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# WORLD VECTOR SHORELINE

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## Abstract

The Defense Mapping Agency (DMA) has developed a digital data file at a nominal scale of 1:250,000, containing shorelines, international boundaries and country names and known as the World Vector Shoreline (WVS). The file was developed with these features in support of geographic information systems, command, control and communications systems. The WVS has been designed to fit varying applications and is convertible to other system specific formats.


## INTRODUCTION

With the exception of the Central Intelligence Agency's World Data Base II (WDB II), there has not been a digital cartographic data base that would support a wide range of geographic information systems and permit the automatic integration of intelligence, environmental, tactical and real time sensor data. In 1985, the Defense Mapping Agency was requested to produce a detailed data set as a replacement for the generalized WDB II (scale of 1:3,000,000) to meet a broad range of applications. The requirement specified that WVS must contain the minimum number of points required to describe the shoreline at a display scale of 1:250,000; use a vector format; tag the landside/waterside of the shoreline to facilitate color filling; show international boundaries with their maintenance status (recognized, disputed, etc.); and include country name labels. In terms of accuracy, the requirement for WVS data was that it be comparable to paper products. i.e. 90 percent of all identifiable shoreline features are to be located within 500 meters (2.0 mm at 1:250,000) circular error of their true geographic position with respect to the World Geodetic System (WGS) Datum. Figure 1 illustrates the differences in data quality and resolution between WDB II and WVS.

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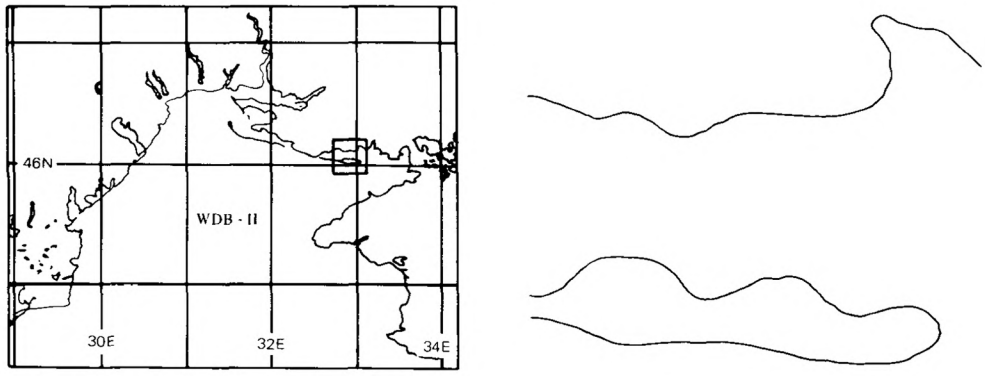
(a) WDB II




(b) WVS

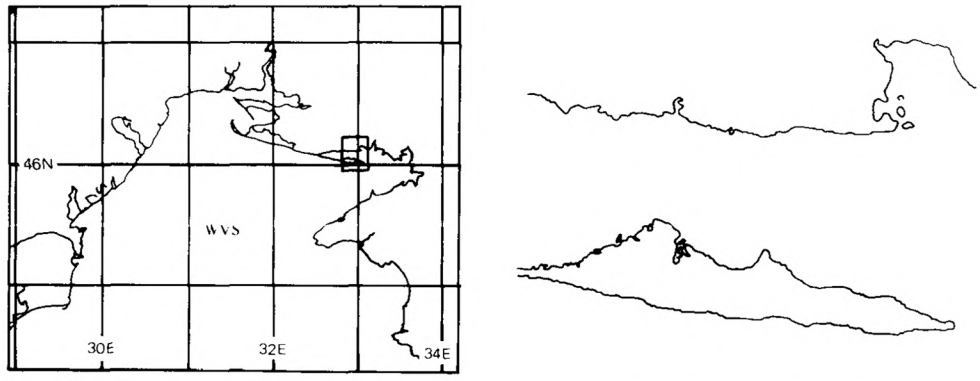



FIG. 1.— Comparison of WDB II and WVS: data resolution. Area shown is the Odessa region in the northern Black Sea. (a) WDB II was digitized at an average scale of 1:3,000,000. (b) WVS was digitized at an average scale of 1:250,000. Therefore, the relative quality of WVS will be much better than WDB II at any given display scale. The difference in resolution between WDB II and WVS is increasingly evident as display scale increases: maps on the right are enlargements (approximately 16 times) of maps on the left, and the difference in resolution between WDB II and WVS is even more apparent here. Figures are courtesy of the Naval Ocean Systems Center.

To meet the production deadline of DMA and minimize the impact on other programs cost effectively, DMA developed a technique of vectorizing shoreline data from the existing DMA Digital Landmass Blanking (DLMB) Data. The DLMB data is divided into land/water matrices (raster data) spaced at 3 by 3 arc-second intervals. This data was derived primarily from the Joint Operations Graphics and coastal nautical charts produced by the DMA. Where DLMB data were not available, DMA utilized the best available cartographic source.

## WVS DATA STRUCTURE

Cartographic features in the WVS data file are stored in the chain-node data structure as opposed to the sequential method. Use of this data structure eliminates redundant segment storage and gaps and/or overlaps between segments of adjacent features. Since any feature in WVS may consist of more than one segment or one segment may be common to multiple features, the chain-node method ensures that each feature and each segment is stored only once. Unique alphanumeric segment and feature identification keys are utilized with pointers to associated features and segments. Figure 2 illustrates the basic differences between sequential data and the chain-node data structures. Figure 2.a shows three adjacent areal features as they might appear on a map. In the sequential method, each feature would be treated as a separate polygon, digitized independently (Fig. 2.b), and stored as a string of X, Y coordinates. The common boundary between two abutting features would be digitized twice, and the two versions may not coincide. This often results in gaps or overlaps along the boundary (Fig. 2.c).

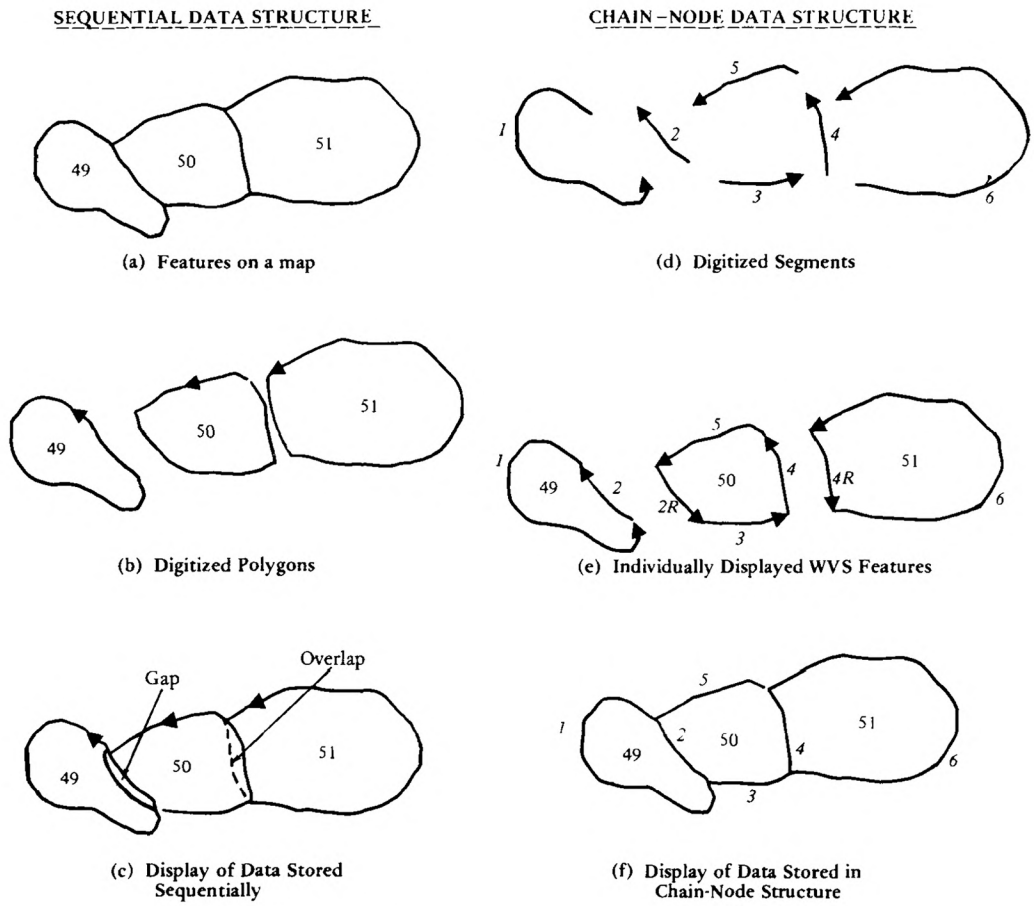
In the chain-node method, the segments that comprise the features are digitized as shown in Figure 2.d. The common boundary between adjacent features is digitized and stored only once, so that the features abut precisely. The coordinates of each segment are stored with a unique alphanumeric segment ID with pointers to the features associated with that segment. Each feature is also stored with a unique ID with pointers to the segments that comprise it. Therefore, features may be displayed either separately (Fig. 2.e) or together (Fig. 2.f). Since a segment may be used more than once in displaying adjacent features, WVS provides a segment direction indicator (e.g. Forward or Reverse) to order the segment coordinates and to delineate the features properly.

## FEATURE CODES AND ATTRIBUTES

The features and attributes used in all the cell types comprising WVS are based on the DMA Feature Attribute Coding Standard (FACS).

## WVS DATA FILE CHARACTERISTICS

The WVS data is coded in ASCII format with a physical record size of 48 bytes. Blocks consist of 200 records for a total block size of 9600 bytes. Data are recorded on magnetic tapes at a density of 6250 bits per inch (BPI) and conform to Federal Information Processing Standards Publication 50 (FIPS PUB 50). However, upon request, magnetic tapes can be recorded at a density




(a) Features on a map

(d) Digitized Segments

(b) Digitized Polygons

(e) Individually Displayed WVS Features

(c) Display of Data Stored Sequentially

(f) Display of Data Stored in Chain-Node Structure

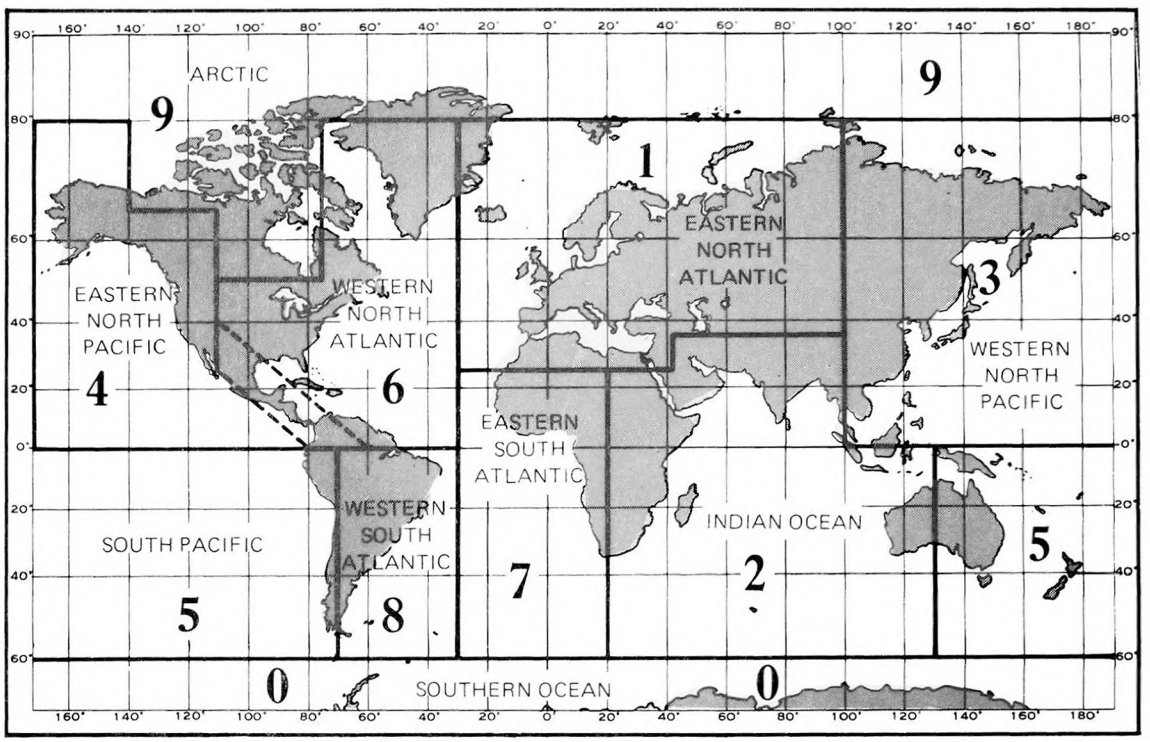
FIG. 2.— Sequential vs. Chain-Node Methods of Cartographic Data Structure. (Arrows indicate the ordering of coordinates within a segment.)

of 800 or 1600 BPI, and will conform with Federal Information Processing Standards Publications 3-1 (FIPS PUB 3-1) for 800 BPI, or Publication 25 (FIPS PUB 25) for 1600 BPI.

## WVS PRODUCTION

Full-scale production of World Vector Shoreline (WVS) was initiated in November 1987. The first edition WVS product will be produced at a scale of 1:250,000 and delineates worldwide shoreline, geopolitical boundaries, and country names. When completed, the data set will consist of 64,800 one degree by one degree cells, subdivided into ten unique ocean basin area files (see

Fig. 3). Together, the ten files form a seamless world, with the exception of Central America where there is an overlap. The names and limits of these areas are unique to WVS and do not correspond to International Hydrographic Organization (IHO) Special Publication No. 23, *Limits of Oceans and Seas.*




| AREA | CELLS | LOCATION |
|---|---|---|
| REGION 0 | 10800 | SOUTHERN OCEAN |
| REGION 1 | 6570 | EASTERN NORTH ATLANTIC |
| REGION 2 | 9180 | INDIAN OCEAN |
| REGION 3 | 7200 | WESTERN NORTH PACIFIC |
| REGION 4 | 5392 | EASTERN NORTH PACIFIC |
| REGION 5 | 9600 | SOUTH PACIFIC |
| REGION 6 | *5001 | WESTERN NORTH ATLANTIC |
| REGION 7 | 4250 | EASTERN SOUTH ATLANTIC |
| REGION 8 | 2400 | WESTERN SOUTH ATLANTIC |
| REGION 9 | 5100 | ARCTIC |
| TOTAL | 65493* | *693 OVERLAP CELLS INCLUDED BETWEEN REGIONS 4 AND 6 |

FIG. 3. — WVS File Boundaries.

WVS files are defined as follows:

0. Southern Ocean — The area south of 60°S.

1. Eastern North Atlantic — The area bounded by lines joining:

   80°N, 30°W;
   80°N, 100°E;
   35°N, 100°E;
   35°N, 42°E;
   25°N, 42°E;
   25°N, 30°W;
   80°N, 30°W.

2. Indian Ocean — The area bounded by lines joining:

   25°N, 20°E;
   25°N, 42°E;
   35°N, 42°E;
   35°N, 100°E;
   0°, 100°E;
   0°, 130°E;
   60°S, 130°E;
   60°S, 20°E;
   25°N, 20°E.

3. Western North Pacific — The area bounded by lines joining:

   80°N, 100°E;
   80°N, 170°W;
   0°, 170°W;
   0°, 100°E;
   80°N, 100°E.

4. Eastern North Pacific — The area bounded by lines joining:

   80°N, 170°W;
   80°N, 140°W;
   65°N, 140°W;
   65°N, 110°W;
   40°N, 110°W;
   0°, 60°W;
   0°, 170°W;
   80°N, 170°W.

5. South Pacific — The area bounded by lines joining:

   0°, 130°E;
   0°, 70°W;
   60°S, 70°W;
   60°S, 130°E;
   0°, 130°E.

6. Western North Atlantic — The area bounded by lines joining:

   50°N, 110°W;
   50°N, 75°W;

80°N, 75°W;
80°N, 30°W;
0°, 30°W;
0°, 80°W;
25°N, 110°W;
50°N, 110°W.

7. Eastern South Atlantic — The area bounded by lines joining:

25°N, 30°W;
25°N, 20°E;
60°S, 20°E;
60°S, 30°W;
25°N, 30°W.

8. Western South Atlantic — The area bounded by lines joining:

0°, 70°W;
0°, 30°W;
60°S, 30°W;
60°S, 70°W;
0°, 70°W.

9. Arctic — The area of lines connecting:

80°N, 140°W;
65°N, 140°W;
65°N, 110°W;
50°N, 110°W;
50°N, 75°W;
80°N, 75°W; thence eastward to
80°N, 140°W.

## PRODUCTION PROCESSES

The production process is comprised of several work flow procedures which result in the generation of the following four WVS cell types:

a. all water cells
b. all land cells (without political boundaries)
c. all land cells (with political boundaries)
d. shoreline or combination cells

The primary source of cell types a. and b. are the existing 1:250,000 Digital Landmass Blanking (DLMB) data and medium scale DMA nautical charts. They were generated utilizing a modification of the IHO Committee on the Exchange of Digital Data Format developed by the Naval Ocean Research and Development Activity (NORDA). These type cells contain a one-record header with the cell identification number, cell origin, and cell content (i.e., type) code.

The primary source for type c. cells is the Operational Navigation Charts

(ONCs) at the scale of 1:1,000,000 and referenced to the World Geodetic System (WGS-84) datum. Multiple boundary data cells are collected at the source scale, rescaled to 1:250,000, trimmed to one-degree size, and merged with shoreline cells where applicable. All boundary/lines of separation data are in accordance with U.S. Department of State requirements.

Type d. cells are produced from the conversion of DLMB data to a system specific vector data format. For areas of the world not covered by DLMB data, the best available hardcopy sources at the preferred scale of 1:250,000 were used to collect shoreline data in vector format.

All shoreline data cells and combined shoreline/boundary data cells then are converted to the final WVS output format developed by NORDA.

Country names are extracted from medium and small scale sources as approved by the U.S. Board on Geographic Names (BGN). Names data are coded (i.e., abbreviated) in accordance with the Federal Information Processing Standards Publication (FIPS Pub 10-3) and include the feature header record of the cell to which the name is associated.

## WVS DISTRIBUTION

Completion of the worldwide data set is currently scheduled for June 1989. Distribution, at the present time, is limited to the U.S. Government and qualified contractors. The Defense Mapping Agency has under review procedures to extend distribution at an as yet undetermined cost to the public upon completion of the entire data set. WVS will be available on magnetic tapes recorded at a density of 6250 bits per inch (BPI), but may be requested at 800 or 1600 BPI, and will also be available on CD-ROM in the near future.

## FUTURE EDITIONS

Additional requirements that will be investigated for future editions of WVS are:

1. Availability at several resolutions to enable the user to thin the 1:250,000 scale data set to accommodate a smaller scale application.

It has been suggested that the WVS product be available at scales of 1:250,000, 1:1,000,000, 1:3,000,000 and 1:12,000,000.

2. Incorporation of digital bathymetric and elevation data into the data file.

3. Addition of navigable rivers, major cities, lakes, airfields, major transportation routes, i.e. roads, ports, railroads, etc.

4. Ranking of features such as islands by size, similar to the ranking utilized by WDB II, to permit display at varying scales.

5. Identification of feature levels, e.g. an island within a lake within a landmass.

## References

CENTRAL INTELLIGENCE AGENCY (1977): *WDB II General Users Guide,* PB 271869, Washington, DC, July.

DEFENSE MAPPING AGENCY (1988): *Product Specifications for World Vector Shoreline.* PS/2GC/030, First Edition, Washington, DC, May.

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