

Using Paper Maps for Geospatial Data Collection

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ABSTRACT

Geo-spatial information is important for a variety of decision-making, planning, marketing, and development activities. Yet, in the developing world, there are significant challenges to collecting this data, including poor network infrastructure, the lack of availability and trained operators of hand-held devices, and the difficulty in finding specialists who can effectively organize spatial data. This project explores the possibility of using a simpler GIS data collection methodology – annotating paper maps – in order to both simplify the data collection process, and capture more qualitative data. Through interviews, prototyping, and testing, we hope to design a viable proof of concept that can both support existing GIS data collection efforts, and lower the barrier to entry for additional organizations to collect geo-spatial data and conducting analyses.

Categories and Subject Descriptors

H.2.8 [Database Applications]: Spatial databases and GIS, Image databases.

H.3.5 [Online Information Services]: Data sharing, Web-based services.

H.4.2. [Types of Systems]: Decision Support.

H.5.1. [Multimedia Information Systems]: Hypertext navigation and maps.

H.5.2. [User Interfaces]: Graphical User Interfaces (GUI), Prototyping.

General Terms: Design, Human Factors, Experimentation.

Keywords: ICTD, Geospatial Data, Participatory Mapping, Rural Development.

1. INTRODUCTION

During the summer of 2009, the University of California at Berkeley, with funding from the Gates Foundation, launched a research project to investigate the potential for information and communications technology to help improve the economic conditions of smallholder farmers in Ethiopia and Uganda. Teams of graduate students, with support from local NGOs, conducted qualitative research on the ways in which farmers, community groups, and development organizations use available communications technology. A common observation was that organizations working in rural development often encountered challenges in obtaining current and accurate spatially referenced data about the communities they wish to serve.

1.1 Observations in the Field

While in Ethiopia and Uganda, we made several key observations that have informed this project. First, many of the development organizations we observed did not have sufficient capacity to collect data in the field or process it using their existing GIS software. Second, we observed that there was an unreliable / non-

existent electricity and cellular network coverage in many of the rural field sites we visited, which reduced the usefulness of collecting data using networked digital equipment. Especially in Ethiopia, we found that a lack of reliable mobile telecommunications infrastructure meant that data collected in the field would have to be transported by hand, or by truck, to a central office for processing. Third, we observed that many organizations used participatory mapping to facilitate dialogue and to help reach consensus on a variety of development topics, such as irrigation, crop production, and forest management. Though the resulting map artifacts contained a wealth of information, these maps were seldom used by planners or incorporated into organizations' larger GIS systems. Fourth, we observed extension agents recording a variety of data about farmer yields and crop production. It was unclear that these forms were ever propagated up to development organizations for analysis.

1.2 Participatory Mapping and Community

For years, organizations have been using participatory mapping techniques to facilitate dialogue and to help reach consensus on a variety of development topics, such as irrigation, crop production, and environmental management [1]. This process usually involves a facilitator, who uses a script or template to ask community members a series of questions [2]. From this dialog, a map is drawn – often on paper, but occasionally drawn on the ground or in the sand – where borders are delineated, problem areas are highlighted, and important issues are brought to light from the perspective of the community members.

Geospatial data can be gleaned from these community-generated maps and provide development organizations with valuable information and perspective that is difficult to gain using other data collection techniques, such as interviews and surveys. Data provided by different community members can be aggregated using the same map, providing an efficient view of complex social behavior. Organizations are able to combine data collected in the field with other data provided by outside sources, to help improve knowledge and decision-making. The maps created can also be used as artifacts to help facilitate dialogue between community members and development workers.

1.3 Project Goals

Given these limitations on human capital and telecommunications infrastructure, fieldworkers' affinity for paper-based data collection, and the potential for hand-drawn maps to reveal community values, perceptions, and tacit knowledge, our project team will explore alternate methods for geo-spatial data collection and place-based communication. We wanted to create a simplified GIS data collection system, which was also capable of

handling hand-drawn maps, and incorporating more actors to participate in data collection.

2. RELATED WORK

There are a number of geo-spatial data collection and dissemination initiatives. Regarding open platforms that accept user-generated geo-spatial content, Google Map Maker and Open Street Map [3] are two of the most prominent, both of which have specific initiatives geared toward digitizing maps in the developing world. For example, in November 2009, residents of Kibera, Kenya's largest slum, used Open Street map and GPS units to annotate what had previously been a blank spot on a map. There are also a number of open source mapping tools, such as Modest Maps and Open Layers, and publicly accessible APIs, such as the Google Maps API and the W3C Geolocation API, that allow users to consume, display, and query existing geographic data. There is also an emerging field of Participatory GIS (PGIS) in which publicly generated data has been incorporated into GIS systems in a variety of ways, in Pittsburg [4] [5], the Tigray region in Ethiopia [6], and Chicago [7], to name a few.

3. PROPOSED WORK

Guided by our field research in Ethiopia and Uganda over the summer, we plan to explore how low-tech data collection and high-tech data processing might be (1) a cheaper, faster, and richer way to gather data, and (2) a medium to enhance the communication of more complex, qualitative ideas between parties. That is, by creating a prototype that leverages paper-based maps, image recognition tools, and GIS, in conjunction with a set of organizational processes, we will demonstrate that paper-based, geo-spatial information gathering can be efficiently streamlined into modern data collection and communication systems in new ways.

We will start with the existing Walking Papers [8] code base, which is a system that allows a user to print a barcode-indexed paper map from a web-based system, annotate this paper map manually, scan it, and incorporate it back into the system using image recognition software. We will then look at how the existing Walking Papers UI might be adapted and supplemented by process to address certain data collection and communication challenges. Questions to explore include: how might fax or postal mail be used as a data transmission alternative? Could using ink-based stamps with particular shapes or ordinary pens with certain characteristics assist computer vision technologies in automatic feature extraction tasks? For which types of data collection could paper maps work? In which scenarios would hand-drawn process- or perceptual- maps interface with GIS systems in useful ways?

With respect to data collection, we will explore specific scenarios in which a paper-based data collection approach might be preferable to using GPS units or sensor-enhanced mobile devices. Though a paper-based geospatial data collection strategy might not be sufficient for all data collection initiatives, it could certainly be a viable substitute in particularly resource-constrained environments or in cases where extremely time-sensitive data needs to be collected on a massive scale. We will also explore the processes that would be needed to ensure a successful data collection effort.

With respect to communication, hand-annotated paper maps can take advantage of affordances that are absent from most spatially oriented hand-held devices. On a map, important areas can be circled, processes and directionality can be expressed, and multiple parties can collaborate together to express a single idea. These more qualitative, information-rich expressions of ideas are often lost in more formal GIS systems, but understanding community perceptions is critical to the success of projects. Our prototype will explore how qualitative spatial expressions of communities and individuals could interface with formal GIS datasets (infrastructure, natural features, etc.), using location as the unifying feature. Again, we will explore the process and technology elements needed to best facilitate this type of communication.

3.1 Prototype Development and Testing

In light of the exploratory research we have already conducted over the summer, we will now begin to validate the usefulness of our prototype concept with potential users of the system. Though it would be ideal to ultimately test the viability of a paper map data collection initiative in East Africa, in the meantime we plan to test our prototype with a local organization that runs an environmental science program for low-income youth in the Bay Area. The science organization already uses a participatory learning approach and coordinates a variety of qualitative and quantitative data collection exercises, where students collect location-based information about their communities, including air and water quality data as well as perceptions about the safety of their neighborhood. Our research team plans to work with the organization to support its more qualitative data collection efforts. Collective brainstorming is currently underway.

3.2 Evaluation

We propose to evaluate the effectiveness of our prototype in two ways. For the data collection portion of the project, we will compare the costs (equipment, training, etc.) and amount of time needed to collect and aggregate geospatial data between hand-drawn and device-generated methods. Secondly, for the qualitative, communication portion of the project, we will conduct a series of interviews to try and determine how useful geo-referenced, hand-drawn maps are to organizations.

4. ACKNOWLEDGMENTS

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