

feature articles

THEMATIC MAPPING WITH ILLUSTRATION SOFTWARE: UNRAVELING THE MYSTERY OF GRAPHIC FILE FORMATS

This paper focuses on using a popular microcomputer graphic design package (CorelDRAW 4.0) in conjunction with a variety of GIS/mapping software to test their capacity to transfer map images. Emphasis is placed on the advantages and disadvantages of transferring different bitmap and vector formats, rather than on the nature of the formats themselves. All of the cartographic packages tested had some capacity to export thematic maps to CorelDRAW, although some file formats provided greater flexibility than others. Generally, it appears that simpler thematic maps transfer easily, while more complex types require considerably more effort to transfer successfully. Both Windows Metafiles and Computer Graphics Metafiles proved to be efficient file formats for exporting most types of map images to CorelDRAW.

Anyone using a microcomputer to analyze and map spatial data has undoubtedly developed their own repertoire of preferred software tools, each of which provides some functionality not shared by the others. Geographic Information System (GIS) software for example, focuses on analytical procedures for querying, manipulating, and overlaying multiple sets of spatial data. While the result of these analyses is often a map, most microcomputer-based GIS packages have rather limited capabilities for graphic layout and map design. Even programs which focus primarily on the cartographic display of information may lack the flexibility to control such design elements as type placement along curves or color selection according to Pantone designations. If a map is to be produced for presentation or publication, more control over the map design process can be gained by employing specialized graphic illustration software to create and print the final version of the map.

The coupling of a graphic design package (such as CorelDRAW, Adobe Illustrator, Aldus Freehand, or Micrographix Designer) with a statistical, mapping, or GIS program (such as Freelance, Atlas*GIS, or IDRISI) can be a powerful combination which exploits the strengths of both. The success with which such programs can be integrated for the same cartographic project depends largely upon the ease with which digital image files can be transferred from one program to the other. Unfortunately, the same proliferation of software programs that enticed us toward the microcomputer environment in the first place have also generated a great assortment of digital file formats for storing graphic images. Because most illustration programs can import a variety of both vector (object-oriented) and raster (bitmapped) file formats, importing graphic images from a mapping or GIS program might be expected to be a smooth and seamless function. In reality, however, the process is frequently problematic, particularly when vector-based graphics are being transferred. This paper focuses on using CorelDRAW 4.0 (a popular microcomputer graphic

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INTRODUCTION

design package) in conjunction with a variety of GIS/mapping software, most of which utilize vector based graphic files. Emphasis is placed on the advantages and disadvantages of file formats for transferring cartographic images, rather than on the nature of the formats themselves.

CHARACTERISTICS OF CORELDRAW

CorelDRAW is a very versatile graphics illustration program which has been widely adopted by PC users. The program was developed by Corel Corporation in Ottawa, Canada, and currently retails for about \$400 (US). The company provides frequent updates (CorelDRAW 5 is scheduled for release in the summer of 1995) and telephone technical support. Recommended minimum system requirements for Version 4.0 include a 386 CPU, Windows 3.1, 4 Mb of memory, a VGA monitor, and a Microsoft supported mouse. A full installation of the program may take up to 34 Mb of hard disk space. A CD-ROM player or drive is required if the user wishes to access the huge library of fonts and clipart images that accompany the program.

The real power of CorelDRAW for cartography lies in its capability to graphically enhance and print maps imported from other mapping or GIS programs.

It is important to recognize that CorelDRAW is a general illustration package which was not specifically designed for cartographic production. It does not support digitizing, nor can it handle geographical coordinate systems or map projections. It does not link objects to a database, so any thematic map based on classifying or sizing symbols according to data values must be accomplished with a more specialized GIS/mapping package. The real power of CorelDRAW for cartography lies in its capability to graphically enhance and print maps imported from other mapping or GIS programs.

Both vector and bitmapped graphics can be imported into CorelDRAW and mixed in a display, but only vector files can be interactively edited. Once a vector image has been successfully imported into CorelDRAW it can be manipulated in a variety of ways. Type can be added to the image from a selection of over 750 fonts. Map lettering can be easily sized and curved to fit irregular areas, or stretched and shadowed to produce special effects. CorelDRAW provides an extensive library of shapes and symbols, many of which are ideally suited to cartographic applications (weather symbols, highway shields, etc.). Over 18,000 clipart images, which are illustrated in a separate reference manual, can be accessed from an accompanying CD-ROM. Map symbols and text can be individually sized and filled with a color or pattern. Colors can be specified in one of six ways: as a Pantone color, % CMYBk (Cyan, Yellow, Magenta, and Black), % HSB (Hue, Saturation, and Brightness), % RGB (Red, Green, and Blue), from a default or custom palette, and from a list of names. Colors can also be made to blend gradually from one hue to another.

Once the symbolization and text for a map has been selected, different design and layout arrangements can be assessed. The interactive process of sizing and positioning map elements allows tremendous flexibility for experimentation before final design decisions are made. One of the most powerful functions of illustration programs is the capability for printing the color separations required for lithographic reproduction of the map. CorelDRAW handles this task nicely. Files can be printed as either negatives or positives with crosshairs and/or crop marks. Tint screen angles and lines per inch can be specified for each printed color. Trapping or overlapping one color with another is accommodated to reduce gaps that may occur due to minor registration problems.

Two supplemental programs which accompany CorelDRAW, CorelPHOTO-PAINT and CorelTRACE, provide a range of functions for modifying imported bitmap images. Although intended primarily for

retouching scanned photographs, CorelPHOTO-PAINT can be used to adjust the contrast or add special effects to raster maps such as satellite images. CorelTRACE is an autotrace program for converting bitmap (raster) images to vector format. Both programs are useful for manipulating image files prior to their importation into CorelDRAW. As such, the Corel software package essentially comprises much of the capability of a combination of other specialized graphics programs that are otherwise necessary to produce finished maps (Byrne 1993).

Clearly, illustration programs like CorelDRAW provide the cartographer with substantial capabilities for map design and printing, making them a valuable companion to more specialized GIS or mapping packages. To take advantage of these tools, it is important to be familiar with different digital image file formats which allow maps produced in PC-based GIS/mapping programs to be transferred to CorelDRAW.

Map images may be imported into CorelDRAW from various mapping programs using several different vector or bitmap export file types. Table 1 lists the export file types produced by some of the more popular PC-based computer mapping programs. The wide variety of import formats for CorelDRAW (Table 2, page 6) allows the importation of peripheral graphics from many separate software packages. Figures 1 through 8 (placed throughout the article) illustrate maps that have been produced in various GIS/mapping programs and then enhanced in CorelDRAW 4.0. These maps were imported into CorelDRAW using several file formats through steps and procedures outlined in the figure captions.

Ideally, enhancing map images in CorelDRAW should involve a minimum level of manipulation once the file has been imported. Alterations of polygon pattern and color, line widths, and thematic symbol types should be accomplished easily and quickly. This ideal necessitates importing map images comprised of closed polygons for those maps requiring polygon or symbol shading. Closed polygons are those in which the feature consists of one continuous line segment and in which beginning and end points share the same location. Of the software packages covered here, Atlas*GIS/PRO, MapMaker, Surfer, and IDRISI all create this type of closed polygon. In contrast, SPANS GIS creates polygons as a collection of line segments that are held together by topological identification rather than as one entire entity in which the starting and end points of the single line segment share a common node. Closed polygons, however, may still be possible within SPANS if the polygons are imported into the program from a digitizing package that creates common boundaries between adjacent polygons, rather than from TYDIG (the SPANS digitizing package). The World Projection program can export both open and closed polygons depending on the data set used; the larger, more detailed data sets available with the package (including the CIA World Databank I) will

IMPORTING MAP FILES INTO CORELDRAW

SYSTEM and VERSION NUMBER	FILE TYPE • = Format available				
	HPGL	Metafile	CAD	EPS	Bitmap
SPANS GIS 5.2	•		•		•
Atlas*GIS/PRO 2.1	•	•		•	
Atlas MapMaker 1.0	•	•			•
IDRISI 4.1	•		•	•	•
World Map Proj. 4.05	•			•	
Surfer 4.15	•		•	•	
Freelance 2.0	•	•			

Table 1. Available Export File Types. SPANS GIS 5.2 is running in OS/2 1.3; Atlas*GIS/PRO 2.1, IDRISI 4.1, World Map Proj. 4.05, and Surfer 4.15 are running in DOS 5.0; and Atlas MapMaker 1.0 and Freelance 2.0 are running in Windows 3.1.

FILE NAME	FILE EXTENSION	FILE NAME	FILE EXTENSION
CorelTRACE	.EPS	Micrografx	.DRW
CorelPHOTO-PAINT	.PCX	Targa Bitmap	.TGA
Windows Bitmap	.BMP	TIFF Bitmap	.TIF
Windows Metafile	.WMF	WordPerfect Graphic	.WPG
Adobe Illustrator	.AI	Ami Professional	.SAM
AutoCAD	.DXF	Excel for Windows	.XLS
CompuServe Bitmap	.GIF	Lotus 123	.WK?
Computer Graphics Metafile	.CGM	Lotus for Windows	.WK?
Encapsulated Postscript	.EPS	MacWrite II	*
GEM	.GEM	Microsoft Rich Text Format	.RTF
HPGL	.PLT	Microsoft Word	*
IBM PIF	.PIF	Microsoft Word for Windows	*
JPEG Bitmap	.JPG	Microsoft Word Mac	*
Kodak Photo CD Image	.PCD	Text	.TXT
Lotus PIC	.PIC	WordPerfect	*
MAC PICT	.PCT	WordPerfect for Windows	*

Table 2. File Types Imported by CorelDRAW 4.0

* Any file extension accepted

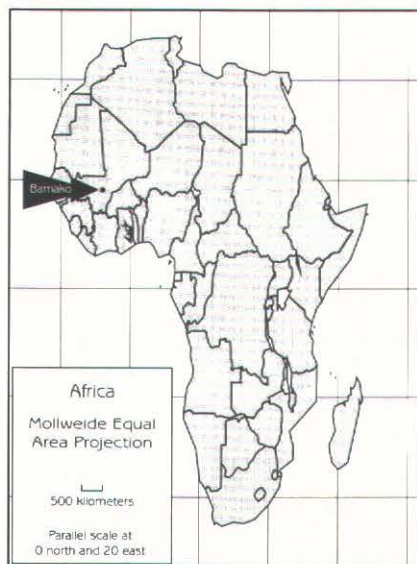
produce closed polygons, whereas the smaller, less detailed files such as the Dahlgren data set will not.

The implication of open polygons for map image manipulation in CorelDRAW is that polygons will not be shaded, making choropleth, dasymetric, or even figure-ground representations difficult to achieve. Line work, consisting of open-ended vectors used to represent roads or rivers (and the component vectors comprising the open polygons), may still be altered in terms of line width and color. The whole or parts of the map image may also be re-sized, skewed or mirrored, regardless of whether polygons are open or closed. However, the use of open polygons must be seen as providing limited flexibility for manipulation once imported into CorelDRAW. Although it is possible within CorelDRAW to close open polygons, this is a tedious process at best (even for a small number of polygons) and defeats the purpose of having the computer do much of the work involved in producing a map.

PLOT FILES

HPGL is currently the most familiar and popular export format available among GISs (Strand 1992). HPGL plot files translate to CorelDRAW in the same manner as they are drawn onto hard copy with a pen plotter. The vector structure of the image is preserved, although polygon fills are represented by a dense pattern of lines. Problems occur upon importing these fills into CorelDRAW, as each component vector of the fill is treated as a separate entity, creating a large file that is time consuming to process. Furthermore, it is not possible to select the vector fill of the polygon in order to manipulate characteristics such as polygon color or pattern. Most line work (e.g. polygon or point symbol outlines, roads, etc.) will be satisfactorily

Figure 1. The Mollweide projection for this map was assigned in the World Projection program. The map image, the graticule, city location dot, scale, and scale caption were exported as an HPGL plot file. The map title, city name and locator arrow, and polygon fill were added in CorelDRAW. The map polygons were grouped and placed in front of the graticule to produce the final map.



reproduced from a plot file, although vectors must be represented by solid lines when exporting, as dashed or dotted lines are disassembled by CorelDRAW into an excessive number of objects which can no longer be manipulated as a single entity. Relative line widths will be preserved on importing into CorelDRAW.

The preparation required to successfully transfer a map to CorelDRAW depends upon the success with which various cartographic elements are translated into CorelDRAW. For example, not all mapping programs will export text recognizable as such by CorelDRAW. Text characters not recognized by the program will translate as curves that cannot be manipulated with a text editor. In such a case text may be omitted from the source map to reduce file size and processing time once in CorelDRAW. Table 3 lists those map elements that transfer successfully to CorelDRAW for each of the mapping programs that produce plot files for export. It should be noted that the classification represented in this and following tables is based on the capability to manipulate map elements in CorelDRAW. For example, imported text must be alterable in terms of textual content, font, size, and color. Vectors are expected to be manipulated in terms of line width, color, and style. Polygon fill must allow flexibility in terms of changing color and/or pattern, while point symbols, whether thematic (houses, proportional symbols) or positional (dots, crosshairs) must be alterable in terms of color and/or size. Repetitive dots require little transformation when in CorelDRAW, except perhaps for color, although any method of successfully importing repetitive dots was accepted for inclusion in the tables. As a guide, those elements that do not transfer

Population Doubling Time in Africa

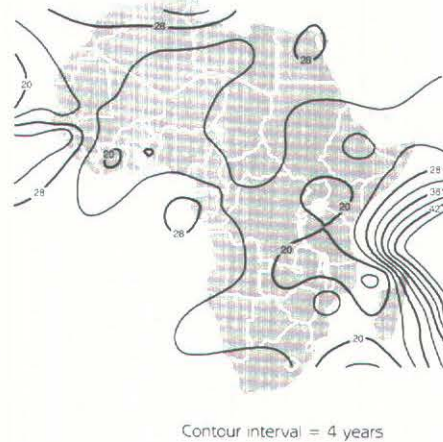


Figure 2. The isolines for population doubling time were interpolated and derived from Surfer, then exported as an HPGL plot file. Although the outline of Africa was also exported with the plot file, a Windows metafile was clipped into CorelDRAW from Atlas*MapMaker to provide a background with polygon fill. This procedure required that the same map projection be used on both maps so that they could be registered properly in CorelDRAW. The final text and isoline labels were added in CorelDRAW.

Elevation Model of Africa

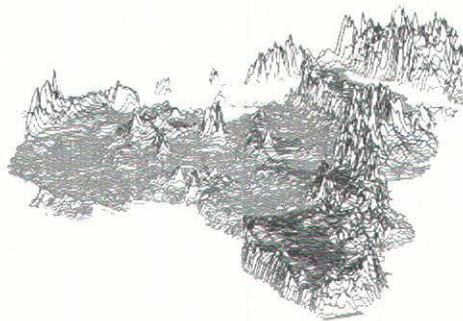


Figure 3. The elevation model was created in IDRISI, saved as a screen dump image, and exported as a TIFF file with a color palette. The TIFF was brought into PHOTO-PAINT, converted to a grey-scale and sharpened prior to importing into CorelDRAW, where the title text was added.

Table 3. Transfer Capability of Plot Files

SYSTEM	MAP ELEMENTS				
	Text	Vector/ Polygon outline	Polygon fill	Point symbols	Repetitive dots
SPANS GIS	Yes (1)	Yes	No	No	(NA)
Atlas*GIS/ PRO	No	Yes	No	Yes	Yes
Atlas MapMaker	No	Yes	No	Yes	Yes
IDRISI	(NA)	Yes	(NA)	Yes (3)	(NA)
World Map Proj.	Yes (1)	Yes (2)	No	Yes	(NA)
Surfer	No	Yes	(NA)	(NA)	(NA)

(1) Text strings will be broken up into component words.
 (2) Requires World Databank I & II data and creation of a World area file (.ARE extension).
 (3) Only positional point symbols available.

The advantages of using plot files for export vary with the mapping program.

should be deleted from the original source map file when possible, and added individually in CorelDRAW.

Once in CorelDRAW, objects without fill must be selected by clicking on the wireframe outline; if the object represents a closed figure, color or gray shades may be applied. Different line styles may be applied to line work once the image is in the CorelDRAW environment. The advantages of using plot files for export vary with the mapping program. In general, they include the easy transfer of solid line work and text to CorelDRAW, as well as a manageable file size. In addition, the transfer of sectored circle symbol outlines from MapMaker to CorelDRAW is possible and more than one map layer can be transferred simultaneously from MapMaker and Atlas*GIS/PRO.

Some of the problems of using plot files for export to CorelDRAW include the inability to export polygon fills and the potential that polygons or symbols may not always be closed upon transfer. Another disadvantage is that proportional circles exported from MapMaker to CorelDRAW will be transformed to large, meaningless ellipses in CorelDRAW. Circles from Atlas*GIS/PRO will export successfully as plot files because Atlas*GIS/PRO actually draws circles as many-sided polygons. The color fill, however, should be omitted in Atlas by selecting "open circle" as the proportional symbol. Dot density maps raise other issues. They will transfer from Atlas*GIS/PRO and MapMaker, however, they result in a large number of objects in CorelDRAW, increasing processing time and file size and reducing the flexibility to make adjustments to the image. Finally, some programs are not able to satisfactorily transfer text to CorelDRAW using plot files.

METAFILES

Metafiles are commonly produced in both the Computer Graphic Metafile standard (CGM), and in the Windows Metafile standard (WMF). Unlike plot files, metafiles can support the export of both bitmap fill and vector components of an image (Strand 1992). However, problems in color compatibility may exist between metafiles produced by different graphics programs (Will-Harris 1992). As a result, particular hues specified in the originating mapping program may not translate well into CorelDRAW, and may have to be reassigned within CorelDRAW. Both CGM and WMF formats can be imported into CorelDRAW and appear to differ only in terms of the operating system in which they are produced. Atlas*GIS/PRO will produce a CGM, while Windows based Atlas MapMaker will produce a WMF. SPANS GIS will also produce a metafile with a .MET file extension. This metafile, however, is produced through the OS/2 system, and our attempts to import the SPANS-produced files into any other DOS or Windows software have been unsuccessful. It is important to note that Atlas MapMaker does not export to a WMF explicitly, but can generate temporary metafiles through the Windows Clipboard utility,¹ whereas Atlas*GIS/PRO can be directed to print to a CGM file for export.

Should it be necessary to transport a temporary Clipboard metafile on floppy disk, the task may be accomplished by: a) accessing the Clipboard utility in Windows, at which point the cut or copied image should appear on the Clipboard; b) saving the Clipboard file using the **File - Save** command within the Clipboard utility; c) recalling the Clipboard file into

¹ Atlas MapMaker can produce a WMF transparently when the map image is cut or copied to the Windows Clipboard. The Clipboard output format must be set to "Picture" (use the Edit - Clipboard - Formats command), which specifies Clipboard output to be in WMF format. The image is stored temporarily within the operating system until it can be transferred into CorelDRAW using the Edit - Paste command.

the Clipboard utility when ready to proceed, and; d) pasting the Clipboard file into the current software application (using **Edit - Paste** for CoreIDRAW). In step "b" it should be noted that, although the image is saved to the Clipboard as a WMF, it will have a .CLP file extension, which enables its identification and recall back into the Clipboard for subsequent pasting (this file extension should not be altered). The Windows, CoreIDRAW and MapMaker manuals contain more information on cutting, copying, saving, and pasting files to and from the Windows Clipboard, and instructions for switching between applications within the Windows operating system.

Table 4 lists those map elements that transfer successfully to CoreIDRAW from Atlas*GIS and Atlas MapMaker using the metafile export format. As with plot files, line work exported through metafiles should be represented by solid lines only. Color fill should be added to both polygons and map symbols, while polygon or symbol outlines should be deleted when possible. CoreIDRAW will import a polygon outline and fill as two separate entities, leading to duplication of map elements within the CoreIDRAW file. If only the fill of objects is exported it will be much easier to select and manipulate polygons and symbols within CoreIDRAW. Also, if polygon or symbol outlines are required on the map they may be added easily in CoreIDRAW. Once imported into CoreIDRAW, polygons and symbols may be selected and manipulated by clicking on the fill itself, which proves to be much quicker than having to click on narrow wireframe outlines. It is also recommended that polygons be exported from their originating programs with full polygon fill, as opposed, for example, to 50% or

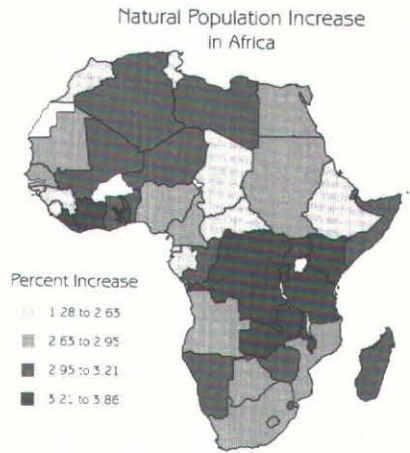


Figure 4. The choropleth classification for population increase was created in Atlas*GIS/PRO and exported as a CGM file. Polygons of similar classes were grouped and assigned associated grey shades in CoreIDRAW. The legend and final text were also added in CoreIDRAW.

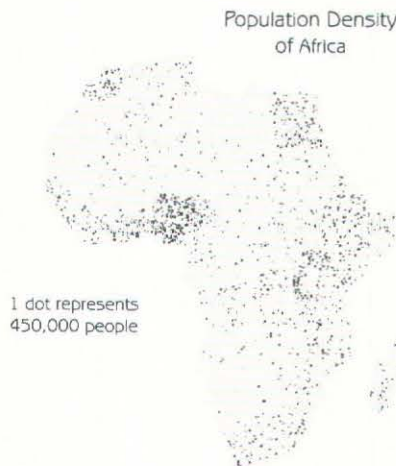


Figure 5. The dot density map of Africa population was originally created in Atlas*MapMaker, and clipped to CoreIDRAW in bitmap format. Since text would not transfer as a bitmap, the title was added in CoreIDRAW. Although the image is not as sharp as one produced by a plot file, this method does overcome the memory problems inherent with importing a large number of dots.

Table 4. Transfer Capability of Metafiles

SYSTEM	MAP ELEMENTS				
	Text	Vector/ Polygon outline	Polygon fill	Point symbols	Repetitive dots
Atlas*GIS/ PRO	No	Yes	Yes	Yes	Yes
Atlas MapMaker	Yes	Yes	Yes	Yes	Yes

25% shading. CorelDRAW may interpret the stippled dot pattern that results from this process as a multitude of small dots, and therefore produce an excessive number of objects.

The advantages and disadvantages associated with metafiles produced by Atlas*GIS and MapMaker are related in part to the capability they possess for thematic mapping. The advantages include the ability to transfer polygon or symbol fill, especially useful in the production of choropleth, dasymetric, and proportional symbol maps; the easy transfer of line work (solid lines); and the successful transfer of repetitive dot symbols, the number of which is limited by computer memory. A disadvantage is the poor reproduction of sectored circles transferred from Atlas MapMaker. If sectored circles with more than two slices are to be exported with a metafile, it is probably better to omit the fill within the slices while keeping the slice outlines intact and adding the fill later in CorelDRAW. There are also other limits in using metafiles. Windows Metafiles (Clipboard transfer) do not permit more than one map layer to be exported at once. CGM files produced by Atlas*GIS/PRO allow the successful transfer of cartographic features only if they have fewer than 1999 points or vertices. As a result, very intricate polygons or lines may have to be simplified either by generalization or by severing a complex feature into smaller component polygons or lines.

AUTOCAD AND GENERIC CAD FILES

Of the mapping programs discussed in this paper, SPANS GIS, IDRISI, and Surfer provide the option of exporting in CAD format. Our attempts to import the IDRISI-produced CAD files into CorelDRAW have been unsuccessful. Surfer-produced CAD files import successfully and create closed polygons within Corel when closed polygons are components of the map image. Two options are provided by SPANS: AutoCAD and generic CAD, both having DXF file extensions. Both types have been successfully imported into CorelDRAW, although the problem of open polygons is especially pronounced. The vector image may be disassembled into component line segments, producing a larger number of objects when imported into CorelDRAW. For example, a simple three-dimensional image exported as a AutoCAD DXF file actually imported into CorelDRAW as more than 12,000 objects. As a collection of open-ended vectors, the map image can only be manipulated in terms of overall

size, line width and line color once imported into CorelDRAW. If the image consists of few separate areas that do not have common boundaries the cartographer may wish to assemble the separate lines into a closed polygon for better effect once the image is in CorelDRAW.

Table 5 lists those map elements that are successfully transferred to CorelDRAW using the CAD export format. Little or no image

preparation is necessary prior to producing CAD files from SPANS. Only the vector images will be exported, while any raster overlay will not be included in the export file. Since text will not transfer to CorelDRAW, it is not necessary to include it in the DXF files created for export. Surfer DXF files may be produced without prior image preparation, although at times it may be advantageous to eliminate isoline labels, which transfer to

SYSTEM	MAP ELEMENTS				
	Text	Vector/ Polygon outline	Polygon fill	Point symbols	Repetitive dots
SPANS GIS	No	Yes	No	No	(NA)
IDRISI	(NA)	No	No	No	(NA)
Surfer	No	Yes	(NA)	Yes	(NA)

Table 5. Transfer Capability of CAD Files

CorelDRAW as curves rather than text objects, and tend to create line breaks in otherwise closed polygons.

Because DXF formats are widely used, they provide the capability to import images from a variety of graphing, mapping, and GIS programs. Another advantage to the DXF format is that closed polygons will be transferred successfully from Surfer to CorelDRAW. Some disadvantages in using CAD export formats are the impossibility of transferring polygon fill to CorelDRAW, the possible disassembly of SPANS-produced vector images, and the conversion of Surfer-produced text to curves in CorelDRAW.

Encapsulated postscript files (EPS) potentially offer the greatest utility and flexibility with respect to transferring map images to CorelDRAW. They export comprehensive information describing the graphic image, for example, vector and bitmap components of a map, as well as information enabling the transfer of type fonts (Will-Harris 1992, Strand 1992). In addition, postscript files have provided some of the earlier capability for transferring cartographic images to graphics and illustration packages, including Adobe Illustrator (DiBiase 1991). Atlas*GIS/PRO, IDRISI, Surfer, and the World Projection program produce Encapsulated postscript files. While Atlas*GIS/PRO produces a generic EPS file, the World program offers two EPS formats: a generic EPS file, and an Adobe Illustrator format EPS with either an .EPS or .AI file extension. IDRISI produces a file with an Adobe Illustrator .AI extension. We have found that neither of the generic EPS files produced by Atlas*GIS/PRO and World successfully import into CorelDRAW, while attempts at importing the Adobe Illustrator format available with IDRISI and World met with some success.

In general, EPS files should provide the best file transformation results, as type fonts and polygon shades should be preserved on importing into the receiving program. Although IDRISI .AI files import easily into CorelDRAW, they do not transfer polygon fill and the vector outlines do not import as closed polygons. Similarly, the transformation of the World-produced files is not entirely successful, as neither text nor polygon shades are transferred to CorelDRAW. The World Projection manual notes that polygon fills are configured to Adobe Illustrator standards, assuming that the receiving program possesses the information necessary to reproduce the fill. However, this does not appear to be the case with CorelDRAW.

ENCAPSULATED POSTSCRIPT FILES

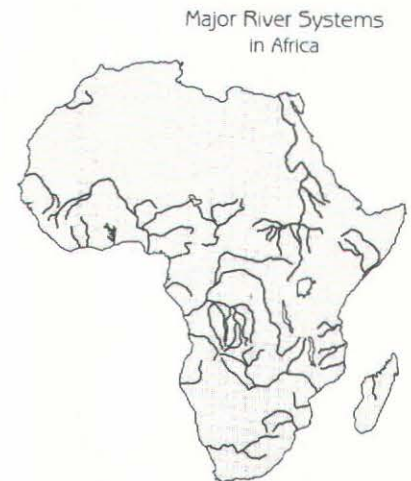
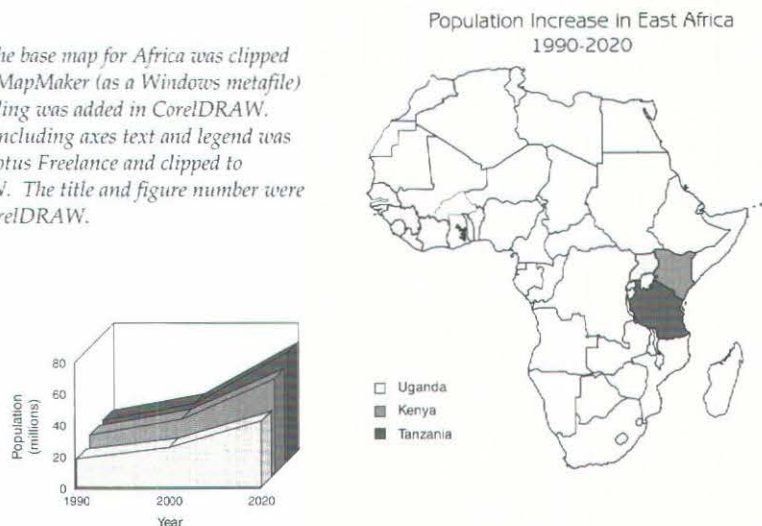


Figure 6. The outline map and rivers of Africa were imported from SPANS as an AutoCAD DXF file. It was possible to close the small number of polygons within CorelDRAW and add a background shade to the continent.

Figure 7. The base map for Africa was clipped from Atlas*MapMaker (as a Windows metafile) and the shading was added in CorelDRAW. The graph, including axes text and legend was created in Lotus Freelance and clipped to CorelDRAW. The title and figure number were added in CorelDRAW.



SYSTEM	MAP ELEMENTS				
	Text	Vector/ Polygon outline	Polygon fill	Point symbols	Repetitive dots
Atlas*GIS/ PRO	No	No	No	No	No
IDRISI	(NA)	Yes	No	Yes*	(NA)
Surfer	No	No	(NA)	No	(NA)
World Map Proj.	No	Yes	No	Yes	(NA)

Table 6. Transfer Capability of Postscript Files

* Only positional point symbols available.

Since only the World and IDRISI programs successfully export postscript files for transfer to CorelDRAW, file preparation in Atlas*GIS/PRO and Surfer are excluded from the following discussion. Little preparation is necessary prior to producing the export file in World. Table 6 lists those map elements that are successfully transferred to CorelDRAW. Before whole polygons can be exported from World (again, using one of the more detailed data sets), a World area file (file extension .ARE),

similar to a polygon file in other computer mapping standards must be produced. The area file must be shaded, although inclusion of the polygon outline is optional. The procedure offers a shading gradient from white, through gray shades, to black. Any shade selection other than full black will result in an error when importing into CorelDRAW. As a result, the choropleth mapping option provided by World cannot have shaded data representation exported to CorelDRAW, whereas this is possible for an Atlas*GIS/PRO metafile. In addition, depending on the projection selected, not all of the geographic regions will be represented as closed polygons. An example of this includes those regions that lie on the outskirts of a projection grid. It should also be noted that even if only part of the globe is to be exported to CorelDRAW, the entire global graticule will be exported with the map image unless extraneous grid lines are excluded by enclosing the map image within a window. Exporting the entire global grid will produce an unnecessarily large file, while dwarfing the geographical image (e.g. North America) once imported into CorelDRAW.

The Adobe Illustrator EPS export file format would appear to offer few, if any advantages for the purposes of importing World Projection and IDRISI map images into CorelDRAW. The inclusion of information with respect to fonts exaggerates the size of EPS files in comparison with other export file formats, increasing processing time. In fact, exporting map images as plot files would be equally suitable, while creating smaller, more manageable files. Other disadvantages inherent with the use of postscript files include the inability to transfer closed polygons from IDRISI; the inability to transfer text and polygon fill from World; and the fact that vectors imported from World may appear with an excessive line width (e.g. 6 inches).

BITMAPS

Atlas MapMaker and IDRISI both produce bitmaps as export file formats. MapMaker can utilize the Clipboard utility within Windows to paste images in bitmap standard into CorelDRAW. IDRISI will export map images as TIFF bitmaps that can be accepted by CorelDRAW. Although not evaluated here, the currently available update version of SPANS GIS (version 5.3) promises a PCX bitmap export format which should be importable into CorelDRAW.

Once in CorelDRAW, bitmap images may be manipulated only in terms of size and orientation, while the polygon and line shades remain fixed. In TIFF images produced by IDRISI, vector patterns will be reproduced as they appeared in the original raster image, as a series of pixels of

uniform width. An alternative to importing directly into CorelDRAW is to first bring the TIFF file into CorelPHOTO-PAINT, an adjunct program available with the main CorelDRAW package. PHOTO-PAINT allows some manipulation and enhancement of the shades in the image by using traditional Windows tools such as pen nibs, erasers, etc. The principal advantage of using PHOTO-PAINT as a step toward the final map is the ability to refine the map image for subsequent presentation and finishing in CorelDRAW. Although processing of map images may be tedious, an advantage in using TIFF files is the ability to import and present satellite imagery in CorelDRAW. PHOTO-PAINT can be used to enhance these satellite images to increase the detail in areas of interest.

There are differences in the TIFF information exported from IDRISI and Atlas MapMaker. IDRISI exports only the raster map image, while omitting any peripheral information including legend or title. MapMaker can save a map image to the Clipboard for pasting into CorelDRAW and can include most map elements in the transfer (Table 7). Unlike some vector files, little or no preparation is necessary prior to creating the IDRISI export version, while none is necessary for the Clipboard bitmap in MapMaker. Upon creating a TIFF file the IDRISI program will inquire whether a palette should be exported with the image. For color maps the best results can be achieved by exporting a full color palette with the image. Exporting a color image without a palette or with a gray scale palette will result in a monochrome image in CorelDRAW and PHOTO-PAINT that is almost uniformly black. Exporting a black and white satellite image for CorelDRAW is best accomplished by including a gray scale palette with the image.

In summary, some of the advantages of using the bitmap format include the ability to import, clarify (using PHOTO-PAINT), and display satellite images and scanned air photos derived from IDRISI's TIFF format. It is also possible to transfer from MapMaker more than one layer of data simultaneously, as well as screen marginal information if desired. For simple maps CorelTRACE may be used to create an EPS vector file from a bitmap file for subsequent use within CorelDRAW, although attempts at this process have met with limited success. Some disadvantages to using the bitmap format include the lack of flexibility in terms of post-import image manipulation, as well as a generally poor image resolution inherent in many bitmap. Also a problem is the large file sizes (even for simple images) that result if an IDRISI TIFF file is exported with a full color palette.

Table 8 presents a summary of the utility and ease with which various export file formats were found to transfer map images to CorelDRAW for the tested software packages. The Map Type column lists a variety of thematic map types, along with cartographic programs that are able to produce each map type.

In terms of the amount of information transferred to CorelDRAW, the most success was attained using Windows Metafiles (usually transferred

Table 7. Transfer Capability of Bitmap Files

SYSTEM	MAP ELEMENTS				
	Text	Vector/ Polygon outline	Polygon fill	Point symbols	Repetitive dots
SPANS GIS	not tested	not tested	not tested	not tested	not tested
IDRISI	(NA)	Yes (1), (2)	Yes (2)	Yes (2), (3)	(NA)
Atlas MapMaker	No	Yes (2)	Yes (2)	Yes (2)	Yes

- (1) Vectors may be exported in bitmap format by transforming vectors to raster within IDRISI or by a screen dump of a raster image with a vector image overlaid on the monitor.
 (2) Feature colors (& pattern of polygon fill) may be manipulated with CorelPHOTO-PAINT.
 (3) Only positional point symbols are available.

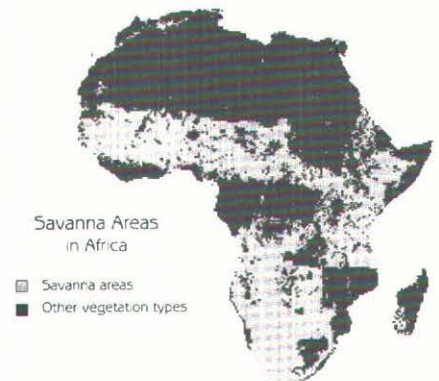


Figure 8. The raster image of vegetation was created in IDRISI and exported as a TIFF file with a color palette. The TIFF file was brought into CorelPHOTO-PAINT where the palette was changed to grey-scale and brought into CorelDRAW for the addition of text and final printing.

SUMMARY AND RECOMMENDATIONS

Table 8. File Format Ratings

MAP TYPE	PROGRAM	FORMAT				
		Plot File	Metafile	CAD	Postscript	Bitmap
<i>Outline map</i>	SPANS GIS	A	F	A	(NA)	(NA)
	Atlas*GIS/PRO	A	A	(NA)	F	(NA)
	Atlas MapMaker	A	A	(NA)	(NA)	C
	IDRISI	A	(NA)	F	A	C
	World Map Proj.	A	(NA)	(NA)	C	(NA)
	Surfer	A	(NA)	A	F	(NA)
<i>Choropleth</i>	SPANS GIS	F	F	F	(NA)	(NA)
	Atlas*GIS/PRO	C	A	(NA)	F	(NA)
	Atlas MapMaker	C	A	(NA)	(NA)	C
	IDRISI	C	(NA)	F	C	C
	World Map Proj.	C	(NA)	(NA)	F	(NA)
<i>Proportional symbols</i>	Atlas*GIS/PRO	B	A	(NA)	F	(NA)
	Atlas MapMaker	B	A	(NA)	(NA)	C
<i>Dot maps</i>	Atlas*GIS/PRO	B	B	(NA)	F	(NA)
	Atlas MapMaker	B	B	(NA)	(NA)	C
<i>Bivariate maps</i>	Atlas*GIS/PRO	B	A	(NA)	F	(NA)
	Atlas MapMaker	B	F	(NA)	(NA)	C
<i>Sectored circles</i>	Atlas MapMaker	B	B	(NA)	(NA)	C
<i>3-D maps</i>	SPANS GIS	C	F	C	(NA)	(NA)
	IDRISI	F	(NA)	F	F	C
	Surfer	A	(NA)	A	F	(NA)
<i>Satellite images</i>	IDRISI	F	(NA)	F	F	B

Letter grades are as follows: A - file format works satisfactorily; B - file format works with some limitations; C - file format should only be used as a last resort to transfer map image to CorelDRAW; F - file format does not satisfactorily transfer map images to CorelDRAW; and (NA) - file format is not available for that particular mapping package.

through the Clipboard utility) followed by Computer Graphics Metafiles. It should be kept in mind that different software programs may produce slightly different versions of export file formats and results of transferring CGMs or TIFFs from programs other than those included here may differ from those reported in this paper. WMFs, however, should be standard throughout the Windows platform so whenever a cartographic program is Windows-based it is recommended that Windows Metafiles be used to transfer map images to CorelDRAW. Alternatively, due to a lack of post-import flexibility, it may be best to leave bitmap file transfers as a last resort.

Although most map images may be transferred from cartographic packages to CorelDRAW it is important to note that the effort required varies for different map types. For example, choropleth and proportional symbol maps may be transferred relatively easily and quickly with appealing results in the final map. The transfer of dot maps on the other hand, may involve more effort, including some sessions of trial and error to achieve an acceptable final product. In some cases, the final product may be less satisfactory than desired.

The capabilities offered by CorelDRAW, however, allow the cartographer to expand greatly on the product that may be achieved using any of the cartographic software packages alone. The variety of export file formats available with any number of software packages lends flexibility to overcome various obstacles that may hinder the enhancement of maps in CorelDRAW. As this paper illustrates, transferring map images between application packages is not always easily accomplished. The guidelines reported in this study reflect the results of repeated experimentation using multiple file formats, mapping programs, and map elements. The bright side of the story is that virtually every map, regardless of the program with which it was created, could eventually be successfully imported into CorelDRAW. Identifying the appropriate file format to facilitate this transfer is the key to unlocking the impressive capabilities of CorelDRAW and other illustration packages. The task, however, is well worth the effort and hopefully the recommendations reported here will make the road a little smoother for those who wish to explore the graphic potential of CorelDRAW.

The bright side of the story is that virtually every map, regardless of the program with which it was created, could eventually be successfully imported into CorelDRAW.

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RESUMEN

Este trabajo enfoca el uso del diseño gráfico microcomputarizado (CorelDRAW 4.0) en conjunción con una variedad de software de mapas GIS para examinar su capacidad de transferir imágenes de mapas. Se hace énfasis en las ventajas y desventajas de transferir diferentes mapas y formatos vectores y no en la naturaleza de los formatos. Todos los paquetes de cartografía examinados tienen capacidad de exportar mapas temáticos a CorelDRAW, aunque algunos formatos tienen mayor flexibilidad que otros. Generalmente, parece que los mapas más sencillos se transfieren con más facilidad, mientras que los mapas de tipo más complejo requieren mucho más esfuerzo para ser transferidos con éxito. Los formatos Metafiles para Windows y los gráficos computarizados Metafiles han dado prueba de ser formatos eficientes para exportar la imagen de la mayoría de tipos de mapas a CorelDRAW.

SOMMAIRE

Ce mémoire se concentre sur l'utilisation d'un ensemble conceptuel graphique de micro-ordinateur connu (CorelDRAW 4.0) en conjonction avec divers logiciels de cartographie/GIS pour mettre à l'épreuve leur capacité à transférer des images cartographiques. L'emphasis se porte sur les avantages et les désavantages du transfert de différents formats de fichiers-mode point et de fichiers vectoriels plutôt que sur la nature même des formats. Tous les groupes cartographiques mis à l'essai possédaient une certaine capacité à exporter des cartes thématiques à CorelDRAW, bien que certains formats de fichiers aient fait preuve de plus de souplesse que d'autres. D'une manière générale, il semble que les cartes thématiques plus simples se transfèrent facilement tandis que les cartes plus complexes demandent des efforts considérables pour que le transfert soit réussi. Les Metafiles Windows et Computer Graphic se sont prouvés des formats fichiers efficaces pour l'exportation de la plupart des images cartographiques à CorelDRAW.