

Technical Notes

The information in this table was provided by *the Water Resources eAtlas*. Four organizations worked to gather and organize this data: WRI, IUCN, IWMI, and the Ramsar Convention on Wetlands. Please refer to the Water Resource eAtlas/Watersheds of the World site (<http://www.iucn.org/themes/wani/eatlas/index.htm>) for more information on this ongoing effort.

VARIABLE DEFINITIONS AND METHODOLOGY:

Modeled Watershed Area measures the area of a river basin in square kilometers by summing the number of 1 km² cells within each watershed using Geographic Information Systems (GIS). Basins were modeled based on elevation data, therefore these values only reflect horizontal extent (slopes are not accounted for) and may underestimate total land surface in the drainage area. Intermittent tributaries are included in most cases; for example the northern part of the Kalahari Desert in Botswana is included in the Okavango basin, as well as many of the intermittent tributaries within the Lake Chad basin. Water surface of rivers and lakes (i.e., Great Lakes in St. Lawrence River basin) are included in the total basin area; however the tidal portions of rivers, such as the St. Lawrence and Ob, are not included in the drainage area calculation.

River basin boundaries are based on two datasets: a revised version of the Major Watersheds of the World dataset distributed on the GlobalARC CD-ROM by the U.S. Army Corps of Engineers Construction Engineering Research Laboratories (CERL) and the EROS Data Center HYDRO1k basin boundaries developed at the U.S. Geological Survey (<http://edcdaac.usgs.gov/gtopo30/hydro/>). The base data layer used for geographic definition of the watersheds was a 5-minute resolution dataset (1/20th of a degree of latitude/longitude) of major basins. There are some limitations associated with the scale of these base data: watershed boundaries are coarse, and some smaller basins and small tributaries are not identified. Basins were edited by WRI to capture some features such as deltas. Sub-basins were then aggregated to include all tributaries of the major river systems.

Average Population Density shows the population density by basin expressed as people per square kilometer. Population growth, industrialization, urbanization, agricultural intensification, and water-intensive lifestyles are placing greater stress on freshwater systems, with both water use and pollution driving the scarcity of useable water. The Gridded Population of the World (GPW) database was used to calculate average population density by river basin. The GPW dataset was compiled from the latest available census data for over 120,000 administrative units worldwide, at a variety of subnational district levels. The population figures were standardized to 1995. The polygon data were converted to 2.5' grid with an assumption that the population is evenly distributed within a census unit. The total number of people in each basin was calculated using the grid data, and then divided by the total area of the basin to calculate the average population density.

Countries within the Watershed measures the total number of countries that are located within the area of the drainage basin. In several cases, countries with less than one percent area in the watershed are excluded from the totals.

Number of Transboundary Treaties refers to those agreements that relate to international freshwater resources and issues such as; water rights, water allocations, water pollution, hydropower/reservoir/flood control development, environmental issues, and the rights of riverine ecosystems. Documents concerning navigation rights and tariffs, division of fishing rights, and delineation of rivers as borders or other territorial concerns are not included, unless freshwater as a resource is also mentioned in the document, or physical changes are being made that may impact the hydrology of the river system (e.g., dredging of river bed to improve navigation, straightening of a river's course).

Water Available Per Person represents the amount of total runoff available, measured in cubic meters per person per year, in each river basin. The estimates are based on a global runoff distribution database developed by the University of New Hampshire and the Global Runoff Data Centre. For those regions where discharged data were available, the modeled runoff was adjusted to match the observed values; for regions with no observed data, the modeled estimates of runoff were used. Water availability per person was calculated by dividing the total runoff available in a basin by the total number of people in that basin. The

runoff distribution database has a spatial resolution of 0.5° and was calculated based on basin boundaries defined by the University of New Hampshire. The population database used was a 2.5-minute resolution population map from CIESIN and WRI for the years 1990 and 1995.

Dams Planned or Under Construction includes dams at least 60 meters high that were under construction in 1998 and reported in the “1998 World Atlas and Industry Guide” of the International Journal of Hydropower and Dams; WRI updated these estimates in 2004. The approximate location of the dams was referenced based on continental-scale maps. The number of dams was later aggregated by river basin.

Degree of River Fragmentation indicates the level of modification of a river system due to dams, reservoirs, interbasin transfers, and irrigation consumption. Irrigation consumption refers to the water that is evaporated as a result of irrigation, but excludes the amount of water returned to the river after irrigation. River systems were classified into three levels of fragmentation: high, medium, and low. These categories are based on the number of dams in the main river channel and tributaries, the level of flow regulation, and the length of the main-channel segment without dams in relation to the entire length of the river. Generally, rivers with low fragmentation do not have dams in the main channel, and, if present, dams on tributaries do not change the river’s discharge by more than 2 percent. Rivers with high fragmentation may have more than three-quarters of their main channels dammed or may have dams that substantially change the annual discharge.

Percent Cropland, Forest, and Grassland within each basin was identified using the USGS Global Land Cover Characterization database (GLCCD) with the International Geosphere Biosphere Programme (IGBP) classification. The land cover database is derived from 1-kilometer resolution satellite data spanning April 1992 through March 1993. Because these data are most useful for analyzing general land cover patterns at a continental or large scale, these data are less reliable for smaller watersheds.

Percent Cropland indicates the percentage of the basin defined as cropland or a crop/natural vegetation mosaic.

Percent Forest indicates the percentage of the basin defined as evergreen needleleaf forest, evergreen broadleaf forest, deciduous needleleaf forest, deciduous broadleaf forest, or mixed forest. **Percent Grassland** includes IGBP classes defined as open shrublands, closed shrublands, woody savannas, savannas, and grasslands.

Percent Wetlands indicates the percentage of the basin comprised of bogs, marshes, lakes, seasonal, permanent, freshwater, tidal, mangroves, and lagoons. Wetland data were obtained from UNEP-WCMC’s Biodiversity Map Library and follow UNEP-WCMC’s definitions. UNEP-WCMC’s dataset was derived from Operational Navigation Charts, existing maps and expert opinion. This dataset includes wetland types that are not easily captured by remote sensing-derived data. However, because of its scale, it underestimates wetlands extent, particularly seasonal wetlands, flooded forests, and wetlands in valley bottoms.

In North America the area occupied by the Great Lakes, the Great Bear Lake, the Great Slave Lake, and Lake Winnipeg are not included in the calculation of wetland area. For North America wetland polygons were not differentiated by type of wetlands, instead the class field identified the proportion of the polygon--represented by a range--occupied by wetlands. To calculate wetland area, polygons were converted to a 1 square kilometer grid using the minimum of the range. Because this method assumes that wetlands are evenly distributed across each polygon, wetland extent may be overestimated in the North American basins.

Percent Developed was estimated from a 1-kilometer by 1-kilometer resolution map derived from nighttime imagery from the Defense Meteorological Satellite Program Operational Linescan System of the United States. The dataset contains the locations of stable lights, including frequently observed light sources such as gas flares at oil drilling sites. Time-series analysis is used to exclude transient light sources such as fires and lightning. The extent of “lit” area may be slightly overestimated due to the sensor’s resolution and factors such as reflection from water and other surface features. It is a good indicator of the spatial distribution of settlements and infrastructure, but should not be interpreted as a measure of population density. (The mean settlement size required to produce enough light to be detected is much greater in developing countries than

in industrialized countries because of differences in energy consumption.) The Nighttime Lights of the World data are more highly correlated with measures of economic activity and energy consumption and are, therefore, considered a measure of relative development within the watershed. The percent developed was calculated by dividing the area within a watershed indicated as "lit" by the total area of the watershed.

Percent Arid area indicates the percentage of the basin that falls in an area defined as semiarid, arid, or hyperarid on the World Atlas of Desertification Global Aridity Zone Map. This map is based on an aridity index derived from the ratio of mean annual precipitation to the mean annual potential evapotranspiration.

Percent Irrigated Area indicates the percentage of the basin that has irrigated agriculture. This percentage was calculated by overlaying the boundaries of the major watersheds on an irrigated area map developed by the University of Kassel. The map is a 0.5° by 0.5° grid depicting the percentage of the area equipped for irrigation in 1995. The map was derived by combining information from large-scale irrigation maps, and national, subnational, and drainage basin level data on irrigated area.

Percent Protected Area indicates the portion of the watershed area designated as a protected area by the World Conservation Union (IUCN). The percentages shown here were derived from a spatial data set produced by the World Conservation Monitoring Center, now UNEP-WCMC. Most of the protected areas are represented by polygons, but some are represented by single points. For the latter, circular buffers around the point locations were generated corresponding to the reported size of the protected area. The World Protected Areas Database is currently being revised and updated by the World Database and Protected Areas Consortium, a group of environmental organizations that hold geospatial databases on protected areas.

Total Fish Species refers to the total number of freshwater and marine fish identified, documented, and recorded in major rivers or basins. Total numbers include both endemic and non-endemic species (a species that is found in a particular region and nowhere else is said to be endemic to that region). The total number of known species may include diadromous and introduced species.

Possible sources of error include the amount of research done in a particular basin; species extinctions; and introductions of non-native species. Some rivers, for example, have been highly sampled and most of their species identified, while others, particularly in the tropics, have not been thoroughly studied and may contain many not-yet-identified species. Due to several potential sources of error in the species richness values, these numbers should be taken as general indicators of fish diversity and not actual measures.

Number of Ramsar Sites measures the number of wetlands of international importance classified under the Ramsar Convention in each basin. The information on each site is included in the Ramsar Database, maintained by Wetlands International under contract with the Ramsar Convention. Wetlands International compiles the database using the official information submitted by each country about its Ramsar sites. Spatial accuracy of the coordinates varies from one site to another. Wetlands International provided WRI with the point location for each Ramsar site, as well as the presence or absence of invasive species reported for each site. Sites were mapped using the coordinates provided in the database and areas were later aggregated by river basin using a geographic information system.

Number of Wetland Dependent Important Bird Areas (IBAs) are globally important sites for the conservation of wild bird populations at the global, continental, and sub-continental level. The IBAs displayed here are solely those sites that are inland wetlands and that are internationally significant for waterbirds. At the time of the preparation of this table, aggregated data were not available for Oceania and the Americas.

SOURCES:

Modeled Watershed Area: Center for Remote Sensing and Spatial Analysis (CRSSA) of Cook College, Rutgers University and U.S. Army Corps of Engineers Construction Engineering Research Laboratory, "Major Watershed Basins of the World," World Resources Institute (WRI), ed. GlobalARC GIS CD-ROM Database (CRSSA, New Brunswick, New Jersey, 1996).

Average Population Density: Center for International Earth Science Information Network (CIESIN), WRI, and International Food Policy Research Institute, Gridded Population of the World, Version 2 alpha (Columbia University, Palisades, New York, 2000) available online at: <http://sedac.ciesin.org/plue/gwp>.

Number of Transboundary Treaties: Department of Geosciences, Oregon State University. 2004. "International Freshwater Dispute Database". Available on-line at: <http://www.transboundarywaters.orst.edu/projects/internationalDB.html>. Corvallis, OR: Oregon State University.

Water Availability per Person: B.M. Fekete, C.J. Vörösmarty, and W. Grabs. 1999. "Global Composite Runoff Fields Based on Observed River Discharge and Simulated Water Balance, Version 1.0" University of New Hampshire, Durham, and Global Runoff Data Centre, Koblenz, Germany.

Dams Planned and Under Construction "1998 World Atlas and Industry Guide," International Journal on Hydropower and Dams (Aqua-Media International, Surrey, U.K., 1998).

Degree of Fragmentation: Unpublished data, Landscape Ecology Group, Umeå University, (Umeå, Sweden, 2000) and M. Dynesius and C. Nilsson. 1994. "Fragmentation and Flow Regulation of River Systems in the Northern Third of the World," *Science* 266:753–762.

Percent Cropland, Forest, and Grassland: U.S. Geological Survey (USGS) and University of Nebraska-Joint Research Center for the European Commission, Global Land Cover Characterization Database, Version 1.2, distributed by USGS Earth Resources Observation System Data Center (USGS, 1997), available online at: http://edcdaac.usgs.gov/glcc/globe_int.html.

Percent Developed: National Oceanic and Atmospheric Administration-National Geophysical Data Center (NOAA-NGDC), Nighttime Lights of the World Database (NOAA-NGDC, Boulder, Colorado, 1997).

Percent Irrigated: Center for Environmental Systems Research, University of Kassel, Global Map of Irrigated Areas (University of Kassel, Kassel, Germany, 1999).

Percent Arid: United Nations Environment Programme (UNEP), World Atlas of Desertification Global Aridity Zone Map (UNEP, Nairobi, 1992).

Percent Wetlands: UNEP-WCMC. 1998. *Biodiversity Map Library*. Cambridge, U.K.

Total Fish Species: Data on fish species were compiled from multiple sources by the World Conservation Monitoring Centre of the United Nations Environment Programme (UNEP-WCMC). Additional data were added by WRI from technical papers and expert opinion.

Ramsar sites: Ramsar Convention Bureau, List of Wetlands of International Importance (Ramsar Convention Bureau, Gland, Switzerland, 2003).

Number of Wetland Dependent Important Bird Areas: These data were originally published in:

Evans, M.I. Ed. 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International,

Heath, M.F. and M.I. Evans. Eds. 2000. *Important Bird Areas in Europe: priority sites for conservation*. 2 vols. Cambridge, UK: BirdLife International

Fishpool, L.F. and Evans, M.I. Eds. 2001. *Important Bird Areas in Africa and associated islands*. Cambridge/Newbury, UK: BirdLife International/Pisces Publications.

See the 'Data Zone' at www.birdlife.org for detailed information on individual IBAs and the waterbird species that they support.