics of VGI. The five case studies have been used for a first more systematic analysis of VGI by thirteen characteristics. However, other methods and more and different case studies might be considered as well for a better understanding of the VGI phenomenon.

### 4.2 Comparing VGI characteristics with SDI

Based on the general characteristics of VGI for each component an explorative analysis has been made of what makes VGI different from SDI. In Table 3 differences between VGI are explored using the SDI component view as comprehensive frame.

| SDI component | Differences<br>VGI | SDI |
|---|---|---|
| **Policy** | Community of registered users | Formal organizations |
| **Access Network** | Bidirectional | One directional focus |
| **Standards** | Data standards | Metadata, data and service standards |
| **Data** | Specific focus or theme | Broad data scope |
| **People** | Broad user base of non-professionals | Limited user base of professionals |

***Table 3:*** Differences between VGI and SDI characteristics based on SDI component view

Main characteristic of VGI is that is based on user communities defining policies and guidelines. In SDIs policies and guidelines are defined by geo-information professionals of formal organization. Access networks of VGIs are bidirectional facilitating use of data and publishing of data by the user

community. SDI access networks are mainly focused on data access and use. In VGI standards are applied to harmonize data content in the community. In SDI standards are applied for metadata, data and services and are needed to ensure interoperability in a distributed network. VGI has a broad user base of mostly non-professionals. SDI has a limited user base of mostly geo-information professionals.

Despite differences between VGI and SDI similarities can be identified. Characteristics of all SDI components have been identified and measured in the VGI case studies. Both organize and make information available and accessible. Both consist of, policies, access networks, standards, people, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data. Those similarities show that underlying concepts of VGI and SDI are not very different and that convergence has the potential to broaden the user base, scope and utility of both.

The objective of this paper is to give a comprehensive characterization of the VGI phenomenon and its relation with SDI. We selected five case studies and thirteen indicators for a first exploration of what is there. Further research is required on the representatively of the case studies for the VGI phenomena and the suitability of the selected indicators to evaluate VGI and its development over time. Giving a characterisation of VGI can be seen as a first step in gaining understanding of the VGI phenomenon and the new challenges it brings to the organization and capabilities of geo-information technology and SDI developments.

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