SMALL SCALE MAPPING OF THE MOUNTAINS WITH THE USE OF SRTM AND MODIS DATA

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ABSTRACT :
The paper describes a research project on the application of the SRTM and MODIS data for small scale mapping. These freely-distributed data allow for making valuable general maps at scale 1:1milion. At this scale hill shading images based on a 3 arc second resolution elevation model of SRTM give quite impressive views of the landscape, particularly when hilly or mountainous. Hill shading images can be mixed with realistic views of the ground from space collected by the MODIS system to produce as a result a kind of photorealistic image of the area. This kind of depiction of landforms on the ground seems both revealing and educative which gave the reason for making a map of Central Europe at scale of 1:1 000 000. A fragment of the map including the Carpathian Mountains is presented in the paper. The paper describes also different methods of mixing images especially the ways of controlling shares of each image in a composition.

Keywords: *SRTM, MODIS, maps, hill shading, methods.*

1. INTRODUCTION

New observations of the Earth together with digital techniques of data processing enable small scale mapping of unprecedented value especially when the data are free of charge. In the internet there are US governmental sites where satellite images and elevation data are offered. Images of Moderate Resolution Imaging Spectroradiometer (MODIS) are available as true-color composites of images acquired during several days or they are from one date as the image used in this paper from September 21, 2003. The images are offered in 3 spatial resolutions: 250 m, 500 m and 1 km.

The elevation data of the Shuttle Radar Topography Mission (SRTM) were collected during an 11-day mission the Space Shuttle Endeavour in February of 2000. They are extremely valuable as the most uniform and detailed set of elevation data on global scale. With the use of cartographic software it is easy to produce a shaded relief map for the area where elevation data (DEM) are available. There are also satellite images of higher spatial resolution and the data in vector format derived from digitized paper maps, however this paper is concentrated on the two products mentioned in the title.

2. EXPECTED PROFITS

With the use of satellite true-color images it is possible to reveal how the Earth looks like from a height. At least with greater similarity than it is shown on maps already existing. Natural colors of the Earth are from the same family as the hypsometric ones but in this case green means vegetation and beige means ground.

When the shaded relief map is used to show the relief of the area instead of the hypsometric colors it appears that the presence of the mountain ranges becomes distinct on

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the background of flat areas and the mountain morphology is clear. There are unexpectedly many details visible at small scales of about 1:1 million and less when the shaded relief technique is applied. It is so because it is possible to use detailed digital elevation model (DEM) for smaller scale maps than in case of contour lines. For example, the level of detail of the SRTM 3" data is similar to that of 1:200 000 scale map, as we can see on **Fig.1** (Lake Genezareth area in Israel).

Interesting thing is that the amount of information possible to show by contour lines is few times smaller than with the use of shaded relief image at the same scale of maps. Even complex forms are clear and acceptable in shaded relief map but contour lines winding too much would have to be generalized before showing anything. With exception to 20th century cartographer Hal Shelton, and Swiss school of cartography, nobody ever depicted mountains at small scale maps with such high detail as is now possible with the use of new data.

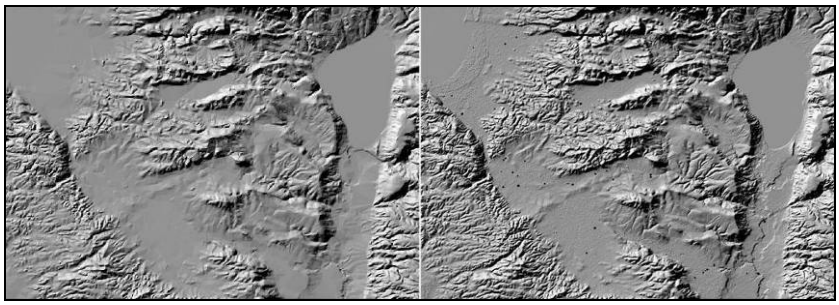

Fig. 1 Shaded relief map of the Lake Genezareth area in Israel: DEM derived from 1:200 000 map (left), and DEM from SRTM 3" data (right)

3. RESEARCH

A problem to solve is to compose a synthetic image of a terrain from two raster layers of data: a Modis satellite image (color) and a shaded relief map (black/white). Both layers are interesting but in different manner. Shaded relief image is showing the terrain full of details at scale 1:1M but as gray scale image looks artificially. Less artificially looks shaded relief covered with hypsometric colors but still it is not natural. The relief map covered with a layer of natural colors of the terrain gives the impression of a real view from height and this is the image we are looking for.

There is another approach discribed by T. Patterson in (3) when we have coverages from the land cover map of a terrain derived from classified Landsat image. In case of Modis true-color image land cover classes are not sharply defined at 1:1M scale because of lower spatial resolution of this image (250 m) in comparison to shaded relief map based on 3" DTM (100 m). Using the whole image information is better solution in this case.

Merging two tonal images with the idea of seeng both at the same time takes some research. The images "use" the same channel of information transmission between a map and our mind, which is a scale of tones, so both images can not be fully visible. A useful compromise is possible only because one image is color. Before research we do not know how looks the image we look for and there are many ready solutions supplied by software developers especially when we use adobe Photoshop software.

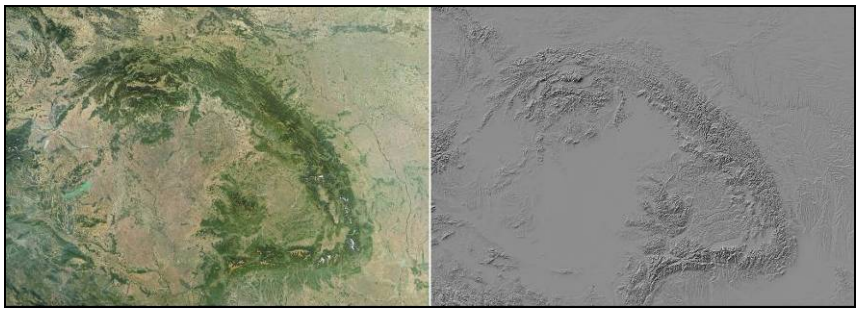

Fig. 2 True-color Aqua MODIS image of Carpathian Mountains from September 21, 2003 (left), and spatially corresponding shaded relief map based on SRTM 3" data (right)

Generally, simple solution for a synthetic image is half of each put together. This would mean a half of the numerical value of each pixel from one image added to a corresponding half from the second image. This solution is realised in Photoshop with reansparency tool. The two images may be added in any proportion between 0 and 100 %. To some degree similar efects are available with screen, overlay and multiply tools, and usually some combination of them appears useful.

For producing shaded relief maps Surfer 7.0 software was used. The maps are gray with the main pixel value 128 and with the classic gaussian shape of the histogram. It was noticed that it is better to use lighter image (higher pixel values) for combinations with the other image. Another experience was to use only some part of the shaded relief map information. First it was the use of the K-channel after transforming the relief map into CMYK mode. Then it was the use of only non-white pixels which was sufficient to mark the shades on the background of a color image.

Also it appeared that the flat parts of the shaded relief map look better when they are somehow enhanced showing a kind of texture or coarsness (**Fig. 3**). Then, the mixed image looks more uniform and the lower spatial frequency of Modis is less apparent. To enhance the texture of flat areas two methods were used. One was the equalize function which is streatching the histogram to look uniformly. The other was to use a contour filter (find edges) to define the flat areas and then to enhance their texture.

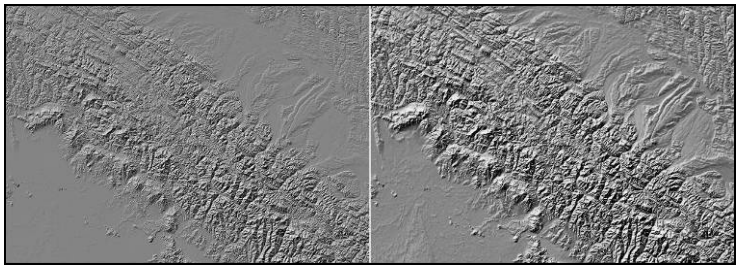

Fig. 3 Enhancement of flat areas of the shaded relief map: before (left), and after (right)

The result presented here as **Fig.4** was produced with the use of the enhanced K-channel overlaid on Modis color image. There are couples of versions of the final result however and it is not decided yet which one will survive after adding other data like rivers, main roads and towns.

4. CONCLUSIONS

Only small part of the mapping process was presented in this paper , but very important: how to produce new background for small scale maps with realistic look. General maps with realistic look of the terrain are particularly valuable for school students when the first ideas of the world are shaped. Mountain chains are more apparent on maps with shaded relief. Using a 1:200 000 map DEM to a 1:1 M map gives the impression of high precision in depicting the terrain. Realistic look of the terrain is helpful in understanding the space, it is somehow a view from height. Such data as SRTM 3" were never available before even if data similar to them were hidden in contour lines of 1:200 000 maps of many countries. It is a pleasure to study a map based on these data. They are explanatory for many phenomena.

Fig. 4 This image of the Carpathians was produced from a true-color MODIS satellite image and a shaded relief map based on SRTM 3" data

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Central Europe image of MODIS was downloaded from "a catalogue of NASA images and animations of our home planet" http://visibleearth.nasa.gov/.
SRTM data were downloaded from NASA page http://dds.cr.usgs.gov/srtm/

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