A Framework for Implementing Volunteered Geographic Information Systems

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Abstract

In an effort to contribute to the conceptualization of the burgeoning field of Volunteered Geographic Information (VGI), we propose to review selected definitions and debates around Geographic Information Systems (GIS). "Traditional" geographic information emerges from the interplay of the components of GIS: hardware, software, data, and application, and it is shaped by the processing of geographic data through a series of functions for input, management, analysis, and presentation within GIS. We suggest framing VGI as an information product originating in "volunteered geographic data" that are sourced and processed within such a complex computer system. Taking this broader perspective of VGI as the output of a system will allow us to understand different types of VGI and the processes of generating them. Ultimately, we may be able to design more effective participatory Geoweb applications. This position paper for the Geothink annual general meeting 2014 summarizes ongoing research in the Geographic Information Science and Systems (GIS) group at Ryerson University.

Background and Relevance

In debates about conceptualizing volunteered geographic information (VGI), VGI is often equaled to "data". For example, Elwood, Sui, and Goodchild (2012) do not seem to distinguish VGI from crowd-sourced data. However, the way the term was coined by Goodchild (2007) with the component "information" in it, it is challenging to conceive it as data. Data are usually placed at the bottom of a chain of constructs with increasing level of abstraction: data - information - knowledge (Meeks, 2007). If we stick to the "i" in VGI, we need to define it as the outcome of data processing, by which data obtain a meaning for a recipient and can be used to answer a question.

In his seminal book "Thinking about Geographic Information Systems", Tomlinson (2007) recommends to implement GIS effectively by defining the first information products to be achieved. These information products originate from data that undergo a series of purposeful transformations. Indeed, the input, management, analysis, and presentation functions for geographic data have often been used to define GIS (e.g., Heywood, Cornelius and Carver, 2006; Longley, Goodchild, Maguire and Rhind, 2011).

In Europe, this definition is known by the initials of the functional groups as the IMAP model of GIS (Bill and Fritsch, 1999).

Furthermore, transformation of geographic data occurs within unique “GIS ecosystems” consisting of specific hardware, software, data, and applications. This HSDA model (Bill and Fritsch, 1999) is another way of defining GIS, which includes the functional IMAP model in its software component. Generally speaking, the IMAP model is suitable to describe a generic GIS software package while the HSDA model characterizes a specific GIS implementation. Of note is that the HSDA model includes users as part of the applications component.

With respect to the Geothink partnership grant, this research has the potential to inform future theoretical research and Geoweb application development across most themes of the partnership. For example, to address the objective of identifying best practices in developing and using the Geoweb ecosystem in local government, we need to first comprehensively identify the components and functionality of existing or potential solutions. Among the Geothink partner organizations, The Neptis Foundation, Sani-ITA, and Ryerson’s Journalism Research Centre have been involved in some discussions around this research, with the potential for practical implementation and application in the near future.

Methods and Data

This research is conceptual, analyzing the published literature along with Geoweb applications that are available for online review. A preliminary model of VGI system components and functionality, and of VGI as an information product was presented by Rinner and Fast (2013). A revised version is shown below.

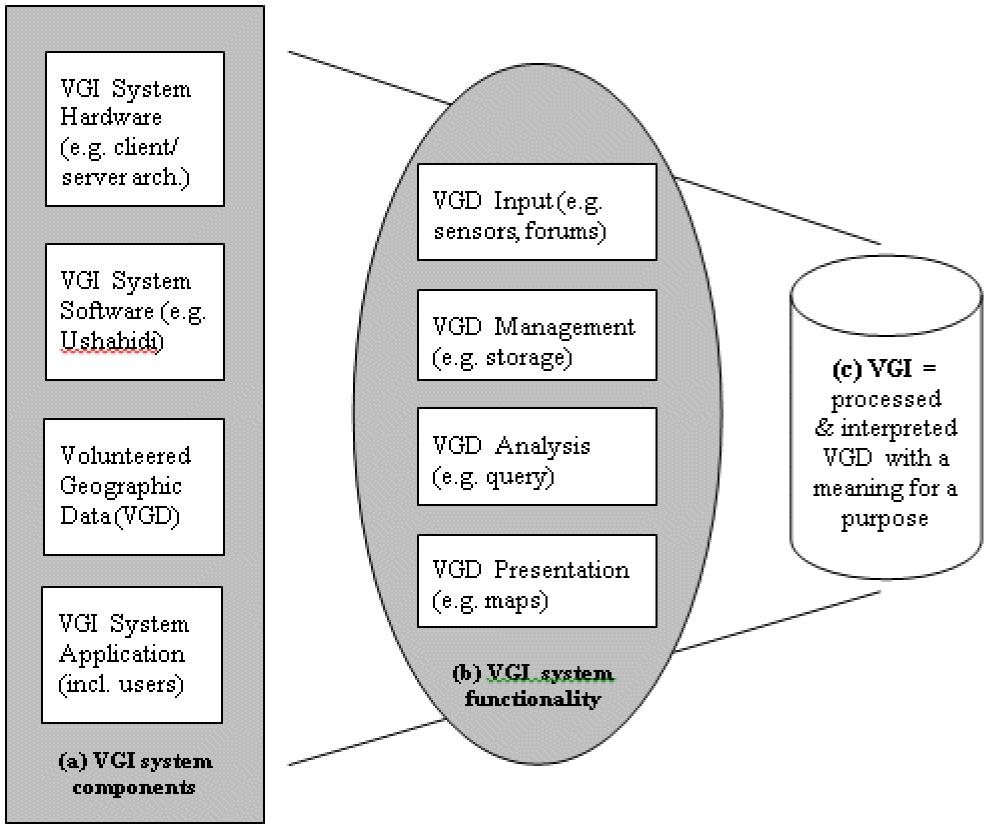

Figure 1: (a) VGI system components (hardware, software, data, application); (b) VGI system functionality (input, management, analysis, presentation); (c) VGI as an information product

Results

Tomlinson (2007) argues that GIS implementation in government or businesses can only be successful, if the "GIS information products" that are needed to support the organization's mission are identified at the planning stage. He views GIS as transforming data into information that is manifest in maps and reports.

Initially, it seems difficult to translate this top-down systems planning approach to the realm of VGI, since VGI initiatives are commonly characterized as "grassroots" or community-based, emerging, and little constrained. Due to the sheer amount of geographically referenced data items being contributed on the Web, it is conceivable that geospatial data mining could generate useful information for selected applications. De facto however, VGI is constrained by the hardware and software used in a particular initiative, as well as by the number and engagement level of participants and the amount and quality of contributed data. For example, the stream of Twitter messages shrinks by about two orders of magnitude, if it is limited to geographically referenced tweets. In addition, each message is limited to 140 characters making it difficult to convey searchable and useful information, without some top-down guidance on the use of identifying hashtags.

If VGI was to be used in professional applications such as to support environmental management or urban planning, then it should be viewed as an information product or output of a VGI system. Examples include a continuously updated list of locations of invasive species observations; a map and associated text of stakeholder suggestions for the site of an additional social program, which were submitted during a public participation phase; or, a map of restaurants in a neighbourhood with associated quality ratings. The form of the VGI output sought by the individual or the organization who set up the VGI initiative, will determine the hardware, software, (base) data, and application (e.g., invited participants) of the VGI system, as well as the data input, management, analysis, and presentation functions offered to users.

Conclusions

We applied a systems perspective to VGI by conceptualizing VGI as the output of a VGI system, in analogy to the role of geographic information in GIS. Specific VGI should be seen as the information product created within specific application systems that consist of hardware, software, and data, and offer data input, management, analysis, and presentation functions. The data input function of such a client/server system is particularly different from traditional GIS, in that it represents the spontaneous, distributed, bottom-up, and collaborative nature of many VGI initiatives.

The systems perspective on VGI promises to provide a comprehensive framework for VGI. Given the relatively long history of the study of GIS concepts, this approach will allow us to identify avenues for future research and development of VGI. Sample research questions include: Are there needs and tools for creating raster-based VGI? Does the raster-vector debate in GIS apply to VGI systems? Can levels of measurement help determine the accuracy of volunteered geographic data? What implications does the geographic scale at the time of data collection have on the value of VGI? Do volunteered geographic data affect our understanding of proximity and neighbourhood? How can spatial relations be extended with VGI? How can we define spatial autocorrelation in a VGI system?

The plethora of potential research question also outlines the complexity of VGI, which requires a solid understanding of geographic space and its representation in GIS. The systems perspective does not aim to pull VGI back into the realm of traditional GIS. But it argues that the lessons learned during the comparatively long history of GIS are more important than ever to guide the development of effective VGI systems.

The development of a revised VGI systems framework is in progress, which will be specific to the Geoweb and include representations of the underlying project and the role of participants. The focus of the revised framework will be on VGI processes rather than the structure of the VGI system.

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