SUPPLMENTAL MATERIALS

Section S-1: Description of Data Use and Availability

S-1.1 URBAN SOURCE LOCATIONS

City Water Map

The City Water Map is a global survey of water sources for large cities with populations greater than 750,000 in 2010. This database identifies the names and spatial coordinates of the primary water sources and water providers for 265 urban areas. More detailed information on the City Water Map is available within the supplementary data found in McDonald et al. 2014.

HydroSHEDS

http://hydrosheds.cr.usgs.gov/

HydroSHEDS is a high-resolution database of hydrographic information that provides information on river networks, watershed boundaries, drainage directions and flow accumulations at various scales. For this study, the locations of urban water sources were intersected with HydroSHEDS watershed boundaries to identify the relevant urban watersheds of interest.

S-1.2 DISCHARGE AND FLOW REQUIREMENT STATISTICS

Mean annual reliable basin discharge

http://atlas.gwsp.org/index.php?option=com_content&task=view&id=55&Itemid=68

Reliable mean annual water discharge was estimated from a WaterGAP dataset of reliable monthly water discharge. This dataset presents a gridded global assessment of accumulated runoff (surface runoff plus groundwater recharge). Due to often large temporal variability in river discharge over time, long-term averages may not be particularly good indicators of the volume of water that can be reliability accessed each year. WaterGAP presents the “90% reliable monthly discharge” as an alternative to long-term mean annual discharge. Estimates are “a statistical estimate of the minimum monthly flow which occurs over 90% of the months during the climate normal period (1961-1990)”. These data were used to estimate the mean annual reliable discharge in the basis from which urban areas acquire their water supplies.

Environmental flow requirements

http://atlas.gwsp.org/index.php?option=com_content&task=view&id=191&Itemid=63

The data used to estimate the volume of water required to maintain freshwater-dependent ecosystems was based on the work done by Smakhtin et al. 2004. This dataset provides a spatially distributed estimate of the fraction of mean annual flow required to maintain ecosystem in “fair condition”, where “fair” implies that the ecosystem endures some level of disturbance such that some sensitive species may have been lost and/or reduced in numbers in these areas. This category assumes that human disturbances are present (e.g. dams, water diversions and water quality degradation). Assumptions made to quantify the volume of water needed to maintain ecosystems in this condition are based on estimates of appropriate low- and high-flow requirements. Futher information on how these flow requirements were calculated can be found in Smakhtin et al. 2004.

S-1.3 RESERVOIR SIZE INFORMATION

Global Reservoir and Dam Database & National Inventory of Dams Database

http://sedac.ciesin.columbia.edu/data/set/grand-v1-reservoirs-rev01
http://geo.usace.army.mil/nid/index.html

The GRanD database contains an extensive collection of information on nearly 7,000 dams and reservoirs around the world. Here, the GRanD database served as the primary source for information on reservoir location, storage capacity and surface area. In this study, the mean annual storage capacity of reservoirs was represented by the "normal capacity" data provided. Normal capacity in this context usually refers to the most commonly reported storage value for a given reservoir. In some cases, the normal capacity was estimated using information on dam height and reservoir surface area (see GRanD database Technical documentation for more details). Reservoir surface areas were also derived from reported GRanD values, and are assumed to be the surface area of the reservoir at normal capacity.

The National Inventory of Dams (NID) database was utilized in cases when GRanD data did not exist. The NID database contains much of the same information as GRanD, but focuses specifically on reservoirs in the United States of America. Again, the mean annual storage capacity of reservoirs was assumed to be their "normal storage" which NID defines as "the total storage space in a reservoir below the normal retention level, including dead and inactive storage and excluding any flood control or surcharge storage". Surface area of the reservoir is given for the impoundment at its normal retention level.

In cases where neither the GRanD nor NID databases provided necessary information, the authors relied on previously published case studies, white literature, and utility websites to estimate reservoir volumes. Estimates of unknown surface areas were made from satellite images of individual reservoirs using Google Earth, and thus may not reflect the surface area at normal storage levels. Reservoir storage estimates included information from only those reservoirs believed to be used for supply (e.g. not smaller storages for local distribution of treated water).

CGIAR CSI- Global Potential Evapo-Transpiration (Global-PET) Geospatial Dataset

http://www.cgiar-csi.org/data/global-aridity-and-pet-database

Based on the assumption that PET is a good surrogate for lake evaporation (Ward and Trimble, 2003), this dataset was used to estimate the volume of water unavailable to urban areas using reservoirs due to evaporative demands. The Global PET dataset is a high-resolution raster that models monthly and yearly average PET using the WorldClim Global Climate database for input parameters. PET is estimated using a modified Penman-Monteith equation, developed to be particularly amenable to global analyses as it does not require estimations of site-specific parameters. In this study, the mean annual PET was measured at the dam location for each reservoir assessed. Averaged values of mean annual PET were calculated for larger water bodies, specifically the Great Lakes and Lake Victoria. Evaporative losses from reservoirs were calculated as the mean annual PET multiplied by the reported surface area of the reservoir. The volume of water lost to evaporation was then simply subtracted from the mean annual storage capacity of each reservoir.

S-1.4 WATER DEMANDS

FAO AQUASTAT

http://www.fao.org/nr/water/aquastat/

Human Demands: We utilized the Food and Agriculture Organization's AQUASTAT database to downscale estimates of national human and agricultural water use statistics to the urban level. Data for the most recent national municipal and human withdrawals came directly from the online database for all countries included in this study. Data were converted to per capita volumes by dividing by the national population.

Agricultural Demands: Data on national agricultural water demands were also obtained from AQUASTAT. Here, the volume of water used for agriculture in urban supply basins was determined as the ratio of agricultural to total water withdrawals. This ratio was used to estimate the volume of water in each basin that is allocated for irrigation purposes in basins with >1% of land area devoted to agriculture. The total land under irrigation within each basin was determined by intersecting each urban supply watershed boundary with the gridded estimates of area equipped for irrigation provided within the AQUASTAT database.

Projected Estimates of Demand

Estimates of human and agricultural water use in 2040 were based on available national water use statistics from 1965-2010. Projections were made using a simple exponential growth model.

Water withdrawals for power plants

http://atlas.gwsp.org/index.php?option=com_content&task=view&id=47&Itemid=68

Estimates of mean annual water usage for thermoelectric withdrawals were made for each water supply basin included in this study. Data were obtained from a publicly available WaterGAP output found on the Global Water Supply Project website.

Section S-2: Additional Tables

Table S-2.1. List of Cities (by country) and their water vulnerability status in 2010 and 2040.

City	Country	2010 Vulnerability	2040 Vulnerability
Luanda	Angola	Non-threatened	Non-threatened
Rajshahi	Bangladesh	Vulnerable	Vulnerable
La Paz	Bolivia	Threatened	Threatened
Asunción	Brazil	Non-threatened	Non-threatened
Belo Horizonte	Brazil	Threatened	Threatened
Florianópolis	Brazil	Vulnerable	Vulnerable
Fortaleza	Brazil	Vulnerable	Vulnerable
Salvador	Brazil	Threatened	Threatened
Teresina	Brazil	Non-threatened	Non-threatened
Sofia	Bulgaria	Threatened	Threatened
Ouagadougou	***Burkina Faso***	***Threatened***	***Vulnerable***
Phnom Penh	Cambodia	Vulnerable	Vulnerable
Yaoundé	Cameroon	Non-threatened	Non-threatened
Dalian	China	Vulnerable	Vulnerable
Guangzhou	***China***	***Threatened***	***Vulnerable***
Nanjing	***China***	***Threatened***	***Vulnerable***
Tashkent	China	Vulnerable	Vulnerable
Wuhan	***China***	***Threatened***	***Vulnerable***
Barranquilla	Colombia	Threatened	Threatened
Cali	Colombia	Vulnerable	Vulnerable
Brazzaville	Democratic Republic of Congo	Threatened	Threatened
Kinshasa	Democratic Republic of Congo	Threatened	Threatened
Guayaquil	Ecuador	Vulnerable	Vulnerable
Alexandria	Egypt	Vulnerable	Vulnerable
Cairo	Egypt	Vulnerable	Vulnerable
Helsinki	Finland	Threatened	Threatened
Accra	***Ghana***	***Non-threatened***	***Threatened***
Kumasi	Ghana	Threatened	Threatened
Budapest	Hungary	Threatened	Threatened
Agra	India	Vulnerable	Vulnerable
Hubli-Dharwad	India	Threatened	Threatened
Kozhikode	India	Vulnerable	Vulnerable
Pune	India	Vulnerable	Vulnerable
Ranchi	India	Threatened	Threatened
Thiruvananthapuram	India	Threatened	Threatened
Baghdad	Iraq	Vulnerable	Vulnerable
Dublin	***Ireland***	***Threatened***	***Vulnerable***
Mombasa	Kenya	Non-threatened	Non-threatened

McAllen	Mexico	Vulnerable	Vulnerable
Maputo	Mozambique	Vulnerable	Vulnerable
Abuja	Nigeria	Non-threatened	Non-threatened
Oslo	Norway	Threatened	Threatened
Panama City	***Panama***	***Non-threatened***	***Threatened***
Bucharest	Romania	Threatened	Threatened
Yekaterinburg	Russia	Threatened	Threatened
Freetown	***Sierra Leone***	***Non-threatened***	***Threatened***
Seoul	South Korea	Vulnerable	Vulnerable
Stockholm	Sweden	Threatened	Threatened
Allepo	Syria	Non-threatened	Non-threatened
Bangkok	Thailand	Vulnerable	Vulnerable
Kampala	Uganda	Non-threatened	Non-threatened
Atlanta	United States of America	Vulnerable	Vulnerable
Austin	United States of America	Vulnerable	Vulnerable
Baltimore	United States of America	Threatened	Threatened
Charlotte	***United States of America***	***Threatened***	***Vulnerable***
Fort Worth	United States of America	Threatened	Threatened
Louisville	United States of America	Threatened	Threatened
Minneapolis	United States of America	Vulnerable	Vulnerable
Nashville-Davidson	United States of America	Threatened	Threatened
New Orleans	United States of America	Non-threatened	Non-threatened
New York	United States of America	Threatened	Threatened
Oklahoma City	United States of America	Threatened	Threatened
Philadelphia	United States of America	Vulnerable	Vulnerable
Pittsburgh	United States of America	Vulnerable	Vulnerable
Providence	United States of America	Threatened	Threatened
Raleigh	United States of America	Threatened	Threatened
Richmond	United States of America	Threatened	Threatened
Saint Louis	United States of America	Threatened	Threatened
Salem	***United States of America***	***Threatened***	***Vulnerable***
Montevideo	Uruguay	Vulnerable	Vulnerable
Harare	Zimbabwe	Vulnerable	Vulnerable

*Bold, italicized items highlight those “cities-of-concern”, who become more vulnerable during the 2010-2040 time period examined.