

## 2.2 SPATIAL DATA

The primary purpose for which the AWRD data archive was developed was to assist less advanced GIS users in Africa—who may not have the training, resources or access to the Internet necessary to download and process raw data themselves—with as comprehensive a set of data as possible consistent with the analytical and visualization requirements defined for the AWRD. A secondary goal was to compile the archive in as rigorous a manner as possible so that the data would be useful to both advanced users of the AWRD as well as scientists within the FAO and the broader international development community. A final goal was to compile certain datasets in such a way that users without access to ESRI's commercial add-on Spatial Analyst and 3D Analyst modules could both analyze and visualize that data easily using the AWRD analytical tools.

Similar to the SADC-WRD, the data contained within the AWRD archive have been organized to facilitate their retrieval via Database Components (DBC). The original SADC-WRD contained four database components: the Surface Waterbody DBC, the Watershed DBC, River DBC and Aquatic Species DBC. However, with the exception of the Aquatic Species DBC which has been only slightly modified from this original baseline, both the spatial extent and depth of archival data compiled for the AWRD have been significantly expanded. Further, in direct comparison to the original SADC-WRD, the AWRD currently provides seamless coverage of continental Africa and related African island states, and in some case the world, while the original SADC-WRD was limited to only a portion of southern Africa. Table 2.1 presents a comparison of the data within these two editions of the WRD.

Efforts were made to reduce the use of technical terms in this section but in many cases this was not possible. Users are recommended to consult the glossary section presented in this publication whenever necessary.

In addition to the relative increase in the number of datasets which allow for the continental expansion of analyses via the AWRD interface, significant in Table 2.1 is the increased number of thematic data layers made available by DBC for this edition of the archive. These layers include not only topographic, physiographical and climatological data – providing the analytic baselines for the AWRD – but also extensive compilations of multi-scale vector data, digital elevation data and satellite imagery to support landscape visualization and base mapping. Combined, these refinements developed for the AWRD comprise what is likely the most comprehensive archive of water management and base resource mapping data ever compiled for Africa.

As currently structured, the AWRD archive is comprised of resource material from some twenty-eight spatial data sources or institutions. Table 2.2 contains an index of the twenty-eight general categories into which data from the AWRD archive can be classified.

From Table 2.2 it can be seen that an extensive archive of data has been provided for analysis and visualization within the AWRD. Because the scales and resolutions of the original source data listed in Table 2.2 are reported in a variety of measures, where possible a comparative scale value based on the nautical mile<sup>5</sup> has been estimated for the raster data listed in the table.

<sup>5</sup> A nautical mile, i.e. a sea or geographic mile, has been standardized at 1.852 km representing the average length of one minute of arc of latitude. Because: (a) the pixel size of non-metric raster data is often reported as arc seconds, minutes or portions of a degree; and (b) the size of projected rasters will vary when transformed into a decimal degrees based on their global location, the nautical mile provides a simple norm for comparison. For example: the measures 30 arc seconds, nominal 1 Km or 0.00833° have been used to describe the size of the GTopo30 DEM data; and the measures 3 arc seconds, 0.00833° and nominal 90 metre are used to describe the more refined publicly available SRTM data. In nautical miles, these data measure 0.5 NM and 0.05 NM respectively.

TABLE 2.1  
Comparison of SADC-WRD and AWRD

Topic	SADC Water Resources Database	African Water Resources Database
Spatial Coverage Database Components (DBC's)	Southern African Development Community Four Database Components: Surface Waterbody, Watershed, Rivers and Aquatic Species	Continental Africa, Madagascar and Island States Eight Database Components: Surface Waterbody, Watershed, Rivers, Aquatic Species, Gazetteer, Ancillary Raster, Ancillary Vector, and Ancillary Image.
Vector Data Format(s) and scale	Proprietary, BNA, and flat ASCII 1:250 000 for some point data and 1:1 000 000 for polygonal and linear features	ESRI Shapefile, nominally an Open-GIS format. 1:65 000 to 1:5 000 000 for a range of point, line and polygon features
Grid Data Format(s) and resolution	WinDisp-IML and IDRISI (OpenGIS) 1 kilometer	ESRI Grid and JPEG 2000, including full resolution point and polygon vector derivatives for climate and rainfall data. 1 to 5 kilometers, with some 15 to 30 meter localized or 500 meter continental imagery
Tabular Data Format(s)	Lotus Approach, dBase3, ASCII text	dBaseIV
Relative number of data layers	4 thematic data layers comprised of 10 datasets from four data sources	28 thematic data layers comprised of 156 totally unique datasets from over 28 data sources or libraries.
Surface Waterbody Database Component	2 data layers	19 data layers
Watershed Database Component	1 watershed model	3 complex watershed (WS) models, 1 basic WS delineation, and 1 integrated maritime/terrestrial WS reference
Rivers Database Component	1 data layer	6 data layers
Aquatic species	1 data layer	1 data layer, and 2 web based resource "layers"

Terminology: SADC (Southern African Development Community); WRD (Water Resources Database); ESRI (Environmental Systems Resource Institute); GIS (Geographic Information System); ASCII (American Standard Code for Information Interchange); BNA (a generic ASCII based vector data format).

TABLE 2.2  
Topical listing of source data comprising the AWRD archive

Data Type or Category	Source Institution	AWRD Extent	Source Data Type	<sup>1</sup> Source scale - resolution	<sup>2</sup> Comparative analytical / map scale	Description
Air Temperature	CRES	Africa	Raster	0.05°	3-NM / 1:20 000 000	Cumulative and monthly summaries of temperature
Aquatic Species	FishBase	Global	Text Point	n.a	n.a / 1:2 000 000	Internet based resource of terrestrial and marine species
	SAIAB	SADC	Point	n.a	n.a / 1:1 000 000	Capture records for 700+ fresh water fish species
Bathymetry	ETOPO2	Global	Raster	0.03333°	2-NM / 1:12 500 000	Nominal 3.7 Km bathymetry and terrestrial elevation values
Climate	CRU	Africa	Raster	0.16667°	10-NM / 1:70 000 000	30 year cumulative/monthly summary for 8 climate types
Coastline – Administrative	WVS+	Africa	Vector	1:250 000	n.a / 1:250 000	Linear and polygonal coastal, country and bathymetry
Digital Elevation Model	SRTM-GTopo30	Africa	Raster	0.00833°	0.5-NM / 1:3 500 000	DEM building on GTopo30, with ETopo2 bathymetry
	SRTM	Volta	Raster	0.000833°	0.05-NM / 1:350 000	Seamless nominal 90 metre DEM of Volta megabasin
	SRTM	Africa Tanganyika	Raster	0.000833°	0.05-NM / 1:350 000	Seamless DEM covering Lake Tanganyika basin-Watershed
Framework Library	VMap0 5th Edition	Africa Africa	Vector	1:1 000 000	n.a / 1:1 000 000	20 plus topical data layers
	RWDBII	Global	Vector	1:3 000 000	n.a / 1:3 000 000	14 plus topical data layers
Gazetteer	GEOnet	Africa	Point	1:250 000	n.a / 1:250 000	1.2 million named locations under 6 major topical classes
Gazetteer and Annotation	DCW	Global Africa	Point	1:1 000 000	n.a / 1:1 000 000	Over 20 000 named locations and map annotation labels
Human Population	ORNL	Africa	Raster	0.00833°	0.5-NM / 1:3 500 000	Weighted human population density, available by WS
Hydrologically Filled DEM	HYDRO1k	Africa	Raster	1 kilometer	0.5-NM / 1:3 500 000	Modified GTopo30 DEM for flow routing networks
	WRIA	Africa	Raster	1 kilometer	0.5-NM / 1:3 500 000	Modified GTopo30 DEM for irrigation run-off networks
Land Cover – AfriCover	FAO	Eastern Africa Africa	Vector	~1:250 000	0.015-NM / 1:250 000	Standardized regional land cover classification baseline
Land Cover – GLC2000	JRC	Africa Africa	Raster	0.00833°	0.5-NM / 1:3 500 000	Standardized year 2000 land cover classification baseline
Large Marine Ecosystems and Terrestrial Basins	GIWA	Global	Vector	~100 000 cell	n.a / 1:20 000 000	A basin delineation of land and related marine environments
Limnological, World Lakes and Rivers	FAO	Global	Tabular Point	n.a	n.a / 1:5 000 000	A series of inter-linked tables based on literature research
Major River Basins	WRI	Global	Vector	~250 000 cell	n.a / 1:65 000 000	Broad delineation of major basins, State of Environment

Data Type or Category	Source Institution	AWRD Extent	Source Data Type	Source scale - resolution	<sup>2</sup> Comparative analytical / map scale	Description
Physiography, Hypsography	DCW	Africa	Vector	1:1 000 000	n.a / 1:1 000 000	Harmonized bathymetry, coastline and terrestrial elevation
Pseudo 3D Backgrounds	FAO	Africa	Image	Varied	all scales	Enhanced 2.5d satellite and elevation background images
Rainfall	EDC	Africa	Raster	8 kilometers	4.3-NM / 1:30 000 000	12 year time series with monthly and annual summaries
Satellite Based Imagery	ETM+ Browse	Africa	Image	465 metre	0.25-NM / 1:1 750 000	Seamless medium resolution African satellite image mosaic
	TM	Volta	Image	28 metre	0.015-NM / 1:125 000	Beta test case for seamless mosaicing of TM imagery
	ETM+	Tanganyika	Image	15 metre	0.008-NM / 1:65 000	Beta test case for seamless mosaicing of ETM+ imagery
	MODIS	Africa	Image	0.00833°	0.5-NM / 1:3 500 000	2.5d enhanced version of NASA Blue-Marble mosaic
Soils	FAO	Africa	Vector	1:5 000 000	n.a / 1:5 000 000	Major soil great groups and characteristics for continent
Surface Waterbodies	SRTM	Africa	Vector	~1:100 000	0.015-NM / 1:125 000	Highest resolution waterbody and coastal mask of Africa
	DCW	Africa	Vector	1:1 000 000	n.a / 1:1 000 000	Consolidation of SWB features, DNNET-LCPOLY
	VMap0 - DCW	Africa	Vector	1:1 000 000	n.a / 1:1 000 000	Harmonized DCW and VMap0 "named" SWB features
Virtual Base Maps	FAO	Africa	Image	1:750 000	0.15-NM / 1:1 000 000	Seamless virtual maps for use either in or outside of GIS
Water Temperature	FAO	Africa	Raster	0.05°	3-NM / 1:20 000 000	Cumulative and monthly summaries of temperature
Watershed Model	WWF ALCOM	Africa	Vector	5 000 cell	n.a / 1:2 500 000	A three level named watershed model of continental Africa
Watershed - River - Irrigation	FAO	Africa	Vector	10 000 cell	n.a / 1:5 000 000	Rivers, surface waterbodies and 2 level watershed model
Watershed and Flow Network	HYDRO1k	Africa	Raster	4 000 cell	n.a / 1:2 000 000	A six level watershed model and derivative flow routes
Wetlands	WCMC	Africa	Vector	1:1 000 000	n.a / 1:1 000 000	Seamless recompilation of country based separates

Terminology: ALCOM (Aquatic Resource Management for Local Community Development Programme); CRES (Centre for Resource and Environmental Studies); CRU (Climate Research Unit, East Anglia University); DCW (Digital Chart of the World); DEM (Digital Elevation Model); DNNET (DCW drainage network layer); EDC (United States Geological Survey Earth Resources Observation System (EROS) Data Center); ETM+ (Landsat Enhanced Thematic Mapper); ETopo2 (2-minute elevation terrain DEM); FAO (Food and Agriculture Organization of the United Nations); GEOnet (Gazetteer Name Server); GIWA (Global International Waters Assessment); GTopo30 (Global 30 arc second topography database); HYDRO1k (Global 1 kilometre hydrological database); JRC (Joint Research Centre of the European Commission); LCPOLY (DCW land cover polygon layer); MODIS (Moderate resolution imaging spectroradiometer sensor aboard the Terra satellite); NIMA (U.S. National Imagery and Mapping Agency); ORNL (U.S. Oak Ridge National Laboratory); RWDBII (Revised/Relational World Databank II); SADC (Southern African Development Community); SAIAB (South African Institute for Aquatic Bio-diversity); SRTM (Space Shuttle Radar Topography Mission); SWB (Surface Waterbodies); TM (Landsat Thematic Mapper); VMap0 (Vector Map Level 0); WCMC (World Conservation Monitoring Centre); WWF (World Wide Fund for Nature); WRI (World Resources Institute); WVS+ (World Vector Shoreline).

<sup>1</sup>Source scale – resolution: The resolution or pixel size of the original source data of each AWRD dataset. The source scale values are reported in either metric or decimal degree units; please see Note<sup>2</sup> below.

<sup>2</sup>Comparative analytical / map scale: The term nautical mile (NM) is used for the comparison of raster data and the determination of their relative scalar representation based on the assumption that a minimum of 100 pixels per inch would be available at any analytical or printed map scale.

### Structural organization and composition of AWRD archive

As noted earlier, the structure of the AWRD archive is based on the concept of Database Components (DBC). There are currently eight DBCs in the AWRD archive and with the exception of data layers derived from framework libraries or data sources containing multiple themes, the topical index provided in Table 2.2 illustrates how each data source is classified by DBC. For example: rivers data, including linear outlines derived from any related surface waterbody polygonal features have been placed in the River DBC; watershed data in the Watershed DBC; and surface waterbody or wetlands-related data in the Surface Waterbody DBC. Because many of the data sources used for the AWRD thematically contain a variety of data layers, individual source layers may have been placed in multiple DBCs. This is particularly true for vector data from so-called “framework libraries” such as the VMap0, which contain river, SWB, gazetteer, roads and a host of other layers.

In all cases, the latest editions of data from only the original source institutions were used as the baseline for any data processed for inclusion in the archive. Table 2.3 provides a summary of the number of unique data layers available by DBC.

To provide consistency with the organization of the original SADC-WRD, additional data which could not be placed into an existing SADC-WRD DBC have been placed into one of three ancillary [i.e. supplementary, auxiliary or additional] DBCs (the Ancillary Raster, Ancillary Vector and Ancillary Image DBCs) or a separate Gazetteer DBC. This was done for a number of reasons: (i) conceptually it was determined that these data were not required to directly facilitate the analytical functions of the AWRD interface; (ii) statistical or other methods were already in place to summarize or encapsulate the layers in question for general use within the AWRD, in particular for users who did not have access to the Spatial Analyst add-on module to ArcView; (iii) the data processed were derived for the purposes of research related to either the future expansion of the AWRD globally or the enhancing the native analytical functions of the interface; and (iv), to facilitate the potential distribution of the AWRD interface and archive via CD-ROM, i.e. to users without access to a DVD device/reader or with only limited hard-disk space.

In short, the DBC structure was maintained and the use of additional ancillary database components added to facilitate both a general and more limited distribution of the AWRD archive via either multiple DVD or CD-ROM based media, while maintaining native access to all of the data via the GIS interface and AWRD tool-sets. Table 2.4 provides a summary of the primary and optional data distributions available for the AWRD.

As shown in Table 2.4 the full AWRD data archive is comprised of 42.2 gigabytes of unique data<sup>6</sup>. However, only approximately 8 GB of data, comprised of approximately 156 unique thematic layers, are essential for the operation of the various AWRD modules and toolsets, and therefore only these data are distributed with the AWRD documentation. The remaining data (mainly high-resolution elevation datasets and images) are available by request to FAO-FIMA for those users who need them.

<sup>6</sup> If uncompressed satellite imagery and derivative RGB images were to be included in this sum, even excluding baseline data, the size of the AWRD lies well in excess of 100 gigabytes of processed data.

TABLE 2.3  
Summary of AWRD Database Components

	Name of Database Component	Acronym	Tabular/ Catalog	Feature types and unique spatial layers in AWRD <sup>a</sup>							Total
				Image	Line	Point	Polygon	Raster	Total		
1	Surface Waterbody	SWB-DBC	3	-	2	9	9	-	-	23	
2	Watersheds	WS-DBC	-	-	-	-	5	-	-	5	
3	Rivers	RIV-DBC	-	-	4	2	-	-	-	6	
4	Aquatic Species	AQSP-DBC	-	-	-	2	3	-	-	5	
5	Gazetteer	GZTR-DBC	-	-	-	2	-	-	-	2	
6	Ancillary Vector	AVEC-DBC	5	-	20	14	25	-	-	64	
7	Ancillary Raster	ARAS-DBC	-	-	-	-	-	26	-	26	
8	Ancillary Image	AIMG-DBC	3	22	-	-	-	-	-	25	
	Total		11	22	26	29	42	26	26	156	

Summary is representative only as it includes the listing of each unique AWRD data layer and not: (i) the number of source data layers which were processed to create a unique layer; (ii) the actual number of tiles or sub-grids comprising an individual raster dataset or any vectorized derivatives if relevant; or (iii) the actual number of unique datasets in the archive. Even though thematically-grouped features from a single dataset such as a gazetteer may be used to inform multiple DBCs, the dataset is listed only once in the table. In addition to classifying the AWRD data by DBC as in Table 2.3, the archive can also be described as containing:

- a) 177 broader topical data classifications, based on both the feature data type and scope, from which it is possible to load;
- b) 665 unique data or map layers for access into the AWRD Interface, based on;
- c) 16 926 individual datasets having some spatial reference.

Note: 16 264 of the individual datasets listed under c) are tiled components of higher resolution data layers, and are set for only limited distribution due to either the total disk space required and/or their limited spatial extent.

Table 2.3 presents the numbers of unique datasets. An individual dataset may be listed in multiple DBC sub-tables if that dataset is a member of more than one database component (see sections below). Terminology: Database Component (DBC) library, Surface Waterbody (SWB), Watershed (WS), Rivers and Drainage/Flow (RIV), Aquatic Species Component (AQSP), Gazetteer/Named Location (GZTR), Ancillary Vector (AVEC), Ancillary Raster (ARAS), Ancillary Image and Map Graphic (AIMG).

TABLE 2.4  
Summary of AWRD distribution media options

Distribution	Distribution Extent and Size	Description
Primary AWRD interface, tool-sets and data integral to the function of the AWRD based on DBCs	(2) DVD 8.5 Gb	Primary distribution of the full AWRD publication, including: interface/tool-sets, all eight archival DBCs and all related documentation in one DVD.
Primary AWRD interface, tool-sets and data integral to the function of the AWRD, as well as more limited distribution data available on request.	Internet 42.2 Gb	Full AWRD data archive will be stored in FAO's GeoNetwork <a href="http://www.fao.org/geonetwork/srv/en/main_home">http://www.fao.org/geonetwork/srv/en/main_home</a>
Limited CD-ROM distribution based directly on the above AWRD primary publication	(10) CD-ROM Limited/on request	AWRD Interface and tool-sets will be stored in "GISFish" A Global Gateway to Geographic Information Systems (GIS), remote sensing and mapping for aquaculture and inland fisheries to be released at the end of 2006.
Limited DVD based distribution of raster DEM and satellite image data for Volta and Lake Tanganyika basins	(1) DVD 4.4 Gb Limited/on request	A more limited distribution of the above primary publication but divided on to ten separate CD-ROM disks. Data cannot be directly accessed by the AWRD tool-sets, and user must copy data from separate CD-ROMs on to a hard-disk. Beta test data comprising: Arc-Grid based DEM and hillshade data, and either Landsat TM or ETM+ satellite image data compressed into the Jpeg2000 format. Purpose of these data are to establish the most suitable structure for the combined distribution of higher resolution raster, satellite image and derivative data to users of the AWRD
Limited DVD based distribution of continental SRTM 3-arc second DEM baseline and derivative DEM data	(4) DVDs 5.3 to 4.3 Gb Limited/on request	Beta test comprised of nominal 90 metre SRTM DEM data providing seamless and full continental coverage of Africa and related Island States. Four different sets of data are available for use, testing or review 3 204 overlapping 1°x1° Arc-Grid formatted tiles; the Baseline data, with oceans set to 0 and terrestrial void areas maintained at the original -32,000 value; the Null dataset, with oceans and terrestrial void areas set explicitly to no-data based on a nominal 1-arc seconds mask derived from the AWRD SRTM-SWBD data; the Filled dataset, with terrestrial no-data areas back-filled with data from the SRTM-GTopo30 DEM; and the Hillshade dataset, derived from the Null dataset based on a combination of slope and aspect designed to minimize shadows. Seamless and pseudo RGB based representations of each dataset are available for as separate image catalogs on each DVD.
Limited DVD based distribution of 2.5d color-classified DEM and hillshaded SRTM 3-arc seconds data derivatives	(1) DVD 2.1 Gb Limited/on request	A 2.5d enhanced RGB image base combining the above Null and Hillshade datasets to highlight topographical changes and relief. These data are again comprised of 3 204 overlapping 1°x1° tiles and provided a seamless image background suitable for visual interpretation and base mapping at the scale of 1:250 000. The data are provided in the jpeg2000 format accessible via an image catalog.

### *Accessing the AWRD archival data by source or theme*

In order to improve access to archival data by source, analytical or mapping requirement, a number of mechanisms have been built into the AWRD interface for the retrieval of data. For the most common analytical and visualization demands programmed into the AWRD, access to the relevant available data is transparent to the user. For example: SWB data are referenced when the SWB Module is started from within a map view and watershed, aquatic species and gazetteer data are all available on demand when the relevant analytical module or tool-set is initialized. Similarly, the majority of the raster data have been integrated into the Watershed Module and are available seamlessly on demand where appropriate via the other modules of the AWRD.

Examples of data available on a module-by-module basis are summarized in Section 2.3 with more detailed information made available in the Technical Manual in part 2 of this publication.

In addition to automated access of data via the AWRD analytical interface, four further mechanisms are also available to assist users with the retrieval of data based on (i) A tool to search for and load specific datasets, (ii) precompiled ArcView projects, (iii) the Image Export and Base Mapping extension, or (iv) standard manual method. The first method allows you to search for any dataset by name, or to select from lists of datasets organized by DBC. The second of these methods is based on a set of precompiled ArcView projects, i.e. APR project files, which can be used as seed files for many anticipated types of analyses. The third method provides access to composite sets of data via the Image Export and Base Mapping extension of the AWRD. In addition to these methods, the standard manual method for loading data into ArcView is of course still available to users of the AWRD. All of these methods for accessing and retrieving data are discussed in the AWRD Technical Manual or in part 2 of this publication under metadata, and are detailed in the on-line Help functions of the interface.

### *Detailed listing of individual data layers by database component*

Due to the number of data sources and the resulting number of individual data layers that have been compiled for the AWRD, the following sections provide an overview of the actual AWRD archive datasets on a DBC-by-DBC basis. Tables summarizing the characteristics of each dataset are included in each section. In these tables, data with limited distribution, i.e. some image or raster data rows listed in Tables 2.11 and 2.12, are highlighted in grey. Further, because (i) an individual AWRD archival layer may be used in more than one DBC, (ii) certain image or raster data layers may be comprised of individual 1 by 1 tiles providing continental coverage of Africa, and (iii) some raster data layers may be comprised of multiple grid datasets representing annual, monthly or decadal values in either summary or time-series, a greater number of data layers may be discussed or represented in the tables below than were listed in Table 2.3.

In the following tables, the “Extent/Purpose” summarizes both the spatial coverage provided by each thematic layer and the native ability for this layer to be currently analyzed using the AWRD Interface. For this latter summary, “Analysis” means that the layer can be processed by the AWRD, while “Reference” means that the layer provides either contextual or visual spatial reference information to the user. Although reference data layers cannot currently be analysed via the AWRD, such data have been added to inform future analytical revision of the interface and to provide robust base mapping capabilities from within the AWRD.

In addition to the discussions and tables which follow, in order to conform to international and FAO spatial data standards for the development and exchange of data, metadata<sup>7</sup> conforming to the ISO-19115 standard are available for each data layer archived within the AWRD. The metadata associated with each dataset contained within the AWRD archive are available via the AWRD “Data and Metadata Module” using either the “Data Inventory” tool (also presented in part 2 of this publication) or the Metadata Viewer for any of the AWRD datasets selected for display.

### Surface Waterbodies Database Component

The Surface Waterbodies Database Component of the AWRD currently contains nineteen unique data layers pertaining to lakes, dams, reservoirs, impoundments, and other types of waterbodies and wetlands, including an extensively processed and seamless version of the 1:100 000 scale surface waterbody database recently made available by NIMA, NASA and EarthSat. This is the highest resolution SWB dataset that will likely be available for the remainder of this decade. The SWB layers of the AWRD are summarised in Table 2.5 and include cross-tabular comparisons/indicators of the polygonal SWB data listed at the sub-national, national and continental levels.

Unlike the original SADC-WRD database component, which was limited to one point feature data layer and one polygonal feature data layer, the AWRD is designed to allow users to access any one of the above layers, or to customise the interface by adding their own SWB data layers. Additionally, in comparison to the SADC-WRD, the AWRD no longer maintains separate tabular attribute databases providing national subsets or pre-classified climatological and aquatic species information for each SWB based on pre-processed GIS overlays. Instead, for the SWB-DBC, the results of either queries or any specific analyses are produced on-the-fly and are only maintained in the temporary workspaces of the AWRD.

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<sup>7</sup> Metadata can be defined as the information about the data, and for geophysical data may include: the source of the data; its creation date and format; its projection, scale, resolution, and accuracy; and its reliability with regards to some standard (ESRI, 2001).

TABLE 2.5  
Overview of Surface Waterbodies Database Component

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
AfriCover Surface Water Body Features	Surface Water Features	FAO	11 296	1:250 000	0.015-NM / 1:125 000	East Africa Analysis	SWB and related hydrological features subset of the AfriCover country separates and compiled into a seamless baseline
Consolidated VMap0 Surface Water-Hydro Features	Surface Water Features	VMap0   DCW	25 128	1:1 000 000	n.a / 1:1 000 000	Africa Analysis	Seamless and topologically robust derivative of source VMap0 SWB and related hydrological features, i.e. swamps, etc. data layers maintaining the inter-layer topological consistency established for the 5th Edition
Consolidated WCMC Wetlands	Wetlands	WCMC	4 404	1:1 000 000	n.a / 1:1 000 000	Africa Analysis	Various SWB and wetland feature types re-encoded from country separates of WRI-AFDS into a seamless continental derivative
FAO-AquaStat 1:1m Major African SWBs	Large Dams	FAO	837	1:1 000 000	n.a / 1:1 000 000	Africa Analysis	Dams from FAO African Water resources in Africa database
FAO-AquaStat Large African Dam Database	Dams and Reservoirs	FAO	1 192	10 000 cell	n.a / 1:5 000 000	Africa Analysis	Large dams and reservoirs projected from a LAEA original used for the FAO African Water Resources and Irrigation database
FAO-MRAG Lake-River Fisheries Tabular cross-table references	Limnological: Lakes-Rivers	FAO	Various based on tables	n.a	n.a / 1:5 000 000	Global Reference	Cross tables: Main Reference; Chemistry/Biology; Demography; Catch Data; Fisheries Data; Hydrology/Climate; Morphology; Waterbodies; Summary, and Bibliographic References
FAO-MRAG Spatially Referenced Water Bodies	Limnological: Lakes-Rivers	FAO	499	n.a	n.a / 1:5 000 000	Africa Analysis	A subset of the World Lake tabular references from the dataset below which could be cross-referenced to VMap0 SWB features
FAO-MRAG World Lakes and Rivers Point Reference	Limnological: Lakes-Rivers	FAO	1 887	n.a	n.a / 1:5 000 000	Global Reference	Spatially referenced point locations of World Lake features
Harmonized DCW-VMap0 Surface Water Bodies	Surface Water Features	DCW   VMap0	25 673	1:1 000 000	n.a / 1:1 000 000	Africa Analysis	Seamless and topologically robust derivative of source DCW and VMap0 perennial/non-perennial SWBs from VMAP0-IW, DCW-DNNET and DCW-LCPOLY sources, harmonized to the original DCW SWB shorelines
Linear representation of above VMap0 SWBs	SWB Shorelines	VMap0   DCW	30 413	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Robust separately encoded depiction of the SWB-Hydro polygonal outlines
Original Tabular edition of the SADC-WRD Surface Water Bodies Database	Dams and Reservoirs	ALCOM	18 098	1:250 000	n.a / 1:250 000	SADC Analysis	Similar to the above dataset but tabular and containing the full set of SADC-WRD attributes, many of which contain only null data
Point representation of above VMap0 SWBs	SWBs as Points	VMap0   DCW	25 128	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Robust centre-point derivative of SWB-Hydro polygonal features
RWDB2 Surface Waterbodies	Surface Waterbodies	RWDBII	831	1:3 000 000	n.a / 1:3 000 000	Africa Analysis	Enhanced SWB polygonal derivative based on 4 separate RWDB2 Library layers
SADC Surface Water Body Database	Dams and Reservoirs	ALCOM	18 098	1:250 000	n.a / 1:250 000	SADC Analysis	Enhanced derivative based on the original SADC-WRD data of lakes and impoundments

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
SRTM Double-lined Rivers and Surface Water Bodies	Surface Waterbodies	SRTM	38 840	1:100 000	0.015-NM / 1:125 000	Africa Analysis	Nominal 30 metre derivative of SWB, Double-Lined River, and Inshore Island features robustly compiled and harmonized seamlessly from over 3 225 separate SRTM-SWBD data tiles
SRTM Surface Water Body Linear Outlines	SWB Shorelines	SRTM	54 741	1:100 000	0.015-NM / 1:125 000	Africa Reference	Linear representation of SWB, Double-Lined River, and Inshore Island Features
SRTM Surface Water Body Point Reference	SWBs as Points	SRTM	38 840	1:100 000	0.015-NM / 1:125 000	Africa Reference	Centroid point locations of SWB, Double-Lined River and inshore island features
Surface Water Body Features from GEOnet Gazetteer	Surface Water Features	GEOnet	46 591	1:250 000	n.a / 1:250 000	Africa Reference	Surface water features based on named locations GNS/GEOnet Gazetteer, i.e. lakes, dams, reservoirs, pools, pans and wetland features
SWB-by-Admin cross-tabular references	SWB-by-Admin	FAO	Various based on tables	1:3m – 1:1m	n.a / 1:1 000 000	Africa Reference	Cross-tables comparing the various SWBs types available in the RWDBZ, WCMC Wetlands, DCW hydro-related, VMap0 and SWBD data layers at the continental, national and subnational levels; link to SWB-By-Admin
VMap0 based Ad1 and Ag2 SWB-by-Admin polygon references	Admin-Bnds	VMap0	0.015-NM 1:125 000	1:1 000 000	n.a / 1:1 000 000	Africa Reference	One-to-one uniquely dissolved national and subnational polygonal administrative boundaries encoded for linkage and mapping of both WS-by-Admin statistics via WS Module and SWB-by-Admin summary statistics
VMap0 Surface Water Feature Point Reference	Surface Water Features	VMap0   DCW	19230	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Robust derivative of VMap0-Ed5 data layers harmonized with DCW dams, lakes, waterholes, wells and other SWBs based on VMAP0-MP and DCW-DN/DSPNT sources

### Watersheds Database Component

Similar to the SWB-DBC, the Watershed Database Component has been greatly expanded in regards to the extent and number of watershed (WS) models available for analysis within the AWRD. As in the SADC-WRD, although a user can still only interact with one WS model at a time, they can now choose between one of five WS data layers to work with. Table 2.6 summarises each of the available WS data layers and categorises them based on whether they are a simple WS delineation or a more complex WS model suitable for analysis.

As can be seen in Table 2.6, two WS delineations and three WS models are currently available within the AWRD. In general, a WS model can be distinguished from a simple WS delineation by the presence of attribute encoding which allows the differentiation between areas that are either upstream or downstream from any specific WS in the model. A WS model must also contain levels, whereby the attribute encoding for a watershed would also allow the determination of broader river systems or megabasins. Using a three-level model as an example, and a watershed surrounding Lake Victoria as a base, a user should be able to determine that the Lake Victoria watershed is part of the broader White Nile River basin, which is in turn part of the Nile megabasin. Although at a certain point nomenclature may become a problem, ideally a six level WS model would allow a user to determine that: the Lake Victoria watershed is part of the Lake Victoria drainage; which is in turn part of the Victoria Nile basin; which is itself a sub-basin of the larger Albert Nile drainage basin; which is again in turn part of the White Nile River basin; and ultimately that the lake is part of the Nile megabasin.

In the AWRD, much of the functionality available to a user is dependant on which WS data layer is chosen by the user, and whether this layer is a properly encoded WS model. The user has the ability to customise the AWRD by the addition of custom WS delineations or models, and a basic tool is provided to check the connectivity of the flow regimes for any models added.

### Rivers Database Component

As with the previous two database components, the extent and number of available data layers in the Rivers Database Component has been increased in comparison to the SADC-WRD. The Rivers Database Component of the AWRD currently contains six data layers (Table 2.7). The four linear data layers use arc vectors (i.e. lines) to represent either the pattern of drainage or the relative flow accumulation of surface water across a landscape, continentally, at differing scales. In the case of river datasets derived from VMap0 and RWDB2, the outlines of relevant SWB features have been added to fill in gaps between certain features. The remaining two non-linear feature layers are based on either gazetteer locations of river confluences extracted from 1:250 000 scale topographic maps, or locations of annotation features representing map label names for river reaches on the base ONC Charts originally used to create the DCW/VMap0.

In addition to the numerical difference in data layers between the AWRD River DBC and the original SADC-WRD, another difference is that river features are no longer broken at country boundaries and the various soil, elevation, and watershed attributes, which were previously hard-coded to the linear features, are no longer maintained specifically within the archive.

TABLE 2.6  
Overview of Watersheds Database Component

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
ALCOM-WWF Watershed Model	Watershed Model	WWF I ALCOM	5 456	5 000 cell	n.a / 1:32 0500 000	Africa Analysis	A 3-level watershed model of Africa developed by ALCOM-WWF/SARPO from DCW hypsographic and GTopo30 based DEMs and edited manually to conform with the VMAP0/DCW Rivers
FAO-AquaStat Major Basins Watershed Model	Watershed - River - SWB - Irrigation	FAO	608	10 000 cell	n.a / 1:5 000 000	Africa Analysis	A 2-level watershed model of Africa, projected and encoded from original FAO-AGLW LAEA based WS model for irrigation and water resources
GIWA Large Marine Ecosystem/Basin Delineation	Large Marine and Terrestrial basins	GIWA – URI	2 936	~100 000 cell	n.a / 1:20 000 000	Global Reference	Global International Waters Assessment's Terrestrial WSs and Large Marine Ecosystems, A medium resolution WS delineation based on terrestrial modifications to the NOAA-URI Large Marine Ecosystems
HYDRO-1 Kilometer Watershed Model	Watershed and Flow Network	HYDRO1k	7 133	4 000 cell	n.a / 1:2 5000 000	Africa Analysis	A 6-level watershed model based on the EDC-UNEP HYDRO1k effort, that was projected, verified and downstream encoded from the original Pfafstetter encoded watershed model in LAEA
WRI Major Watersheds of the World Delineation	Major River basins	WRI- Rutgers	254	~250 000 cell	n.a / 1:65 000 000	Global Reference	Watersheds of the World published by the World Resources Institute, A cleaned version of this watershed delineation enhanced to include WRI's original_publication attributes

TABLE 2.7  
Overview of Rivers Database Component

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
Consolidated VMap0 River-Surface Water body Network	Rivers and SWBs	VMap0I DCW	173 504	1:1 000 000	n.a / 1:1 000 000	Africa Analysis	Seamless and topologically robust derivative of source VMap0 SWB linear outlines integrated with WC, dam, canal and other feature data layers
Drainage network - River annotation map labels as point features	Map Labels	DCW	~3 900	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Enhanced derivative based on annotation layers of DCW-DNNET data source
FAO-AquaStat 1:5m African Rivers	Rivers	FAO	32 636	1:5 000 000	n.a / 1:5 000 000	Africa Analysis	Rivers from the FAO Atlas of Water Resources and Irrigation in Africa, A robustly encoded rivers data layer with fair connectivity. Scale listed as 1: 5 m, but more detailed than layers of similar scale.
HYDRO-1 Kilometer Flow Drainage Network	Watershed and Flow Network	HYDRO1k	15 478	4 000 cell	n.a / 1:2 5000 000	Africa Analysis	Hydro1k based river flow accumulation network for Africa, projected to decimal degrees from Lambert Azimuthal Equal Area base, the only confirmed network river layer in AWRD
River Features from GEONet Gazetteer	River Discharge	GEONet	138 700	1:250 000	n.a / 1:250 000	Africa Reference	GNS/GEONet named river confluence and outflow locations Value-added derivative of source w/non-diacritical names of river confluences
RWDB2 Rivers and Surface Water Body Outlines	Rivers and SWBs	RWDB2	4 376	1:3 000 000	n.a / 1:3 000 000	Africa Analysis	Enhanced Rivers linear derivative based on 4 separate RWDB2 Library layers, with outlines of surface waterbodies topologically intersected and integrated

### **Aquatic Species Database Component**

Unlike the previous three database components discussed, the Aquatic Species Database Component is the one component of the archive that could not be expanded significantly to provide Africa-wide coverage for the AWRD. However, the aquatic species data covering the SADC region has been recently updated, as well as expanded and rigorously re-encoded to account for both verified and unverified species reference locations within the AWRD. The core revisions to the AQSP-DBC were carried out in large part by the South African Institute for Aquatic Bio-diversity (SAIAB). The SAIAB was formerly known as the JLB Smith Institute of Ichthyology and in regards to aquatic species data, the AWRD contains an FAO specific revision of the data in the SAIAB's "GIS Atlas of Southern African Freshwater Fish", (SAIAB, 2003). The data layers contained in the Aquatic Species DBC are summarized in Table 2.8.

In addition to the revised aquatic species data, the AQSP-DBC also includes a tool to link to FishBase (<http://www.fishbase.org/home.htm>), an Internet-based global information system of fish species data. FishBase and other pending linkages to sites maintained by organisations such as the SAIAB are also being evaluated as potential test beds for increasing the spatial extent of data coverage and as data maintenance hubs which can be used to ensure the long term viability of aquatic species monitoring via the AWRD.

### **Gazetteer Database Component**

Gazetteers are tabular listings of named locations which allow the spatial referencing of each place name. The AWRD currently contains two fully featured gazetteer baselines, each of which is summarised in Table 2.9. In addition to hydrographic features, each of the gazetteers described below also provide named locations for: other natural and physiographic features, populated places, and various types of related social and physical infrastructure.

TABLE 2.8  
Overview of Aquatic Species Database Component

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
Aquatic Species Political Boundary Reference	Aquatic Species   Political	Varied	5 690	varied	n.a	Africa Analysis	Aquatic Species Political Boundaries processing data layer
Aquatic Species Watershed Modeling Reference	Aquatic Species   Watershed	Varied	608	varied	n.a	Africa Analysis	Aquatic Species Watershed Boundaries processing data layer
Restricted version of main SAIAB Aquatic Species Locations	Aquatic Species	SAIAB	798	n.a	n.a / 1:1 000 000	SADC Analysis	A compressed version of the main SAIAB aquatic species data layer, including endangered-threatened species locations. A password is required to unzip these data, which would then be used to replace the existing dataset.
SAIAB Aquatic Species Locations	Aquatic Species	SAIAB	766	n.a	n.a / 1:1 000 000	SADC Analysis	Main aquatic species data layer containing point and ancillary tabular attributes of capture data, Verified: 35 292 location references comprising 247 unique aquatic specie   Unverified: 1 080 location references covering 517 unique aquatic specie
SAIAB Threatened and Endanger Species Boundaries	Aquatic Species	FAO	92	n.a	n.a / 1:2 000 000	SADC Analysis	Threatened to endangered species watershed boundaries based SAIAB and HYDRO1k

TABLE 2.9  
Overview of Gazetteer Database Component

Dataset Name	Data Class	Source	Number Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
DCW Gazetteer	Gazetteer	DCW	151 739	1:1 000 000	n.a / 1:1 000 000	Global   Africa Reference	Full Digital Chart of the world Gazetteer database
GEOnet Gazetteer Database	Gazetteer	GEOnet	1 083 354	1:250 000	n.a / 1:250 000	Africa Analysis	Full value-added derivative of ASCII GEOnet January 2006 gazetteer baseline, including non-diacritical names

### Ancillary Vector Database Component

The Ancillary Vector Database Component (AVEC-DBC) contains the greatest number of unique data layers within the AWRD. The AVEC-DBC can be considered as a repository for all vector data which could not be placed or accounted for in the other DBCs of the AWRD. Hence, the AVEC-DBC was developed primarily to support various scales and types of either base mapping or analyses.

The Ancillary Vector Database Component contains robust and enhanced versions of the source data layers residing in four framework data libraries: the 2005 SRTM Surface Waterbody Database; the 2004 3<sup>rd</sup> Edition of the World Vector Shoreline; the 2000 5<sup>th</sup> Edition of the Vector Smart Map Level 0; and Version 1.1 of the Relational World Databank II released in 1997. In addition to data from these four sources, this DBC also contains data layers compiled from the original 1992 DCW which were dropped during the transition from the DCW to the VMap0 and other data. A framework data library can be considered as differing from other sources of data in that it generally contains multiple thematic layers, (e.g. coastlines, political boundaries, roads, rivers and/or populated places), and is generally maintained and released as various editions. As is the case for all the data processed for the AWRD, these data are derived directly from the original data source and are generally reprocessed from the ground up in order to provide robust derivatives<sup>8</sup>. The data layers contained in the AVEC-DBC are summarised in Table 2.10.

As can be seen on Table 2.10, the AWRD contains almost complete compilations of data from the specified framework libraries, including: contours and spot elevations; cities and populated places; roads, rail, and air transport infrastructure; generalised and detailed political boundaries; physiography; marine waterbodies; etc. In addition to these framework based compilations, the AVEC-DBC also contains FAO third-order administrative boundaries and seamless translations of all land surface features contained in the original DCW which were dropped during the transition to the VMap standard. The AVEC-DBC also contains an annotation layer, using ESRI's Arc-Info coverage format in order to provide users with the seventeen layers of map labels captured from the source ONC Charts for the original DCW.

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<sup>8</sup> The processing of robust derivatives from a source library is a somewhat complex task requiring a number of basic steps and cross-checks. In general, the process starts with: (i) building coastlines from linear source features, followed by (ii) building polygons which reflect oceanic islands and landmasses, (iii) checking for gaps or other topological errors and (iv) cross-checking results against any polygonal baseline that may also reside in the source library. After processing offshore islands and landmasses, additional polygonal features such as surface waterbodies, political boundaries, etc. are added. Next, linear features such as rivers and roads are added, and finally any point feature types from the source library. In this way, both linear and polygonal attributes can be maintained separately, while at the same time ensuring any spatial accuracy is maintained. Coincident feature error checks are performed and where possible, or necessary, encoding harmonization is performed to minimize the number of output derivative layers. Once completed, the resulting derivatives are generally compared against previously published editions of the source library to ensure that no features were dropped by the maintenance organization or contractor, and further feature consolidation is performed where necessary. The specific processing details associated with data processed from all source data are provided in the metadata accompanying each dataset.

TABLE 2.10  
Overview of Ancillary Vector Database Component

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
Consolidated table of air temperature	Air Temperature	CRES I/FAO	1 004 351	0.05°	3-NM / 1:20 000 000	Africa Analysis	Consolidated table of monthly air temperature
Consolidated table of CRU Evapotranspiration	Evapo-transpiration	CRU	92 717	0.16667°	10-NM / 1:70 000 000	Africa Analysis	Consolidated Table of CRU Evapotranspiration
Consolidated table of CRU Precipitation	Precipitation	CRU	92 715	0.16667°	10-NM / 1:70 000 000	Africa Analysis	Consolidated Table of CRU Precipitation
Consolidated table of water temperature	Water Temperature	CRES I/FAO	1 004 351	0.05°	3-NM / 1:20 000 000	Africa Analysis	Consolidated table of water temperature
Consolidated tables of 8 km average 10 day cumulative Meteosat-GTS interpolated daily rainfall	Precipitation	EDC	471 688	8 kilometers	4.3-NM / 1:30 000 000	Africa Analysis	Consolidated set of 14 cross tables representing the vectorized values consolidated by year, long and short-term average rainfall values: 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, long-term and short-term tables
Consolidated VMap0 Bathymetric-Coast-Contour Lines	Bathymetry and Land Contours	VMap0 I 3rd Edition	108 715	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of all linear VMap0-Ed3 bathymetric, coastline, and terrain contour data layers
DCW Annotation or original ONC-Chart Map Labels	Annotation Map Labels	DCW	26 278	1:1 000 000	n.a / 1:1 000 000	Global I Africa Reference	A robust compilation annotation from all 17 of the original DCW layers containing annotation features, including: Ocean\ Underwater, Physiographic; Transportation; Drainage; Land Cover and Populated Places as separate annotation layers in a single Arc-Info coverage
DCW Drainage Network Point Features	Surface Waterbodies	DCW	4 808	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Enhanced derivative based on annotation layers from DCW-DNNET source layer translated into point features for reference in the SWB-DBC
DCW Drainage Point Features	Surface Waterbodies	DCW	1 635	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Enhanced derivative based on annotation layers from DCW-DNPNT source layer translated into point features for reference in the SWB-DBC
DCW Elevation Class Polygons	Elevation Range	DCW	21 456	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Elevation class range class for vehicular suitability
DCW Land Cover (Hydrological Features)	Surface Water Features	DCW	7 067	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Wetlands and other SWB features dropped during the DCW standard change to VMAP0wet/inundated land and other hydrological features from the DCW DNNET and LCPOLY sources, updated w/VMAP0 IW
DCW Land Cover (Land Surface Features)	Land Surface	DCW	7 682	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless dataset containing all other DCW land feature types not subset into the above dataset for use via the SWB-DBC

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
FAO 1:5 Million Scale Soils	Soils	FAO	4 909	1:5 000 000	n.a / 1:5 000 000	Africa Reference	Compilation of FAO Soil great group and major attribute characteristics with country boundaries removed
FAO National-Ad1 Boundaries	Admin.	FAO	58	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Ad1-Polygonal representation of countries based on VMap0 and perhaps DCW
FAO Subnational-Ad2 Boundaries	Admin.	FAO	674	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Ad2-Polygonal representation of 1st-order subnational boundaries from country sources integrated with VMap0/DCW Ad1 boundaries
FAO Subnational-Ad3 Boundaries	Admin.	FAO	5 690	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Ad3-Polygonal representation of 2nd-order subnational boundaries from country sources integrated with VMap0/DCW Ad1 boundaries
RWDB2 Airports	Airports	RWDBII	15 044	1:3 000 000	n.a / 1:3 000 000	Global Reference	Point based representation of Airports
RWDB2 Coastal-Surface Water Body Linear Boundaries	Coastline Shoreline	RWDBII	25 319	1:3 000 000	n.a / 1:3 000 000	Global Reference	Linear output of coastlines and SWB features, derived from integration of 7 RWDB2 library layers
RWDB2 Coastal-Surface Water Body Polygon Boundary	Landmass and SWBs	RWDBII	20 874	1:3 000 000	n.a / 1:3 000 000	Global Reference	Topologically corrected polygonal derivative of 7 RWDB2 library layers to create continental baselines
RWDB2 Gazetteer	Gazetteer	RWDBII	3 031	1:3 000 000	n.a / 1:3 000 000	Global Reference	Point based gazetteer of named locations
RWDB2 National-Ad1 Linear Boundaries	Admin.	RWDBII	18 870	1:3 000 000	n.a / 1:3 000 000	Global Reference	Ad1-Linear coastlines, national and other areas of sovereignty boundaries compiled from multiple RWDB2 source layers; circa 1997
RWDB2 National-Ad1 Polygonal Boundaries	Admin.	RWDBII	12 905	1:3 000 000	n.a / 1:3 000 000	Global Reference	Ad1-Polygonal representation of national and other areas of sovereignty boundaries compiled from multiple RWDB2 source layers; circa 1997
RWDB2 National-Ad2 Linear Boundaries	Admin.	RWDBII	26 648	1:3 000 000	n.a / 1:3 000 000	Global Reference	Ad2-Linear coastlines, national, 1st order subnational and other areas of sovereignty boundaries compiled from multiple RWDB2 source layers; circa 1997
RWDB2 National-Ad2 Polygonal Boundaries	Admin.	RWDBII	16 035	1:3 000 000	n.a / 1:3 000 000	Global Reference	Ad2-Polygonal representation of national, 1st-order subnational and other areas of sovereignty boundaries compiled from multiple RWDB2 source layers; circa 1997
RWDB2 Populated Places	Admin-Business Centres	RWDBII	55 038	1:3 000 000	n.a / 1:3 000 000	Global Reference	Point based representation of Populated place with encoding differentiating national and subnational capitals and other related administrative centres
RWDB2 Ports	Ports	RWDBII	4 792	1:3 000 000	n.a / 1:3 000 000	Global Reference	Point based representation of major port and harbours

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
RWDB2 Railway Lines	Railroad	RWDBII	25 407	1:3 000 000	n.a / 1:3 000 000	Global	Linear railway layer consolidated from 2 separate source data layers
RWDB2 River-Surface Water Body Network	Rivers and SWBs	RWDBII	29 177	1:3 000 000	n.a / 1:3 000 000	Reference Global	Linear outlines of SWB features integrated with Rivers and other linear surface hydrological features
RWDB2 Roads	Roads	RWDBII	72 099	1:3 000 000	n.a / 1:3 000 000	Reference Global	Linear roads layer consolidated from 3 separate source data layers
RWDB2 Surface Waterbodies	Surface Waterbodies	RWDBII	8 750	1:3 000 000	n.a / 1:3 000 000	Global	Enhanced SWB polygonal derivative based on 4 separate RWDB2 Library layers
SRTM 1-by-1 Degree Reference Polygons	Reference Tiles	SRTM	64 800	1:100 000	0.015-NM / 1:125 000	Africa Reference	SRTM 1x1 degree tile reference layer with various encoding attributes such as SRTM tile names, availability, extent and UTM 1:250 000 map reference
SRTM Coastlines	Coastline	SRTM	11 070	1:100 000	0.015-NM / 1:125 000	Africa Reference	Linear representation of the nominal 30 metre coastlines; this is the highest resolution determinate currently available and was compiled and harmonized seamlessly from over 3 225 separate SRTM-SWBD data tiles
SRTM Data Source Reference Polygons	DEM Source	SRTM	7 536	1:100 000	0.015-NM / 1:125 000	Africa Reference	Polygonal representation of the original grid data specifying the source data used to compile the SRTM 3 and 30 arc-second DEM data
SRTM Landmass and Ocean Island Polygons	Island-Landmass	SRTM	4 333	1:100 000	0.015-NM / 1:125 000	Africa Reference	Seamless polygonal continental landmass and oceanic island mask data layer derived from SRTM-SWBD tiled database
Vectorized 10-by-10 minute Grid (Point)	Climate	CRU	92 718	0.16667°	10-NM / 1:70 000 000	Africa Analysis	Vectorized 10-by-10 minute Grid (Point)
Vectorized 10-by-10 minute Grid (Polygon)	Climate	CRU	92 718	0.16667°	10-NM / 1:70 000 000	Africa Analysis	Vectorized 10-by-10 minute Grid (Polygon)
Vectorized 8-by-8 Kilometer Rainfall Point Reference	Precipitation	EDC	471 688	8 kilometers	4.3-NM / 1:3 500 000	Africa Analysis	Vectorized 8-by-8 Kilometer Grid Reference
Vectorized 8-by-8 Kilometer Rainfall Polygonal Reference	Precipitation	EDC	471 688	8 kilometers	4.3-NM / 1:3 500 000	Africa Analysis	Vectorized 8-by-8 Kilometer Grid Reference
Vectorized CR5 Half Degree Point Reference	Water	CRES	1 004	0.05°	3-NM / 1:20 000 000	Africa Analysis	Vectorized CRU 10-by-10 Minute Point Reference
Vectorized CR5 Half Degree Polygon Reference	Temperature Climate	FAO CRES   FAO	351 1 004 351	0.05°	3-NM / 1:20 000 000	Africa Analysis	Vectorized CRU 10-by-10 Minute Polygon Reference

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
VMap0 Airports	Airports	VMap0 I 5th Edition	762	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Robust derivative of VMap0-Ed5 data layers with harmonized encoding
VMap0 Canals	Canals	VMap0 I 5th Edition	194	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of all linear Transport/Rail VMap0-Ed5 data layers
VMap0 Capital Cities	Capitals	VMap0 I 3rd Edition	55	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Derivative of current African capital cities from other VMap0-Ed3 data layers
VMap0 General Point Feature Reference	Reference	VMap0 I 5th Edition	17 136	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Consolidation of all VMap0 point features, robust derivative of VMap0-Ed5 data layers with harmonized encoding
VMap0 Generalized Coastline-National Reference	Reference	VMap0 I 5th Edition	5 978	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of VMap0-Ed5 data layers
VMap0 Industrial Pipeline Reference	Pipelines	VMap0 I 5th Edition	186	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of VMap0-Ed5 data layers
VMap0 Industrial Processing Polygons	Processing Zones	VMap0 I 5th Edition	92	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of VMap0-Ed5 data layers
VMap0 International Date Line	Reference	VMap0 I 5th Edition	82	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of linear VMap0-Ed5 Industry and related data layers
VMap0 Land Surface and Physiographic Reference	Land Type	VMap0 I 5th Edition	7 047	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of VMap0-Ed5 data layers
VMap0 Landmass and Oceanic Island Polygons	Mask	VMap0 I 5th Edition	2	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of source VMap0 data layers for landmass and oceanic island data layers
VMap0 Major Road Library Reference	Reference	VMap0 I 3rd Edition	10 113	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Major roads as contained in the VMap0-Ed3 Library Reference, but dropped in VMap0-5th Edition
VMap0 National-Ad1 Linear Boundaries	Coastline – Admin.	VMap0 I 5th Edition	1 826	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Ad1-Seamless and topologically robust derivative of all linear VMap0-Ed5 coastline and national/sovereign boundary data layers cross-checked against related polygonal vectors
VMap0 National-Ad1 Polygonal Boundaries	Admin.	VMap0 I 5th Edition	1 122	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Ad1-Seamless and topologically robust derivative of all polygonal VMap0-Ed5 coastline and national/sovereign boundary data layers cross-checked against related linear vectors
VMap0 National-Ad2 Linear Boundaries	Coastline – Admin.	VMap0 I 5th Edition	3 656	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Ad2-Seamless and topologically robust derivative of all linear VMap0-Ed5 coastal, national, subnational and sovereign boundary data layers cross-checked against related polygonal vectors
VMap0 National-Ad2 Polygonal Boundaries	Admin.	VMap0 I 5th Edition	1 753	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Ad2-Seamless and topologically robust derivative of all polygonal VMap0-Ed5 coastal, national, subnational and sovereign boundary data layers cross-checked against related linear vectors

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
VMap0 Ocean and Sea Polygon Reference	Oceans	VMap0 I 5th Edition	25	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of VMap0-Ed5 polygonal Ocean/Sea data layers
VMap0 Oceanic Island Point Reference	Offshore Islands	VMap0 I 5th Edition	1 474	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Oceanic point feature derivative of VMap0-Ed5 Political Point data layer
VMap0 ONC and Data Quality Reference	Data Class	VMap0 I 5th Edition	284	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of VMap0-Ed5 data layers
VMap0 Populated Place Point Reference	Reference	VMap0 I 5th Edition	39 172	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Robust derivative of VMap0-Ed5 Populated Place data layer
VMap0 Populated Place Polygons	Populated Place	VMap0 I 5th Edition	1 505	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of VMap0-Ed5 data layers
VMap0 Railway Line Reference	Railroad	VMap0 I 5th Edition	2 492	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of all linear Transport/Rail VMap0-Ed5 data layers
VMap0 Roads Reference	Roads	VMap0 I 5th Edition	84 205	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of all linear Transport/Roads VMap0-Ed5 data layers
VMap0 Spot Elevation Points	Spot Elevations	VMap0 I 3rd Edition	80 449	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Robust derivative of VMap0-3rd spot elevation layers spatially crossed checked against DCW coincident spot features to establish small closed contour features attributed improperly as points
VMap0 Utilities Line Reference	Utility	VMap0 I 5th Edition	2 476	1:1 000 000	n.a / 1:1 000 000	Africa Reference	Seamless and topologically robust derivative of linear VMap0-Ed5 Utility and related data layers
WVS+ Coastline-Political Boundary Reference	Coastline – Admin.	WVS+	6 065	1:250 000	n.a / 1:250 000	Africa Reference	Linear and polygonal coastal, country and bathymetry
WVS+ Landmass-Island-National Boundary Reference	Coastline – Admin.	WVS+	5 409	1:250 000	n.a / 1:250 000	Africa Reference	WVS+ Landmass-Island-National Boundary Reference
WVS+ Landmass-Island-National Point Reference	Coastline – Admin.	WVS+	5 409	1:250 000	n.a / 1:250 000	Africa Reference	Linear and polygonal coastal, country and bathymetry

### Ancillary Raster Database Component

The Ancillary Raster Database Component (ARAS-DBC) contains a large number of datasets formatted as ESRI grids. Table 2.11 provides an overview of the raster data layers in this component database. Because these datasets are in grid format, they can be viewed in ArcView but they cannot be analyzed unless the ArcView Spatial Analyst extension is installed. Users will find that these datasets are much more useful if Spatial Analyst is available. As discussed previously, data layers highlighted in grey within this table are set for only limited distribution or on-line access for this edition of the AWRD.

From Table 2.11 it can be seen that the AWRD contains raster data at a number of different pixel sizes or resolutions. These raster datasets are integral to the functionality of certain tool-sets within the AWRD. For users without the Spatial Analyst module, statistical summary tables have been prepared on a watershed-by-watershed, and in some cases administrative boundary, basis for each of the datasets listed. As a further aid to users without Spatial Analyst, vectorized versions of the climatologically-related data listed above have also been prepared. These data are available from within the AVEC-DBC (see Table 2.10) and their use is documented in the case studies section of the publication. Similarly, a number of pre-classified pseudo 3D image backgrounds have been prepared to facilitate the visualization and map output of the DEM data listed in Table 2.11. These data are described in the Ancillary Image DBC section of this document.

Lastly, due to copyright distribution issues, human population data previously slated for integration into this DBC could not be included and users must download LandScan or GPW data directly from ORNL or CIESIN respectively. Statistical summaries of the LandScan data have however been included in the AWRD on a watershed-by-watershed basis and are therefore available for analysis.

### Ancillary Image Database Component

The eighth and final database component of the AWRD archive is the Ancillary Image DBC. The data layers in the AIMG-DBC were developed to provide pre-classified elevation backgrounds; contextual base map graphics, and satellite image backdrops against which the core functionality of the AWRD interface could be displayed and highlighted. The layers are geo-referenced and provide users with a number of ways to visualise landscapes and differentiate hydrographically related features.

Table 2.12 provides an overview of the data layers which were developed, enhanced, or compiled for inclusion in the AIMG-DBC. These images and maps enable users to view and print high-quality graphical backgrounds at map scales ranging from approximately 1:750 000 to over 1:100 000 000 from within the AWRD. Higher-resolution imagery, up to 1:65 000, are available in the larger optional distribution of the AWRD archive.

All of the graphics listed in Table 2.12 are in highly compressed image formats and their use within the AWRD is dependant on the automated loading of standard viewer extensions to ArcView. The use of these compression formats allow each of the layers in the AIMG-DBC to be displayed at, and in some cases below, the minimum viewing scales listed in Table 2.12; albeit with some potential loss in interpretive and/or output quality. Pseudo RGB representations of all the raster data listed in Table 2.12 are also available to users of the AWRD, regardless of whether the Spatial Analyst module is available. Therefore, these data also represent an important resource for landscape visualization and base mapping.

TABLE 2.11  
Overview of Ancillary Raster Database Component

Dataset Name	Data Class	Source	Number of Cells	Source Pixel Size	Comparative analytical / map scale	Extent Purpose	Description
**Annual Total Air Temperature	Air Temperature	CRES I FAO	15 grids 1 450 x 1 380	0.05°	3-NM / 1:20 000 000	Africa Analysis	Air Temperature. 3-arc minute, 15 grids of monthly and summary annual statistics. A vectorized version of these data is contained in AVEC_DBC for users without Spatial Analyst.
Consolidated 30 as SRTM-ETopo2 Hillshade	Hillshade	SRTM- GTopo30	10 800 x 11 400	0.00833°	0.5-NM / 1:3 500 000	Africa Analysis	Grid based hillshade of consolidated 30 as SRTM-ETopo2 DEM
Consolidated SRTM 30 as DEM and ETopo2 Bathymetry	DEM	SRTM- GTopo30	10 800 x 11 400	0.00833°	0.5-NM / 1:3 500 000	Africa Analysis	Consolidated SRTM-GTopo30 DEM with masked ocean values backfilled based on ETopo2 Bathymetry
ETopo2 2 arc-minute Hill-Bathymetric Shading	Hillshade Bathymetry	ETopo2	5 400 x 10 800	0.03333°	2-NM / 1:12 500 000	Global Analysis	ETopo2 2 arc-minute Hill-Bathymetric Shading
ETopo2 2 arc-minute Terrain-Bathymetry DEM	Bathymetry	ETopo2	5 400 x 10 800	0.03333°	2-NM / 1:12 500 000	Global Analysis	ETopo2 2 arc-minute Terrain and Bathymetric DEM
FAO-AquaStat 1 km Hydrologically Filled DEM	Hydro- Filled DEM	FAO	9 194 x 8 736	1 kilometer	0.5-NM / 1:3 500 000	Africa Analysis	Hydrologically filled GTopo30 DEM with the main stems of cartographic rivers "burned-in" for irrigation analysis for the AWRIA
GLC-2000 Based 1 km Global Land Cover	Land Cover GLC2000	JRC - FAO	8 457 x 9 745	0.00833°	0.5-NM / 1:3 500 000	Africa Analysis	1 Km Global Land Cover processed from the SPOT Vegetation sensor
HYDRO1 Kilometer Hydrologically Filled DEM	Hydro-Filled DEM	HYDRO1k	9 194 x 8 736	1 kilometer	0.5-NM / 1:3 500 000	Africa Analysis	An hydrologically filled version of the GTopo30 DEM employing a Afro-centric Lambert Azimuthal Equal Area Projection
Lake Tanganyika SRTM 3 as DEM Mosaic	DEM	SRTM	14 401 x 16 801	0.000833°	0.05-NM / 1:250 000	Tanganyika Analysis	Lake Tanganyika SRTM 3 as DEM Mosaic
Lake Tanganyika SRTM 3 as Hillshade Mosaic	Hillshade	SRTM	14 401 x 16 801	0.000833°	0.05-NM / 1:250 000	Tanganyika Analysis	Lake Tanganyika SRTM 3 as Hillshade Mosaic
Land/Island 30 as Mask based on WVS+	Mask	WVS+	10 800 x 11 400	0.00833°	0.5-NM / 1:3 500 000	Africa Analysis	WVS+ 1:250 000 based landmass and oceanic mask derived for processing SRTM-GTopo30 DEMs
Land-Ocean Processing Mask	Climate	CRU	1 080 x 2 160	0.16667°	10-NM / 1:70 000 000	Africa Analysis	Land-Ocean Processing Mask, 10-arc minutes
**Monthly Evapo-transpiration	Evapo- transpiration	CRU	13 grids 1 080 x 2 160	0.16667°	10-NM / 1:70 000 000	Africa Analysis	Evapotranspiration, 10-arc minute, 13 grids of monthly and summary annual total. A vectorized version of these data is contained in AVEC_DBC for users without Spatial Analyst.
**Monthly Precipitation	Precipitation	CRU	13 grids 1 080 x 2 160	0.16667°	10-NM / 1:70 000 000	Africa Analysis	Precipitation, 10-arc minute, 13 grids of monthly and summary annual total. A vectorized version of these data is contained in AVEC_DBC for users without Spatial Analyst.
**Monthly Water Temperature for April	Water Temperature	CRES I FAO	19 grids 1 450 x 1 380	0.05°	3-NM / 1:20 000 000	Africa Analysis	Water Temperature. 3-arc minute, 19 grids of monthly and summary annual statistics. A vectorized version of these data is contained in AVEC_DBC for users without Spatial Analyst.

Dataset Name	Data Class	Source	Number of Cells	Source Pixel Size	Comparative analytical / map scale	Extent Purpose	Description
**Rainfall, 8 Kilometer, Long Average	Precipitation	EDC	36 grids 1 152 x 1 152	8 kilometers	4.3-NM / 1:35 000 000	Africa Analysis	Interpolated rainfall data based on gauge data for the period 1920 to 1980, 36 grids. A vectorized version of these data is contained in AVEC_DBC for users without Spatial Analyst.
**Rainfall, 8 Kilometer, Short Average	Precipitation	EDC	36 grids 1 152 x 1 152	8 kilometers	4.3-NM / 1:35 000 000	Africa Analysis	Meteosat-GTS 10 day cumulative daily satellite estimated rainfall average, 1995 to 1999, 36 grids. A vectorized version of these data is contained in AVEC_DBC for users without Spatial Analyst.
**Rainfall, 8 Kilometer, Decadal 1995-2004	Precipitation	EDC	342 grids 1 152 x 1 152	8 kilometers	4.3-NM / 1:35 000 000	Africa Analysis	Set of 342 monthly grids of Meteosat-GTS 10 day cumulative rainfall estimates from April of 1995 to December of 2004. A vectorized version of these data is contained in AVEC_DBC for users without Spatial Analyst.
SRTM 30 as DEM w/Oceans Masked	DEM	SRTM-GTopo30	10 800 x 11 400	0.00833°	0.5-NM / 1:3 500 000	Africa Analysis	Enhanced SRTM-GTopo30 DEM with ocean values masked and set to null
*SRTM 3-arc second DEM-Baseline 1°-by-1° Grid Tiles	DEM	NASA   SRTM	3 204 grid tiles 1 201 x 1 201	0.000833°	0.05-NM / 1:250 000	Africa Analysis	"Seamless" set of 3 204 Arc-Grid based DEM tiles derived from the Version 2 of the SRTM 3-arc second data library covering Africa; nominal 90 metre
*SRTM 3-arc second DEM-Filled 1°-by-1° Grid Tiles	DEM	FAO	3 204 grid tiles 1 201 x 1 201	0.000833°	0.05-NM / 1:250 000	Africa Analysis	Derivative of the above "Null" SRTM 3-arc second dataset with terrestrial void areas backfilled with SRTM-GTopo30 DEM, 3 204 Arc-Grid tiles
*SRTM 3-arc second DEM-Hillshade 1°-by-1° Grid Tiles	Hillshade	FAO	3 204 grid tiles 1 201 x 1 201	0.000833°	0.05-NM / 1:250 000	Africa Analysis	Arc-Grid "2.5d Hillshade" based derivative of SRTM 3-arc second "Null" set covering Africa, 3 204 tiles
*SRTM 3-arc second DEM-Null 1°-by-1° Grid Tiles	DEM	FAO	3 204 grid tiles 1 201 x 1 201	0.000833°	0.05-NM / 1:250 000	Africa Analysis	Derivative of the above "Baseline" SRTM 3-arc second dataset with ocean and terrestrial void areas set to null using a SRTM-SWBD 1-arc second mask, 3 204 Arc-Grid based tiles
SRTM-SWBD Based 30 Arc-Second Land/Ocean Mask	DEM	SRTM-GTopo30	10 800 x 11 400	0.00833°	0.5-NM / 1:3 500 000	Africa Analysis	A 30 arc-second land/ocean mask derived from the SRTM-SWBD nominal 30 metre coastline data
Volta Basin SRTM 3 as Based DEM Mosaic	DEM	SRTM	13 201 x 14 401	0.000833°	0.05-NM / 1:250 000	Volta Analysis	Volta basin SRTM 3 as Based DEM Mosaic
Volta Basin SRTM 3 as Based Hillshade Mosaic	Hillshade	SRTM	13 201 x 14 401	0.000833°	0.05-NM / 1:250 000	Volta Analysis	Volta basin SRTM 3 as Based Hillshade Mosaic

\*Data layer is comprised of multiple source 1x1 degree tiled raster grids for the Extent area listed

\*\*Data layer is comprised of multiple raster grid datasets of the same cell dimensions which represent annual, monthly or decadal value summaries for some time period in years and/or the same values over a time-series

TABLE 2.12  
Overview of Ancillary Image Database Component

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
2.5d DEM Sharpened 2 <sup>nd</sup> Generation MODIS Blue Marble mosaic	Satellite based Imagery	SRTM MODIS	37 221 x 45 583	0.002083°	0.125-NM / 1:850 000	Africa Reference	MODIS image mosaic, see below, overlaid atop 7.5as Hillshade of derived from SRTM 3as base. As with image above, only provides greater detail in areas of high relief
2.5d DEM Sharpened ETM+ Image Mosaic	Satellite based Imagery	SRTM ETM+	37 221 x 45 583	0.002083°	0.125-NM / 1:850 000	Africa Reference	ETM+ image mosaic, see below, overlaid atop 7.5as Hillshade of derived from SRTM 3as base
2.5d Enhanced 1 <sup>st</sup> Generation NASA Blue Marble 30as Mosaic	Satellite based Imagery	MODIS	9 600 x 9 600	0.00833°	0.5-NM / 1:3 500 000	Africa Reference	2.5d enhanced version of circa year 2000, NASA Blue-Marble mosaic
2.5d Enhanced 30 as ETM+ Shaded Mosaic	Satellite based Imagery	ETM+ Browse	19 509 x 18 899	465 metre	0.25-NM / 1:2 500 000	Africa Reference	Derivative of the above ETM+ mosaic base, 2.5d enhanced based on the SRTM 30as DEM for $\approx$ 1:2.5m scale mapping
2.5d Enhanced ETopo2 Terrain and Bathymetry color classified	Elevation Bathymetry	ETOPO2	10 800 x 5 400	0.03333°	2-NM / 1:12 500 000	Global Reference	2.5d enhanced color classified, nominal 3.7 Km, bathymetry and terrestrial elevation enhanced with hillshade
2 <sup>nd</sup> Generation MODIS Blue Marble mosaic	Satellite based Imagery	MODIS	18 612 x 22 793	0.004167°	0.25-NM / 1:1 750 000	Africa Reference	NASA Blue Marble, nominal 460 metre MODIS August 2004 based RGB Satellite Image Mosaic
7.5as Hillshade based on SRTM3as and ETopo2 Bathymetry	Hillshade	SRTM	37 221 x 45 583	0.002083°	0.125-NM / 1:850 000	Africa Reference	Nominal 230 metre hillshaded DEM building on v2 SRTM 3as base with ETopo2 bathymetry added
Africa Background, ETopo5	Elevation Bathymetry	ETOPO5	985 x 973	0.083333°	5-NM / 1:45 000 000	Africa Reference	2.5d enhanced color classified, 5-arc minute nominal 9.25 Km, bathymetry and terrestrial elevation enhanced with hillshade used for rapid production graphics in part 2 of this publication.
African Virtual Base Map	Virtual Base Map	FAO	51 784 x 51 084	1:750 000	0.15-NM / 1:1 000 000	Africa Reference	1:750 000 scale seamless base map of continental Africa based on VMap0-Ed3, DCW, and Classified GTopo30 DEM
Baseline 15as ETM+ Image Mosaic	Satellite based Imagery	ETM+ Browse	18 910 x 23 158	465 metre	0.25-NM / 1:1 750 000	Africa Reference	Seamless medium resolution LandSat ETM+ satellite image mosaic, circa year 2000 baseline, modified for natural color
Color Shade of SRTM30as w/ ETOPO2 Bathymetry	Hillshade	SRTM- GTopo30	9 600 x 9 600	0.00833°	0.5-NM / 1:3 500 000	Africa Reference	DEM building on GTopo30, with ETopo2 bathymetry
ETopo2 Color Classified Terrain and Bathymetric Elevations	Elevation Bathymetry	ETOPO2	10 800 x 5 400	0.03333°	2-NM / 1:12 500 000	Global Reference	Nominal 3.7 Km bathymetry and terrestrial elevation color classified based on elevation range values
Flattened SRTM 30 as Based Elevation/Relief	DEM	SRTM- GTopo30	9 600 x 9 600	0.00833°	0.5-NM / 1:3 500 000	Africa Reference	DEM building on GTopo30, with ETopo2 bathymetry
Grayscale 15as ETM+ Image Mosaic	Image Hillshade	ETM+ Browse	19 509 x 18 899	465 metre	0.25-NM / 1:1 750 000	Africa Reference	Derivative grayscale version of the above medium resolution ETM+ satellite mosaic baseline, 2.5d enhanced based on the SRTM 30as DEM data
Grayscale Hillshade of ETopo2 Terrain and Bathymetry	Hillshade Bathymetry	ETOPO2	10 800 x 5 400	0.03333°	2-NM / 1:12 500 000	Global Reference	Nominal 3.7 Km Grayscale image of bathymetry and terrestrial elevation

Dataset Name	Data Class	Source	Count of Features	Source Scale	Comparative analytical / map scale	Extent Purpose	Description
Grayscale Hillshade of SRTM30as w/ETOP2 Bath.	Hillshade	SRTM-GTopo30	9 600 x 9 600	0.00833°	0.5-NM / 1:3 500 000	Africa Reference	DEM building on GTopo30, with ETopo2 bathymetry
*Lake Tanganyika LandSat ETM+ 2.5d Shaded Image Catalog	Seamless Image Catalog	FAO	Access to 120 tiled images	15 metre	0.008-NM / 1:65 000	Tanganyika Reference	Catalog based on the above baseline of 120 natural color ETM+ orthorectified images, 2.5d enhanced based on the SRTM 3as DEM data
*Lake Tanganyika LandSat ETM+ Baseline Image Catalog	Seamless Image Catalog	FAO	Access to 120 tiled images	15 metre	0.008-NM / 1:65 000	Tanganyika Reference	Catalog of 120 natural color enhanced LandSat-ETM+ orthorectified Lat/Long projected RGB images, 7 805 x 7 805 pixels, in JPEG2000 format, tiled to match the structure of the SRTM 3as DEM; circa year 2000
Lake Tanganyika SRTM ~90m Hillshade Mosaic	Hillshade	SRTM	16 801 x 14 401	0.000833°	0.05-NM / 1:250 000	Tanganyika Reference	Seamless DEM hillshade covering Lake Tanganyika basin-watershed
**SRTM 3as 2.5d Hillshade Grid Catalog	Seamless Image Catalog	FAO	3 204 grid tiles as images	0.000833°	0.05-NM / 1:250 000	Africa Reference	Catalog of Arc-Grid based hillshaded depiction of NASA 3as SRTM Version 2 for Africa, seamless compilation of 3 204 1°x1° overlapping tiles
**SRTM 3as 2.5d Null/Backfilled Grid Catalog	Seamless Image Catalog	FAO	3 204 grid tiles as images	0.000833°	0.05-NM / 1:250 000	Africa Reference	Catalog of Arc-Grid based derivative of SRTM 3-arc second Version 2 DEM for Africa, seamless tiled compilation with oceans set to null using SRTM-SWBD 1-arc second mask and terrestrial void areas backfilled with SRTM-GTopo30 DEM
**SRTM 3as 2.5d RGB Image Catalog	Seamless Image Catalog	FAO	Access to 3 204 tiled images	0.000833°	0.05-NM / 1:250 000	Africa Reference	Catalog of RGB image derivative of v.2 SRTM 3as hillshaded DEM for Africa, seamless tiled compilation of color classified DEM by elevation range and hillshade
**SRTM 3as Baseline Grid Catalog	Seamless Image Catalog	FAO	3 204 grid tiles as images	0.000833°	0.05-NM / 1:250 000	Africa Reference	Catalog of Arc-Grid based derivative of SRTM 3-arc second Version 2 DEM for Africa, seamless baseline of 3 204 1°x1° overlapping tiles
**SRTM 3as Null Value Grid Catalog	Seamless Image Catalog	FAO	3 204 grid tiles as images	0.000833°	0.05-NM / 1:250 000	Africa Reference	Catalog of Arc-Grid based derivative of SRTM 3-arc second Version 2 DEM for Africa, seamless tiled compilation with ocean and terrestrial void areas set to null SRTM-SWBD 1-arc second mask
Volta Basin LandSat TM 2.5d Shaded Image	Satellite based imagery	FAO	42 465 x 46 324	28 metre	0.015-NM / 1:125 000	Volta Reference	Above TM orthorectified image base 2.5d enhanced based on the SRTM 3as DEM data
Volta Basin LandSat TM Baseline Image	Satellite based imagery	FAO	42 465 x 46 324	28 metre	0.015 / 1:125 000	Volta Reference	Natural color enhanced LandSat-TM orthorectified Lat/Long reprojected RGB images in JPEG2000 format, circa 1995
Volta River Basin SRTM ~90m Hillshade Mosaic	Hillshade	SRTM	13 201 x 14 401	0.000833°	0.05-NM / 1:250 000	Volta Reference	Seamless nominal 90 metre DEM hillshade of Volta megabasin

\*Data layer is comprised of multiple JPEG2000 images and provide seamless coverage for the Extent area listed in a rapid manner without the need for a user to load individual source tiles.

\*\*Data layer is comprised of multiple source 1x1 degree tiled raster grids. For users either with or without the ArcView Spatial Analyst extension, such catalogs provide a rapid and seamless mechanism for portraying grid based data as an image.

### Summary of data compiled for the AWRD data archive

Earlier in this section it was stated that, the AWRD archive likely represents the most comprehensive archive of water management and base resource mapping data ever compiled for Africa. The following list attempts to examine this assertion in light of the primary and secondary purposes for which the archive was developed based on the general applications anticipated for each of the diverse thematic layers presented previously in Table 2.2.

- 1. In terms of water resources and fisheries management**, this assertion is supported in part by the integration of thematic layers from each of the baseline and/or pre-eminent databases which have been either developed or made publicly available between 1997 and November, 2006. Thematically these layers were presented in Table 2.2 and include: aquatic species data; hydrologically filled DEMs<sup>9</sup>, related watershed models and linear flow networks; and surface waterbody and limnological data. With the exception of the DEM baselines, all of the above thematic layers included in the archive have undergone extensive spatial and attribute error checking, and include other significant forms of value-added processing. Summary statistical data have been generated and are available via the AWRD Interface for the DEM data to enable their integration in any watershed-based analysis undertaken via the AWRD Interface.
- 2. In regards to base resource mapping data**, the above statement is supported by the inclusion of layers from each of the source baselines for: 1:3 000 000 and 1:1 000 000 scale cartographic framework data libraries; 1:3 000 000, 1 000 000 and 1:250 000 scale gazetteer data resources; and terrain and bathymetric DEM resource baselines at nominal scales ranging from 1:12 500 000 to 1:350 000 made publicly available between 1992 and June, 2006. It should be noted that within the AWRD archive, these resources have been integrated in as complete a manner as possible, and include highly refined derivatives which in some cases also represent further analytical inputs for both AWRD uses and/or the general international development community. Summary statistical data have been generated and are available via the AWRD Interface for the 30 arc-second DEM data referenced above, nominal 1:3 500 000 scale, for users without Spatial Analyst.
- 3. Additional analytical resources:** In addition to these water, fisheries and base mapping resources, a variety of further analytical resource layers representing: decadal, monthly and annual rainfall and climatic data for time periods or series including 1920–1980, 1961–1990 and 1995–2005 at nominal scales of 1:220 000 000 through 1:30 000 000; year 2000 human population and land cover at a nominal scale of 1:3 500 000, and soils circa 1995 at a scale of 1:5 000 000 have also been integrated into either the AWRD archive directly or are available via the interface. For users without access to Spatial Analyst: rainfall and climatic data have been summarized for direct analysis via the various modules of the AWRD Interface, and vectorized versions of these data have also been prepared. Human population data have been summarized for direct analysis via the various modules of the AWRD Interface and land cover data are available as a simple visual reference. To facilitate regional and watershed-based analyses, the baseline Soils data were processed to remove national boundaries for coincident units based on attribute consolidation.

<sup>9</sup> DEM is an acronym for Digital Elevation Model. It represents a topographic surface using a continuous array of elevation values, referenced to a common datum. DEMs are typically used to represent terrain relief.

4. **Additional reference, base mapping and publication quality graphic** renditions of all reference DEMs listed under 2) above have been prepared to facilitate a variety of rapid pre-classified DEM and pseudo 3D landscape visualizations regardless of whether a user has access to either ESRI's Spatial Analyst or 3D Analyst commercial add-on modules. The renditions represent full-resolution geo-referenced versions of the source DEMs and can be viewed both within a GIS and outside via a browser or most image viewing software. Although the highest resolution DEM data are set for only limited release, a seamless continental mosaic was created from this baseline as a 2.5d image backdrop for users to support potential reference mapping down to a scale of 1:850 000. In addition to these DEM derivatives, for users without access to Leica's Image Analyst commercial add-on module to ArcView, a variety of satellite-based and 3D-enhanced imagery has been integrated into the AWRD archive. Continental wide circa year 2000 imagery at scales of 1:3 500 000 and 1:1 750 000 are available to all users of the AWRD; while circa 1995 1:125 000 scale imagery for the Volta megabasin and circa 2000 1:65 000 scale imagery for the Lake Tanganyika Watershed are set for limited distribution.

Overall, perhaps the chief value of the data contained within the AWRD archive is that, although the data are derived from some twenty-eight spatial data sources or institutions, the data were processed in a consistent manner by one organization. One of the benefits of this development method is that a considerable amount of expertise has been gained and to some degree institutionalized. Because the AWRD tool-sets and analytical modules are largely *not* African centric, the only reason the AWRD cannot be used directly outside of Africa at the time of publication are related to data. Hence, the level of expertise gained will become an important consideration towards making the global expansion of the AWRD more cost-effective and possible. Another benefit of the AWRD archive development is that both the ultimate source and the processing history of each input data layer, i.e. its lineage, is clear on a layer by layer basis for all AWRD derivatives. Because the lineage is clear, even though no known errors have been identified as having been introduced into the AWRD outputs, if at some point in the future errors are found they will likely be consistent<sup>10</sup> and more readily corrected.

In particular, with regards to vector based derivative data contained within the AWRD archive, a further general benefit of having outputs processed by one organization using a clear processing lineage is that a variety of checks were able to be performed between different editions of the source material. Such checks are most often confined to the realm of commercial data products. To the knowledge of the AWRD developers, the archive represents the first time such efforts have been undertaken for publicly available data. Related to this, a further benefit of the AWRD archival data is that their copyright is clear and is specifically unencumbered for use and onward distribution for any non-commercial purpose.

For both direct users of the AWRD and any institution requiring data for a river basin, country, region or continent-wide area of interest within Africa, the AWRD data archive will provide access to many high quality value-added data layers which were previously unavailable publicly. Table 2.13 provides a summary of what the AWRD development team consider to be some of the unique and/or essential data layers which have been compiled for the archive.

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<sup>10</sup> Unless specifically stated in the metadata documentation, double-precision coordinate references were used for all processing of source vector and raster data. Due to this, it is highly probable that if errors are found at some future date, they will not have been degenerative. Rather, any such errors should be the result of introduced biases or improper shifts in either coordinate geometry or attribute values which can be easily rectified in a consistent manner.

TABLE 2.13  
Summary of AWRD datasets

Dataset name	Source	Number of features	Source scale
<b>Surface Waterbodies Database Component</b>			
AfriCover Surface Water Body Features	FAO	11 296	1:250 000
Consolidated WCMC Wetlands	WCMC	4 404	1:1 000 000
FAO-MRAG Spatially Referenced Waterbodies	FAO	499	n.a
RWDB2 Surface Water Bodies	RWDBII	831	1:3 000 000
SRTM Surface Water Body Point, Line and Polygon Reference	SRTM	38 840	1:100 000
Surface Water Body Features from GEOnet Gazetteer	GEOnet	46 591	1:250 000
VMap and Harmonized DCW-VMap0 Surface Water Bodies	VMap0 I DCW	25 128	1:1 000 000
<b>Watersheds Database Component</b>			
ALCOM-WWF Watershed Model	WWF I ALCOM	5 456	5 000 cell
FAO-AquaStat Major Basins Watershed Model	FAO	608	10 000 cell
GIWA Large Marine Ecosystem/Basin Delineation	GIWA – URI	2 936	~100 000 cell
HYDRO-1 Kilometer Watershed Model	HYDRO1k	7 133	4 000 cell
WRI Major Watersheds of the World Delineation	WRI-Rutgers	254	~250 000 cell
<b>Rivers Database Component</b>			
Consolidated VMap0 River-Surface Water body Network	VMap0 I DCW	173 504	1:1 000 000
FAO-AquaStat 1:5m African Rivers	FAO	32 636	1:5 000 000
HYDRO-1 Kilometer Flow Drainage Network	HYDRO1k	15 478	4 000 cell
River Features from GEOnet Gazetteer	GEOnet	138 700	1:250 000
RWDB2 Rivers and Surface Water Body Outlines	RWDB2	4 376	1:3 000 000
<b>Aquatic Species Database Component</b>			
Aquatic Species Political Boundary Reference	Varied	5 690	varied
Aquatic Species Watershed Modeling Reference	Varied	608	varied
Restricted version of main SAIAB Aquatic Species Locations	SAIAB	n.a	1:1 000 000
SAIAB Aquatic Species Locations	SAIAB	798	1:1 000 000
SAIAB Threatened and Endanger Species Boundaries	FAO	92	1:2 000 000
<b>Gazetteer Database Component</b>			
DCW Gazetteer	DCW	151 739	1:1 000 000
GEOnet Gazetteer Database	GEOnet	1 083 354	1:250 000
<b>Ancillary Vector Database Component</b>			
DCW (Digital Chart of the World) Datasets	DCW	Various	1:1 000 000
FAO 1:5 Million Scale Soils	FAO	4 909	1:5 000 000
FAO National and Subnational Boundary Datasets	FAO	Various	1:1 000 000
RWDBII 2001 (Revised/Relational World Databank II) Datasets	RWDBII	Various	1:3 000 000
SRTM (Space Shuttle Radar Topography Mission) Landmass, Offshore Islands and Coastlines Datasets	SRTM	Various	1:100 000
VMap0 2000 5 <sup>th</sup> Edition (Vector Map Level 0) Datasets	VMap0	Various	1:1 000 000
WVS+ (World Vector Shoreline) Datasets	WVS+	Various	1:250 000
<b>Ancillary Raster Database Component</b>			
Annual and Monthly Air Temperature	CRES I FAO	1 450 x 1 380	0.05°
Annual and Monthly Evapo-transpiration	CRU	1 080 x 2 160	0.16667°
Annual and Monthly Precipitation	CRU	1 080 x 2 160	0.16667°
Annual and Monthly Water Temperature	CRES I FAO	1 450 x 1 380	0.05°
ETOPO2 2 arc-minute Terrain-Bathymetry DEM	ETOPO2	5 400 x 10 800	0.03333°
FAO-AquaStat 1 km Hydrologically Filled DEM	FAO	9 194 x 8 736	1 kilometer
GLC-2000 Based 1 km Global Land Cover	JRC - FAO	8 457 x 9 745	0.00833°
HYDRO1 Kilometer Hydrologically Filled DEM	HYDRO1k	9 194 x 8 736	1 kilometer
Monthly, Decadal, Short- and Long-Term Rainfall	EDC	1 152 x 1 152	8 kilometers
SRTM 30as DEM and Hillshade for Africa	SRTM	Various	0.00833°
SRTM 3as DEMs and Hillshades for Africa	SRTM	Various	0.000833°
<b>Ancillary Image Database Component</b>			
2.5d Colored ETopo5 Terrain/Bathymetry	ETOPO5	985 x 973	0.083333°
2.5d Enhanced 30 as ETM+ Shaded Mosaic	ETM+ Browse	19 509 x 18 899	465 metre
2.5d Enhanced ETopo2 Colored Terrain/Bathymetry	ETOPO2	10 800 x 5 400	0.03333°
2.5d Enhanced NASA Blue Marble 30 as Mosaic	MODIS	9 600 x 9 600	0.00833°
African Virtual Base Map	FAO	51 784 x 51 084	1:750 000
Baseline 15 as ETM+ Image Mosaic	ETM+ Browse	25 473 x 18 921	465 metre
Classified ETopo2 Terrain/Bathymetry	ETOPO2	10 800 x 5 400	0.03333°
Color Shade of SRTM30as w/ETOPO2 Bathymetry	SRTM-GTopo30	9 600 x 9 600	0.00833°
Flattened SRTM 30 as Based Elevation/Relief	SRTM-GTopo30	9 600 x 9 600	0.00833°
Grayscale 15 as ETM+ Image Mosaic	ETM+ Browse	19 509 x 18 899	465 metre
Grayscale Hillshade of SRTM30as w/ETOPO2 Bath	SRTM-GTopo30	9 600 x 9 600	0.00833°
Grayscaled Hillshade of ETopo2 Terrain/Bathymetry	ETOPO2	10 800 x 5 400	0.03333°
SRTM 3as Color Classified Image Catalog for Africa	SRTM	Various	0.000833°