Proceedings of the 27th West Indies Agricultural Economics Conference

In collaboration with

The Ministry of Agriculture and Fisheries, Belize,

Caribbean Agricultural Research and Development Institute (CARDI),

The University of the West Indies (UWI)

and

la Asociación de Latinoamérica y del Caribe de Economía Agrícola (ALACEA)

Improving Marketing and Sustaining Natural Resource Systems in Latin America and the Caribbean

Belize City, Belize

23rd - 27th July, 2007

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Editor

Multimedia Mapping and GIS Integration for Data Acquisition and Sustainable Resource Management in Extension

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Introduction

The agric-food sector in the Caribbean is facing global challenges. The integration of Information Communication Technologies however, can open opportunities for improvements in communication, environmental monitoring, pest and disease management, program planning, and marketing. Joseph (2003) conducted research in Trinidad between 1999 and 2001, and concluded that GIS and GPS technology do have the potential to act as catalysts for change within extension in the Caribbean, and the knowledge generated through social interaction can become the fundamental driver for change in the region.

This paper discusses the potential for Geographic Information Systems (GIS), Global Positioning Systems (GPS), and multimedia, for becoming primary enablers for communication within the agricultural sector. The combination of these digital technologies to provide a multidimentional and dynamic perspective of the physical and social landscape is becoming increasingly important for resource management. This paper outlines a simple procedure for using GIS, GPS, and multimedia technologies to acquire, organize, display, and analyze data for extension field activities.

An integrated multimedia communication strategy seems to be appropriate for acquiring and sharing information. Continuous evolution of communication technology in agriculture depends on decisions to adopt or reject their use. Retooling of extension will become necessary if we are to satisfy operational needs. It is not a question of choice, but one of survival (Schifer 2004). This paper is about purposeful social innovations that focus on changes in values, functions, and approaches to learning and applying new technology in agriculture. It examines the potential for implementation, and institutionalization of GIS, GPS, and multimedia technology for data acquisition and management; and

their impact on transforming agricultural production, program planning, and marketing.

Defining GIS

Chrisman (2002) defines GIS as organized activity by which people measure aspects of geographic phenomena and processes; represent these measurements, usually in the form of a computer database, to emphasize spatial themes, entities, and relationships; operate upon these representations to produce more measurements and to discover new relationships by integrating disparate sources; and transform these representations to conform to other frameworks of entities and relationships. These activities reflect the larger context (institutions and cultures) in which these people carry out their work. In turn, the GIS may influence these structures. GIS is similar to conventional database technology, its principal distinction is that it organizes, processes, and reports information, which is of a geographical nature.

Defining GPS[1]

The Global Positioning System was developed by the United States Department of Defense in 1973. It is a navigation and positioning tool made up of a constellation of 24 satellites orbiting the earth about 12,000 miles above us at speeds of about 7,000 miles an hour. We use these satellites as reference points to calculate positions on the earth using GPS receivers. GPS technology is now used in countless other professions. There are many applications beyond determining basic positions or locations of objects in space. These include monitoring the movement of people, pests, diseases etc.

Defining Multimedia

Multimedia is a combination of various types of media to convey information (audio, video, pictures, graphics, text, and animation) via an integrated vehicle such as CD-ROM/DVD, Internet, radio, television, interpersonal communication, telephone, and print media. Sheifer (2004) describes it as a range of services, methods, techniques, applications, equipment, and electronic technologies used for the collection, manipulation, processing, classification, storage, recovery, transfer, manipulation, and delivery of data, sound, and graphics, including video.

GIS, GPS and Multimedia Integration

GIS organizes spatial information, GPS tells you where things are located, and multimedia describes it. Together, they can transform the way we communicate with the farming community, but there is an urgent

[1] Trimble GPS tutorial available from http://www.trimble.com/gps/whygps.shtml

need to expose agricultural and extension professionals to this interesting and exciting technology innovation, and explore their combined potential. It is also important to investigate cost and training effort required to integrate multimedia and spatial technologies. Understanding the role of the Internet in delivering services and communication needs require adequate awareness of how much people understand social behavior in context of modern communication technologies. We also need to be aware of stakeholder's media choices for communication.

Exploring Opportunities for GIS, GPS, and Multimedia

Akpabio, Okon and Inyang (2007) demonstrated that modern communication technologies have the ability to revamp agricultural production in developing countries based on research in the Niger Delta, Nigeria. The study focused on constraints affecting the utilization of Information Communication Technologies (ICT), and findings revealed that poor communication infrastructure development was one of the factors preventing progress. The rapid development and applications of the Internet and other forms of ICTs in the Kenyan agricultural sector have presented a whole new dimension in the transfer and access of agricultural information (Kiplang'at and Dennis 2005).

According to Asaba et al (2006), Kenya and Uganda recognized the potential of agricultural knowledge centers as delivery models of Information Communication Technologies, confirmed that rural information and knowledge centers provided opportunities for bridging the information and knowledge gap between urban and rural communities. Asaba (2006) stated that education level had a positive correlation with usage of the centers, and the most commonly used information service in Kenya was market information; and in Uganda agricultural production information. But there are other innovations that can be used in conjunction with the ICT technologies used in Africa. Seepersad (2000) pointed out that Agricultural Extension in Trinidad and Tobago has faced many challenges over the years, and has been constantly trying to adapt to the changing scenario.

Disruptive Technologies

Coates (2004) describes technologies as disruptive or sustaining. According to Coates (2004), disruptive technologies are innovative, and may not fit with traditional standard practices. GIS and GPS fit within that framework. Initially people may view these technologies with skepticism since the initial benefits are not apparent. Extension by nature prefers sustaining technologies because they maintain the status quo. GIS and GPS technologies can change organizational structures in the

workplace.

It is understandable that there will be hesitation to implement GIS and GPS. But knowing how to implement these technologies will greatly improve extension services in the region. Ezell (1989) examined technological and organizational trends and the use of information technology, and stated that with the availability of new technologies and changes in information processing, extension should position itself to reinvent its future. Present organizational structures must be adjusted to take advantage of new communication technologies. Case studies show that social alliances can effect rapid improvements in local institutions confirming that bureaucratic reform and improved community social organizations allow for powerful coalitions and rapid, self-sustaining development (Gupta, Grandvoinnet, and Romani 2000).

GIS, GPS, Case Study

Since 1999 the Ministry of Agriculture in Trinidad and Tobago has been experimenting with Geographic Information Systems (GIS) and Global Positioning Systems (GPS) technology to help address the needs of the farming community. Extension officers who participated in a one-month workshop learned how to acquire, organize, and analyze spatial data using a combination of GIS, GPS, and multimedia. Successful use of these technologies demonstrated that there is potential for managing extension activities in a way that extension could communicate more effectively with its clientele. Extension officers collected location data on farms using inexpensive GPS units and also used digital cameras to record spatial information. The activity proved to be practical, dynamic, holistic, proactive, and inclusive for extension activities. Working together in groups, extension officers were able to create farm profiles showing important aspects of farms. They were able to explore data and discover patterns and characteristics of farming communities (Joseph 2003).

On-line GIS and GPS Map Integration

GIS and GPS technology are therefore indispensible but neglected tools for managing agricultural and natural resources in the Caribbean. Free on-line mapping tools and services (Google, Microsoft Maps etc) are available for integrating GIS, GPS, and multimedia. They are effective for program planning, communication and decision-making (Bishop et al 2002). In order for these technologies to be sustainable there must be training, peer collaboration, and willingness on the part of participants to learn to use these technologies. There has been rapid development of GIS worldwide, but little preparation of people and institutions for its implementation. Few researchers have questioned the appropriateness of GIS and GPS technology, and the role they could

play in developing new approaches in the region.

Implementation

There are many ways to incorporate multiple data into a GIS and display on-line. For example, Computer Aided Design (CAD) maps can be transformed and displayed in a GIS, and managed via on-line collaborative documents such as Google Docs. Free on-line map viewers and servers can also be used to conduct analyses and build queries on agricultural data. Extension officers can use digital cameras and combine them with GPS units to acquire farm data such as diseases, flood damage, etc. Geographic coordinates can be easily added to photographs and displayed in a GIS.

Where to Begin

Muir (1911) explained that *w*hen we try to pick out anything by itself, we find it hitched to everything else in the Universe. The bar is being raised for extension to develop educational resources and materials that are attractive and engaging. Extension professionals need to begin considering how they might take advantage of new and exciting opportunities so that they can communicate more effectively. They can begin by building capacity, i.e., coming together to acquire and share resources. They need to also increase their knowledge and improve their technology skills.

An essential mechanism for capacity building is partnership development. Capacity building encompasses human, scientific, technological, organizational, institutional, and resource capabilities. A fundamental goal of capacity building is to enhance the ability to evaluate and address the crucial questions related to policy choices and modes of implementation among development options, based on an understanding of environment potentials and limits and of needs perceived by the people (Agenda 21, 1992).

GIS, GPS, and multimedia technologies can increase the political, social or economic strength of individuals and communities because people become empowered with knowledge gained from these technologies. The result of empowerment is confidence. The agricultural community will stagnate without the impulse of individuals. Mark Victor Hansen[2] said that we

[2] Mark Victor Hansen is an American inspirational and motivational speaker. He is best known as the founder and co-creator of the "Chicken Soup for the Soul" book series. Chicken Soup for the Soul books are one of the most successful publishing franchises in the world today, with more than 140 million books sold internationally and more than 100 licensed products. The name “Chicken Soup” was chosen because of the use of chicken soup as a home remedy for the sick. The first Chicken Soup book, published by Health Communications, Inc., sold more than 2 million copies. There are now over 140 million copies in print and in 54 languages world-wide (http://en.wikipedia.org/wiki/Mark_Hansen).

should not wait until everything is just right, because conditions will never be perfect, and there would always be challenges, obstacles and less than perfect conditions. Hansen urges people to get started now, because with each step we grow stronger and more skilled, more and more self-confident and more successful.

Empowerment through GIS Cognition

GIS and GPS are engaging, and promote critical thinking, integrated learning and analysis, and multiple intelligences. GIS and GPS training help extension professionals develop computer literacy, problem solving, and communication skills. As integrative tools, GIS and GPS give extension professionals the ability to acquire, organize, and analyze spatial data. These technologies combined with multimedia have the potential to change the way they plan programs, and organize their field activities (Hudson-Smith et al 2005). Extension however, must engage in a systematic approach that includes a community of users, training, and pilot studies (Figure 1).

Extension should try to develop long-tem strategies for collaboration through convenient partnerships, and work together to address needs. Agricultural professionals, communities, and GIS/IT specialists should identify the best GIS integration and sustainable practices (figure 2).

Data Acquisition Methodology Example Using GPS and Multimedia

Raw data for GIS and GPS can be acquired using affordable GPS and digital cameras. Typical GPS data consist of lines, points, and polygons to represent features such as trees, roads, and garden plots. A Garmin GPS unit and GPS camera were used to acquire data in a park in Belize City for 30 minutes. Raw data from the camera and GPS unit were downloaded to a computer to create a thematic map. Lines were collected using the Garmin GPS (dataset 1), and point locations were collected simultaneously with the GPS camera (dataset 2). Figure 3 shows the raw data and point/line overlay.

Each dot in figure 3 represents a point of interest in the park, and was acquired every time an object was photographed. The camera retained coordinate information (latitude & longitude) which were assigned to each dot (figure 3).

The data was edited with GIS software to remove errors. GIS software was used to display aerial and linear measurements (figure 4). This simulation can be used to do rudimentary measurements on farms. Cost of the GPS unit was $200US. Any digital camera could've been synchronized to the GPS unit (by time) to generate locations where pictures were taken.

Photos (points of interest) were geocoded and hotlinked within GIS software. Attribute data was also

added to identify and describe points of interest on the map (figure 5). These maps and images were uploaded to Google Earth, and Microsoft maps for viewing and evaluations.

Points of interest were separated and classified into themes to allow analyses based on conditions of proximity, adjacency, and containment and intersection (figure 6).

The data was collected using a standard coordinate frame for the earth (WGS 84), and was tested for positional accuracy and usability by overlaying it on an existing independent map source. The entire data collection, analysis, and display took one hour. The above map is an overlay of the data at three different scales on a standard base map of Belize. The green arrows point to the location of the park in relation to the base map. The combined use of the Garmin Etrex Legend GPS unit and GPS camera did provide a reasonable estimate for determining absolute and relative location with accuracies ranging from seven to 15 feet.

Conclusion

Developing geographic awareness within the extension services in the Caribbean through collaborative mapping projects will help foster learning communities that can work together to share useful information via kiosks, internet mapping services and the World Wide Web. Empowering extension professionals through GIS/GPS training would enable them to observe patterns, associations, and spatial order. These concepts are important for analyzing production and marketing activities. The goal should be to train a core user group who will then become coordinators of countywide programs to recruit others and collaborate with them to incorporate GIS into their programs. They should meet periodically to review and determine the best approach for incorporating GIS.

Ministries of Agriculture should encourage baseline mapping for developing community atlases to share information with their clientele. The extension services should consult with farmers and community leaders to identify attributes that will help shape the future of agriculture in local communities. They should get together to promote Asset Mapping , and use GIS, GPS and multimedia to inventory farms, classify them, quantify them, and look for spatial relationships (patterns, densities, and concentrations). Getting to know the farming community through the use ICTs and spatial tools will improve agriculture in the region.

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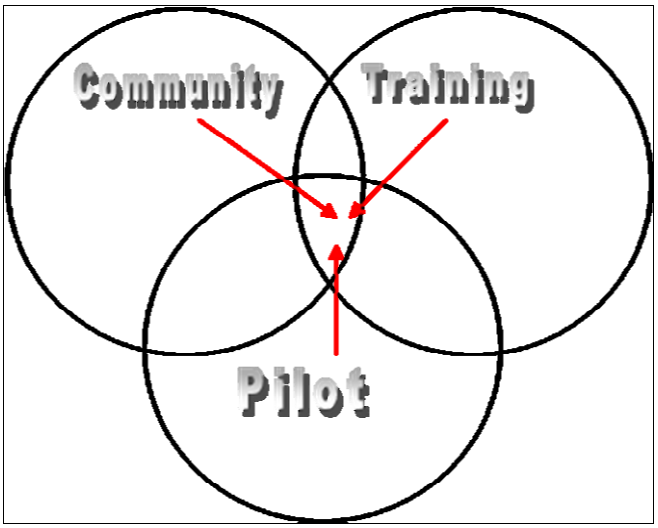

Figure 1: A sustainable Approach for GIS, GPS and Multimedia Integration

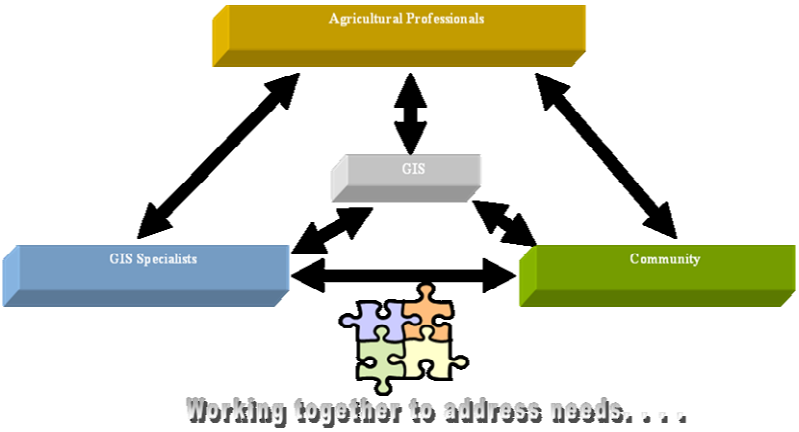

Figure 2: Developing Convenient partnerships for GIS

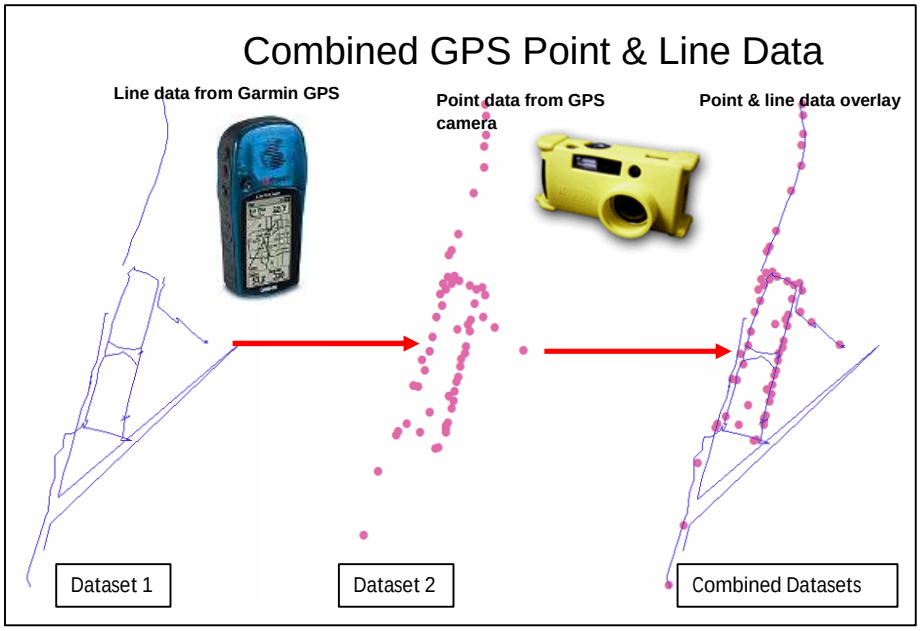

Figure 3: GPS Data from Low Cost GPS Unit and GPS Camera

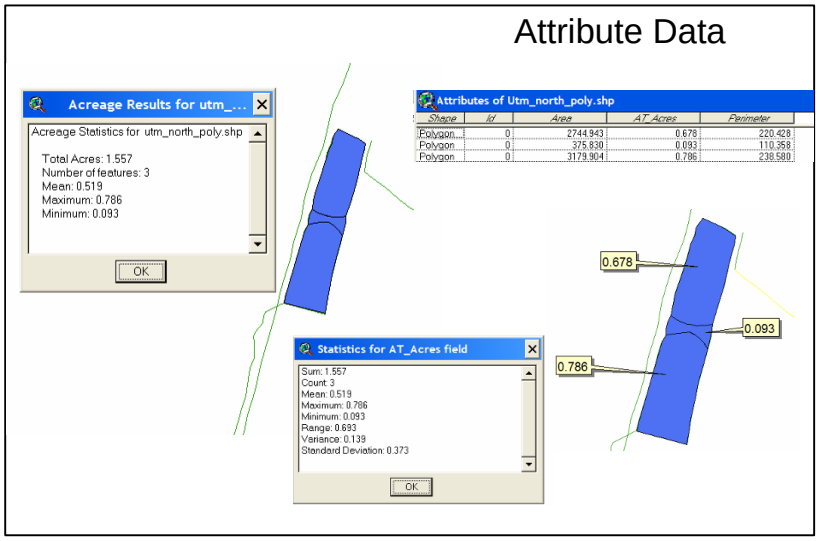

Figure 4: GIS Software Used to Compute Areal and Linear Measurements

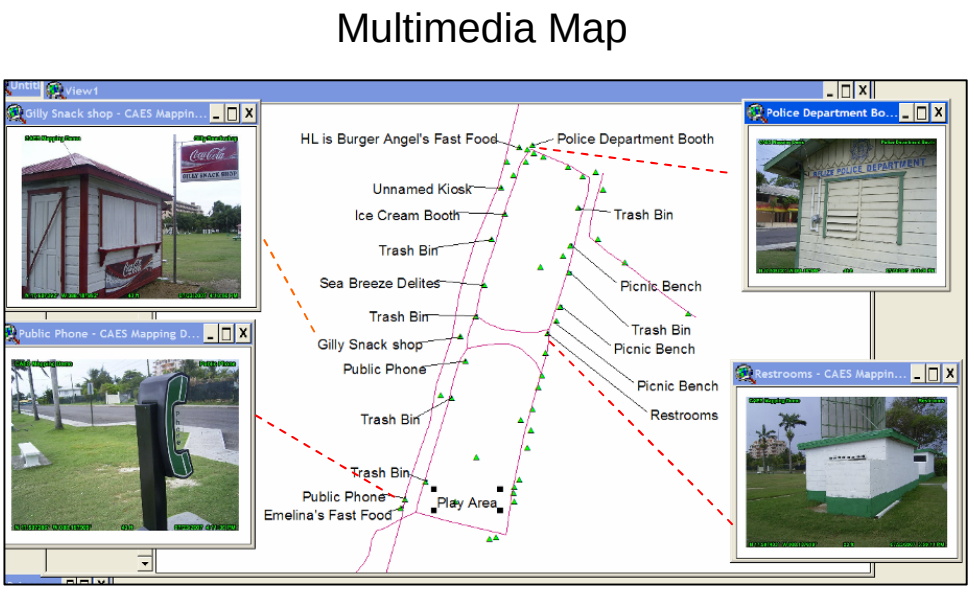

Figure 5: Multimedia Integration and Hotlinks

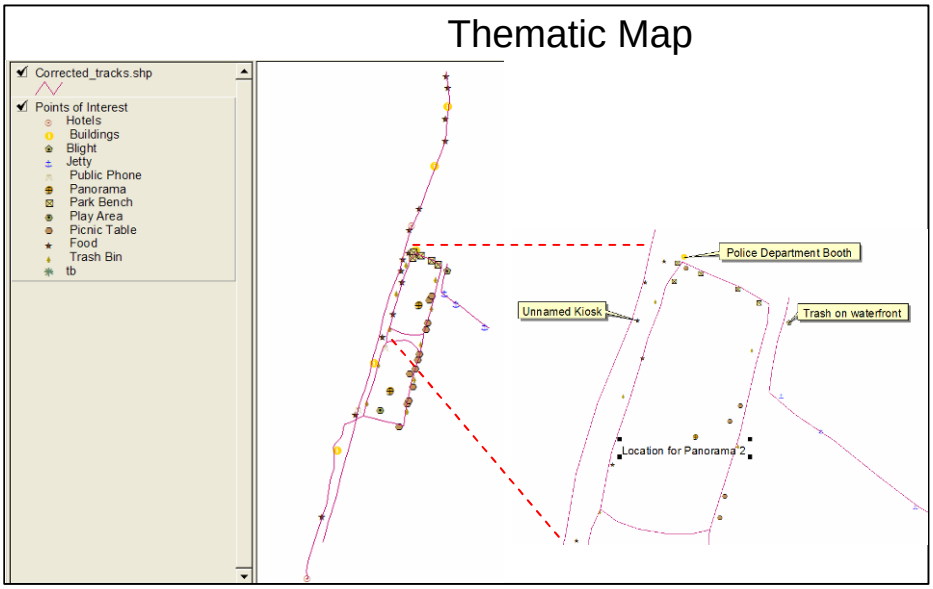

Figure 6: Creating Thematic Maps of Points of Interest

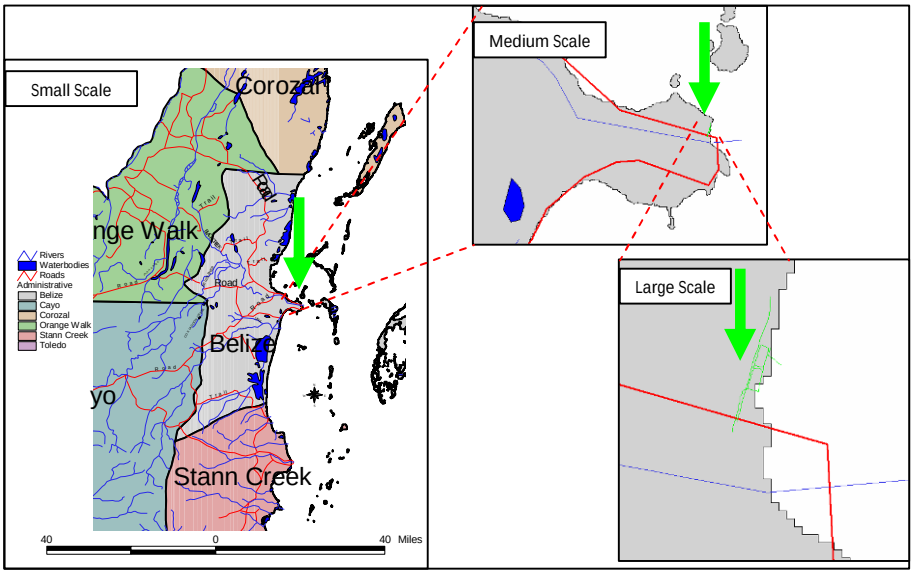

Figure 7: Integrating Data with Existing Maps