A SURVEY OF DIGITAL CHART OF THE WORLD (DCW) USE AND DATA QUALITY

Christopher G. Smith
Sindre Langaas

Project Report No. 3/1995

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Christopher G. Smith

UNEP/GRID-Arendal
Longum Park, PO Box 1602, Myrene
N-4801 Arendal, Norway
E-mail: smith@grida.no
http://www.grida.no/

Sindre Langaas

UNEP/GRID-Arendal - Stockholm Office
c/o Dept. of Systems Ecology
Stockholm University,
S-106 91 Stockholm, Sweden
E-mail: langaas@grida.no

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Table of Contents

ABSTRACT

The Digital Chart of the World (DCW) is one of most comprehensive global GIS databases available to the public. There exists a wide variety of potential applications for using the DCW data, yet there is limited information about current use of DCW and its associated data quality. This brief report presents the results of a small Internet based survey of DCW use and issues of data quality. In addition, there are details on some products derived from the DCW and information of two applications of DCW use in the Arctic.

1.0 INTRODUCTION

The Digital Chart of the World (DCW) is the most comprehensive and detailed global GIS database available to the public. It has the potential to be used in variety of mapping and analysis applications, especially in data poor regions of the world or where better data are available but access to these data are limited by cost. As part of our research toward learning more about the DCW use and its data quality, we initiated a general survey to users through various Internet newsgroups and mailing lists to give users a chance to relate their experiences with the DCW. A special focus of the survey was to learn more about actual problems that users encountered while working with the data.

This brief report summarises the results of our survey and provides further information on some select DCW derived products and applications. Further details concerning DCW and data quality are reviewed by Langaas and Tveite (1995).

The DCW database, originally created from the Operation Navigational Charts (ONC) and Jet Navigational Charts (JNC), exists at a scale of 1:1 million (1:2 million for Antarctica) and contains 16 thematic layers ranging from populated places to drainage networks to ocean features and a data quality layer including information on compilation and revision dates of the source ONCs. The database was originally created by ESRI on commission for the US Defence Mapping Agency for public use to support the development and spreading of the Defence Mapping Agency's Vector Product Format (VPF), a recently developed military geographic information system (GIS) format (DMA 1992). Currently, the DCW is available from a variety of commercial GIS software vendors in formats such as ARC/INFO, MapInfo, Atlas, and Intergraph.

2.0 THE SURVEY

On October 31, 1994 we posted a questionnaire to 12 Internet Newsgroups and Mailing lists. During the next year we received 27 responses with the majority of respondents replying within 3 months from our original posting date. Of the 27 respondents, 20 people completed the survey and 7 people requested reprints of our reports.

2.1 THE QUESTIONNAIRE

The questionnaire was structured to minimise respondents' time for completion and still provide us a general overview of data use and associated data quality problems. The questionnaire included 7 questions. They are listed below:

Q1: Please provide your name, address, phone, and e-mail

Q2: Briefly describe you particular use of the DCW data.

Q3: Which geographic region(s) do you use DCW data?

Q4: Which layer(s) of the DCW are you using?

Q5: Which software package do you use to work with the DCW data?

Q6: Did you experience problems with the quality of the data?

Q7: Are you willing to provide further information concerning the quality of these data.

2.2 THE RESULTS

As an introduction to the results of our survey we present the response by ESRI (Redlands, CA) . ESRI played a large role in the automation of the DCW and subsequently have released the data on CD-ROM in their propriety GIS format - ARC/INFO. They report that over 1000 copies of the DCW have been distributed to institutions world-wide with 47% donated to educational and conservation organisation, 38% sold commercially, and 15% distributed through various marketing channels. From the copies distributed by ESRI, they summarise the use of the DCW into the following categories:

- Basemap for Global, continental and regional studies
- Basemap for natural resource mapping and analysis
- Backdrop and registration for satellite imagery
- Many cartographic product manufactures
- Country level GIS databases for developing nations
- Conservation project work all over the world
- Atlas type mapping applications

For our study, we summarised the survey responses for Questions 1-5 in various tables. For the question regarding data quality we provide a brief statement on common problems respondents experienced with the DCW, and perhaps more interesting, we also provide the actual response as supplied to us for this question.

Of the 20 replies we received, the majority came from Australia, USA, and the UK (Table 1). We had anticipated a higher number of replies, especially from the USA. Still, we were pleased with the responses and we feel that the results provide some interesting insight into the use and data quality of the DCW.

Table 1. **Summary of locations of respondents.**

Country	Number of Respondents
Australia	4
USA	4
South Africa	3
UK	2
Canada	1
Germany	1
Italy	1
Malaysia	1
New Zealand	1
Norway	1
Sweden	1
Total	20

Our second and third question asked users to provide information on their particular use of the DCW, specifically for details on their application and the location of their study areas. From our survey, we received a broad range of replies from mapping well sites in Chad to studying sea routes in Northern Russia to archaeological projects in Australia (Table 2). The most important use of the DCW seems to be in basemap preparation and atlas creation for trans-national areas or for the world in general. Another frequent use of DCW data was in hydrology and topography applications.

Table 2. Summary of data use and geographic level.

Application	Sub-national	National	Inter-national	Total
Archaeology	1			1
Cartography (includes atlases and basemaps)	1	1	5	7
Decision Support Systems	1		1	2
Environmental Assessment			1	1
Geology		1		1
Hydrology			3	3
Hyspography (includes DEM generation)			3	3
Landuse Classification		1		1
Location Tracking			1	1
Total	3	3	14	20

Our fourth question asked users to list the DCW layers that they use. From our summary of responses, the drainage layer was the most frequently used by respondents (Figure 1). Political/Ocean boundaries, Cultural Landmarks, and Populated Places layers also ranked high in use.

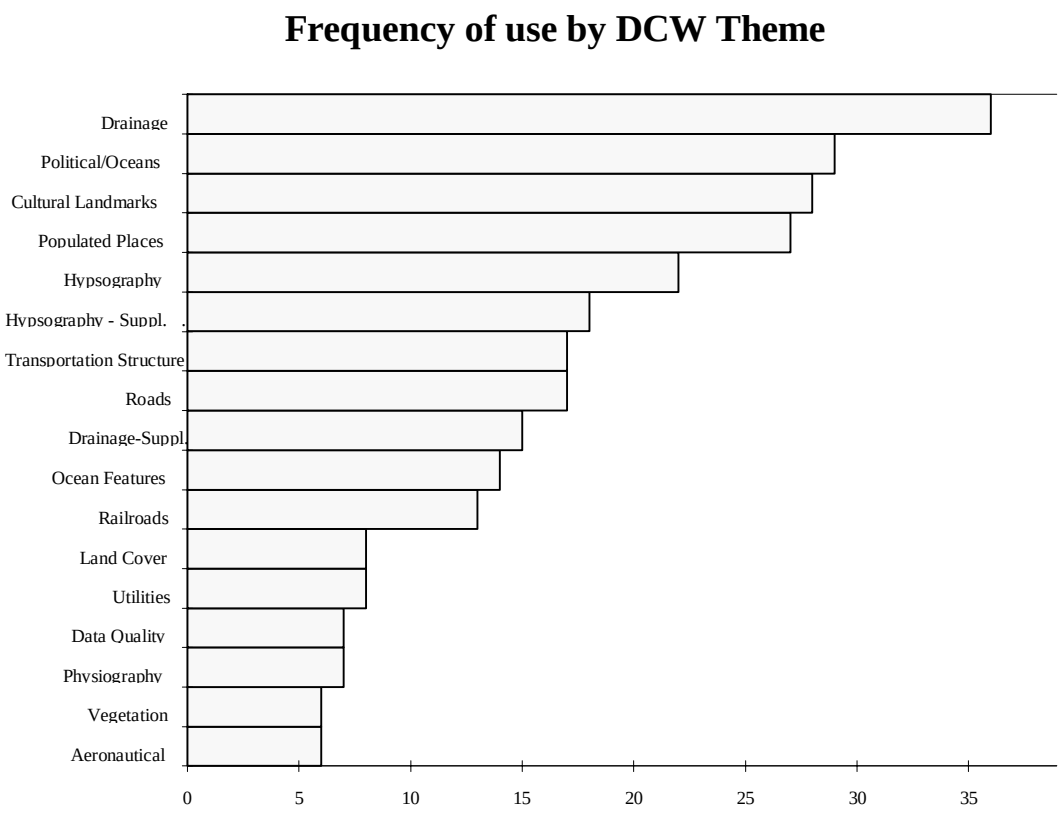

Figure 1. Chart showing the frequency of DCW themes as used by respondents (n=20) measured as percentage.

For Question Five, users were asked to list the software packages that they use to work with DCW data. The results for this question show that ESRI products, such as ARC/INFO, PC Arc/Info, ArcView, etc. were the most common response (Table 3). Interestingly, only one user was using VPFview, the software product that reads the original DMA DCW format.

Table 3. Summary of software packages used by respondents

Software	Occurrence
ARC/INFO	12
Mapinfo	4
AutoCAD	3
Custom made	3
Intergraph MGE	3
IDRISI	2
GENASYS II	1
Spans	1
VPFview	1
Total	30

Our most interesting question asked users to describe their experience with data quality problems while working with DCW data. We received a broad range of replies each with specific problems related to their own DCW data subset. A brief summary of the most common problems experienced by users is provided below:

- Trouble displaying data on computer screens and maps
- Labelling errors (e.g., mislabelled polygons/isolines)
- Out of date annotation (i.e., place names can be archaic)
- Completeness issues
- Insufficient documentation describing layers
- Problems related to database structure
- Missing data in tiles

The following paragraphs are the complete responses we received for Question 6. These statements provide some details on the exact data quality problems users experienced and some statements on general problems users encountered while working with the DCW.

1) "The problems are generally associated with the scale (1:1 million) which is too coarse for regional analyses. However, this is not due to the accuracy of the data. In the part of the world (South Africa) we experience name changes quite often, and so the annotation in many places is outdated. Again this not the fault of the DCW data, and we have manually corrected the most vital coverages. There have been a few discrepancies in the river coverage (DNNET), where rivers cross catchment boundaries and on closer inspection do not correspond

with topographic maps. This has also been corrected with manual editing, and an attempt is being made to obtain rivers at 1:500,000 scale. Some DCW dams classified as seasonal, as well as some DCW wetlands are in fact salt pans. South Africa is a largely arid country and dams are built with regularity. This render the dam coverage rapidly out of date, but not due to poor quality data."

2) "We find the high feature density of the database difficult to clearly display features on a computer er screen. Very limited attribution on many geographic features. Being able to select features based on cartographic scale would be convenient. The missing elevation data areas are frustrating particularly when working in the South America. Some Awkwardness associated with working with a database that was designed as a copy of existing paper map series."

3) "Some tiles do not display at certain scales."

4) " The DCW is useful if that is all that is available. In New Zealand better databases are available but are expensive therefore the DCW gets used. The DCW is good for getting a test of what could be done if you had access to better databases."

5) "Polygons cross themselves. Polygons are often repeated with a variance of one or two points. Data are missing in numerous areas."

6) "As expected, there are discrepancies in the coverages mainly related to tile boundaries (e.g., missing part of south coast of Crete, Krassnovodsk area of Caspian Sea coast). Assorted problems with drainage, coverage having inconsistent line work either side of a tile boundary, although some did appear to related to original ONC data. "

7) "No problems"

8) "Missing data, mislabelled edges, insufficient documentation (use of text data), specification does not match data in all cases (mostly in Browse library)."

9) "I have experienced many problems with the raw DCW database, so far specifically in South Africa and Madagascar. The problem range from poor database structure (totally altered), redundant, repeating and ambiguous isolines..."

10) "We were not satisfied with he consistency and accuracy of landcover information, especially the LCPOLY layer (and absence of VGPOLY) for this region. Also, not satisfied with large city representation in PPPOLY (size of city is not always close to reality - e.g., Helsinki). We found inconsistent labelling in PPPOINT (some labels with no attribute into; some names in all caps, some in mix of caps and small letters - difficult to select these features). We found several label errors in DSPOINT (mislabelled attributes) and found it difficult to join tile of more complicated network coverages (esp. DNNET) without exceeding software limitations (e.g., in PC Arc/Info). We were frustrated by the structure of some coverages, that is can not use PPPOLY alone to select particular cities."

11) “The charts are fairly old, and none of the new town names have been used in Zimbabwe (capital still Salisbury!) even though the changes happened about 15 years ago. South Africa has a whole new set of boundaries, and will soon have a while new set of names - some how this kind of changes needs to be incorporated into the globally available data base. No doubt similar problems exist in eastern Europe.”

12) ”Sometimes not enough detail, for example DNNET. Item fields are not defined as suggested in the data dictionary.

13) ”It is the best quality data that we have at “world coverage” and although we do from time to run into some inconsistencies they are easily rectified with a little manual editing from the regional Operational Navigational Charts... and I believe there are plans to update the data. We have overlaid the 1:2M Digital data product by the Surveys Mapping and Remove Sensing Division of NRCan, as well as their larger scale 1:250k National Topographic Data Base and have found the data to be georeferenced and generalise to an acceptable resolution for use in medium scale geological mapping projects. Overlaying TM and Spot imagery confirms that the data set is well suited for resource mapping at this scale.”

14) ”Minor problems with duplication of some rivers which needed some cleaning. General problem of not knowing exactly how up-to-date or complete the individual items are. For example, I noticed that there are virtually no “cultural landmarks” present in the data for Sicily, whereas in reality there are many famous historic monuments/temples etc. in Sicily.”

15) ”We have had problems extracting DN for tile XE22 at record 2859. There are several tiles in DN and HY in western and central Australia which appear to have no data. There are various small glitches in e.g., island in Bass Strait joined to one-another.”

16) ”Incomplete and out of date. I would not like to comment on the accuracy at this stage.”

17) ”Contours mislabelled; hydrology in spaghetti format rather than topologically-structured from Source to sink; hydrology not properly named and labelled; inconsistent quality of contours (sometimes 250 foot present, other times not).”

18) ”It is generally untrustworthy for any accurate work without calibration, but great for planning. But, I know this and appreciate its limitations but it is the only coverage of its type available in the world today.”

19) ”In general we were very satisfied with the DCW data. Our study area is in Northern Russia and the DCW is the best available data for this area. However, we noticed considerable problems along the coast with the DN and PO coverages. Often, we found open sea areas coded as lakes or rivers and included as part of Russia’s political boundary. This was a problem for us since we were mapping sea route traffic and areas around Russian ports. These errors may be a

function of scale, yet on smaller scales maps (1:5,10,30 Million) some of these same areas were coded correctly as open water."

20) "Drainage data for Chad (wells, wadis) are not of a good quality (according to a hydrologist who travelled the country several times). This is what he said when I used drainage DCW-data as a basis for Thematic Mapping of the results of his year long field work."

3.0 EXAMPLES OF DCW PRODUCTS AND APPLICATIONS

As a follow-up to our questionnaire, we chose to briefly describe some applications that make use of DCW data. The first section describes two products that have been created from the DCW and the second section describes two applications that incorporate the DCW into modelling routines and decision support systems.

3.1 PRODUCTS

3.1.1 Africa Data Sampler

The Africa Data Sampler (ADS) is a project initiated by the World Resources Institute (WRI) to develop a series of digital maps for every country in Africa. The data samplers incorporate drainage, topography, and infrastructure data from the DCW along with protected areas data from the Biodiversity Map Library of the World Conservation Monitoring Centre and sub-national boundaries with selected demographic statistics from the National Center of Geographic Information Analysis, University of California, Santa Barbara. A goal of the project is to promote the use of spatial information into decision making and the policy planning process and to provide a mechanism to view environmental resources in Africa countries. Using data from this project, natural resources from different countries can be merged to create regional, watershed, other transborder maps.

WRI hopes that this project encourages other data collection activities that will work toward developing more "up-to-date and accurate georeferenced databases, especially at the national and local level."

The data provided in ARC/INFO format and are available on diskettes for individual countries or on CD-ROM for the entire continental data. The ADS guided tours and views are accessible through ArcView 1. For further information about availability of the Africa Data Sampler contact the address below.

Africa Data Sampler Project
World Resources Institute
1709 New York Avenue, NW
Washington, DC 20006
USA

fax: +1 (202) 638 - 0036
email: nhenninger@wri.org

3.1.2 DCW derived Digital Elevation Model data

The US Geological Survey EROS Data Center in cooperation with UNEP/GRID-Sioux Falls have initiated a project to develop a global 30 arc-second Digital Elevation

Model (DEM). The project uses DCW hypsography and drainage layers to create an equally spaced elevation model. The processing steps to create the DEMs include Drainage Orientation and DEM generation. In the Drainage Orientation process, stream networks and hypsography data are processed to ensure that all streams are represented as flowing downhill. These data are then used as input into the Australian National University Digital Elevation Model generation program (M Hutchinson, Center for Resources and Environmental Studies, ANU) which creates a grid at 30 arc-second intervals.

To date, the following data sets are available online at the EROS Data Center: Africa, Haiti, Madagascar, and Japan. DEM's for Europe and South America are near completion. The data are available without charge through and internet anonymous File Transfer Protocol account (FTP to edcftp.cr.usgs.gov). For further information on technical details or on an update on
soon to be released data, contact the address below.

Customer Services
U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57198
Tel: 605-594-6151 (7:30 am to 4:00 pm CT)
TDD: 605-594-6933 (7:30 am to 4:00 pm CT)
Fax: 605-594-6589 (24 hours)
Internet: custserv@edcserver1.cr.usgs.gov (24 hours)

or visit the URL http://sun1.cr.usgs.gov/glis/hyper/guide/30asdcwdem

3.2 APPLICATIONS

3.2.1 Wilderness Quality Mapping in the Euro-Arctic

The Wilderness Quality mapping project was initiated by the Norwegian Directorate for Nature Management (Norway), UNEP/GRID-Arendal (Norway), and the National Remote Sensing Centre (UK) to develop a methodology for wilderness quality mapping in Northern areas and to assess environmental quality in the Barents Region. For this project Wilderness Quality is defined as the extent to which the nature is changed or disturbed due to influence from modern society. The project has attempted to assess wilderness quality by applying a methodology developed by the Australian Heritage Commission.

For the Barents region, DCW data served as the primary data input into creating three indicator maps; remoteness from settlement, remoteness from access, and apparent naturalness. The remoteness from settlement maps used the Populated Places and Cultural Landmark features from the DCW. The remoteness from access maps included Railroads, Roads, Aeronautical, and Land Cover features and the Apparent Naturalness maps incorporated Transportation Structures, Utilities, Roads, Railroads, Aeronautical, Populated Places, and Land Cover features.

Further details about this project are available from

Even Husby
UNEP/GRID-Arendal
Longum Park
PO Box 1602, Myrene
N-4801 Arendal, Norway
husby@grida.no
Phone +47 370 - 35650
Fax +47 370 - 35656

A paper on this application is online at URL
http://www.esri.com/resources/userconf/proc95/to150/p113.html

3.2.2. INSROP GIS: A Decision Support System for the Northern Sea Route

Initiated in 1993, The International Northern Sea Route Program (INSROP) is a multidisciplinary and multilateral research program that examines the physical, environmental, political, and economic factors that affect transit through Russia's Northern Sea Route. The three principal partners are, Central Marine Research & Design Institute (CNIIMF), St.Petersburg, Russia, Ship and Ocean Foundation (SOF), Tokyo, Japan and Fridtjof Nansen Institute (FNI), Lysaker, Norway.

In order to facilitate storage, retrieval and analysis of information obtained within the INSROP programme, an INSROP Information System based on GIS technology was developed. The system, called INSROP GIS, has been jointly developed by the researchers in the physical and environmental sub-programmes.

INSROP GIS uses DCW data extensively, especially the Political/Ocean, Populated Places, and Drainage themes, for use in operational and accidental impact scenarios as well as for creating environmental atlases of the region. Further information about the INSROP GIS can be obtained from the address below:

Stig M. Løvås
SINTEF NHL
Klæbuveien 153
7034 Trondheim
Norway
email: stig.m.lovas@nhl.sintef.no

or from URL http://www.npolar.no/insrop/gis.htm

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5.0 REFERENCES

Defence Mapping Agency. 1992. Military Specification for Vector Product Format. MIL-STD-600006.

Langaas, S. and H. Tveite. 1995. Selected papers from the DCW data quality project. Project Report No. 1/1995 DCW Data Quality Project, UNEP/GRID-Arendal. 36 pages.