

# MAKING INTERNATIONAL DEVELOPMENT MORE EFFICIENT AND TRANSPARENT WITH REMOTE SENSING AND GEOSPATIAL INFORMATION

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**ABSTRACT:** It has long been recognized that geospatial information is of great value in international development. Simply stated a map helps you understand where you are and can also help one identify where problems are. At one time geospatial information meant maps: today it is much more. In addition to traditional maps one can think of satellite imagery of various kinds, Global Positioning Satellites (GPS), and geospatial data bases containing census information, land ownership records, or environmental and natural resource information. All of this information can be stored, viewed and manipulated in a geographic information system or spatial data infrastructure. This information has become even more important as we enter the GeoEconomy – the new economy dependent on and driven by geo-information. Today we can and should go one step further. While geo-information is useful in informing decisions – where to locate a new hospital, where a new road should go, or where illegal logging has occurred – it is also useful in many more ways and for many more reasons for those involved in development assistance – whether on the giving or receiving end.

This paper focuses on how and why geo-information is of value in the context of international assistance. It first introduces the roles of geospatial information or geo-information in development – what it can be used for and where. It then examines the value proposition – essentially explaining why geospatial information should be used. Lastly we introduce an approach to the integration of geo-information into development assistance, with the goal of improved delivery of bilateral and multilateral assistance.

## 1. INTRODUCTION

It has long been recognized that geospatial information is of great value in international development. Simply stated a map helps you understand where you are and can also help one identify where problems are. At one time geospatial information meant maps: today it is much more. In addition to traditional maps one can think of satellite imagery of various kinds, Global Positioning Satellites (GPS), and geospatial data bases containing census information, land ownership records, or environmental and natural resource information. All of this information can be stored, viewed and manipulated in a geographic information system or spatial data infrastructure. This information has become even more important as we enter what we have called the GeoEconomy – the new economy dependent on and driven by geo-information. (Ryerson and Aronoff, 2010)

Brandenberger once said that developed countries did not have good maps because they were developed; they were developed because they had good maps. (Brandenberger, 1968) While some may see this as hyperbole, or at least as an exaggeration, others have more recently said much the same thing. In 1999 the United Nations adopted this statement that came from a workshop in which the senior author participated:

“Whereas maps and geospatial data derived from a combination of Earth observation information and other data were as much a part of a nation’s infrastructure as the transportation network, the health-care system, telecommunications and education, the creation of a national geospatial infrastructure should be accorded the same level of support as the other elements of national infrastructure.” (UNISPACE, 1999)

Today we can and should go one step further. While the information is useful in informing decisions – where to locate a new hospital, where a new road should go, or where illegal logging has occurred – it is also useful in many

more ways and for many more reasons for those involved in development assistance – whether on the financing or receiving end.

The balance of this paper will focus on how and why geo-information (a term we take to include location, land survey and remote sensing imagery) is of value in the context of international assistance. Section 2 introduces the roles of geospatial information or geo-information in development – what it can be used for, where, and by whom. Section 3 examines the value proposition – essentially explaining why geospatial information should be used and its importance in ensuring more efficient and transparent development. Section 3 closes with a short examination as to why geo-information is not used more often. Section 4 proposes an approach to implementing the integration of geo-information into development assistance, with the focus on explaining a model for the improved delivery of bilateral and multilateral assistance that has already gained traction in a number of agencies involved in development assistance.

## **2. THE ROLE OF GEO-INFORMATION IN DEVELOPMENT**

### **2.1. Introduction**

One of the most important uses of geo-information in development today is the creation of land ownership or land tenure records. While the importance of land ownership in development has been well documented elsewhere (deSoto, 2000), it is not further considered here except to note that remotely sensed imagery has been used as a base upon which to record ownership boundaries. (Ryerson et al, 2003, page 23).

Returning to development assistance issues more generally, geo-information (including remote sensing) can be discussed in terms of how it is used, where it is used, and by whom. These three topics are the subject of the remainder of this section. Obviously, since we are dealing with geo-information, a location factor, or “where,” is also an element of both the “How” and the “Who” questions.

The question “How is Geo-information used in development assistance?” is interesting to consider because of the complexity of the response. While mapping has long been seen as a fundamental tool in development, the broad understanding of the importance of integrated spatial data bases has been less well accepted, leading to the current situation: while geo-information’s use in development is growing, its use is far below its potential application.

Considering the question: “where can geo-information be used in development assistance?” the broad answer can be given in one word: everywhere.

The question: “who can use geo-information in development assistance?” can also be answered succinctly: everyone involved in development can use geo-information. This includes donor agencies, agencies of the recipient government, local recipients, those on the ground managing delivery of the assistance, and those wishing to compare results or level of assistance from one place to another.

More detailed explanations of the responses to the “How,” “Where,” and “Who” questions are given in the following sections that provide some sample of questions related to development assistance answered by geo-information, supported by cases from the published literature and anecdotal evidence from the authors’ experience.

### **2.2. How Geo-information Can be Used in Development Assistance**

In many areas where geo-information and remote sensing are used it can be said that the range of applications is limited only by the imagination of the potential users. That is not the case when these tools are applied in development assistance. A previous study for CIDA identified common attributes of successful projects in remote sensing. (Ryerson and Quiroga, 2000) With additional experience we can generalize to conclude that in development there are four prerequisites for the successful application of geo-information: the information must be accessible, appropriate to the task, potential users must be what we call “geo-aware,” and there must be adequate funding. Without all four of these, the application will at best be sub-optimal, and at worst fail.

Accessible implies a data policy as has been developed by and for the country involved, as has been done in a number of jurisdictions (Ryerson, 2005; Atwood et al, 2009; Shafee et al, 2010.) Appropriateness of the data will

vary with the application. The application will dictate the required accuracy (in terms of the data's geometry, for example), age, spatial resolution, information content, and up-date cycle of the required data. While there are a number of general guidelines on appropriate data for specific applications, in general, given the highly variable nature of the prerequisites cited, one must treat each application as a separate exercise. Some of the many widely distributed papers and monographs have been provided by agencies such as the Food and Agricultural Organization of the United Nations (See for example the references to Ryerson et al, 2003; FAO, various dates; and Kapetsky and Aguilar-Manjarrez, 2007) as well as many papers in the scientific and technical literature ranging from international journals such as the *International Journal of Remote Sensing*, and *Geocarto International* on to more locally focused but very useful journals such as the *Malaysian Journal of Remote Sensing & GIS* or the *Journal of the Indian Society of Remote Sensing*.

We can identify four basic applications of geo-information in development:

1. To create information used to decide what assistance is needed and where it is needed;
2. To integrate and understand information in the appropriate spatial context for development;
3. To track results of assistance at a specific location or within a specific region; and
4. To track and compare the results of development assistance from one place to another.

Questions that might be answered related deciding what assistance is needed are simple and straightforward. They might include:

- Where might small land holders benefit from small loans?
- Where will agriculture need to adapt to changing precipitation patterns?
- Where was the flood? Where is temporary shelter required?
- Where is the drought? Where is food assistance required?
- Where should small weirs be located on the stream course to recharge the ground water supply without introducing naturally occurring arsenic?
- Where is the new school/hospital/water well required?
- Where can the new transit system be located to minimize the impact on the environment?

Questions that integrate and help understand information in the appropriate context for development add a dimension of other data and further analysis of these data in an integrated fashion. Such applications depend on more sophisticated national, sub-national, or regional data bases. They might include:

- Where can additional tourism facilities be located without a negative impact on the environment?
- What is the range of the endangered animal that must be protected to foster eco-tourism?
- Where is the logging taking place? Is the annual cut on that forest sustainable?
- Where is the source of the pollution entering the river/lake/bay?
- Where and how are the wetlands being destroyed and with what result?
- What crops will be grown where with 20 cm less rain and a 2 degree increase in temperature?

Tracking the results of assistance at a specific location or within a specific region can be seen as a tool for monitoring results of programs in an open and transparent fashion. Questions related to such tracking might include:

- Has the AIDS infection level decreased in the study area? Is there a relationship to recent assistance?
- Has infant mortality increased or decreased in the state and the sub-regions in the state? Is there a relationship to recent assistance?
- Has food production increased?
- Are there regional differences in the gender program? If so, how much and where?

Tracking and comparing the results of development assistance from one place to another is another application of geo-information and associated tools. Questions that might be answered include:

- Are the regional differences in the gender program related to a specific aid delivery modality?
- Where is the environment in worse condition now than 10 years ago? Can this change be linked to different development activities?
- Given regional changes in infant mortality, where have pre-natal programs been delivered and by whom?
- What is the distribution of World Bank's projects within Sub-Saharan Africa?

### **2.3. Where Can Geo-information Be Used in Development Assistance**

When applying geo-information in development assistance, the ‘where’ question is the easiest one to answer. Geo-information can be used across the full range of geographic jurisdictions implicated in development assistance: from villages to major cities, on to the state or provincial level, and nationally. International organizations are now using geo-information regionally involving several countries (for example those sharing a major River Basin such as the Mekong), sub-continent (such as the Sub-Saharan region of Africa), and continents. Some international organizations produce global comparisons at the national level, while others produce simple maps to allow one to draw comparisons.

### **2.3. Who Can Use Geo-Information in Development Assistance**

We have answered the question ‘Who can use geo-information in development assistance?’ with one phrase: everyone involved in development. The rest of this section reviews how each group can make use of geo-information.

Donor agencies have long contributed to the creation of maps and related geo-information for development. While such contributions remain important, there has been a shift in emphasis to the creation of land ownership and cadastral records, environmental information, as well as national geospatial data bases such as have been described in Shafee et al (2010). One of the difficulties often encountered is that different agencies of a recipient government would receive assistance from different donors, and the data and systems would be incompatible, preventing national-level planning. This issue, noted as early as 2000 (Ryerson and Batterham), is now being addressed with attempts to coordinate information and systems from different donors so that the information can be used in an integrated fashion.

Agencies of the recipient government can use geo-information in several ways. The first use is for planning – to evaluate the trade-offs between different courses of action. The second use is in the development of proposals to donors to provide the “what, where, and why” justification for assistance. Lastly, recipient nations can use the information for monitoring and assessing results of actions taken under the assistance umbrella. The latter is often a pre-condition set by the donor community that now wants to demonstrate openness and transparency in assistance.

Local recipients have benefited as expected from the application of the information to a specific situation – location of a weir for water harvesting, or better prediction of flooding, for example. But the information has often been used in innovative ways and for purposes not envisioned when the data were first presented to local recipients. In a case in Bankura, India the District Magistrate obtained GIS outputs from a UNDP funded program that was designed to develop and use GIS at the more local level. She used this information (on the level of education of residents, availability of land, infrastructure support, etc) to generate information for potential investors in the region’s industry. Investment increased. This small and simple application convinced the District Magistrate of the potential importance of the technology in a broader range of activities including land use planning, resource management, etc. This sort of simple but successful demonstration of the value of geospatial technology over a number of years led to the Government of India to lessen restrictions on data access.

Those on the ground managing the delivery of assistance can include both those working for the donor agency as well as those working for the recipient agency or the local populace. Geo-information is used to improve local decision-making by improving transparency and by providing better information to support different options. For example, one regional elder in Bangladesh was reported to the senior author to be especially supportive of the GIS for school location. His village already has a school. When the decision was being made as to where to locate the next school, each of his cousins each argued for their specific village. The GIS solved this potential conflict within the family – the GIS could be “blamed” for the decision, not the elder.

The use of geo-information has grown to be much more than just creating useful information. The demand on donor agencies for transparency and demonstrated results has led to an interest in and demand for tools that allow comparison and assessment of the relative effectiveness of various aid activities. The early leader in this sort of activity was the United States Agency for International Development (US-AID) that started the development of its

geo-based monitoring and tracking system in 2005. US-AID uses geospatial to both track and assess their aid programs. US-AID has linked their activities to location to better assess where aid is going and results of that aid. They have developed an Internet-based Management Information System and GIS to track and evaluate its projects, measure results, and tell its story to stakeholders and the public in general. See <http://proceedings.esri.com/library/userconf/feduc05/docs/pap194.pdf>.

More recently the World Bank developed a program called “Mapping for Results.” The Bank has (as of August 2, 2011) mapped 2,813 financed activities working in 16,520 sites. The “initiative visualizes the location of World Bank projects to better monitor projects and impact on people; to enhance transparency and social accountability; and to enable citizens and other stakeholders to provide direct feedback.” (<http://maps.worldbank.org/> and <http://data.worldbank.org/>) In the words of one of the senior managers involved in the program “It is about geo-enabling the Bank and creating the foundational data that will allow for all kinds of analysis, better planning, better monitoring, and eventually direct engagement with citizens. (Aleem Walji, WBI Innovation Practice Manager, quoted in World Bank 2010). The questions that can be answered by aid agencies with appropriate data included:

- Where did we spend money, what was money spent on in these areas, and with what outcome?
- Where was the development money most effective in achieving goals? What lessons can be learned?

### **3.0. THE VALUE PROPOSITION: WHY GEOSPATIAL INFORMATION SHOULD BE USED, AND WHY IT OFTEN ISN'T**

As noted above, the value proposition for the use of geospatial information in development has been articulated by a number of authors and agencies, beginning with Brandenberger (1968). West Africa in general and Burkina Faso in particular provide an especially useful example of some of the successes that can be achieved by coordinating even simple applications of geo-information. (Bassolé et al, 2001) More recently it has been argued that the appropriate use of geo-information leads to more efficient and transparent development by allowing the comparative evaluation of the inputs and resulting outputs and outcomes of development assistance from one place to another. Without these comparisons the impact of assistance and any variability that might exist from one place to another cannot be assessed. Furthermore, the efficacy of different modalities of assistance cannot be evaluated.

The use of geo-information is especially important where one encounters variability in the need for assistance within a country. For example one might consider countries where there are highly variable levels of development demanding different levels of assistance from one place or region to another. In evaluations in the field involving hundreds of geospatial projects (Ryerson and Batterham, 2000; Ryerson and Quiroga, 2000) it has been found that where assistance has enabled geospatial to be fully integrated in management of resources and planning (especially across the country to strategically link its many ministries), it has tended to have advanced a country's development. However, where assistance has resulted in piecemeal geospatial implementations and was not viewed or developed as a truly national effort, important opportunities tend to be missed and scarce human resources (especially in geospatial) have been squandered. At best there has often been a waste of scarce resources, and at worst a legacy of systems and data that cannot “speak” to each other. Both situations hamper development.

On a broader basis, but similar in concept to the country examples in the previous paragraphs, are the international agencies that operate either world-wide or in a number of countries within a region. They too should be expected to be able to compare the need for assistance to what is being delivered and what is being achieved, including the impacts of using different delivery modalities in different locations.

From the discussion to this point it would appear that it should be a simple matter to decide to include geospatial information and technology as part of development assistance as well as using it as a tool for planning and assessing the efficacy of assistance. But this is not always the case<sup>1</sup>. At one time geospatial information in the form of topographic mapping was seen as a basic building block for development. Indeed, it was funding under the Colombo Plan and other aid activities in the 1950s and 1960s that led to the early rapid growth of the aerial survey industry in the USA, Canada and Europe following World War II. Provision of maps was seen as the basis of development – whether in Africa, Asia, or elsewhere in the developing world. That situation has changed in ways sometimes beneficial and other times not. Some aid agencies seem to have moved away from providing what we call direct geospatial and other infrastructure assistance and now focus on so-called “softer” aid issues (such as gender equality, governance, and AIDS). At the same time, there has been less emphasis on and knowledge of engineering

and technology, leading in turn to a general lack of knowledge of the value of geo-information, among other issues. Parenthetically, these softer aid issues yield results that are often difficult to measure – especially if there is no geospatial basis upon which to compare results from place to place. The question that arises is how can an aid agency know where their money is spent, for what purpose and with what results in different locations? Are their efforts being focused on the areas in greatest need? Does the aid they deliver account for regional variations in the area they service?

The question that then arises is why isn't geo-information more widely used to both deliver development assistance and monitor its effectiveness? The response to this is multifaceted. Those involved in the socio-economic dimensions of aid issues such as governance, tend not, as noted above, to be well versed in geospatial information and its application. On the other hand, those more directly concerned with the technologies tend not to understand the socio-economic context of assistance well enough. These so called technologists can be perceived to be more interested in selling straight geospatial technology applications rather pursuing more complex solutions, such as monitoring systems, which could have a higher development value.

In some cases, there is institutional or other momentum that slows change. For example, it may be that the agency has long delivered a certain geospatial product (for example, a map of land use or cover). While at one time quite useful, today it may be more beneficial to deliver a map and the technology and information to customize that map for local applications using remote sensing, for example. At the same time, the use of geospatial information in monitoring development can contribute to making development assistance more transparent. One can see what has been done and with what result. In this case, remote sensing can be especially useful when assessing activities related to natural resources, the environment, and the like.

Regardless of the reasons for the limited use of geo-information in development, the introduction of geo-information in program management and assessment requires a strong management team and staff that are willing to have their programs analyzed, and changed.

#### **4.0. TOWARDS A STRATEGIC APPROACH TO THE INTEGRATION OF GEO-INFORMATION INTO DEVELOPMENT ASSISTANCE**

The improved delivery of bilateral and multilateral assistance through the use of geo-information has already gained traction in a number of agencies involved in development assistance. It is interesting that in many ways the development banks seem to be leading the way in bringing together geospatial and international assistance. This is most often done with a focus on planning national geospatial programs. This sees geospatial applied to topics like property rights, property ownership, and three areas of management: environmental (including climate change), natural resources (agriculture, forestry and water), and urban. These various applications of geospatial data and technology are easily understood and answer many of the typical “where” questions posed in development assistance. Here we introduce an approach to implementing the integration of geo-information into development assistance based on work done in several countries as well as with several international agencies.

The use of geospatial data and technology in international development assistance provides an interesting window not on just its value in aid programs, but also on the perceived value of geospatial information and technologies in general by both the donor and recipient countries. This in turn provides some clues as to how these countries will perform in the new economy – the GeoEconomy – that we believe is driven by and dependent upon geo-information. We believe that those countries and agencies with greater advantage in the GeoEconomy will be those who are doing one or (preferably) more of the following:

- Actively providing appropriate aid in geospatial;
- Actively seeking aid in geospatial; and
- Organizing their bilateral aid programs (donor or recipient) with geospatial technology.

From the preceding material one can conclude that geo-information and development assistance come together in one of three ways. First there can be appropriate assistance in providing the basic geospatial information and technology used to run a country. By appropriate we mean that the assistance offers a complete solution to a specific need of the recipient country as a whole. It is not just meeting the needs of vendors in the donor country, or only certain ministries in the recipient country. Second, one can find geospatial information or technology linked to a specific program – environmental monitoring of a sensitive eco-system tied to ecotourism, or a forest inventory, for

example. The third approach sees the technology used to monitor the results of the assistance. Each of these, if done well, can contribute to the continuing development of a country, as well as to the growth of its geospatial infrastructure and capabilities.

While there has been a shift to socio-economic issues in some aid agencies, many have still continued to provide geospatial training, data and technology – including CIDA, US-AID, and the Japanese, Swedish, Dutch, Australian and German aid programs. Indeed, some of these are providing assistance using another country's technology. However, before anyone embarks on the provision of geospatial technology and data to a country, we advocate doing a strategic analysis of the country's needs and requirements. The process is well described elsewhere (Shafee et al, 2010). Without a strategic analysis the provision of direct geospatial assistance will at best lead to inefficiencies, and at worst to a complete waste of the money spent. The strategic analysis should involve the main users and suppliers of geospatial data in the country and an unbiased assessment of the major issues faced by the country. Both the donor and recipient must also ensure that the data will be updated and used in a consistent and sustainable fashion: this implies a long term commitment from both the country and donor. Another of the problems we have seen in a number of countries receiving assistance is the piecemeal introduction of geospatial. One technology will be introduced into the forestry department by one donor, another technology into the environment department by another donor, and yet another into a third department. Often the result is that the systems cannot communicate with each other and it is impossible to bring together various data sets for national planning. (Ryerson and Batterham, 2000) Approaches have been developed to ensure that countries integrate geospatial information into their on-going governmental management and avoid the problems noted here. One such program was recently undertaken in the Maldives, and other analyses have been performed in Thailand, Bermuda, and other countries. (See Ryerson and Peanvijarnpong, 2007; Atwood et al, 2009; and Shafee et al, 2010)

## 5. CONCLUSION

This paper has focused on how and why geo-information including remote sensing is of value in the context of international assistance. It introduced the roles of geospatial information or geo-information in development – what it can be used for and where. It then examined the value proposition – essentially explaining why geospatial information should be used. Lastly we introduced an approach to the integration of geo-information into development assistance, with the goal of improved delivery of bilateral and multilateral assistance.

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<sup>i</sup> Some of the material in this paragraph and much of Section 4.0 is from or is based on Ryerson and Aronoff, 2010.