

# Notes for ACC Pilot Project Test site DEM

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January, 2008.

## 1 Introduction

### 1.1 Study Area

The Australia-China Project Phase 2 looks to develop a detailed Digital Elevation Model (DEM) and mapping base for a relatively small section of Shu Roads and demonstrate some visualization, data base options and applications of 3S with Hanzhong Museum. The area that has been selected is centred approximately on Jiangwozi where the highway from Meixian in the Guanzhong meets the highway from Baoji. It includes Liuba on the Baoji road, Jiangkou on the Meixian road and reaches to Madao along the road south along the side of the Bao River towards Baocheng and Hanzhong. This is quite a large area but has many significant historical relics and is a common section of the major route through the Qinling for much of its history. A map reproduced from a publication obtained at Jiangliang Miao<sup>1</sup> (Liuba) shows some of the relics that are close to this area. It can be viewed as Figure 1 in the presentation document (Figures\_for\_Data.pdf) which contains illustrations of the data being described here. These notes have been developed to accompany the initial selection of base and derived data collected for the task.

### 1.2 SRTM Data

The basic data set is the US SRTM (Shuttle Radar Terrain Mapping) mission (see SRTM\_Topo.pdf and techguide\_srtm.pdf). These data cover most of the world and are a 3 second geographic projection DEM of the earth that is compatible with GPS heights (measured relative to the WGS-84 spheroid). They are average heights from a finer 1 second DEM only accessible in the US. They are not surveyed data but are interpreted radar data and so have some issues. This means that they need to be treated as remote sensing data rather than surface elevations. But they are a good base to start with. 3 arc seconds is roughly 90 metres on the ground. This is quite coarse and we believe for the kind of work that will be done in the study area a finer resolution and locally accurately surveyed DEM is needed. SRTM data have been adjusted to a specific datum and geoid and so if local DEM data are surveyed to different baselines this must be taken into account when being processed or combined.

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<sup>1</sup>陈泽孝, 陈宁 (1999) “张良庙与紫柏山”, 留坝县张良庙文管所

### **1.3 Google Earth and GPS**

As background supporting information and software for presentation we have used Google Earth (in which the elevation is the SRTM data) and some GPS data collected in the study area. These data provide the positions of some sites and GPS tracks of the modern roads. Google Earth (GE) is available as free software but the free version has some limitations and so the GE Pro version has been used to prepare the data and make some illustrations. It is not necessary to have GE Pro to use the data provided but it does allow more advanced data integration and presentation to be achieved.

### **1.4 Russian Topographic Maps**

Early in the project, a number of digitised maps were purchased to provide information and mosaics of large areas of the Shu Roads. The maps in the data set originally purchased were Soviet Military Topographic maps intended to be printed at 1:200,000 scale with 20-40m contours, Gauss-Kruger Projection, Pulkovo 1942 (S-42) datum. The maps were scanned by East View Cartographic (a US Company with a branch in the EC) at 400 dpi. They were geo-referenced and delivered as raster images saved as GeoTiff files. The data is in the native Gauss-Kruger projection and Pulkovo 1942 (S-42) datum. The pixel size of the 1:200k GeoTiff files is close to 12.7 metres.

Recently, a new set of four map sheets that are at 1:100,000 scale with pixel size at half the above (6.3 metres) have been purchased. These have clear 20 m contours (the 1:200k maps sometimes had merged contours due to the scale) and will provide the best source for additional DEM information in the study area. Vector maps for the area also exist but are very expensive (\$750 per 1:100,000 sheet). The four 1:100,000 map sheets have been put into a mosaic in Gauss-Kruger projection. It is provided with the base data. The 1:200k and 1:100k maps can be mosaiced together easily using only the georeferencing. In the data sets above I have provided the original images and a mosaic as well. The study area lies across four map sheets at both scales and so needs accurate mosaicing.

The information on the two Russian map series is not the same and both provide valuable sources of information. The maps are based on aerial photography taken in the late 1950's and early 1960's and so the roads are the ones that existed prior to the construction of the current highways and at that time neither the Shimen Dam nor the Shitou Dam was built and so that valley floor is close to the original terrain.

## 2 Data sets in JWZ\_Base Folder

All of the base and derived data have been collected into a folder named “JWZ\_Base” for “Jiangwozi Base”. GE files are provided for easy viewing of GPS and other data. The following sections list the data and its characteristics. If there is any information missing or inaccurate please let me know so that the documentation can be corrected.

The JWZ\_Base Folder contains data in three sub-folders. The subfolders are:

Folder	Comment
Docs	Some documents and Jpegs including this document in two sub-folders, Text and Pics..
GPS_Tracks	Some GPS tracks through the test area collected during two visits to China. Can be plotted over a DEM to check positions and imported into GE for presentation and visualisation.
SRTM	SRTM data for Qinling and Daba mountains plus subsets with slope and aspect for visualization. Current estimated test area included as a GeoTiff file. A file that can be checked in GE is included in the Docs folder.
Russian_Topo	Two sub-folders containing the study area and mosaics made using ENVI/IDL. A 1:200k scale set (200k sub-folder) and a set of four new 1:100k map sheets of the study area and their mosaic (100k sub-folder).

The contents of the Folders are described in the following sections.

## 2.1 Docs

### 2.1.1 Text Sub-folder

File Group	Comment
ACC_Pilot_Project_site_DEM.doc ACC_Pilot_Project_site_DEM.pdf	This document as word file and PDF file
Figures_for_Data.doc Figures_for_Data.pdf	Set of Figures as word file and PDF. PDF is about 2.2 MB
Fin_Subset_Places.doc Subset_Comp.xls	Two files with working to define the subset making up the pilot project site.
techguide_srtm.pdf SRTM_Topo.pdf	SRTM Documentation

### 2.1.2 Pics Sub-folder

(Figure number refers to the Figure in “Figures\_for\_Data.doc”. Descriptions are included in that document as Figure Captions.)

File Group	Comment
ZL_Miao_Sm2_reduce.JPG	Figure 1
GE_Places_Tracks_KMZ.jpg	Figure 2
SRTM_Qinba_Mosaic_Annotated.jpg SRTM_QinBa_Mosaic_Tiff_Qlook_small.jpg	Figure 3 and image base for annotation
SRTM_Baoji_Test_Subset_Ht_Sl_SlSl_Qlook.jpg SRTM_Baoji_Test_Subset_Ht_Sl_SlSl_Qlook.jgw	Figure 4
Study_area_GE.jpg	Figure 5
SRTM_Baoji_Test_Subset_Ht_Sl_SlSl_Fin_Subset_Qlook.jpg SRTM_Baoji_Test_Subset_Ht_Sl_SlSl_Fin_Subset_Qlook.jgw	Figure 6
Study_area_plus_Image_GE.jpg	Figure 7
Study_area_plus_Image_oblique_GE.jpg Study_area_plus_Image_oblique_2_GE.jpg	Figures 8 and 9
Fin_Subset_surface.jpg	Figure 10
mosaic_qlook_small.jpg	Figure 11
Jiangwozi_detail_qlook.jpg	Figure 12

## 2.2 GPS\_Tracks

All data are geographical (Latitude and Longitude) with WGS-84 Datum for both location and height. Geoid not used. SRTM uses the WGS84 EGM96 geoid.

File Group	Comment
Shu_Roads_Edit_1.kmz	Google Earth (KMZ <sup>2</sup> ) file showing current set of Shu Roads with only one new GPS track. Work in progress.
Day_1_Yangling_Baocheng_Geog_2007.kmz	Google Earth KMZ file of GPS tracks and places for 2007 visit to Chengdu
Day_1_Yangling_Baocheng_Geog_2007.shp Day_1_Yangling_Baocheng_Geog_2007.dbf Day_1_Yangling_Baocheng_Geog_2007.shx	SHP file and ancillary files for the GPS data collected during the “Shu” (Sichuan) visit in October 2007
BYD_Track_HY_Track3_2006.kmz	Google Earth KMZ file of GPS Track from Yangling to Baocheng and Hanzhong in May 2006.
BYD_Track_HY_Track3_2006.shp BYD_Track_HY_Track3_2006.dbf BYD_Track_HY_Track3_2006.shx	SHP file and ancillary files for the GPS data above (Yangling to Hanzhong in 2006).

A Figure showing the three KMZ files above presented in Google Earth is in the “Data Presentation” file as Figure 2. SHP files provided for easy input to ArcInfo and other Arc software. GE Pro can import SHP files as well.

Once KMZ files are in GE they can be re-exported as KML files if it is necessary to use these in other processing.

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<sup>2</sup>Zipped Keyhole Markup Language (KML) file.

## 2.3 SRTM

File Group	Comment
SRTM_QinBa_Mosaic_Tiff.tif SRTM_QinBa_Mosaic_Tiff.tfw	GeoTiff of SRTM data for Qinling and Daba mountains from Guanzhong and almost to Chengdu. Stops at Zitong at the end of the old Jinniu Road (near Qishushan). Covers most of the Shu Roads. Has one band, altitude. Level 2 data. Pixel size is 3 sec. Geographical projection. It is a single band, integer data with 6001 samples and 6001 lines.
SRTM_Baoji_Test_Subset_Ht_Sl_SlSl_Tiff.tif SRTM_Baoji_Test_Subset_Ht_Sl_SlSl_Tiff.tfw	GeoTiff Subset used for slope scaling work but includes new study area. Has three floating point bands; height, slope and slope of slope (curvature) for visual display. Geographical projection with 3 sec pixel size. Image size is 1500 samples by 1200 lines.
SRTM_Baoji_Test_Subset_Ht_Sl_SlSl_Final_Subset_tiff.tif SRTM_Baoji_Test_Subset_Ht_Sl_SlSl_Final_Subset_tiff.tfw	GeoTiff of final subset from the above file of proposed area for study including Liuba, Jiangwozi, Jiangkou, Madao and nearby relics. Pixel size is still 3 sec. Data are floating point and the image size is 300 samples by 606 lines
SRTM_Baoji_Test_Subset_Ht_Sl_SlSl_Final_Subset_Qlook_GE.tif SRTM_Baoji_Test_Subset_Ht_Sl_SlSl_Final_Subset_Qlook_GE.tfw	Same as the final subset but a saved image from ENVI. It is a byte GeoTiff image size 300 samples by 606 lines. It can be imported into Google Earth (hence the “GE” tag).

The overall SRTM data set is shown as Figure 3 in the presentation document. It is annotated in Powerpoint to show the three major basin areas of the Guanzhong, Hanzhong and Sichuan. The image called the “Baoji Test Subset” is shown in Figure 4. The colour is achieved by displaying the height on red, slope on green and curvature on blue. The patterns of terrain are highlighted in this way. Zibai Mountain near the Zhang Liang Miao is clear as a remnant of the mountain building processes.

The final subset was selected using the main locations that were decided as being necessary for the pilot demonstration which are illustrated using GE in Figure 5. The locations of these places and the final subset specifications from the image SRTM\_Baoji\_Test\_Subset\_Ht\_Sl\_SlSl\_Tiff.tif are as follows:

Place	地点	Latitude	Longitude	Sample	Line
Liuba	留坝	33.6146°	106.919°	766	817
Liuhou Zhen	留侯镇	33.6911°	106.854°	647	677
Houziling	猴子岭隧道	33.748°	107.057°	1019	573
Jiangkou	江口	33.7236°	107.051°	1008	617
Jiangwozi	姜窝子	33.5552°	106.981°	879	926
Madao	马道	33.4265°	106.99°	896	1162

“Collar” is about 5 pixels. Subset definition is:

TL= 735, 565

BR= 1034, 1170

Nsamp= 300

Nlines= 606

The final subset is shown as Figure 6 in the presentation document.

The Final Subset can be displayed in many ways using different software packages. If the final subset is displayed in ENVI and the display saved as an integer GeoTiff file (this file is in the Pics folder of the Docs subfolder) the scope and extent of the subset is clear. This is shown in Figure 7 of the presentation document. This may be looked at as a 3D image and rotated to visualise the terrain in GE as illustrated in Figures 8 and 9. Figure 10 shows how it would look in other software (in this case ENVI/IDL).

## 2.4 Russian\_Topo

### 2.4.1 200k Folder

Original data and mosaic of two which are appropriate for the area selected. It was previously intended to use the 1:200k data to develop a new DEM. However, the contour interval is often 40 metres and also the scanned map images show contours “bleeding” into each other – especially when the 20 m contours are used. That is why the 1:100k data have been added. However, the 1:200k data have a range of information not on the 1:100k data and so they have been retained for their information on roads and land marks.

File Group	Comment
i4823img.tif.zip i4824img.tif.zip	Two original base images of individual Russian 1:200k Topographic maps sheets I-48-XXIII and I-48-XXIV as zipped GeoTiff files. Projection is Gauss-Kruger (UTM) with Pulkovo (1942) datum.
Mosaic_23_24_Tiff.tfw Mosaic_23_24_Tiff.tif	Mosaic of the two original files i4823 and i4824 as GeoTiff files. Join is good but not perfect. Software used was ENVI/IDL. Gauss-Kruger projection with Pulkovo (1942) datum.

NOTE: The description of these data on the EVC website (<http://www.cartographic.com/>) is:

“Soviet Military Topographic Maps 1:200,000

Publisher: Voенно-topograficheskoe upravlenie General'nogo shtaba (Soviet Union) (VTU GSh)

Soviet 1:200,000 Military Topographic Maps / VTU Gsh. Over 18,000 sheets, contour interval: 20-40m. Gauss-Kruger Projection; Datum: Pulkovo 1942; Language: Russian. It is designed for terrain study and assessment, and is the main map for controlling troops in formations. It is widely used as a road map. The map depicts the general topography, the principal water barriers, major timber stands, and populated places as well. It is also often used for aircraft navigation.”

### 2.4.2 100k Folder

There are two sub-folders in this area. One is called “Legend” and has Jpeg files showing the legends of maps that were cropped after digitizing. The other is called “zip\_files”. It contains the zip files originally sent from EVC. The Tiff files have been expanded from these files and will be listed below. The zip files are backup copies.



File Group	Comment
I48082imgtm.tif I48083imgtm.tif I48094imgtm.tif I48095imgtm.tif	Four scanned map sheets as Tiff files
Topo_100_mosaic_Tiff.tif Topo_100_mosaic_Tiff.tfw	Tiff file of the mosaic of the four map sheets.

The mosaic of the four 1:100,000 scale images is shown in Figure 11 of the presentation document and a zoom window at full resolution is shown in Figure 12 to illustrate the resolution of the contours and other annotation. These data are very clear, with contours separated at the resolution provided and are suitable for digitizing.

NOTE: The description of these data on the EVC website (<http://www.cartographic.com/>) is:

“Soviet Military Topographic Maps 1:100,000

Publisher: Voenno-topograficheskoe upravlenie General'nogo shtaba (Soviet Union) (VTU GSh)

Published: 1954 – 1995

Soviet 1:100,000 Military Topographic Maps / VTU Gsh. Over 39,000 sheets, contour interval: 20m. Gauss-Kruger Projection; Datum: Pulkovo 1942; Language: Russian. It is used by the ground forces, and designed for studying terrain and assessing tactical properties in planning combat operations, in organizing troop coordination and control in large formations, in performing orientation and targeting, topographic referencing of elements of troop orders of battle, and determining the coordinates of enemy objects and targets. It is used in the design of military engineering structures and execution of activities in the engineering equipment of terrain.”

The Pulkovo (1942) datum (or S-42) for Russia is defined as follows:

Datum	X shift (m)	Y shift (m)	Z shift (m)	Ellipsoid
Pulkovo (1942) (S-42)	28	-130	-95	Krassovsky

It is not clear if the shifts have also been used for China but it is most likely the case.