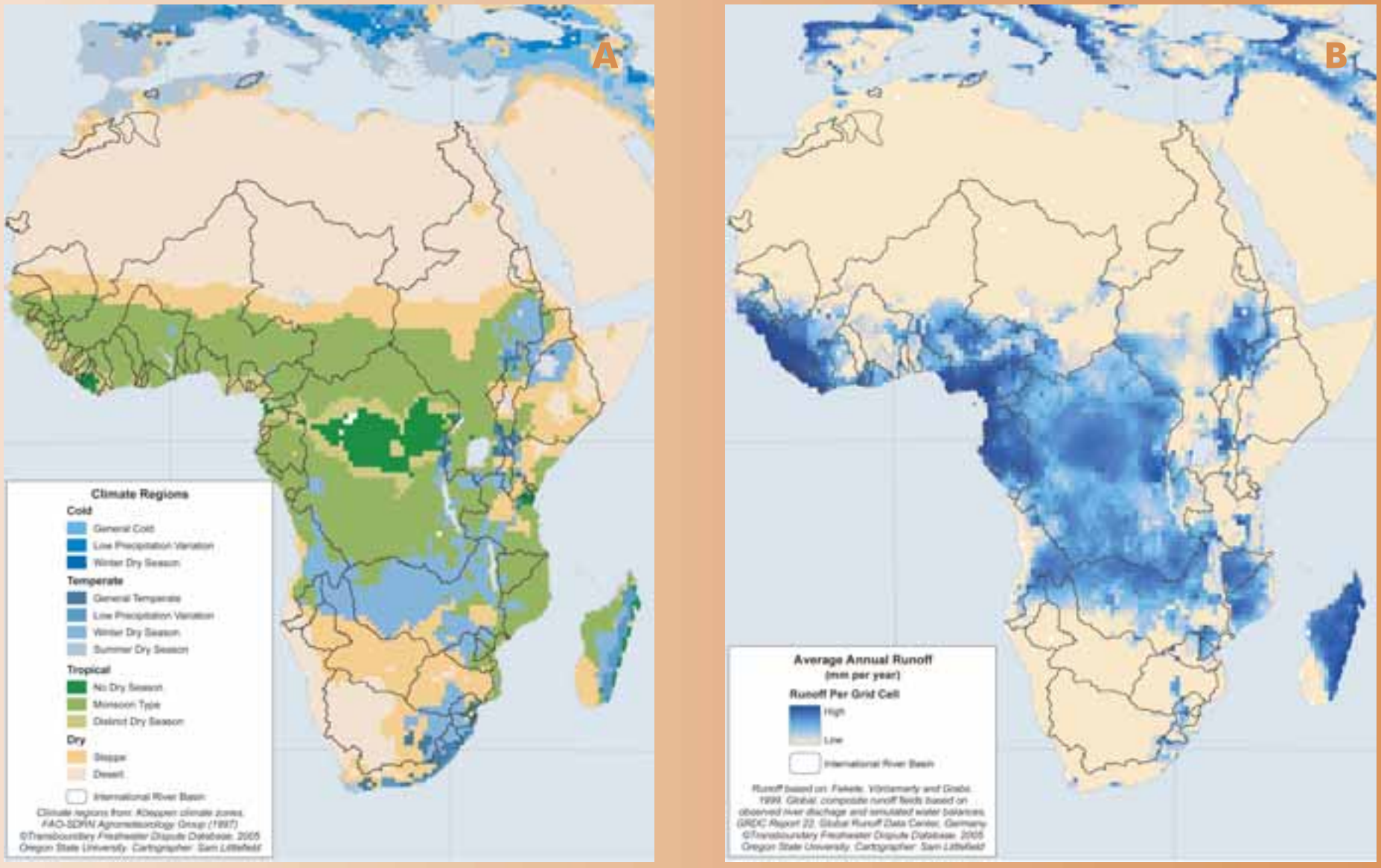
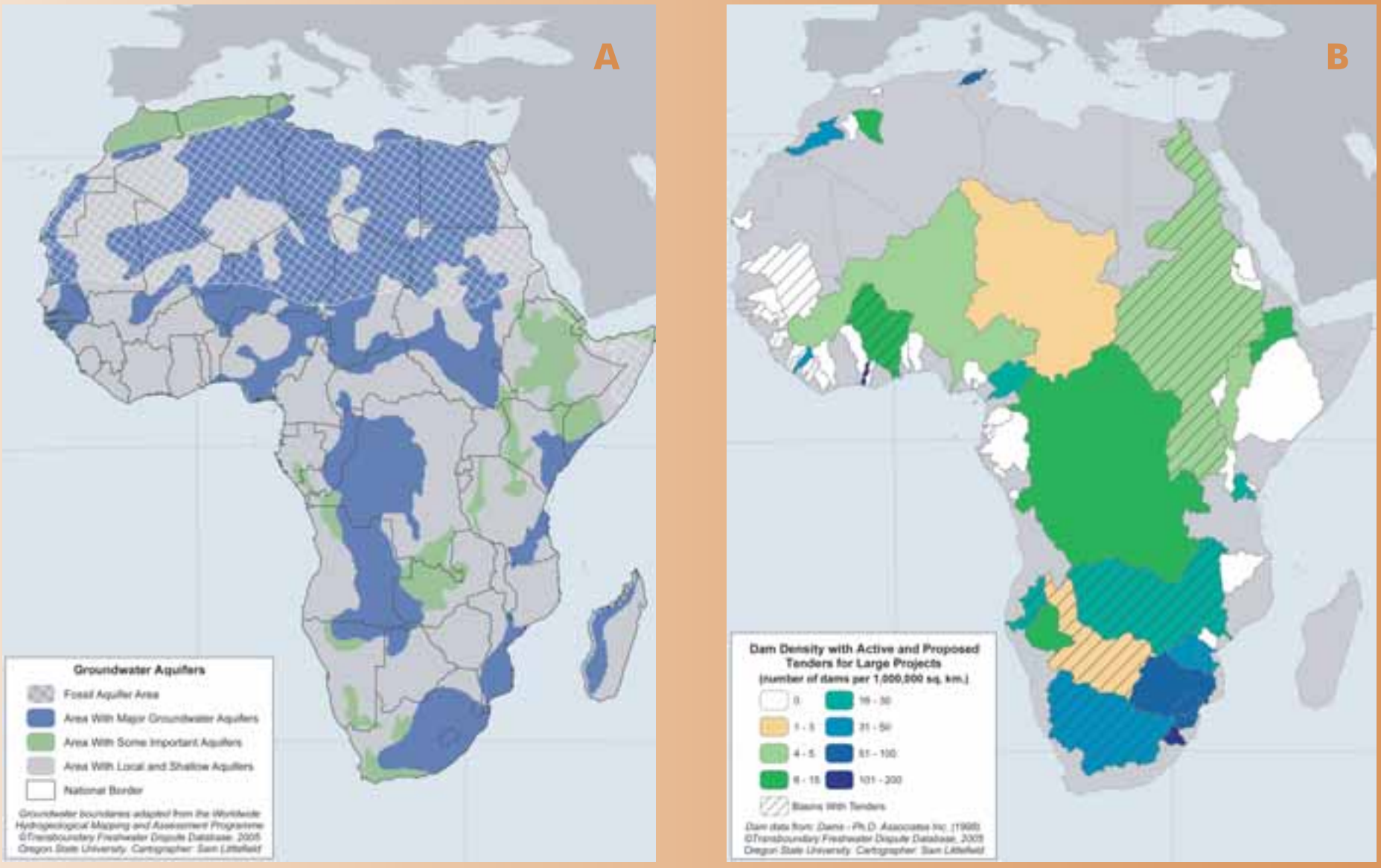
Atlas of Hydropolitical Vulnerability and Resilience: *Africa*

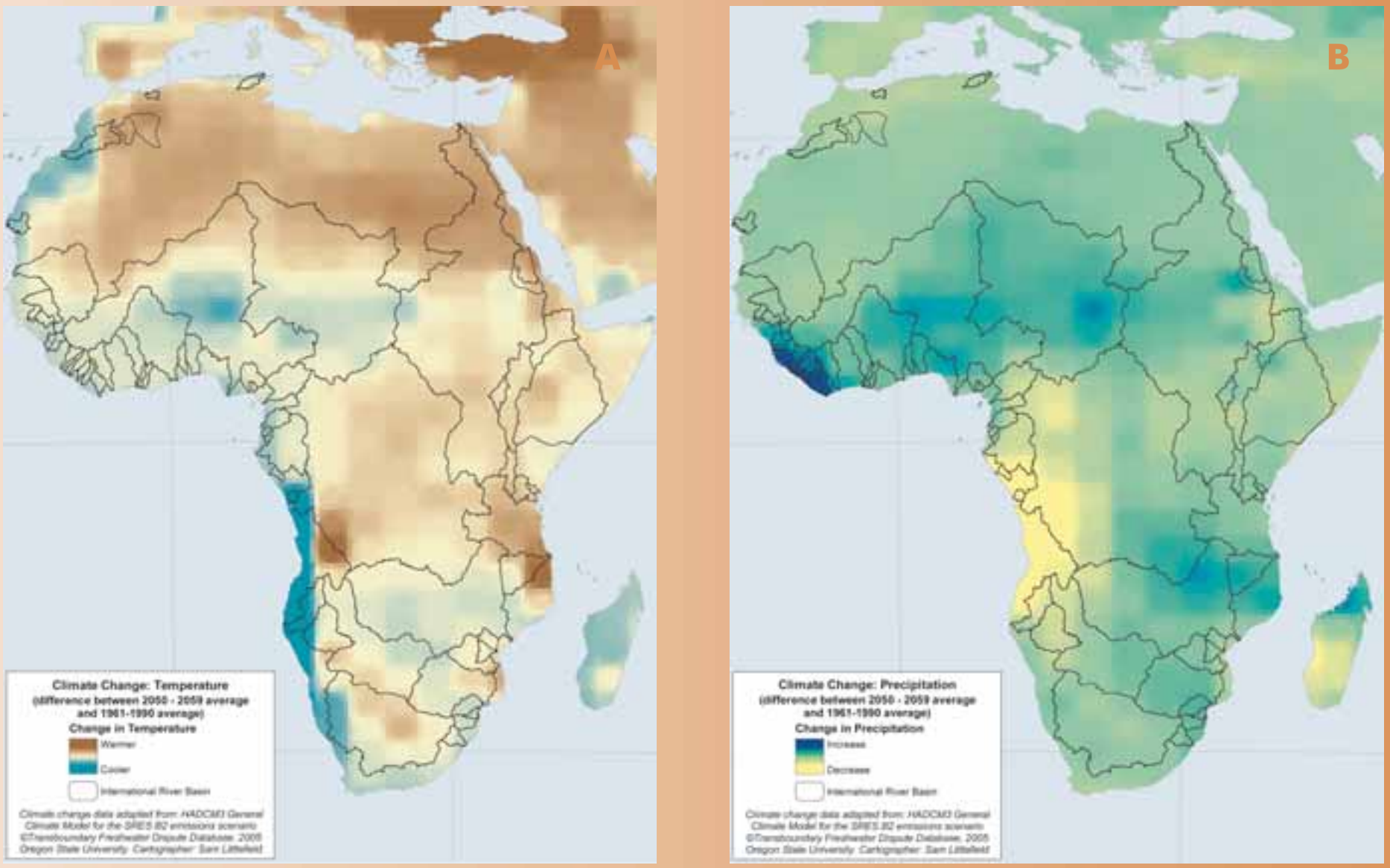
Watering nursery seedlings, Kenya. www.forestryimages.org



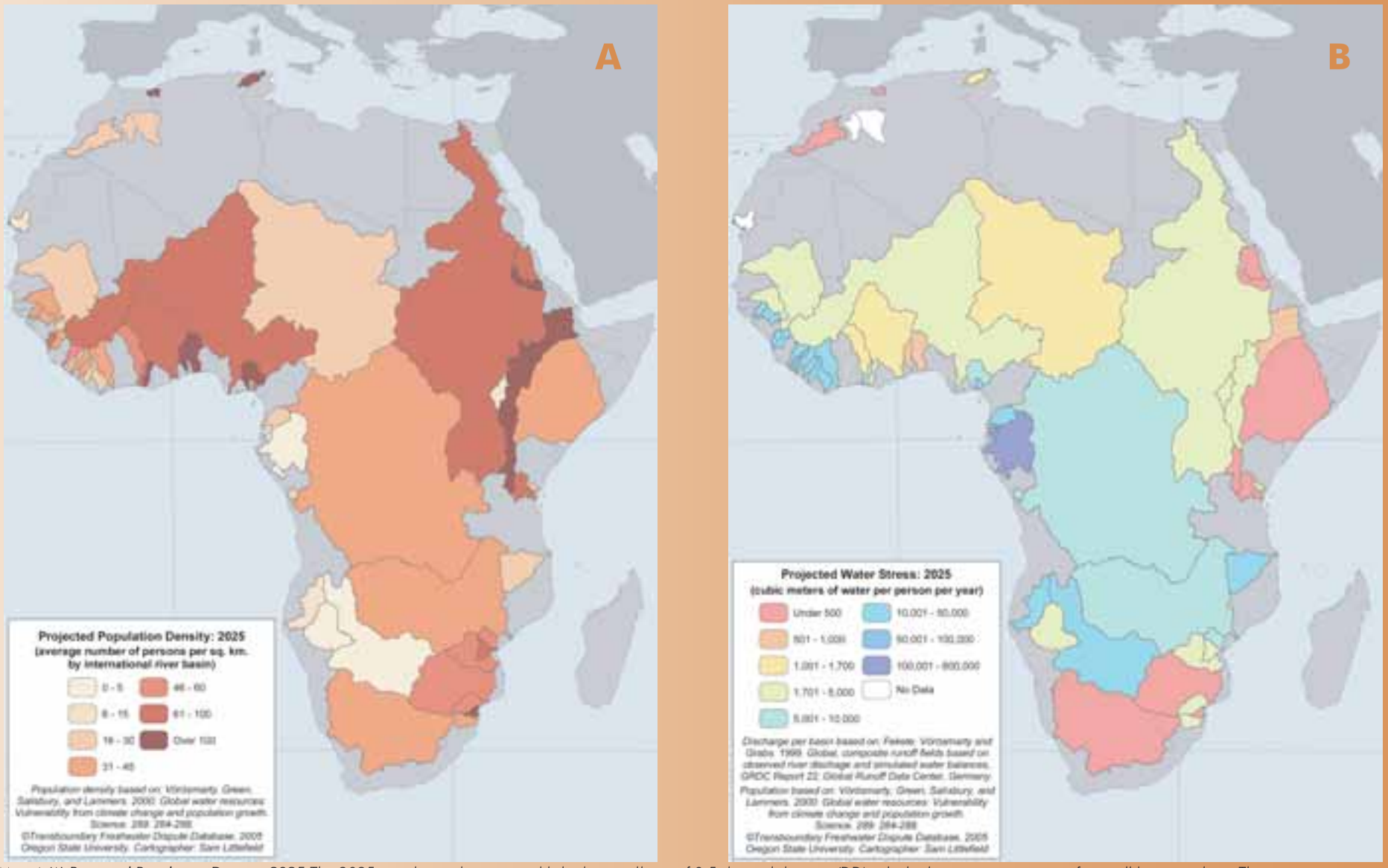
Map 1 (A) Climate Regions. *Köeppen climate zones based on a 0.5 decimal degree grid by Leemans and Cramer (1991) published by the International Institute for Applied Systems Analysis (IIASA). The Köeppen system integrates IIASA average monthly rainfall total and average monthly temperature, in most cases averaged from 1961 – 1990, to yield five base climate types: tropical, dry, temperate, cold and polar. Each primary type is divided into sub-classes based mainly on the distribution of rainfall and temperature throughout the year. Not all classes may be represented at the continental level.* (B) Average Annual Runoff. *Fekete et al. (1999) produced composite runoff fields by accessing GRDC discharge data, selecting significant global gauging stations, and geo-registering the discharge information to locations on a simulated topological network. This dataset was deemed accurate for presentation with a 0.5 decimal degree grid. Summary statistics based on the runoff dataset, such as those used for projected water stress (human indicators), may not be considered accurate for basins with an area less than approximately 25,000 km^2.*



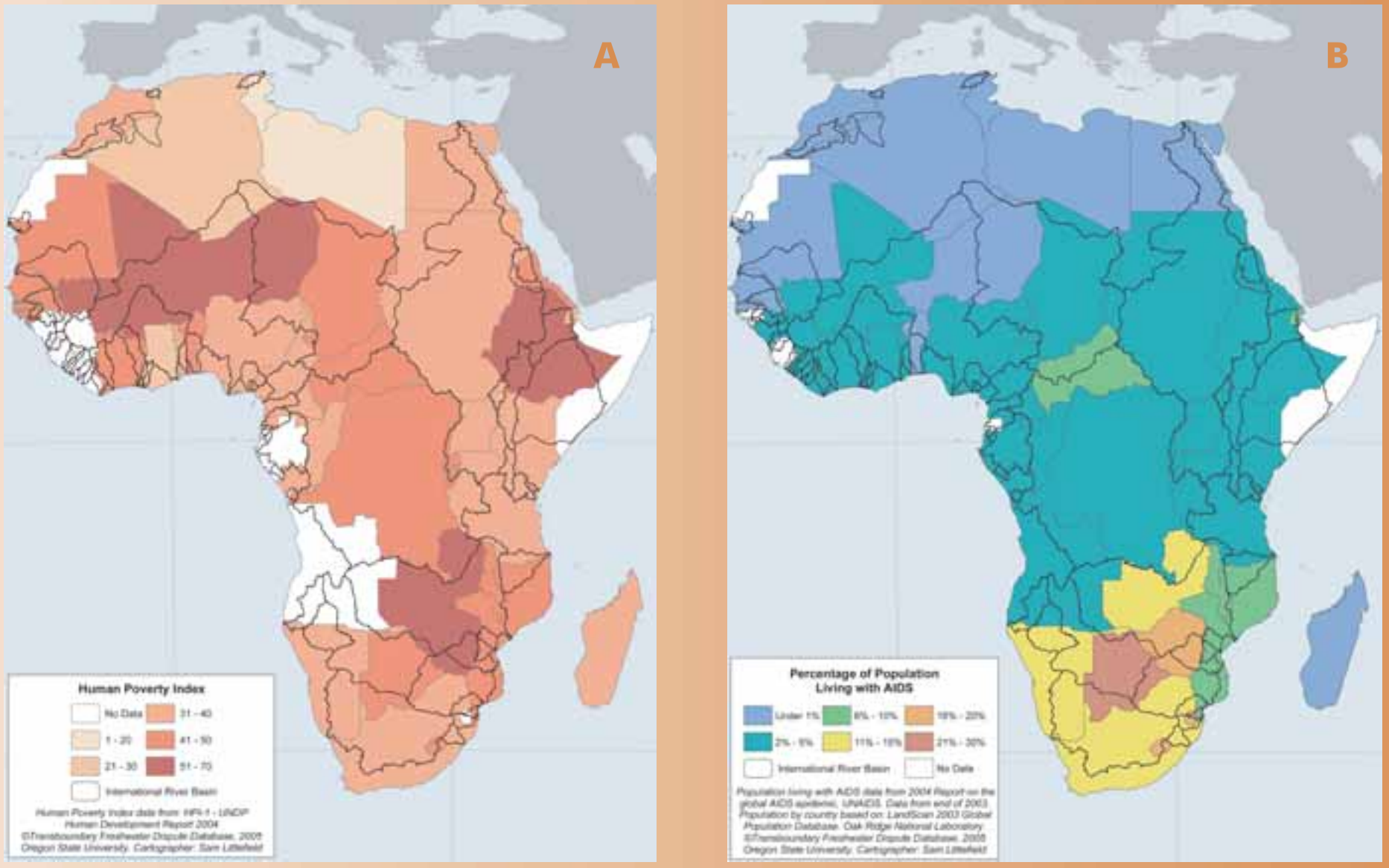
Map 2 (A) Groundwater Aquifers. *Adapted from a map developed by the World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP), August 2004. The most important groundwater basins are shown in blue. The green color symbolizes hydrogeological environments of complex structure. Unmarked regions are occupied by local and shallow aquifers in which relatively dense bedrock is exposed to the surface. Hatching has been applied in areas where "fossil" or non-renewable groundwater is stored. The boundaries of the various colored hydrogeologic regions are first order approximations using the best available information.* (B) Dam Density with Active and Proposed Tenders for Large Infrastructure*: Global Dams Data from: Ph.D. Associates Inc. 1998. DCW in ASCII version 3.0. 1998; Density Calculations from Fiske and Yoffee, 2001. Data on tenders is taken from the International Rivers Network "Dams In The Pipeline of Financial Institutions" database, which includes new projects in the lending pipeline from the World Bank, the Asian Development Bank, the African Development Bank and the Inter-American Development Bank, as well as links to ongoing and completed projects on the individual websites.*



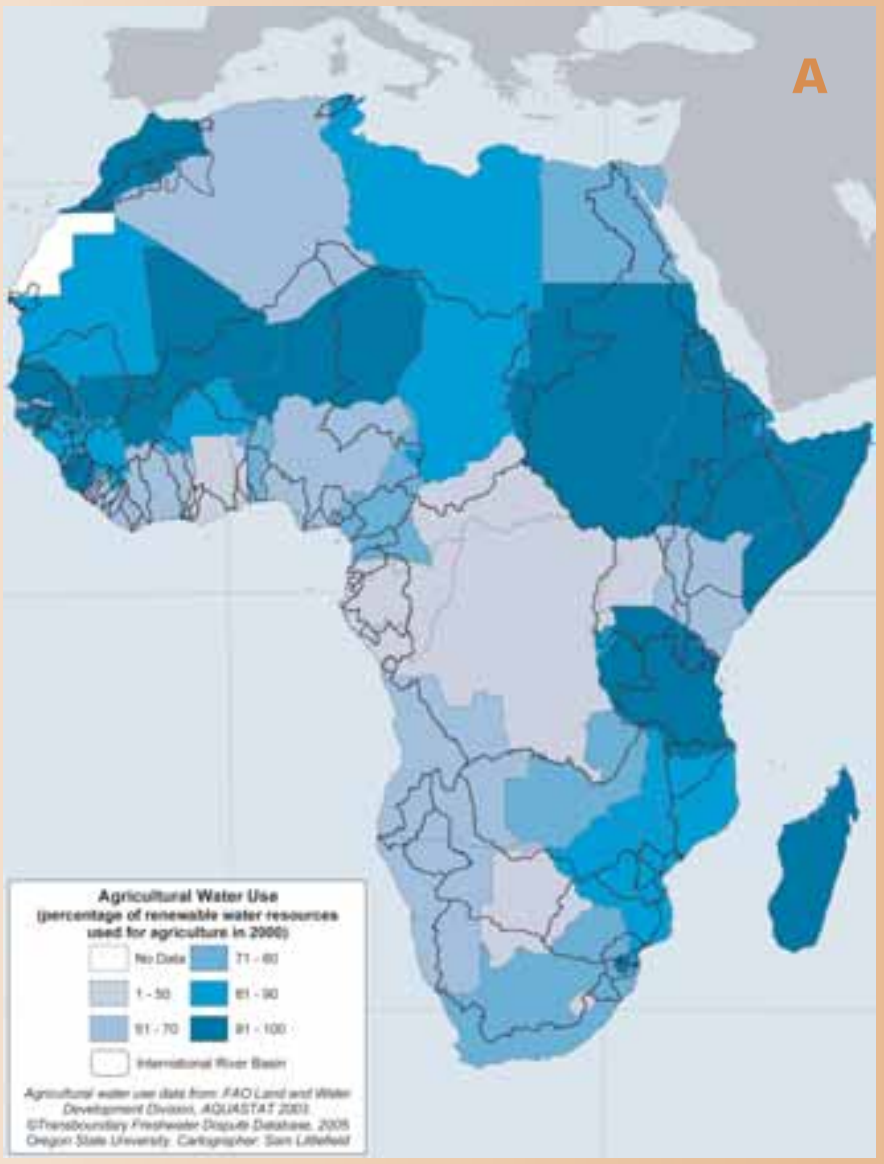
Map 3 (A) Climate Change in Africa: Temperature. (B) Climate Change in Africa: Precipitation: Based on HADCM3 general climate model using the SRES B2 (moderate emissions, climate change, and technological advancement) emissions scenario. HADCM3 is distributed as 2.5 x 3.5 decimal degree data, which could not be properly projected in a GIS without square grid cells. Cell values were distributed to points at 2.5 x 3.5 decimal degree cell centroids, which were interpolated, using the inverse distance weighted method, at a resolution of 0.5 decimal degrees. The interpolated data used here should not be taken to exactly represent HADCM3 projections, but do provide a reasonable cartographic representation of current HADCM3 climate change predictions.

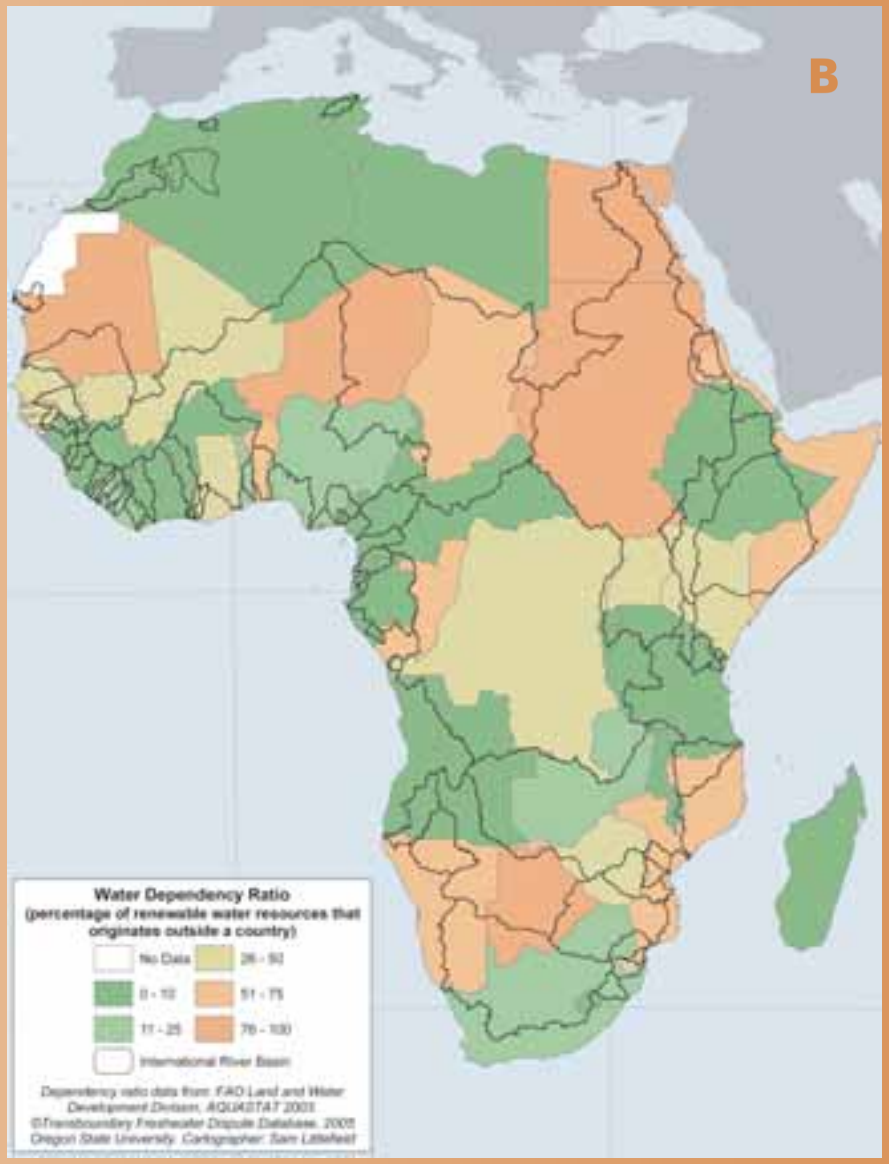


Map 4 (A) Projected Population Density: 2025 The 2025 population dataset is published at a cell size of 0.5 decimal degrees (DD), which places a size constraint for small basin analysis. The raster was resampled at 0.01 DD to overcome the deficiency. This disregards some of the assumptions of the original 0.5 DD cell size, but affords a tentative estimate of predicted population in small basins. Because small basins maintain less area, there is less area to smooth out data errors. Therefore, some basins, especially those with a relatively small area (less than 25,000 km^2), may have projected populations significantly lower or higher than they should be. (B) Projected Water Stress: 2025. *Water stress is the amount of water available per capita. Water stress estimates do not account for spatial variability of water resources, nor for technological or other adaptations effecting how a given population manages water scarcity. The map's calculation of water stress is based on renewable water supply defined by discharge, and does not consider groundwater extraction. Falkenmark's (1989) definition of water stress, calculates water supply based on renewable surface and groundwater flows. According to Falkenmark, a threshold value of 1000 cubic meters per person per year indicates a general point at which water shortages begin to chronically hamper economic development and human health and well-being in moderately developed nations.*

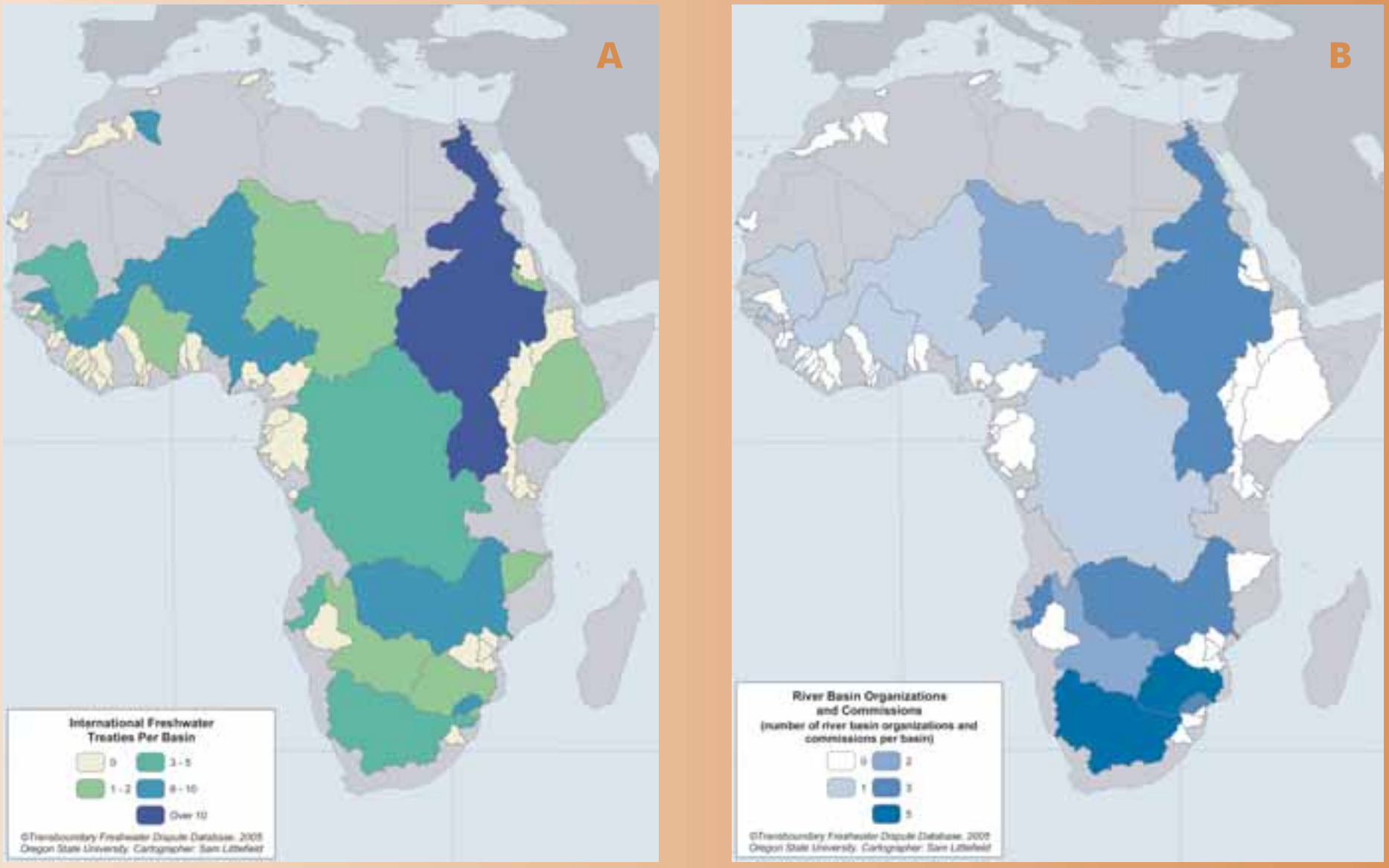


Map 5 (A) Human Poverty Index. *The Human Poverty Index (HPI-1) is taken from the United Nations Development Programme: Human Development Report 2004. The HPI-1 value measures deprivations in three basic dimensions of human development: probability at birth of not surviving to the age of 40, adult illiteracy rate, and a decent standard of living (the unweighted average of the population without sustainable access to an improved water source and children under weight for age). The formula to calculate the HPI-1, as well as specific data on the indicators, can be found at http://hdr.undp.org/reports/global/2004/.* (B) Percentage of Population Living with AIDS: *Based on 2004 UNAIDS data for the end of 2003. Values represent the percent of the total population living with AIDS as calculated with UNAIDS estimates of number of infected and LandScan 2003 population data aggregated by country.*

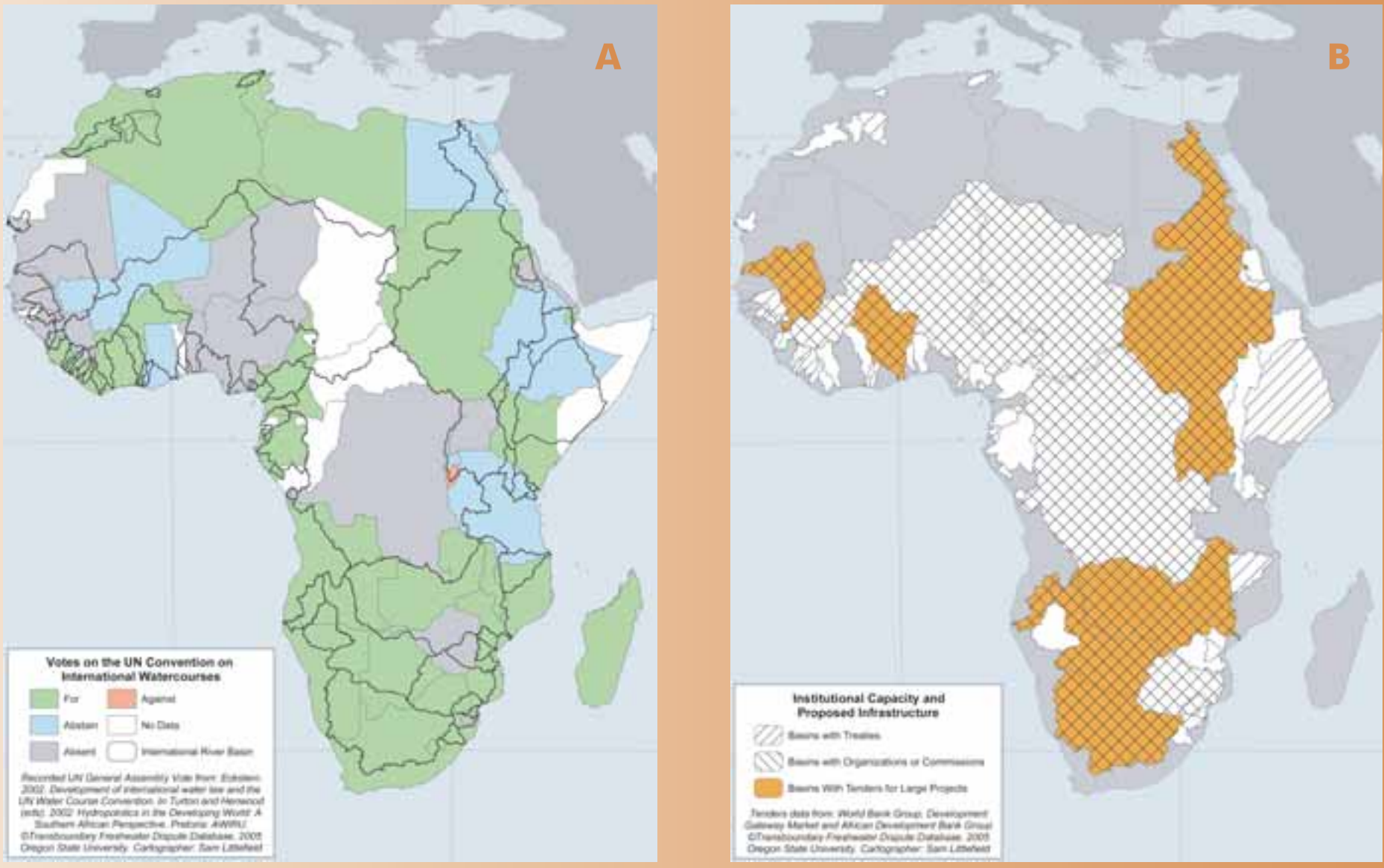




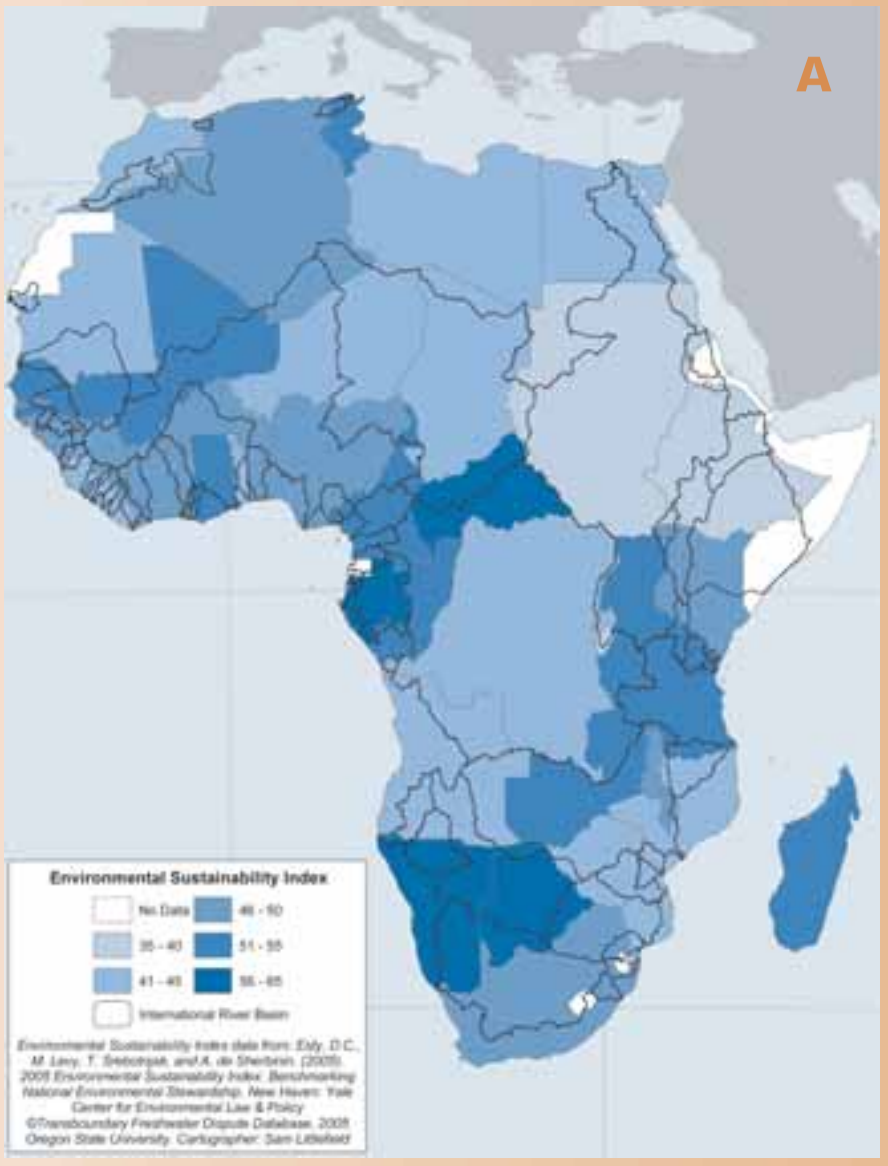
Map 6 (A) Agricultural Water Use: *Agricultural water use is based on a model of irrigation water requirements developed for AQUASTAT by the FAO Land and Water Development and incorporates crop, reference, and actual evapotranspiration, crop coefficient, area under irrigation as percentage of the total area under analysis, and cropping intensity. Renewable water resources available for agricultural use are defined as the sum of internal renewable water resources and incoming flow originating outside the country, taking into consideration the quantity of flows reserved to upstream and downstream countries through formal or informal agreements or treaties.* (B) Water Dependency Ratio*: Water dependency ratio is calculated for AQUASTAT by the FAO Land and Water Development Division. It incorporates total country inflow and outflow of surface water and groundwater after accounting for flow submitted to and reserved by bilateral and multilateral treaties.*



Map 7 (A) International Freshwater Treaties Per Basin. *Number of treaties per basin is the sum of all agreements (historical, present, general) which have been signed by States governing water resources in the basin, either with one another or as part of a regional agreement, where the concern is water as a scarce or consumable resource, a quantity to be managed, or an ecosystem to be improved or maintained. 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.* (B) River Basin Organizations and Commissions (RBO/RBC). *Data for map was collected over a 6-month period from July to December 2004, drawing from: a compilation by Johannes Akiwumi at UNEP's Division of Environmental Information and Assessment (Nairobi); and internet searches and email interviews with international waters practitioners and scholars. (See appendices for sources). Presence of an RBO/RBC in an international river basin does not imply that all riparian countries are parties to the institution. Zero values do not necessarily reflect an absence of an RBO/RBC.*



Map 8 (A) Votes on the UN Convention on International Watercourses. *Vote records presented are based on data from the original convention voting period, which was open from May 1997 until May 2000. However, though the convention closed in 2000, member states may choose to become party to the convention at any time.* (B) Institutional Capacity and Proposed Infrastructure: *Treaties and River Basin Organizations and Commissions may serve to increase the hydropolitical resilience of a basin. This may be particularly important in basins with tenders for large projects, which can alter river functions and displace local inhabitants.*



Map 9 (A) Environmental Sustainability Index. *The 2005 Environmental Sustainability Index (ESI) measures the ability of a country to protect the environment over the next several decades. The ESI is an equally weighted average of 21 indicators, grouped into categories such as environmental systems, reducers of environmental stresses, reducers of human vulnerability, societal and institutional capacity and global stewardship. These data are combined from 76 separate data sets of natural resource endowments, pollution levels, environmental management efforts, etc. The ESI is useful for comparative analysis in identifying leading countries in environmental sustainability. The full ESI report is available at http://www.yale.edu/esi.* (B) Riparian Country Collaborations. *Data for the map was collected from internet searches, and compiled over a 5-month period from July to December 2004. Due to the short time period in which the study took place, the number of projects represented on the map may not accurately reflect the number of collaborations actually occurring. Detailed information about each riparian country collaboration (including participating countries; principal issue area; level of collaboration; dates of collaboration; and source from which the information was gathered) is compiled in the appendices.*