Analysis and Training Systems Project

Corps Battle Simulation (CBS)
Version #1.81

Terrain Database Preparation System
TDPS Users Guide, Version 1.1a

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SECTION 1
SCOPE

1.1 IDENTIFICATION

This User Guide pertains to the Terrain Database Preparation System (TDPS) subtask authorized under the Jet Propulsion Laboratory (JPL) “Corps Battle Simulation (CBS)” task, JPL Task Plan No. 80-6351, Project Number 101435-03.25.02, “CBS Terrain,” performed under management of the California Institute of Technology (CalTech) via contract with the National Aeronautics and Space Administration (NASA-CALTECH contract NAS7-03001, Task Order NM0715408), as prepared for the U.S. Army Program Executive Office (PEO) for Simulation, Training, and Instrumentation (STRI), headquartered in Orlando, Florida. PEO-STRI’s agent for technical management of this subtask is the U.S. Army National Simulation Center (NSC) in conjunction with the Battle Command Training Program (BCTP), co-located at Ft. Leavenworth, Kansas, under the auspices of the U.S. Army Combined Arms Center (CAC). Primary funding for this activity was provided by the 7th ATC (Army Training Center) based in Grafenwoehr, Germany.

1.2 OVERVIEW

This document describes version 1.1 of the CBS Terrain Database Preparation System (TDPS), including requirements, design, operation, data inputs/outputs, installation, and Users Guide. In brief, the TDPS software system creates CBS-compatible terrain databases (in text format) that provide the terrain "game boards" upon which CBS wargaming simulations are played. The CBS-terrain database *does not* include the CBS “Simulation" database, which is a separate CBS creation. The TDPS generates terrain polygons containing Trafficability (water, smooth, gently rolling, mountainous, marsh), Vegetation (sparse, moderate), and Urban (village, town, city) information, and terrain vector representations of three levels of Roads and Rivers for a user-defined geographical land-based playbox location. A Terrain Vector Editor is provided to display, verify, and edit the polygons and vectors as desired. The Editor includes a map-background display derived from NGA ADRG (Arc-Digitized Raster Graphics) products, which is separate and distinct from the CBS "Workstation" map background display. A separately managed Quadtree algorithm is incorporated within the TDPS system to extract and encode elevation values for use by the CBS GEEP and DEM Server. The TDPS's terrain output product files are input to the "Road/River Preprocessor" and the "Polygon Preprocessor," which are separate CBS programs that are documented and maintained elsewhere. The hexagon-based map projection ".trn" file required by the CBS GEEP is also separately managed by CBS. The raw terrain data ingested by the TDPS is derived from standard (and preliminary) NGA (National Geospatial-Intelligence Agency) data products. A set of utility programs facilitates the update of TDPS databases with new NGA products. The TDPS software/system is an extension of the JPL VICAR/IBIS (Video Image Communication And Retrieval / Image Based Information System) rapid prototyping software system, with a custom user interface developed using the “tcl tk” (tool command language toolkit).

1.3 LICENSE AGREEMENT AND DATA RESTRICTIONS

The TDPS software system is based upon JPL's VICAR/IBIS image processing and Geographic Information System. The United States Government has a non-exclusive, non-transferable, royalty-free (no cost) worldwide license to VICAR. Third party use of VICAR is limited to uses for, or on behalf of the US Army (which is licensed), but any further use must be negotiated with the NASA Patent Office. A copy of the license is provided in Appendix B. For further information, contact the Caltech/JPL Administrator for Software Licensing, 4800 Oak Grove Drive, Mail Code 202-233, Pasadena, CA 91109-8099, Phone 818-393-3424.

“tcl tk” (pronounced *‘tickle tk’*) is the “tool command language toolkit” copyrighted by the University of California, Sun Microsystems, and others. It is classified by the DOD as “Commercial Computer Software,” but carries no costs, license, or limitations on its use.

The TDPS utilizes the following NGA (formerly NIMA/DMA) products: 1) ADRG (Arc-Digitized Raster Graphics (all scales); 2) Vmap (Vector Map Product) Level-0 and Level-1; 3) DTED (Digital Terrain Elevation Data) Level-1; and a preliminary version of the SRTM (Shuttle Radar Topography Mission) Level-1 height/elevation models, with ‘voids’ (holes in the data) filled-in by DTED-1 and other publicly available coarser elevation models. Many of the NGA data products carry "LIMITED DISTRIBUTION" and “FOR OFFICIAL USE ONLY” restrictions that limit their use to the DOD, DOD designates, and designated DOD contractors. As the SRTM-1 elevation models are mixed with DTED-1 data, the entire DEM dataset provided with the TDPS carries the same restrictions as DTED-1 products (until otherwise reclassified). Any TDPS-provided data that is superseded or no longer required by users of the TDPS system should be destroyed as defined by "FOR OFFICIAL USE ONLY".

SECTION 2
APPLICABLE DOCUMENTS

(1) CBS, "Analyst's Guide, Volume 1, Ground, "http://mcs642.jpl.nasa.gov. Password Required.

(2) CBS, "CBS Version 1.8.0 Model Design," http://mcs642.jpl.nasa.gov. Password Required.

(3) CBS, "Database Description Document," http://mcs642.jpl.nasa.gov. Password Required.

(4) JPL, "VICAR User's Guide," Document D-4186 Rev B, 14OCT94. ," http://www-mipl.jpl.nasa.gov/ VICAR Documentation.

(5) JPL, "The Multi-Mission Image Processing Laboratory (MIPL)," and "The VICAR Image Processing System," http://www-mipl.jpl.nasa.gov/ VICAR Documentation.

(6) JPL, "Shuttle Radar Topography Mission (SRTM), http://www2.jpl.nasa.gov/srtm.

(7) JPL, "Terrain Database Preparation System, TDPS Users Guide, Version 1.1," (This Document). 18JAN05.

(8) NGA, Compressed ARC Digitized Raster Graphics, MIL-C-89038, 6OCT94.

(9) NGA, Digital Terrain Elevation Data (DTED) Level 1, MIL-D-890000, 26FEB90.

(10) NGA, Vector Smart Map (Vmap) Level 1 Military Specification, MIL-V-89033, 01JUN95.

(11) NGA. Vector Smart Map (Vmap) Level 1 Performance Specification, Amd1, MIL-PRF-89033, 27MAY98.

(12) NGA, Vector Smart Map (Vmap) Level 0 Performance Specification, MIL-PRF-89039, 09FEB95.

(13) NGA, Vector Smart Map (Vmap) Level 0 Performance Specification, Amd 2, MIL-PRF-89039, 27JUN01.

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SECTION 3
SYSTEM DESIGN

3.1 INTRODUCTION

Previous methodologies for creating CBS terrain databases were based upon the *manual digitizing* of road, river, and other physical ground features from 1:500,000 TPC (Tactical Pilot Chart) *paper* maps. Such methodologies are fundamentally labor intensive and produce customized (non-standard) databases. The long database preparation time (typically 3-6 months) also limits the number of databases that can be produced, and makes it difficult to respond quickly to new political crisis areas.

Currently, NGA is managing a number of major terrain programs to rasterize *paper* maps, generate *vector* files from the paper maps, and create global Digital Elevation Models (DEMs). With these NGA programs nearing completion of global terrain databases, it has become practical to develop automated systems that utilize the new terrain files. By 2004, the NGA terrain library had become sufficient to cover most of the world at 1:250,000 scale, significantly increasing the credibility (and standardization) of training simulation products. Given this evolving situation, the 7th ATC (Army Training Center) located in Grafenwoehr, Germany, decided in early 2003 to fund the development of a terrain preparation system for CBS that could take advantage of the new terrain data as well as the latest computerized software technologies.

3.2 REQUIREMENTS

In support of the 7th ATC's request, the National Simulation Center (NSC), in conjunction with the Battle Command Training Program (BCTP), and under the direction of PEO-STRI (Program Executive Office – Simulation, Training and Instrumentation), prepared the following list of requirements for a new terrain database preparation system for CBS:

- Develop an automated rapid terrain generation capability.
- Be capable of utilizing standard NGA (NIMA/DMA) terrain products.
- Be capable of generating CBS-defined “feature data.”
- Operate on a PC computer utilizing the Red Hat Linux operating system (OS).
- Easily allow for the addition of future new CBS terrain features types.
- Be easy to operate by technical personnel.
- Provide a new or upgraded terrain Editor capability.
- Provide at least one week of testing and training.
- Provide user documentation.

- Be compatible with the current CBS version (except for TIN generation).
- Include the Quadtree software product for CBS 1.8.1.
- Have the goal of creating a CBS playbox in less than 96 hours.

3.3 DESIGN APPROACH

Figure 3-1 provides an overview of the TDPS design approach, and Figure 3-2 provides a focused view of the operational design with "pre-staged" terrain data. The primary terrain data used by the TDPS includes Vmap1 (1:250,000 scale) vector road, river, urban, vegetation, and relevant cross-country data, plus an interim 3 arc-second SRTM-based DEM (Digital Elevation Model) trafficability product, and 1:250,000 scale ADRG map data which provides a background display that facilitates vector editing. The term "Pre-staged" means that the input Vmap1, SRTM/DEM, and ADRG data have been pre-processed into the format required by the TDPS. By delivering *global* "pre-staged" data with the TDPS, a critical timesaving is obtained that supports the design goal of preparing a CBS terrain database in less than 96 hours.

To simplify the process of preparing CBS Terrain databases, the design process (and user labor) are divided into seven steps. "Step 1" requires the user to define a terrain database "name" for the new database (that also becomes a directory containing all the data files for the new database). As shown in Figures 3.1 and 3.2, the basic TDPS design begins with the import of terrain data. "Step 2" requires the user to specify the CBS Playbox's geographic area-of-interest (AOI). "Step 3" ingests the pre-staged NGA Vmap vector road, river, vegetation, and urban data, and reformats ("filters") the Vmap data classes into CBS terrain classes. Vmap1 (1;250,000 scale) data are used wherever possible, and Vmap0 (1:1,000,000 scale) data are used when Vmap1 data are not available. The Vmap data are trimmed to the specified CBS Playbox AOI boundaries, and embedded polygons ("donut holes") are extracted as independent polygons. Water, Marsh, Lava, Karst, and "Distorted Surface" terrain features are separately collected and exported for input to the trafficability step (4). ADRG data is processed to provide a map background file specific to the playbox AOI. In "Step 4," pre-staged (3 arc-second) 90 meter resolution DEM data are reduced to 270 meter resolution, "simplified" (by a low-pass 'mode' box filter), processed by a "Standard Deviation" box filter algorithm, and separated into "Smooth", "Gently Rolling", "Mountainous", and "Water" CBS terrain classes. Vmap-based vector/polygon adjustments (Water, Marsh, Lava, Karst, Distorted Surfaces) are added to modify/update the DEM-based trafficability class. The resulting trafficability "image" is then converted from raster to vector format. In "Step 5," the user has the option of employing the Terrain Vector Editor for custom editing of the Vmap or DEM-based vector/polygons. "Step 6" activates the embedded "Quadtree" algorithm that processes the pre-staged DEM data into a format useable by the DEM Server. The final step, "Step 7," converts the edited (or unedited) terrain vector/polygon files into CBS Terrain text-file format. These files are finally read into the CBS terrain "Pre-processors" for re-formatting and use by the CBS GEEP. A database "receipt" file is generated that summarizes all relevant information about the created CBS Terrain database.

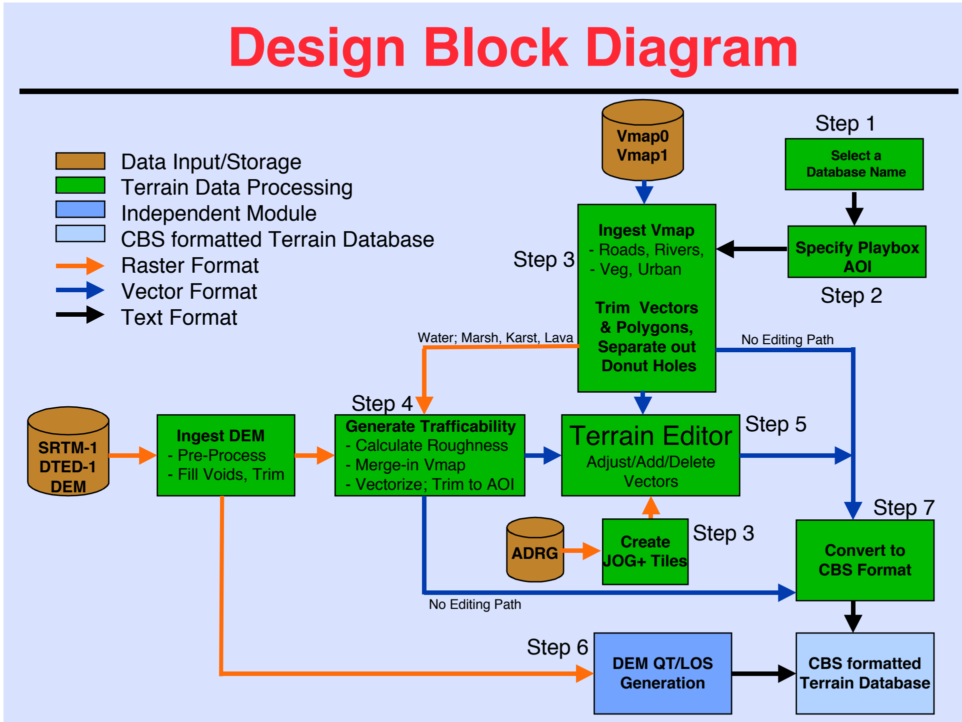


Figure 3-1. TDPS Design Approach Flow Block Diagram.

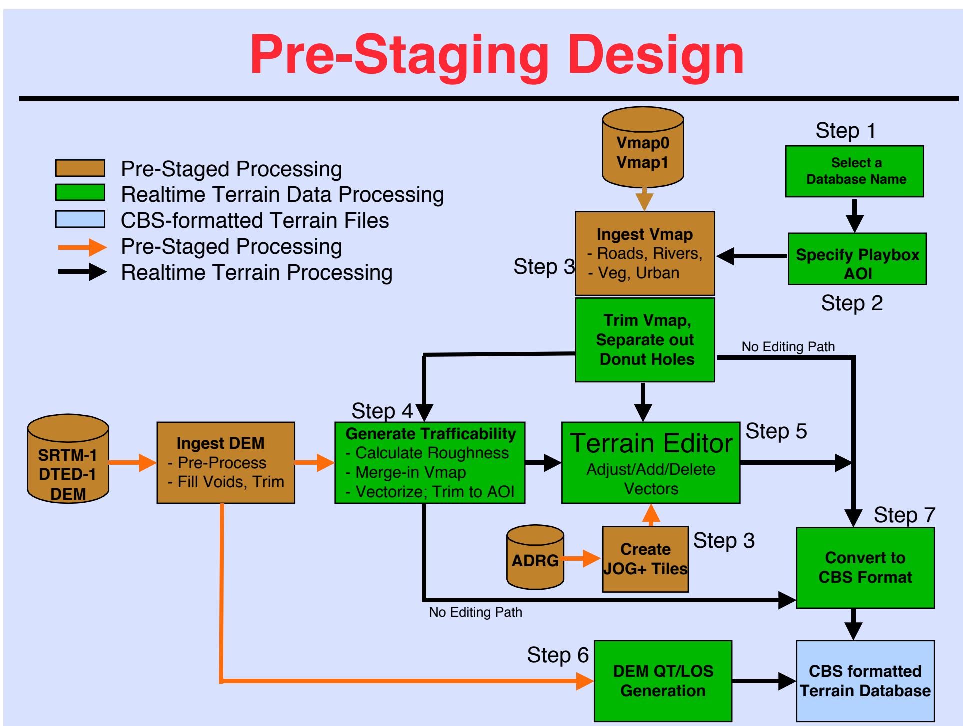


Figure 3-2. TDPS Data Pre-Staging Flow Block Diagram.

3.3.1 Vmap Terrain Classes Overview

The NGA Vmap product contains many more terrain features than are currently utilized by CBS. Figure 3-3 shows the complete complement of terrain features available for Vmap0 (1:1,000,000 scale) and Vmap1 (1;250,000) scale. As CBS evolves, the TDPS design can be modified to include many of the Vmap terrain classes not currently utilized. The resolution differences between Vmap0 and Vmap1 are shown in Figure 3-4.

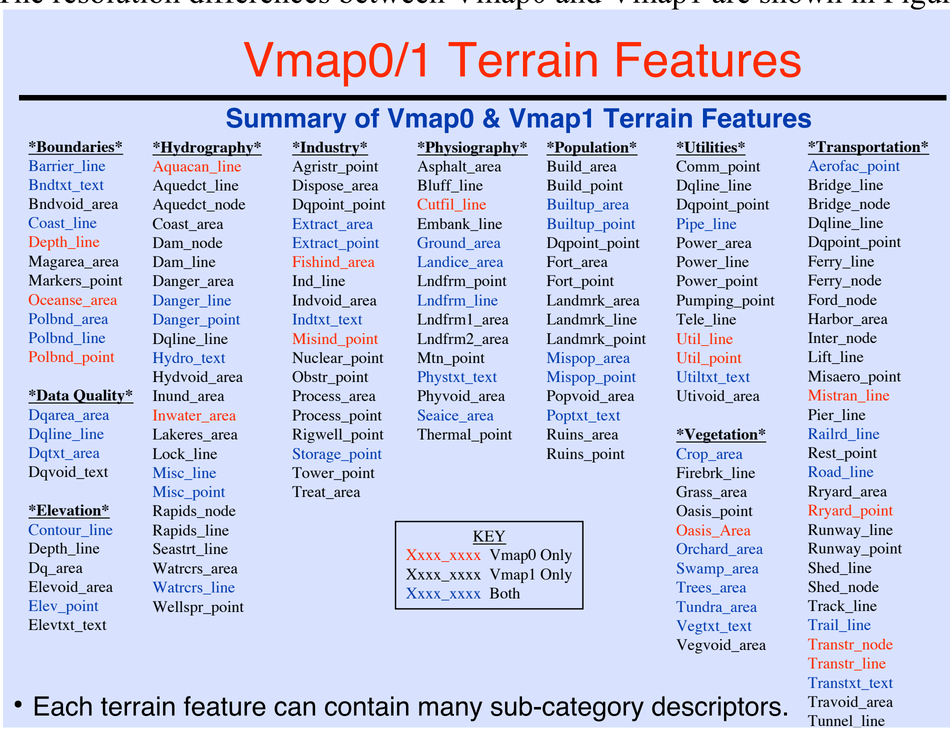


Figure 3-3. Summary of all Vmap0 and Vmap1 Terrain Features

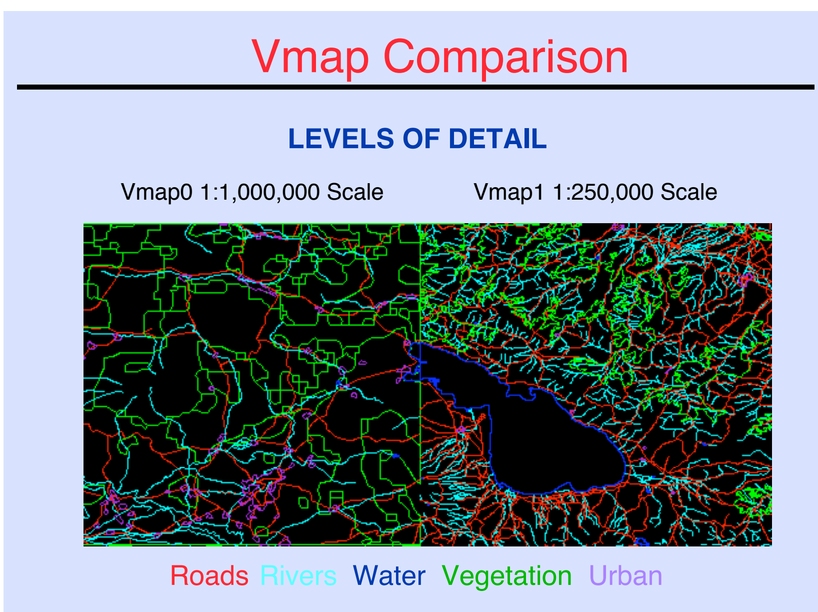


Figure 3-4. Vmap Resolution and Scale Differences

3.3.2 Vmap1-To-CBS Terrain Conversion Classification/Mapping

CBS terrain classes are populated by converting the appropriate Vmap1 terrain classes into their CBS equivalent. The decision rules ("Filters") for converting Vmap1 into CBS terrain classes were determined through interaction with NSC and BCTP personnel. In Step 3, the user also has the option of selecting a "Low" or "High" resolution database. The purpose of this option is to control the data volume (size) of the output CBS database. Choosing the "Low" option reduces the data volume by eliminating Intermittent River classes, but the data volume will vary depending upon the specific geographic location. Figures 3-5 through 3-9 define the conversion rules for Vmap1-to-CBS, with the letter "L" indicating the classes that are *deleted* when the "Low" data volume option is selected.

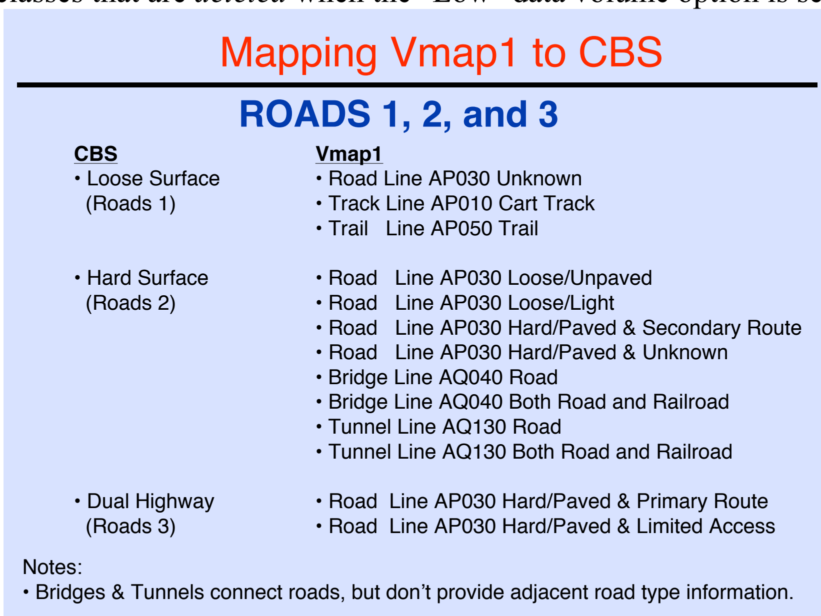


Figure 3-5. Vmap1-to-CBS Roads Terrain Mapping.

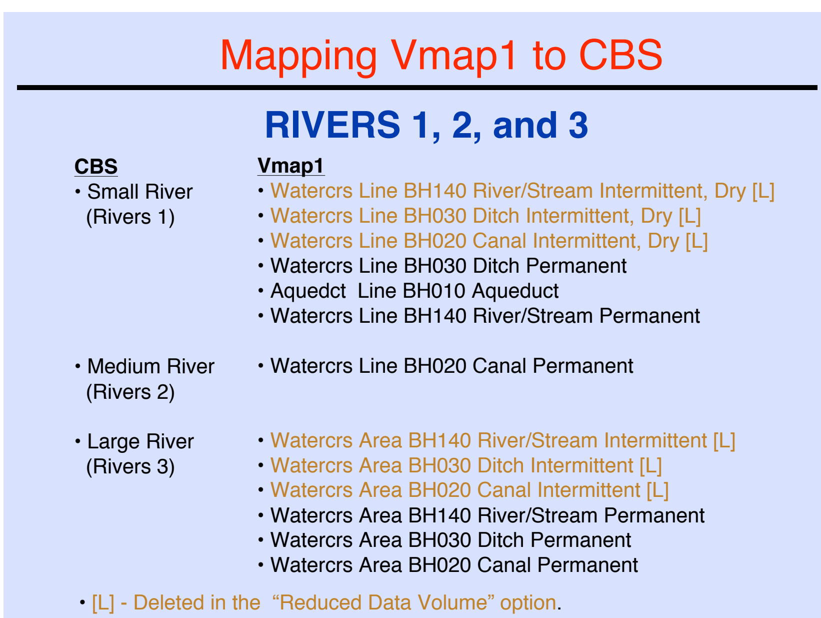


Figure 3-6. Vmap1-to-CBS Rivers Terrain Mapping.

Mapping Vmap1 to CBS

URBANIZATION

CBS	Vmap1
• No Settlement	• Absence of Builtup Area (Donut Holes)
• Village	• Builtup Area AL020 Fourth Order
• Town	• Builtup Area AL020 Third Order • Builtup Area AL020 Unknown
• City	• Builtup Area AL020 Second Order • Builtup Area AL020 First Order (>500,000 pop)

Figure 3-7. Vmap1-to-CBS Urbanization Terrain Mapping.

Mapping Vmap1 to CBS

VEGETATION

CBS	Vmap1
• Barren	• Absence of Vegetation (Donut Holes)
• Sparse	• Crop Area EA010 Cropland • Grass Area EB010 Grassland • Tundra Area BJ110 Tundra • Orchard Area EA050 Vineyards
• Moderate	• Orchard Area EA040 Orchard/Plantation • Trees Area EC030 Trees
• Dense	• None

Figure 3-8. Vmap1-to-CBS Vegetation Terrain Mapping.

Mapping Vmap1 to CBS

TRAFFICABILITY

CBS	**Vmap1**
• Water	• Lakeres Area BH080 Lake/Pond • Lakeres Area BH130 Reservoir • Coast Area BA040 Water (Except Inland)
• Impassable	Optional: User entered input via the Terrain Editor
• Smooth	• Derived from Standard Deviation Filter applied to DEM
• Gently Rolling	• Derived from Standard Deviation Filter applied to DEM
• Mountainous	• Derived from Standard Deviation Filter applied to DEM, plus • Ground Area DA010 Lava MCC=52 • Ground Area DA010 Karst MCC=119
• Marsh	• Derived from Standard Deviation Filter applied to DEM, plus • Swamp Area BH095 Marsh/Swamp • Rice Area BH135 Rice Field

Figure 3-9. Vmap1-to-CBS Trafficabilty Terrain Mapping.

3.3.3 Vmap0-To-CBS Terrain Conversion Classification/Mapping

Where Vmap1 data (1:250,000 scale) are not currently available (circa JAN05), the lower spatial resolution Vmap0 data (1:1,000,000 scale) are substituted for Vmap1. Vmap0 terrain classes differ from Vmap1 classes not only in terms of map scale differences (See Figure 3-4), but also by their terrain classification. The decision rules for converting Vmap0 to CBS terrain classes were determined through interaction with NSC and BCTP personnel (Figures 3-10 through 3-14). No Vmap0 data are removed as part of the Low Resolution data base option.

Mapping Vmap0 to CBS

ROADS 1, 2, and 3

CBS	**Vmap0**
• Loose Surface	• Road Line AP030 Unknown • Trail Line AP050 Trail
• Hard Surface	• Road Line AP030 Secondary Route
• Dual Highway	• Road Line AP030 Primary Route

Figure 3-10. Vmap0-to-CBS Roads Terrain Mapping.

Mapping Vmap0 to CBS

RIVERS 1, 2, and 3

CBS	**Vmap0**
• Small River	• Aquecan Line BH000 Inland Water (Aqueduct/Canal)
• Medium River	• Watercrs Line BH140 River/Stream Intermittent
• Large River	• Watercrs Line BH140 River/Stream Permanent

Note:
• Vmap0 provides only two levels of Watercrs/Rivers.

Figure 3-11. Vmap0-to-CBS Rivers Terrain Mapping.

Mapping Vmap0 to CBS

URBANIZATION

CBS	**Vmap0**
• No Settlement	• Absence of Builtup Area (Donut Holes)
• Village	• None
• Town	• None
• City	• Builtup Area AL020

Note:
- Vmap0 provides only one level of Builtup/City Areas.
- A City 'Point' option is available (but not used).

Figure 3-12. Vmap0-to-CBS Urbanization Terrain Mapping.

Mapping Vmap0 to CBS

VEGETATION

CBS	**Vmap0**
• Barren	• Absence of Vegetation (Donut Holes)
• Sparse	• Crop Area EA010 Cropland • Grass Area EB010 Grassland • *Grass Area BH077 Hummock* • Grass Area EB020 Scrub/Brush • Tundra Area BJ110 Tundra • *Orchard Area EA050 Vineyards*
• Moderate	• Trees Area EC030 Deciduous/Evergreen/Mixed • *Grass Area EC010 Bamboo/Cane* • *Oasis Area EC020 Oasis* • *Orchard Area EA030 Nursery* • *Orchard Area EA040 Orchard/Plantation*
• Dense	• None.

Note: Classes in *italic* exist in the Vmap0 Spec, but not in the actual data.

Figure 3-13. Vmap0-to-CBS Vegetation Terrain Mapping.

Mapping Vmap0 to CBS

TRAFFICABILITY

CBS	Vmap0
• Water	• Inwater Area BH000 Inland Water • Oceanse Area BA040 Water (Except Inland)
• Impassable	• Optional: User entered input via the Terrain Editor
• Smooth	• Derived from Standard Deviation Filter applied to DEM
• Gently Rolling	• Derived from Standard Deviation Filter applied to DEM
• Mountainous	• Derived from Standard Deviation Filter applied to DEM • Ground Area DA010 Lava • Ground Area DA010 Distorted Surface
• Marsh	• Swamp Area BH095 Marsh/Swamp • Swamp Area BH015 Bog • *Crop Area BH135 Rice Field*

Note: Classes in *italic* exist in the Vmap0 Spec, but not in the actual data.

Figure 3-14. Vmap0-to-CBS Trafficability Terrain Mapping.

3.3.4 CBS Vector/Polygon Terrain Codes

The TDPS adheres to the standard CBS coding scheme (Figure 3-15).

CBS Terrain Format

CBS TEXT TERRAIN CODES

Terrain Type	Polygon Type	Polygon Subtypes
• Roads	100	
• Loose Surface		101
• Hard Surface		102
• Dual Highway		103
• Rivers	200	
• Small		201
• Medium		202
• Large		203
• Vegetation	300	
• Barren		300 / 301
• Sparse		302
• Moderate		303 / 399
• Dense		304
• Urbanization	400	
• None		400
• Village		401
• Town		402
• City		403
• Trafficability	500	
• Water		501
• Impassable		502
• Smooth		503
• Gently Rolling		504
• Mountainous		505
• Marsh		506

Figure 3-15. CBS-designated Terrain Codes.

3.3.5 Trafficability Preparation And Decision Rules

The TDPS Trafficability terrain class is primarily derived from a "Standard Deviation" 3x3 pixel box-filter as applied to the SRTM/DTED DEM (Digital Elevation Model) covering the Area of Interest (AOI) playbox. The processing is performed iteratively on each 1x1 degree DEM cell. The Standard Deviation filter provides a measure of "variance," or "elevation-change-per-unit-area," which is essentially an indication of terrain "roughness." Several tests were conducted with varying pixel scales and secondary modal filtering to simplify (smooth) the data. Testing indicated that the nominal 3-arc second (~93meter) DEM data created excessively large Trafficability data volumes that were overly detailed for the nominal CBS playing scale (Figure 3-16). The user-preferred trafficability product was determined to be a DEM sized down (using bilinear interpolation) by a factor of 4 to ~270m (9-arc seconds) pixel resolution, then subjected to the 3x3 Standard Deviation filter. The resultant Standard Deviations were converted to CBS Trafficability classes (Figure 3-17) using the following formula:

0-15 std = Smooth
16-33 std = Gently Rolling
34+ std = Mountainous

The Trafficability classes were subsequently smoothed (simplified) using a "connected-components" 3x3 box filter (modal) algorithm (which replaces the center pixel of a 3x3 box with the arithmetic 'mode' of the nine pixels) to reduce the number of single-pixel classes and simplify the larger terrain polygons. The resultant product is restored to its original 3-arc second size, and then augmented by Water, Marsh, Karst, Lava, and other "Distorted Surface" terrain vector data derived from Vmap. These vector data are combined with the roughness image by first converting them to a raster binary image (e.g., water=0; not water=1), and multiplying that product with the roughness image. The zero (0) value of the water feature (and other features in turn) zero-out the underlying roughness values, and re-assigns the value associated with the new terrain feature (i.e., Water, Marsh, etc.). The Vmap-based Water and Marsh form their own Trafficability class (501), and the Karst, Lava, and Distorted Surface features are folded into the Mountainous class (505). The "Impassable" Trafficability class is reserved for user-created polygons made using the Vector Editor. The resultant Trafficability product is finally converted from raster-to-vector format for Vector Editing and processing into CBS terrain text files. Figure 7-17 shows some sample Trafficability data displayed in the Vector Editor. Note the “Stair Step” polygon boundaries are an artifact of the square shape of the raster DEM pixels.

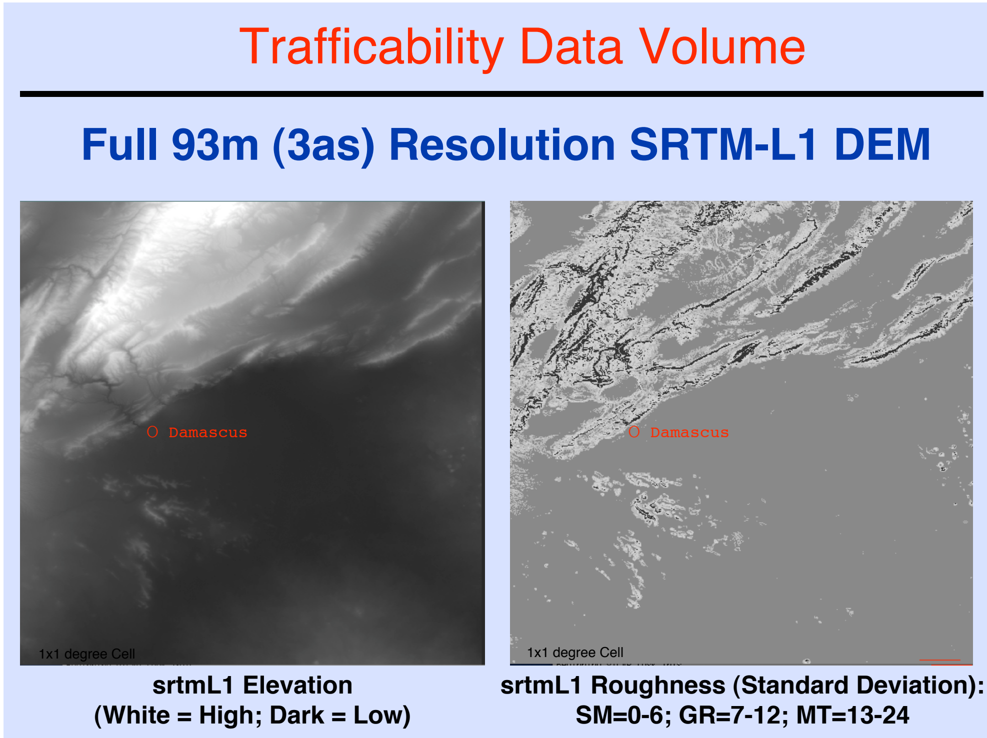


Figure 3-16. 1x1 Degree SRTM DEM (left) and Roughness image (right). At Full Resolution, it was determined that the Detail and subsequent Trafficabilty Data Volume would be Larger than Desired.

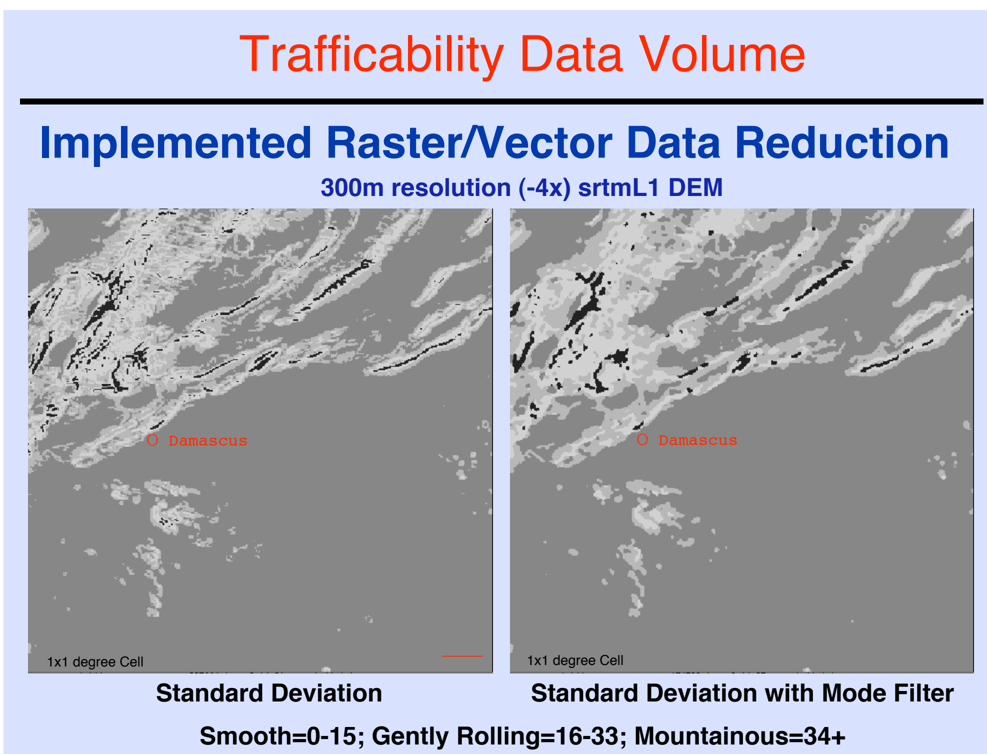


Figure 3-17. The Implemented Trafficability Preparation Approach.

SECTION 4
SYSTEM INSTALLATION

4.0 TDPS INSTALLATION AND INITIAL TESTING

Version 1.1 of the TDPS currently operates on Red Hat (RH) Linux Enterprise v3 computer systems, including RH Linux System 9 (with all update patches installed), but *not* earlier Linux versions. A Linux System Administrator should perform the installation.

4.1 TPDS Software Distribution Files

TDPS software is nominally distributed on one or more CD-ROMs containing the following software and data files:

- vicar3203.tar.Z	(vicar software version 32.03 or greater)
- vdev.tar.Z	(TDPS-specific vicar software supplement)
- tdps.tar	(TDPS-specific gui/interface software)
- TDPS_User_Guide.pdf	(this document)
- vug.tar.gz	(Optional VICAR Users Guide documentation)

4.2 Software Locations

In the **/home** directory (or most anywhere with plenty of disk space, for example, the **/opt** directory), gunzip and untar the "vicar3203.tar.gz" file. This will create a **/vicar** directory and many additional subdirectories and files.

gunzip vicar3203.tar.gz
tar xvf vicar3203.tar (The directory path to vicar will be **/home/vicar/vicar3203**)

In the **/home** directory, make a **/vdev** directory, and copy the "vdev.tar.Z" file in to it. From inside /vdev, uncompress and untar the file. The directory path to /vdev should be:

/home/vdev

Inside /vdev, use a text editor to open the ulogon.pdf and xvd.pdf files and change the directory path to /vdev:

/home/vdev/…..

TDPS data files (Section 5) are distributed through special arrangement with the U.S. Army National Simulation Center (NSC). Geographic subsets of the data can be extracted to reduce the online data volume. The data, however, must be placed in three name-specific directories:

tdps_vmap1	(about 30GBs)
tdps_srtm	(about 56-75 GBs)
tdps_adrg	(about 815GBs)

4.3 Shell and Path

VICAR/TDPS expects the "tcsh" shell. The use of other shells is not recommended, and vicar *will not* work with the “bash” shell. The tcsh shell should be selected as the 'default' shell by the Administrator when setting up the account where the TDPS will be used. For user accounts to run VICAR, add the following to the end of the **/etc/csh.cshrc** file, and make sure each user account's login accesses it:

```
# VICAR
if ( -d /home/vicar/vicar3203 ) then
   if ($?V2TOP == 0) then
   setenv V2TOP /home/vicar/vicar3203
   source $V2TOP/vicset1.csh
   endif
source $V2TOP/vicset2.csh
endif
```

4.4 Setting Up The TDPS Directory

To complete the final setup of TPDS, each user should create a directory where they intend to use TDPS (and have full ownership permissions).

1) Create a TDPS Working directory, for example: **mkdir tdps**
2) Change the directory location to the new directory: **cd tdps**
3) Copy the tdps.tar file into the new directory, and untar it:
 tar xvf tdps.tar

4) Rename the following files:
 mv tdps_linux tdps
 mv ulogon.pdf_linux ulogon.pdf

5) Using a text editor, edit the “tdps” file by adding your system’s *directory path* to the three *tdps data* directories (Section 4.2 above). For example:
 setenv TDPS_DATA_ROOT **/data** (where “**/data**” is an example path)

6) Also in the "tdps" file, change the directory paths to vicar and vdev:
 /home/vicar/extern….. (one occurrence)
 /home/vdev/….. (three occurrences)

7) Using a text editor, edit the "ulogon.pdf" file by adding your system's directory path to vdev:
 /home/vdev/….. (one occurrence)

8) Change your directory to “vdev”. Using a text editor, edit the "xvd.pdf" file by adding your system's directory path to the vdev directory:
 cd /home/vdev
 /home/vdev/xvd (one occurrence)

4.5 Testing VICAR

To test the VICAR/TDPS installation, move to your TDPS-installed directory and type **vicar** at the Unix prompt. The system should respond with the vicar prompt: "%VICAR>"

Test vicar by running the following tasks:

%VICAR>**gen a**	(creates a 10x10 pixel file called “a”)
%VICAR>**list a**	(lists all the pixels in file “a”)
%VICAR>**hist a**	(generates a histogram of file “a”)
%VICAR>**xvd a**	(displays file “a” if you are working in an X-window)
%VICAR>**gtstat a b**	(calculates image sigma statistics)
%VICAR>**list b**	(lists sigma pixel values; all 1s)

If the "gen" command fails, the path to VICAR or VICAR-required libraries was not found.
If the "hist" command fails, the fortran library path was probably not found.
If the "gtstat" command fails, the path to /vdev was probably not found.

4.6 Trouble Shooting VICAR

The most common problem when VICAR fails upon initial installation is that a library is missing. To determine the missing library, type “ldd $R2LIB/gen” at the linux prompt to display all the directories and libraries required by program “gen” to work:

```
$ ldd $R2LIB/gen
    librtl.so => /home/vicar/vicar3203/olb/x86-linux/librtl.so (0xb7501000)
    libm.so.6 => /lib/tls/libm.so.6 (0xb74cd000)
    libc.so.6 => /lib/tls/libc.so.6 (0xb7395000)
    libncurses.so.5 => /usr/lib/libncurses.so.5 (0xb7354000)
    /lib/ld-linux.so.2 => /lib/ld-linux.so.2 (0xb75eb000)
    libgpm.so.1 => /usr/lib/libgpm.so.1 (0xb734f000)
```

Check (run down) *every* link until the *actual* library file is found or determined to be missing. It may be necessary to reinstall linux (with all available options) and all subsequent patches to insure that all libraries have been installed. This approach can also be used for problems found with “hist” and “gtstat”.

4.7 “tcl tk” Location

“tcl tk” (tool command language tool kit, pronounced "*tickle tk*"; See Section 1.3) is required for the TDPS gui interface to operate. The TDPS uses tcl tk version 8.4 ("wish8.4"), which is *not* the default Linux Enterprise installation (version 8.3 is the default). Therefore, tcl tk v8.4 is provided in the ~/vdev/tcl/ directory, and is referenced by the TDPS where required. The TDPS will not operate with version 8.3.

4.8 Launching TDPS

To launch TDPS, move to your working directory (e.g., **/tdps**). Open an "X" window (if not already the default) and type:

./tdps

The "CBS TDPS Main Menu" gui will appear (Figure 6-1). Click the "?" help buttons for information about how to run TDPS, or review the User Guide provided in Section 6.

The TDPS also has an "expert" mode that provides additional functionality (of limited value for CBS Users). It can be entered by typing "./tdps expert" at the X-window prompt.

4.9 TDPS Database Limitations

Other than the normal disk space and memory limits that are specific to the computer system upon which the TDPS is installed, the known TDPS limitations are:

- A requested database may not cross the International Date Line (180° East/West).

- A requested database may not cross the North or South Poles.

- A requested database must be in the shape of a single rectangle, and that rectangle may not require more than sixteen of the pre-staged 10x10 degree ADRG tiles (Section 5.4). This equates to a TDPS database size limit of 1600 square degrees (for example, a database with dimensions like 40x40 degrees, 20x80 degrees, or 10x160 degrees). Note that this limitation only applies to the creation of the Map Background. The TDPS can generate near global size CBS terrain files. However, until CBS moves to a 64-bit computer architecture, the maximum terrain database that can be handled by the GEEP is estimated to be about 120 square degrees (e.g., 10x12 degrees).

4.10 TDPS Hardware Recommendations

The TDPS is both cpu (computer processing unit) intensive and I/O (input/output) intensive. Therefore, the TDPS should have the fastest processor, maximum memory, and largest/fastest disk drives possible. In January 2005, this equates to a 3.4+GHz cpu, 2+ GBs of cpu memory, and about 2.5TBs (Section 4.2) of disk space. The disk drives should be in a raid array configuration connected directly to the cpu, or via a server. The system should also have a 3-button mouse, USB, Firewire, or SCSI ports for connecting backup and data exchange devices.

SECTION 5
DATA SOURCES AND PREPARATION

5.1 INTRODUCTION

The TDPS uses three data sources: 1) NGA Vmap (Vector Map) Level 1 and Level 0; 2) SRTM-based DEM (Digital Elevation Models) Level 1 and NGA DTED Level 1; and 3) NGA ADRG (Arc-Digitized Raster Graphics and "Compressed" ADRG (CADRG) as a map background in the Terrain Editor. Refer to Section 1.3 for restrictions on the use of this data. The raw forms of Vmap, SRTM/DEM, and ADRG data can not be used directly by the TDPS; they must be first "pre-processed" into a format usable by the TDPS. As this processing only needs to be performed once (or until a new NGA update arrives), *all* the available data for the *globe* was processed in advance, and is provided with Version 1.1 of the TDPS. These data are referred to as "Pre-Staged," i.e., ready and available for building TDPS terrain databases. Pre-Staging of the data saves the user considerable time in building a CBS Terrain Database and greatly simplifies the entire terrain building process. This Section provides an overview of the Vmap, SRTM/DEM, and ADRG data used by the TDPS, and the pre-processing that was performed to create the Pre-Staged data products.

5.2 VMAP DATA

Vmap1 (1:250,000 scale) vector feature data is the primary source of TDPS terrain data. Where Vmap1 is not available, Vmap0 (1:1,000,000) scale data are used. All the available Vmap data for the globe (circa January 2005) have been Pre-Staged, providing road, river, vegetation, urban, water, marsh, lava, karst, and other terrain vector information for use by the TDPS. Figure 5-1 shows the global distribution of Vmap data as delivered with TDPS Version 1.1. Figures 3-5 through 3-15 define how the raw Vmap data were converted into CBS terrain classes.

Pre-Staged Vmap data *is* Vmap data that has been converted into "shape" file format. Several commercial products (including ESRI, ENVI, GlobalMapper, the NGA's 'MUSE' software [used for TDPS version 1.0], and others) can perform this conversion. For TDPS version 1.1, the "Open Source Software Image Map" (OSSIM) software was used to convert Vmap data into "shape" file format. However, the original OSSIM software was found to contain numerous flaws. These problems were corrected by JPL to suit TDPS requirements (and the revised software was posted/contributed to the OSSIM community). The resulting software converts Vmap data into "shape" file format with better error-checking and (resulting) quality, in about 1/100th the time compared to using the "MUSE" software.

To process Vmap data into CBS terrain files, the Vmap "Shape" file data are first extracted for the given playbox area, then "filtered" (selected and combined) into CBS terrain classes. If an Urban or Vegetation polygon contains an interior (embedded) polygon ("donut hole"), it is extracted and placed at the end of the data file and assigned to the "background" terrain code (Veg=301; Urban=400). If another Vegetation or Urban polygon also exists for the donut hole, the "background" polygon is (later) deleted by the "PreProcessor." All vector/polygons are trimmed exactly to the playbox boundaries.

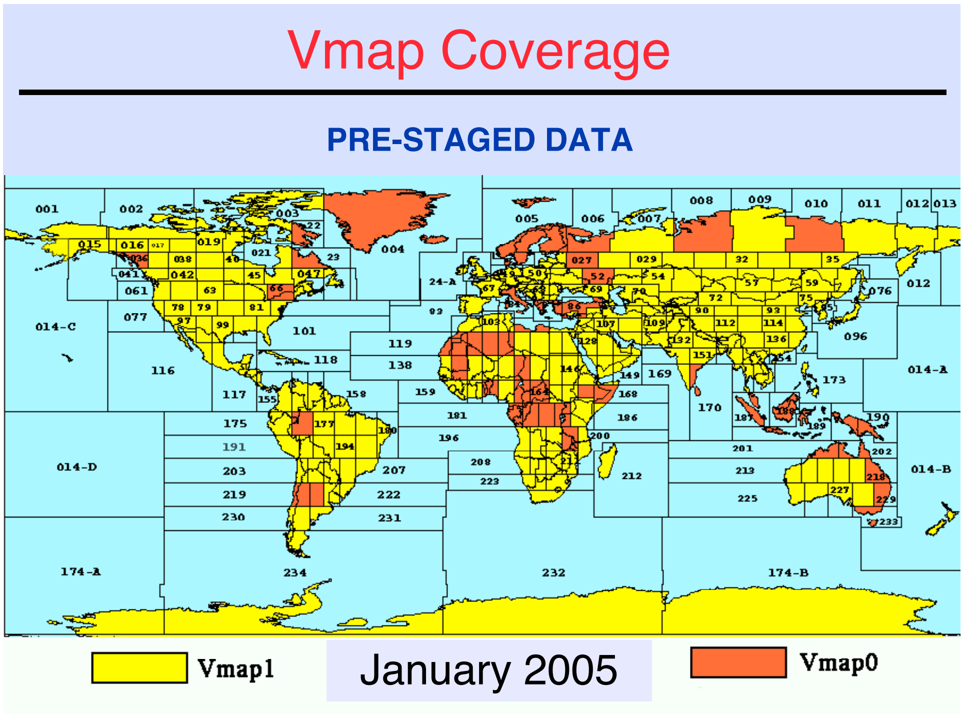


Figure 5-1. Distribution of Pre-Staged Vmap1/0 Data.

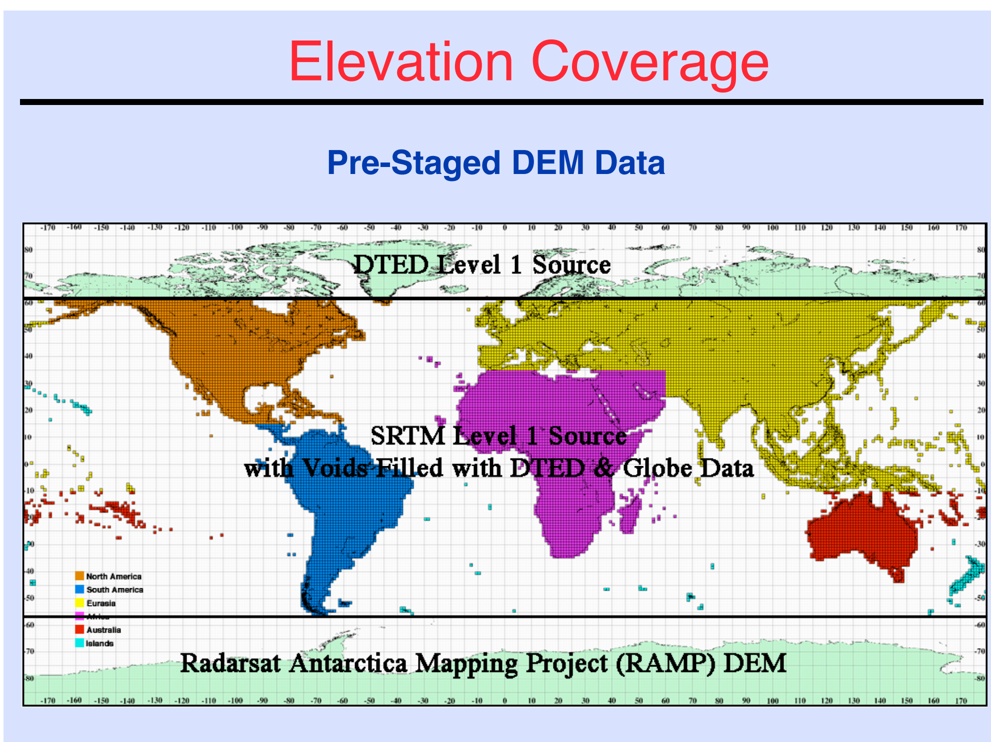


Figure 5-2. Sources and Distribution of Pre-Staged DEM Data.

5.3 DEM DATA

DEM (Digital Elevation Model) is the primary source of TDPS Trafficability and Quadtree data preparation. The DEM data coverage provided with TDPS Version 1.1 is *globally complete* from pole to pole (Figure 5-2). The primary DEM source is the SRTM (Shuttle Radar Topography Mission) database produced at 3 arc-second (~93m) resolution (Level 1) for the areas between 60° North and South of the Equator (see www2.jpl.nasa.gov/srtm for description). Above 60° North Latitude, standard NGA DTED (Digital Terrain Elevation Data) 3 arc-second (~93m) Level 1 data are used. Where DTED data are not available, coarser 30 arc-second (~930m) Level 0 data (resized to 3 arc-seconds) from the NGDC (National Geophysical Data Center) "GLOBE" (Global Land One-km Base Elevation) database (www.ngdc.noaa.gov/seg/topo/globe.shtml) are used as filler. Users should note that DTED data (above 60° North) often contains numerous terrain artifacts (see Figure 5-3). Below 60° South Latitude, the Radarsat Antarctica Mapping Project (RAMP) 1km DEM Version 2 dataset (www.nsidc.org/data/nsidc-0082.html) from the NSIDC (National Snow and Ice Data Center) is used. This data was also converted to 3 arc-second scale for compatibility with the SRTM and DTED datasets. The conversion of DEM data into TDPS Trafficability data is described in Section 3.3.5, and into CBS Trafficability classes as shown in Figure 3-14.

SRTM was a joint NASA/DOD Shuttle Mission which used interferometric Synthetic Aperature Radar (SAR) to produce Earth surface elevations (*not* bald Earth elevations). The FEB2000 SRTM Shuttle Mission produced very precise global elevation values (+/- 60° latitude), but in the shadow of mountainous terrain, and in relatively flat ocean/sea/lake and sandy land areas, the radar "return beam" often bounces away from the Shuttle radar, resulting in "voids," or bogus data areas.

The TDPS "Pre-Staged" SRTM/DEM data has had the "void" areas filled (Figure 5-4) and oceans "flattened." The data is "preliminary" in that the TDPS-provided DEM data is not the "official" NGA SRTM-based DEM product. The TDPS-provided DEM data should be replaced by the official NGA/SRTM DEM product when it becomes available.

As noted, the SRTM DEM data provided with Version 1.1 of the TDPS underwent a number of special pre-processing steps. The original source data was the Level 2 (1 arc-second) data available from the JPL SRTM Mission archives. After completion of the Level 2 processing (described below), it was resized (using a nearest-neighbor algorithm) to the Level 1 (3 arc-second) format used by the TDPS.

A 1x3 low pass box filter was first applied to the Level 2 data to expand the void areas by one pixel in the East/West direction on both sides of the void, This was done to remove a few transitional (void/non-void) pixels that appeared in some geographic locations (particularly Scotland and some Scandinavian areas).

A calculation was performed to determine if the given SRTM 1x1 degree cell contained more than 2380 ocean pixels. If so, it was processed as an "ocean" DEM as opposed to a "land" DEM. The "2380" threshold was determined subjectively based upon a decision as to when enough ocean data was present in the cell to warrant special processing to "flatten" the usually "noisey" ocean areas. The calculation was derived from a land/water mask created from the 1:250,000 scale NGA World Vector Shoreline (WVS) product that had been rasterized and converted to 1 arc-second scale. Void areas were filled with DTED Level 1 data, or GLOBE data if no DTED data existed for the given area.

"Land" DEM void "filling" was performed by first applying a connected components algorithm to locate all connected holes and their boundary (edge) pixels, as well as the corresponding elevation values in the DTED or GLOBE (secondary) data. The elevation values of the two sets of boundary pixels were compared, and the secondary data were "boosted" to match the SRTM boundary pixels. If a non-linear boost was determined, a bilinear interpolation approach was used to adjust the secondary elevations to seamlessly mesh with the SRTM data. Thus, the filler data and all its internal structural detail were transferred to the SRTM, although this does not improve the inherent lower resolution detail of the secondary filler data.

"Ocean" DEMs had their land areas filled in the same manner as that described for the Land DEMs, but used the ocean information (zero elevation) values in the secondary data as a mask. Under the ocean mask, all SRTM ocean elevation values below a specific threshold were set to zero. A threshold value of "20" was used for the TDPS-produced Ocean DEMs. While this threshold approach effectively flattened the ocean areas, it also had the effect of creating 20m cliffs where the more accurate SRTM data and the secondary data occasionally disagreed as to the location of the shoreline.

Lakes were not flattened (as per the ocean DEMs) because of the seasonal fluctuation of many lakes, and the lack of a high resolution lake/land mask. Where lakes contained voids, the corresponding lake elevations from the secondary DTED or GLOBE data were used as filler. This means that lake areas will show some false elevation values. If a lake were large enough that an entire 1x1 degree DEM cell was completely contained within it, a DEM was generated for that area using a lake elevation value selected from an adjacent lake cell. Fifteen such cells were created for the Caspian Sea and two elsewhere. Thus, an elevation cell exists for every1x1 degree region of the world for which at least one non-zero elevation value occurs. Correspondingly, no 1x1 degree DEM cells exist for regions that are 100% ocean.

Negative SRTM elevation values are reset to zero by default. However, in those areas of the globe that have legitimate negative (below sea level) elevations, a threshold value was assigned to cap the lowest possible elevation. This cap was determined individually for each of the 1x1 cells found to contain true negative elevations. The cap was determined by reviewing NGA topographic maps as well as the National Geographic Atlas of the World (Seventh Edition, 1999).

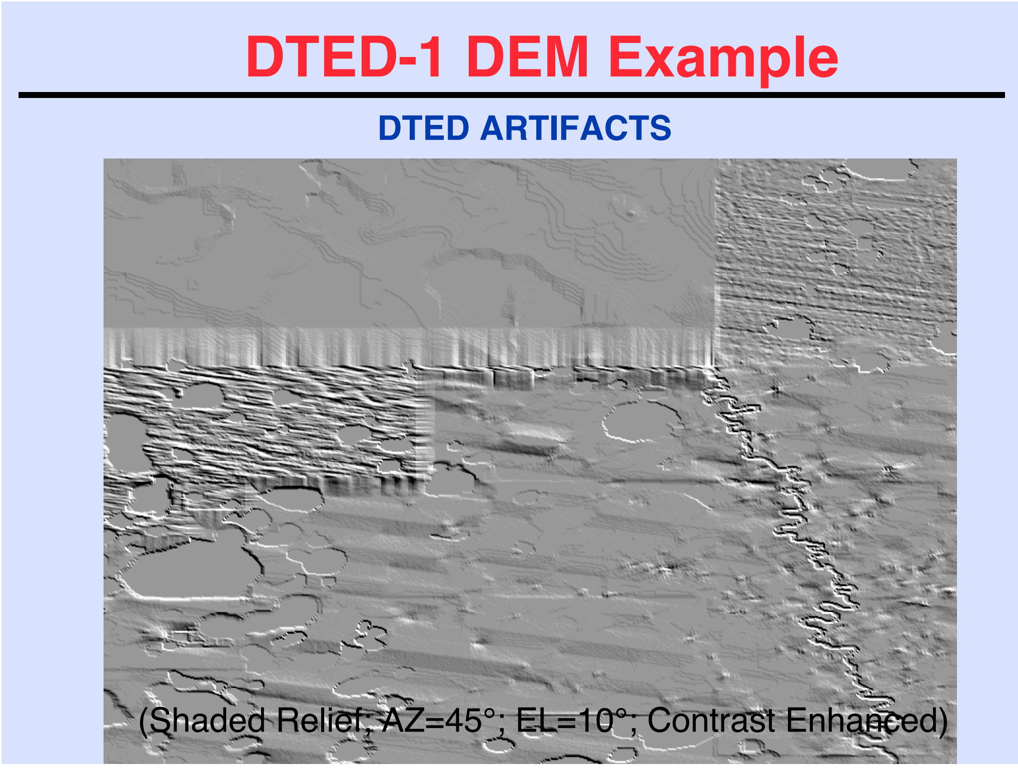


Figure 5-3. DTED Artifacts.

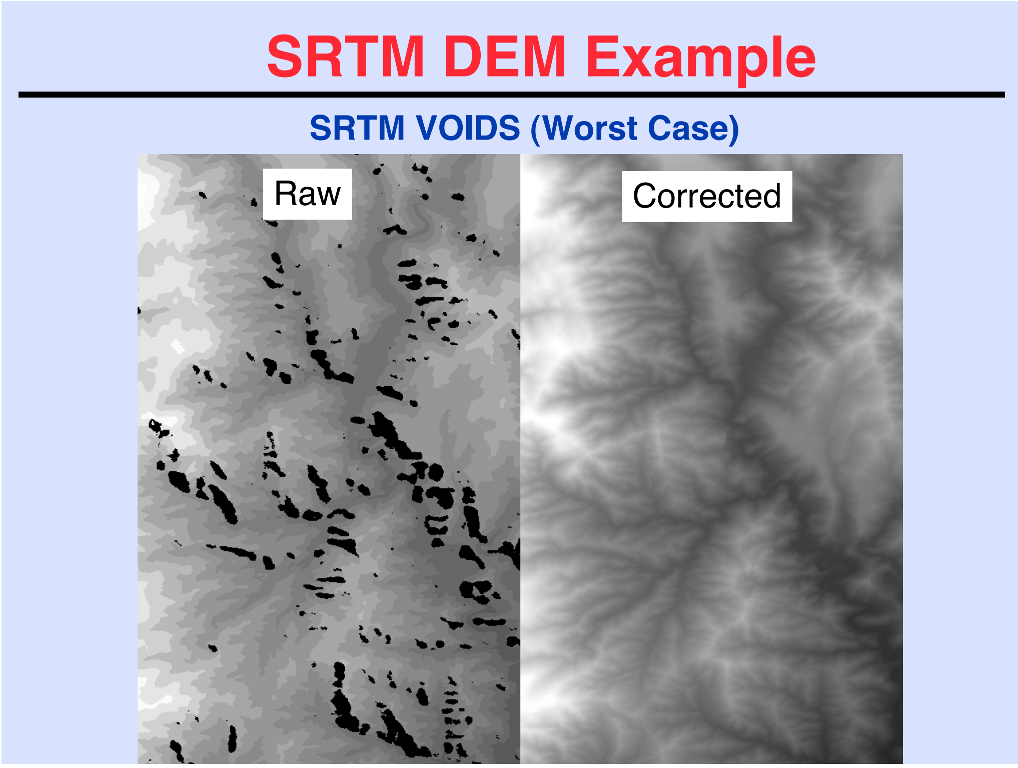


Figure 5-4. Filling SRTM Voids.

Of the final 14,353 SRTM 1x1 degree cells (between 60° North and South of the Equator), 164 contained negative elevations, with the lowest point (-402m meters) occurring in the Dead Sea. The highest elevation was found on Mt. Everest (8,724m). About 25 cells required some form of special handling (usually to reduce the number of voids). The least successfully 'void-filled' SRTM DEMs occurred in the Sahara Desert, where coarse GLOBE data filled several large sand sea void areas. One Sahara cell, n24e12, was replaced entirely by DTED data. A few Florida cells around n30 also contained a large proportion of DTED data. There were 4,870 DTED/GLOBE cells (60° North and above) and 6,498 Antarctica cells (61° South and below). When including the 17 Lake cells discussed earlier, a grand total of 25,738 1x1 global DEM cells are provided with TDPS version 1.1.

The Pre-Staged Level 1 DEM data provided with the TDPS are in VICAR format, which is binary, 16-bit (halfword), 1201 lines by 1201 samples, plus two 'lines' of label information located at the beginning of the file. The label contains georeference information that can be converted into GeoTIFF file format. Relative to the standard DTED format, the VICAR DEM files are rotated 90° clockwise and origin flipped.

5.4 ADRG/CADRG DATA

NGA ADRG (Arc Digitized Raster Graphics;) and its compressed version (CADRG), are scan-digitized paper maps. They are used to provide a map background in the Vector Terrain Editor. The pre-staged ADRG products provided with the TDPS are a composite of up to five map scales. At the top level, the JOG (Joint Operational Graphics) 1:250,000 scale is provided. Where a JOG file was not available, the TPC (Tactical Pilot Chart) at 1:500,000 scale is provided. Where neither a JOG or TPC are available, the next coarser level map scale is provided in the following order: ONC (Operational Navigation Chart) at 1:1,000,000 scale, JNC (Jet Navigation Chart) at 1:2,000,000 scale, and finally, the GNC (Global Navigation Chart) at 1:5,000,000 scale. The result is complete global map coverage with the best available map resolution on top. However, as the ADRG products are literally scans of paper maps (some showing paper creases!), the well known variations in map style, quality, information content, and preparation date, are similarly represented in the ADRG maps. Significant changes can occur between maps of the same scale as well as the expected changes between maps of different scales. The result is a "patchwork quilt" effect as shown in Figure 5-5. Figure 5-6 shows the variation in map style, content, and scale, but also shows the excellent registration between adjacent maps (due to the "Arc" projection).

The ADRG maps (no longer in production) were processed into georeferenced files using JPL's "BigMap" software. The current production CADRG data (version 1; circa 1995) were processed into georeferenced files using NGA's "MUSE/Raster Importer" software. All scales of georeferenced maps were converted to 2048 pixels per degree, and the various map scales composited (with JOGs on top) into 10x10 degree files, with separate red, green, and blue component files. As there are 648 10x10 degree global cells, the total number of pre-staged ADRG files is (648x3 for rgb =) 1944 files.

The pre-stage ADRG data provided with the TDPS are in VICAR format, which is binary, 8-bit (Byte), 20480 lines by 20480 samples, plus a two 'line' label located at the beginning of the file. The label contains georeference information that can be converted into a GeoTIFF file format. The TDPS provides a ‘Utility’ tool for updating the map background as new CADRG data becomes available from NGA.

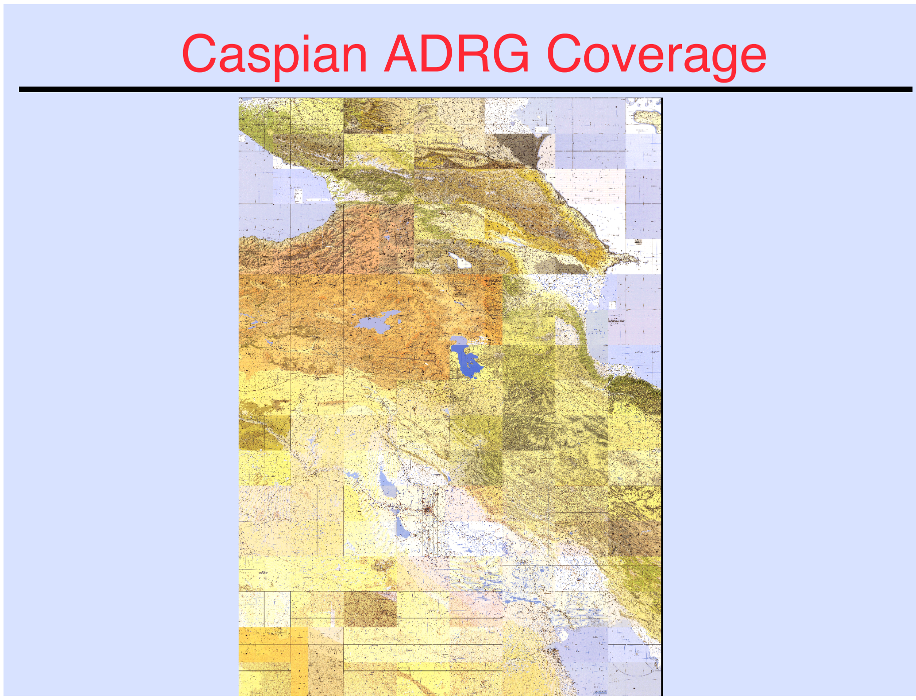


Figure 5-5. The "Patchwork" Quilt effect when combing multiple ADRG maps.

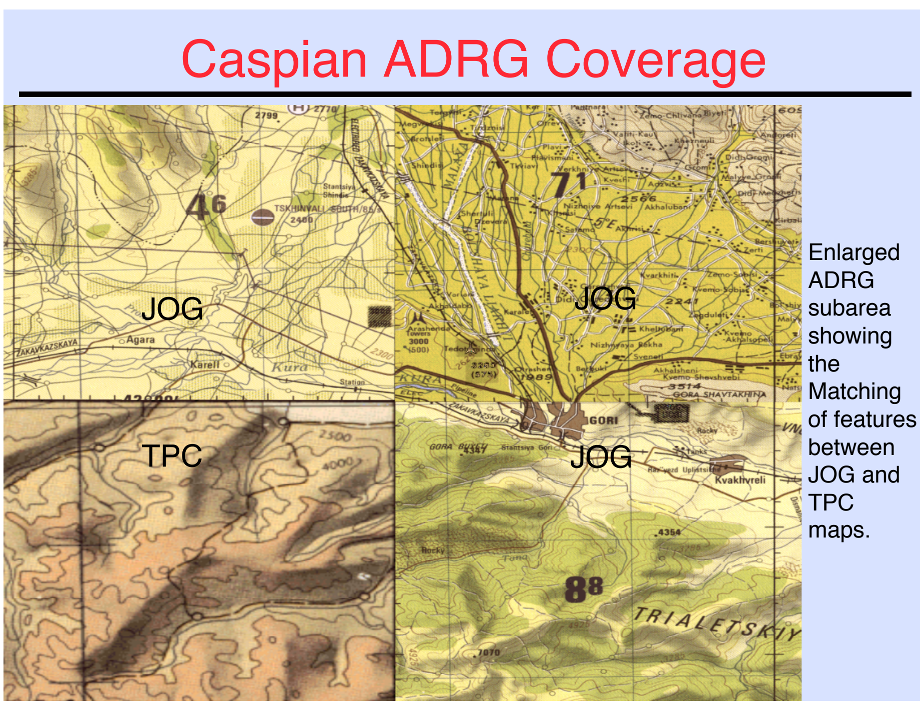


Figure 5-6. The Registration (Matching) of multiple ADRG map styles and scales.

5.5 VMAP DATA ABERRATIONS

As an NGA Government product, Vmap provides the advantages of standardization and comprehensive global coverage. However, Vmap products are produced by the Cartographic Departments of various Countries using maps with varying levels of quality and detail. The result is that map details do not always align at map boundaries, resulting in discontinuities. Figure 5-7 shows a worst-case situation. Use of the TDPS Vector Editor will be necessary to correct these types of data aberrations.

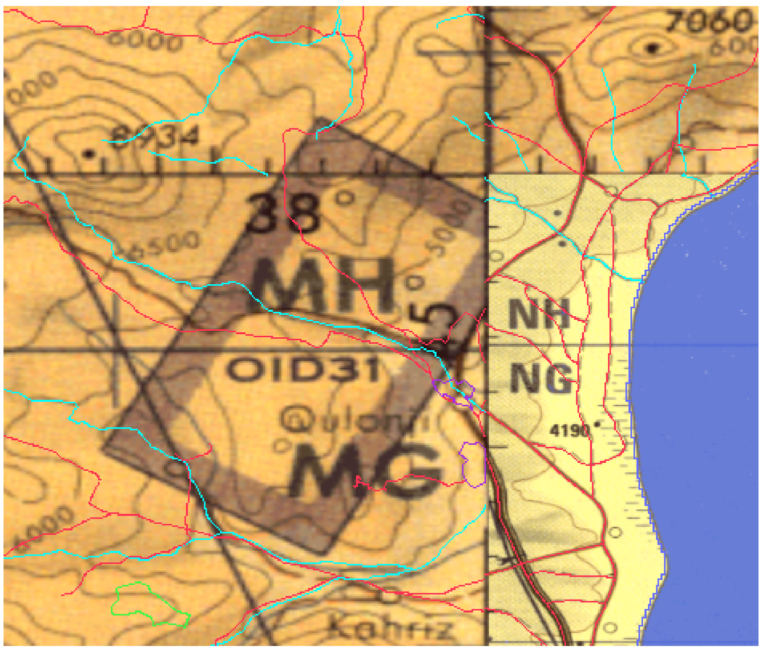


Figure 5-7. Worst-case Vmap Data Aberrations at Map Boundaries.

The user may also notice an apparent inconsistency in the TDPS presentation of vector "donut holes." For example, an island intersecting the edge of a 1x1 degree cell will have a coastline boundary, but an island interior to that same 1x1 degree cell will not have a vector coastline boundary. The CBS GEEP recognizes these types of situations and correctly handles the situation.

SECTION 6
USERS GUIDE - TERRAIN PROCESSING STEPS

6.1 INTRODUCTION

The TDPS Users Guide is provided in two parts (Section 6 and 7), where the first part describes the process of creating a CBS Terrain Database from Pre-Staged NGA data, and the second part describes the Vector Terrain Editor. The bulk of the data processing occurs in this Section, but is largely hidden behind the User Interface. Refer to Section 3.3 for a detailed discussion of the TDPS processing steps outlined herein, and Figures 3-1 and 3-2 for a visual depiction of the overall process.

Before beginning the preparation of a CBS Terrain Database, be sure to review the limitations described in Section 4.9, especially the maximum database size of about 120 square degrees (for example, 10x12 degrees). Also, if the TDPS becomes unresponsive (i.e., appears to freeze), check to see if a warning message or dialog box has popped up (hidden) behind a window.

6.2 THE TDPS GUI INTERFACE

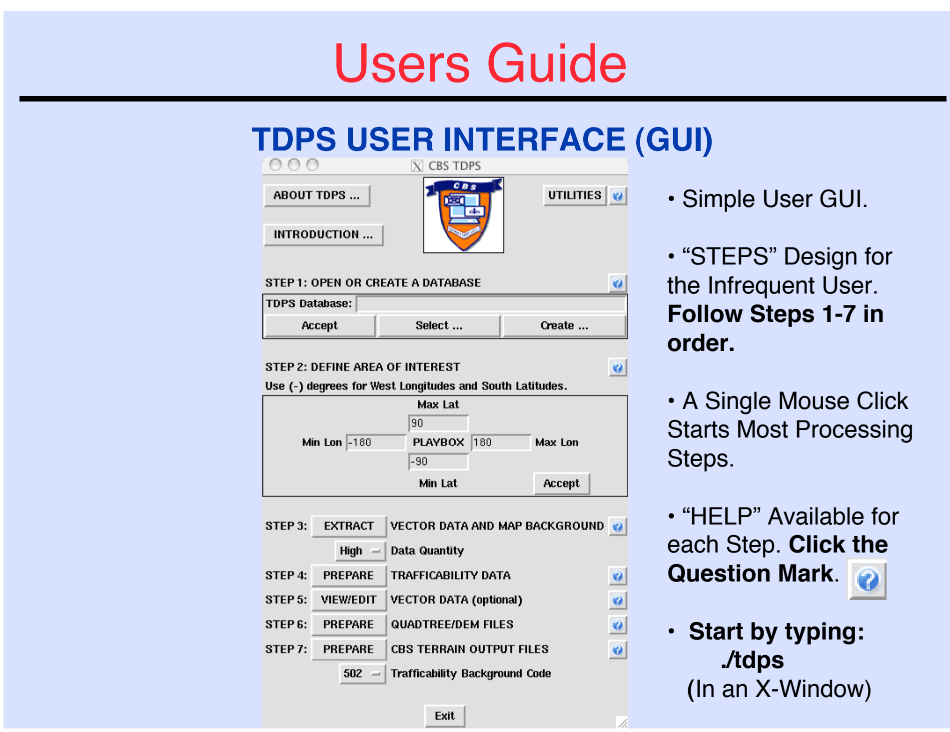


Figure 6-1. The TDPS User Interface

6.3 STEP 1 – CREATE A NEW CBS DATABASE

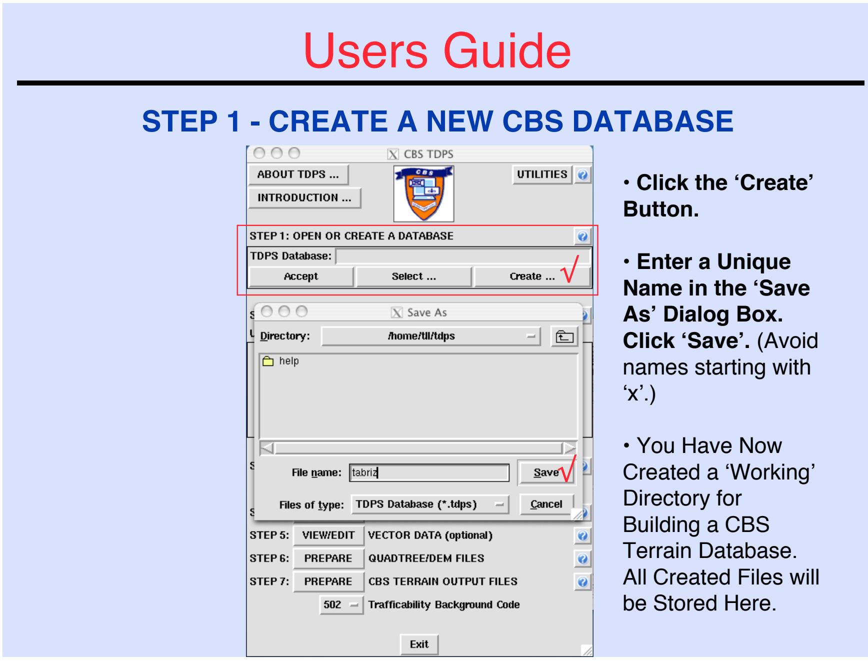


Figure 6-2. Step 1 Defines the Name of a New Blank Database.

6.4 STEP 2 – DEFINE THE PLAYBOX DIMENSIONS

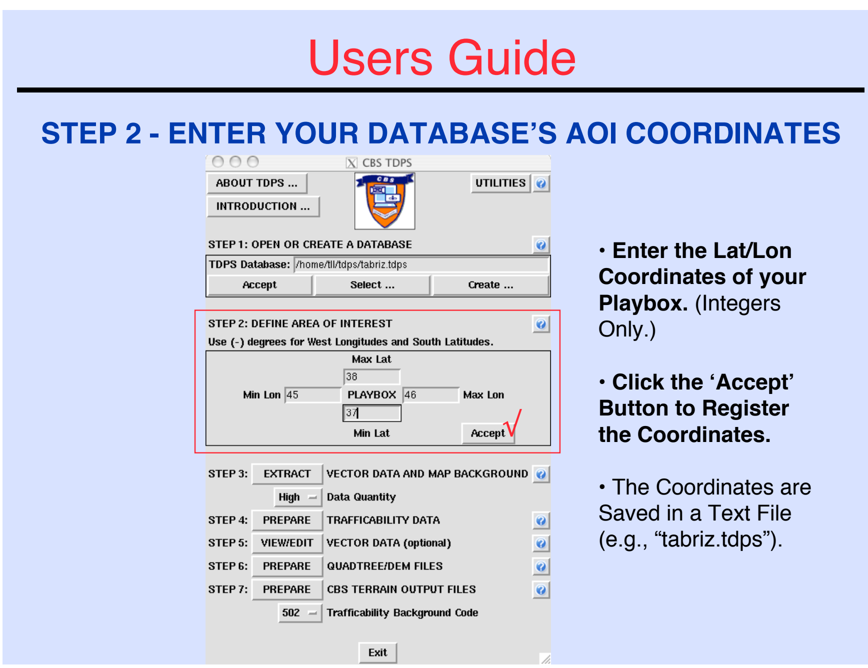


Figure 6-3. Step 2 allows the User to Enter the Latitude and Longitude bounding coordinates of the Playbox. Only Integer Coordinates are Permited.

6.5 STEP 3 – EXTRACT VMAP AND ADRG DATA

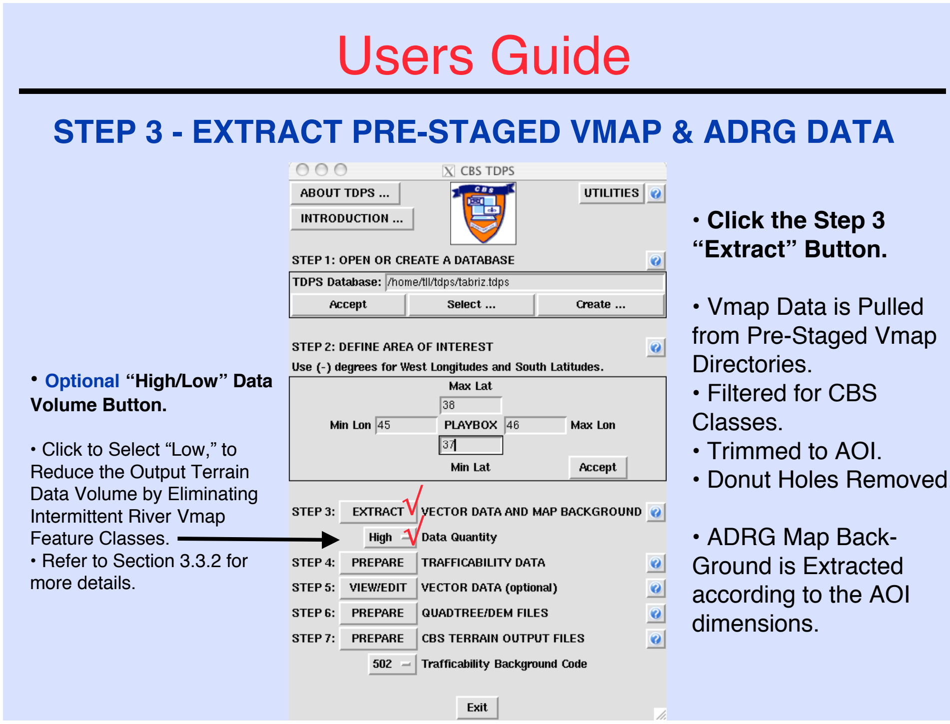


Figure 6-4. Prepare the Vmap and ADRG Data in One Mouse Click.

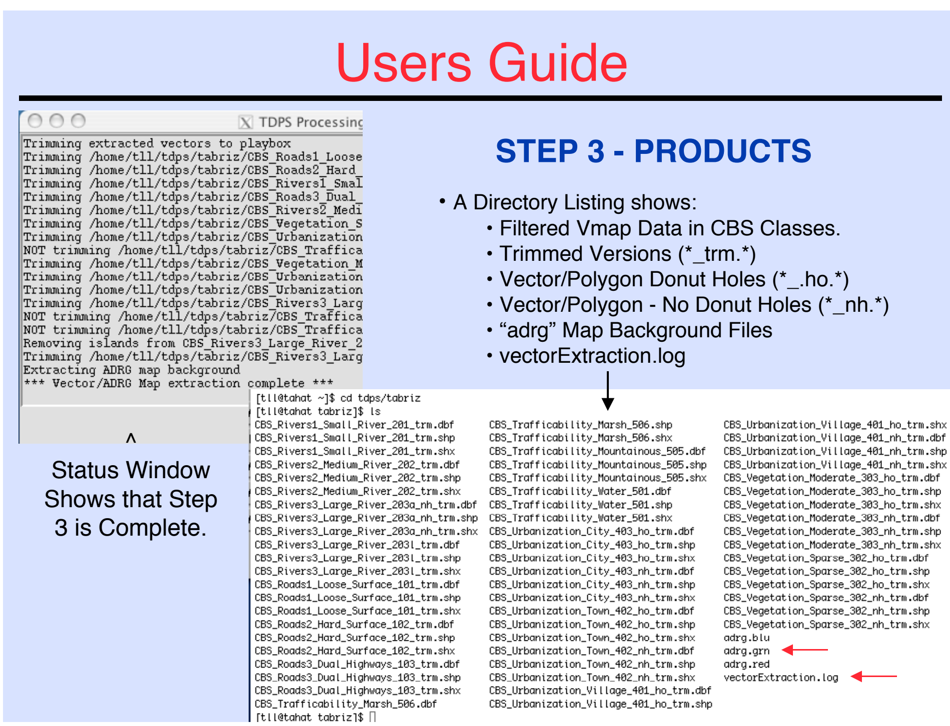


Figure 6-5. Step 3 Progress Window and Output Products.

6.6 STEP 4 – GENERATE TRAFFICABILITY FILES

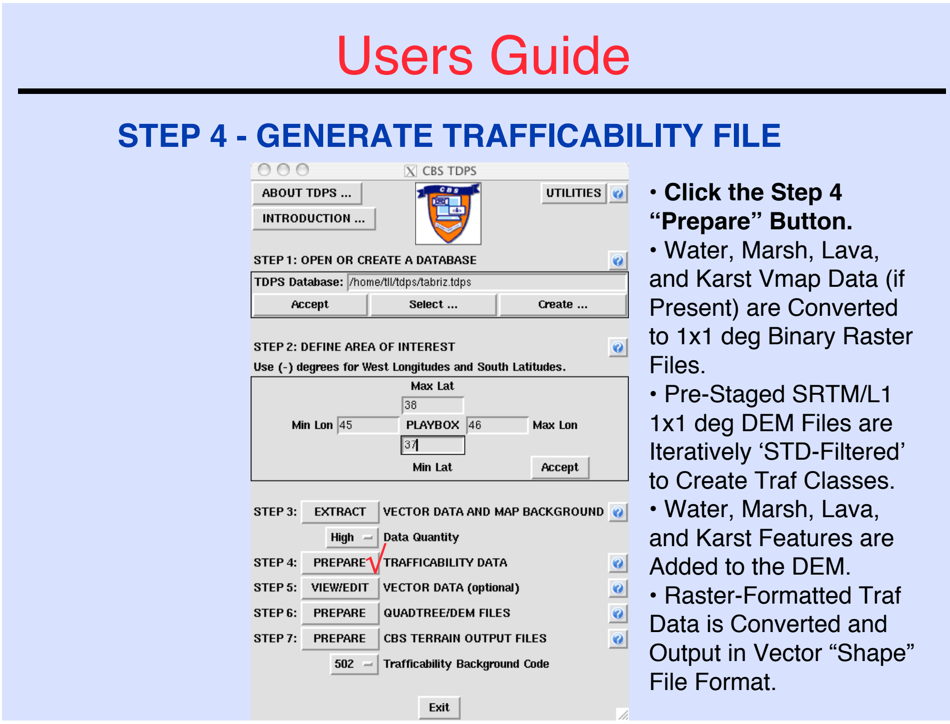


Figure 6-6. Prepare Trafficability Data in One Mouse Click.

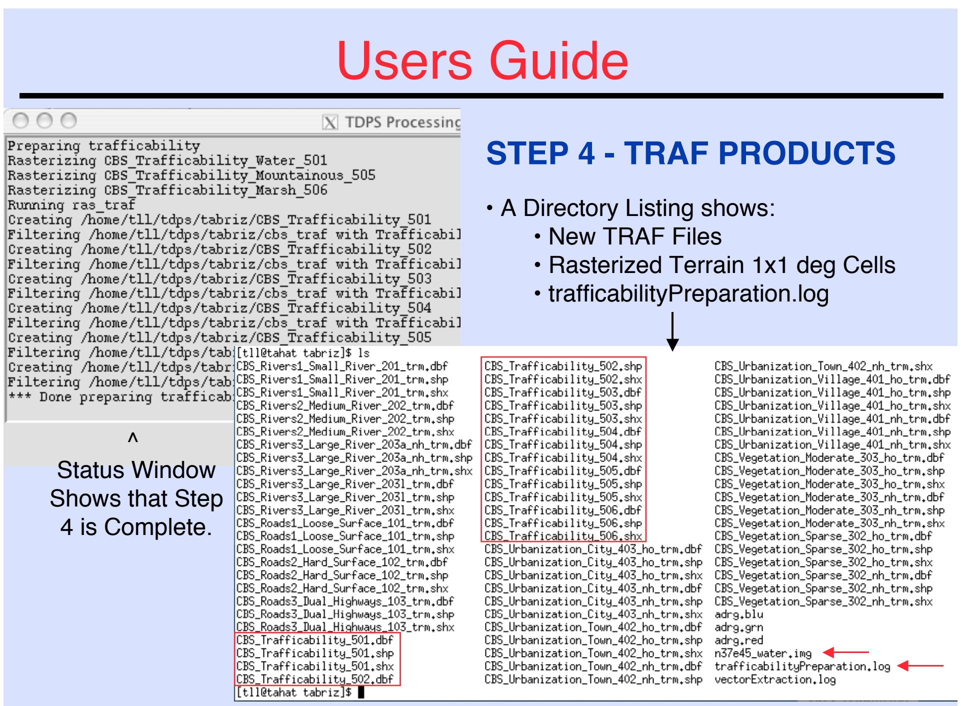


Figure 6-7. Step 4 Progress Window and Output Products.

6.7 STEP 5 – DISPLAY AND EDIT VECTOR DATA (OPTIONAL)

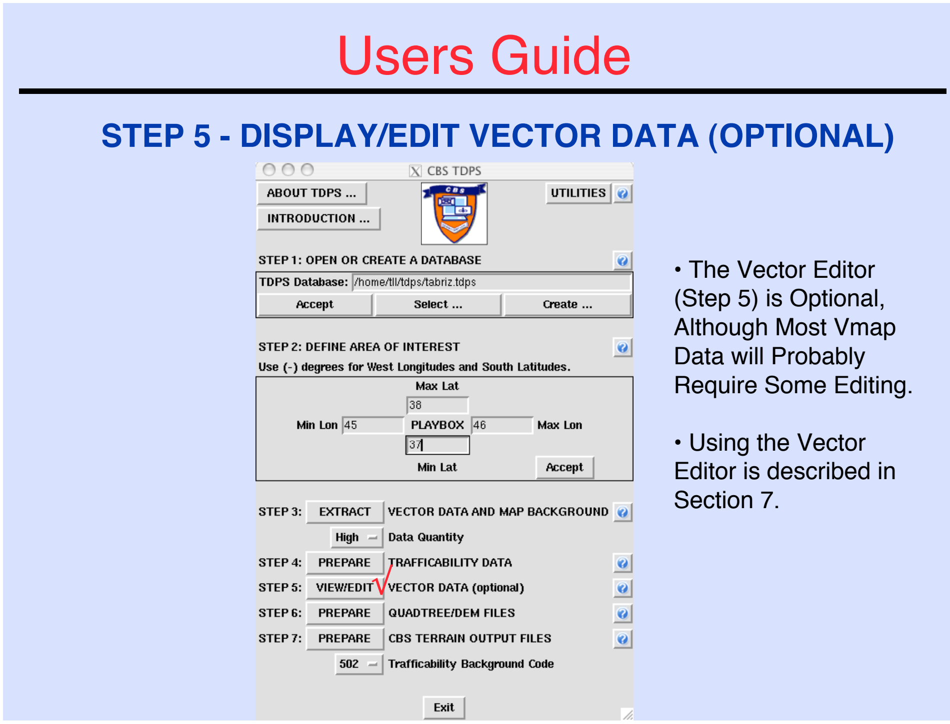


Figure 6-8. Launch the Vector Editor by Clicking the Step 5 Button. Use of the Editor is described in Section 7.

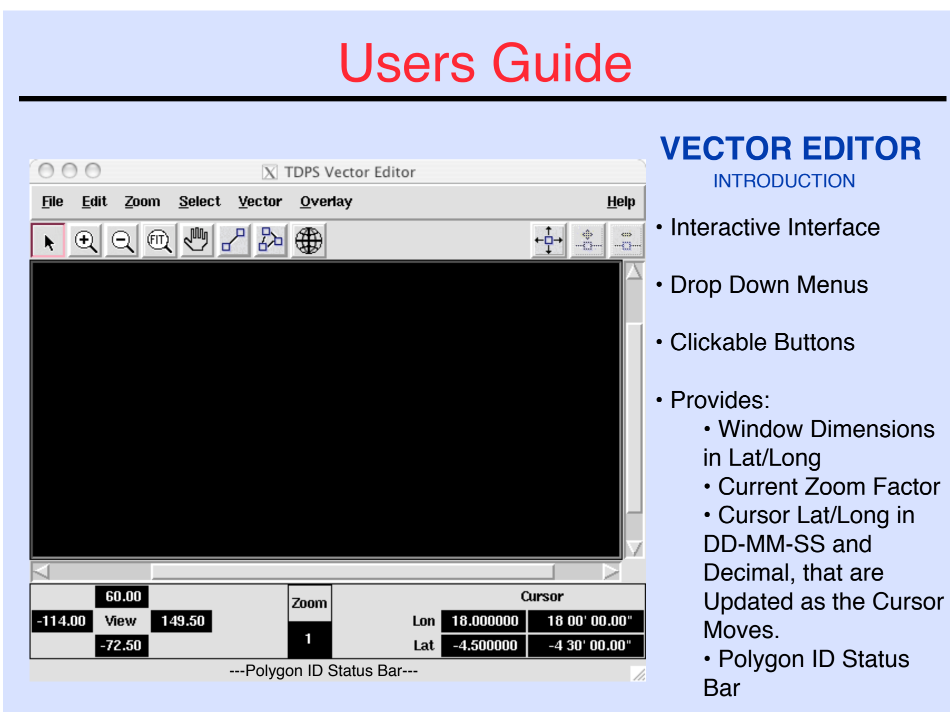


Figure 6-9. The Vector Editor's User Interface.

6.8 STEP 6 – GENERATE THE QUADTREE DEM FILE

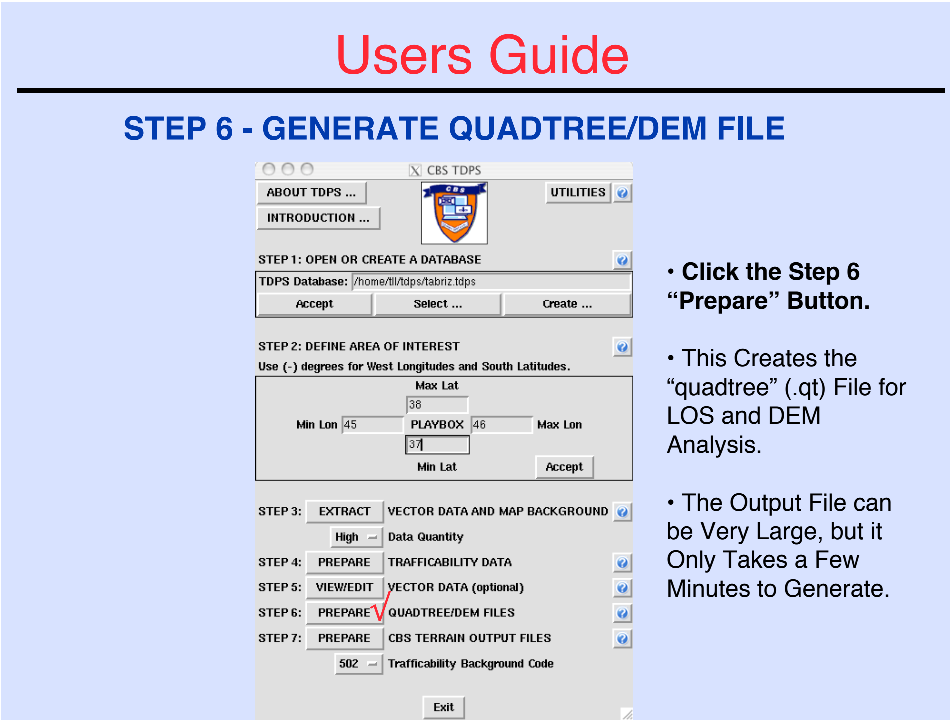


Figure 6-10. Create the Quadtree DEM File in One Mouse Click.

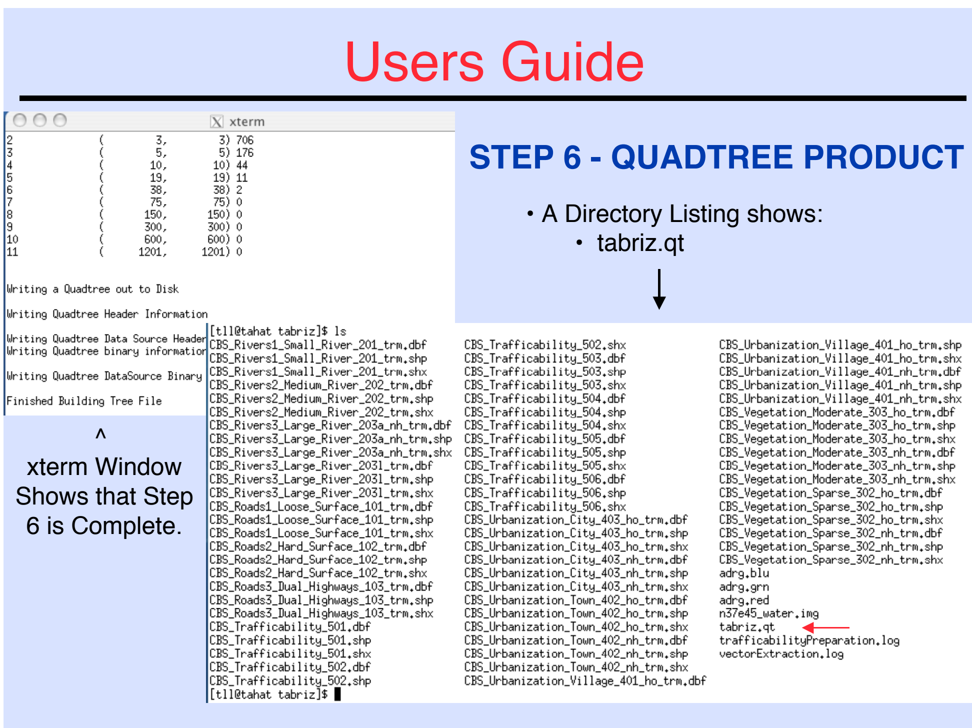


Figure 6-11. Step 6 Progress Window and Output Products.

6.9 STEP 7 – CREATE CBS TERRAIN-FORMAT FILES

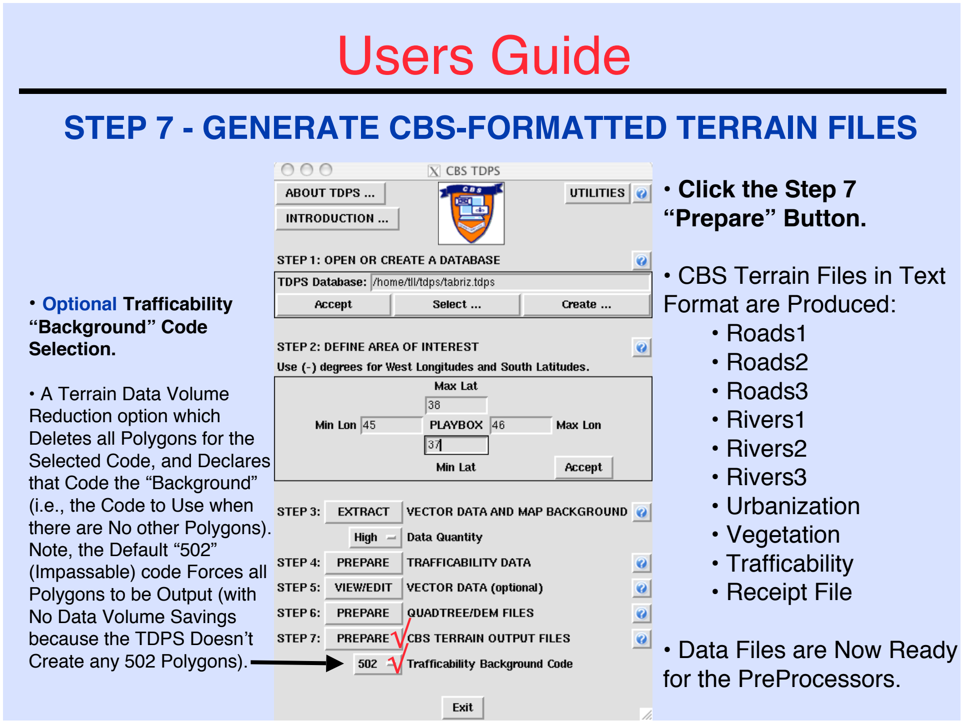


Figure 6-12. Convert Vmap and Trafficability Data to CBS Format.

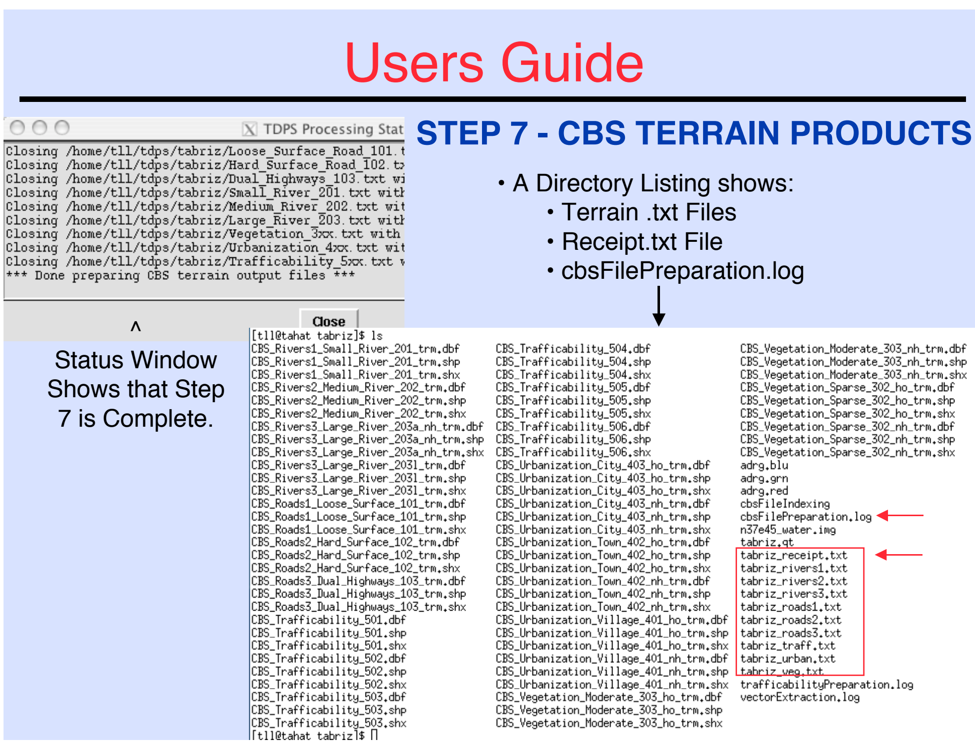


Figure 6-13. Step 7 Progress Window and Output Products.

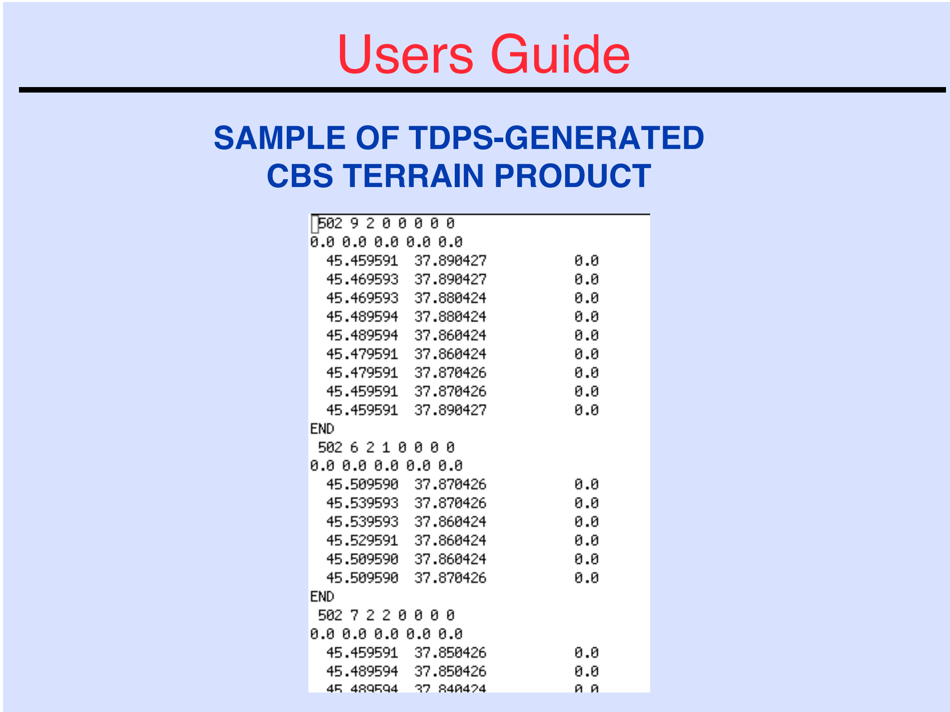


Figure 6-14. Example of an Output Terrain File.

6.10 TDPS RECEIPT FILE

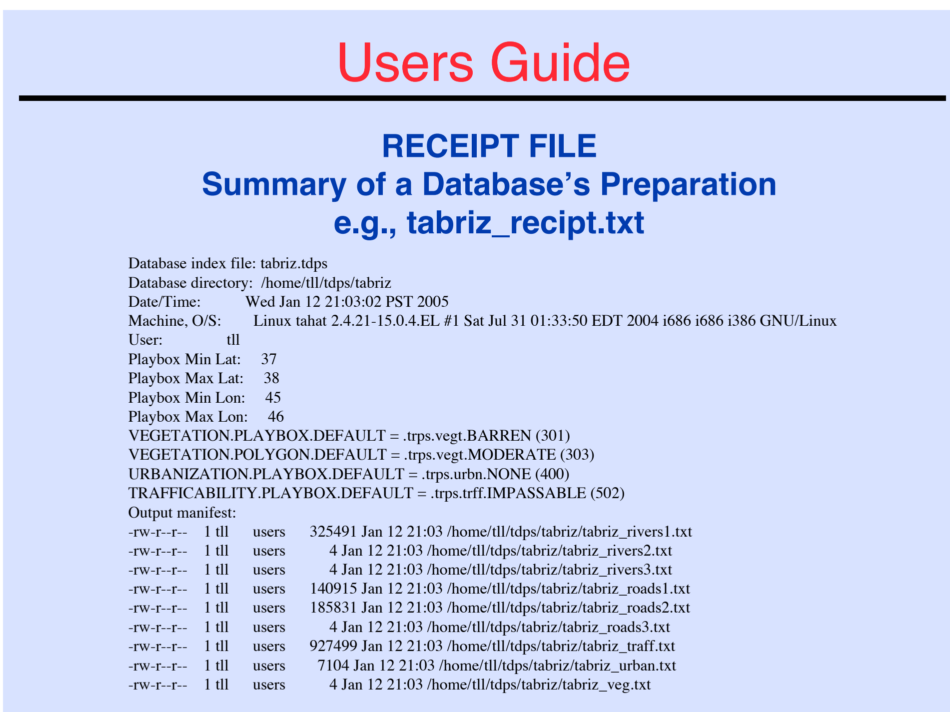


Figure 6-15. The Receipt File Summarizes the Prepared Database.

SECTION 7
USERS GUIDE - TERRAIN VECTOR EDITOR

7.1 INTRODUCTION

The TDPS Terrain Vector Editor is used to display and edit terrain data derived from Vmap lines and polygons. While vector editing is optional, most databases will require some level of editing to correct for data inconsistencies that occur when adjacent data sources are adjoined. However, the editing of Trafficability polygons should be avoided, as their complex computer-generated boundaries are difficult to adjust, and any introduced boundary discrepancies could result in the affected polygons being destroyed by the Pre-Processor.

The processing and editing flow of TDPS vector is one directional---from Vmap vector format to CBS Terrain text format. CBS text files cannot be edited by the TDPS. If a problem is found in a CBS Terrain text file, it must be corrected in the Vmap data using the Vector Editor, then reprocessed into a CBS file using STEP 7 (Section 6.9).

The Vector Editor is also both cpu and data input/output intensive. On "slower" computers, or computers with multiple simultaneous users, the display and refresh speeds may be slow, cursor movement may become "jerky," or the cursor icons may be slow to change. On these slower systems, some relief can be obtained by reducing the size of the Vector Editor window.

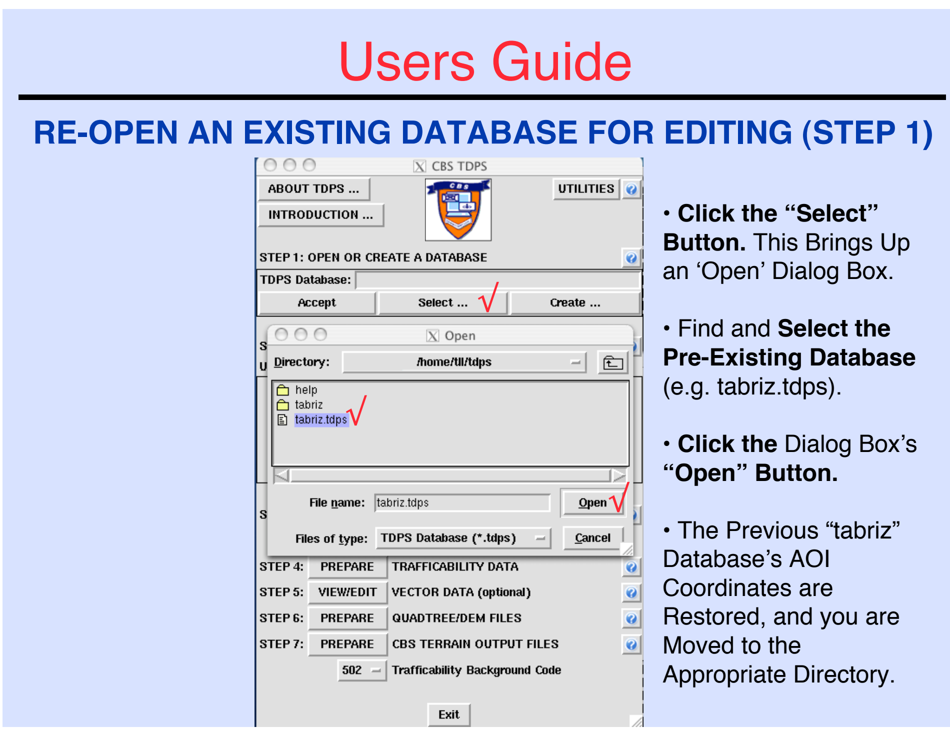


Figure 7-1. Only an Existing Database can be Edite. Complete Steps 1-4 first.

7.2 LAUNCH THE VECTOR EDITOR

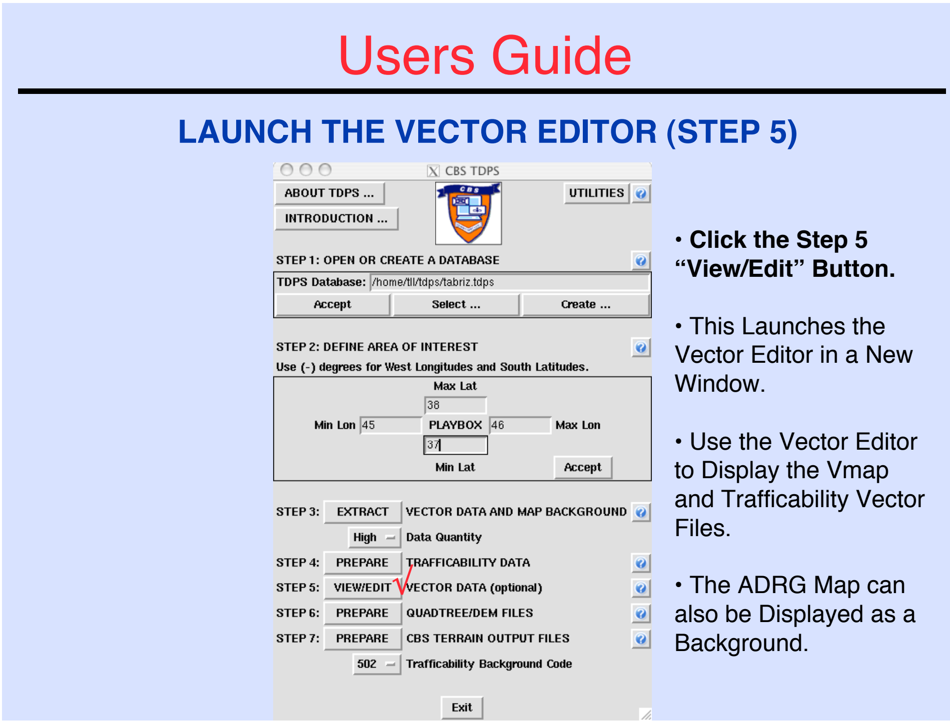


Figure 7-2. Launch the Vector Editor by Clicking the Step 5 “View/Edit” Button.

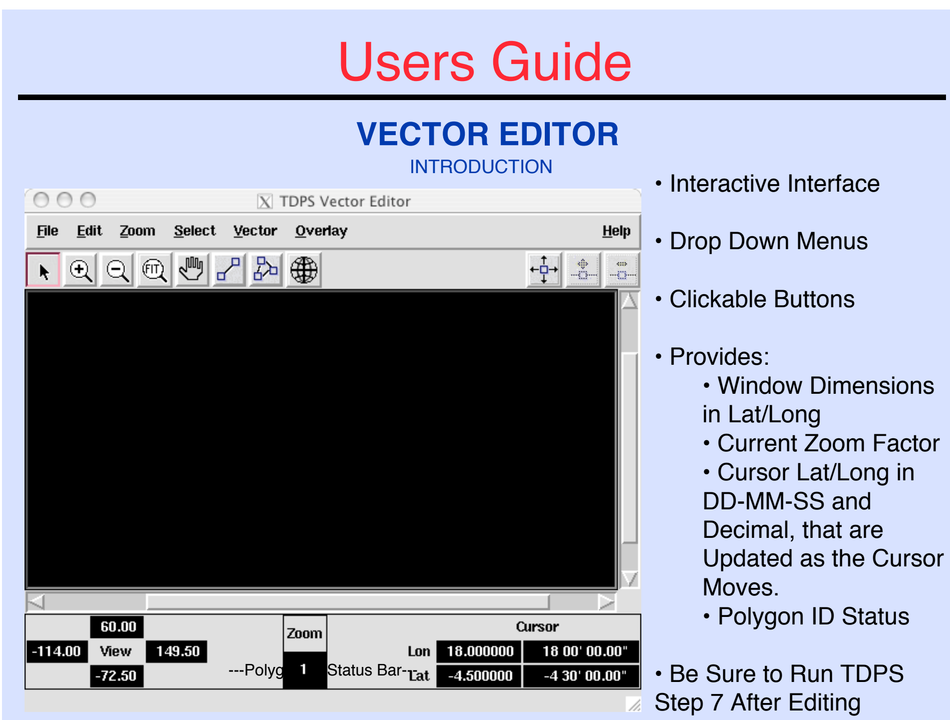


Figure 7-3. The Terrain Vector Editor’s Interface.

7.3 EDITOR MENUS

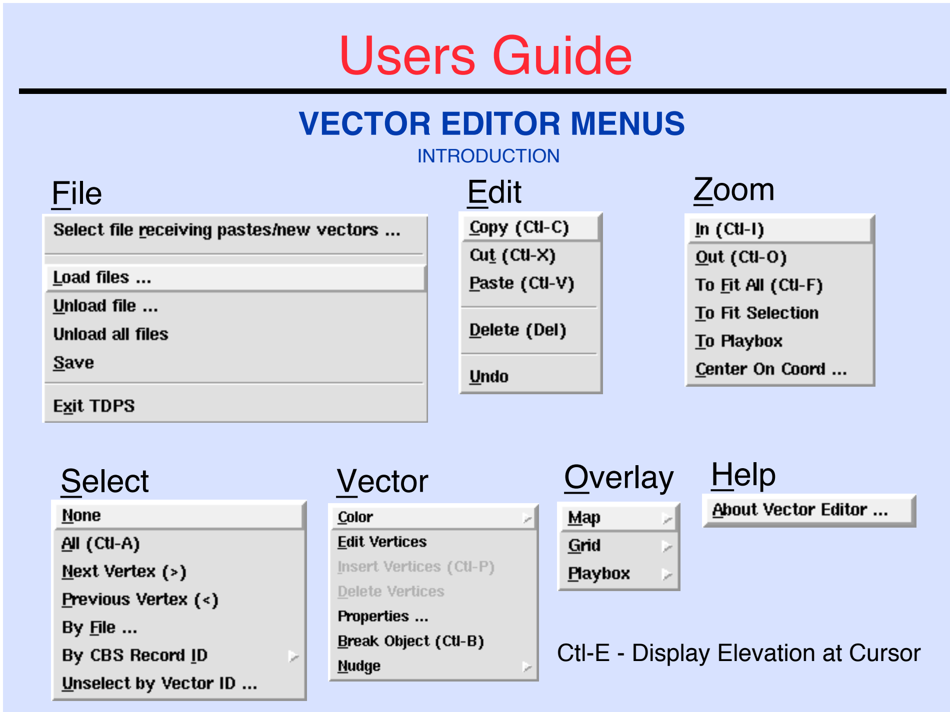


Figure 7-4. Vector Editor Main Menus.

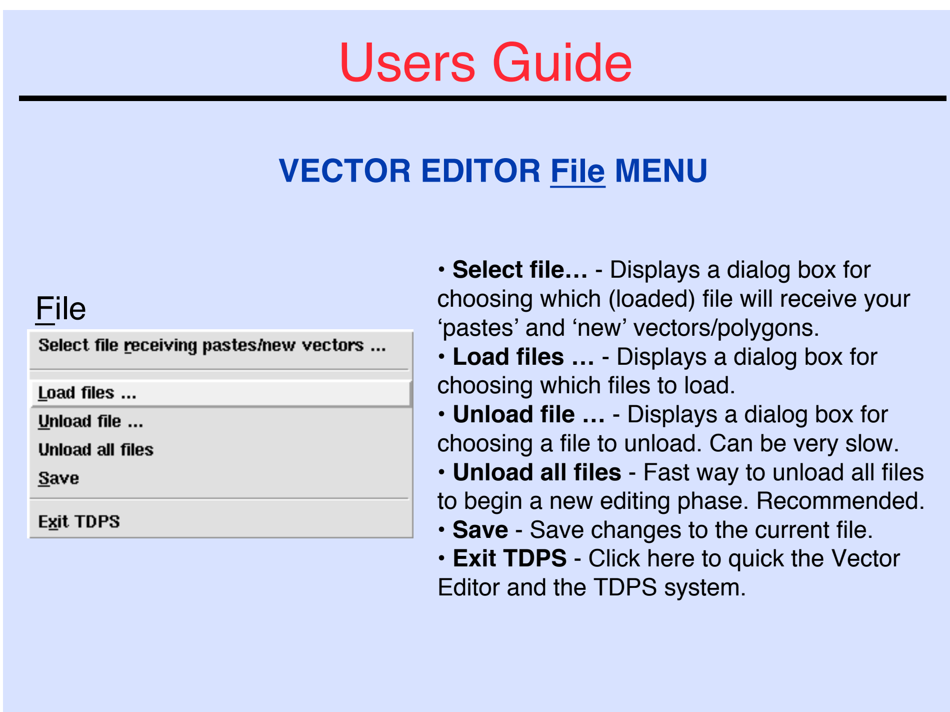


Figure 7-5. File Menu.

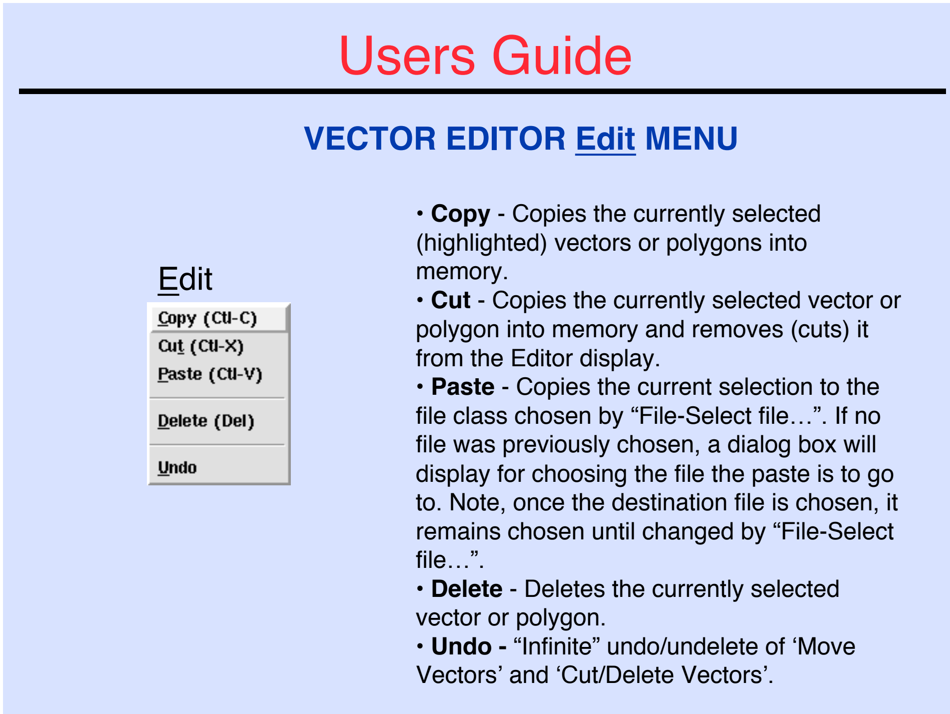


Figure 7-6. Edit Menu.

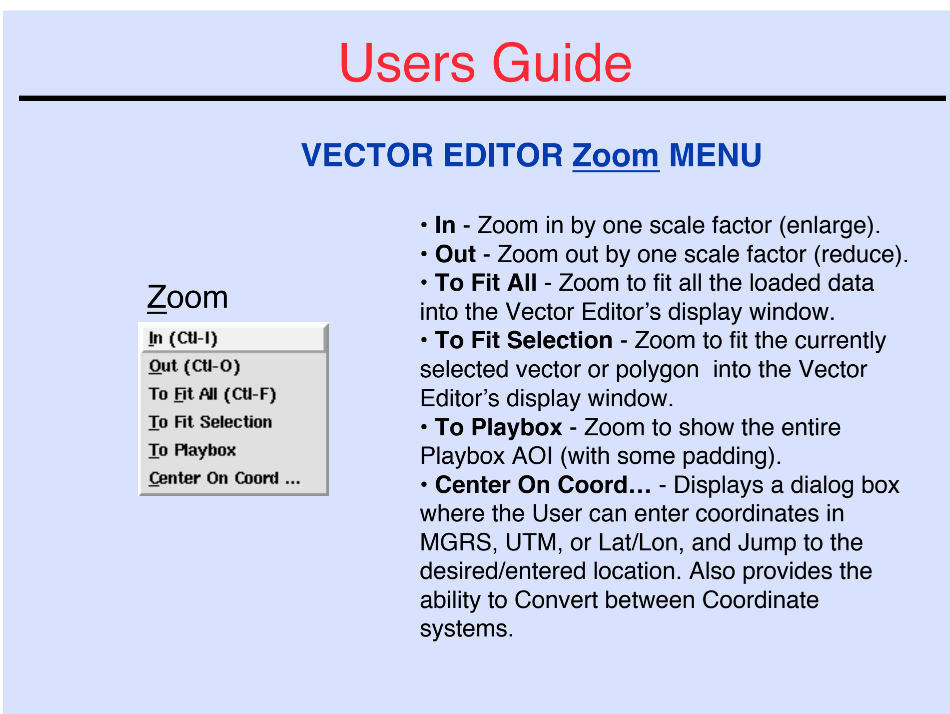


Figure 7-7. Zoom Menu.

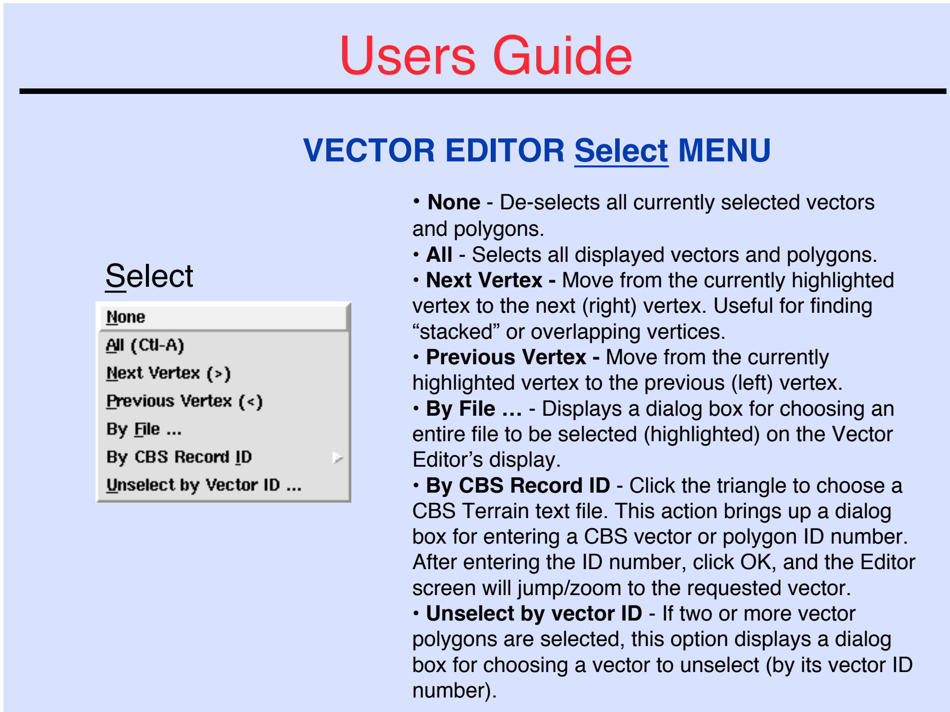


Figure 7-8. Select Menu.

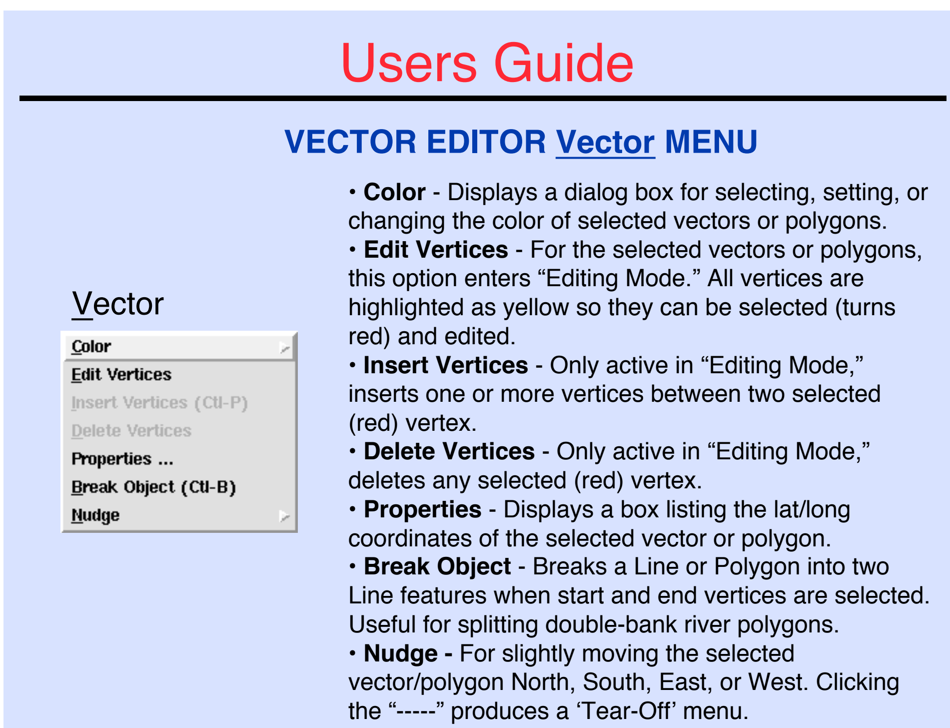


Figure 7-9. Vector Menu.

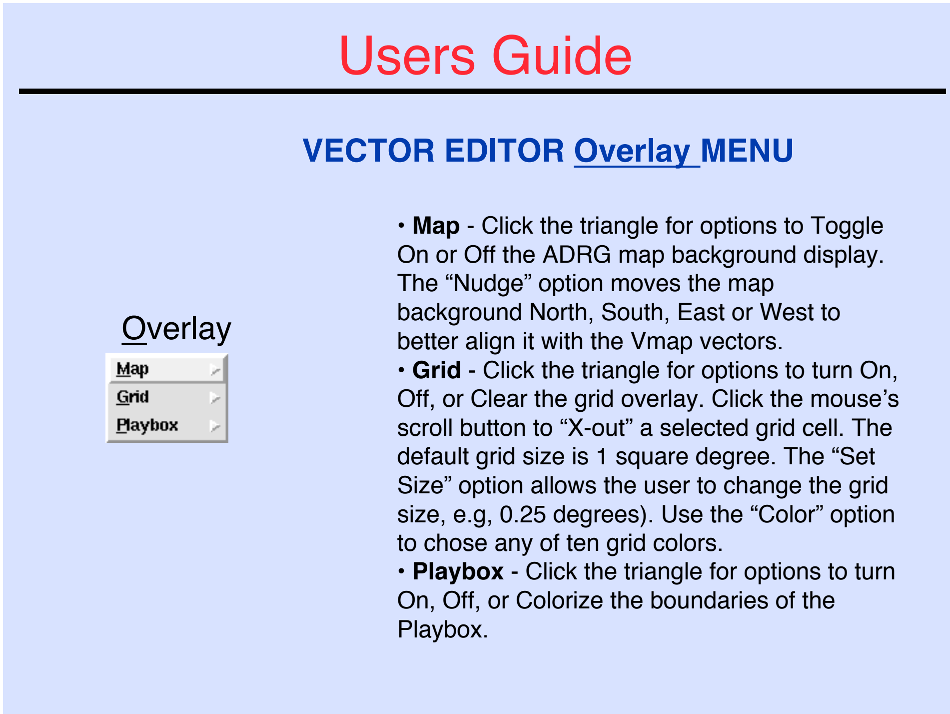


Figure 7-10. Overlay Menu.

7.4 EDITOR BUTTONS

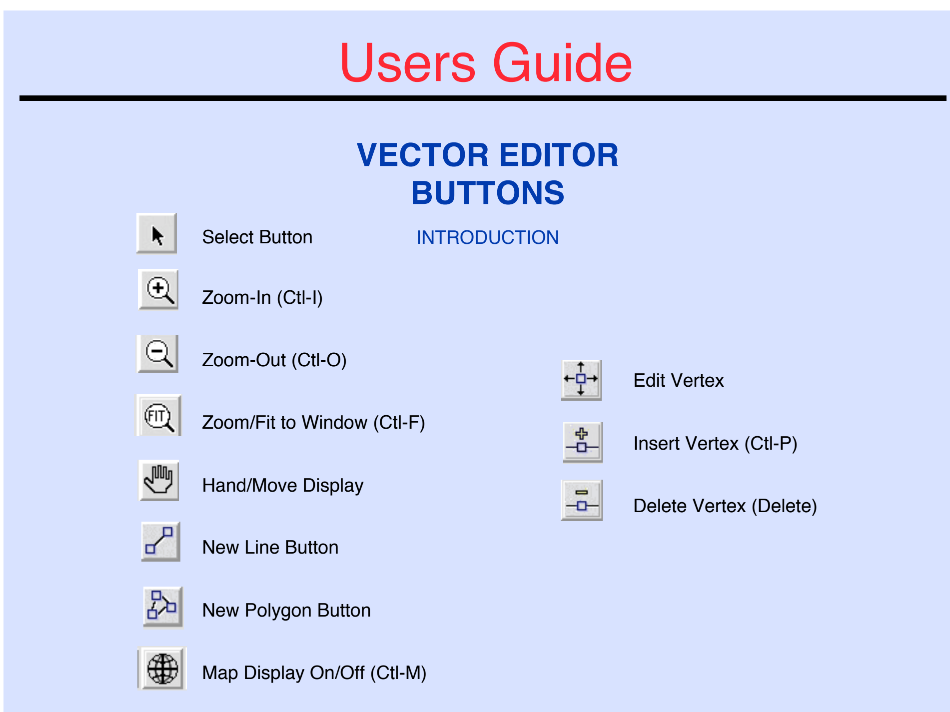


Figure 7-11. Editor Buttons and their Function.

7.5 LOADING FILES

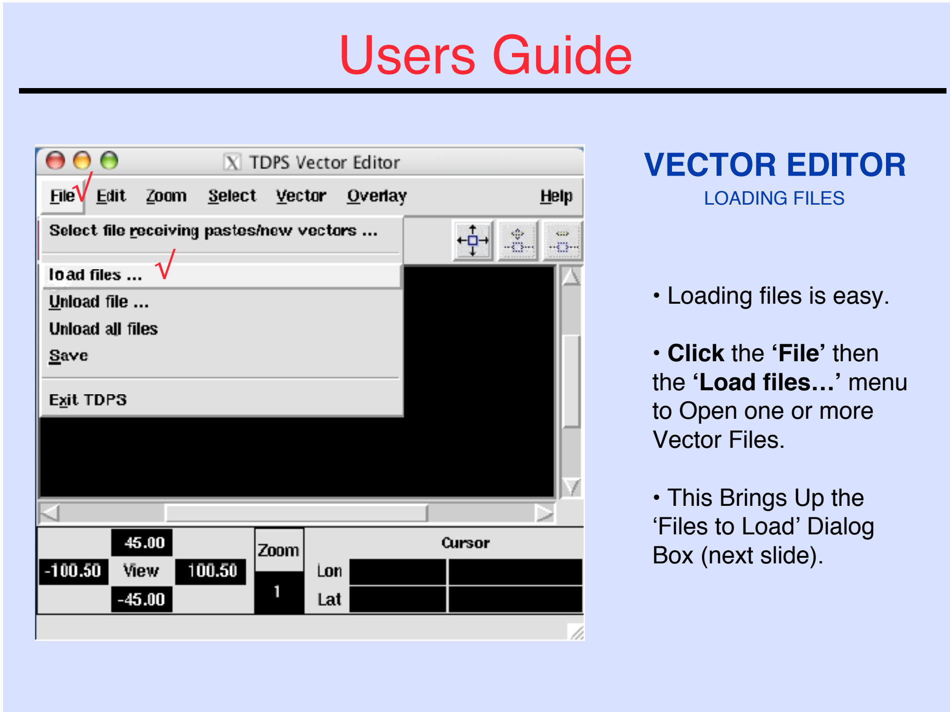


Figure 7-12. How to Open a Vector or Polygon File.

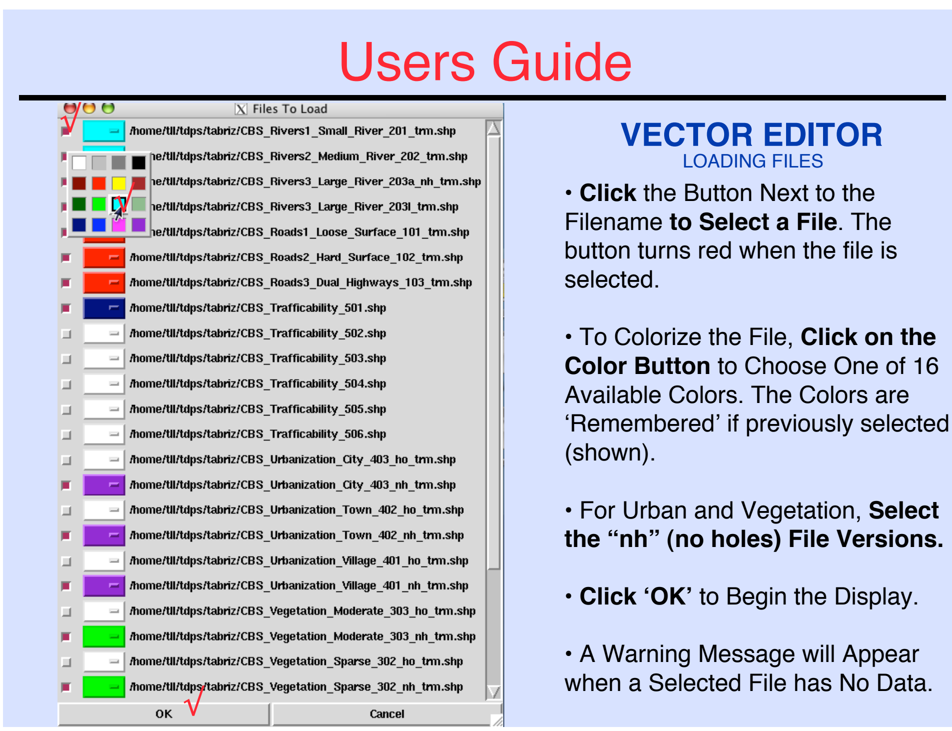


Figure 7-13. Selecting the File and its Display Color. Files are Read and Displayed in Order from Top to Bottom. The Color of the Last File is Displayed on Top.

7.6 FITTING FILES TO THE DISPLAY WINDOW

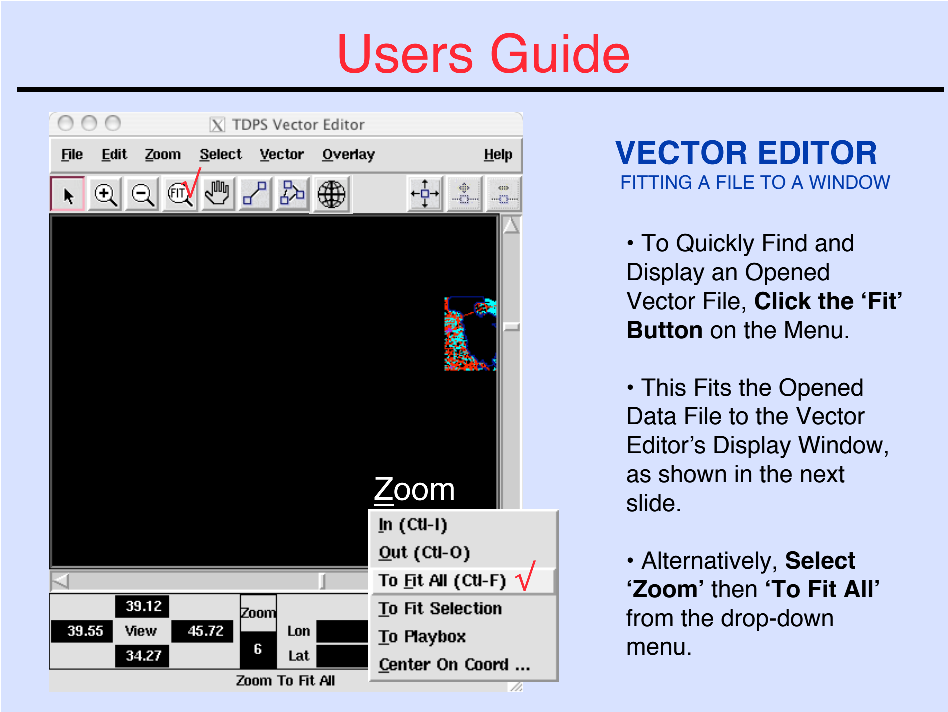


Figure 7-14. Use the "Fit" Button or "To Fit All" Menu to Zoom and Center Files.

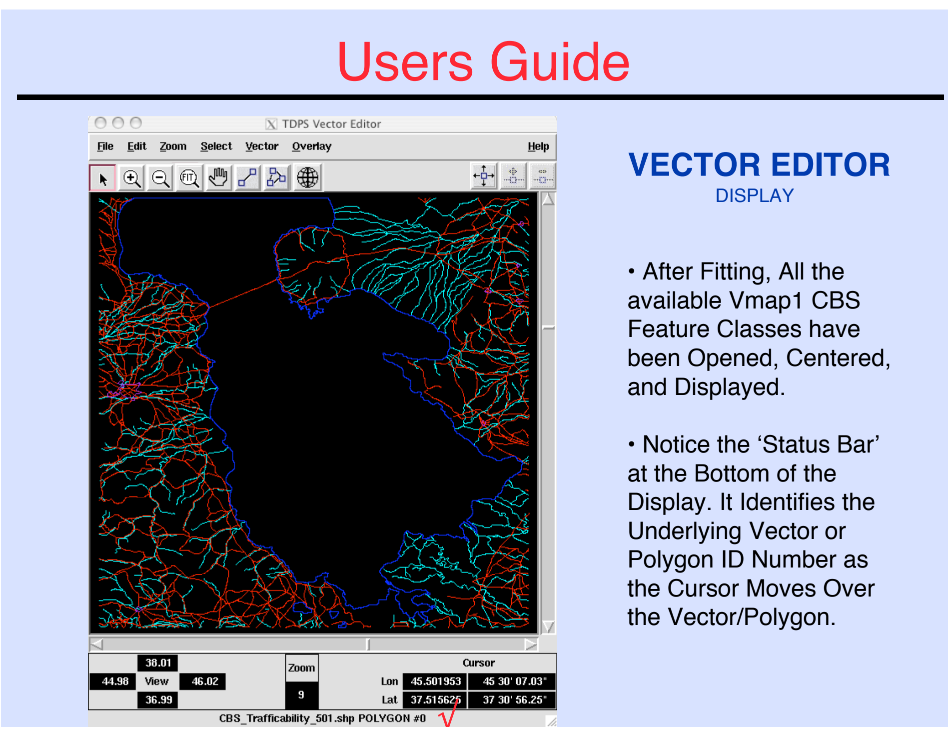


Figure 7-15. The Centered Vector Display.

7.7 UNLOADNG FILES

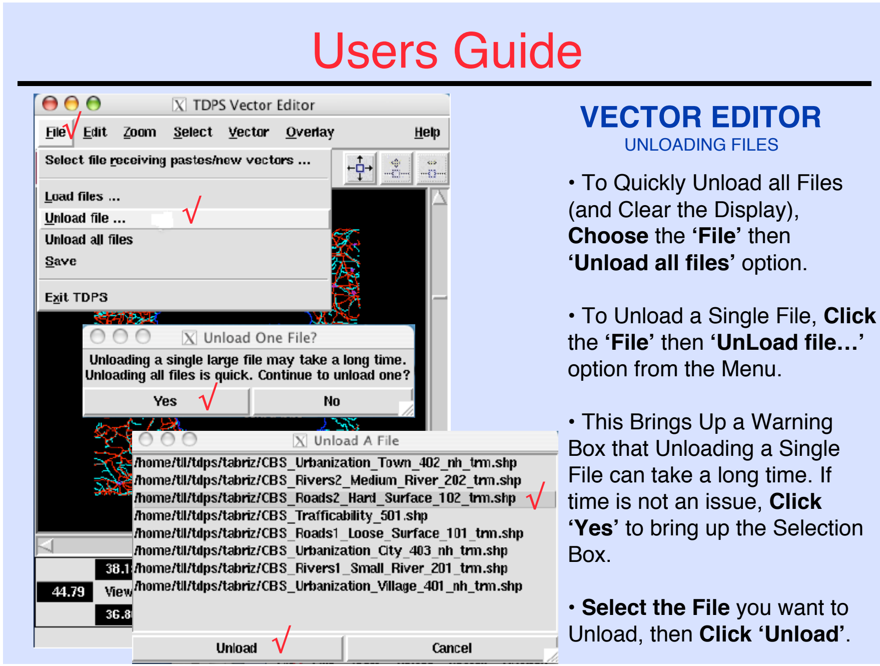


Figure 7-16. To Avoid Confusion, and Speed the Re-Display of Large Data Files, it is Best to Unload All Files, then Reload just the Desired Files.

7.8 TRAFFICABILITY DISPLAY

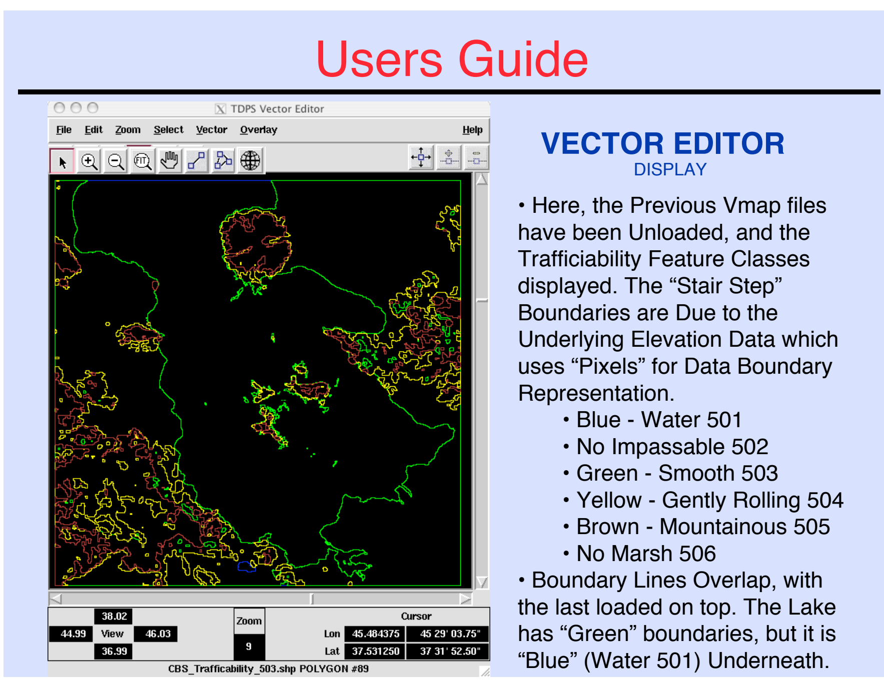


Figure 7-17. Trafficability Files all have "Stair Step" Boundaries (Section 3.3.5).

7.9 TURNING-ON THE ADRG MAP BACKGROUND

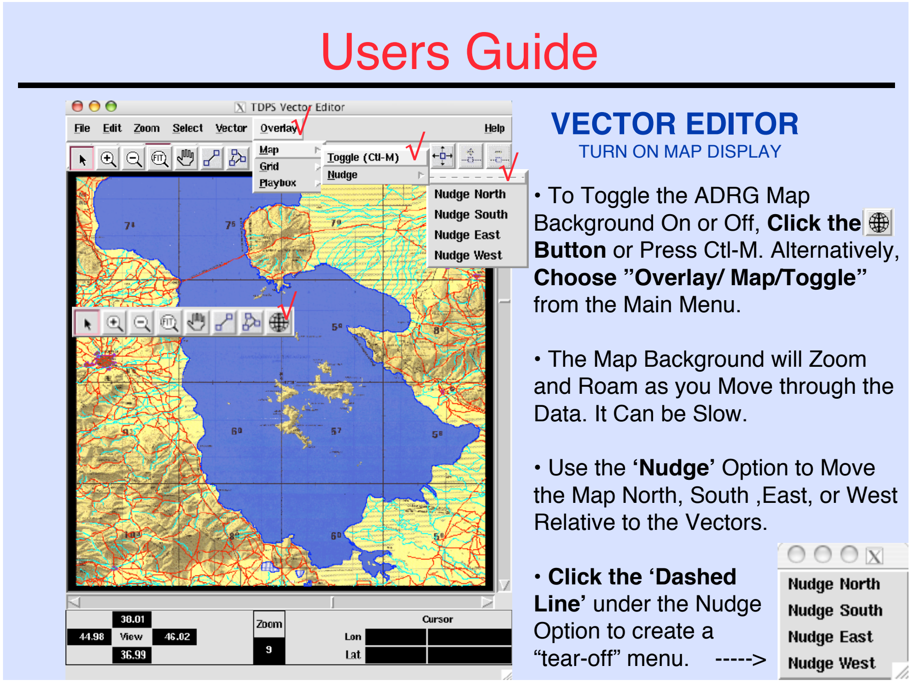


Figure 7-18. Displaying and Adjusting the ADRG Map Background.

7.10 TURNING -ON THE GRID OVERLAY

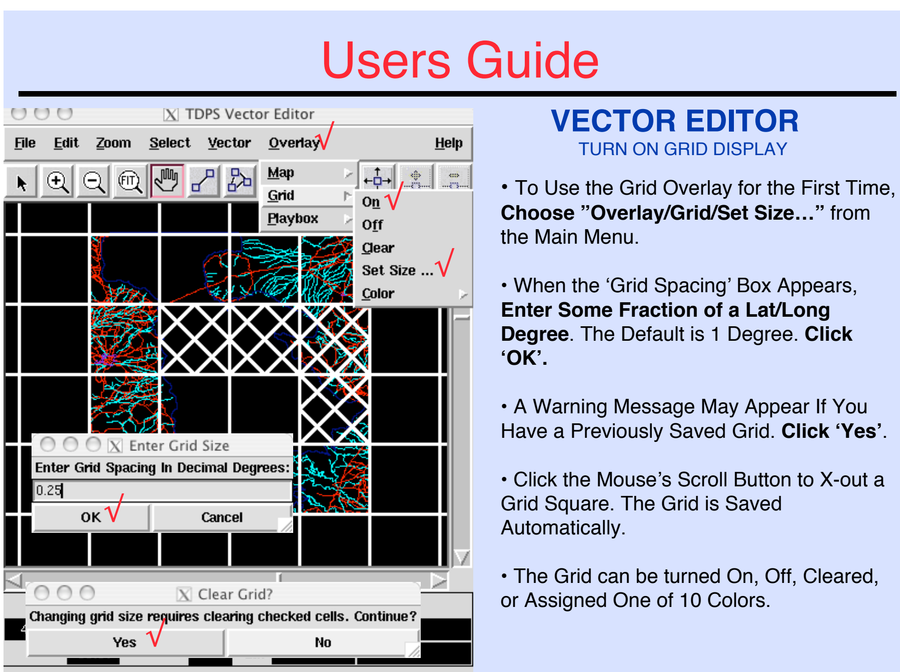


Figure 7-19. The Grid Overlay can be used to 'Mark-Off' Verified Areas.

7.11 LOCATING A CBS TERRAIN VECTOR/POLYGON

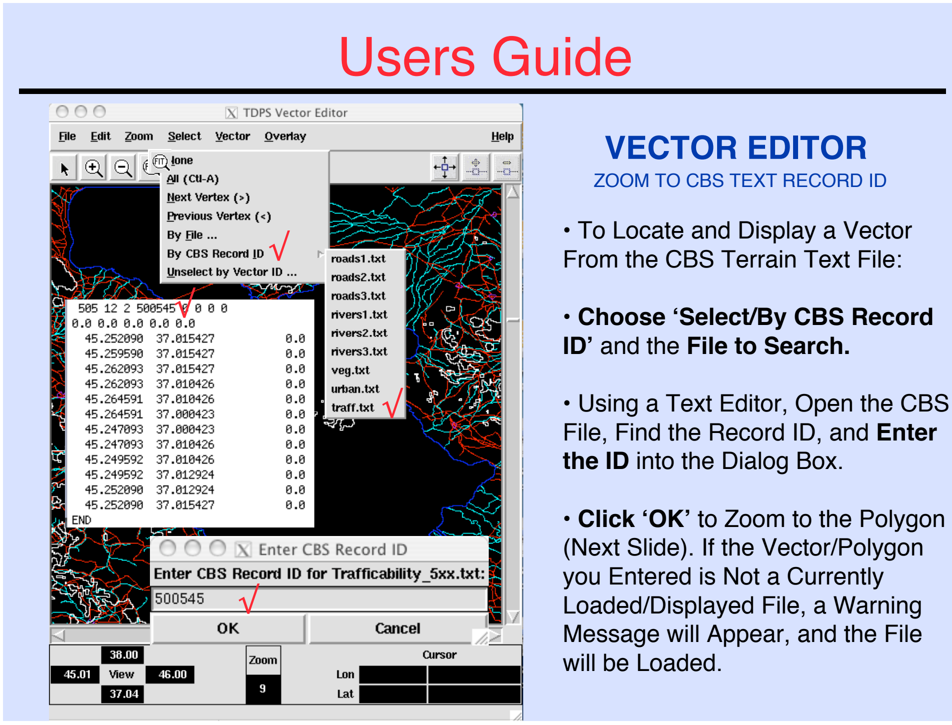


Figure 7-20. Find a CBS Terrain Vector/Polygon in the TDPS.

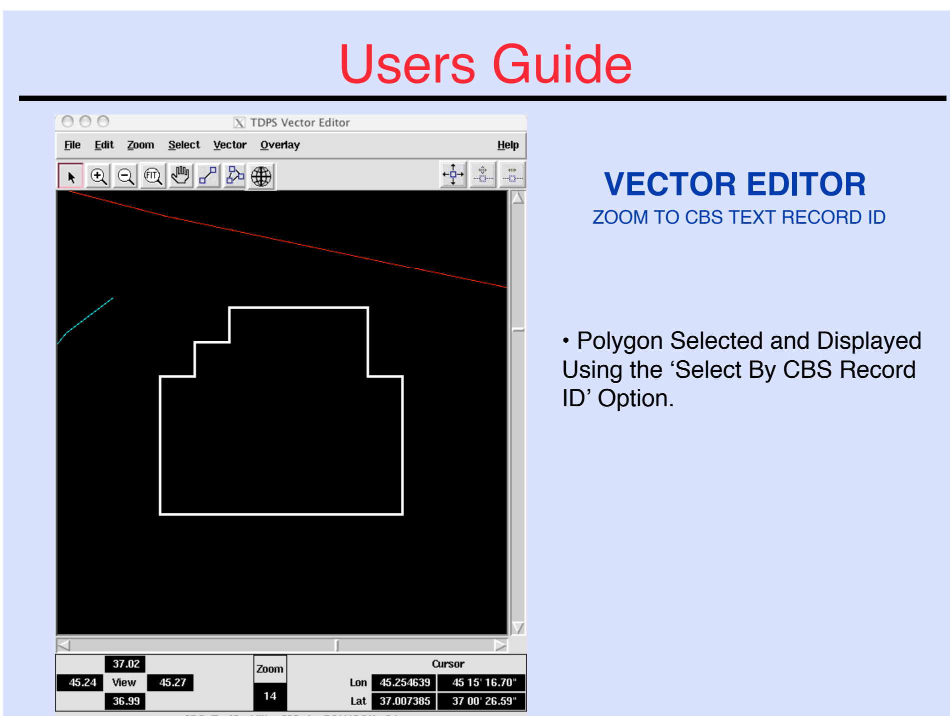


Figure 7-21. Polygon #500545 Found and Displayed (Continued From Figure 7-20).

7.12 JUMPING TO A LOCATION AND COORDINATE CONVERSION

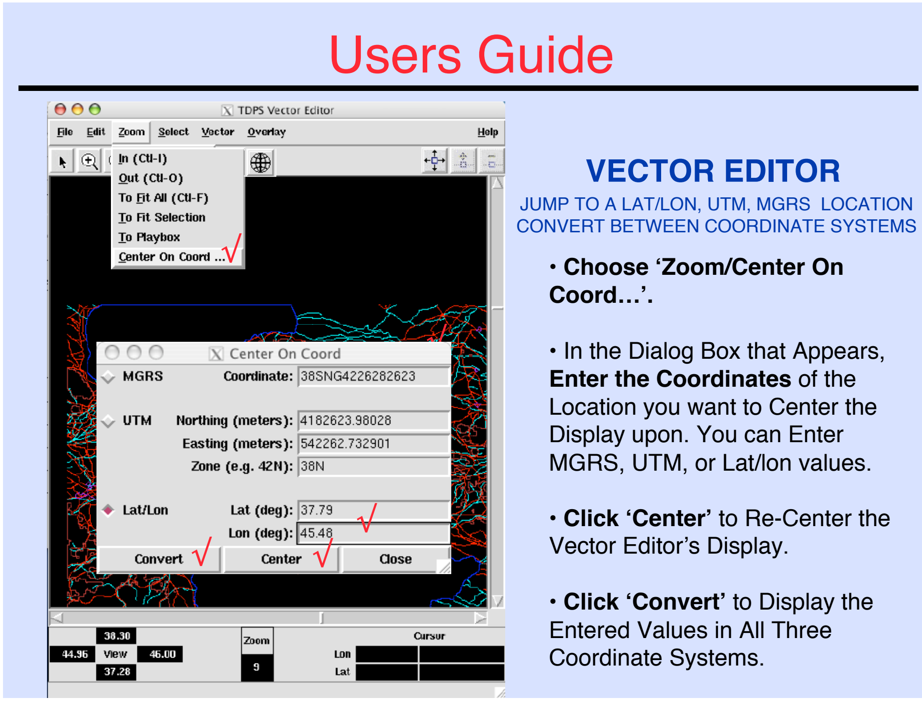


Figure 7-22. How to Jump to a Lat/Lon, UTM, or MGRS Location, and Convert Between the Three Coordinate Systems.

7.13 COPY, CUT, AND PASTE

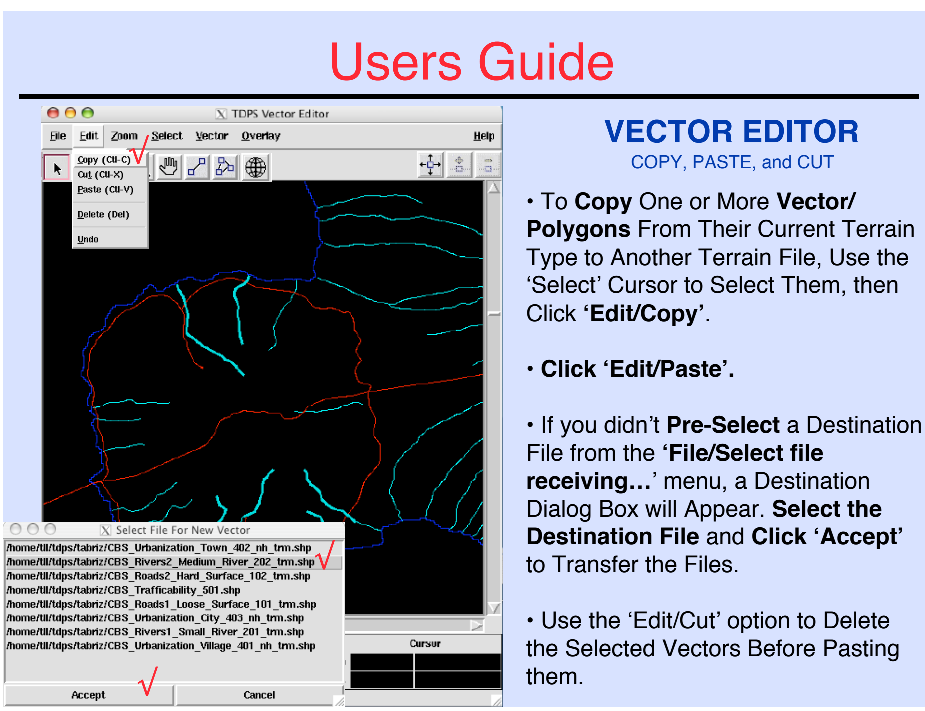


Figure 7-23. Copying Vectors From One File and Pasting them into Another.

7.14 CREATING/EDITING LINES AND POLYGONS

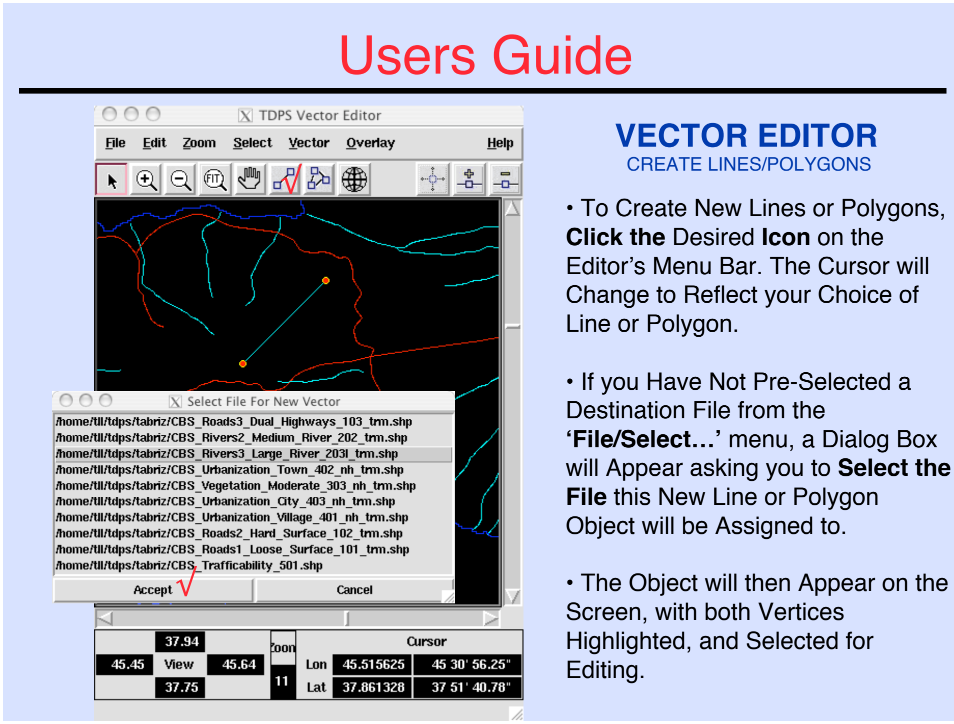


Figure 7-24. Creating New Lines and Polygons.

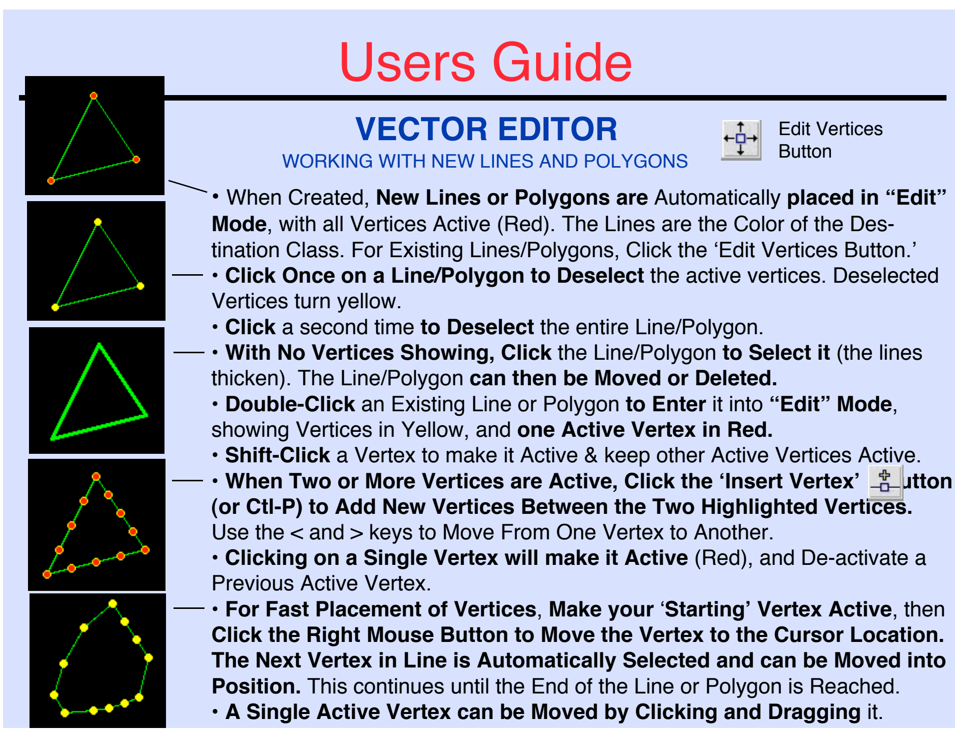


Figure 7-25. Manipulating New and Existing Vectors.

Users Guide

THE RIVERS3 DOUBLE-BANK CASE

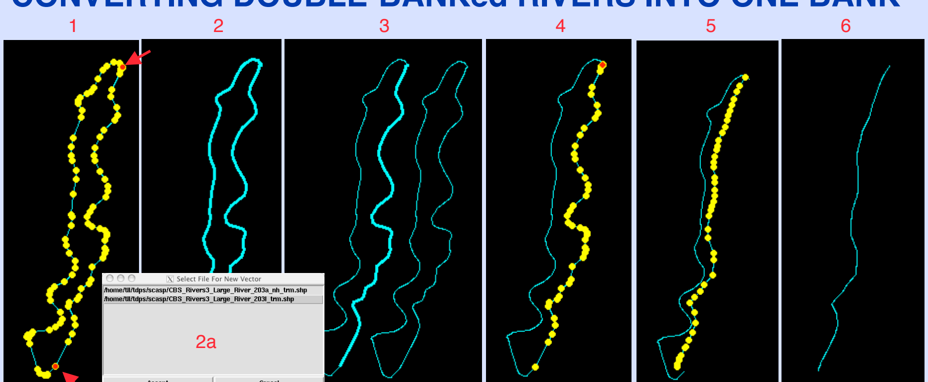
OPTIONAL SOLUTIONS

- Vmap's "Large Rivers" are Produced as Double-Banked Polygons (~Lakes).
- Despite Extensive Discussions, No Automated Solution was Found to Either Convert them to Single Lines, or Modify the CBS GEEP to Accept Double-Banks.
- The Current Default is to Convert River3 Polygons to Lines (format-wise), But the Double-Banks will Remain in the Output CBS Rivers3 File. CBS Game Entities moving along a Road that Crosses a Double-Banked Large River will therefore experience a 2x Time Delay (I.e., Two Bridges are Crossed).
- Several Optional Solutions Exist for Manually Adjusting/Editing Double-Bank Rivers3 'Polygons' via the Vector Editor:
    - Cut/Paste appropriate Double-Banked Rivers3 to Trafficability/Water (501).
    - Edit a Double-Banked River3 Polygon into a Single River3 Line.
        - Create a New River3 Line Down the Middle of a Polygon (See Next Slide).
        - Delete One River Bank (side) of the River3 Polygon.
        - Edit the Double-Banks to a Single Bank ONLY at a Road Crossing.
    - Delete 'Intermittent' Rivers3 Polygons, where appropriate.

Figure 7-26. The Rivers3 Area Polygon Case.

Users Guide

CONVERTING DOUBLE-BANKed RIVERS INTO ONE BANK



- (1) **Double-Click the Polygon**, Note the First Red (Active) Vertex, **Shift-Click a Second Active Vertex**.
- (2) **Type Ctl-B** to Split the Polygon. If you haven't specified a Destination File, a Dialog Box will appear (2a). The polygon boundaries will thicken when the Split (polygon break) has completed.
- (3) **Click/Drag the original overlying Polygon aside**, revealing the Split Polygon (now two Lines) beneath. Click one side to highlight it. **The original Polygon can be deleted** by Clicking it, then hitting the Delete key.
- (4) **Double-Click one "line"** to show its vertices. Make the "top" (clockwise) vertex Active (if not already).
- (5) **Create a new Line** by Clicking the Right Mouse Button to Move the Active Vertex to the Cursor Location. Continue Clicking/Tracking until the End of the Line is Reached, and your new line has replaced the old Polygon.
- (6) Click to **Select the remnant "left bank" Line and Delete it**, Leaving your New Line as its Replacement.

Figure 7-27. An Approach for Making Single-Banked River3 Terrain.

7.15 SAVING FILES

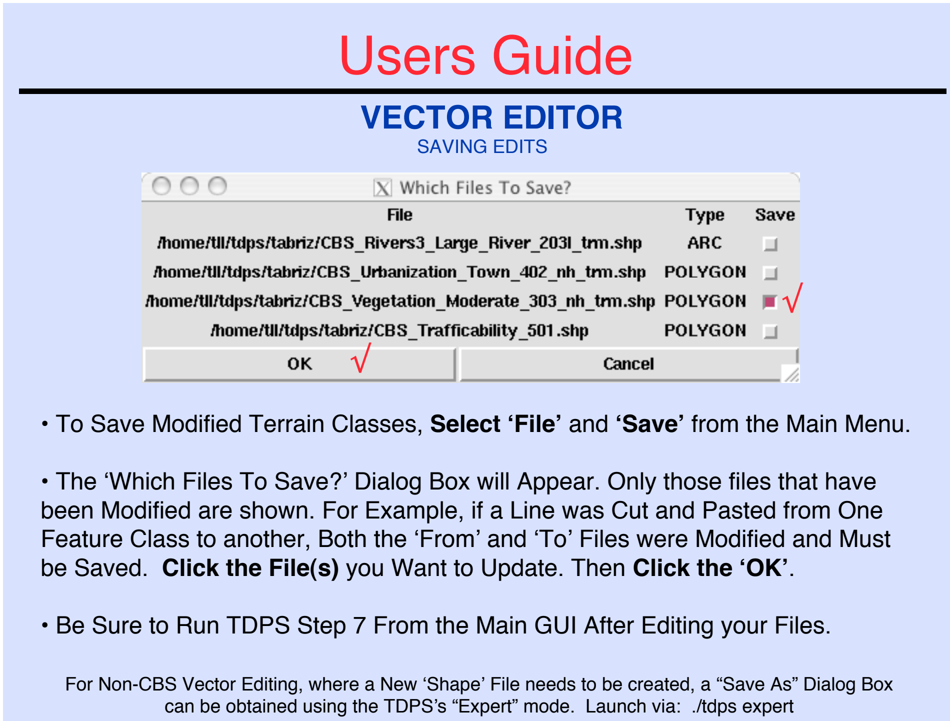


Figure 7-28. Saving Edits.

7.16 VECTOR DELETE, UNDO, PROPERTIES, AND NUDGE

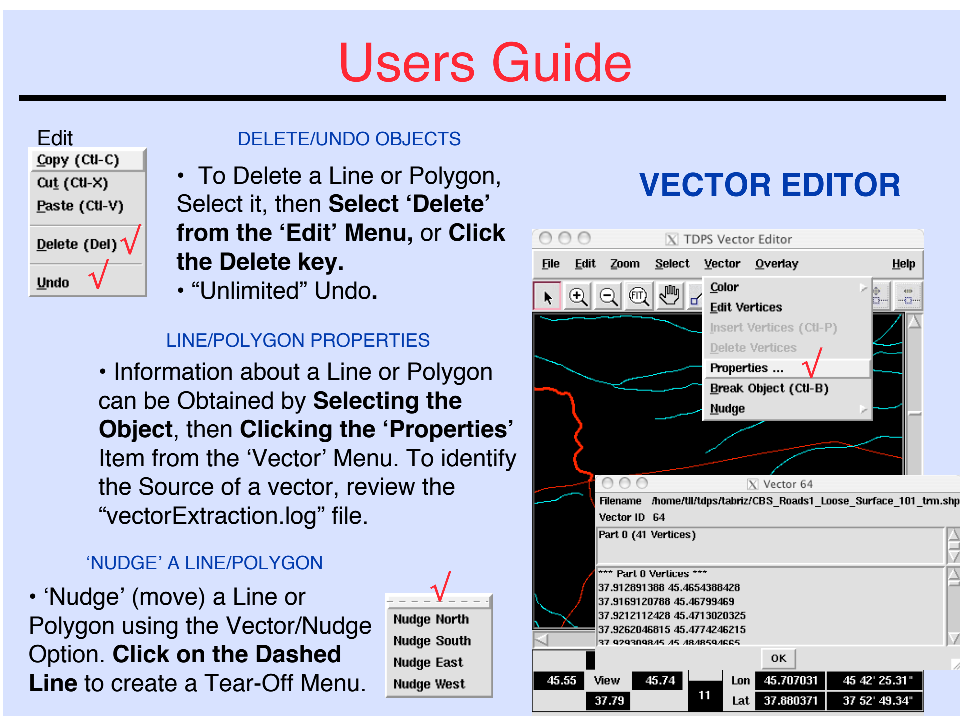


Figure 7-29. "Undo" is Available Only Within the 'Current' Mode.

7.17 VECTOR COLOR CHANGES

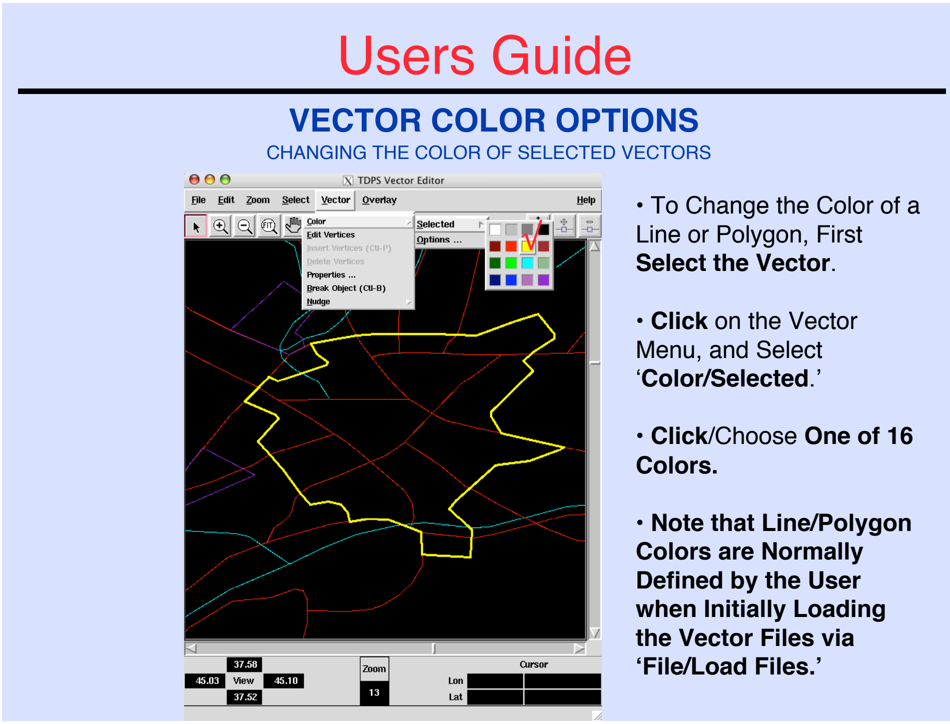


Figure 7-30. Changing the Color of a Line or Vector.

7.18 COLOR PALETTE AND VERTEX CHANGES

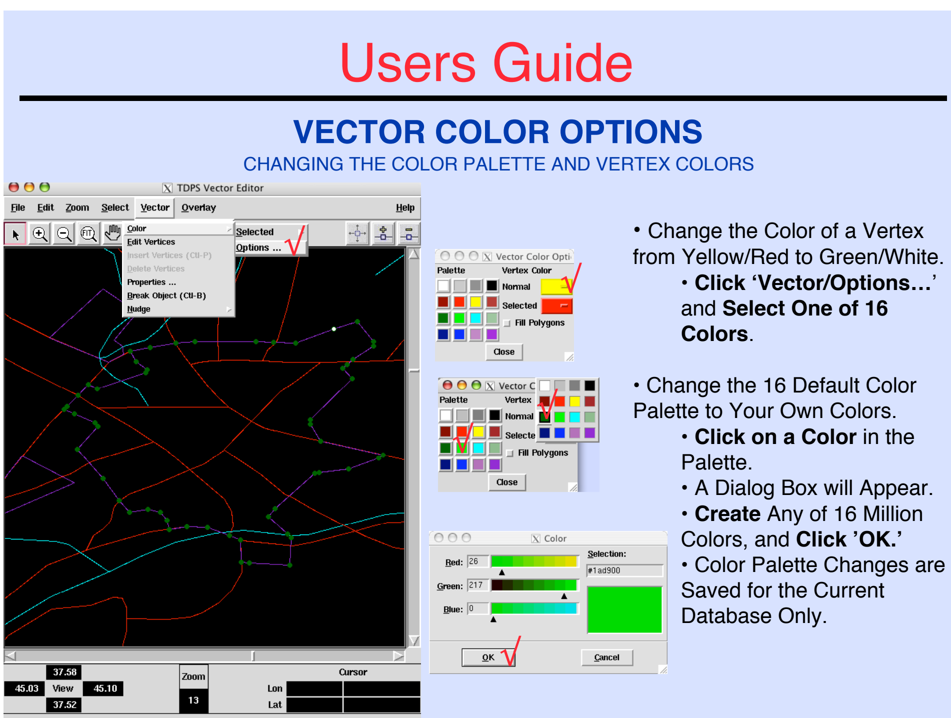
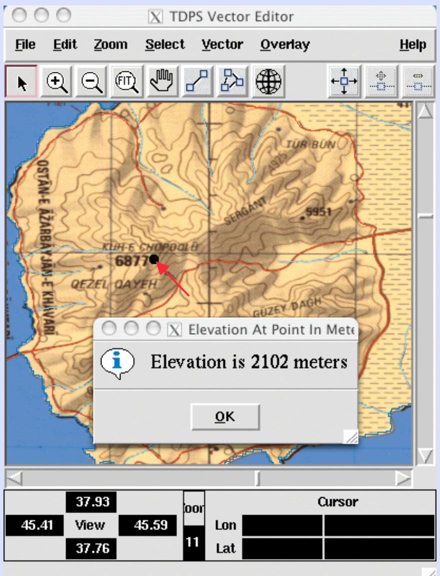


Figure 7-31. Change the Default Color Palette and the Vertex Colors.

7.19 OBTAINING POINT ELEVATIONS

Users Guide

DETERMINING THE ELEVATION AT A POINT



Control-E

• To View the Elevation at a Point, **Place the Cursor** at the Desired Location and **Press Ctl-E**.

• **A Dialog Box will Appear** with the Elevation in Meters. **Click 'OK' to Continue**.

• To See Several Point Elevations in Rapid Succession, Use 'Ctl-Left Mouse Click.' Position your Hand to Click the 'Control' and 'Return' key. Left Click the Mouse then the Control key to Display the Elevation, then 'Return' to Kill the 'OK' Box, and Repeat for the Next Point.

• Elevations Over Water are Approximate.

Figure 7-32. Using the Elevation 'Hot Key' (Ctl-E).

7.20 SUMMARY OF KEYBOARD COMMANDS

Users Guide

VECTOR EDITOR

KEYBOARD SHORTCUTS

• Up Arrow	Nudge Vector North
• Down Arrow	Nudge Vector South
• Left Arrow	Nudge Vector West
• Right Arrow	Nudge Vector East
• Control-A	Select All
• Control-C	Copy
• Control-E	Display Elevation at the Cursor Location
• Control-F	Zoom To Fit All
• Control-G	Toggle Grid Cell On/Off
• Control-I	Zoom In
• Control-M	Toggle Map On/Off
• Control-O	Zoom Out
• Control-P	Insert Vertices
• Control-U	Undo
• Control-V	Paste
• Control-X	Cut
• Delete Key	Delete (Cut without Paste)
• BackSpace	Delete (Cut without Paste)
• <	Move to Previous Vertex
• >	Move to Next Vertex

Figure 7-33. Vector Editor 'Hot Keys'.

7.21 QUIT/EXIT THE TDPS AND EDITOR

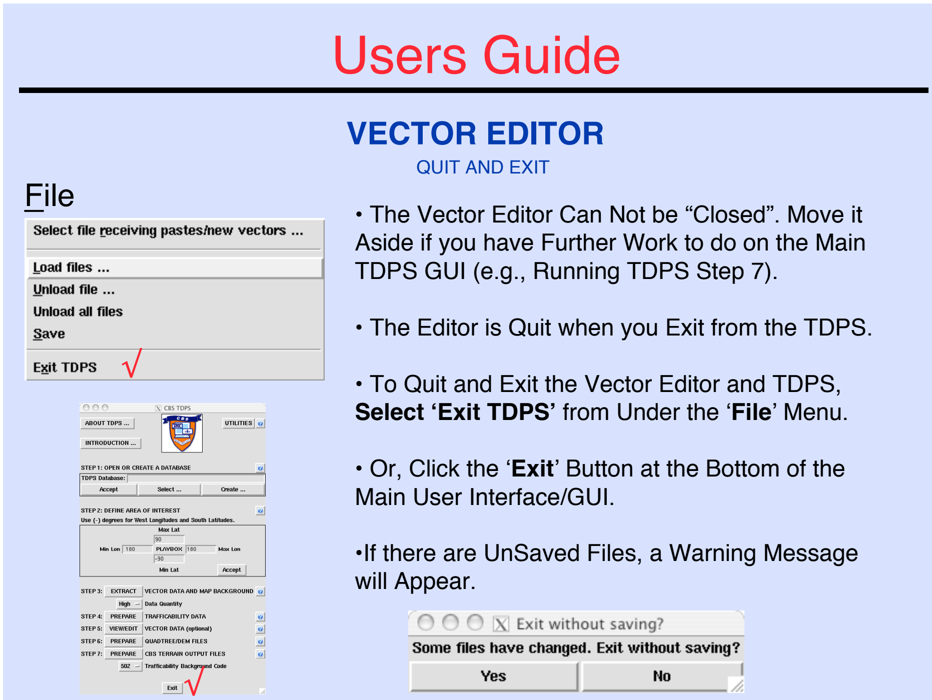


Figure 7-34. Quit/Exit the TDPS and Editor.

7.22 EXAMPLE TERRAIN DATABASES

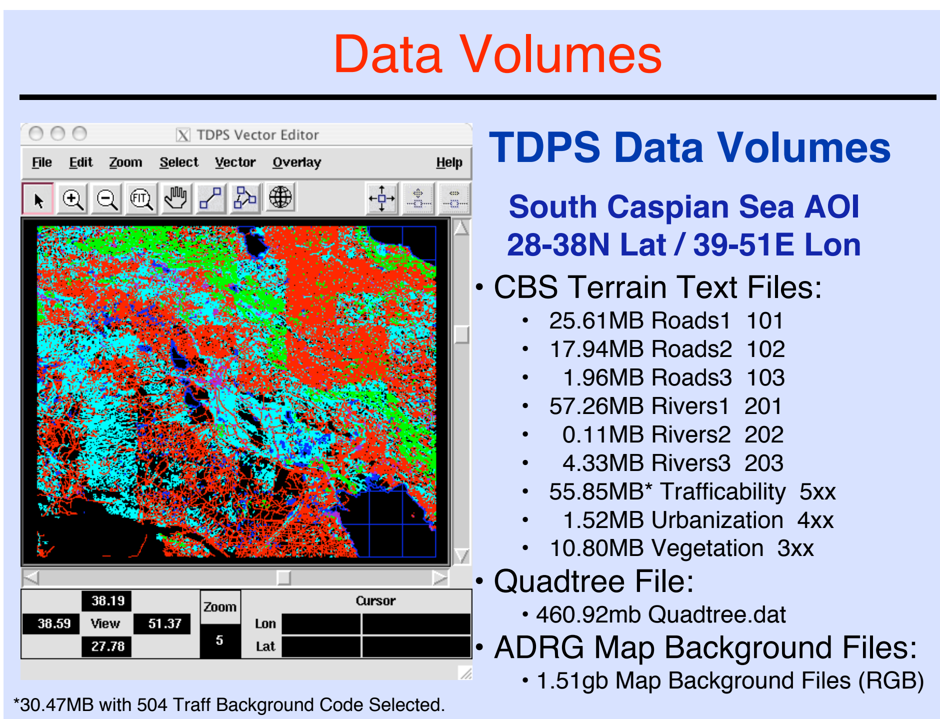


Figure 7-35. The 10x12 Degree South Caspian Database is Currently the Largest Usable Terrain Database.

SECTION 8
USERS GUIDE - UTILITIES

8.1 INTRODUCTION

The TDPS Utilities are primarily for updating and maintaining the Pre-Staged datasets (See Section 5), including the ADRG map background, Vmap1 vector data, and the SRTM/DEM elevation files. These tools allow the user to integrate the latest map products from NGA without dependence up JPL. The tools are also independent of the general terrain database preparation and the Vector Editor, i.e., they are used without opening a terrain database.

The three primary Utilities are: 1) Update CADRG; 2) Update VMAP; and 3) Update DEM. Two additional tools: 4) Mosaic DEM; and 5) Export CADRG, provide special capabilities for mosaicking and exporting TDPS elevation and ADRG map background files into GeoTiff format. The TDPS does not use these files. They support external TDPS terrain requirements.

The ultimate purpose of the Utility tools is to allow the user to *Overwrite* and *Replace* the existing Pre-Staged TDPS data sets (with newer Pre-Staged data files). Be sure all your old TDPS Pre-Staged data files are *Backed Up* in case of a processing error. The Utility tools were not designed or intended for mass data reprocessing.

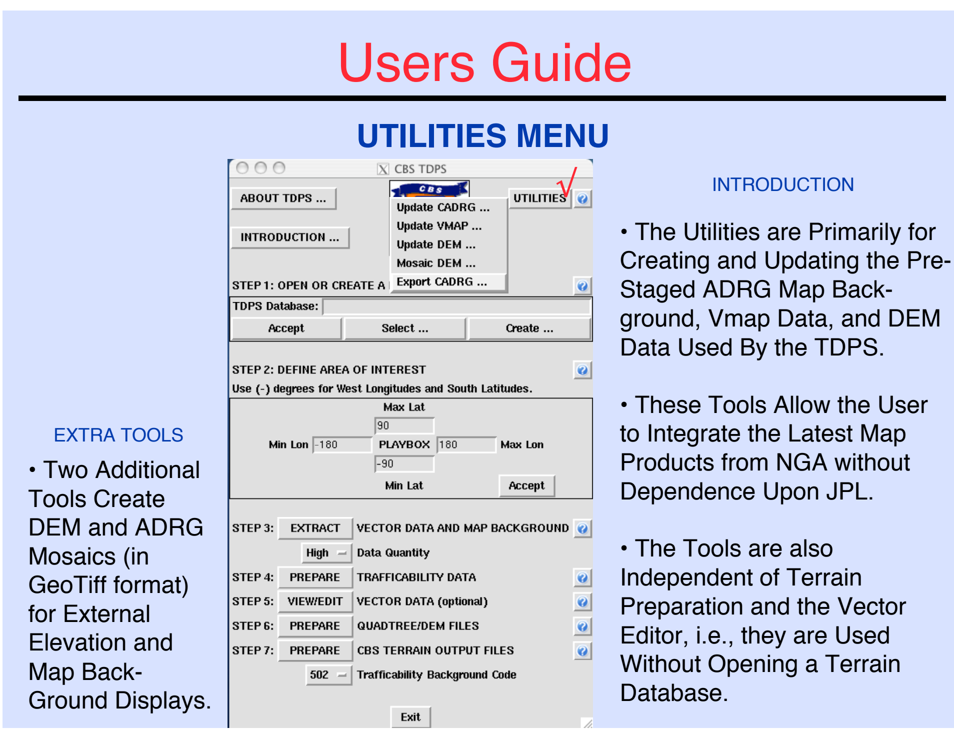


Figure 8-1. The Utilities are Launched from the Main TDPS GUI.

8.2 UTILITIES – UPDATE CADRG

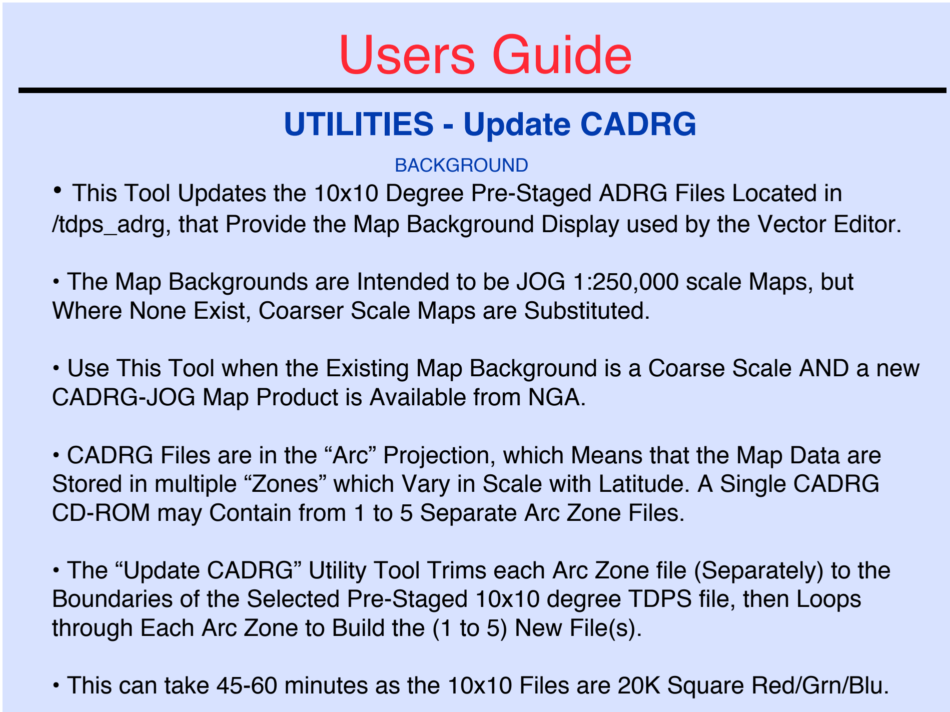


Figure 8-2. Update CADRG Introduction. Note that the NGA "ADRG" Product is Out of Production and has been Replaced by the "CADRG" Product.

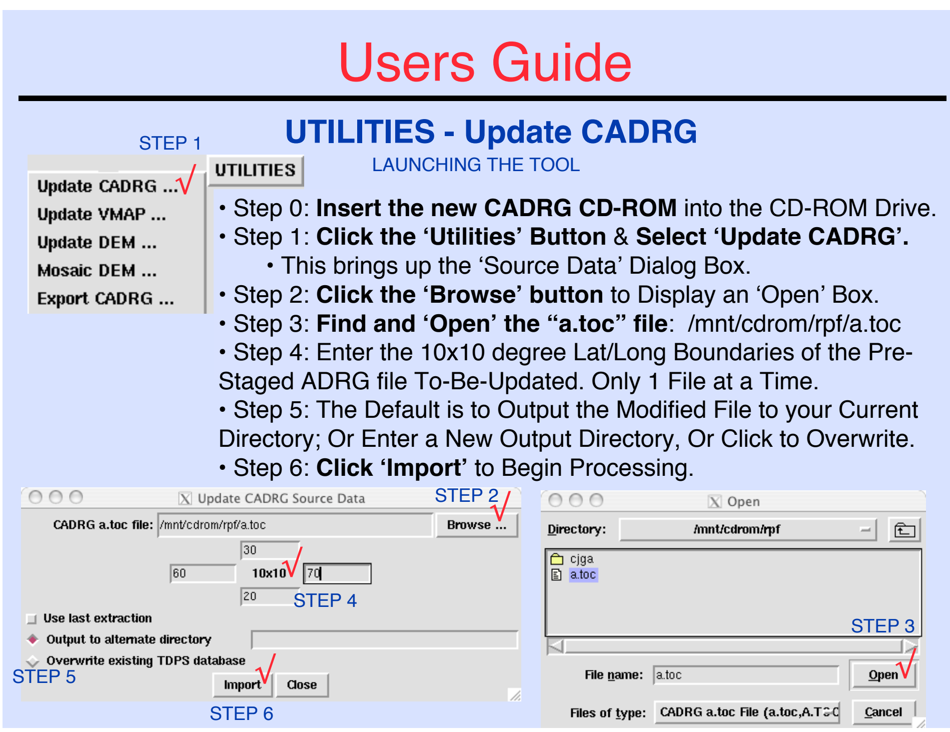


Figure 8-3. Launching the Update CADRG Tool.

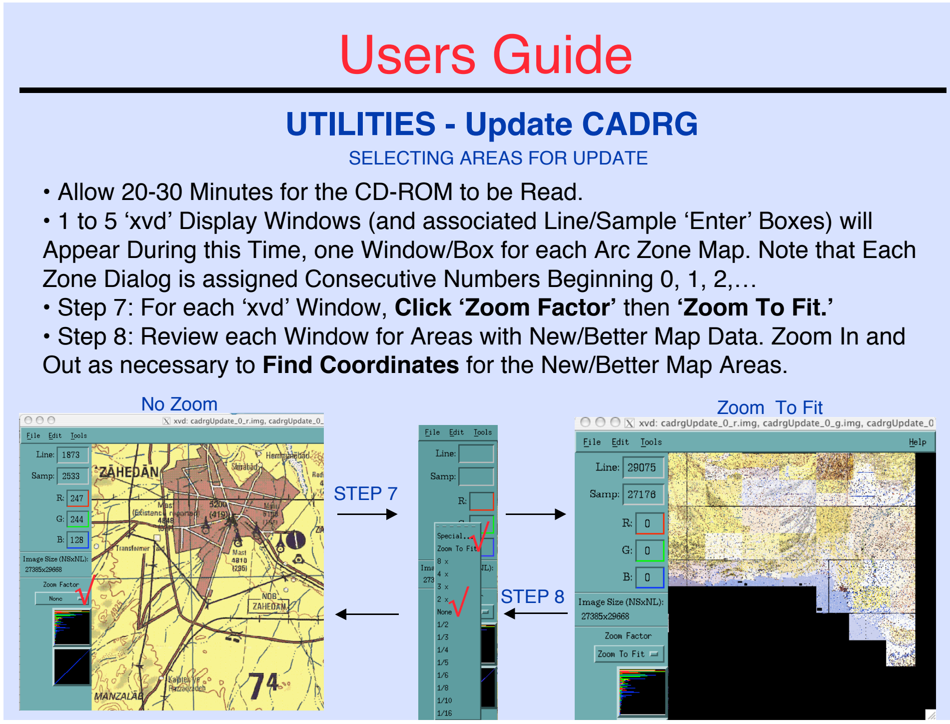


Figure 8-4. Selecting Areas for CADRG Update.

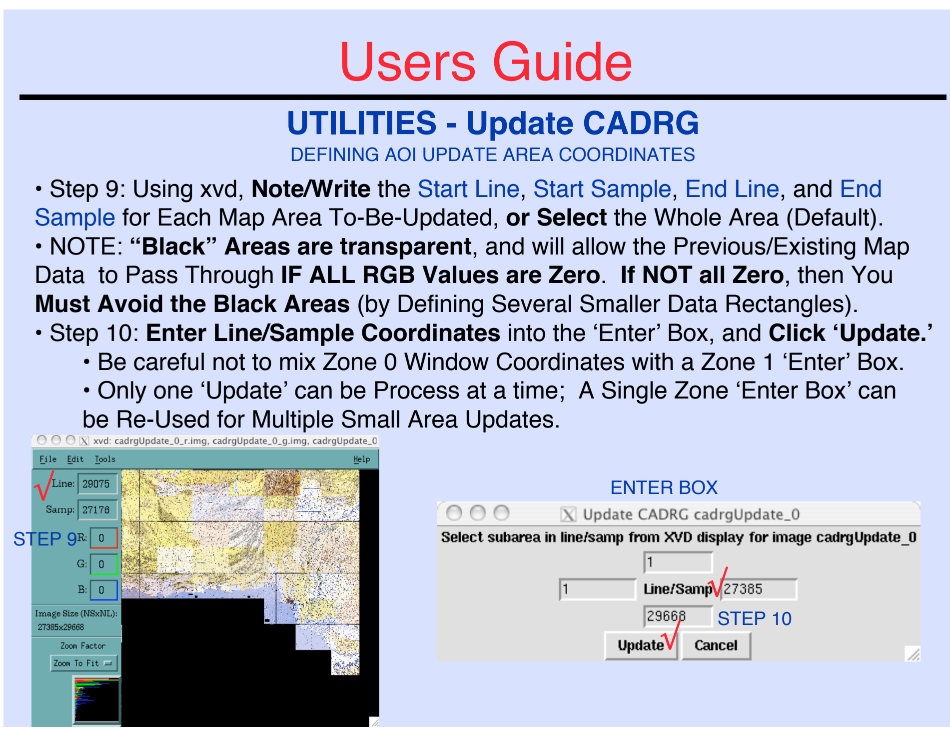


Figure 8-5. Defining AOI Area Coordinates.

Users Guide

UTILITIES - Update CADRG

PROCESSING MAP UPDATES

• Step 11: When a Zone Update Finishes, a New ‘xvd’ Window will Appear for your Review. If it looks good, **Click ‘File’** then **‘Exit’** to Close the xvd Window, then **Click the ‘OK’ button** on the Pop-Up Dialog Box.

• Step 12: Repeat Steps 9-11 for each Arc Zone File and Within-Zone Map Updates.

• NOTE that Input CADRG Zones are Different Scales than the Output Pre-Staged TDPS Product, so Coordinates will Vary Between xvd Map Displays.

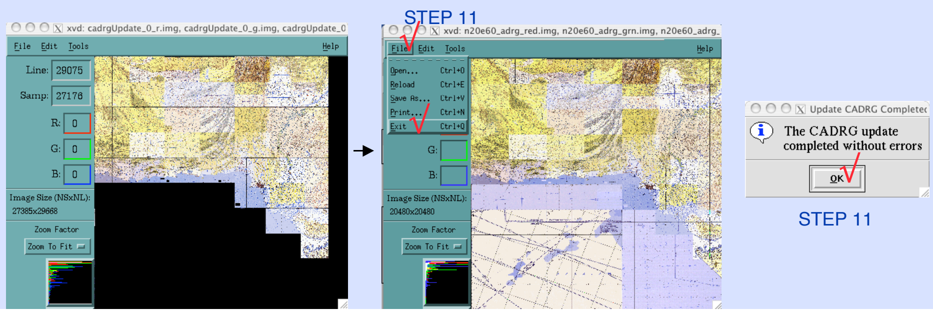


Figure 8-6. CADRG Processing.

Users Guide

UTILITIES - Update CADRG

FINISHING

• Step 13: When Completely Finished with an Arc Zone, **Click the ‘Cancel’ Button** to Exit that Arc Zone’s Processing.

• Step 14: If a Problem Occurs and You Need to Start Over, You can Avoid Re-Reading the CADRG CD-ROM by **Clicking “Use last extraction”** on the ‘Source Data’ Dialog Box, then **Clicking ‘Import**.’ The Update Process will Restart.

• Step 15: If you Didn’t Select the ‘Overwrite’ option, Copy your Newly Updated Pre-Staged ADRG (Red-Grn-Blu) files to the /tdps_adrg directory.

• Begin Again with Step 0 if you have another 10x10 Pre-Staged ADRG file that requires a CADRG Map Update.

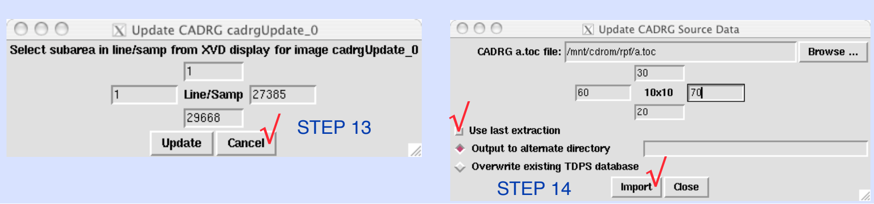


Figure 8-7. Completing the CADRG Update.

8.3 UTILITIES – UPDATE VMAP

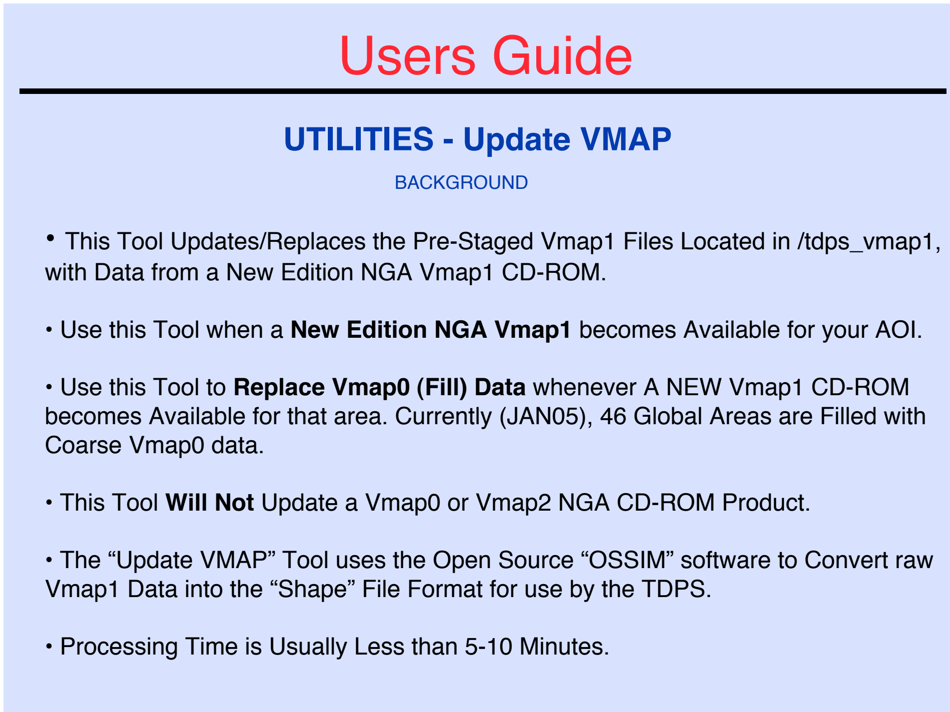


Figure 8-8. Update Vmap1 Introduction.

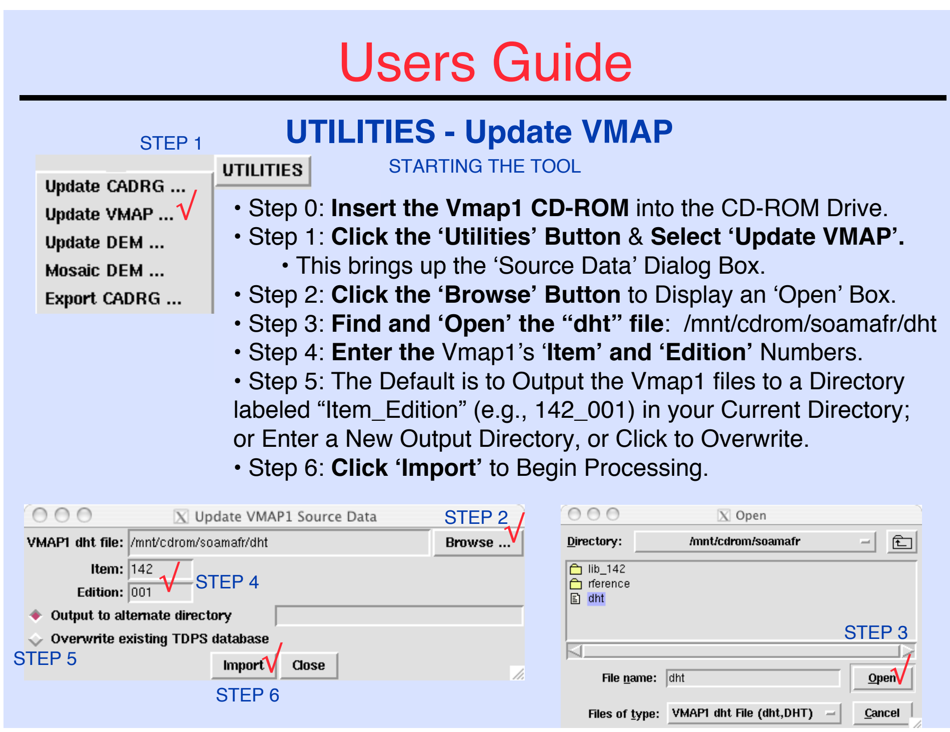


Figure 8-9. Launching the Update Vmap Tool.

Users Guide

UTILITIES - Update VMAP

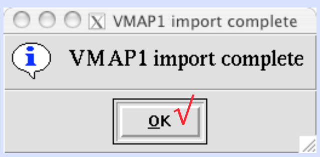
FINISHING THE TOOL

• Step 7: When Processing has Finished, **Click 'OK'** in the 'Complete' Dialog Box.

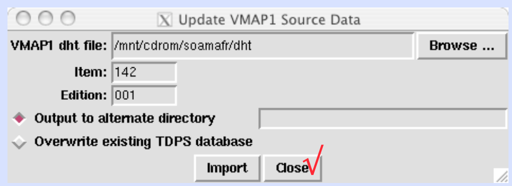
• Step 8: **Click the 'Close' Button** on the 'Source Data' Box to Exit "Update VMAP."

• Step 9: If you Didn't use the 'Overwrite' option, Replace your Old TDPS Pre-Staged Vmap1 Data with your New Pre-Staged Data by Copying your New Vmap1 Directory (e.g., 142_001) to the /tdps_vmap1 Directory.

• Begin again with Step 0 if you have another Vmap1 Update CD-ROM.



STEP 7



STEP 8

Figure 8-10. Completing the Update Vmap Process.

8.4 UTILITIES – UPDATE DEM

Users Guide

UTILITIES - Update DEM

BACKGROUND

• This Tool **Converts NGA "DTED"-format DEM** (Digital Elevation Files) into Pre-Staged TDPS/VICAR "gt"-format Files. The New Files should **Overwrite** the Current Pre-Staged Vmap1 Files Located in /tdps_srtm.

• The TDPS-Provided Files are a Preliminary Version of SRTM Level-1 (90 meter; 3 arc-second) DEMs with the "Voids" Filled and Oceans Flattened. These Files Should be Replaced When NGA Releases their Official Version SRTM-based DEM Product (with Voids-Filled).

• It is **ASSUMED** that the Future SRTM/DEM Product Released by NGA will be in "DTED"-format. **If the Release is NOT in DTED Format, DO NOT Use this Tool!** Contact JPL for Help.

• This Tool can Process Multiple DEMs at One Time, and Cross the Equator and Prime Meridian, But Not the International Dateline (180EW Longitude).

Figure 8-11. Update DEM Introduction.

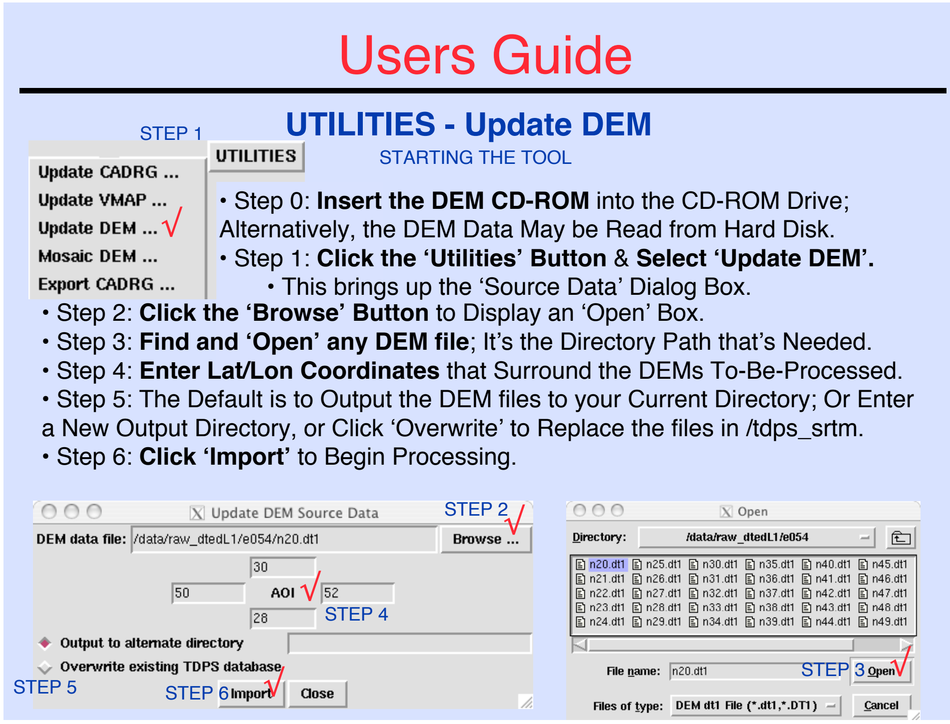


Figure 8-12. Launching the Update DEM Tool.

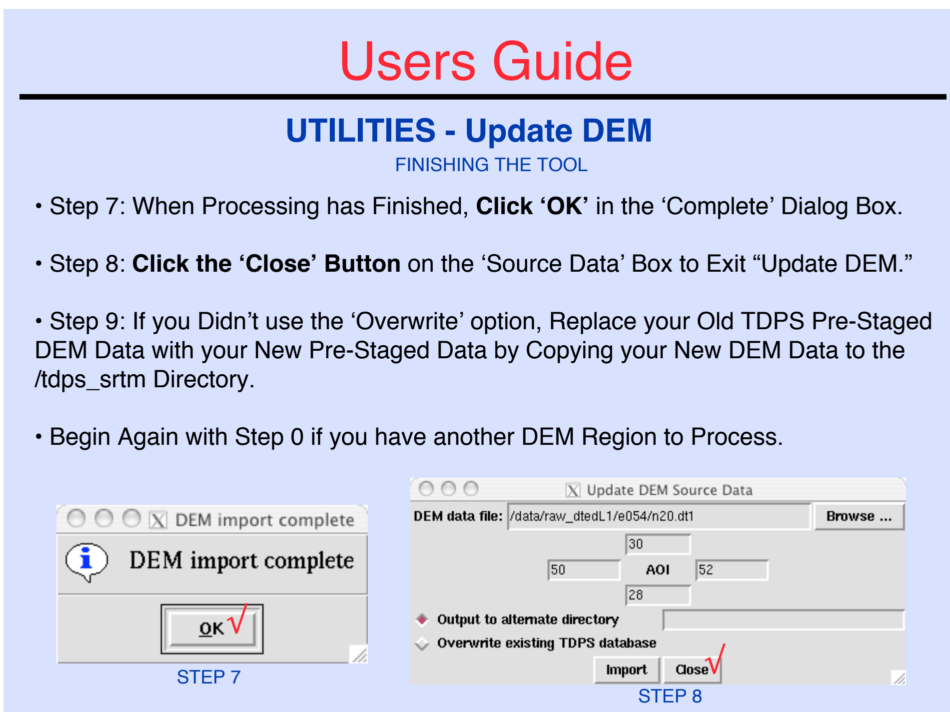


Figure 8-13. Completing the Update DEM Process.

8.5 UTILITIES – MOSAIC DEM

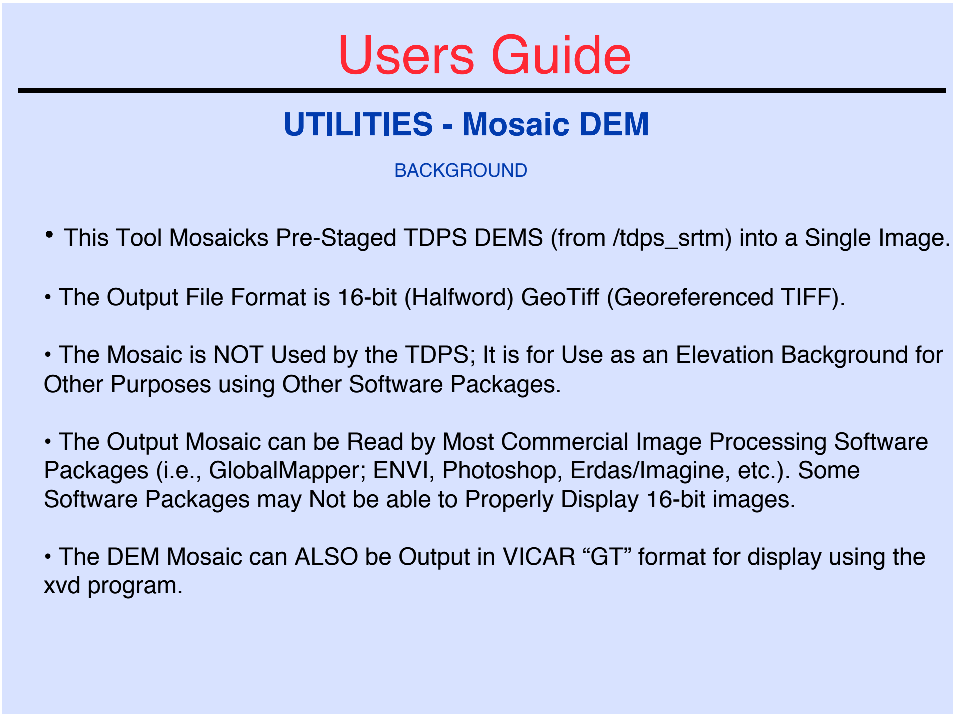


Figure 8-14. Mosaic DEM Introduction.

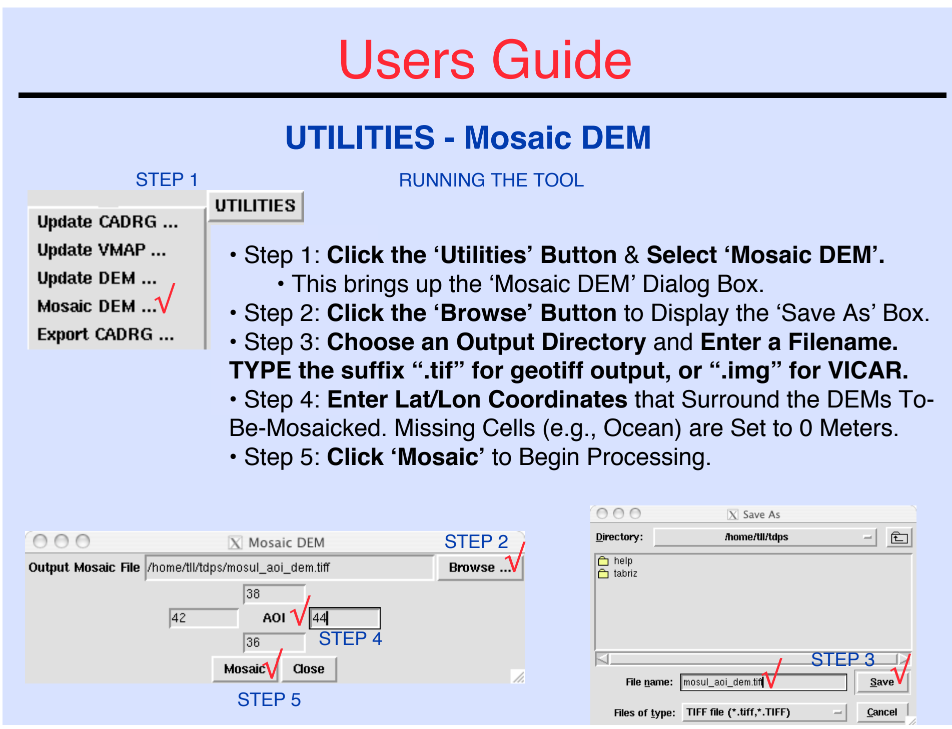


Figure 8-15. Launching the Mosaic DEM Tool.

Users Guide

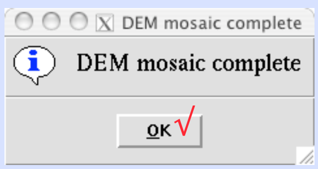
UTILITIES - Mosaic DEM

FINISHING THE TOOL

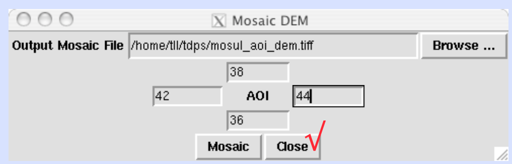
• Step 6: When Processing has Finished, **Click 'OK'** in the 'Complete' Dialog Box.

• Step 7: **Click the 'Close' Button** on the 'Mosaic DEM' Box to Exit.

• Begin Again with Step 1 if you have another DEM Region or CD-ROM to Process.



STEP 6



STEP 7

Figure 8-16. Completing the Mosaic DEM Process.

8.6 UTILITIES – EXPORT CADRG

Users Guide

UTILITIES - Export CADRG

BACKGROUND

• This Tool converts the ADRG Map Background created for a given TDPS Database from VICAR format to GeoTIFF (.tif; georeferenced-TIFF) format. It will also convert the Pre-Staged TDPS 10x10 degree ADRG files (from /tdps_adrg) into TIFF format.

• The Output File is an RGB composite GeoTIFF file (24-bits).

• The Exported ADRG is NOT Used by the TDPS; It is for Use as a Map Background for Other Purposes using Other Software Packages.

• The Output ADRG file can be Read by Most Commercial Image Processing Software Packages (i.e., GlobalMapper; ENVI, Photoshop, Erdas/Imagine, etc.).

Figure 8-17. Export CADRG Introduction.

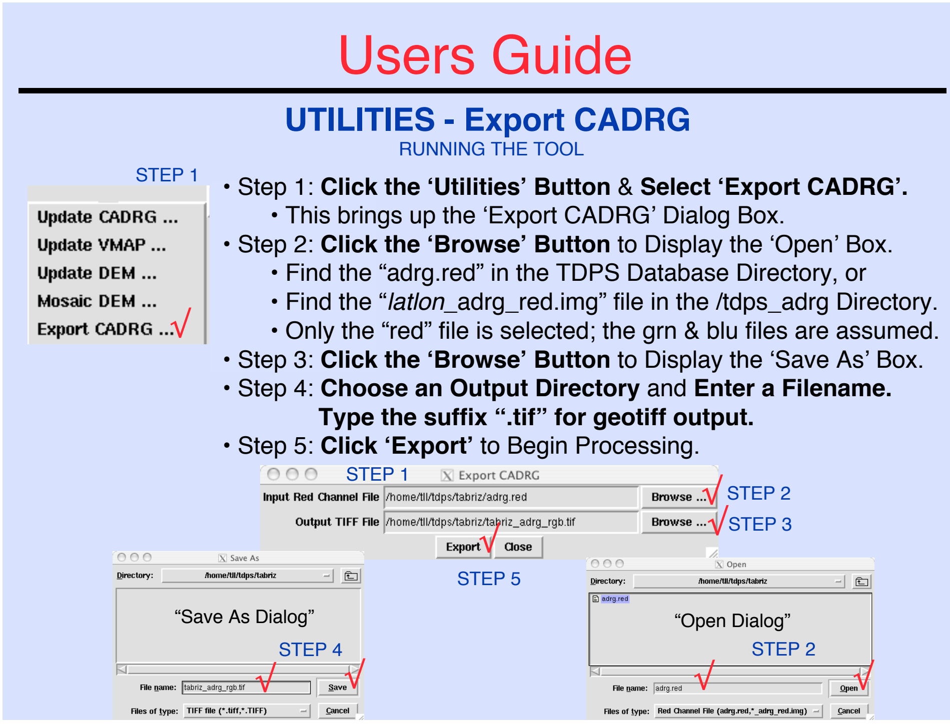


Figure 8-18. Launching the Export CADRG Tool.

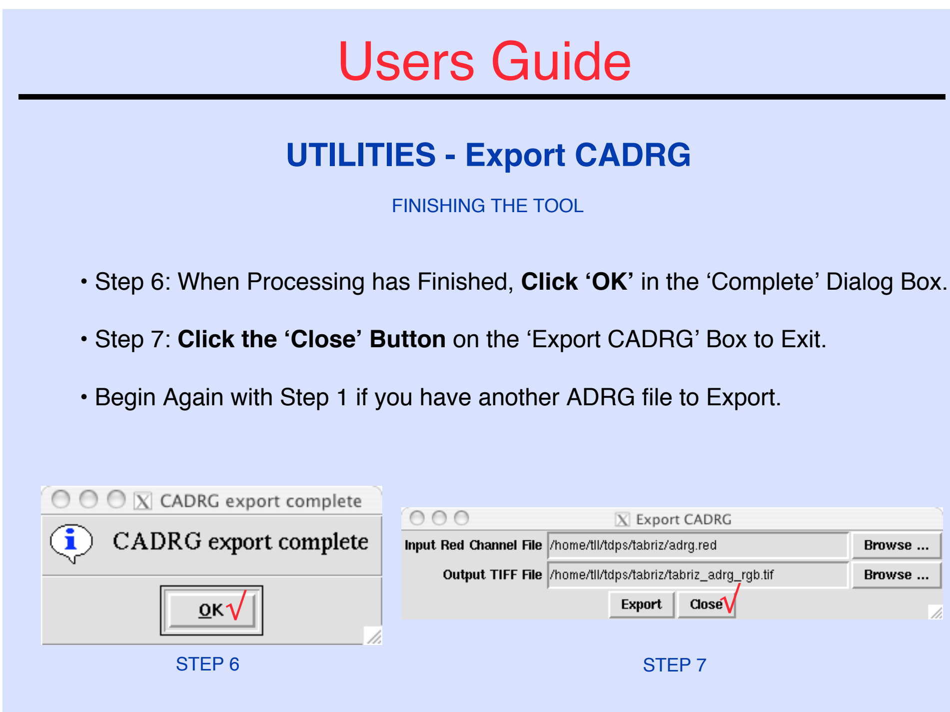


Figure 8-19. Completing the Export of a CADRG Map Background.

APPENDIX A
VICAR/IBIS TUTORIAL

While the gui interface reduces the need for most direct interaction with VICAR command-line procedures, some interaction may be necessary depending upon the situation. For this purpose a quick introduction to the use of VICAR syntax is provided herein. Refer to the "VICAR User's Guide" for comprehensive instructions, reference information, and a list of basic programs. It is assumed that VICAR has been fully installed and tested prior to this point.

To launch VICAR, type **vicar** at the Unix prompt. The system will respond with the vicar prompt:

%VICAR>

To leave/quit VICAR, type **exit**

%VICAR>**exit**

To execute a Unix command while in VICAR (except for 'ls'), type **ush** and the command:

%VICAR>**ush df -k**

To execute a VICAR application program, type it's name and parameters at the command line. For example, VICAR program "gen" is used to generate a test image with the output filename "a", 552 lines (rows), and 818 samples (columns):

%VICAR>**gen out=a nl=552 ns=818**

To verify the new file, read the file's label with the program "label-list":

%VICAR>**label-list inp=a**   or just:
%VICAR>**label-l a**

To list the first 20 lines by 10 samples of the file to your screen, use VICAR program "list":

%VICAR>**list a size=(1,1,20,10)**

To display the image file on your screen, use the interactive VICAR display program "xvd":

%VICAR>**xvd a**

To identify all the parameters associated with a program, use the tutor mode (below). At the bottom of the tutor screen, type "**help *parameter***" to display information about the parameter (then **exit** to leave the parameter description). The tutor mode can also be used to run the program by filling in the parameter fields with values. Type **exit** to quit tutor mode, or **run** to execute the program (after filling in the parameter values):

%VICAR>**t gen** (or **tutor gen**)

To determine the function of a particular program (a partial list of programs can be found in the "VICAR User's Guide"), use the help mode (**exit** to quit):

%VICAR>**h gen** (or **help gen**)

The directory in which VICAR is run must have a "ulogon.pdf" to specify where VICAR searches for its programs. The location of basic VICAR programs is hardwired, but most of the TDPS programs are in a separate directory that must be specifically identified, for example "/home/vdev". An example ulogon.pdf is:

```
procedure
body
write  "Executing from /home/tll"
setlib-delete library=($R2LIB)
setlib-add library=(/home/tll,/home/vdev,$R2LIB)
end-proc
```

The "ulogon.pdf" demonstrates the basic syntax of a VICAR command-line 'procedure' or 'script'. The VICAR 'procedure' is a text file with the suffix ".pdf" (that predates Adobe Acrobat). The file must have the keywords "procedure", "body", and "end-proc", with some VICAR applications after the 'body' keyword. (The space between 'procedure' and 'body' is reserved for special declaration statements, if needed.) An example procedure is:

```
procedure
body
gen      a nl=250 ns=255
label-l  a
list     a size=(1,1,20,10)
hist     a
end-proc
```

The procedure can be written using any text editor such as **textedit**, **joe** or **vi.** Just be sure to end the filename with a ".pdf". To run the procedure in realtime, simply type its name at the VICAR prompt. To obtain a log of the running process, run the job in batch mode (below). If the procedure were named "testjob", the output logs would be named "testjob1.log" and "testjob1.log.stdout". (Note, logs can be printed using the **cat** command while the job is running.)

%VICAR>**testjob|run**=**batch|**

VICAR uses the exclamation point (!) to identify comment lines in the procedure. This can be useful for adding notes and descriptive text as well as bypassing program calls. The "goto *here*" command is also useful for jumping to different locations in a procedure. For example:

```
!This is a test
procedure
body
gen      a nl=250 ns=255
!Jump over the label-list program
goto next           !Any single word could be used in
!                   place of 'next'.
label-l  a
next>               !The ">" is required.
hist     a
end-proc
```

If a VICAR command-line must continue to a second line, place a plus sign (+) at the end of the first line to tell VICAR to continue to the next line.

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APPENDIX B: U.S. ARMY VICAR LICENSE

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July 13, 2004

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APPENDIX C: ACRONYMS AND ABBREVIATIONS

adrg	Arc-Digitized Raster Graphics
aoi	Area of Interest
as	Arc-Second
atc	Army Training Command
bctp	Battle Command Training Program
cadrg	Compressed Arc-Digitized Raster Graphics
Caltech	California Institute of Technology
cbs	Corps Battle Simulation
dem	Digital Elevation Model
dma	Defense Mapping Agency (now NGA)
dod	Department of Defense
dted	Digital Terrain Elevation Data
gb	GigaBytes
geep	Game Events Executive Processor
geotiff	Georeferenced TIFF (Tagged Interface File Format)
globe	Global Land One-km Base Elevation
gnc	Global Navigation Chart (1:5,000,000 scale)
ibis	Image Based Information System
jnc	Jet Navigation Chart (1:2,000,000 scale)
jog	Joint Operational Graphics (1:250,000 scale)
jpl	Jet Propulsion Laboratory
los	Line of Sight
nasa	National Aeronautics and Space Administration
mb	MegaBytes
nga	National Geospatial-Intelligence Agency
nima	National Imagery and Mapping Agency (now NGA)
nsidc	National Snow and Ice Data Center
muse	MC&G Utility Software Environment (software tools)
nsc	National Simulation Center
onc	Operational Navigation Chart (1:1,000,000 scale)
os	Operating System
ossim	Open Source Security Information Management (software tools)
peo	Program Executive Office
qt	Quadtree
ramp	Radarsat Antarctica Mapping Project
rh	Red Hat (Linux)
sar	Synthetic Aperature Radar
stri	Simulation, TRaining, and Instrumentation
srtm	Shuttle Radar Topography Mission
tb	TeraBytes
tcl tk	Tool Command Language Toolkit (“tickle tk”)
tdps	Terrain Database Preparation System
tpc	Tactical Pilot Chart (1:500,000 scale)
usb	Universal Serial Bus
vicar	Video Image Communication and Retrieval
vmap	Vector Map Product

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