Perceptions of virtual globes, volunteered geographical information and spatial data infrastructures

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Abstract

The Internet has spawned the development of virtual communities or virtual social networks which generate and share information with one another, and with the public at large. Volunteered geographical information (VGI) refers to user-generated content that is made available as base data on public mapping web sites or as third party data overlaid on virtual globes such as Google Earth and NASA World Wind. Several attempts have been made to determine and categorise what motivates the contributors of VGI. However, while the contributors themselves might generally understand VGI, this is not necessarily the case amongst geographical information professionals at large. We used a questionnaire to explore this by gathering some data on the perceptions held by geographical information professionals of virtual globes, VGI and spatial data infrastructures (SDI). These perceptions are important because they influence how VGI and virtual globes will be used in future in the more formal SDI environments of official mapping agencies and other official custodians of spatial data. The questionnaire was administered at a meeting in Addis Ababa, Ethiopia, in April 2009 and at another in Ekurhuleni, South Africa, in June 2009. The results are reported on here. Some of the results confirm previous research, while others raise questions that warrant further research.

Key words: volunteered geographical information, VGI, virtual globe, geobrowser, spatial data infrastructure, SDI, user-generated content.

1. Introduction

One of the distinguishing characteristics of the use of *spatial data* is that the same, common, base data sets are used by many different users for many diverse applications. Hence, there is a growing need to share and organise spatial data across different disciplines and organisations, which has resulted in the development and implementation of *spatial data infrastructures (SDIs)* and of the theory and notions behind them. An SDI is an evolving

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concept about facilitating and coordinating the exchange and sharing of spatial data and services between stakeholders from different levels in the spatial data community [Hjelmager 2008]. An SDI is more than just the technology of a *geographical information system* (GIS): it is generally considered to be the collection of technologies, policies and institutional arrangements that facilitates the availability of, and access to, spatial data. It provides a basis for spatial data discovery, evaluation and application for a variety of users and providers [Nebert 2004].

The Internet has spawned the development of *virtual communities* or *virtual social networks* which share data with one another, and with the public at large. This *user generated content* is most obvious in web sites such as Wikipedia [Wikimedia 2010], the free, online encyclopaedia in many languages, consisting of contributions mainly from the public at large, rather than from domain experts (though it does also include much content from encyclopaedias that are out of copyright and other expert sources). Similarly, virtual communities have also facilitated *folksonomies* or *collaborative tagging*, which are the classification and identification of content by the general public, rather than by domain experts. Within *geographical information science (GISc)*, user generated content is also known as *volunteered geographical information (VGI)* and is made available as base maps on public websites, such as Tracks4Africa [2010] and OpenStreetMap [2010], or as third party data overlaid on other data in virtual globes, such as Google Earth [Google 2010a] and NASA World Wind [NASA 2010].

Today, the term virtual globe is most often used to refer to a client application that provides masses of digital geographical information in the form of a globe over the Internet, the best-known example being Google Earth. However, a virtual globe does not have to be available online: in 1998, Microsoft released '*Microsoft Encarta Virtual Globe 1998 Edition*' that allowed users to browse seamlessly a 3-D model of the Earth [Microsoft News Center 1997].

A *geobrowser* is a client application for accessing a complex infrastructure of software and geographic data behind the scenes [Craglia *et al* 2008], i.e. the software that allows a user to view digital geographical information over the Web. Following Harvey [2009], a *virtual globe* will be regarded here as the software-based representation of the world in the form of a globe. If the geobrowser presents the geographic information as a globe, then it is also a virtual globe. Conversely, if the virtual globe is presented over the Web, then it is also a geobrowser. Geobrowser and virtual globe are used interchangeably when referring to Google Earth [Butler 2006, Craglia *et al* 2008, Goodchild 2008, Graham 2010].

In the context of VGI, it is important to note that the data repository is distinct from the software, i.e. the virtual globe or the geobrowser, through which it is viewed. This distinction is noted by Google, for example, in its terms of service, stating that one may only access or use the content (i.e. the geographic information) through technology (i.e. a virtual globe such as Google Earth) authorized by Google [Google 2010b]. Potentially, should the commercial interests so allow, a virtual globe or geobrowser could access

several different data repositories, and one data repository could be accessed by several different virtual globes or geobrowsers. Thus, the same set of VGI can be viewed through any geobrowser or virtual globe. Virtual globes are a major conduit for disseminating VGI, and hence are closely coupled with VGI.

The term VGI was introduced in 2007 by Goodchild [2007] and already quite a bit has been published on it, especially in the context of an SDI (e.g. Craglia *et al* [2008], Budhathoki *et al* [2009], Coleman *et al* [2009], McDougall [2009]). An indication of the novelty of the field is that a comprehensive classification of municipal web sites from as recently as 2005 did not cater for VGI [Caron *et a*l 2005]. The emerging research on VGI is multifaceted, taking into account industry, technology, discipline, social, political and other aspects [Elwood 2008a]. Nevertheless, this does not mean that the concept of VGI is well understood. For example, with Tracks4Africa, the data are contributed voluntarily, directly and on their own initiative by individuals [Tracks4Africa 2010]. Similarly, in a citizen-science project such as the 2nd South African Bird Atlas Project (SABAP2), the data are gathered by pentad (areas 5' by 5') by individual, amateur birders and contributed directly to SABAP2, according to the published protocol [Harrison *et al* 2008; Animal Demography Unit 2010]. Some of these birders also contribute the coordinates of their species records directly to another web site, NaturalWorld [2010]. However, De Longueville *et al* [2009] have a different perspective, considering VGI to be data collected, synthesised and posted to the Internet by the research team from interviews with stakeholders. Expressions that interviewees used in relation to a location were extracted from transcribed interviews in order to assign a location to the environmental phenomena described by the interviewees. Many of these stakeholders could be considered to be professionals and/or experts in their respective fields, though not necessarily GISc professionals.

Elwood [2008b] has pointed out that the debate about the societal significance of VGI and whether it empowers marginalized individuals and social groups or serves to exclude and disempower them is "strikingly similar to the so-called 'GIS and Society' debates of the mid 1990s". VGI can contribute to make playful interpretations of space, as well as for conventional mapping, and the results are always experienced by others incongruously on an individual scale. Further, VGI availability is uneven because of technological, economic, language and other barriers, and the ordering principles for presenting VGI are neither objective nor benign [Graham 2010].

Several attempts have been made to understand the role of the user in contributing data to an SDI (as *produsers* [Budhathoki *et al* 2008]) and to determine and categorise what motivates the contributors of VGI, such as Budhathoki *et al* [2009] and Coleman *et al* [2009], with the latter realising that not all contributors do so altruistically or without bias. For example, while much of the user-generated content about the earthquake in Haiti on 12 January 2010 has been essential for communicating about the situation there, some has been shown to be false [Palmer 2010]. Such an understanding is essential for determining the utility of VGI. However, while the contributors themselves might generally understand VGI, this is not necessarily the case amongst geographical information

professionals at large. Concerns that are raised by professionals include the quality of VGI and issues of liability of organizations who utilize VGI. Furthermore, the integration of VGI into SDIs will require considerable re-engineering of information flows and institutional arrangements [McDougall 2009]. We drafted a questionnaire and gathered some data to explore geographical information professionals' perceptions of virtual globes, VGI and SDI, and the results are reported here.

In the remainder of this paper we first provide background to the questionnaire, followed by a summary of the responses received at the two events where the questionnaire was distributed. Section 4 presents an analysis of the responses and lists the key issues that are highlighted by the responses.

2. Background to the questionnaire

During April 2009, we compiled a questionnaire in English on the use of virtual globes, volunteered geographical information and spatial data infrastructures, with some inputs from colleagues. A copy of the questionnaire is included in an appendix. The two-page questionnaire was printed on a single A4 sheet, double-sided. This limited the number of questions that could be asked and was intended to ensure that an individual's responses could not be separated. Unfortunately, it was not made obvious on the first page that there were questions on the reverse, and several respondents did not answer any of the questions on the reverse.

With permission from the United Nations Economic Commission for Africa (UN ECA), a copy of the questionnaire was circulated at the end of April 2009 at the meeting of the Geoinformation Subcommittee of UN ECA's Committee on Development Information, Science and Technology (CODIST), held in Addis Ababa, Ethiopia. The membership of CODIST-Geo consists of senior representatives of relevant government departments, such as national mapping agencies, topographical surveying departments and cadastral surveying departments. However, the meetings also include observers from academia, non-government organisations, the private sector, international organisations, and from outside Africa.

The reason for selecting the CODIST meeting was that the first author had been invited to make a presentation at the CODIST Plenary (which included delegates from all three of CODIST's sub-committees) as a Discussant on behalf of CODIST-Geo. This questionnaire then drew on some of the ideas discussed in this paper, entitled *Geoinformation perspectives on innovation and economic growth* [Cooper 2009]. It was also an opportunity to gauge opinions from other African countries.

Unfortunately, while about 100 paper questionnaires were circulated to CODIST-Geo (and an electronic version given to selected delegates on request), only 14 were completed and returned (13 at the meeting and one emailed later). This was not entirely unexpected,

however, as by its nature, the questionnaire had an advocacy component because VGI is a new concept and possibly unknown to some of the delegates. Some delegates might have retained the questionnaires as a reference document for when they had returned home. Further, many national mapping agencies in Africa are constrained by lack of equipment, skills and funding – some are still restricted to manual cartography only. Hence, for them, virtual globes and VGI can represent threats to their sustainability and they might have been reluctant to respond to the questionnaire. Further, it was not possible to translate the questionnaire into French given the tight deadlines and this lack of a French version would have reduced the number of responses, as many of the delegates at CODIST-I were from Francophone Africa and some of them are not fluent in English.

The first author also circulated about 25 questionnaires at a meeting of the Gauteng Branch of the Geo-information Society of South Africa (GISSA), hosted by the Ekurhuleni Metropolitan Municipality at their offices in Kempton Park on Friday, 19 June 2009. This meeting was selected because it was the first relevant local meeting the first author attended after CODIST-I and because he reprised his CODIST-I presentation for the local audience. Seventeen questionnaires were completed and collected at the GISSA meeting.

Given the limited number of responses received to date, it is not possible to draw any statistically-valid conclusions from the questionnaire. However, it was never the intention that these admissions of this questionnaire should provide empirical data. Rather, the purpose was to perform some qualitative research to gauge the opinions of informed persons interested in responding to the questionnaire. These responses could be used to refine the questionnaire so that it could be used to gather empirical data from which statistically valid conclusions could be drawn about some population, though that would probably be an expensive exercise.

In drafting the questionnaire, both free-text and multiple-choice questions were included deliberately, to see what effect they would have on the responses received. Free-text questions were used for questions 3 to 10 to minimize the bias of the questionnaire, especially as the disadvantages of virtual globes, geobrowsers, VGI and the lack of metadata might not be well known, and some of the respondents might not have considered their impact on official mapping. We believe that the responses have supported this.

In general, it appears that the responses to the free-text questions could be used to draft meaningful categories to convert these questions into multiple choice questions, but this would undoubtedly bias the responses.

3. Summary of the responses from CODIST-I and GISSA

The questionnaire was circulated to CODIST-Geo in the morning of Tuesday, 28 April 2009, and the completed questionnaires were collected during the week, though mainly on

the Tuesday. The emailed response was received within a fortnight after CODIST-I – it was a much more detailed response and from a respondent who has clearly given the issues much thought. The first author's plenary presentation was made late on the Wednesday afternoon, so it probably had no influence on the responses received. Some of the issues were discussed with some respondents before they completed the questionnaires, but these specific individuals are sufficiently well informed about virtual globes, geobrowsers and VGI that their responses probably were not influenced significantly by such discussions.

The questionnaire was circulated to GISSA during the morning (19 June 2009) and while the author's presentation was the last of the day (mid-afternoon), some of the respondents only completed the questionnaire during this presentation. Further, there was discussion of issues such as the quality of the data in a virtual globe during some of the other presentations. One of the other presentations was about using KML and Google Earth to deliver government data [Silberbauer & Geldenhuys 2008]. Hence, these discussions probably influenced some of the responses. Nevertheless, circulating the questionnaires at this GISSA meeting was a useful exercise, complementing the responses from the CODIST meeting, as most of the respondents were from the private sector and some of the respondents are active users of virtual globes and geobrowsers.

In the questionnaire, we provided the following definitions for a virtual globe and geobrowser:
A virtual globe provides masses of digital geographical information over the Internet, typically in the form of a globe.
A geobrowser is the interface to a virtual globe, typically allowing users to zoom into the data, switch data layers on and off, create three-dimensional views and add their own data (user generated content), such as geographical features (e.g.: roads and places of interest), tags (with text or links to web sites) and photographs.
Perhaps the best-known example of a virtual globe is Google Earth.

While these definitions distinguish between a 'virtual globe' and a 'geobrowser', in the Introduction above we pointed out why the terms are sometimes used interchangeably to refer to Google Earth. Also, in the questionnaire, the two terms were treated as a single entity, e.g. *What do you think of the quality of the data in virtual globes/geobrowsers*? Since Google Earth is by far the most widely used virtual globe, evident from the responses, it is most likely that they had Google Earth and its functionality for user generated content in mind when answering the questions on 'virtual globes/geobrowsers' in the questionnaire.

One weakness in the questionnaire highlighted by these responses was that the following question was misinterpreted:

> *7. What do you think of the documentation of the data (i.e.: the metadata) in virtual globes/geobrowsers?*

The intention of this question was to assess what the respondents thought of the quality of the metadata currently available in virtual globes/geobrowsers, but some interpreted this question as asking if they thought that metadata was necessary *per se*.

One CODIST and five GISSA respondents completed only the first page of the questionnaire (up to question *11. Do you think that the legislative and policy environment in your country encourages or stifles innovation in the field of geographical information?*), and hence missed the request for their details. Five other GISSA respondents submitted anonymous responses.

The following is an assessment of the responses received. Questions 3 to 10 inclusive required free-text responses and to preserve the privacy of the respondents, these answers have been mixed up and interpreted by us – hopefully correctly! Questions 11 to 22 were multiple-choice questions.

1. *Country of current residence*

Table 1: Countries of residence

CODIST	GISSA
10 African countries, 1 European country & 1 Asian country	16 South Africans & 1 not specified

2. *Economic sector in which employed*

Table 2: Economic sectors

CODIST	GISSA
Mainly government, 3 academia (1 also private sector) & 1 non-governmental organisation (NGO).	4 government (including local government), 11 private sector, 1 academia & 1 not specified

3. *Main advantages of virtual globes and geobrowsers*

Table 3: Advantages of virtual globes and geobrowsers

CODIST	GISSA
• Quick and easy access to free data • Ability to share data (particularly of current global events) • Low skills required to access the data • Assist visual planning and quick decision making, particularly in allowing broader participation from earlier on, facilitating multiple views	• Quick and easy access for people in the street to a wide range of free data that are relatively up to date (particularly imagery) • Spatially enabling society and making the public spatially aware (a map is worth a thousand words) • Create awareness about GIS-related

of the situation and promoting feedback and dialogue • Replacing the moralistic rhetoric of `ought' with a technical analysis of `is' • Data are valuable and range from "relatively good" to "more precise and tested", seeming to contradict some responses to the next question • Provides an unique global reference • Promotes the democratization of data by allowing technical analyses countervailing those of intelligence and other government agencies, to shift the epistemic balance of power between civil society and the state – e.g.: using VGI and satellite imagery on virtual globes as resistance to military secrecy (e.g. the scale model built near Huangyangtan, China, of a disputed border area in Tibet [Haines 2006]) • Brought geographical information to lay people, allowing them to play with the data for fun, such as engaging in virtual tourism, searching for interesting things or making subversive mash-ups	technology and make the technology available to the public and easy to use • Provides an interactive exposure to geography • Results in the public demanding better quality spatial data and reduces the commercial sales cycle for the technology and data • Knowing "where" is now just the beginning • However, they do require connectivity to be accessible • Multiply the spatial-enablement efforts of others • Allow one to concentrate on the data one is trying to present, while leaving the fancy image serving and draping to the geobrowser • Allow engineers to do high-level planning, such as identifying possible corridors • Finally, of course, virtual globes and geobrowsers are fun!

4. *Main disadvantages of virtual globes and geobrowsers*

Table 4: Disadvantages of virtual globes and geobrowsers

CODIST	GISSA
• Uncertainty over the legitimacy and quality of the data (can one trust what is on the virtual globe?) • Lack of moderation over what is added • Lack of metadata which could be used to determine the quality of the data (e.g.: currency or positional accuracy) • One cannot identify when data have been removed or edited at the behest of a government or someone else, in an effort to delude the public	• Uncertainty over the quality, accuracy, currency, consistency and reliability of the spatial data • Lack of metadata • Requirement for Internet connectivity with high bandwidth • Naïve users can place too much faith in the reliability and accuracy of the data, often

• The perception held by the organisation owning the virtual globe of what is important regarding the currency and resolution of the data might be tailored to their perception of market potential, which might not gel with the public interest (e.g.: the one might perceive currency as being more important than resolution, and vice versa) • Allow the visualizations of lay people to enter the public discourse and affect decision-making, raising difficult value questions of "who has a legitimate voice?" and "whose visualisation is right, or more legitimate?" • Invasion of privacy (making surveillance available to everybody) • Exposure of sensitive sites (for national security, as well as cultural and environmental sites (e.g.: ruthless collectors exploit the data to steal fossils and cultural artefacts) • Risk of the data being used by vandals or criminals • Security of the data placed on the virtual globes • Geobrowsers have limited functionality • Availability of free data (presumably because of the threat it poses to national mapping agencies) • The need for electricity, a computer and connectivity – never mind reasonable bandwidth – and these are luxuries in many African countries	using them as an "exact science" • Naïve users could feel that all they need is the virtual globe and geobrowser because they are so easy to use, posing a potential threat to commercial GIS software • Limited functionality of geobrowsers, such as exporting data, using them with other systems (possibly proprietary), the lack of graphical tools (e.g.: snapping to existing geometry), and requiring the purchase of the commercial version of the geobrowser to be able to upload data • Uncertain whether higher resolution data are better than up-to-date data • Some corporate computer centres don't like installing the software (presumably because of bandwidth issues and corporate policies) • They increase the gap between the computer literate and computer illiterate • One respondent did not know of any disadvantages

5. *Main advantages of user generated content in a virtual globe/geobrowser*

Table 5: Advantages of VGI

CODIST	*GISSA*
• *Allows ordinary people to* contribute data quickly and easily that are then globally available	• Everyone is now able to contribute and share their spatial data (and maps and knowledge) and add value to other data sets

• Can give a geographical context to imagery • Can encourage ordinary people to become interested and add their local knowledge to suit their needs • Adds value to the generic viewer which can benefit other users • Reflects an individual's ideas in the information exchange • Can become an unlimited source of data • Facilitates quick generation of user-defined answers and easy customization • Includes three-dimensional data • The data are unedited (did the respondent actually mean uncensored?)	• Adds local knowledge • Enables the "wisdom of the crowd"' to make its way into applications • Presenting results with an imagery backdrop (the cosmetics) is a "wow" factor • Data are made available freely • Anyone is then able to participate in a global community by looking for spatial data by foraging for them in a visual landscape • Can be suitable for the needs of many users and fit for their purposes • One can see and experience areas of interest from one's desk • The increasing volume of data becoming available • Facilitates verification • Allows a free, easy-to-use application to act as a GIS • The large "help desk" effectively available through the community using the virtual globes and geobrowsers

6. *Main disadvantages of user generated content in a virtual globe/geobrowser*

Table 6: Disadvantages of VGI

CODIST	GISSA
• Veracity of the data – unmoderated, unverified, uncontrolled, subjective, inadequate precision, lack of a common standard, and data might be misunderstood by others • Knowing which data sets to use • Longevity of the data (they are disposable) • VGI might "pollute" (i.e.: obscure or replace incorrectly) the base data • Ability to propagate VGI is open to abuse • Limited availability of fast connectivity denies many the opportunity to contribute VGI (which biases the available VGI)	• Quality of the data – accuracy, currency, trustworthiness • Uncertainty over the quality of data (how does one verify the data?) • Users not aware of the quality issues could have the attitude "I saw it on the Internet so it must be true" • Limitations on uploading data • The data might not meet one's perspective • The required data might not be available • The data might be dependent on transient details in the

• Grows a user community beyond the traditional GIS community • Provides quick access and definition of user-defined uses – presumably, the problem being that user-generated content could be produced carelessly and without understanding of key issues, such as geo-referencing • Attention shifts from what happens inside a single organisation, to what happens in the new social system of geo-information production • The right to define and judge the value of the geo-information being co-produced is distributed among all co-producers • New rules and standards are required to take into account the values of the equity of volunteers, security, community building and privacy, in the evaluation of the performance of the new production system	background imagery and might lose its context when the imagery is updated (this is the classic problem of the incremental updating and versioning of base spatial data sets [Peled & Cooper 2004]. E.g. in his presentation at both meetings [Cooper 2009], the first author gave the example of VGI on Google Earth, showing what was claimed to be pirate boats on the beach at Eyl in Somalia ["expedition" 2009] – the boats might then be at sea when the updated image is loaded on Google Earth and the KML would then point to an empty beach • Security • Lack of support for applications • One respondent could not think of any disadvantages

7. *Documentation of the data (metadata) in virtual globes/geobrowsers*

Table 7: Metadata

CODIST	GISSA
• Some misinterpreted this question as asking if they thought that metadata was necessary, and they obviously did • The available metadata was the biggest shortcoming of virtual globes and geobrowsers • Metadata is inadequate, incomplete, obsolete, not complying with international standards and contains errors (spelling and misidentification) • Currency and resolution of images reflect perceptions of market potential, not of public interest • Some respondents felt the metadata was OK for most practical purposes	• Most were unimpressed with the quality, quantity, depth, currency and verification of the metadata • Metadata should be improved and adhere to standards • One respondent felt it was getting better • One respondent felt that the metadata was not relevant • Two respondents considered the metadata to be generally very good and up to date • Two respondents had not investigated the metadata

8. *Quality of the data in virtual globes/geobrowsers*

Table 8: Data quality

CODIST	GISSA
• Varies from "very poor" through "acceptable" to "high", depending on the application • The data (both the base imagery and the VGI) come from disparate sources with variable degrees of quality, with the imagery being considered to be better • Data for the American continent are better than for the African continent • The age of the data sets is ambiguous • Information on the quality of the data is not available • The data need to be peer reviewed for them to be used for scientific purposes, but not necessarily for obtaining opinions	• Varies from "very coarse" (especially for road data) or "questionable" (especially positional accuracy), to "very good" or "high standard", with most respondents rating the quality as being "fair"/ "adequate" or better • The data need to be maintained and updated regularly • Cannot assess the quality without there being adequate metadata • The quality required depends on the use and the scale, and how much one was prepared to pay for quality data (VGI tends to be free) • Most of the data are vague and not important for general users • The ownership of the data is also a problem

9. *Current impacts of virtual globes/geobrowsers on official mapping*

Table 9: Current impacts on official mapping

CODIST	GISSA
• A topic of great research interest, because of the issues raised by the other questions • Currently, the impact on official mapping is considered to be low to none • The main impact is in the early stages of the mapping cycle – planning, viewing places, as a backdrop for vector data and preparing working	• Already changing official mapping for the better • Forcing mapping agencies to be more consumer oriented • Educating mapping agencies to understand the value of information • Creating a greater awareness amongst the public of spatial data • Official mapping should be provided through a geobrowser • The presentation at the meeting by Mike Silberbauer [Silberbauer & Geldenhuys 2008] showed that virtual globes and geobrowsers have already had a significant impact! • To have a real impact, the data need to be up to date and accurate

documents • They are attractive for both experienced users and novices • Could reduce the importance of official mapping • Could help official mapping as their use and understanding improves • Issues of privacy with the data being opened to the public	• Maps4Africa (presumably they meant Tracks4Africa?) is a good example of a virtual globe with quality data • Allow digital data to be served or viewed through an easy-to-use viewer and provide useful backdrops for mapping • Generally prevent one from generating maps from the geobrowser • While experts in spatial technology might use them extensively for business purposes, the general public use them primarily for entertainment • The business opportunities are not limited to the lack of data • They are having no impact on official mapping yet • Several respondents did not know if they were having an impact

10. *Impacts of virtual globes/geobrowsers on official mapping through to end of 2014*

Table 10: Future impacts on official mapping

CODIST	GISSA
• Again, a topic of great research interest • The impact will be positive: to be used more than now for research, planning and perhaps updating other maps • Help gain access to new data • Help disseminate new products • Promote geo-information • Provide good access to geo-information • Facilitate instant decision making by top level officials in government • Could supplement the national mapping series – or could reduce the importance of official mapping • Likely to have very little	• More variation than the CODIST responses, but generally positive • Improve the quality of the data and maps because of greater pressure to supply accurate and up-to-date data as the demand increases and because people with access to geobrowsers will become more critical of map updates (though they're currently a minority in South Africa) • Will drive the priorities or initiatives of official mapping • Will provide easy delivery of map updates • Will enhance knowledge of 'where' • Will result in the virtual obsolescence of paper maps • Will have a huge impact if their integration and use in education is done properly – or will have no impact because of the existing GIS awareness initiatives in the country! • Hopefully will result in boundaries becoming standardized through a single entity, as the

impact on national mapping agencies, but could assist thematic mapping • Will impact on defining the mapping strategy and in planning and execution of mapping projects (not certain if this would be negative or positive) • To have an impact, the information would have to be updated	boundaries from various official organisations are not aligned • Hopefully, postal code boundaries will be defined and made available • May limit the need for GISc professionals • Quality of mapping may deteriorate as 'amateurs' feel they can do it themselves • Might not have a huge impact on information input because surveying companies supply government organisations with data • Several respondents did not know if they would have an impact

11. *Do you think that the legislative and policy environment in your country encourages or stifles innovation in the field of geographical information?*
12. *Do you think that the legislative and policy environment in your country encourages or stifles the development of spatial data infrastructures (SDIs)?*
13. *Do you think that the legislative and policy environment in your country encourages or stifles the development of, use of, and adherence to, standards?*

Table 11: CODIST views of legislative and policy environment

	Encourages	*Neither*	*Stifles*	*Don't know*
Innovation	*4*	*7*	*3*	*0*
*SDI*s	11	2	0	0
Standards	7	4	1	1

Table 12: GISSA views of legislative and policy environment

	Encourages	Neither	Stifles	Don't know
Innovation	5	6	0	4
SDIs	6	3	0	2
Standards	7	2	2	1

Generally positive responses, with one CODIST respondent who selected *stifles innovation* adding that more effort is needed. The positive response concerning SDIs is not surprising as South Africa was one of the first countries in the world to have an SDI Act [2003], and several other African countries have been following suit. The positive response for standards is a bit surprising as Africa has had a very limited participation in international standards generating bodies: for example, South Africa has been the only active African participant in ISO/TC 211, *Geographic information/Geomatics*, though Morocco has sent a delegate to one Plenary. Perhaps the legislation and policy need to be backed up with financial support?

14. *How well do you think the legislative and policy environment in your country deals with issues such as virtual globes, volunteered geographical information and open access to geographical information?*

Table 13: CODIST views of environment for VGI, etc

	CODIST	GISSA
Very well	2	2
Adequately	2	1
Poorly	6	4
Does not cater for them at all	4	1
Don't know	0	4

Unsurprisingly, this resulted in a negative response. One CODIST respondent marked both *very well* and *adequately*.

15. *Access to a virtual globe/geobrowser at home*
16. *Access to a virtual globe/geobrowser at work*
17. *Use of a virtual globe/geobrowser for personal purposes*
18. *Use of a virtual globe/geobrowser for work purposes*

Table 14: CODIST access to virtual globes

	Work use	Both	Personal use	Not used
Access at home	0	0	0	0
Access at both	2	6	0	0
Access at work	0	0	1	1
Access at neither	1	0	0	2

Table 15: GISSA access to virtual globes

	Work use	Both	Personal use	Not used
Access at home	0	0	1	0
Access at both	1	7	2	0
Access at work	0	0	0	1
Access at neither	0	0	0	0

Three CODIST respondents do not have access at either home or work – this might surprise people from outside of Africa as the respondents are from the wealthier "classes" in Africa, but it does not surprise us. A key problem is the very high costs of Internet access across Africa, because of all the telecommunications monopolies, which results in access costing many times what it costs in Europe, North America and North-East Asia. Hence, even if these respondents have access to the Internet, a resource such as a virtual globe consumes too much bandwidth and is either

prohibitively expensive to use – or is even impossible to use because it is so slow and one is likely to lose the connection before one gets any results. The respondent who uses it for work purposes but does not have access to a virtual globe/geobrowser from home or work, would then use it at a friend's house, at an Internet café, at a conference such as CODIST-I, or the like. This is a clear indication of the limited availability of the Internet and Internet-based services in Africa, because these respondents are senior government officials or the like.

19. The virtual globes/geobrowsers used

Table 16: CODIST choices of virtual globe or geobrowser

	CODIST	GISSA		CODIST	GISSA
Google Earth	11	12	NASA World Wind	1	4
OpenStreetMap	1	1	Microsoft Virtual Earth	0	1
Yahoo! Maps	0	2	Other	0	4

All respondents use Google Earth, an indication of its dominance, both in actual use and in perceptions of what a virtual globe/geobrowser is. The GISSA respondents are heavier users of the technology, so it is unsurprising that they have explored and used the alternatives more. The others used are ArcGIS Explorer (by two respondents), Tshwane street map guide, Open GIS and Global Mapper.

The main reasons for using a virtual globe/geobrowser

Table 17: Uses of virtual globes

Reasons	**CODIST**	**GISSA**	**Comments**
Travel planning (work or leisure)	4	7	We expected this to be more popular with CODIST.
Providing a geographical context to news items	1	3	The low response might be an indication of limited bandwidth, in that a user would not use a news web site and a virtual globe simultaneously.
Accessing data for work purposes	6	5	This option was possibly badly worded as it was meant to see who used a virtual globe or geobrowser for specific project work, rather than used them for work purposes in general (e.g.: travel planning).
General curiosity	6	6	Unsurprisingly, a common activity.
Publishing your data	1	3	For CODIST, this correlates well with the low active use of virtual globes, but for GISSA, this does not correspond well with the high response rates for using the virtual globe as a backdrop and

			for using a markup language in a geobrowser, which is surprising.
Reconnaissance for work purposes	6	7	This question was meant to gauge the use of the data on virtual globes for planning work activities, so the CODIST response is surprisingly high, given the other responses. This option might have been confused with t*ravel planning*, which would then be an example of the very common weakness of brevity in questionnaires!
Providing a geographical context to correspondence from friends and family	0	4	The low response rates correlate well with that for *providing a geographical context to news items*.
Backdrop for other geographical data	1	8	The low response rate for CODIST correlates well with that for *publishing your data*, because of the cost of maintaining the Internet link to the virtual globe to use it as a backdrop. The high response rate for GISSA correlates well with the high number of users of a markup language in a geobrowser.
Armchair travelling	0	7	Surprisingly, no one from CODIST selected this option, but it does overlap with *general curiosity*.
Searching for data	4	5	Clearly, this option could be considered to overlap with all the others, but it is likely that the respondents interpreted it to mean searching for data that they could download.
Other (please specify)	0	4	Quite a variety of other uses were provided here by the GISSA respondents: research (could be covered by some of the uses listed, so it would be interesting to know what sort of research was envisaged by the respondent); Basic querying of data (again, several of the uses listed are really querying data); performing calculations of area and distance (not covered above, and there are other functions that geobrowsers provide); reviewing data (a temporary form of publishing your data?); and plotting the pilgrimage of a friend to allow their family and friends to track progress.

The respondents could select several options if they so chose. Of course, there are some overlaps between these categories, such as between *general curiosity* and

armchair travelling. This was deliberate, to ensure that the questionnaire covered what was anticipated would be the common uses of virtual globes and geobrowsers. Eleven of the GISSA respondents selected at least two options each, with eight selecting at least four each and a ninth selecting all the options and adding three and "a lot more" under other – clearly, an indication that the GISSA group includes power users.

20. *Use of VGI in a virtual globe/geobrowser*

Table 18: VGI use

	*CODIS*T	GISSA
Yes	4	7
No	6	3

Of course, a key issue with exploring this issue is how easy it is for the casual user to identify VGI. With more GISSA respondents being heavy users one would expect a greater awareness of VGI – but these responses might also have been biased by the presentations and discussions at that meeting.

21. *Use of a markup language in a geobrowser*

Table 18: Markup language use

	*CODIS*T	GISSA
Yes	2	9
No	9	1

More of the GISSA respondents use a markup language than use VGI: this would indicate that they are active contributors of data to virtual globes, supporting that they are power users. The CODIST usage is unsurprisingly low, as it would only be used by those contributing structured data.

4. Analysis of the responses

In general, even though the response rate was low, there was much variety in the answers received, indicating quite disparate exposure to virtual globes, geobrowsers and VGI amongst the respondents. There were more power-users amongst the GISSA respondents, who probably have 'cheaper' and 'faster' Internet access than many of the CODIST respondents. The power users are better informed about these technologies and data, as one would expect from their greater use of them. However, there appears to be a greater disparity within the GISSA respondents. The responses confirm previous research, but also raise questions that need further investigation.

The responses to our survey confirm that virtual globes and VGI promote the use of geographical information in general, but they are sometimes perceived as threats to commercial GISs and to official mapping. Virtual globes provide quick and easy access to free data, the ability to share data, and require low skills to access the data. Virtual globes and VGI encourage democratization (broader participation) by allowing ordinary people to contribute data quickly and easily that are then globally available – the wisdom of the crowd. These findings are confirmed in various reports [Butler 2006, Goodchild 2007, Sui 2008].

A key concern, evident from the responses, is the legitimacy, quality, veracity and persistence of VGI. The quality is perceived to be quite variable, while the requirement is that data need to be up to date and accurate. Similarly, a key concern of respondents is the inadequate nature of the available metadata for VGI and the (perceived) lack of moderation and verification. McDougall [2009] considers the quality of VGI to be the most contentious issue and other sources confirm the quality and metadata concerns [Goodchild 2009, Craglia *et al* 2008].

Another concern is that naïve users can place too much faith in the reliability and accuracy of VGI. In 2007, Goodchild contemplated whether VGI, which relies on the essential 'goodness' of people in the virtual community, will in future be subjected to antisocial elements, much as the early days of the Internet were characterized by a certain altruism that was later 'invaded' by spam, viruses and denial-of-service attacks. The false reports about the Haiti earthquake [Palmer 2010] confirm this concern.

Respondents have concerns over bias in VGI, which are highlighted in the studies that attempt to understand the motivation behind VGI contributions [Budhatoki *et al* 2009, Coleman *et al* 2009]. Further concerns relate to transgressing privacy (as surveillance is now available to anyone), the security of the VGI, the exposure of sensitive sites and the use of VGI by vandals and criminals. These concerns are confirmed in other reports [Goodchild 2007, Sui 2008].

The respondents consider Google Earth to be the dominant virtual globe and have diverse uses for virtual globes, particularly general curiosity and reconnaissance for work purposes. Other common uses are travel planning, accessing data for work purposes, using them as a backdrop for other geographical data, and armchair travelling. There is a moderate use of VGI in virtual globes by the respondents, and a low use of markup languages in a virtual globe by the CODIST respondents, but a high use by the GISSA respondents. The questionnaire did not attempt to gauge the intensity of the use of virtual globes.

While VGI and virtual globes encourage democratization, one needs a computer, electricity and decent connectivity to be able to use a virtual globe, which respondents consider to be a problem. There is extensive use of mobile phones in Africa, even for accessing VGI, so this perception might be because the respondents themselves do not use

VGI on their mobile phones. We consider research on the use of VGI contributions through mobile phones to be very important, especially in Africa, and have already embarked on further studies in this direction.

From the survey it is evident that virtual globes are having a limited impact on official mapping, such as by forcing them to be more consumer-oriented, but they are expected to have a positive impact over the next five years, such as by encouraging better quality and improved availability of the data because of the competition from VGI.

The legislative and policy environment is perceived to encourage the development of SDIs, and the development of, use of, and adherence to, standards, and to encourage more than stifle innovation in the field of geographical information. However, the legislative and policy environments deal poorly with issues such as virtual globes, VGI and open access to geographical information and require further research.

5. Conclusions

Previous attempts have aimed at determining and categorising what motivates the contributors of volunteered geographical information. In contrast, our paper reports on a survey to ascertain actual perceptions of VGI, virtual globes and spatial data infrastructures. We drafted a questionnaire to gather some data on the perceptions of these issues held by geographical information professionals from Africa, and the results have been reported here. These perceptions are important because they determine future use of VGI and virtual globes in these communities.

This questionnaire has now been applied to two groups with largely different backgrounds, experience with SDIs and access to virtual globes and geobrowsers. There was much variety in the answers received, indicating quite disparate exposure amongst the respondents. It would obviously be interesting to apply the questionnaire against other groups, such as geographical information professionals in a country with cheap and abundant bandwidth, or the lay public in such a country. It would also be interesting to apply the questionnaire to a sample that would provide a statistically meaningful representation of some population of interest. It might also be useful to update the questionnaire, addressing the weaknesses highlighted by the responses to date (e.g.: completion of only the first page and misinterpretation of the question on metadata), and making other appropriate changes. We intend to follow up the questionnaire with structured interviews with key people to improve the understanding of, for example, the intensity of use of virtual globes or the required legislative and policy environment for virtual globes, VGI and open access to geographical information in SDIs. We have also embarked on studies about VGI contributions through mobile phones, which we consider to be important in the African context.

The results from the questionnaire have provided useful insights into the perceptions of geographical information professionals about virtual globes, VGI and SDIs. Some of the results confirm previous research, while others raise questions that warrant further research.

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This questionnaire has been compiled as a follow-up to a paper on geographical information perspectives on innovation and economic growth, to be presented at the first session of the Committee on Development Information, Science and Technology (CODIST) in Addis Ababa, Ethiopia, from 27 April to 1 May 2009.

1. Your country of current residence	

2. In which sector of the economy are you employed?

Government (national, provincial or local)	United Nations or related international agency	State-owned enterprise (eg: utility, science council)	Academia (including full-time students)	Private sector (including self-employed)	Non-government organisation (NGO)	Other (including retired, unemployed)

A virtual globe provides masses of digital geographical information over the Internet, typically in the form of a globe. A geobrowser is the interface to a virtual globe, typically allowing users to zoom into the data, switch data layers on and off, create three-dimensional views and add their own data (user generated content), such as geographical features (eg: roads and places of interest), tags (with text or links to web sites) and photographs.
Perhaps the best-known example of a virtual globe/geobrowser is Google Earth.

3. What do you think is/are the main advantage(s) of virtual globes and geobrowsers?

4. What do you think is/are the main disadvantage(s) of virtual globes and geobrowsers?

5. What do you think is/are the main advantage(s) of user generated content in a virtual globe/geobrowser?

6. What do you think is/are the main disadvantage(s) of user generated content in a virtual globe/geobrowser?

7. What do you think of the documentation of the data (ie: the metadata) in virtual globes/geobrowsers?

8. What do you think of the quality of the data in virtual globes/geobrowsers?

9. What impacts are virtual globes/geobrowsers having now on the official mapping in your country?

10. What impacts do you think virtual globes/geobrowsers will have on the official mapping in your country over the next five years (through to 31 December 2014)?

11. Do you think that the legislative and policy environment in your country encourages or stifles innovation in the field of geographical information?

Encourages innovation	Neither	Stifles innovation	Don't know

12. Do you think that the legislative and policy environment in your country encourages or stifles the development of spatial data infrastructures (SDIs)?

Encourages SDIs	Neither	Stifles SDIs	Don't know

13. Do you think that the legislative and policy environment in your country encourages or stifles the development of, use of, and adherence to, standards?			
Encourages standards	Neither	Stifles standards	Don't know

14. How well do you think the legislative and policy environment in your country deals with issues such as virtual globes, volunteered geographical information and open access to geographical information?				
Very well	Adequately	Poorly	Does not cater for them at all	Don't know

15. Do you have access to a virtual globe/geobrowser at home?	Yes	No
16. Do you have access to a virtual globe/geobrowser at work?	Yes	No
17. Do you use a virtual globe/geobrowser for personal use?	Yes	No
18. Do you use a virtual globe/geobrowser for work purposes?	Yes	No

Other than the last question (concerning your contact details), the remaining questions are only relevant if you use a virtual globe/geobrowser.

19. If you use a virtual globe/geobrowser, which ones do you use? You may select more than one.				
Google Earth	NASA World Wind	Open Street Map	Microsoft Virtual Earth	Yahoo! Maps
Other (*please specify*)				

20. What are the main reasons you use a virtual globe/geobrowser? You may select more than one.				
Travel planning (work or leisure)	Providing a geographical context to news items	Accessing data for work purposes	General curiosity	Publishing your data
Reconnaissance for work purposes	Providing a geographical context to correspondence from friends and family	Backdrop for other geographical data	Armchair travelling	Searching for data
Other (please specify)				

21. Do you use the user generated content (volunteered geographical information) in a virtual globe/geobrowser?	Yes	No
22. Do you use a markup language in a geobrowser, such as the Keyhole Markup Language (KML)?	Yes	No

If you are interested in getting feedback on this survey or participating in follow-up surveys, please include your name and email address below (please write clearly!). If you would prefer your questionnaire response to remain anonymous, you can rather email your contact details to my address below.

Family name	*Given name or initials*	*Email address*

Thank you!