



Accessibility, transport and travel time information.

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Summary

Activity 2.5.

Compose a comprehensive transport map showing all communications for sample sites, including time to market

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A transport map has been generated at the national level from a series of over 200 1:50,000 map sheets. Furthermore, fieldwork, photogrammetric data and land cover imagery have contributed to accurate transportation maps for the CIAT benchmark site in Yorito Honduras.

Travel times around Yorito were calculated for the dry season, wet season and for foot-based travel. The dry season and foot-based travel models were validated by real journey times and farmer's assessments of travel time between 18 aldeas and the nearest market. The model predictions were very close to the real travel times and the few anomalies (attributed to inaccurate road quality data) were easily corrected.

This report shows how we have created an accessibility extension to a common GIS package. This extension allows users to create and explore a variety of accessibility indicators using a grid based cost-distance algorithm. The users will be able to use their own data but will be guided as to the most appropriate data sources for the cost-distance process.

Following the cost-distance calculation the users will be able to analyse not only the travel cost maps but also the allocation of services and least-cost paths to services.

The extension allows users to explore accessibility to any type of point type target, e.g. agricultural market, viable ports for export, health care, schools or seed distribution centres. They will also have the flexibility to explore different scenarios such as the season (and its implications on ease of travel) and disaster type events (such as loss of infrastructure due to flooding, earthquakes or landslides).

Accessibility has social, economic and environmental dimensions and can be seen both as a pressure on existing natural resources and as a key factor in the development process. Access is a precondition for the satisfaction of almost any need and certainly for all physical needs. We propose that accessibility could provide a central integrating concept with which to grasp the complex interaction between the agricultural (subsistence), economic and social needs of any population.



Introduction

Transportation is a critical function for an economy as it affects the movement of people, goods and services, and development. In countries such as Honduras a complex transportation network permeates the countryside with paths for walking, paths for horses and donkeys, single lane seasonal roads that take *chivas* (buses that often take regional and national farmers and their produce to market), one and two lane all-weather gravel roads, local surfaced roads, regional and national surfaced roads, and motorways or freeways with dividers separating the carriageways. In all there are more than six transport classes. Each of these has typical speed of travel associated with it, which can be adjusted to take into account slope, the type of vehicle traversing it, rainfall over a 2, 3 or 7 day period, or an adjustment for congestion. In the end it is possible to work out how long it takes to get from anywhere on the map to the nearest market town or hospital or school using a particular vehicle class. The time taken to reach a desired location can be generally referred to as its 'accessibility'.

Accessibility can be defined as the ability for interaction or contact with sites of economic or social opportunity, (Deichmann 1998), however there are a multitude of ways in which this intuitive concept has been expressed in the literature. Goodall (1987) defines accessibility as the ease with which a location may be reached from other locations, and Geertman (1995) states that the concept of accessibility can be used in rural development policy as an indicator of rural deprivation and as a variable on location analysis

Over the last ten years there has been a growing awareness that rural accessibility concerns more than just roads, (Barwell 1996). Reports and surveys carried out in developing regions paint a picture of rural isolation and unproductive use of limited resources, in which the farmer largely inhabits a walking world. In his introduction to *Transport and the Village*, Cleaver states that:

It is clear that the extremely poor state of off the road transport system in Africa acts as a powerful brake on agricultural productivity and growth. Improved accessibility will reduce the economic costs of moving goods from local markets and ease the barriers to social facilities. This will contribute to economic growth and enhance social well being.

But before national governments can provide environments conducive to the development of local infrastructure, there is a need for a model that can incorporate the local environmental factors that define rural *inaccessibility*. Also any model should be flexible enough not only to quantify time and cost of travel but also infrastructure improvement (or degradation) scenarios to be created and evaluated.

Clearly there are different levels of infrastructure availability, transport availability, and many different environmental effects, and economic considerations. For example it would be impossible to apply the same model of rural accessibility to Sub Saharan West Africa and Central American Hillsides, but any model should be capable of incorporating all of these factors in a way which is not only sensible and geographically sensitive but also educational and explanatory.



Background and Justification

Spatial accessibility is determined by geographic location in relation to target locations, and by the transportation facilities that are available to reach those destinations. Accessibility is also influenced by social factors such as knowledge and information and by economic factors since the use of transport and communication facilities is usually associated with some monetary cost. Although it is difficult to incorporate these economic factors explicitly in formal models, the selective weighting of one market can imply the social and economic dimensions over another.

In public planning, an important objective is the equal provision of services for all people and in all parts of a country. For example, the population of a country or region should have similar access to public services, independent from their location of residence. Poor infrastructure and consequently limited accessibility implies fewer opportunities for improving economic status, health or social standing. Ravallion (1996), for example, speaks of a “spatial poverty trap” that may prevent the poor from breaking out of local level constraints.

Operational quantitative measures of accessibility are therefore useful in policy analysis where the focus is on service provision, for example, in the health sector. Other areas in which accessibility is important are economic applications, and, in fact, many of the operational measures of accessibility have first been developed for labour market research and retail analysis.

Geographical information systems (GIS) lend themselves naturally to the computation of accessibility indicators. GIS can represent networks, villages or facilities and provide functions to compute distances and to define relationships among spatial objects. Consequently, certain accessibility measures can be computed using commercial packages such ArcView®.

However, there is a distinct lack of any step by step, or easy to use models to develop transport maps, accessibility surfaces and the economic catchment areas of towns and markets. This is a strange omission from the planner's toolbox, when accessibility is considered such a fundamental indicator of economic potential and an undeniable pressure on ecological systems. One possible explanation is that accessibility is so poorly defined; many people talk about accessibility and there are many differing opinions as to what it actually is. With so many differing definitions perhaps we should not be so surprised that there are few tools and methods available.

Methodology

To begin with, it is necessary to clarify some of the terminology that will be used in this model. Accessibility is calculated on a *friction surface*. A friction surface consists of a regular two-dimensional grid where each cell in the grid represents either a transport route such as roads, railway lines, tracks, or navigable rivers, or relatively inaccessible land and water bodies.



Different types of transport infrastructure have different characteristics. A surfaced road, for example, allows faster travel speed than a dirt road. In practice, it is therefore not enough to measure the *distance* of a road connection between two points. Instead, a measure of travel *cost* is preferable. This cost can be measured in monetary terms or as *travel time*. As will be discussed later in this section the cost to travel across different types of land can be easily estimated.

Sources (points of interest) such as villages, hospitals, or schools are usually located on the transport network and can therefore be represented in another grid as cells that have a certain characteristic. This characteristic could be the village's population, the hospital's number of doctors or beds, or the number of teachers at a school. If we are simply interested in is the presence or absence of a point of interest, then all points can have the same value.

The underlying theory is outlined in Figure 1, adapted from the Arc Info "Help Documents" From the cell perspective, the objective of the cost functions is for each cell location in the analysis window, to determine the least costly path to reach a source. Each cell will need to determine the least accumulative cost path to a source, the source that allows for the least cost path and the least cost path itself. Cost distance functions apply distance in cost units, not in geographic units.

The cost grid can be a single grid that is generally the result from the composite of multiple grids. The units that are assigned to the cost grid can be any type of cost desired. The dollar cost, time, energy expended, or a unitless system that derives its meaning relative to the cost assigned to other cells.

The cost values assigned to each cell are per-unit distance measures for the cell. That is, if the cell size is expressed in meters, the cost assigned to the cell is the cost necessary to travel one meter within the cell. If the resolution is 50 meters, the total cost to travel either horizontally or vertically through the cell would be the cost assigned to the cell times the resolution.

$$\mathbf{total\ cost = cost \times 50}$$

To travel diagonally through the cell, the total cost would be 1.414 times the cost of the cell times the cell resolution.

$$\mathbf{total\ diagonal\ cost = 1.414 \times cost \times 50}$$

A cost path consists of sequentially connected links that provide the route for each cell location to reach a source. A cost path distance (or cost distance) from any cell to a source is the accumulative cost of all links along the path for the cell to reach the source cells. There are many possible paths to reach each source cell and there are many paths to reach the many source cells. There is on one least cost path. The least cost path distance from a cell to a source cell is the smallest (or least) cost distance among all



cost path distances from the cell to the source cells. Figure 2 graphically describes the input and outputs of the model.

All that is needed to create an accessibility map, and the two optional outputs are:

- A point coverage of markets or points of interest
- A grid where each cell's value represents the cost of traversing that particular cell.

So far the problem seems trivial, the cost-distance function is simple in concept and the data requirements are minimal. In fact these are two of the reasons for selecting this type of analysis. However there are several points to note.

1. You need geographic data that is in an Equal Area Projection (for example Lambert Azimuthal), to preserve areal qualities.
2. You are unlikely to have such a friction surface ready to hand.
3. The friction surface is totally dependent on the user and purpose, and will possibly change for differing scenarios; i.e. foot based/vehicle based, wet season/dry season.
4. The amount of pre-processing required to create the equal area projected grids.

Interface design

The GIS, ArcView 3, was chosen as the working environment for this activity. Previous work in CIAT had used ArcInfo and its associated macro language AML to produce accessibility surfaces, but by version 3, ArcView had become mature enough to allow development of the interface using its Avenue scripting language.

The ArcView extension and accompanying user interface address all of these issues, with a simple definition or concept of accessibility “What is the cost of getting from any location to the nearest point of interest?”. This is a fairly general question, where *cost* can be:

- Real cost (cost of transport).
- Perceived cost (cost of transport with other factors).
- Time (simply time taken to get there).
- Perceived time (travel time plus factors introduced by the nature of the transport).
- Any other concept of cost that the user is able to express.

A *point of interest* can be:

- A market where goods can be bought or sold (large towns).



- A service industry (so called enterprise zones).
- A hospital or school.
- A transport exchange node (i.e. between road and rail, rail and sea)

The *location* can be anywhere in the area of study.

This model uses purely geographic data to create accessibility models. There is no explicit accounting for social or economic factors, as in the classical Von Thunen model, although it is very easy to incorporate them. The following section is a step-by-step introduction to the accessibility interface.

Step by step guide through the interface

1 Set your work directory

The process of creating an accessibility surface is not only computer memory intensive, but can also use a lot of disk space with temporary files. Make sure you set a work directory on a disk with plenty of space.

2 Create a view

Open a new view within ArcView where the input datasets will be visualised.

3 Add friction coverages to the view

Here you will start to add coverages and grids that will eventually combine to make a friction surface.

4 Add a Road map

There are two essential coverages you will need to build a friction surface. The first one is a land transport network, usually road a road map but it could also be rail or a combination of both.

5 Add a Boundary map

A boundary coverage is required to act as a barrier to the cost-distance function. This prevents the algorithm calculating costs in area outside the are of interest.

6 Option to add a river, land-cover, urban-area, slope or barrier map.

Additionally, if it is relevant to your study you can include any and all of these coverages and incorporate them into your friction surface.

7 Add point of interest coverage

When the friction components are complete, a point coverage needs to be included to define markets and locations of interest.



8 Sub select points, (select manually, select by database query, or select by spatial query)

Very often this point coverage is not ideal and may contain too many points or perhaps too few. The interface includes the option to select only the points that are relevant to your study, and to manually create others. Points can be selected by any combination of these three common ArcView select tools, *SQL Query, Spatial selection and Table query*.

9 Reclass grid coverages into useful classes

The grid components of the friction surface, may contain hundred of values. This stage involves the classification of the grids into useful ranges and is a purely technical stage reflecting the limitations of the software. The reclassification step is strongly recommended, as ArcView will convert the grids to Shapefiles, and the fewer the classes contained within each grid, the smaller the Shapefile will be.

10 Convert grids to Shapefiles

As stated in the previous stage, all grids must to be converted to Shapefiles, as ArcView cannot project grids.

11 Clip all themes to a desired area of interest

Here you have the option to “clip” all the coverages simultaneously to an area of interest. It is quite possible that each map is from a different source and hence will cover a different extent. Using the data view, you can define an area of interest and the coverages will be clipped accordingly.

12 Project data to Lambert Azimuthal Equal Area Projection

As mentioned earlier, the cost-distance function will only give sensible results if all the data exists in an Equal Area projection. This function will simultaneously re-project all your coverages, and place them in a new view. Your dataset must be less than one hemisphere in extent, otherwise the projection will not work. If you want to create an accessibility surface that is greater than one hemisphere, then you are evidently into accessibility in far bigger way than we are!

13 Convert Shapefiles to grids

Again this is a purely technical stage where we convert the Shapefiles back to grids in order to build the friction surface.

14 Reclass grids to reflect their friction components

This is the most important (and certainly the most subjective) part of the model where we need to decide how to define the friction surface. If the friction cost is time, we will need to estimate the time required to traverse 1 cell of each class of road that exists in the road coverage.

For example a 2km-resolution road coverage might have 3 classes of road,



Class	Description
1	Highway
2	Road
3	Track

We estimate the speed by truck, assuming we are carrying goods to market, to be

Class	Description	Speed
1	Highway	120 km/hr
2	Road	60 km/hr
3	Track	30 km/hr

On a 2km-resolution grid we have to reclassify this by converting km/hr into metres per minute (1 km/hr equals 16.667 m/min). The new classes represent the time taken (in minutes) to cross 2km of each road type at the given speed.

Old class	Description	Speed	New class
1	Highway	120 km/hr	1
2	Road	60 km/hr	2
3	Track	30 km/hr	4

This estimation has to be repeated for all other optional coverage to. For example are rivers barriers (high cost per unit cell) or potential routes (low cost per unit cell). If there is a slope grid, then this acts as a multiplying factor over all other grids. For example gentle slopes hardly effect speed of travel, but steep slopes will heavily impede travel over any surface. For example:

Old class	Description	New class
1	Slopes of 0 – 5 degrees	1
2	Slopes of 5 – 10 degrees	3
3	Slopes greater than 10 degrees	5

These reclassified grids will be placed in a new view.

15 Combine grids to create friction surface

This step automatically combines the friction components into one grid, with the following logic.

$$\text{Friction} = \text{Slope} \times [\text{Precedence} (\text{Barriers} , \text{Roads} , \text{Rivers} , \text{Urban} , \text{Land Cover})]$$



Where, on a cell by cell basis Barriers have precedence over Roads, Roads have precedence over Rivers, etc. etc.

16 Run cost distance function, with two optional outputs

Here we can select the optional outputs of

Direction to nearest point of interest.

Allocation zones for each area of interest.

17 Re-project outputs back to original format.

When the cost-distance function is complete, the outputs will be projected back into the original projection (this step also includes the hidden functions of making all the grids integer grids, converting them the Shapefiles before the projection, and reconvertng them to grids after projection!)

Finally we have created an accessibility surface (and optional datasets) containing information on:

- Time/distance to market.
- Direction of travel to reach nearest market.
- The catchment area (the economic equivalent of a watershed) for each market.

It is a relatively simple task to calibrate the time to market output by questioning local farmers for small sites and by general consensus when determining travel times across countries or continents. The model has been run on sites as small as the three Honduran test sites (10km by 10km) up to continental scales (all of Latin America and the Caribbean at 1km resolution), and calibration has proved relatively easy. In most cases the original estimates input into the model proved to be accurate enough without rerunning the model. So it was seen that the model was not only simple in its concept but also applicable across a huge range of scales, although there are issues that need further consideration, such as border crossings and international trade and tax limitations.

Application and Validation

Travel time and communication links for sample sites.

Following the guidelines in the previous sections, data was collected for the area shown in figure 3, namely the municipios of Yorito and Sulaco. The main source for these data were digitised 1:50,000 map sheets including towns (fig. 4), households (fig. 5) , roads (fig. 6), slopes (fig. 7) and aerial photographs. Additionally 30m-resolution TM land cover imagery was available from 1994 (fig. 8). The friction surface (fig. 9) was composed and an initial 50m-resolution accessibility map was generated with the following assumptions.



Dry Season		Velocity per transport type (km/hr)			
Surface type	Car	Truck	Bus	Walking	
Paved road	100	80	60	6	
Packed earth road	60	40	30	6	
Track or footpath	20	10	NA	5	
Forested	NA	NA	NA	4	
Croplands	NA	NA	NA	4	
Bare soil	NA	NA	NA	4	

Wet Season		Velocity per transport type (km/hr)			
Surface type	Car	Truck	Bus	Walking	
Paved road	80	50	40	5	
Packed earth road	40	30	20	5	
Track or footpath	NA	NA	NA	4	
Forested	NA	NA	NA	3	
Croplands	NA	NA	NA	3	
Bare soil	NA	NA	NA	3	

These values were estimated and later validated by fieldwork in the study site. In all, 6 accessibility coverages (dry season transport, wet season transport and walking) were generated, from which it is possible to determine:

1. Travel time to market (the town of Yorito was cited as the main market by local farmers)
2. Travel time to the nearest town centre, for each household

These accessibility maps are shown in figures 10 through 12. An example travel-time matrix is shown in Figure 13. The model calculates all possible travel routes through the transport network. The figures in bold, are journeys that were made as part of the verification. Figure 13 also compares the model dry season travel times to the actual travel times. Additionally farmers were asked to estimate the time it took to walk to markets, and this too was compared to the model, although sometimes the responses were vague, and we acknowledge that it is difficult to verify these results.

The model corresponds very well to the observed data. Over 60 routes were travelled and the average error per route was less than 10%, with the lowest errors being on routes with flat, good quality roads, and the greatest errors on steep sinuous paths and trails. Most errors were attributed to inaccurate and old road quality data, for example the roads between Sulaco and Yorito has been recently re-paved with



compacted earth and gravel, producing far quicker travel times than the model had predicted. After changes were made to the road database to reflect the current situation, an almost perfect fit was achieved

Example: Accessibility to services within Honduras

By computing accessibility to services for all of Honduras, it is possible to target problem areas and suggest priorities for further action and investment for the most urgent needs of rural communities. Local level planning could use such methods to:

- Categorise or rank communities according to their level of access
- Compare levels of access to a service within and between different administrative areas, leading to a more realistic setting of local targets.
- Assess the relative significance of access to each different service.
- Relate local levels of access to regional or local standards.
- Monitor development

The 1988 census provided information on the number of colleges and major health centres in Honduras. We can be reasonably sure that the numbers represented in the census are under-enumerated, but nevertheless, the data will serve as a dramatic example of how accessibility can be used for local and national level planning.

For the case of education, aldeas with colleges were selected from the census database and used as the target or market data. An ease of travel map was generated from national level road, slope and land cover maps. From these an accessibility map and catchment map were produced (figures 14 and 15 respectively). A simple overlay of the population data (figure 16) does not reveal much, but by calculating the percentage of rural children within one hour, two hours, etc., of the nearest college, the graph below figure 16 was produced. Furthermore this data can be visualised by classifying each aldea by its level of access to the nearest facility (figure 17). This final visualisation reveals the inequality of education provision across the country.

From the examples on the following pages we see that over 80% (over one million) of the rural child population is more than one hour away from the nearest school, and over 50% (700,000) are more than two hours away. This is not to say that those with good access to education facilities will necessarily have the freedom (economic or otherwise) to use them, but it does highlight the huge inequality of service provision across the country, inequalities that lead inexorably towards the spatial poverty trap.

A similar process was applied to hospital data. For health care the figures for the entire rural population indicate that around 90% (two million) of the rural population are over one hour from a general hospital



(this does not include local rural health centres) and 70% (one and a half million) are over two hours away!

We can see from the examples that it is a relatively easy task to identify the 'black-spots' and high priority areas, which in turn can lead to an intervention strategy.

Discussion & Conclusions

Outputs compared with a restatement of the objective

Compose a comprehensive transport map showing all communications for sample sites, including time to market.

A transport map has been generated at the national level from a series of over 200 1:50,000 map sheets. Furthermore, fieldwork, photogrammetric data and land cover imagery have contributed to accurate transportation maps for the CIAT benchmark site in Yorito Honduras. Travel times around Yorito were calculated for the dry season, wet season and for foot-based travel. The dry season and foot-based travel models were validated by real journey times and farmer's assessments of travel time between 18 aldeas and the nearest market. The model predictions were very close to the real travel times and the few anomalies (attributed to inaccurate road quality data) were easily corrected. Further changes to the model were unnecessary, reflecting the ease with which travel times can be estimated with little local knowledge.

Accessibility as a framework for analysis and intervention in local development

Access is a precondition for the satisfaction of almost any need and certainly for all physical needs. We propose that accessibility provides a central integrating concept with which to grasp the complex interaction between the agricultural (subsistence), economic and social needs of any population. Using this concept it is possible to investigate the patterns of movement of rural populations and identify their involvement in local economic activities (ILO, 1998). Given that transport is in reality a means to an end, and that that end is to gain access, there is huge potential to use accessibility models to aid decision-making in critical sectors such as:

- Water
- Energy
- Health
- Education
- Markets
- Agricultural inputs and outputs
- Crop marketing
- Post harvest facilities



The International Labour Organisation (ILO) have recently proposed that integrated rural accessibility planning provides a solid starting point for grasping local realities and understanding what is happening from the point of view of socio-economic development in many critical areas of rural life.

Time to market analysis and transport maps

The cell based COST-DISTANCE algorithm, has been found to perform well for estimating travel time by foot or by transport, for small regions with high-resolution data and for country level analysis. It has even been used in other CIAT projects for calculating accessibility at a continental level for all of Latin America and the Caribbean. The algorithm is described in detail in a separate document, with information taken from ArcInfo Help Docs.

Assessment of population pressure on limited resources

The examples of health-care and educational catchment areas paint a stark picture of the pressure upon Honduran social and educational resources. Both are seen as strong indicators of general welfare of the population. The ability to quickly assess and map these phenomena is unquestionable. Admittedly, the reliance here on census records over 10 years old is suspect, but the reasoning is valid, simply update the data and repeat the process. This concept leads to other possibilities in the realm of resource allocation.

Resource Allocation Potential

The optimal location of facilities such as schools, hospitals and industries as an important and difficult decision especially as governments tend towards increasing decentralisation and democratisation. Such increased levels of responsibility in local government necessitate the development of effective tools and methods for assessing a range of socio-economic impacts of one site location over another in an arena of high pressure and scarce resources.

Potential for visualisation and pseudo-quantitative assessment of policies

As highlighted in the final project report, (the pre and post Mitch scenarios) there is great potential for the mapping of the effects of natural disasters and policy decisions, before they occur. It is only with hindsight after Hurricane Mitch that this potential of the model was realised, but the results generated from this analysis have been put to good use and were included in the CIAT CD-ROM Atlas of Honduras for distribution to aid agencies, governments and other interested parties in the wake of this national disaster.

Further more it is possible to incorporate farming practises into the analysis to estimate impact of one infrastructure development policy over another based on the change on accessibility to local farmers and their produce. Such policies could influence the choice of one market crop over another or the movement from one market to another.



Economic catchment areas and areas of economic influence

It is worth paying attention to one of the optional outputs of the model, but potentially one of the most interesting and powerful coverages it is possible to generate within a GIS environment. These units are unique in that they:

- Are focused on a resource or market, unlike administrative boundaries
- Are self-explanatory, the concept of a market catchment is very intuitive.
- Are able to integrate socio-economic, biophysical and agricultural factors, unlike watersheds.
- Are user definable

The final point is critical to spatial analysis. It is possible to create exactly the areal units or boundaries that are required, by explicitly stating the focal point or resource that the local population need to access (market or service), and their potential to gain access to it (infrastructure, topography and land cover). Indeed these areal units promise to be a partial solution to the Modifiable Areal Unit Problem as they allow the user to predefine areas based on economic and physical criteria and to then aggregate data accordingly using user-defined units more suitable to the purpose than other pre-conceived administrative boundaries. An included case study contains an example of using hierarchical market definitions to aggregate census data.

The delineation of the catchment potential of each market is of unquestionable value to decision-makers and planners. In the Mitch example it was suggested that the impact of bridge destruction could force a farmer to move to a new unknown market, and how the option of bridge reconstruction (under differing policies) could be visualised and impact of the construction policies assessed. Considering the impact that GIS watershed delineation has had on hydrology, it is possible to see a very bright future indeed for economic catchment areas, since they have the added flexibility to be generated on demand for differing scenarios, different scales.

User friendly interface development

Producing the interface required about 6 months of work, from conception, design, construction, testing and finally documentation. Accessibility is being used more and more frequently as an input to other models in CIAT that the time and effort spent constructing the interface was deemed worthwhile.

Impact assessment

Through ESRI's web site <http://www.esri.com> it is possible to distribute the interface to a wider audience and to gauge the impact of the work, from the number of times the interface is downloaded, and the feedback which is received.

We also plan to make the interface (complete with documentation) available via CIAT's web site <http://www.ciat.cgiar.org>, again requesting information from the visitors who wish to download it.



Another aspect of this work, is the learning experience gained from building an interface such as this. From meetings last year with other CSI (Consortium for Spatial Information) of which CIAT is the coordinating member, the interface will be made available to all consortium members and a personal report from the two developers will be included, describing the difficulties encountered and obstacles overcome on the way to creating the final product. It is hoped that such experiences can be shared and learned from by other consortium members, leading to improved understanding, improved co-operation and sharing of ideas and products in the future.

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