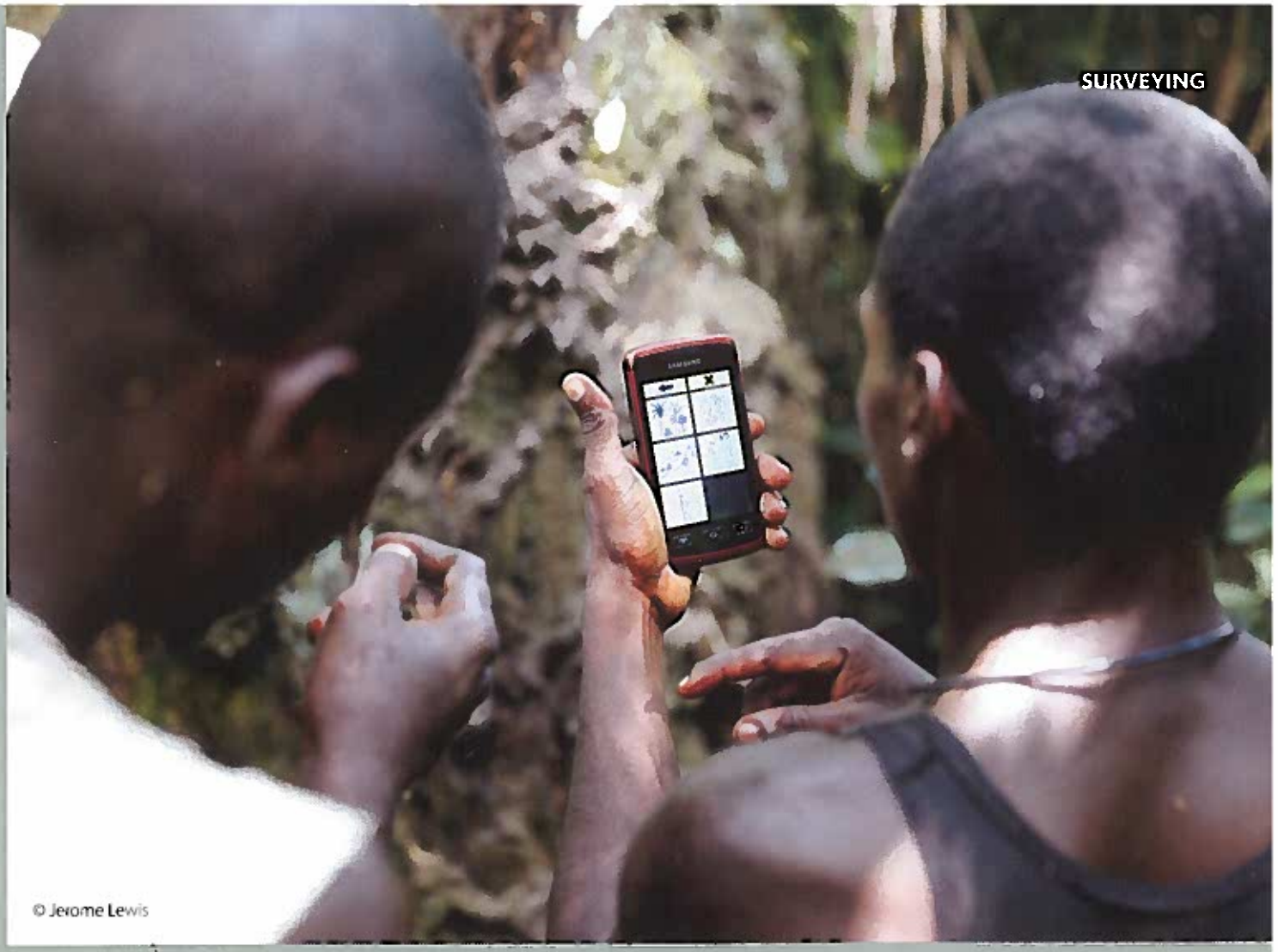


© Jerome Lewis

BEATING THE BOUNDS

LAND RIGHTS ARE IMPORTANT FOR INDIGENOUS PEOPLES AND WHO BETTER TO COLLECT THE DATA ABOUT THEIR LAND THAN THE PEOPLES THEMSELVES? BUT HOW DO YOU DESIGN A DATA COLLECTION SYSTEM FOR PEOPLE WHO CAN'T READ AND DON'T USE TECHNOLOGY? JIM BAUMANN REPORTS FROM A PROJECT IN THE CONGO BASIN THAT MANAGED TO SOLVE THIS PROBLEM

In medieval England, a common practice to preserve knowledge of village boundaries was to perform a perambulation known as 'beating the bounds'. Elders would pace the boundaries of the village with groups of children and point out landmarks to refresh the memories of the old and reinforce landmark identification with the young. In an age when village maps were rare, this helped perpetuate knowledge of the village and later aided in mapping it.

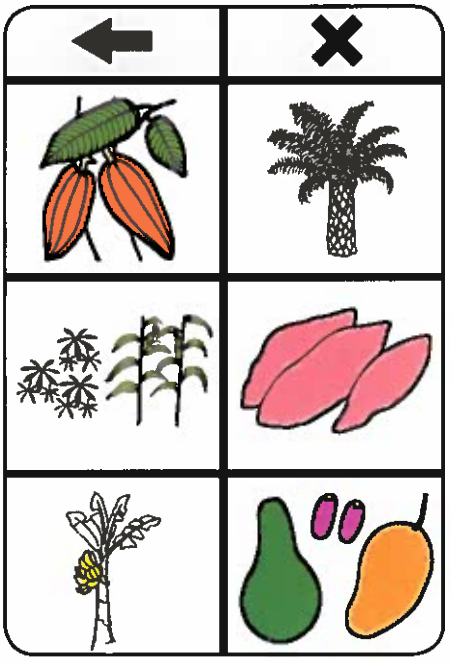
The development of modern surveying equipment began more than 400 years ago with the introduction of the plane table. Its level surface was initially used to make field drawings. Other devices, such as a compass, were later added to it and used in conjunction with 'Gunter's chain' for incremental measuring.

Today, there is a variety of mobile GPS and data collection devices to assist surveyors. However, there are still areas in the world where the knowledge of ancestral territory is passed down from generation to generation by walking the land and noting its landmarks. The Mbendjele are a group of indigenous people living in the Congo Basin of Africa. Trees are a vital source of food and an important part of the Mbendjele culture. Some trees are considered sacred, while others are used for medicinal purposes or attract a certain edible caterpillar in huge quantities during the 'hunger season' when other food sources become scarce.

However, the Mbendjele live in an area where logging is a critical part of the national economy. This has put the tribe into conflict with Congolaise Industrielle des Bois (CIB), a local logging company. Because the Congolese government is sensitive to the rights of its indigenous citizens, it supports an international programme called the Forest Stewardship Council. Certification from this programme identifies logging companies that are environmentally and socially sustainable in their forestry operations.

Part of the certification requires companies to respect the rights and resources of indigenous and local forest people. However, when CIB asked the Mbendjele to indicate their territories on a map, tribal members were unable to interpret it. Complicating matters, landowner ship is considered illegitimate to the Mbendjele, who believe that the creator made the forest for all creatures to share according to their

The USB pot charger used to recharge the smartphones (© Julia Altenbuchner)



Examples of Sapelli pictograms © Michalis Vitos

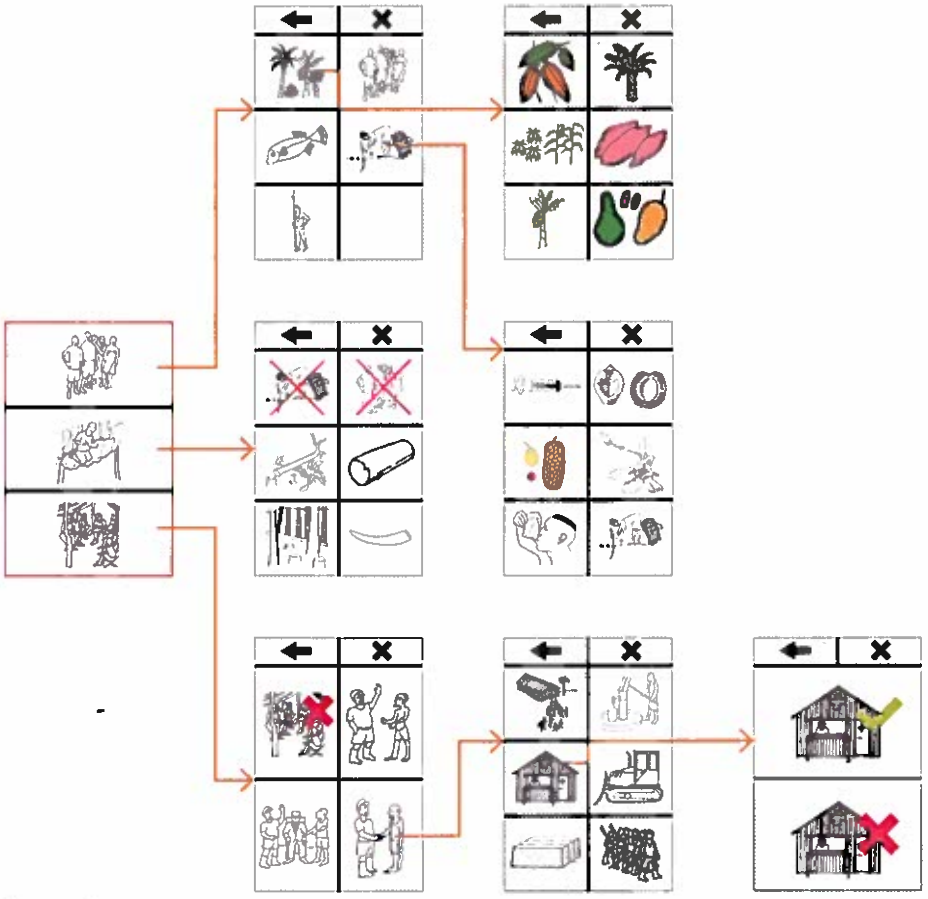
needs. The Mbendjele see themselves as an extension of the forest.

Jerome Lewis, a University College London (UCL) lecturer in anthropology, is the lead anthropologist working with the Mbendjele. Recognising the ability of GIS technology to underpin citizen-based initiatives, he and Muki Haklay, professor of geographical information science at UCL, founded the Extreme Citizen Science (ExCiteS) research group. This is an interdisciplinary team composed of researchers, artists, and information and communication technology specialists who work with local people to better engage them in citizen science, which involves participatory action.

Sapelli and GeoKey

One of their first tasks was to develop software and hardware for the Mbendjele's mapping needs. With the support of Esri, team members Matthias Stevens, Michalis Vitos, Julia Altenbuchner, Gill Conquest, Carolina Comandulli and others began the creation of Sapelli, a mobile phone-based data collection platform, and GeoKey a data storage and translation system. The two systems took roughly 1.5 years to develop using a variety of tools: Android development, Java, Django, HTML, JavaScript, SQL, UNIX, Server Administration, GIS, user interface/user experience design and others.

"Extreme citizen science is a bottom-up practice that takes into consideration local needs, practices and cultures. We work with residents to understand their needs and problems and help them develop solutions and transform their communities using innovative GIS applications," says ExCiteS research associate Patrick Rickles. "Results are shared with the community and interested parties, based on the sensitivity of the data and consent from participants, so that the project can continue to develop as they see fit."



The Sapelli pictogram tree © Michalis Vitos

Sapelli is an open-source Android app that is driven by pictogram decision trees. The application is named after the large Sapelli mahogany tree, which grows in the Congolese rain forest and is one of the main points of conflict between the local communities and the logging companies, as the tree is valued by both. It uses the Samsung Galaxy XCover smartphone for data collection, as it is extremely robust and can endure harsh conditions.

To connect the data to Esri technologies, ExCiteS developer Oliver Roick and others created GeoKey. This is an open-source web API that is used to store and access geospatial information in an Open Geospatial Consortium-compliant format. With this platform, the data can be stored and remote sources of data translated, so it can be used by a number of different GIS programs and applications. After data is imported into GeoKey, which stores it

in a PostgreSQL/PostGIS database hosted on cloud servers, it can be visualised in a web browser or desktop GIS that can consume KML, GeoJSON or CSV data, such as ArcGIS Online or Google Earth. Additional data format outputs are planned for the future.

Challenges

As the team works in remote areas, transmitting data can be a problem. When the signal strength is weak or nonexistent, information must be gathered offline and transmitted when possible. Sapelli is programmed in a way that allows the transfer and reassembly of very small packets of information whenever possible and has redundancies set up to ensure the integrity of its information. It uses a compressed SMS message to transfer key data, such as time stamps and selected points on the decision tree.

Few tribal members had seen a mobile phone before they were introduced to them by the ExCiteS team. Sapelli's pictograms were designed by the ExCiteS researchers and then altered according to feedback from the Mbendjele and other local users so that they could easily understand and use the pictograms. For example, there are pictograms of cut trees to signify logging and of tusks to represent poaching activities. These pictures are then selected by the user to note the occurrence of a particular activity. Once recorded, the category and the GPS location from the phone's internal sensors are saved and transmitted when the phone gets into a network.

The battery life of the mobile phones allow them to operate for only a few days. The batteries can be recharged by using special cooking pots that are heated over an open fire. The heat is transformed into electricity that powers a USB connector, all while the evening meal is being prepared. The pots are manufactured by Hatsuden-Nabe, a Japanese company.

While surveying with mobile phones can be a challenge, the data accuracy will vary because it depends on both the environment and the phones used. "By using the Samsung Galaxy XCover smartphones, we get accuracies of about 20m under a dense forest canopy," says ExCiteS developer Altenbuchner. "This platform provides us with both GPS and network positioning. The latter determines location based on the availability of a cell tower and Wi-Fi access points. The desired positioning systems can be determined by adding a simple tag to the project definition file."

Future developments

With these technologies, the Mbendjele were able to map their tribal lands and highlight the trees that were important to them. Those trees important to the Sapelli were then verified and removed from the cutting schedule of the timber company. The tribe also documented illegal logging and poaching activities.

The system will also be used by ExCiteS with other groups around the world, living in challenging conditions such as the Arctic. "The pictogram decision trees in the application can be swapped out for other pictograms to assist in its use by completely different communities," says Rickles. "For example, while we originally did this work for use by the Mbendjele, it is currently being used by tribes in the Amazon."

The ExCiteS developers are currently completing a revision of their data transmission system, which works with either a mobile phone network or an Internet connection, depending on availability. In addition, the system will be directly integrated with GeoKey. In the project management UI, the transmission end point can be set dynamically. This allows records to be sent from one Sapelli data collection instance to another, which assists data aggregation in the field. All projects have a unique identifier that is used to determine which data belongs to which database table, regardless of the device that was originally used for data collection. While the ExCiteS developers are working to fully automate the data transmission process, currently it is possible to locally export data records to CSV and XML files, which can then be used with any database management system and/or GIS. This functionality will be kept in future revisions of the application for those instances when no network coverage is available.

Currently, no reference maps are used by Sapelli because it allows simple data collection by navigating through the pictorial decision tree. "Since the communities in the Congo have no prior experience with using maps, we are simultaneously carrying out research on how to build an appropriate GIS that can be used by communities in their local environment in order to view and edit collected data," concludes Altenbuchner.

FEW TRIBAL MEMBERS HAD SEEN A MOBILE PHONE BEFORE THEY WERE INTRODUCED TO THEM BY THE EXCITES TEAM

Jim Baumann is a writer at Esri (www.esri.com)