"A System for Mobile Community monitoring of Natural Resources: A Case Study in the Sierra Madre of Chiapas, Mexico"

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SUMMARY FOR INTERESTED PARTIES

Overview

For our thesis work in the cloud forests of the Sierra Madre of Chiapas, Mexico, we tested an emerging natural resource monitoring methodology that uses Android phones, Open Data Kit (ODK) and Google Earth as a tool to collect, analyze and share environmental data. Natural resources information that can be shared and visualized is considered valuable, if not central, to large-scale payment for ecosystem services programs like carbon payment initiatives and the UN REDD program, that will require ecosystem service accounting on a national scale. In collaboration with the coffee cooperative Comon Yaj Noptic and a private coffee farm and reserve Finca Arroyo Negro, we carried out 190 sampling events with four community volunteer monitors between September and December 2011. We tested ODK for use in six different monitoring targets: avian biodiversity point counts, above ground biomass, incidence of rare species, forest utility, land-use and internal control for coffee production. These data, collected in digital format with the aid of smart phones, led to the creation of in depth spreadsheets and real time dynamic maps for use on Google Earth. In addition to developing the mobile data collection system, we conducted a social analysis to determine the organizational support for mobile monitoring as well as individual learning capability and community perceptions of the system. We determined that community monitors could use ODK to collect large quantities of ecological data at a relatively low cost and effort (~76 sampling hours at $1.21 US per hour). ODK allowed for data collection to include images, GPS, audio and cloud-based sharing which has the capability for community collected data to be verified by a third party. Our social analysis concluded that community monitors can learn quickly (1-2 days) to collect environmental data using Android phones running ODK, but the organizational support for the management of the data once it has been submitted is lacking. Therefore, at this stage we recommend that local actors like state governments, NGOs or educational institutions facilitate the management and visualization of data while communities collect and report data and then receive the finished product in the form of data rich maps. However, given the right motivations and capacity building we believe that ODK combined with Google Earth can be a complete bottom up natural resource monitoring tool, especially within the agroforestry sector. The Mexican conservation organization, Pronatura Sur, will be continuing the use of ODK for its projects in the Sierra Madre as part of its larger monitoring network throughout the Mesoamerican Biological Corridor, especially as a tool to support community-based monitoring within the agroforestry sector.

Methods

We determined our ecological sampling methods through literature review of payment for ecosystem services monitoring, locally based monitoring and interviews with our field partners. We selected monitoring targets based on their ability to integrate with regional, national or international payment schemes as well as their local relevance to the community and producers. Based on these objectives we set out to monitor above ground biomass (using a methodology for community technicians from the Woods Hole Research Center), avian biodiversity (capitalizing on a preexisting 'campesino' monitoring program run by Pronatura Sur), rare species, land-use classification and forest utility (a measure of local forest degradation).

In addition to these ecological or ecosystem service variables, we used ODK to measure variables associated with the shade grown, fair trade and organic coffee certification process, the prominent economic activity in the region. Our partner for this initiative, the cooperative Comon Yaj Noptic, is made up of small producers with an average of ~2 hectares per producer in production. They normally have to travel to the disparate parcels, sometimes up to 6 hours away, to fill out information in preparation for its yearly certification process. We used ODK to collect information about coffee production as means to streamline the process and simultaneously collect natural resource data.

All data was collected with ODK (by community volunteers), uploaded to ODK Aggregate for analysis and then published to Fusion Tables for eventual conversion to a dynamic data rich map on Google Earth.

For our social analysis we conducted semi structured interviews and participant observation throughout our data collection process, especially during assisted sampling days in the field. At the end of the pilot we distributed surveys to determine community level perceptions on the process and ideas on future implementation. We based our training on eHealth Nigeria's training guide then adapted it to ecological data collection.

Results

For a detailed set of results, see our final report found at cltl.org.

Our results suggest that community volunteers can collect a large quantity of environmental data at a relatively low effort and cost (190 sampling events, ~76 sampling hours at $1.21 US per hour). These data, which measured biodiversity, biomass estimations and canopy height, all have the potential to serve as indicators for measuring the provisioning of ecosystem services, a crucial step in large-scale conservation initiatives. When the data from all methodologies were eventually represented as Google Earth layers, improved spatial analysis is possible, for example by comparing avian biodiversity and varying degrees of coffee conservation practices.

The majority of our data was collected through surveillance monitoring, or sampling carried out opportunistically. Monitors may not be motivated to carry out targeted monitoring, like running biomass plots or avian point counts without evidence of an incentive. Normally, ecological data of this type is avoided because of its limited power or analysis. However, ODK captures and verifies surveillance data, creating a data set of point-referenced observations with little opportunity cost for the community.

The record audio function of ODK resulted in an unexpected but welcome natural history diary from our field partners who possess immeasurable ecological knowledge. Community interviews have long been used as a tool to detect trends in natural resource use. ODK, through geo-location and the addition of notes or images, amplifies the utility of this strategy to detect long-term natural resource trends.

Our social analysis revealed that despite limited service, the use of smart phones and camera phones was well established in the area. Users could learn ODK within two days of use in the field, but some struggled to determine when to collect data. Additionally some community monitors preferred the paper data collection process to the ODK process due to perceived reduction in the risk of data loss. However they did emphasize the usefulness in the efficiency of the data transfer process. For a private landowner with more technical capacity, this system was perceived as means of acquiring autonomy in the face of rigorous external certifications or international payment for ecosystem services schemes. Interviews with producers suggested that the coffee certification process is complex and tumultuous and that data autonomy is desired.

Our field partners responded most positively to the potential of using ODK in internal control of coffee operations applications. They saw timesaving benefits, improved management and increased social marketing potential, possibly using the dynamic maps of Google Earth to reach new buyers.

Recommendations

ODK could potentially be a tool for complete bottom up natural resource monitoring and forest management. However, our case study suggests that the motivation and technical capacity to manage a cloud-based database is incomplete. Until the digital divide can be bridged with simpler tools and improved technical capacity, we suggest that local conservation NGOs could fulfill the role of data management and visualization of the community collected data.

Our pilot test with internal control of coffee operations suggests the potential for defining monitoring targets that are mutually relevant for the international (ecosystem services) and local (coffee production) interests. By defining targets that are mutually relevant, motivation for monitoring can become community driven and therefore more sustainable. This type of synergy, the economic incentive to streamline data collection combined with the ability to collect natural resource data, is an example of a leverage point for measuring ecosystem services for programs like REDD while at the same time strengthening local agroforestry livelihoods.

Our social analysis suggested that monitors carried out avian sampling for their personal interest and concern beyond the economic compensation they received. Interviews with the monitors suggested that their community did not particularly value their avian monitoring, citing coffee production as a priority over ecological interests. Therefore, before implementing purely financial incentives for monitoring, we suggest more research and equal emphasis be placed on the intrinsic motivations for conducting monitoring along with the financial (like a PES program).

For ODK to be truly tested as an ecosystem service monitoring tool we recommend community monitoring with near real time reporting be incorporated to an extant payment for ecosystem services program.

Finally, we have provided a specific set of recommendations for ODK in the context of ecological sampling (Appendix 1).

Conclusion

Mobile data collection is becoming a prominent tool to support bottom-up data collection around the globe. Mobile devices have been used to report crop yields in Tanzania, conduct household health surveys in Ghana, map near real time disaster needs in Haiti and Japan and project environmental consequences of the recent Gulf of Mexico oil spill. Android features, like predictive text, language options, and built in audio, GPS and images allow for a powerful and diverse data collection experience. Our pilot project suggests that mobile data collection tools have promise to monitor natural resources and contribute to improved environmental governance especially by capturing the local ecological knowledge that is present in the agroforestry sector. These systems are designed to turn the data collection process of traditional top-down conservation on its head. Instead of requiring expert consultants, communities can monitor their own resources and in turn, diversify their environmental awareness and governance.

By giving communities the role of monitoring forest data, regional to international scale payment for ecosystem services programs have the potential to become more streamlined, transparent and accountable. When communities have a tool that allows them to collect, store and validate data concerning their own natural resources, they can take the first step to engaging in improved environmental decision-making. Communities that practice good forest stewardship create benefits across scales: the community gains improved livelihood from their reliance with well-managed natural resources, for NGOs and governments who seek to preserve integrity of landscapes dominated by humans and from an ecosystem services perspective the enhancement of services that flow downstream to other communities.

A community monitor uses ODK to collect data in a coffee parcel

Using the internal camera to record an image of an animal track

APPENDIX: TECHNICAL RECOMMENDATIONS FOR OPEN DATA KIT

ODK Collect

Feature Requests

Widget for mapping lines and parcels: Land tenure, habitat boundaries and area measurements are a crucial baseline for the payment for ecosystem service context, as well as many others. Using ODK to accomplish these tasks would be a welcomed feature.

Panorama image capture feature: When capturing habitat, photo plot reference or sample plot centers, a panoramic photo feature, like Photosynth would be very helpful instead of adding multiple photos.

Compass with image capture: Sometimes in dense forest the cardinal direction was unknown and most of our community monitors walked without a compass. Therefore a compass arrow with images would be a very helpful feature.

System Improvements

Autocomplete with text option feature: occasionally the user would not enter the correct pre-programmed answer for the autocomplete question. In these cases the user would advance, assuming the autocomplete finished the answer for them and the answer would be left blank. If possible include a notification if user fails to choose an autocomplete answer.

Automatic revision function at the end of form: include an automatic revision of the finished form at the end before saving and sending could ensure unanswered questions are caught before they are sent. This would be complementary to the already existing review function within the menu.

Shortcut to forms as radio button on home screen: To streamline the data collection process, especially for users without a localized ODK Collect, an option to go directly to forms from the desktop could remove confusion of navigating through the ODK Collect menu screen.

Login account for observers: a feature that allows for users to create an ODK account on the application would reduce the need to program the question into individual forms and in an ecosystem services context it would ensure clarity of individual payments to landowners monitoring their services.

Home icon menu: due to language barriers we often had difficulties describing the English translations of the home menu. While we know ODK is aware of this the suggestion is actually to use icons for the main menu, including the preferences. We found that the users readily associated with the icons when we encountered language difficulties.

ODK Aggregate

Name Fusion Table upon publishing: We would often change the Fusion Table name of localization and organization. Does this break the link for streaming submissions? We were unsure. It would be ideal to name the Fusion Tables upon publishing and then be reassured that the link between streaming submissions and that fusion table is intact.

Indication of what data is currently streaming and to where: With multiple data types and aggregates, we found that there was not a simple way to track where submission were being published to, specifically to what file name in either Google Fusion Tables.

Option to automatically merge grouped data with other data upon publishing: For most data sets with multiple groups, the end result is a merged data set with the group results corresponding with the data outside the groups (often date, location, observer etc.). This creates an additional editing step in Fusion Tables and again suggests a break in the streaming function. From Aggregate, a merge data option is desired, so that data publishes to Fusion Tables as merged.

Option to choose how columns will publish to Fusion Tables: When creating a KML file from Fusion Tables, Google Earth uses the first column to name the points on the map. In our experience, this was always the 30+ character instance id, resulting in a garbled and incomprehensible map. What we named each point always varied and therefore, we had to edit the Fusion Table. An improvement could be a choice of the column order when publishing.

Link publish options from aggregate to known citizen science or participatory research websites such as Ushadidi, eBird or iNaturalist.