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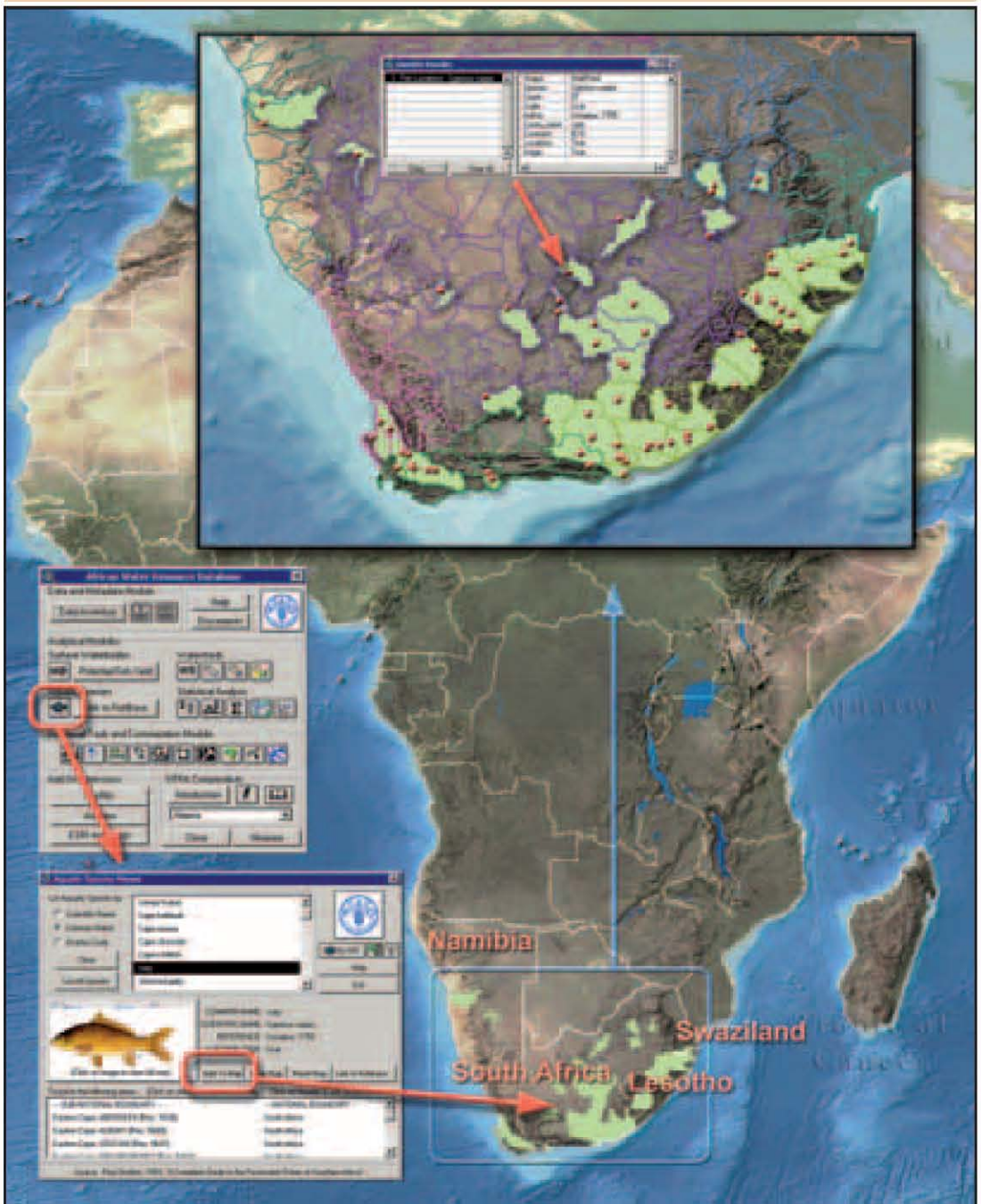
African Water Resource Database

GIS-based tools for inland aquatic resource management

2. Technical manual and workbook



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2. Technical manual and workbook

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Preparation of this document

This study is an update of an earlier project led by the Aquatic Resource Management for Local Community Development Programme (ALCOM) entitled the "Southern African Development Community Water Resource Database" (SADC-WRD).

Compared with the earlier study, made for SADC, this one is considerably more refined and sophisticated. Perhaps the most significant advances are the vast amount of spatial data and the provision of simplified and advanced custom-made data management and analytical tool-sets that have been integrated within a single geographic information system (GIS) interface.

The publication is presented into two parts to inform readers of various levels of familiarity with the benefits of spatial analyses for aquatic resources management.

Part 1 is divided into two main sections:

- The first section is aimed at administrators and managers with only a passing knowledge of spatial analyses but who would be interested to know the capabilities of the African Water Resource Database (AWRD) to assist with their decision-making. They may be department or division heads in government, non-governmental organizations (NGOs) and international organizations. Thus, a few examples of decision-making at this level based on spatial analyses from AWRD are described.
- The second section is addressed to professionals in technical fields who may actually or potentially employ the results of spatial analyses in their work. They may be in international organizations, government, universities or in the commercial sector. The case studies best serve to inform them of AWRD capabilities.

Part 2 is also divided into two main sections:

- The first section is written for spatial analysts in government, international organizations or the private sector.
- The second is for university teachers and students who may wish to use AWRD for educational purposes. This section includes a workbook with exercises, offering educational possibilities of AWRD.

Foreword

The "Status and Development of the African Water Resources Database (AWRD)" was presented at the twelfth session of the Committee for Inland Fisheries of Africa (CIFA) held in Yaoundé, Cameroon, from 2 to 5 December 2002. The Committee acknowledged that such GIS-based products are "powerful tools for fishery and aquaculture management, planning and development." The Committee also noted that there were still outstanding issues to be resolved before such tools could practically and effectively be used by Member countries. The present report represents the follow-up activities based on CIFA's recommendations.

Inland aquatic resources in developing regions around the world are immensely significant for food security as well as economic growth and poverty alleviation. However, the rational and sustainable use of essential resources is critical. The multi-purpose nature of inland water use patterns creates distinct sets of challenges for implementation of responsible development and management measures, and hence to the promotion of water, food and environmental security.

Geospatial information is increasingly being used for better understanding development issues and improving decision-making. The Millennium Development Goals (MDG) and their 2015 targets for halving the proportion of people living with hunger and poverty, and improving living conditions in the sector of education, gender, health and sanitation have heightened this awareness.

This report is one of a series of GIS-based publications under production by FAO's Aquaculture Management and Conservation Service (FIMA) to update an earlier project led by the Aquatic Resource Management for Local Community Development Programme (ALCOM) entitled the "Southern African Development Community Water Resource Database" (SADC-WRD). The body of work presented represents both an expansion to the data and an enhancement of the original SADC-WRD analytic interface. Extended to cover the entire African continent, the new WRD has been entitled the "African Water Resources Database" and it is aimed at facilitating responsible inland aquatic resource management. It thus provides a valuable instrument to promote food security.

The AWRD allows for the integration of different types of information, e.g. fishery statistics, into a cohesive program that, because of its visual nature, is easy to understand and interpret. Systems such as the AWRD are excellent means to attract and direct investments in aquaculture and fisheries development.

I am confident that further explorations and applications of the AWRD data will deepen our understanding of inland aquatic resource management and will demonstrate the usefulness of the AWRD tool, whilst being immediately applicable to assist in a wide variety of recent issues addressed at CIFA such as: improving the reporting on status and trends in inland fisheries and aquaculture; co-management of shared inland fisheries resources; transboundary movements of aquatic species; and increased participation of stakeholders in the decision-making process about watershed area uses.

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Abstract

This report represents a follow-up activity based on the recommendations by the Committee for Inland Fisheries of Africa (CIFA). The report is an update of an earlier project led by the Aquatic Resource Management for Local Community Development Programme (ALCOM) entitled the "Southern African Development Community Water Resource Database" (SADC-WRD). The body of work presented in this publication represents both an expansion to the earlier data and an enhancement of the original SADC-WRD analytic interface. Extended to cover the entire African continent, the new set of data and tools has been entitled the "African Water Resource Database" (AWRD). The overall aim of the AWRD is to facilitate responsible inland aquatic resource management. It thus provides a valuable instrument to promote food security.

The AWRD data archive includes 28 thematic data layers drawn from over 25 data sources, resulting in 156 unique datasets. The core data layers include: various depictions of surface waterbodies; multiple watershed models; aquatic species; rivers; political boundaries; population density; soils; satellite imagery; and many other physiographic and climatological data types. The AWRD archival data have been specifically formatted to allow their direct utilization within any geographic information system (GIS) software package conforming to Open-GIS standards. To display and analyse the AWRD archive, the AWRD also contains a large assortment of new custom applications and tools programmed to run under version 3 of the ArcView GIS software environment (ArcView 3.x). There are six analytical modules within the AWRD interface: 1) the Data and Metadata Module; 2) the Surface Waterbodies Module; 3) the Watershed Module; 4); the Aquatic Species Module; 5) the Statistical Analysis Module; and lastly, 6) the Additional Tools and Customization Module. Many of these tools come with simple and advanced options and allow the user to perform analyses on their own data.

The case studies presented in this publication illustrate how the AWRD archive and tools can be used to address key inland aquatic resource management issues such as the status of fishery resources and transboundary movements of aquatic species. This publication by no means cover all the issues that could be resolved using the AWRD, but they do provide a solid reference base for inland aquatic resource management in Africa. Based on a review and recommendations by CIFA, a number of opportunities to implement the AWRD tools and data in Africa have already been identified. Likewise, a number of future developments for the AWRD have been proposed, including AWRD-like frameworks for Latin America and Asia.

This publication is organized in two parts to inform readers who may be at varying levels of familiarity with GIS and with the benefits of the AWRD. The first part describes the AWRD and is divided into two main sections. The first presents a general overview and is addressed to administrators and managers while the second is written for professionals in technical fields. The second part is a "how to" supplement and includes a technical manual for spatial analysts and a workbook for university students and teachers.

The primary AWRD interface, tool-sets and data integral to the function of the AWRD are distributed in two DVD's accompanying part 2 of this publication and are also available for download on the Internet in FAO's GeoNetwork and GISFish GIS portals. A more limited distribution of the above primary database/ interface, but divided among ten separate CD-ROM disks, is available upon request to FAO's Aquaculture Management and Conservation Service. Also, high resolution elevation datasets and images amounting to 38 gigabytes are available upon request for those who need them.

Jenness, J.; Dooley, J.; Aguilar-Manjarrez, J.; Riva, C.
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Appreciation goes to John Moehl for his general advice; Luigi Maiorano, for his contributions to the technical edits of part 2 of the present publication; and John Jorgensen for his review of part 1 and for suggesting references to the introduction of this publication.

Patrizia Monteduro prepared the AWRD archive datasets for their publication on the Internet in FAO's GeoNetwork GIS portal, and Roberto Giaccio wrote the script to convert the metadata documentation from the AWRD archive into an XML format for display in GeoNetwork.

Emily Garding made a final quality check on the AWRD tools and tested the exercises presented in the workbook of part 2 of this publication.

The authors benefited from the data provided by Jippe Hoogeveen on the "Atlas of Water Resources and Irrigation in Africa" and by John Latham on "Africover" databases.

The following persons are recognized for their support, in alphabetical order: Devin Bartley, Gertjan de Graaf, Ashley Halls, Matthias Halwart, Eric Reynolds, Doris Soto, and Ashley Steel.

Some of the locational referencing tools for the AWRD were adapted from original tools developed for the McLennan Co. 9-1-1 Emergency Assistance District in Waco, Texas, the United States of America, and are presented here with their permission. Several general purpose tools, including the Select by Theme tool, the Query Builder tool, the Summarize tool and the statistics Histogram window, are adapted from original tools developed for the Saguaro project (University of Arizona; Tucson, Arizona, the United States of America, and are also presented here with their permission. We gratefully acknowledge the generosity of both organizations for sharing these resources with us.

We thank all the organizations which created the datasets and made them available for our use.

Chrissi Smith, Françoise Schatto-Terrible and Tina Farmer proofed the document and supervised its publication. The document layout specialist was Nadia Pellicciotta.

Contents

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Acronyms and abbreviations

ADM	Administrative data layer
AFDS	African Data Sampler
AGLW	Agriculture, Land and Water Division
AIMG	Ancillary Image and Map Graphic
ALCOM	Aquatic Resource Management for Local Community Development Programme
ANNO	Annotation
ANOVA	Analysis of Variance
AOI	Area Of Interest
AQSP	Aquatic Species
ARAS	Ancillary Raster
ASCII	American Standard Code for Information Interchange
AVEC	Ancillary Vector
AWRD	African Water Resources Database
AWRIA	FAO-AGLW's African Water Resources and Irrigation in Africa
BADC	Belgian Administration for Development Cooperation
BIL	Band Interleaved by Line raster data format
BIP	Band Interleaved by Pixels image file format
BMP	Bitmap
BNA	Early ASCII mapping format for Atlas-Graphics thematic mapping package
BSQ	Band Sequential image file
CCRF	FAO Code of Conduct for Responsible Fisheries
CD	Compact Disk
CGM	Computer Graphics Metafile
CIA	US Central Intelligence Agency
CIFA	Committee for Inland Fisheries of Africa
CRES	Centre for Resource and Environmental Studies
CRU	Climate Research Unit
DAF	Digital Atlas of Africa
dBASE	Database
DBC	Database Component
DCW	Digital Chart of the World
DD	Decimal Degrees
DEM	Digital Elevation Model
DMA	The former U.S. Defense Mapping Agency, which is now entitled the U.S. National Imagery and Mapping Agency (NIMA)
DN/DNNET	DCW Drainage Network layer
DPI	Dots-Per-Inch
DTED	NIMA's Digital Terrain Elevation Data at various raster postings
EC	European Commission
ECW	Earth Resource Mapping's "Enhanced Compression Wavelet" format for raster imagery
EDC	United States Geological Survey Earth Resources Observation Systems (EROS) Data Center

EMF	Enhanced Metafile Format
EPS	Encapsulated Postscript (file extension)
EROS	Earth Resources Observation Systems
ESAD	NASA's Earth Science Applications Directorate
ESRI	Environmental Systems Research Institute, Redlands, California
ETM+	Landsat Enhanced Thematic Mapper Data
ETOPO2	A 2 minute Elevation Topographic DEM including bathymetry
ETOPO5	An early global 5 minute DEM
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FIMA	Aquaculture Management and Conservation Service
GARP	Genetic Algorithm for Rule-Set Production
GeoCover-LC	Land Cover based on Ortho-Rectified LandSat Imagery
GeoNet	Gazetteer Name Server
GeoNetwork	FAO's Spatial Data and Information Portal
GIEWS	FAO's Global Information and Early Warning System
GIF	Graphic Interchange Format (file extension)
GIS	Geographic Information Systems and software platforms
GIWA	Global International Water Assessment
GLOBE	NOAA distributed release of GTopo30
GNS/GeoNet	NIMA's Geographic Names Server Gazetteer of Named Locations
GSDI	Global Spatial Data Infrastructure clearing-house for SDI
GSM	Golden Software Map, a proprietary GIS format
GT30/GTopo30	Global Topographic 30 arc second DEM database, nominal 1km postings
GT30BATH	Combined GTopo30 and Scripps/Smith and Sandwell Bathymetry
GUI	Graphical User Interface
GZTR	Gazetteer/Named Location
H1k/HYDRO1k	Global Hydrological 1 kilometre database
HTML	Hyper Text Markup Language
HYD	Hydrological feature subset of the LC/LCPOLY (DCW Land Cover layer)
ID	Identifier, usually denoting a unique numerical or alphanumeric code
IEBM	Image Export and Base Mapping tool-set of the AWRD
IHO	Standards for Maritime Waterbodies based on the International Hydrographic Bureau of the International Hydrographic Organization
ISCGM	International Steering Committee for Global Mapping
ISO	International Organization for Standardization
IW	VMap0 Inland Water layer
JPG/JPEG	Graphics file type/extension (lossy compressed 24 bit color image storage format developed by the Joint Photographic Experts Group)
JPL	NASA's Jet Propulsion Laboratory
JRC	Joint Research Centre of the European Commission
LAEA	Lambert Azimuthal Equal Area projection system
LC/LCPOLY	DCW Land Cover layer
LCL	Lower Confidence Limit
LME	Large Marine Ecosystems

LO	Layout
LOE	Level of Effort
LWDD	FAO's Land and Water Development Division
MADE	Multipurpose land cover databases
MGLD	MSSL Global Lakes Database
MM	The secondary maritime encoding parameter pertaining to the proposed FAO hydrological encoding standard
MODIS	Moderate resolution imaging spectroradiometer sensor on Terra satellite
MrSID	LizardTech's commercial compression format for spatial imagery
MSSL	Mullard Space Science Laboratory
NASA	U.S. National Aeronautical and Space Administration
NGA	National Geospatial-Intelligence Agency (new name for NIMA)
NGDC	NOAA's National Geo-Physical Data Center
NGO	Non-Governmental Organization
NIMA	U.S. National Imagery and Mapping Agency, formerly the U.S. Defense Mapping Agency (DMA)
NOAA	U.S. National Oceanographic and Atmospheric Administration
ODB	Object Database
ONC	Operational Navigation Charts
ORNL	U.S. Oak Ridge National Laboratory
Ortho/ORTH	Orthographically-rectified, i.e. flattened or adjusted for elevation changes
OrthoTM	Ortho-rectified or flattened imagery
OS	Operating System
OVRVW	A virtual Overview map
PAIA	FAO's Priority Areas for Interdisciplinary Action
PDF	Portable Document Format (Adobe Acrobat)
PNG	Portable Network Graphics (graphic file standard/extension)
PS	PostScript (file name extension)
PTES or Pfaf	Pfafstetter Topological Encoding Scheme, a 5 to potentially 22 long numeric digit or encoding string for encoding spatially based continental hydrographic data.
PY	Potential Yield
PYPUA	Potential Yield per Unit of Area
RAID	Redundant Array of Inexpensive Disks
RDBMS	Relational Database Management Systems
RGB	3 band spatial imagery forced into the Red:Green:Blue spectrum
RIV	Rivers and Drainage/Flow
RRSU	The SADC Regional Remote Sensing Unit located in Harare Zimbabwe
SADC	The Southern African Development Community
SAIAB	South African Institute for Aquatic Biodiversity (formerly known as JLB Institute of Ichthyology)
SARPO	The Southern African Regional Programme Office of WWF located in Harare Zimbabwe
SDE	see Manual (subsect. Excel Import and Export Tools)
SDI	Spatial Data Infrastructure
SHD	Shaded Relief

SIFRA	Source Book for the Inland Fisheries Resources of Africa
SRTM	Shuttle Radar Topography Mission
SSN-TF	FAO's Spatial Standards and Norm Task Force
SWB	Surface Waterbody
TIF/TIFF	Tagged Image File Format (graphics/image file format)
TM	Landsat Thematic Mapper.
TOC	Table Of Contents
TOR	Terms of Reference
U.S.	The United States
UCL	Upper Confidence Limit
UFI	Unique/Universal Feature Identifier
UN	United Nations
UN-CS	United Nations Cartographic Section
UNEP	United Nations Environment Programme
UN-GD	The UN-CS 1:10-1:5 million Global GIS Database
UNGIWG	United Nations Geographic Information Services Working Group
UNL	University of Nebraska at Lincoln, USA
URI	University of Rhode Islands, USA
URL	Universal Resource Locator for the identification of specific locations or web-sites on the WWW
USAID	The U.S. Agency for International Development
USFS	The U.S. Forestry Service
USGS	The United States Geological Survey
UTM	Universal Transverse Mercator
VMAP	NIMA's Vector Smart Map standard for various scales of vector data
VMAP0	Vector Map for Level 0
VPF	NIMA's Vector Product Format for the encoding of VMAP data libraries
VRTL	A seamless 1:750 000 Virtual basemap
WC	Water Course layer of VMAP0
WCMC	World Conservation Monitoring Centre
WDBII	CIA's 1:3 - 1:5m scale World Database II
WGS	World Geodetic Standard, 1984 standard datum and spheroid
WMF	Windows Metafile (file name extension)
WRD	The original SADC Water Resource Database produced by ALCOM
WRI	World Resources Institute
WS	Watersheds
WTLND	Wetlands
WVS	World Vector Shoreline
WWF	World Wide Fund for Nature (known as World Wildlife Fund in the U.S.)
WWW	World Wide Web