

**BASICCD - THE RASTER BASIC MAP OF FINLAND ON CD-ROM**

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**Abstract**

National Land Survey of Finland (NLS) completed the first revision of nation's most important large-scaled topographic map, the 1:20,000 Basic Map series, in 1977 and since then the map series has been updated regularly.

To better meet the needs of the national GIS data marketplace, NLS published the Basic Map on CD-ROMs in 1994. The 12 counties of Finland are covered on 13 discs. The digital raster maps on these CDs can be used for large-scale analysis and backdrop purposes etc. Also some smaller-scale maps are included, e.g. to help application builders create easy-to-use, intuitive end-user applications. To ensure easy access to the data, no extraneous retrieval software is needed to read the disc; the non-encrypted raster data is in TIFF format, which is supported by all major GIS and publishing software products. To accommodate maximal hardware compatibility, BasicCDs are published according to ISO 9660 standard.

The new national, all-digital Topographic Data System produces accurate and comprehensive geographical data, gradually replacing the old Basic Map data.

**1 Background***1.1 The Basic Map and the Topographic Data System of Finland*

Basic Map 1:20,000, covering Finland with its 3700+ sheets according to the General Map Sheet System (GMSS), is a detailed map, printed in five colors and revised every three to ten years. Basic Map is widely used for planning, positioning, military and recreation purposes. So far the map users have used the traditional print-map for these purposes. However, during the last few years, professional map users have increasingly migrated to digital processes thus creating a demand for nationwide databases for general-purpose geographic data, both in raster and vector formats.

Production of the old Basic Map went totally digital in 1993 and a concept called Topographic Data System (TDS) was launched [2, 3]. The aim of TDS is simply to provide general-use spatial data for national spatial data infrastructure, thus creating the Topographic Data Base (TDB). TDB is a digital replacement for the old Basic Map. Thus, data from TDS is also used to update TOPRAS.

*1.2 Projections and coordinate systems*

To minimize map projection distortions, Finland is divided into six projection zones, using Gauss-Krüger or Transverse Mercator projection. This means that there are six different projection

parameter sets for the Basic Map series. The coordinate system for all national maps is called Map Coordinate System (MCS), which is divided into two sub-systems. Basic or Zonal Coordinate System (ZCS) defines the six zones for the Basic Map; Uniform or Common Coordinate System (CCS) defines a single system, which is mainly used in small-scale (1:200k and smaller) maps. For large-scale analysis, maps (e.g. Basic Maps) on different zones need to be projected into a common system (CCS). And, even for locally operating raster map applications, to make it easy and smooth to move across the bounding meridians, data on sheets next to the zone boundary need to be projected to the neighboring zone.

### 1.3 *The Topographic Raster Database*

The printing originals of the Basic Map series – totalling some 25000 units – were scanned and archived into a CD-ROM database called TOPRAS (Topographic Raster Database). In this database the sheets are archived elementwise according to their original projection zones. The original uncompressed image files were converted to compressed TIFF format. In the same process, elements were automatically georeferenced by using an executable. Another executable was used to change the Photometric Interpretation Field (tag 262) of TIFF files to zero, because many software products can not handle non-zero TIFF tag values properly.

The TOPRAS database is in two parts: Part 1 includes water (blue), field (yellow), black base (roads, buildings, power lines, shore lines etc.) and eventual overprint (purple) elements; Part 2 includes elevation contour lines. Currently, third revision of the database is being built.

### 1.4 *BasicCD Outline*

A CD-ROM-based product, BasicCD, is derived from TOPRAS. It is different from the original TOPRAS concept in the way the data is organized. BasicCDs go by counties, not by projection zones. Each county is covered on a single CD-ROM. Each BasicCD volume includes all the Basic Map sheets for the county in question, with some overlap over the adjoining counties. In order to let the BasicCD user have more flexibility and to make the display and retrieval fast, sheets are not mosaiced nor are the elements stacked to form a single multibit raster-file.

On each disc there are also smaller-scale maps for application developers for overview and zoom-in purposes. Also some important vector data sets are provided.

## 2 **Process Outline**

Processing the Basic Map sheets for BasicCDs was very straightforward and easy. They were copied from TOPRAS. Sheets next to the projection zone boundaries were projected over to the neighboring zone. Raster Basic Map sheet elements were stored as separate 1-bit TIFF images on BasicCD.

Other, small-scale vector data (administrative boundary lines in two different scales and GMSS grid) for the BasicCD is the same for every disc and is copied directly from a general database.

Overview maps in three different scales were provided: 1:8M, 1:2M and 1:400k. First, mylar sheets – i.e. printing originals – were scanned and transferred to a GIS for georeferencing. The warped color separates were stacked into a single grid, thereby defining the colors of the final map image. Then this grid was split and converted into small color TIFF tiles so that the index maps could be utilized effectively.

Finally, the map files were recorded on an ISO 9660 CD-ROM.

ARC/INFO was used as the GIS platform throughout the production. In this paper, only the processing of Basic Map sheets is described in more detail. A full description of the production process can be found in [1].

### 3 Processing the Basic Map Sheets

From the TOPRAS database, Basic Map sheets were copied either to a workstation running ARC/INFO or directly to a CD-R workstation; only the sheets that needed to be projected to another zone were taken in to ARC/INFO workstation. The following concerns only the sheets to be projected.

#### 3.1 Projecting a Single Element

For every BasicCD there were 36 to 120 sheets – each with three or four elements i.e. color separates – to be projected. In all, there were 1500 elements to be projected. Each one of these elements was projected in an automated process, using a specially written ATOOL command PROIMAGE.

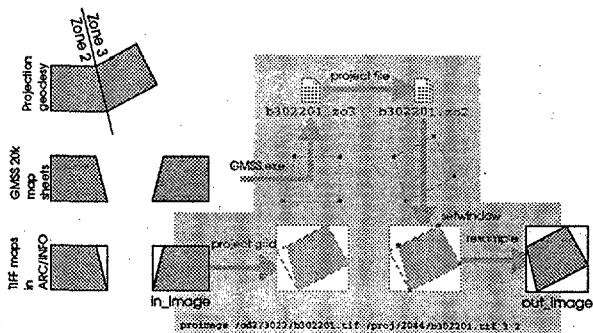


Figure 2: Projecting a single image

GMSS map sheets next to projection zone boundaries are not rectangular. Projecting these non-rectangular sheets make a special case: some raster GIS packages can not handle the expanded blank left-overs so these had to be cut out. Cutting out the left-over was done by first finding out whether the actual sheet was rectangular or not (from a raster GIS's point of view all sheets are of course rectangular, but the underlying map data may be non-rectangular as well, see Figure 1). To find out rectangularity, an executable (based on GMSS geodesy) was used. The output of this executable is a file containing the source zone ZCS coordinates of the true input sheet corners. In case of a non-rectangular sheet, the direction of projection (west-to-east or vice versa) and the non-rectangularity are compared together: if the projection goes from west to east and the right side of the sheet has a left-over triangle, the triangle has to be cut out. The same applies for projection going east-to-west on a sheet that has a left-over triangle on the left (as shown in Figure 1). Once the need for cut-out has been realized, the true edge ZCS coordinates on the target zone are computed by projecting the source zone ZCS file. Processing of these non-rectangular sheets was fully integrated with the basic image projection.

### 3.2 Projecting a Stack of Images

Although the binary elements – both in TOPRAS and on BasicCDs – are stored separately, they can be projected as a single stack. Doing this cuts projecting time by almost 75 % on a sheet with four elements. For this purpose, a projection tool called PROIMAGESTACK was developed.

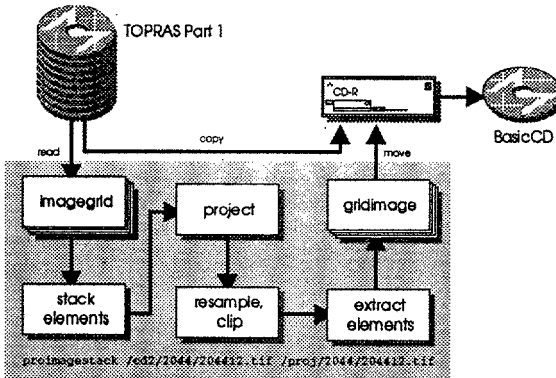


Figure 2: Process outline using PROIMAGESTACK in image projection

In PROIMAGESTACK, the binary images are first converted to grids. In ARC/INFO's GRID, these binary color separates are coded to certain values and stacked together.

```
Grid: stack = yellow + 2 * blue + 4 * black + 8 * purple
```

After this, `stack` is treated like a single image. It is projected, clipped and resampled just like a single-bit image described above. Finally the layers are easily extracted from the projected stack using bitwise-AND (&&) operator as follows:

```
Grid: yellow_pro = stack_pro && 1
Grid: blue_pro = (stack_pro && 2) >> 1
Grid: black_pro = (stack_pro && 4) >> 2
Grid: purple_pro = (stack_pro && 8) >> 3
```

The bitwise-AND compares the binary cell values of the input grid on the left and the input scalar value on the right. For example, the above expression `stack_pro && 4` compares the bit pattern of each cell in `stack_pro` with the bit pattern of 4, i.e. 0100. The bit patterns are ANDed pixelwise, resulting in a bit pattern either 0000 or 0100. They correspond to "black color not set" and "black color set", respectively. The corresponding base<sub>10</sub> value (0 or 4 in the example) becomes the value of the output cell. Bitwise operators are used because they perform faster than the corresponding normal operators – even with type 2<sup>n</sup> divisors. In addition, the code becomes much more compact.

In the process, extracted grids were converted back to images one at a time. The resulting projected binary elements were moved to the hard disk of the CD-R workstation (Figure 2).

#### 4 Updating

The data from the TDB process is gradually replacing the old data in TOPRAS. Since BasicCDs are not pressed in volume, also the BasicCD discs are updated continuously. The updating is based on PostScript output from TDB [3]. Product models define the features that make the new digital elements of the BasicCD. According to these models, features are drawn in a set of PostScript files, one file for each element (or color) of the Basic CD.

These PostScript files are converted to TIFF raster images by using slightly modified software downloaded from an Internet site. The conversion is done in two steps: first the PS file is converted to PPM format using `ps2ppm`; the PPM file is further converted to TIFF, using `ppm2tiff`.

#### 5 Discussion

The main goal in producing the BasicCD was to provide an open, inexpensive and comprehensive raster data set for a wide customer spectrum, for both GIS and desktop publishing users. Thus, BasicCD is not optimized for use with any single GIS package.

To ensure ultimate openness and compatibility, some decisions were made. ISO 9660 is a guarantee for ultimate system compatibility. Likewise, TIFF is the most widespread and portable image format. The sheet-by-sheet and element-by-element organization of the Basic Map data was maintained to guarantee good performance (retrieval and display) and to enable elementwise analysis. Also disc geography optimizing functionality of the CD-R software was used to decrease the data access delays caused by the relatively slow CD-ROM technology. The most radical decision about the product was not to introduce any special retrieval software. The map data on disc is as is: unencrypted files with plain GMSS file names. No special software is needed to decode the disc; it is a true mount-and-play GIS data component.

Typical customers use the BasicCD as data source for various applications: farming and water analysis, DTM creation for planning mobile phone networks and showing utilities on a detailed map. As an example, a major Finnish paper company has put up a concept called Logging Operation System [5], with a PC in every log-truck, including CD-ROM for custom Basic Map storage, GPS for positioning and telecommunications for updating the log-pickup information.

#### References

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