Suggestions for the ACC Pilot Area DEM project

The pilot project area has been chosen and a data set collected to start on it. The information about the data is in a document called:

ACC_Pilot_Project_site_DEM.pdf

And a set of illustrations of the data is included in:

Figures_for_Data.pdf

The data are included in sub-folders of a main folder called “JWZ_Base”. JWZ stands for Jiangwozi (姜窝子) which is the approximate centre point for the study and where the Baoji and Meixian roads meet.

This document contains some suggestions as to how to go about processing the data and achieving the project objectives. Basically, my suggestion is that there be two stages to the work. The first should use the SRTM data as the DEM and undertake a number of studies in which integration between the various data types is illustrated and the compatibility of the Russian Topographic maps and the SRTM (and Google Earth) and GPS data are established.

There is also a need to look ahead to terrain products. By this I mean that terrain will need to be classified into landform elements. These can involve differential measures (slope and curvature are some of these) and integral measures (such as catchments, watersheds, divides and streamlines as well as upslope and downslope areas). These will be quite significant for the archaeology but are obviously important in environmental studies as well. It is best to try these tools on SRTM and see that all will be ready when the detailed DEM is ready.

The second is to develop a finer scale DEM from the Russian Topographic maps that is compatible with the SRTM in scaling but detailed enough to support the site based archaeology that we hope to undertake in the study area. It is important that the compatibility between the data types be established first. This can be done in the first stage. This includes establishing differences in spatial registration, datum issues (both horizontal and vertical), establishing the seamless integration between the maps, Google Earth, SRTM and the GPS data and illustrating this with 3D visualisation. Only then can the data scales be established and the detailed DEM developed.

Merging SRTM and map data to create a finer scale DEM that has the advantages of both and checks out on the ground as well is not a trivial task. It is a research project. My suggestion is that the first step could be to develop a DEM from the Russian Topo maps as if they were the only base information. This means digitising contours, spot heights and streams and streamlines. The techniques used at ISWC using ANUDem and various methods is a good way to approach this. The next phase will attempt to establish a DEM which scales up to SRTM and is accurate when checked on the ground. We can discuss this more later.

In order to achieve this, I have decided to purchase some new Russian Topo Maps. These are 1:100,000 scale (the previous data were 1:200,000) and have done so. There are four map sheets needed to cover the study area and it is at a boundary as often happens. But the 20m contours are very clear in these data and they provide a better base for developing the spot height, contour, streams, rivers and streamline data needed for interpolation and drainage enforcement.

The Russian Topo Maps also have another advantage. They are based on aerial photography taken in the 1950's and 1960's. As such, many of the modern roads were not built and neither of the Shimen or Shitou dams (at each end of the Baoxie Road) were built. So they provide a way to estimate the terrain before the dams were built and also provide tracks of roads that are older than the current roads. So, one task is to digitise the roads and tracks in the study area. The maps at both scales can also be compared for compatibility. There may have been changes in information between the dates of the photography used. The maps will help with the modern history of the Shu roads!

A more detailed discussion follows:

1. Initial activities

    a. Using SRTM data as the DEM

In the first instance I suggest that the SRTM data be used to check that all of the basic steps to combine different data and visualise it can be done. The SRTM data are DEM data and can be presented in many ways and combined with map or GPS data. Some examples are to be found in the set of Figures for the above report (in Figures_for_Data.pdf).

As might be expected if the software is good, the GPS data, Google Earth and SRTM data come together very well in the cases shown in the set of Figures. But you will need to test that whatever software you use it also achieves these simple steps. The results can also provide the museum with some immediate products. This step is useful and important. Any ideas on forms of visualisation and presentation are welcome – based on the SRTM as DEM.

The GPS data provided in the data set are useful to test the integration and accuracy of the various data sets. For example:

- If you can get the altitudes from the Track positions from the SRTM data and compare it with the GPS heights this will start to test the data integration as well as the registration between GPS and SRTM.

- If you get some points from Google Earth and locate the same places in the SRTM data – are the heights the same?

Programs to locate paths through DEMs or fly through valleys exist. If you have these it is best to try them out initially on the SRTM as the DEM. It is not what we wish to do in the end but it is the place to start. The SRTM data provide the DEM for Google

Earth. The Figures provided show that they are exactly the same as the SRTM data downloaded from NASA and the geocoding is identical.

b. Checking the Topopgraphic map data against SRTM

The Russian Topographic Data are not of the same kind as the SRTM, Google Earth and GPS data. They are UTM on a Russian datum. It is not clear what the height datum (Geoid) is. I have added information about the datum (Pulkovo 1942) with the text description of the data.

My suggestion is to go through some simple tests before putting in a lot of effort digitising all of the contours and streamlines. For example:

- Get the positions and heights at the spot heights (usually peaks) from the digital version of the maps and see if they map to similar points in the SRTM data (or Google Earth) and have similar heights above SL (vertical datum).

- Map the GPS waypoints and tracks into the map (you may need to change the map projection first or convert the GPS data to the Russian projection and Datum). Do they match the correct places?

- There are also roads marked on the Russian maps. These roads were mainly pre-1965 and so have historical value. If these roads are digitised it is an important test to see if they can be mapped into the SRTM data and come in at the correct location. These roads will form an important data set in the historical data base. What are the heights at the points along the roads from SRTM?

- Rivers, streams and streamlines can also be digitised and the heights at the points along the track of the stream can be used to check that it is in the right place. If these tests do not show the data in the same place it is probably the Datum or other data characteristic that is involved. These must be sorted out as quickly as possible.

You can create contours in the SRTM data by software. If these are plotted in the Map data (it is geocoded data but you have to handle the change in projection and Datum) do the two sets of contours match? Digitise selected contours from the map. How do they plot in SRTM and Google Earth? What are the SRTM heights along these lines? There are many other ways to cross match but at some point it is hoped they match as much as is possible.

But this first stage is not all about testing software and maps. At this stage there needs to be a discussion about how the data will be visualised and presented for the Museum. All possible software and tools can be tested using the SRTM as the DEM. When the finer DEM is available you will be ready.

2. Constructing the fine scale DEM

    a. Using the maps to create a DEM

The complete activity is one of combining the information from the different sources. However, this will not be easy as they are at a different scale and have different surveying bases. The first part above will establish how different they are and also if the differences can be reduced.

My suggestion is to digitise contours, spot heights, streamlines and rivers and then use software such as ANUDem and techniques used by ISWC in the Loess Plateau to obtain a DEM that drains correctly and interpolates the heights. The gridcell size could be 10m-30m (30m is 1 arc second) to compare with SRTM interpolated down to 1 second. Then you should compare the data sets carefully. Are the data co-registered? Are the height histograms close and similar? Are there systematic (probably Datum) issues? If the major problems are sorted out – then it is possible to think about how to use both data sets together.

It may be that this product is sufficient in itself and without the need to combine it with SRTM in a single software adjustment. If so, then the visualisation and terrain mapping as well as products defined previously can all be created and the field work planned. But the research topic of making the fine and coarse scale data compatible and scaling correctly is an important one and I suggest it be attempted.

b. Combining the data sets

If the initial effort removes the systematic and controllable disturbing elements of mis-registration, overall relief scale, baseline, geoid and other factors then using components of both sets together should be feasible. This is a research issue but one that is highly practical in the circumstances. Whether this means processing two DEMs together to reach a common pair that scale or whether it means combining the SRTM with the contours and streamlines I do not know. There are advantages in both. It is a discussion topic.

The question of how many contours and what area to digitise also needs discussion. Can all contours in the study area be digitised or only some? If only some can be done then the combined reduction to a fine grid becomes even more critical and the need to avoid the “systematic” effects even more important. Trying to combine incompatible data does not lead to any improvements.

3. Steps

I suggest that we discuss this document, the data and your findings when you go through the data as well as any questions arising using email or Skype. The first stage may seem to be a delay. However, I suggest it is critical as the basic factors of registration and datum as well as compatibility of data sets will have a such a strong influence on the second stage that the time will not be wasted!

Good Luck.

DLBJ
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