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The EcoGeo Cookbook for the assessment of Geographic Information value*

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Abstract

The EcoGeo II project has, as its main goal, the establishment of an economic model to evaluate geographic information (GI). The first phase of the EcoGeo Project has provided a visual representation, called Socioscope, of the overall flows of geospatial data between the main private and public stakeholders of the geomatic sector in the province of Quebec (Canada). From this foundation, EcoGeo Phase II was launched in 2008 with several goals. The first goal was to analyze the most important existing research and approaches to evaluate the economic value of the GI sector. The results show that the value chain concept is, in theory, one of the most suitable approaches that can be adapted to assess GI value. However, it is also one of the most complex due to the number of variables involved with how are GI produced and used within and between organizations. Our second goal was to define the basis or conventions for evaluating GI and, more specifically, to develop a list of parameters which need to be considered for evaluating GI. We defined a set of guidelines that we called the EcoGeo cookbook, which aims at identifying, listing and describing the most

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important variables and attributes relating to GI value which have been identified in literature. These attributes relate to how GI is produced and used (e.g. value of the location attribute, time dependency, quality, etc.), the costs of the GI product (e.g. transaction costs) and the price definition (based on value pricing strategy). Caution must be used when evaluating intangible benefits, which are less easily estimated than tangible ones. The final goal will be to implement such variables and attributes into the Socioscope's database structure. This will also allow for the definition of a specific value chain for the GI sector in Quebec.

Keywords: Geographic Information assessment, evaluation guidelines, value chain.

1. INTRODUCTION

Geographic information is increasingly central at all levels of modern society. Information that was previously expensive and reserved for specialists is now accessible to all users (Longhorn and Blakemore, 2008). The impact of the Internet has been substantial and GI has gradually followed a democratisation process (Gauthier, 1999; Noucher and Archias, 2007). For example, the advent of free web mapping services (e.g. Google Maps) has allowed the wider public to have free access to GI.

GI is considered to be extremely valuable and its collection, processing and management are expensive. Conversely, it is inexpensive to disseminate (Longhorn and Blakemore, 2008; Welle Donker, 2009). The same information can be used by many segments of society for different purposes, therefore there is a wide debate on how society assigns different values to GI (Genovese et al., 2009b).

Today, the province of Quebec, Canada, enjoys a privileged position in the world of geomatics because of the remarkable progresses it has made over the last couple of decades (http://www.quebecgeographique.gouv.qc.ca/). The Quebec government is the primary user and major producer of GI in Quebec. In 2007, The Ministry of Natural Resources and Wildlife in conjunction with a private consortium financed the EcoGeo project which aimed to quantify geomatics data flows in Quebec, and thereby to determine the value chain of geographic data. In particular, the project sought to quantify the cost of inefficient access to data and to identify the future prospects for GI in the development of Quebec's geomatics sector.

Several international projects have had a similar intent to evaluate GI. This is evident in a growing body of literature that documents the need for a systematic assessment of GI overall impact, how companies and governments use GI, and the impacts that GI has on social and economic activities.

The Australian study “The Value of Spatial Information” (ACIL Tasman, 2008) has a similar objective to the one that EcoGeo project has for Quebec. It aimed to establish the economic impact of spatial information on the Australian economy in 2006-2007.

Some recent studies have developed remarkable theoretical frameworks to evaluate Spatial Data Infrastructure (Grus, 2009; Toomanian and Mansourian, 2009; Rodriguez Pabon, 2005).

An important report with a consultative approach was published by the European Commission in 2006, which provides useful guidance on the range of methods available for assessing the socio-economic impacts of SDIs (Craglia and Nowak, 2006).

However, all of these studies are focused on SDI, in contrast to the concern of EcoGeo, which aims to evaluate the whole GI sector (Genovese et al., 2009b). Therefore, although relevant efforts to evaluate GI have been made, most of these studies remain largely theoretical (Genovese et al., 2009b). Moreover, a scientific framework that identifies criteria that can be used to determine and compare the value and benefits of GI projects still remains undefined.

At least in theory if not in practice, it is a reasonably manageable task to assess the value of GI within a single organization through approaches such as value chains, cost-benefit analysis (CBA) or return on investment (ROI). The value of most inputs, outputs and any intermediate products or services can be quantified pretty accurately.

The weakness is that these studies tend to be performed before the project launch and focus on initial set-up costs and short-term efficiency benefits, which are relatively easy to assess when compared to the longer-term social, political and economic benefits (Craglia and Nowak, 2006; GITA, 2006). Moreover, the value of GI should not be assessed exclusively by considering tangible economic impacts since the contributions of GI toward achieving intangible societal or political objectives (e.g. improved quality of life, enhanced economic opportunities, etc.) are often of high importance to decision makers (Longhorn and Blakemore, 2008).

As noted elsewhere (Genovese at al., 2009b), the value chain is considered in the literature as one of the most suitable approaches to assess GI value (Krek and Frank, 2000; Longhorn and Blakemore, 2008; Genovese et al., 2009b). It is also one of the most complex due to the number of variables related to the production and dissemination of GI. Consequently, a value chain dedicated to GI has still not been demonstrated in operational terms.

In this paper, we try to define a basis for the assessment of GI value within the value chain and to develop a specific set of guidelines in a "cookbook" format. The first aim of the "EcoGeo cookbook" is to identify, list and describe the most important variables and attributes relating to GI value which have been identified in literature. These attributes relate to how GI is produced and used, the costs of the GI product (i.e. transaction costs) and the price definition. In particular, intangible benefits have to be considered and, with some approximation, we try to determine how to evaluate them.

2. VALUE AND VALUE CHAIN OF GI

2.1. EcoGeo project

The EcoGeo II project aims to enhance our understanding of GI data flow within the GI sector in Quebec and to assess the appropriateness of the value chain concept as a suitable approach to evaluate GI. The objective is the development of a model for assessing the economic impacts of GI.

The first phase of the EcoGeo Project (EcoGeo I, in 2006) provided a visual representation of the overall flows of geospatial data between the main private and public stakeholders of the GI sector in Quebec. To achieve this, the EcoGeo I team first identified stakeholders involved in the Quebec market and then proposed a new visual tool (called Socioscope) to represent and analyze geospatial data flows of the distribution and dissemination of Geographic Information data.

Based on this foundation, the EcoGeo Phase II project was launched in 2008 with several goals. The first goal was to analyze the most important existing research and approaches to economically evaluate GI sector. For this reason, we tried to define the basis or the conventions for evaluating the effectiveness of investments in the GI sector and develop a list of the parameters which need to be considered.

Attempting to define the value of GI requires introducing several concepts dealing with value theory, the nature of information, and the value of information generally. First, it is necessary to decide which type of value has to be considered: a) the financial (monetary, exchange) value or, b) the socioeconomic value, which is not always easy to define because of the intangible dimensions inherent to many GI uses. We describe the concepts of value and value chain below, and define the variables, attributes and costs which need to be considered when trying to determine GI product value.

2.2. The concept of value

Value can be defined in different ways and it is not always possible to assign a monetary figure to it. Exchange value, which refers to the commercial value of data or services, is only one example. Depending on who is using the information, for what purpose and in what format, different values can be assigned to the same information (Longhorn and Blakemore, 2008). In the private sector and from a market standpoint, a product will not be viable if the costs of data collection, processing, dissemination, and management do not provide a satisfactory return on investment.

The buyer’s perception of the value must be carefully considered when trying to determine a suitable price of a good, for both the private and public sectors. Knowing which properties the potential buyers consider important and how much customers are willing to pay are key considerations in determining the price of a given geographic dataset (Krek, 2002).

If GI transaction involved only private producers and vendors, pricing would be simple, but when we consider the direct and indirect social value these data have for the public sector, the task becomes more complicated. The public sector applies GI data to a great variety of uses and social aims, which create problems in assessing its value.

For example, public safety agencies have begun installing Global Positioning Systems for their emergency services vehicles such as ambulances and fire trucks. Placing GPS systems in ambulances brings emergency care to patients faster and helps to pinpoint the caller's location. Thus, GI information is deemed to be valuable not only for the data owner or user, but also for society as a whole, even though this social value is difficult to quantify in monetary terms (Genovese et al, 2009a).

2.3. The value chain of GI

The concept of value chain is an approach that has been suggested by several authors (Genovese et al., 2009a; Longhorn and Blakemore, 2008; Krek and Frank, 2000; Pira Study, 2000; Porter, 1985) for assessing the value of goods and services.

The value chain concept was initially developed for the manufacturing sector and is perhaps most easily understood in that context because inputs, outputs and value-adding activities are comparatively easy to identify and quantify. More recently, the value chain concept has been applied to other sectors including information and technology where the good or service, and the benefits it provides, are less tangible in nature (Longhorn and Blakemore, 2008).

Porter (1985) initiated the idea that value chain could be used as a tool to evaluate a firm's competitive advantage. He defines value as "the amount buyers are willing to pay for what a firm provides them (Porter 1985, p. 38)". The factors used in this calculation are determined by the price of a firm's product and the number of products available on the market which determine the total revenue (Krek, 2004a).

The value chain is defined by Longhorn and Blakemore (2008, p. 38) as "the set of value-adding activities an organization performs in creating and distributing goods and services, including direct activities such as production and sales, and indirect activities such as managing human resources and providing finance".

Value is created step-by-step along the chain, thus, pricing in a value chain serves to determine the way in which the value created for the end user is distributed among the contributors. The sum of all such margins, at the end of the chain, equals the total value added (Krek and Frank, 2000).

In the context of GI, the value chain relates to the set of value-adding operations undertaken by one or more producers, to transform GI data (datasets or analogue maps) by integrating them with other sources of information, attributes, models, and dissemination technology to create new products (e.g. enhanced data sets, maps and tabular outputs, etc.).

Assessing the GI value chain entails consideration of many variables. The initial cost of producing a dataset represents a high percentage of the total cost due to the labor costs involved in capturing or measuring the data as well as the cost of data transformation, analysis, and modification (Krek and Frank, 2000). Having defined the value chain for a specific product or service, it is possible to assign costs to the activities along the chain.

Understanding the value of a good is essential when considering the pricing of a good since the best measure of the value of GI is the consumer`s willingness to pay for the finished product– which is closely related to the "fitness for use" concept (De Bruin et al, 2001). If we deduct the cost of the product from this figure, we have a true measure of the net benefits to society.

In a previous study (Genovese et al., 2009b), we analysed the current literature related to assessing the value of GI with reference to two key variables: topics and approaches. We benefited from this as we aimed to summarize the attributes and evaluation methods that we found in the existing literature.

In Section 3, we list the intrinsic attributes of GI value that can add related value to raw geographic data. In Sections 4 and 5, the methodologies for cost evaluation and price setting are described in detail. Prior to discussing these issues, it is important to acknowledge the similarities and differences between the private and public sectors. We propose that the value chain perceived by public sector GI owners (government agencies), who collect and use such GI for legally mandated purposes relating to governments of society, differs from the value chain for commercial actors in the information market (table 1).

Public organizations, such as national mapping agencies, also sell their data on the geoinformation market. When this happens, they can be likened to the private sector. Similarly, public-private partnership activities often take place and may eventually produce a socio-economic value that needs to be taken into account.

2.4. Different components of the value of GI: intrinsic attributes

Understanding the value of GI requires a closer look at the relationships between data and intrinsic attributes that can add contextual value to raw geographic data such as location, context, timeliness, data format and standards, legal status network effect and quality (Longhorn and Blakemore, 2008). We briefly describe how to evaluate these attributes in Table 2.

Table 1: What to evaluate and how to evaluate in private and public sector

	SECTOR	WHAT TO EVALUATE	VALUE TO WHOM	HOW TO EVALUATE
	PRIVATE SECTOR	COMMERCIAL, MONETARY (EXCHANGE) VALUE)	The data owners and commercial vendors	Commercial sector GI has identifiable monetary value for its producers and vendors. Value to the first buyer is set to production cost recovery, profits margins, and return on investment (ROI).
WHICH VALUE			The data user	This type of value is typically reflected in the price that the consumer is willing to pay for the product or service offered and can also be determined reasonably well.
	PUBLIC SECTOR	COMMERCIAL, MONETARY (EXCHANGE) VALUE	The data owners and commercial vendors	Financial value can also apply to public sector GI if use of the information helps deliver cost savings or aids in managing financial risk.
			The data user	Social GI has less quantifiable direct and indirect value to the society resulting from the services offered by using GI data.
		SOCIO-ECONOMIC VALUE	The society as whole	Public sector bodies that collect and use GI assess the added value to users or to society at the least possible cost. The value of the GI is measured in terms of most efficient service delivery to citizens.

Table 2: Attributes of GI value (adapted from: Longhorn and Blakemore, 2008)

INTRINSIC ATTRIBUTES of GI VALUE	WHAT TO EVALUATE
Value of the location attribute in GI	The location attribute provides spatial context to the other attributes in the information package, thus increasing the value of the data for applications where spatial awareness is key.
Time dependency value of GI	The value of certain types of GI may depend on whether it is real-time data or historical, e.g. the time related value of GI meteorological data used to prepare weather forecasts that underpins a myriad of decisions at private and governmental levels, or real time data for Location Based Services.
Value determined by cost savings	Value can be determined by the cost savings realized by reducing duplication in the data collection process, especially when developing a national SDI.
Adding value via information management and tools	The value of GI can be increased depending on the data formats, standards and metadata used since the impact on how the data can be disseminated and incorporated with other data sources.
Value due to legal or other mandatory use requirements	In many legal jurisdictions, information is given an official or legal status for certain types of transactions. One of the most common examples is the boundary data in cadastral land registration systems. The certification component could also be a substantial value-adding element.
Value due to network effects	Some information has added value simply because it is used by large numbers of people (i.e. market size), e. g. online maps (Google map and others).The value created by network effects is referred to as a “network externality” in economic literature (Katz and Shapiro, 1985). Positive network externalities exist if the benefits increase as a function of the number of additional users.

Value due to quality of an information resource	The factors related to the production and dissemination of GI are: context, attributes, timeliness, quality, accuracy, completeness, exhaustiveness, provenance, history (when data was collected, validated, and updated) or the method by which it was measured.

3. HOW TO EVALUATE COSTS?

One of the basic principles of GI strategies is that data relating to a given feature or phenomenon should be collected by one government agency and shared with other levels whenever possible. This reduces duplication of data collection and transaction costs. Inputs, including monetary costs to create, update, market and distribute a particular data set, can be calculated with reasonable accuracy in this context (Krek, 2004b) as illustrated by table 3.

Institutions sometimes increase costs by creating barriers to market entry, encouraging restrictions, and impeding the low cost flow of information (Krek, 2004b). In the past, the National Mapping Agencies were seen as institutions that prevented further development of the GI market due to their data policies.

At present, institutions are facing a liberalization effort. They often possess high-quality large-scale GI, which is primarily created, collected, developed and maintained to support their public tasks (Welle Donker, 2009). They sometimes make information available online, according to different business models (see Section 4.2).

Electronic networks can potentially reduce collection and transaction costs for potential buyers and sellers of the GI product by allowing easy access to information. Selling GI products on the Internet is now quite common and makes information more widely available, but this kind of dissemination presents several difficulties.

First, the seller has no control over the use of the product and cannot prevent misuses of its derivatives. To manage this, organizations frequently face enforcement costs, including the costs of protecting rights, policing and enforcing agreements (Krek, 2003; Genovese et al., 2009a).

Inputs, including monetary costs to create, update, market and distribute a particular data set, can be calculated with reasonable accuracy in this context (Krek, 2004b) as illustrated by table 3.

4. PRICE DEFINITION

Many data producers make do not accurately link prices to production costs. As a result, price is not revised often enough to capitalise on market changes and set independently of other market factors, making it not varied enough for different product items, market segments, distribution channels, and purchase occasions.

The demand for GI is characterised by the range of information needs and the differing degrees of willingness to pay for the information. This implies that different groups of users require different GI and are willing to pay different prices for this information.

The price for GI should, therefore, be designed in such a way as to correspond to these varieties. According to other studies (Longhorn and Blakemore, 2008; Krek, 2004a), we suggest value pricing, which is described in Table 4 below, as an appropriate pricing strategy to satisfy different market segments.

4.1. Price setting strategies

Value pricing is a market-based pricing technique where the price of the product is set according to the value that the product has for the buyer (Krek, 2004a Shapiro and Varian 1999; Varian 1996). It enables producers and sellers to derive higher revenue by serving new markets that would otherwise not have been served.

The economic value a buyer attaches to the product and its characteristics reflects their preferences and needs. Value pricing has been recognized as an efficient pricing strategy for information products because the cost structure of GI products has a high fixed cost of production and a relatively low marginal cost of reproduction.

In order to determine price, GI producers must be able to identify which product characteristics have economic value for the buyer, separate buyers into different categories and differentiate their products, as explained in Table 4. Metric conjoint methods enable producers to examine consumer behavior, measure their preferences, and predict their choices from several alternatives.

While some users may believe that offering the same or very similar products to different buyers at different prices is unfair, the value pricing approach is used successfully with many vendors offering discounted software or data to non-profit organisations, governments, and the education sectors.

Table 3: Evaluating the costs of GI products.

COSTS OF GI PRODUCTS	WHAT TO EVALUATE	HOW TO EVALUATE
1. TRANSACTION COSTS	An exchange (sale or trade) of GI data is a transaction and involves transaction costs. These refer to the cost of measuring valuable attributes of what is being exchanged (measurement cost) and the cost of protecting rights, policing and enforcing agreements (enforcement cost) (North, 1997; Krek, 2004b).	We can evaluate measurement costs and enforcement costs in the following manner.
1.1 Measurement costs	Measurement cost is the cost of measuring the valuable attributes and characteristics of what is exchanged, that is incurred by both vendors and purchasers to different extents and in different ways (Krek, 2004b). Searching for the right datasets and acquiring the information about the level of quality and usability for the specific application is costly. The potential buyer incurs cost while trying to find the appropriate seller or producer of the dataset and in contacting possible providers. Consequently, the datasets should be offered in such a way as to minimize the transaction cost for the buyer.	We can measure - the time required - person-hours worked - the economic value of tests and benchmarks. We can determine the time involved in the different phases of the transaction. This gives us a concrete number of hours spent in the whole process that can be transformed into monetary value. To attempt to measure the transaction cost, it is possible to select several datasets that can be used in different applications, structure the buying procedure and measure the transaction cost, and then compare the transaction cost with the prices of the datasets.

1.2 Enforcement costs	Enforcement cost is the cost of protecting rights, policing and enforcing agreements (Krek, 2004b). These includes resources involved in defining, protecting, and ensuring property rights, security standards, the right to use, the right to derive income from the use of, the right to exclude, and the right to exchange.	We can consider: - professional certification - legal costs. Moreover, it is possible to analyze the restrictions that are imposed by institutions, such as National Mapping Agencies (NMA), and look at how they affect the transaction cost imposed on the potential buyer of the dataset.
2. DATA COLLECTION COSTS	Data collection itself can be very costly and can represent a high percentage of the total cost of producing a dataset (Krek, 2003). It includes production and transformation costs. Thanks to new technologies, data collection costs are generally falling. New technologies facilitate the capture of data, but it may be necessary to transform the data before using it.	The fixed cost can be elevated mostly because of the high labor cost of capturing data from data sources or measuring them with measurement techniques (topometry, photogrammetry, geodesy, etc.) and the cost of data transformation, analysis, and modification (Krek, 2003). For example, it may be less expensive for a company to buy a topographic map or a base map that has been produced by NMA than producing it, and then editing and modifying to suit particular needs. Data collection can be less expensive when there are established procedures and automated tools available (e.g. GPS, AVLS…) to capture new data.

2.1 Production costs	Production costs include the labor costs involved in capturing or measuring the data from the data sources, as well as the cost of data transformation, analysis, and modification.	Production costs are transparent and relatively measurable (Krek, 2003). The dataset producers are aware of the production costs and they try to cover them with cost-recovery pricing of their products that can represent a barrier for the potential users because it exceeds the maximum price that they are willing to pay. In addition it is possible to reduce production costs by using data that is distributed by public organizations.
2.2 Transformation costs	The transformation cost is the cost of transforming resource inputs into the physical attributes of a product (Krek, 2003).	The transformation cost is reasonably measurable. As with production cost, the dataset producers are aware of the transformation costs and they try to cover them with cost-recovery pricing. This can represent an obstacle for the potential users who have a limit on how much they are willing to pay.
2.3 Maintenance and upgrading	Maintenance and upgrading are essential activities and can be very expensive, when added to the ongoing operational costs of an organization. For example, the maintenance expenses can be very high when the digital maps of an urban database have to be upgraded.	We can measure: - the time required - person-hours worked. These cost decrease because of better organization and reduced data duplication.

Table 4: How to define the price of GI product

PRICE DEFINITION	WHAT TO EVALUATE	HOW TO EVALUATE
1. User valuation and preferences	According to value pricing, the producer sets the price based on the value that the product has for the potential buyer. The economic value the potential buyer attaches to the product reflects his preferences and valuation of the product's characteristics. It is directly related to the buyer's needs and willingness to pay for certain properties of the product (Krek, 2004a and 2006).	According to Krek, metric conjoint analysis identifies characteristics of the product that can be identified and measured (Krek, 2006). Conjoint analysis is used to study product preference data and simulate consumer choice. Its theoretical roots are in the psychological literature on information processing and complex decision-making (Green, 1971).
2. Differences in market segments and resulting market changes.	Value pricing can be successfully implemented to GI if the producer knows the preferences of the potential buyers and is able to segment them into different groups, combining buyers with similar GI needs into common groups.	In order to set the price, potential buyers have to be divided into groups of users with similar sets of wants. Such groups are called market segments.

3. Product differentiation	Product differentiation is concerned with how the producer of GI offers its products in the marketplace, to make it more attractive to a particular target market. Differentiated products are both similar and different, and these differences are grounded in the preferences of a buyer. GI products can be differentiated according to different characteristics such as: quality of sources of GI, completeness of the application, time, form, and format of GI delivery, copyright, etc. (Krek, 2006).	Market characteristics of products which can influence the price are: - differences in quality which are usually accompanied by differences in price - differences in functional features or design; - ignorance of buyers regarding the essential characteristics of goods they are purchasing - sales promotion activities of sellers, especially advertising; - differences in availability (e.g. timing and location).

4.2. Internet changes the rules

The advent of Internet-based data access and dissemination has partially changed the rules of pricing strategies by altering the marginal costs of processing payments and distributing data. Price can be related not only to the traditional component cost of production, but to a higher value based on brand and legally enforced exclusivity. The brand and exclusivity pricing approach is a form of reputation pricing, wherein the preservation of reputation is ever more challenging with the global flows of information (Longhorn and Blakemore, 2008).

Moreover, the price is often not the crucial topic of debate, especially in the case of web GI data distribution. When topographic data is freely available from public agencies, such as the USGS in the U.S. or Geoconnection in Canada, the critical debate is over the consistent resources for reinvestment and maintenance of information since some of them are reported to be several years out of date (Brown, 2002; Longhorn and Blakemore, 2008). The costs of web services are high and revenues do not always cover these costs.

Assuming that there is “no such thing as a free lunch” related to the public sector GI (Longhorn and Blakemore, 2008), some studies suggest business and financial models to evaluate public sector geo web services (Zevenbergen, 2006; Welle Donker, 2009).

According to Welle Donker (2009), the possible business models are:

1. *Subscription model*: revenue is raised through periodic fees.

2. *Usage Model*: revenue is raised through actual usage of a service. Usage may be measured in time, per bytes, per area or per session.

3. *Royalty model*: revenue is raised through royalties paid after a value added product has been successfully produced. The price, the royalty, is usually a fixed percentage of the turnover or the revenue of the value added product of the user.

4. *Free Model*: there is no direct revenue raised through this model, although there will be indirect benefits. Public sector organisations employ this model. The immediate benefits are intangible, e.g. a better-informed citizen or better policy effectiveness, or the benefits may be financial in the long term.

Starting from these four key models, several hybrid models can be defined. In general, the Free model is the most appropriate for the public sectors. In this context, the Royalty model resembles the Free model because no value is being added. For the private sector, the Royalty or Hybrid models would be more appropriate than the commonly applied Usage model, which is not viable in the long term (Welle Donker, 2009).

Note: the cookbook evaluation framework does not aim to explore how to determine the value of free resources such as Google Map and Google Earth, or tools based on Volunteered GI (e.g. Wikimapia, OpenStreetMap, Google MyMaps, etc.), which allow casual users to create and disseminate geographic data (Goodchild, 2007). Because of their specific characteristics, these topics require more specific analysis and the definition of appropriate frameworks and business models.

5. INTANGIBLE BENEFITS

When quantifying the effectiveness of GI solutions, it is important to consider both the influence these technologies have on society, as well as society's influence on the development of these technologies (Goodchild, 1995; Tulloch et al., 1998; Roche and Caron, 2004; Chrisman, 2005). Much has been written about the social value of information and building our understanding of the interactions between technical and social factors that exist in GI environments (Budhathoki and Nedovic-Budic 2007; Georgiadou et al. 2005). In part, this can be traced to the fact that many uses for a GI product or service relate to broader societal goals (e.g. road safety improvements related to real-time traffic updates, enhanced emergency response through ambulance navigation systems, etc.). In addition, many information products have direct or indirect value to which it is exceptionally difficult to attach an exact monetary-financial value.

While tangible benefits can be monetised with reference to future revenue or cost savings, many benefits are not easily estimated and it is not possible to quantify the economic value of a particular project's outcome. According to Craglia and Novak (2006), these intangible social-political benefits associated with GI projects include:

1. Benefits to citizens (greater access to information, more transparent and accountable governance; improved empowerment and participation; customer/citizen goodwill, quality of life).

2. Benefits to government (improved collaboration with other stakeholders within and outside government, greater political legitimacy; improved decision making; improvements in emergency services, public safety, environmental issues and sustainable development, forestry, agriculture, urban and rural planning, land management, military, security and health service).

3. Benefits to business (increased innovation and knowledge, new business opportunities and applications, job creation).

Socio-economic aspects of GI infrastructure are increasingly considered in GI development and particularly in GI research. Originally the technological dimension of GI infrastructure was the dimension assessed to be most relevant, now it is commonly understood that the non-technical aspects should also be addressed and understood in order to assess GI value (Van Loenen, 2008).

Although intangible benefits do not usually affect the financial analysis directly, they can be equally or even more important than the tangible benefits (Genovese et al., 2009b). Wishart (2007) tried to find a systematic and practical approach for identifying and quantifying all the intangible benefits of a GIS business case, as summarized in Table 5. The method for valuing these assets is based on the fact that, if these benefits are important to us, then they must be detectable in some way. Wishart defines a list of intangible benefits and determines the possible metrics that can be applied to evaluate them:

Table 5: How to evaluate intangible benefits (adapted from Wishart, 2007)

Intangible benefits	Possible metrics
Better decision making	Numbers of appeals Speed of process
Improved customer service	Volume of contacts in Customer Relationship Management Systems Revenue per customer
Easier access to data	Staff time spent compiling reports
Improved data quality	Data audit

However, the evaluation matrix proposed by Wishart is focused on the private business sector. Much more effort needs to be dedicated to the identification and measurement of socio-economic impacts and benefits of GI, particularly those that appear to be intangible (at the public level). For example, this can be done by organizing citizen focus groups, round tables and surveys which can help derive the value of specific GI applications or structures in modern societies. Statistical analysis can help in determining the enhancement that GI produces, for example in the case of public safety emergency intervention (e.g. increased number of saved lives or reduction of arrival time for ambulances and fire trucks).

6. SUMMARY AND CONCLUSION

After reviewing all possible methodologies, we have concluded that the best measure of GI value is the willingness to pay for the finished product by the final consumer (Longhorn and Blakemore, 2008). If we deduct the cost of the product, as we described in Section 4, we have a measure of the net benefits of the GI.

For commercial stakeholders, earning a suitable return on investment is the justification for generating, collecting and/or selling GI datasets and GI based services. Inevitably monetary value is their primary motivation.

For a private organization producing GI, added value can be determined as the difference between its revenues (which is determined by the selling price) and its costs, including: salaries, material costs, an imputed cost of capital, and the appropriate previously described data collection costs, including transaction costs. These components of cost have to be included in the value chain.

Net output measures the difference between revenue and costs, and either measure can be used to provide insight into the value chain. Expenditure by the final consumer, less all the costs incurred along the value chain, will provide an estimate of the net benefits to the organization. Sometimes potential indirect benefits also have to be considered in the private sector.

For the public sector, where prices may be substantially below cost, accounting for the value chain using the same approach may be extremely confusing. Too much added value may be attributed to the first buyer of the information in the chain.

However, when information is re-packaged and sold, estimates for final value may still be calculable (Pira Study, 2000). In other cases, where information is sold well below cost to final users, value estimates can be based on other components like transaction costs. To define the final benefits, the intangible benefits also have to be considered, even if their evaluation is often complicated to calculate in monetary terms.

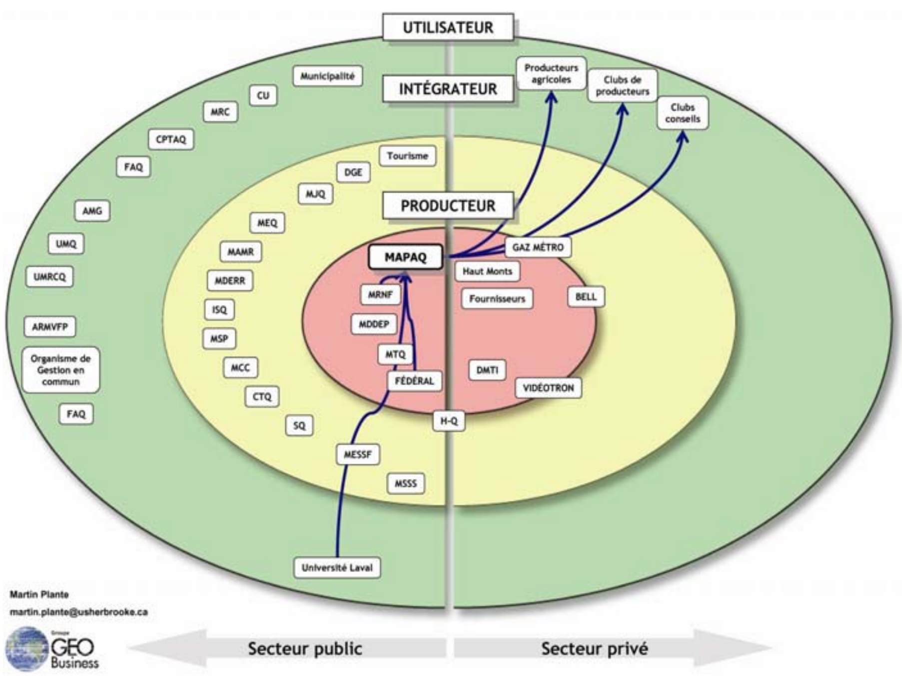
6.1. Future work

The aim of EcoGeo is to use the Socioscope prototype, defined during the first phase of EcoGeo. The main user interface of the prototype includes the organizations that have been identified in the Quebec area. It is fundamental to know the stakeholders involved in the value process (data producer, data owner, users or the entire society) and understand their roles in defining the value of GI, and Socioscope is useful in this task.

The Socioscope identifies the relationships among organizations (Plante, 2006) in order to evaluate different sub-sector values. The sum of these value components provides a fairly accurate idea of the total GI sector value. GI flows may have various forms according to the organisations involved (sale, loan, gift, donation, exchange, sharing and others). These links can be single direction or double direction. They have been grouped by function: data producer, solution integrator, and user (listed in Figure 1 and 2 with the corresponding French names: *producteur*, *intégrateur*, and *utilisateur*).

The prototype differentiates the economic realities of the GI market for the public and private sectors. This distinction is of primary importance when considering the perception of the value chain by public sector GI owners (government agencies) who collect and use the GI for purposes relating to society, which involves a quantity of socio-economical uses and objectives for which the value is difficult to evaluate.

Figure 1. Global representation of GI data flows within the geomatic sector in Quebec: Socioscope interface



Even though these organizations can play more than one role in the geomatic sector, they have been grouped by their primary one. This is a limit of the interface because producers can also be consumers at the same time, and this characteristic affects the value chain. In 2008, Budhathoki et al. (2008) coined the definition of "producers" to emphasize the combination of roles of "producer" and "users", which is becoming more and more used to define this peculiarity of modern GI sector.

The next step of the EcoGeo project will be to define a value chain specific enough for the Quebec GI sector, encompassing an extensive range of issues including production, maintenance, distribution, and consumption of GI. The new focus is on developing and improving the Socioscope functions in order to reach the goal of implementing the value chain inside the prototype. Using the information gained by adding new attributes, described in this Cookbook, we will be able to define where and when value is added during each step of the life cycle of a GI product.

With the definition of a value chain for the Quebec GI sector, using modalities that are defined by the EcoGeo Cookbook, it will be possible to roughly follow the generation of added value on a specific network of geospatial data flows, starting from the original producer and ending with the final consumer. The next step of the project is an economic evaluation for a test-area inside the value chain.

The ability to economically assess the GI value will provide key support in strategic decisions making and business efficiency, helping private companies to obtain a positive return on investments, but more importantly to improve the citizens' quality of life and deliver more efficient government in the institutional sector. The weakness of using the value chain concept to assess the value of GI arises at the implementation stage due to the complexity of formalizing it into inter-organizational context.

We would like to point out that this article contains Cookbook – Version I. For future research the goal is not only to apply its guidelines within the Quebec value chain, but to expand its utilisation to other international context in order to improve the Cookbook and develop more complete and detailed future versions.

We invite international researchers to mobilise around the Cookbook and encourage its use in more widespread contexts. Eventually this will result in an upgraded version that could be adapted to other segments of the GI economic evaluation field.

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