IAF B1.5.5--EARTH OBSERVATIONS AND HUMAN AND ENVIRONMENTAL SECURITY: OPPORTUNITIES AND CHALLENGES

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ABSTRACT

As we approach 2010, we see that taken as a whole, the world community operates sufficient numbers and varieties of Earth observations satellite systems to make enormous contributions to improving human security and to make a striking positive difference in the lives of billions of people around the world. The benefits to society worldwide are potentially very great.

To deliver these benefits efficiently and effectively, space system operators will have to be better integrated with service providers, both public and private. Together, they will need to develop the appropriate tools to turn data into useful information and appropriate services inexpensively and expeditiously. They will also have to collaborate more deeply and effectively with ground system operators and value added organizations around the world.

In the public sector, if local communities and individuals are to realize the full benefits possible from Earth observations, they will need to have the tools to be able to contribute local information to the publicly available resources. Such local information can provide much greater analytic depth to the overhead imagery, improving the capabilities of Earth observations to contribute to human and environmental security. Yet the greatest benefits could well accrue to the private sector with applications associated with individual safety, disaster response, etc. emerging. Improved knowledge of localized severe weather from car-based sensors, delivered via commercial companies, represents just one example. Fortunately, the development of modern communication tools such as smart phones, netbooks, and other wi-fi and internet devices provide the new information tools needed to improve citizen inputs to information derived from Earth observation data. Such inputs have been termed Community Remote Sensing (CRS) (http://www.igarss2010.org/). CRS also encompasses new opportunities for sensing, analyzing, validating, and sharing remotely sensed information of all kinds.

This paper examines the role of Earth observing systems for serving human security needs as defined by the United Nations Development Program (UNDP), and explores solutions to some of the current hurdles that impede the delivery of services to people. In particular it discusses the role that CRS can play in making Earth observations truly responsive to human needs at the local level.

INTRODUCTION

Human security is a concept that was developed out of the experiences of the Cold War in which major power politics pushed the needs of individuals, communities, and small states into a secondary position. Proponents of the concept of human security assert that to improve security for individuals, rather than focusing effort and wealth on territorial security, development efforts should instead first focus on the direct needs of people, both individually and as members of a community. As articulated in a major 1994 United Nations Development Program (UNDP) report [1], the concept involves seven aspects of human existence:

- Economic security
- Food security
- Health security
- Environmental security
- Community security
- Personal security
- Political security

None of these loosely-defined concepts is independent of the others. Indeed, each relies upon the others in complex, sometimes surprising, ways.

Earth observing, telecommunications, and satellite position, navigation, and timing (PNT) systems (e.g., the U.S. Global Positioning System) all have a role in

improving human security throughout the world by contributing to economic security, food security, health security, environmental security, and community security. Nevertheless, the promised benefits of space systems do not always reach the citizen in an efficient, timely way. However, CRS provides an important means not only for delivering the benefits of space systems to the citizens who are the beneficiaries, but also involving them directly in the effort. One benefit of CRS is that it helps us expand beyond government organizations (with their ultimate resource limitations) to enhance human and environmental security through contributions from individuals, businesses and NGOs.

In addition to exploring the role of CRS in human security, this paper discusses the role of data policies either in promoting or impeding the efficient and prompt delivery of services, and the sometimes broken chain of processes from data collection to the end user of information. Finally, the paper examines the importance of involving.

HUMAN SECURITY AND REMOTE SENSING

For most of the nearly three decades of digital data collection from remote sensing satellites, the data could only be used by experts proficient in using the complex software needed to analyze the data and tease out the information inherent in them. Further, collecting the positional information required to put the imagery in a detailed geographical context was costly. Even government departments and major companies were slow to incorporate the benefits of this powerful space technology into their operations.

As a result, despite the many successes and enormous benefits of remote sensing technologies, at times the benefits of remote sensing have been slow to reach ordinary people. For example, in some cases following a natural disaster, this has been catastrophic for the affected population. Even in the United States, which has an extremely well-developed scientific remote sensing program and has developed numerous applications, effective use of the data has fallen short in practice. For example, soon after government officials understood what destruction Hurricane Katrina wrought on New Orleans and nearby communities, several government agencies made aerial and satellite data available to affected communities. However, lack of electrical power, internet and telephone service made it impossible for communities to use the information effectively to assist in rapid response and recovery. Even those communities that had electrical power and the software to make use of the data often found that the data were not in formats useable by the software available to them.[2] In contrast, during the recovery phase, the continual update of imagery of affected areas was extremely useful to property owners, and local officials who were able to track recovery progress visually.

As is often the case for the delivery of services from advanced technologies, the failure is not in the technologies but in the delivery mechanisms, which generally depend on a series of government policies at different levels of government that are often not well coordinated. Further, for too long, space agencies have focused on building and operating exquisite remote sensing satellite systems but often neglecting the development of institutional delivery mechanisms to make the data that these impressive systems collect truly useful to enhance people's lives.

In a recent review of the use of data provided by the International Charter: Space and Natural Disasters following natural disasters, researcher Adina Gillespie found that only 27 percent of the value-added data products (maps, annotated imagery requested and turned into data products by value-added resellers) had been documented to have been delivered to end users who could have used the information to aid in response and recovery efforts (fig. 1). Twenty-three percent of the Charter reports indicated that no value-added data products had been delivered and 50 percent of the reports were silent on the matter. [3]

The low figure for data product delivery might simply have been poor reporting. However, even if in half of the reports for which there was no information on product delivery, the reports' authors had simply failed to mention such deliveries, the total for delivered information to end users would have been strikingly low (just over 50 percent).

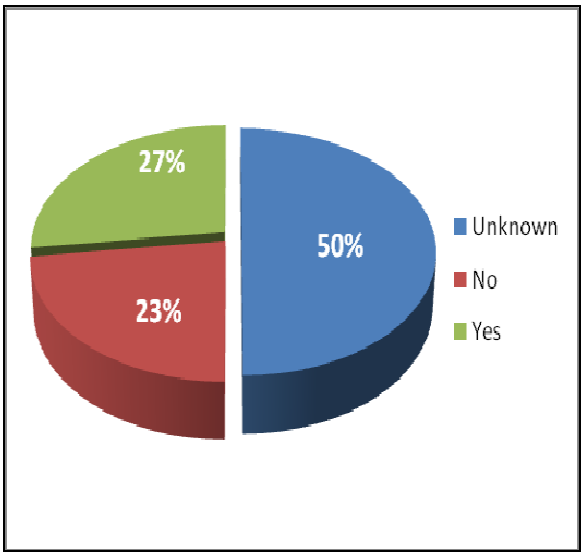

Fig. 1: Percentages of International Charter activations for which value added products were distributed to end users.

THE REVOLUTION IN DELIVERING THE BENEFITS OF REMOTE SENSING INFORMATION

Over the past decade, the proliferation of position, navigation and timing (PNT) applications in the consumer market and the development of simpler geographic information systems (GIS) tools have broadened the attractiveness of satellite data. At the same time, to maintain market share in competition with the digital format of satellite remote sensing, aircraft sensing has evolved to use large digital cameras and radar devices for specialized high-resolution information products, adding new breadth and depth to the marketplace. Satellite and aerial remotely sensed data are now much easier to incorporate into business and government processes than ever before.

As Jacques Blamont has elaborated [4], the significant breakthrough in market access to data came with the advent of Google's Google Earth Web application in 2005. Nearly instantaneously, Google Earth brought millions of people with access to the Internet high resolution imagery of large parts of the globe. This made it possible for ordinary people to see how their neighborhood appears from space, or to look back on their childhood home. Yet its real power is in the hundreds of applications that individuals, non-governmental organizations (NGOs), and businesses have developed using the application. For example, the website, http://www.biblemap.org uses Google Earth to display the places mentioned in the Bible. Also included is extensive information about the geographic sites and their relationship to the books of the Bible.

Microsoft's Bing, a similar application, brought additional capability to the web services available to users. What is important about the ease of use provided by Google Earth and Bing software and data platforms is that they supply the stage for involving ordinary citizens and communities in contributing to science and to remote sensing applications, thereby generally improving their quality of life.

COMMUNITY REMOTE SENSING

One benefit of CRS is that it helps us expand beyond government organizations (with their ultimate resource limitations) to enhance human and environmental security through contributions from individuals and businesses (and NGOs). In some cases Google Earth and Bing allow average citizens to assume better control over their own local environments by using remotely sensed data to influence policymakers. For example, Appalachian Voices, an environmental advocacy group in the Eastern United States (http://www.appvoices.org/) has used Google Earth and a plethora of local photographic and other data gathered by citizens to show the sometimes disastrous environmental and health effects of mountain top coal removal on those local communities located down-slope from the mining operations.

The key to such applications is the incorporation of local data into the overall picture that Google Earth provides. Ground level digital photographs and videos, two forms of remote sensing, and audio recordings can be added to the mix of information to provide a compelling and detailed story to which policymakers can respond.

The many new digital appliances, such as smart phones, netbooks, and other wi-fi and internet applications now make it easy to bring local data into the picture to provide additional granularity to

aircraft or satellite images. Face Book, Twitter, and other means of connecting with friends and colleagues also provide powerful new tools to gather information quickly and efficiently. For example, do you need to collect photographic data quickly on a given area? Twitter your colleagues to pick up their GPS-capable digital cameras, or better yet their camera cell phones, and send you the pictures, with the GPS information built in to the image's metadata. CRS also has the ability to monitor rapidly evolving information and respond in adaptive ways to unanticipated information needs (e.g., where disasters are occurring).

More sophisticated uses could include sending temperature and pressure measurements from a variety of locations encoded with the latitude, longitude, and altitude to a central location to contribute to the creation of high-resolution weather models of an area. This would be the logical extension of applications like the free U.S. Weatherbug Internet program that relies on weather observations at small weather stations at schools across the United States to provide local weather information for subscribers. Applications of community remote sensing include:

- Contributions to science research using personal-scale sensors
- Education in geography, environment, remote sensing
- Augmentation of community mapping
- Citizen Calibration and Validation of Satellite Remote Sensing
- Citizen Analysis and Processing of Remotely Sensed Data
- Citizen Augmentation of Environmental Monitoring

In another application, students at the International Space University at the NASA Ames Research Center in California developed a smart phone program [5] designed to enable the quick and efficient collection of data about urban buildings (e.g., number of floors, age, type of construction). The students were contributing to a World Bank-sponsored project by assisting the World Bank to understand the possible advantages of adding aerial and space data to the disaster reduction risk models developed from the Bank's CAPRA software tools for Central America. The detailed building data are needed to characterize the urban environment more completely, as overhead satellite or aerial imagery does not capture the many important building details (e.g., number of floors, construction materials, age) that can be gleaned from a few seconds of on-site observation. The data, which can be collected by a few teams of university students in a relatively short time, would be added to the risk model databases available for various Central American countries.

The possible applications of such a mash-up of distributed local observations and remotely sensed data from aircraft or satellites are limited only by the human imagination. The importance of such capabilities for enhancing human security cannot be understated. They contribute in two important ways: first, they enable the rapid collection of local information that can provide greater depth to the interpretation and understanding of local and regional environmental and geographical conditions; and second, they empower local people to engage directly with their communities and their government on issues of concern and thereby take greater charge of their own destiny.

In recognition of the growing importance of community remote sensing through citizen science and social networking to communities around the world, the 2010 annual IEEE International Geoscience and Remote Sensing Symposium (IGARSS 2010), to be held July 26-30 in Honolulu, HI, has adopted the conference theme of "Remote Sensing: Global Vision for Local Action" (http://www.igarss2010.org/). Indeed the conference will begin with a plenary session entirely devoted to the topic.

IGARSS plenary organizers are soliciting the participation of organizations that are pursuing projects embodying the plenary theme. They are looking for projects that demonstrate a promise to create either new knowledge or new technologies associated with community remote sensing.

CRS takes a bottom-up approach to the delivery of services to communities and individuals, adding details to the largely top-down delivery of services that can only be provided from a local or individual

scale. Seen from the standpoint of the scientist or the developer of remote sensing applications, CRS provides them with another tool, in this case, one that provides more detailed ground level data, data that they need to sharpen their scientific investigations. Seen from the standpoint of the participant, CRS, when combined with aerial and satellite data, provides them with powerful tools for accomplishing a variety of applications, from documenting environmental changes in the local community to creating persuasive arguments in support of desired policy directions.

Community remote sensing, as defined in this paper, contributes to human security in two ways: first, by providing the mechanisms for citizen inputs to the solutions of very real local and regional problems; and second, by actively involving citizens directly in solving the problems that affect them, which leads to a sense of empowerment and consequently a greater sense of community.

CHALLENGES

Some cautions are in order. For community remote sensing methods to contribute effectively to the enhancement of human lives they will need to be easy to use and readily available to a wide swath of society, especially in developing countries. Fortunately, market forces are at work creating ever cheaper smart phones, portable computers and other devices that can be used as platforms for citizen input.

Nevertheless, CRS faces the problem of finding imagery cheap enough for widespread use. Outside of Google Earth and Bing, current restrictive data distribution and sharing policies prevent more widespread use of satellite imagery, even those funded by taxpayers. In recognition of this, the Brazilian space science organization INPE and the China Center for Resources Satellite Data and Application began distributing data from the China-Brazil Earth Resources Satellite (CBERS) series of satellites to other countries for free. [6] Latin American countries, data users in most of Africa and countries bordering China now benefit from receiving this free medium resolution data. Following Brazil's announcement of this data policy, the U.S. Geological Survey announced that U.S. Landsat data would be available free for online distribution.

Research organizations and community groups can now gain free access to French firm SPOT Image's extensive archive of five to 20 meter data for approved projects that examine climate change under the Planet Action public good initiative. [7] The U.S. firms GeoEye and Digital Globe have also launched their own non-profit organizations designed to make some data available for public good applications.

Finally, some U.S. states have purchased state-wide data that are licensed for use by all government agencies, including county-level governments. Community groups could benefit by partnering with State or local governments to pursue projects of interest.

CONCLUSIONS

In summary, over the past 35 years or so, remote sensing of Earth's surface has provided enormous benefits to humanity. Now CRS promises to improve the delivery of useful services to citizens, leading to improved human security. A related but different benefit, perhaps equally important, is the enabling of individuals to contribute to the scientific knowledge base from which these services are derived. Unless our centralized knowledge is calibrated and refined at the local/individual level, we will be delivering inadequate services at that level.

However, in order for the full benefits to be realized, citizens need to become involved in their own future by using tools developed for them and by them. The challenge they face is in developing the wide variety of mechanisms for delivering CRS applications to solve human security problems.

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