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*Clean and Efficient Use of Energy and Water Resources - Initiating an APEC Road Map and Best Practices for the Energy-Water Nexus*

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**APEC Energy Resiliency Task Force Meeting, Honolulu, Dec. 17, 2015**



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# Growing Interest in the Energy-Water Nexus

## World Water Day 2014: Water and Energy



Azzizia desalination plant, Saudi Arabia - Flickr CC BY-NC-SA 2.0 by Waleed Alzuhair

Water and energy are closely interlinked and interdependent. Energy generation and transmission requires utilization of water resources, particularly for hydroelectric, nuclear, and thermal energy sources. Conversely, about 8% of the global energy generation is used for pumping, treating and transporting water to various consumers.

In 2014, the UN System – working closely with its Member States and other relevant stakeholders – is collectively bringing its attention to the water-energy nexus, particularly addressing inequities, especially for the 'bottom billion' who live in slums and impoverished rural areas and survive without access to safe drinking water, adequate sanitation, sufficient food and energy services. It also aims to facilitate the development of policies and crosscutting frameworks that bridge ministries and sectors, leading the way to energy security and sustainable water use in a green economy. Particular attention will be paid to identifying best practices that can make a water- and energy-efficient 'Green Industry' a reality.

### Objectives of World Water Day in 2014



Global Agenda Council on Energy Security

## The Water-Energy Nexus: Strategic Considerations for Energy Policy-Makers

May 2014



## securing energy in a water-constrained world



### the energy-water challenge

Significant amounts of water are needed in almost all energy generation processes, from generating hydro-power, to cooling and other purposes in thermal power plants, to extracting and processing fuels. Conversely, the water sector needs energy to extract, treat and transport water. Both energy and water are used in the production of crops, including those used to generate energy through biofuels. Population growth and rapidly expanding economies place additional demands on water and energy, while several regions around the world are already experiencing significant water and energy shortages.

Today, more than 700 million people lack access to potable water, and over 1.3 billion people lack access to electricity. At the same time, estimates show that by 2030, global energy consumption will increase by 35%, while water consumption by the energy sector will increase by 20%. Climate change will further challenge water and energy management by causing more water variability and intensified weather events, such as severe floods and droughts.

These interdependencies complicate possible initiatives and make it compelling case to expeditiously improve integrated water and energy planning in order to avoid unwanted future scenarios.

### will water constrain our energy future?

While a global water crisis could take place in the future, the energy challenge is present. Water constraints have already adversely impacted the energy sector in many parts of the world. In the U.S., several power plants have been affected by low water flows or high water temperatures. In India, a thermal power plant recently had to shut down due to a severe water shortage. France has been forced to reduce or halt energy production in nuclear power plants due to high water temperatures threatening cooling processes during heatwaves. Recurring and prolonged droughts are threatening hydro-power capacity in many countries, such as Sri Lanka, China and Brazil.

Despite these concerns, current energy planning and production is often made without taking into account existing and future water constraints. Planners and decision-makers in both sectors often remain ill-informed about the drivers of these challenges, how to address them, and the needs of different stakeholders. The absence of integrated planning between these two sectors is socio-economically unsustainable.



THE WORLD BANK  
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UN WATER

Report

The United Nations World Water Development Report 2014

# WATER AND ENERGY

VOLUME 1



# WWDR 2014

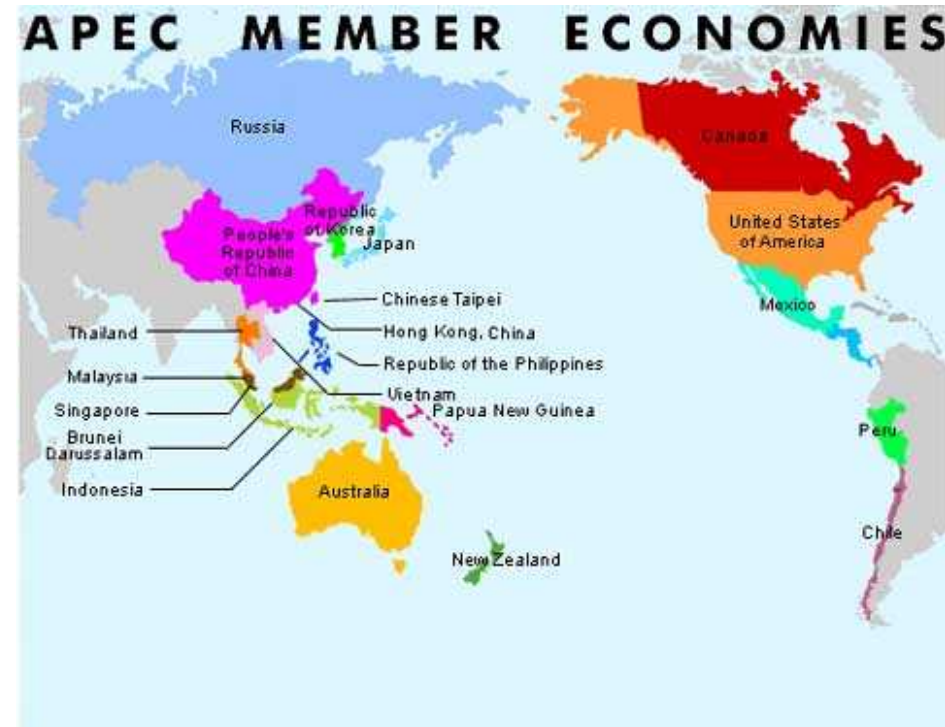


# Energy-Water Quick Facts

- 90% of power production is water intensive
- The International Energy Agency estimated (2010) global water withdrawals for energy production at 583 billion m<sup>3</sup> representing some 15% of the world's total withdrawals.
- Thermal power generation accounts for roughly 80% of global electricity production .
- Hydroelectricity accounts for about 15% of global electricity production
- By 2035, global water withdrawals for energy are expected to increase by 20%, whereas water consumption for energy is expected to increase by 85%.
- 8% of world's energy production is used in the water sector.

# Objectives

- Support the Asia-Pacific Economic Cooperation by investigating the Energy-Water Nexus in each member economy:
  - Map water use for energy
  - Map energy use for water
  - Perform mapping at a regional level
  - Compare to measures of water stress



# Methods

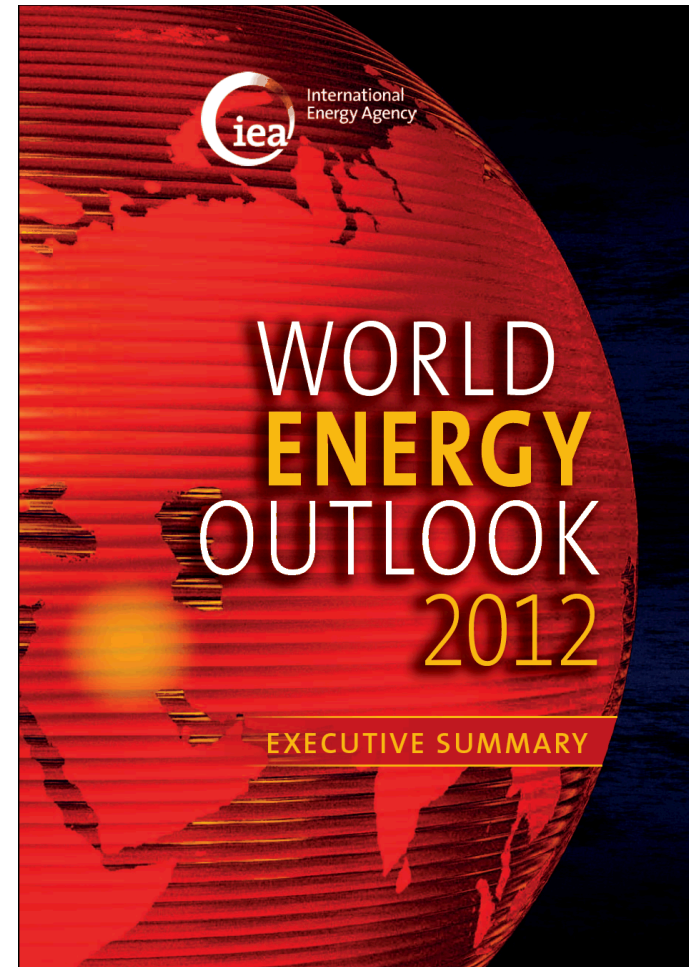
- Utilized publically available data

DOE/EIA-0383(2015) | April 2015

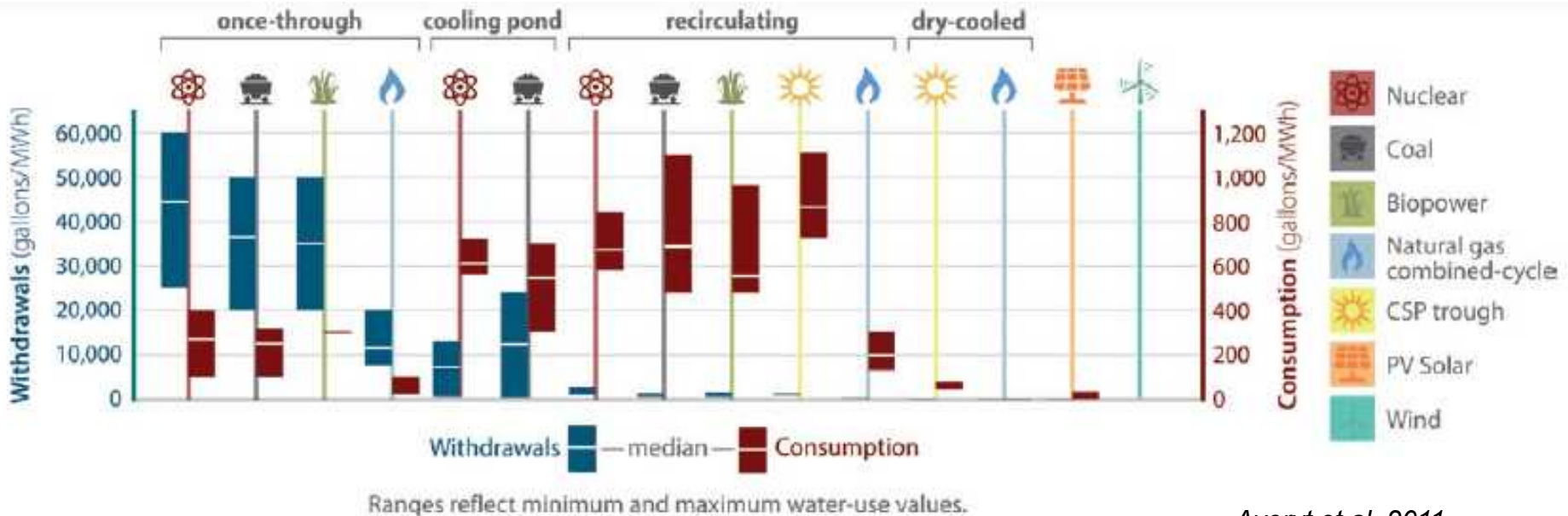
## Annual Energy Outlook 2015 with projections to 2040



 *Independent Statistics & Analysis*  
U.S. Energy Information  
Administration



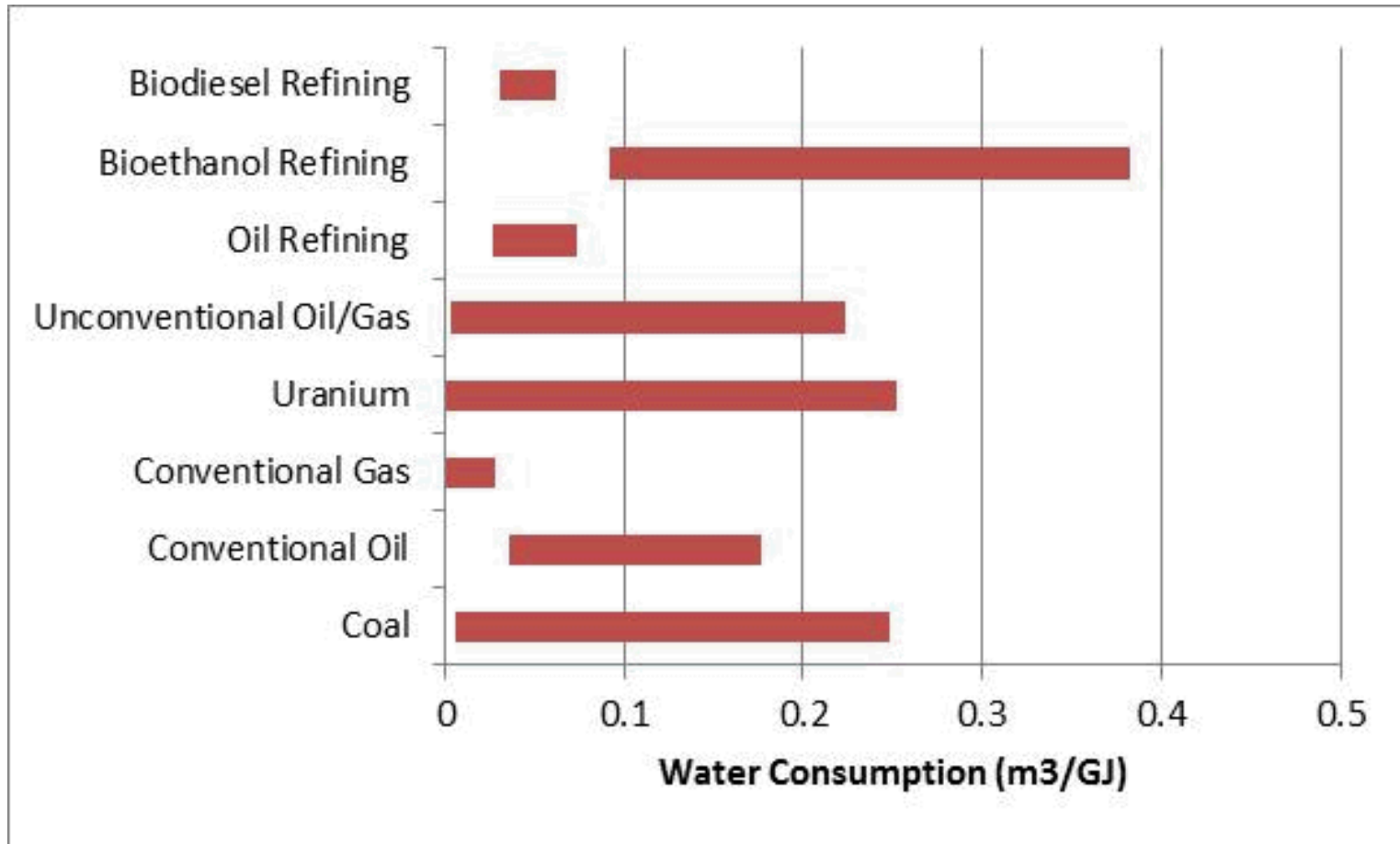
# Water for Thermoelectric Production



Averyt et al. 2011

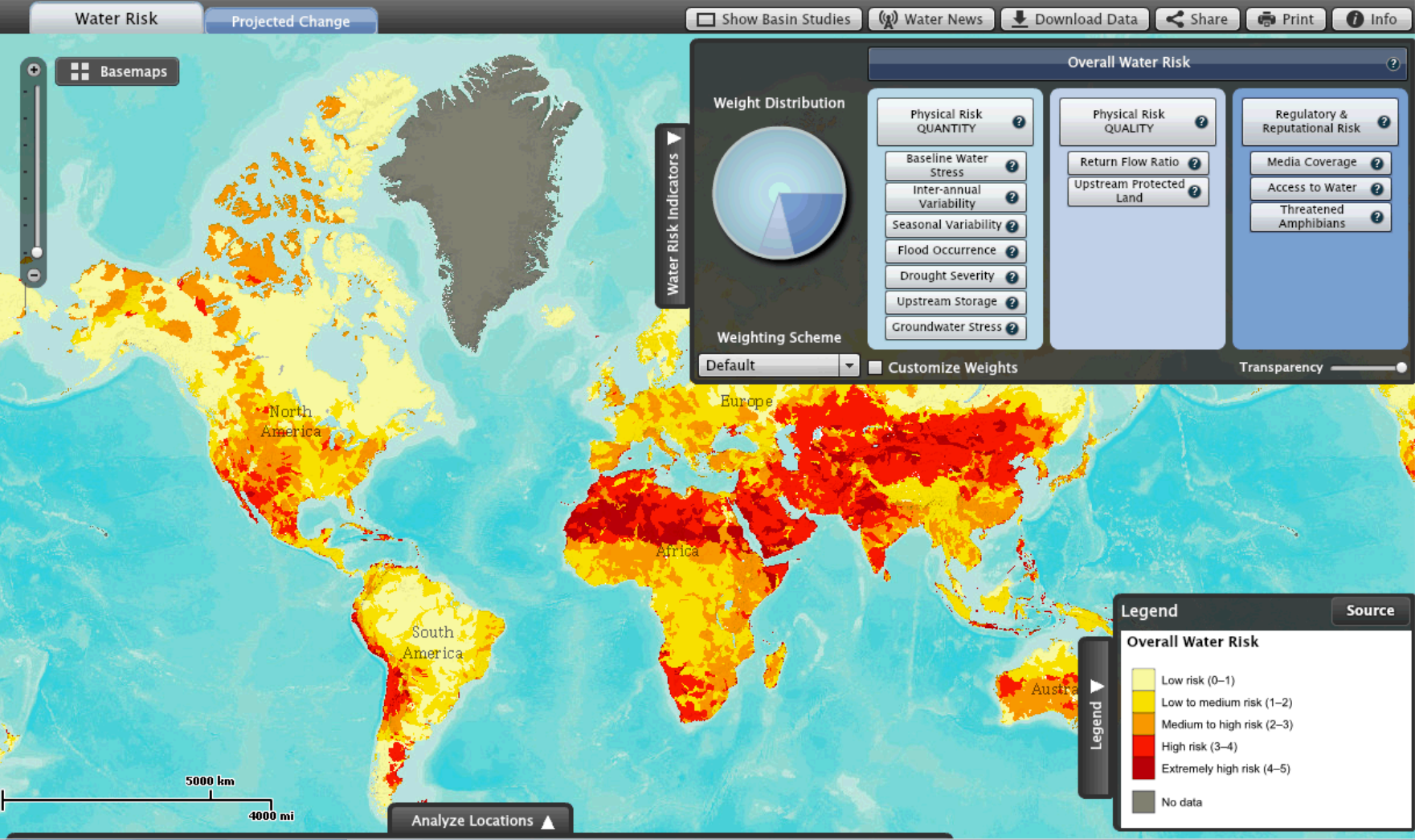
- Water use for thermoelectric production varies by:
  - Withdrawal vs. consumption,
  - Plant/fuel type, and
  - Cooling type.

# Water for Energy Extraction and Processing



Source: Spang and others 2014

# Global Water Risk Mapping



# Water Utility Energy Use

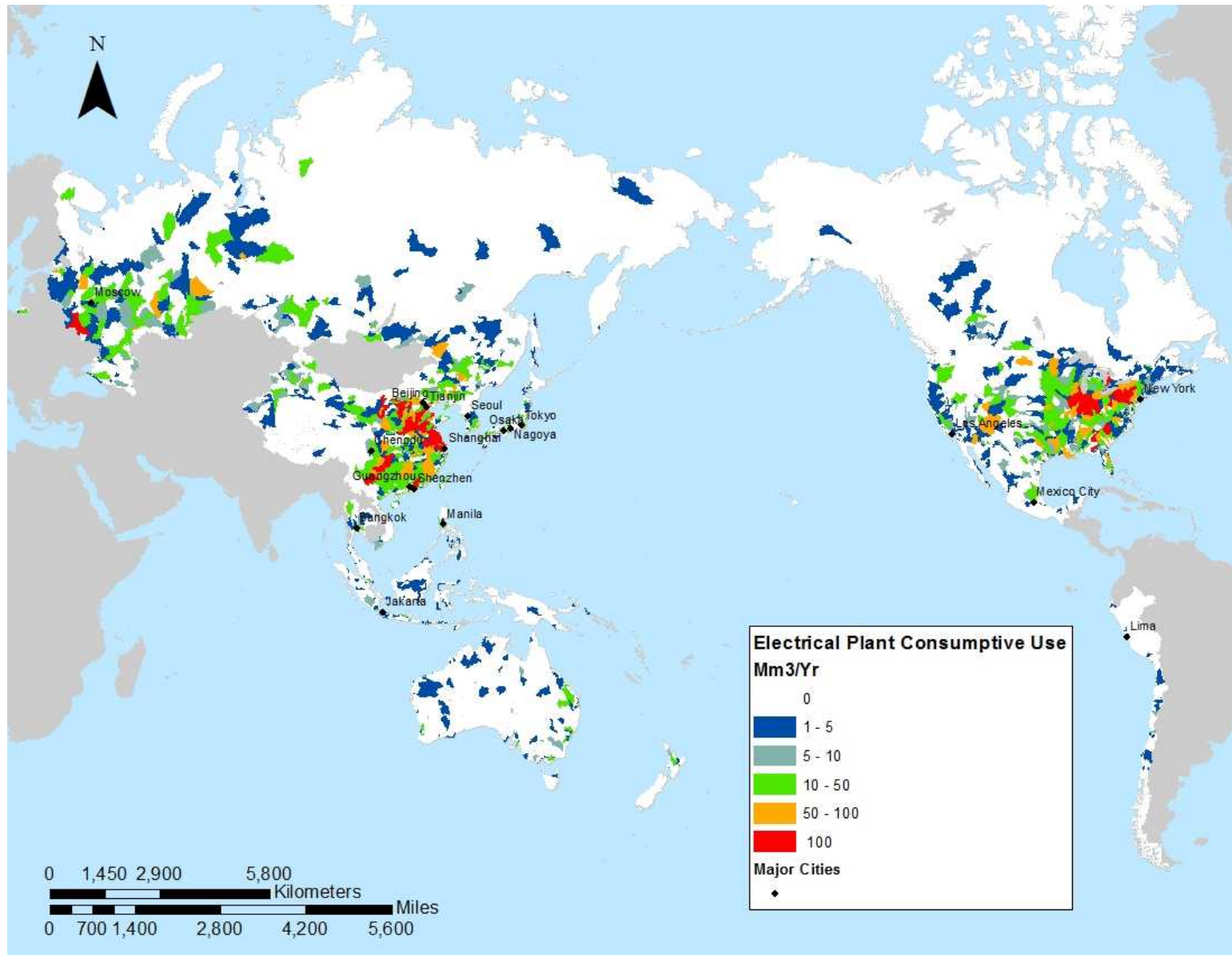
- Energy use distributed by distribution of population
- Use reduced by percentage of population with access to improved water services



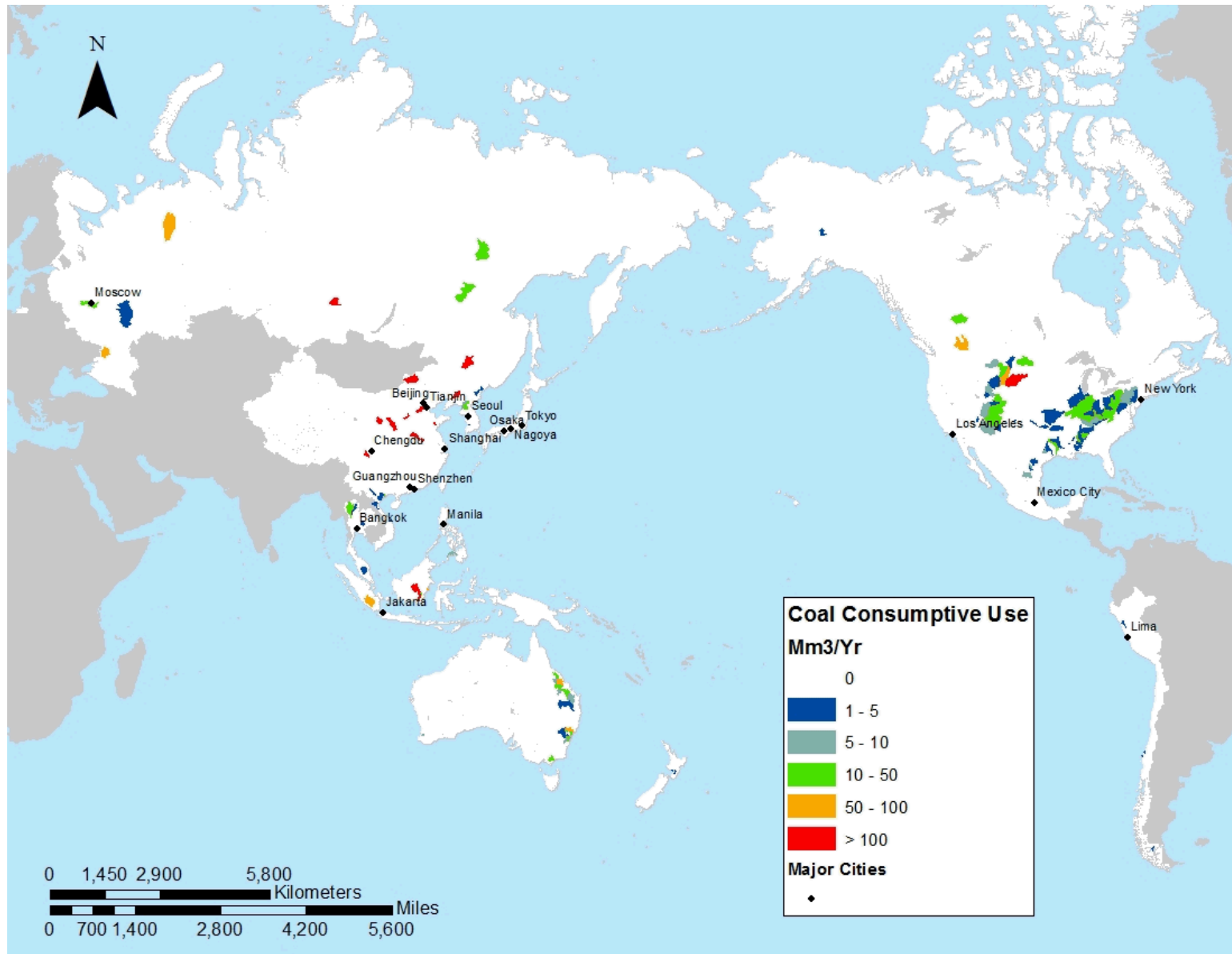
- Drinking water accounts 1% of total electricity use in the U.S.
- Wastewater use 0.8%

*(EPRI 2013)*

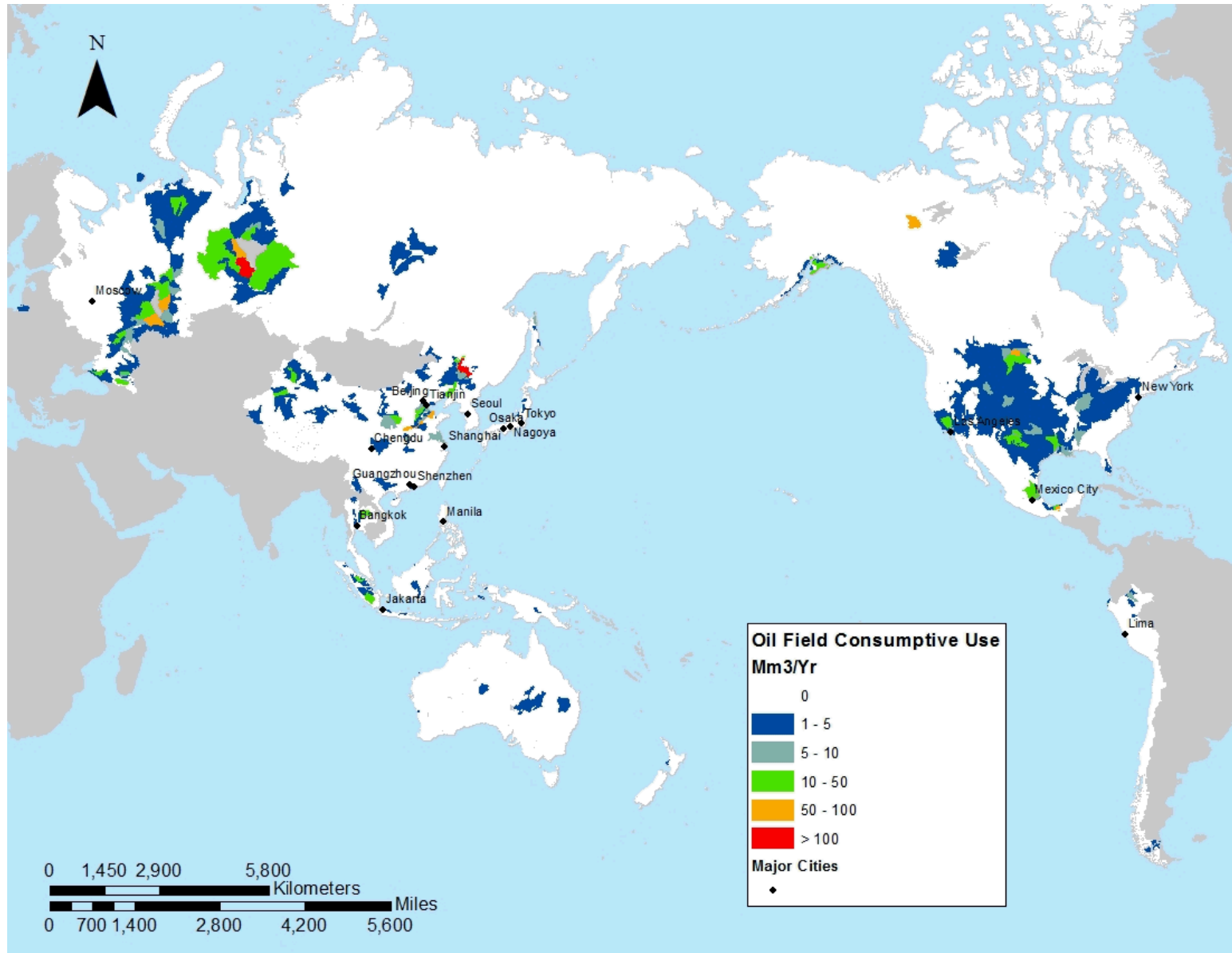
# Water for Thermoelectric Power



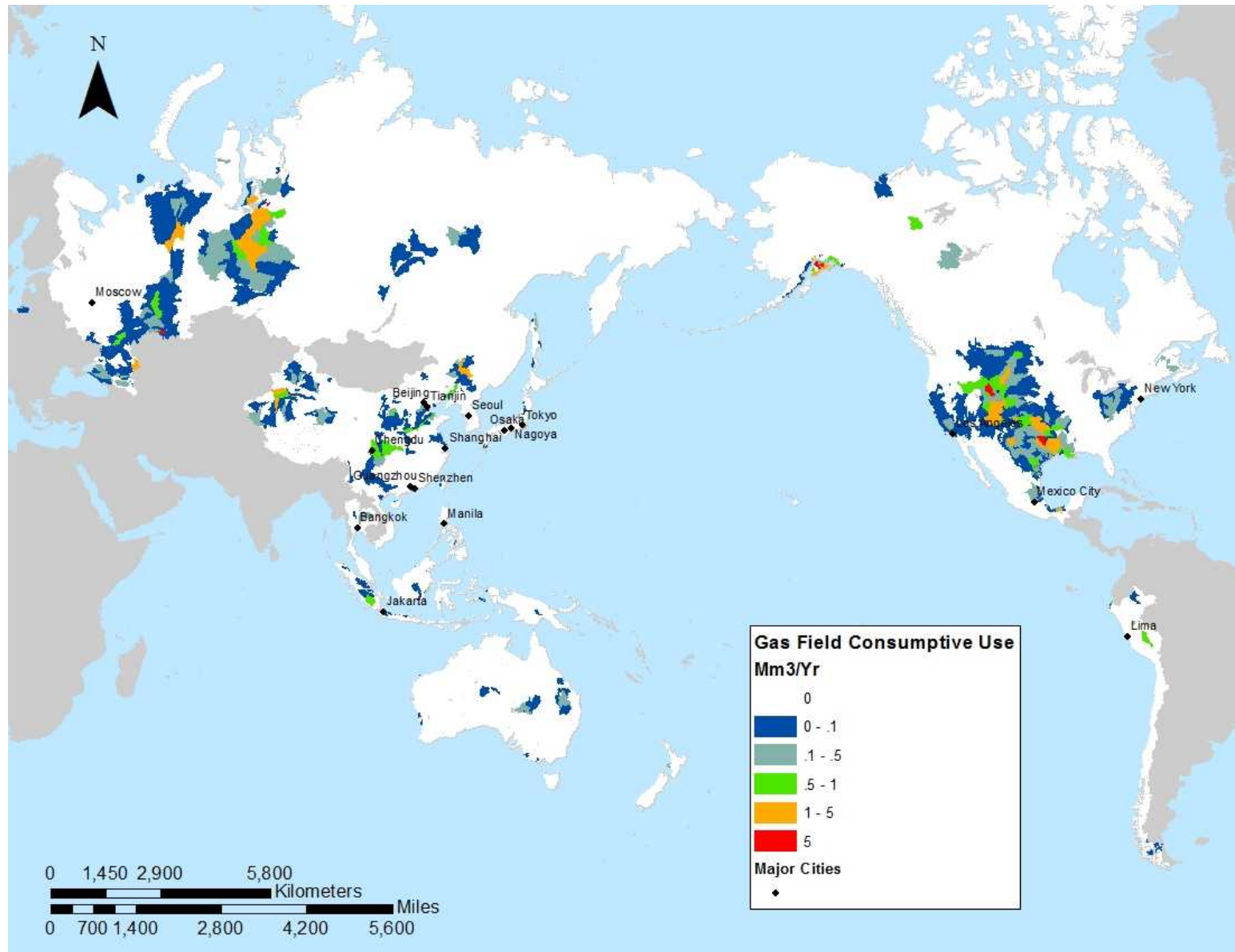
# Water for Coal Extraction



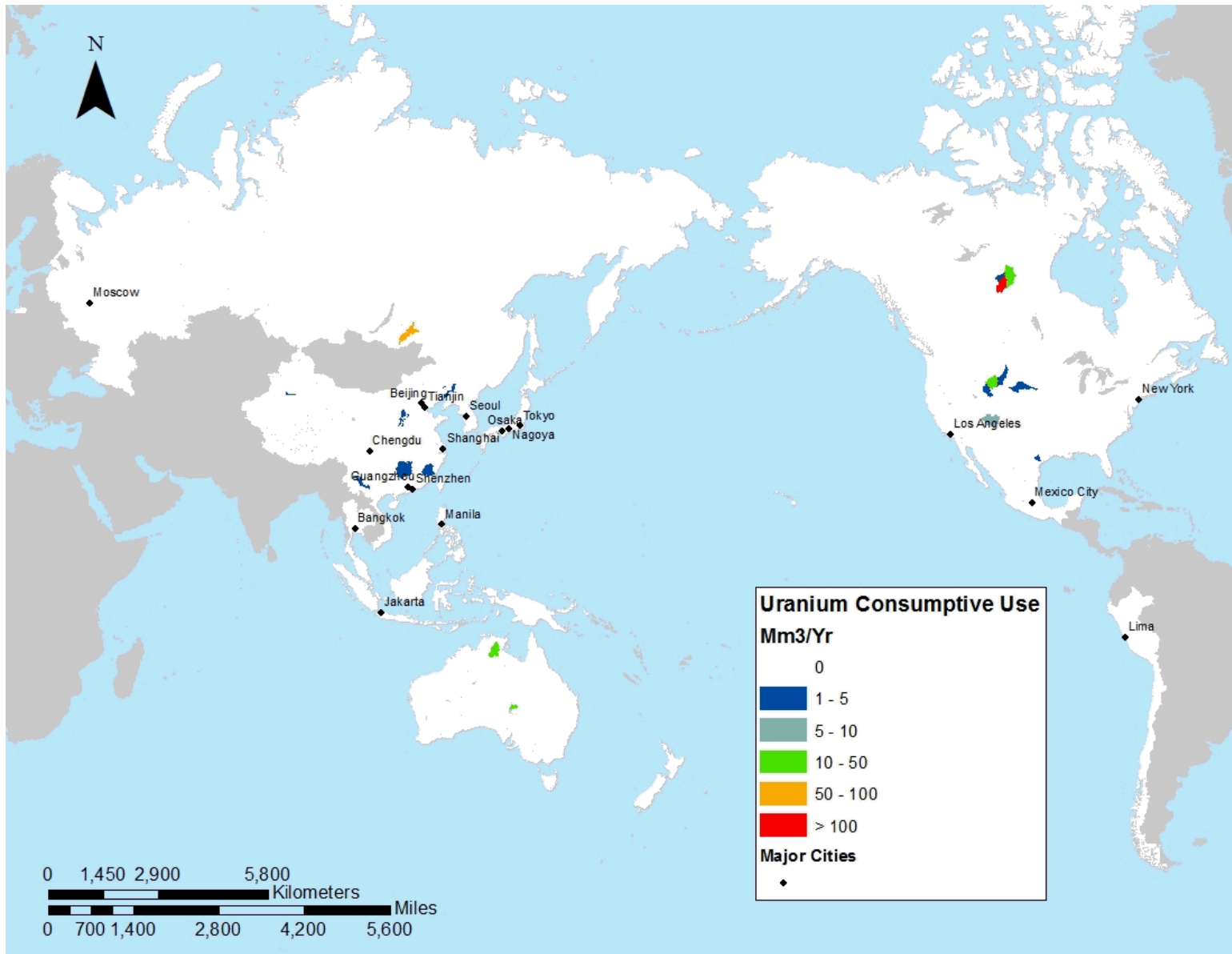
# Water for Oil Extraction

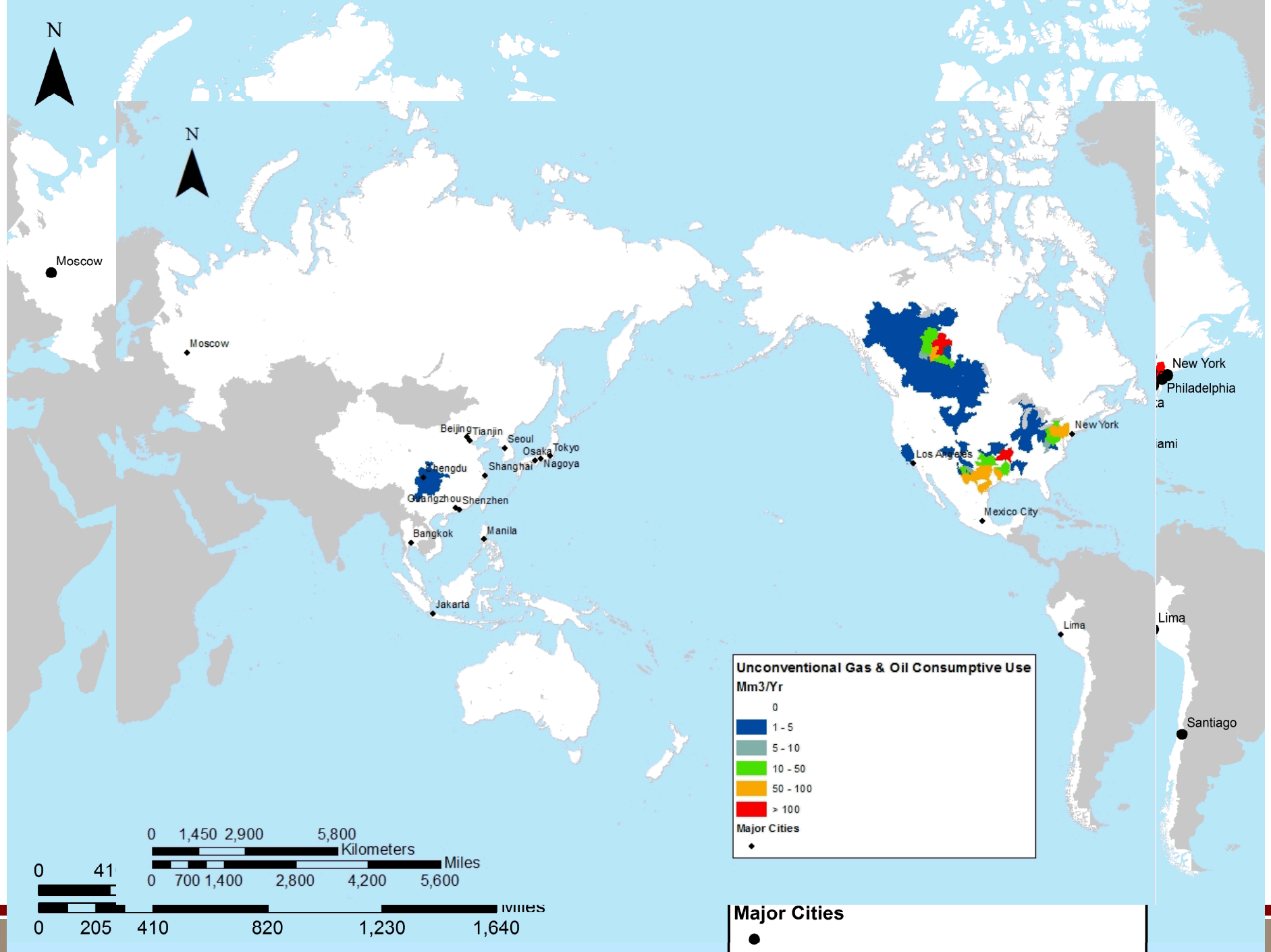


# Water for Natural Gas Extraction



# Water for Uranium Extraction





N



N



Moscow



Moscow



Beijing Tianjin Seoul Osaka Tokyo  
Shanghai Nagoya

Chengdu  
Guangzhou Shenzhen

Bangkok Manila

Jakarta

Los Angeles

New York

Mexico City

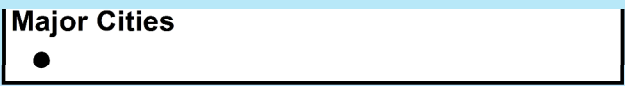
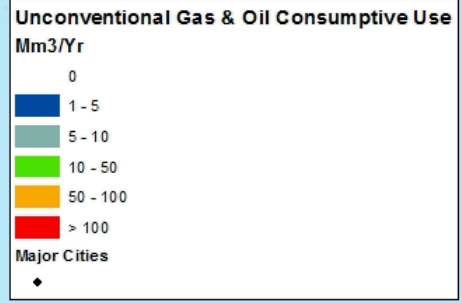
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Miami

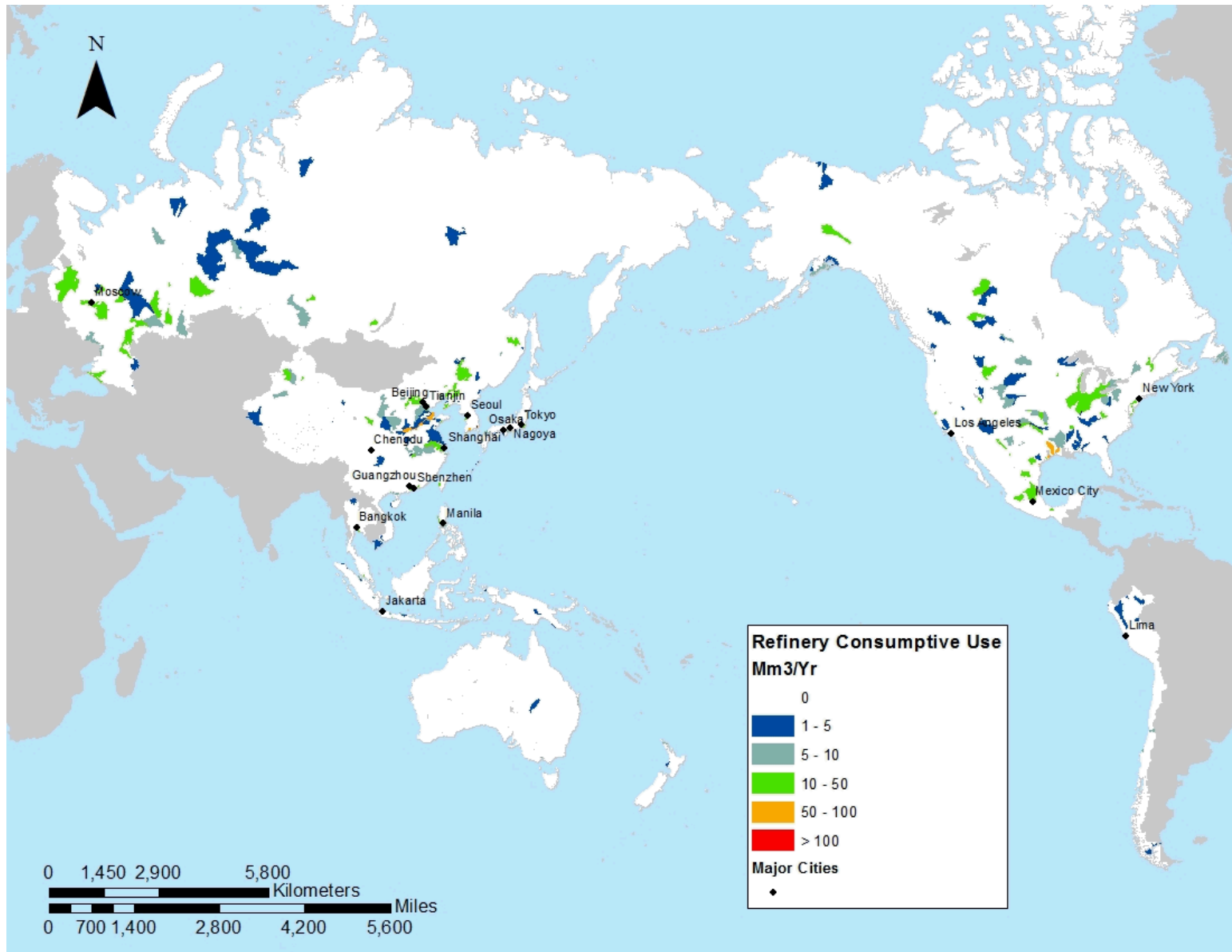
Lima



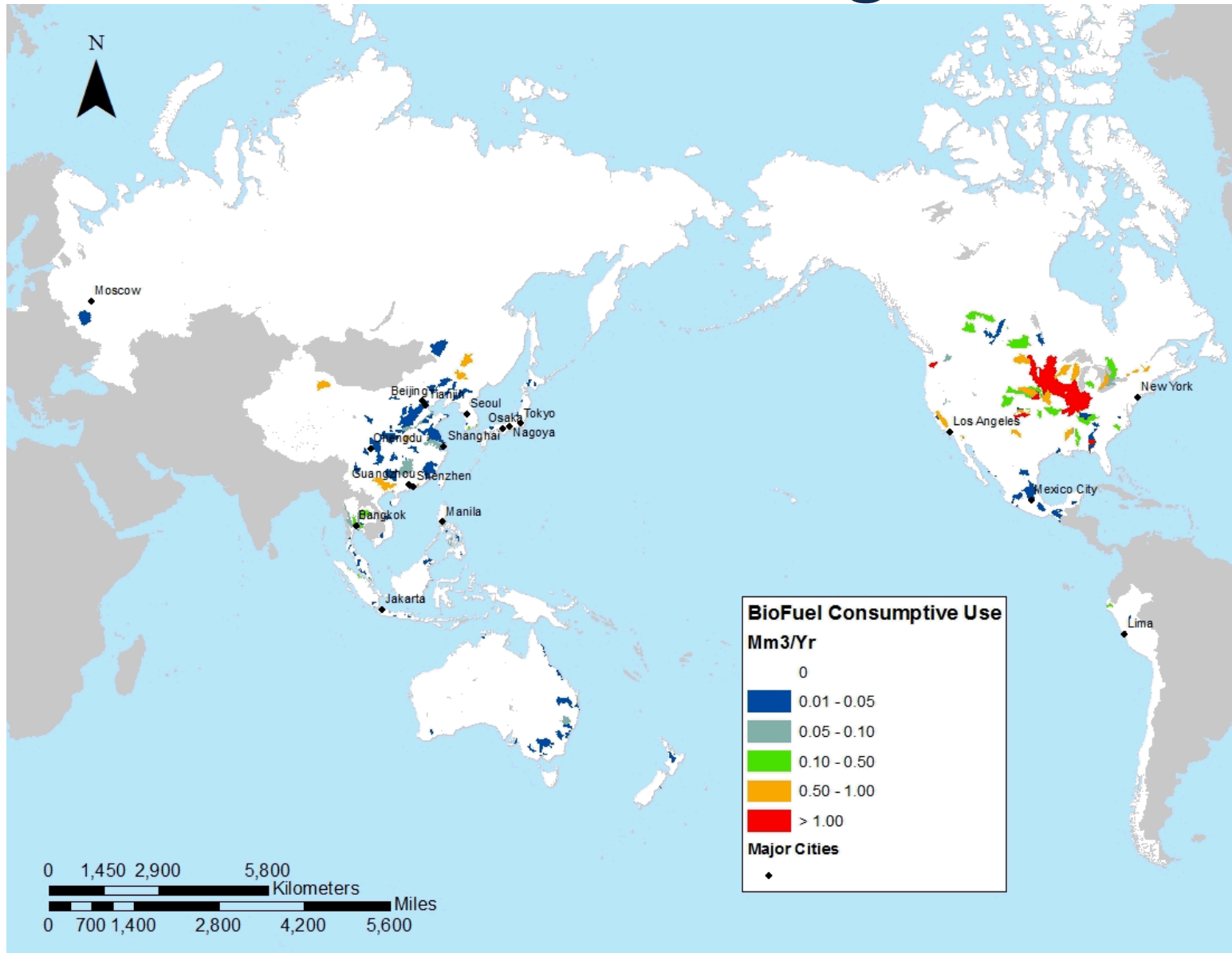
Santiago



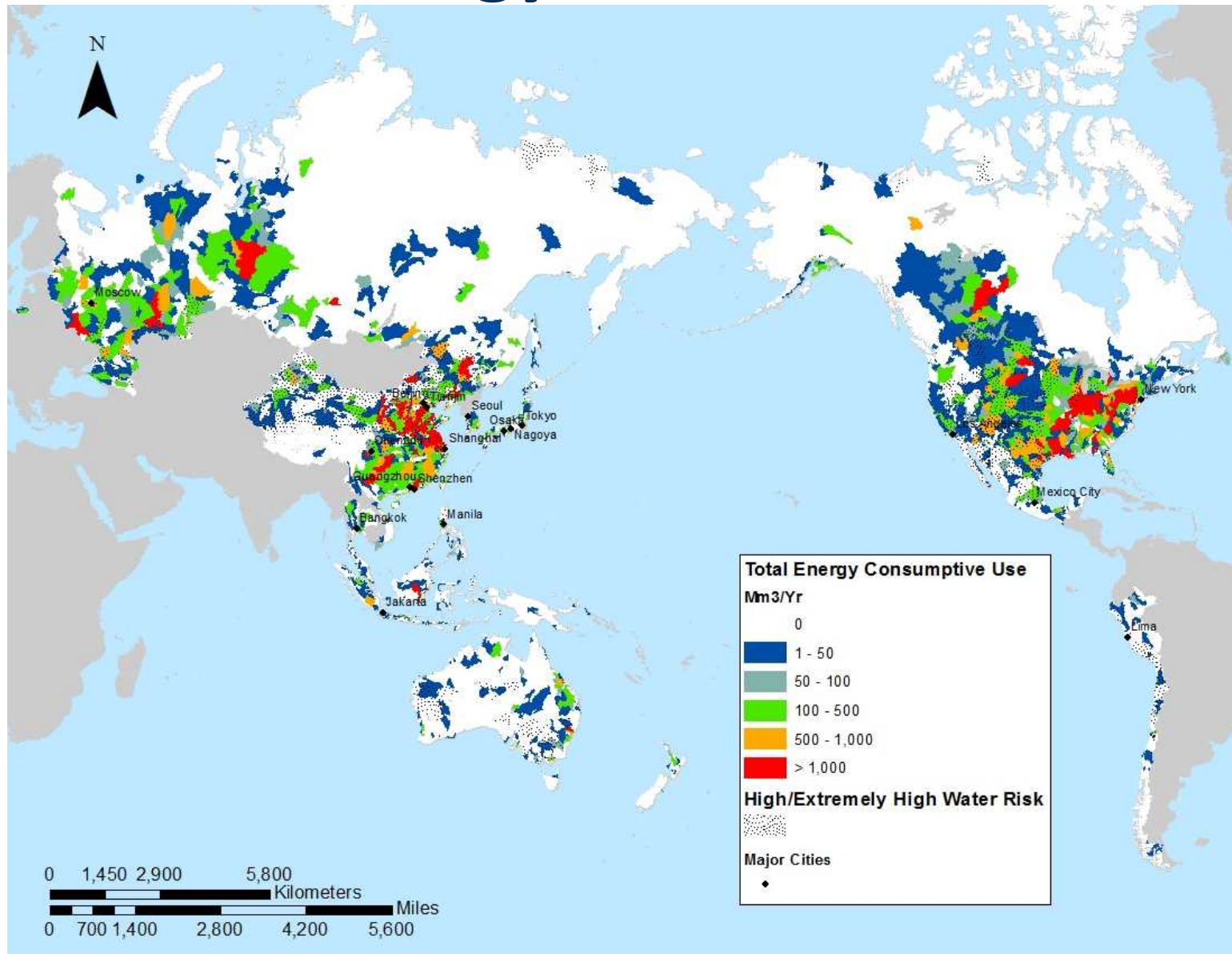
# Water for Oil Refining



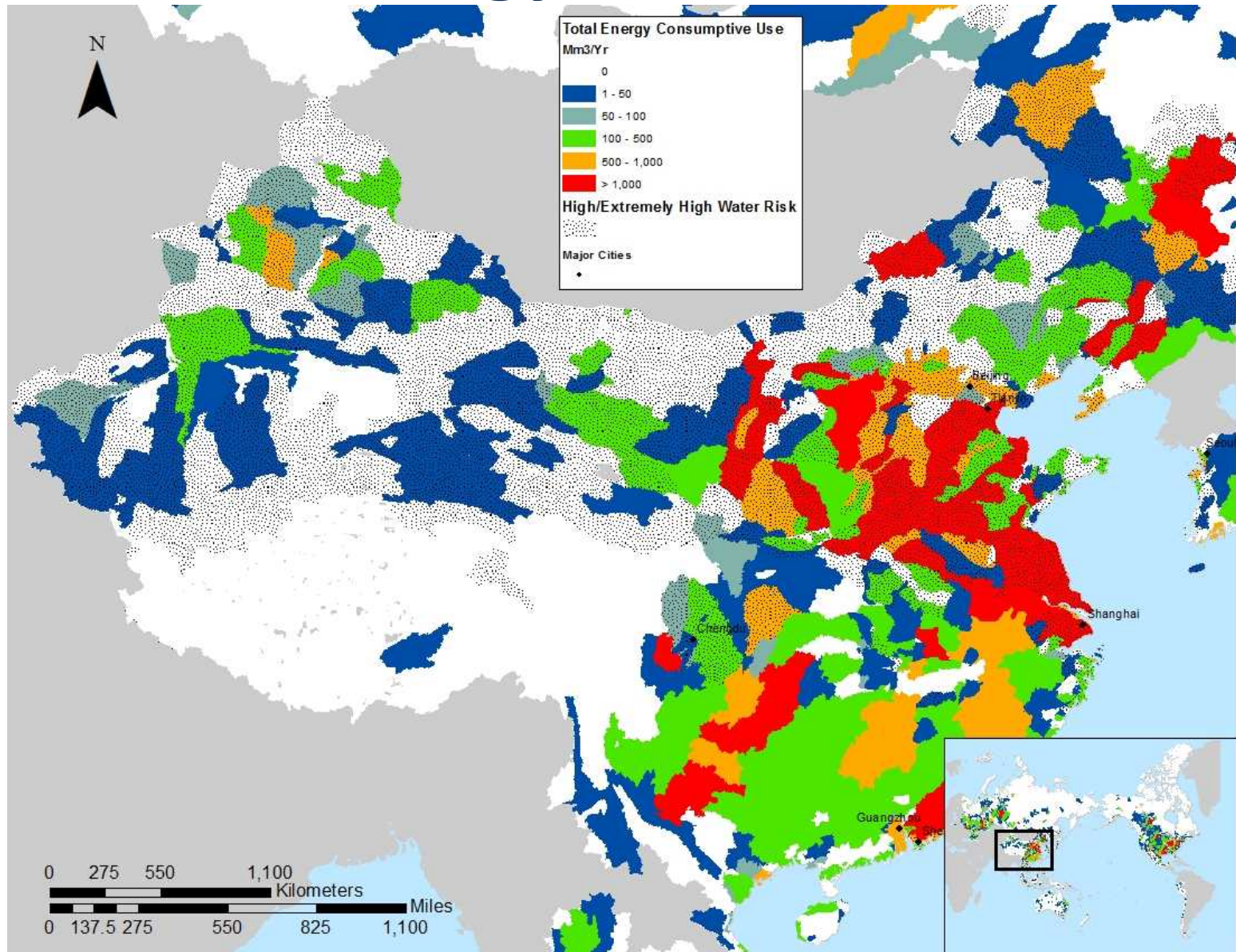
# Water for Biofuel Refining



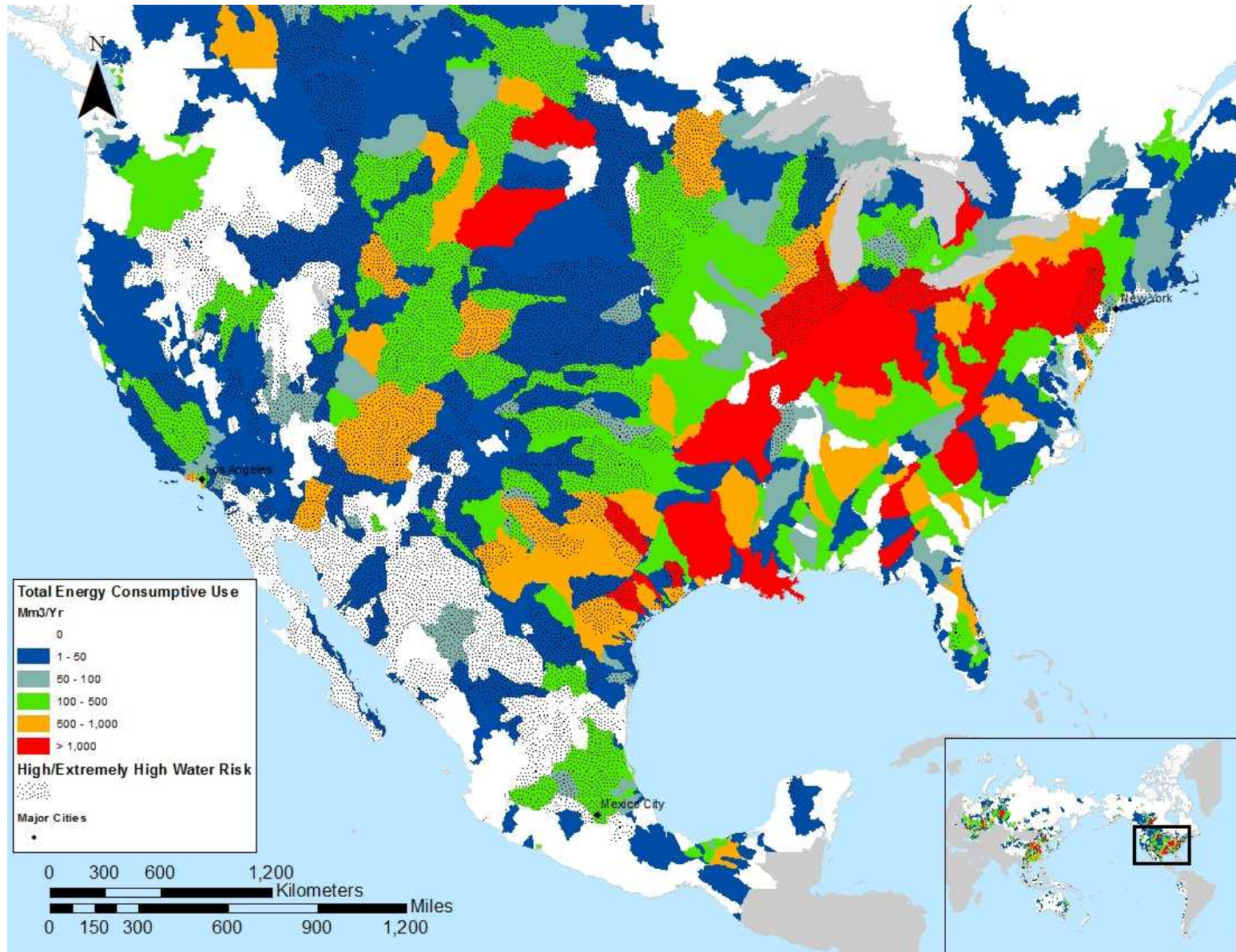
# Water for Energy with Water Stress



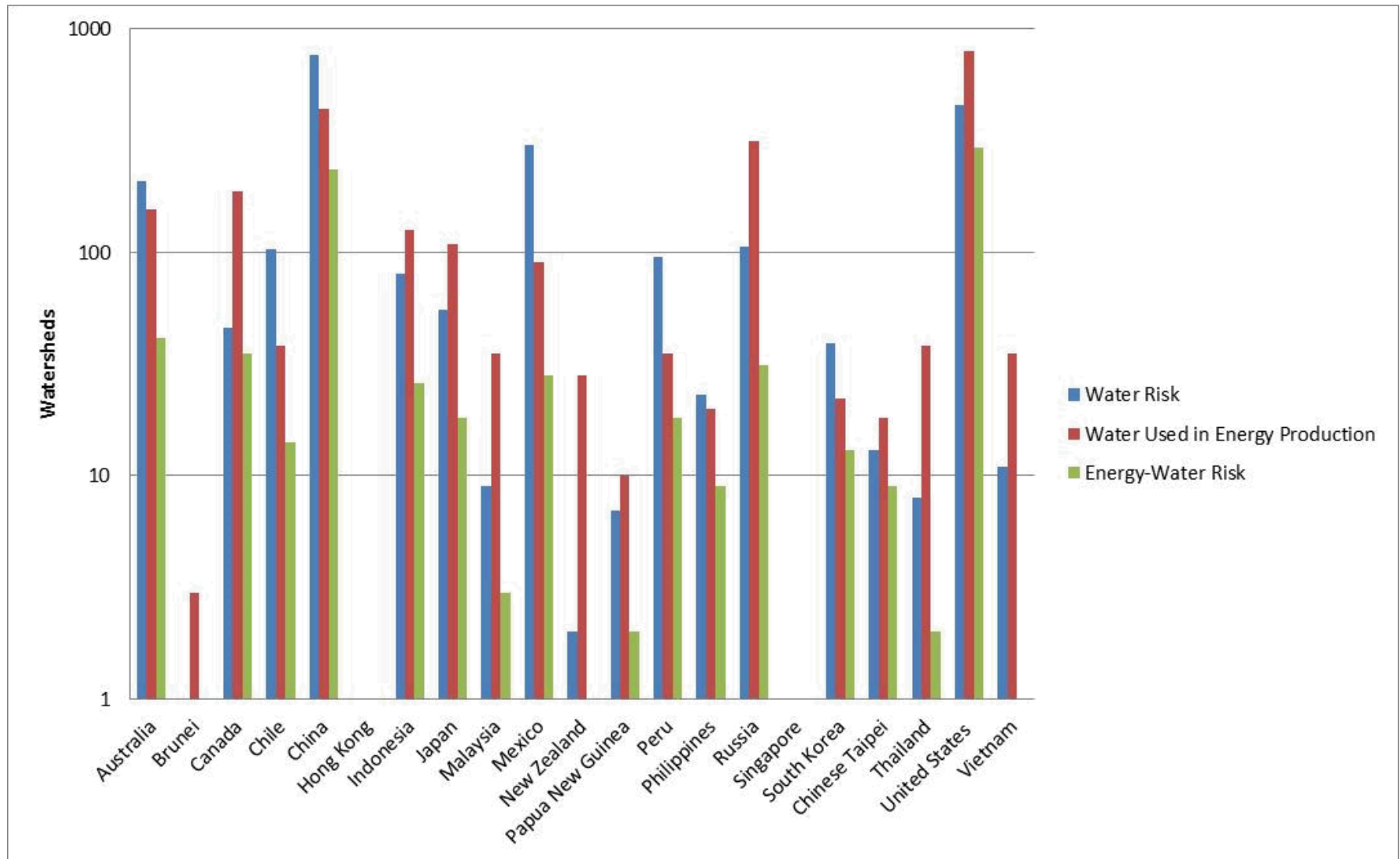
# Water for Energy: Detail China



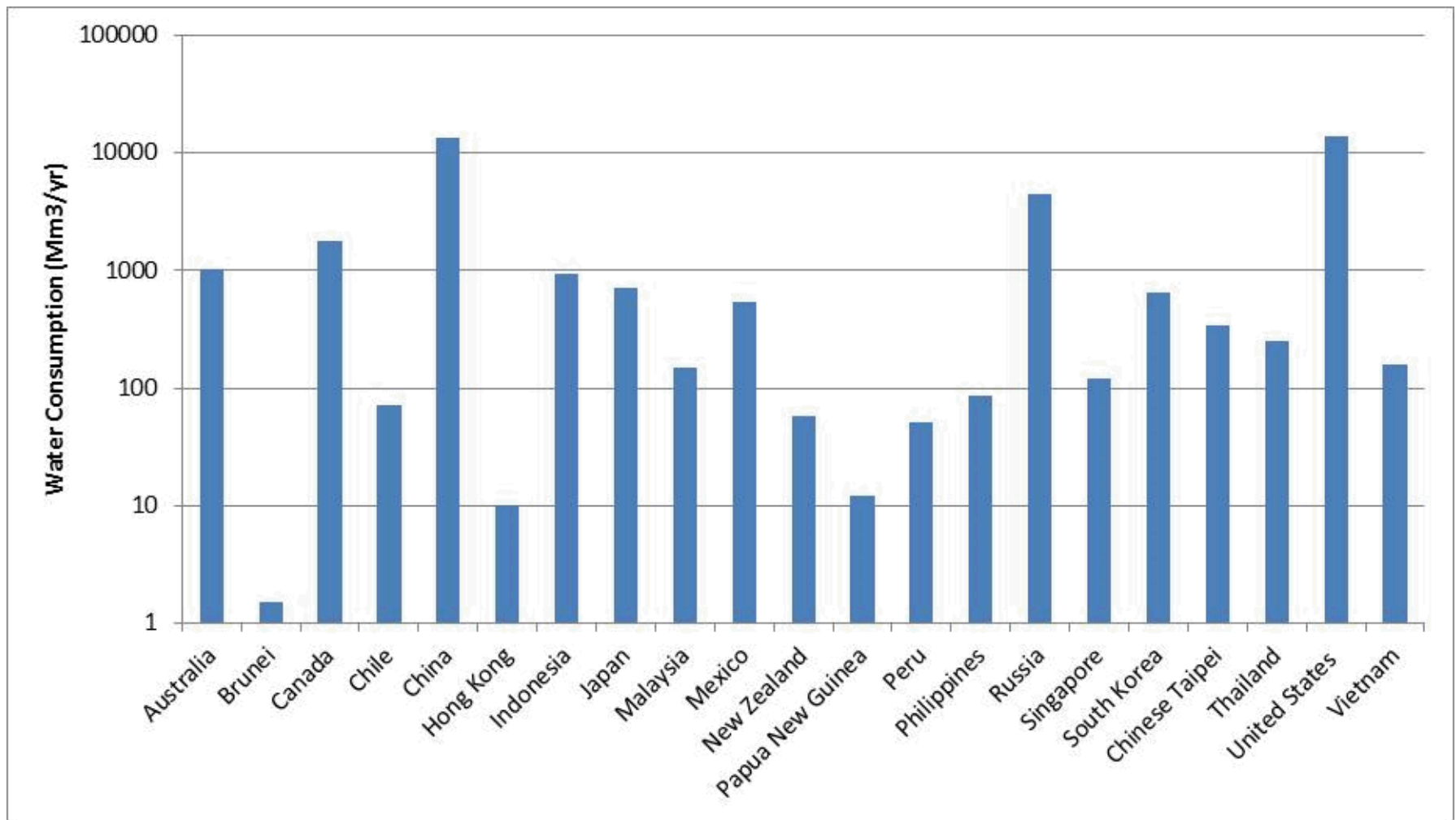
# Water for Energy: Detail U.S.



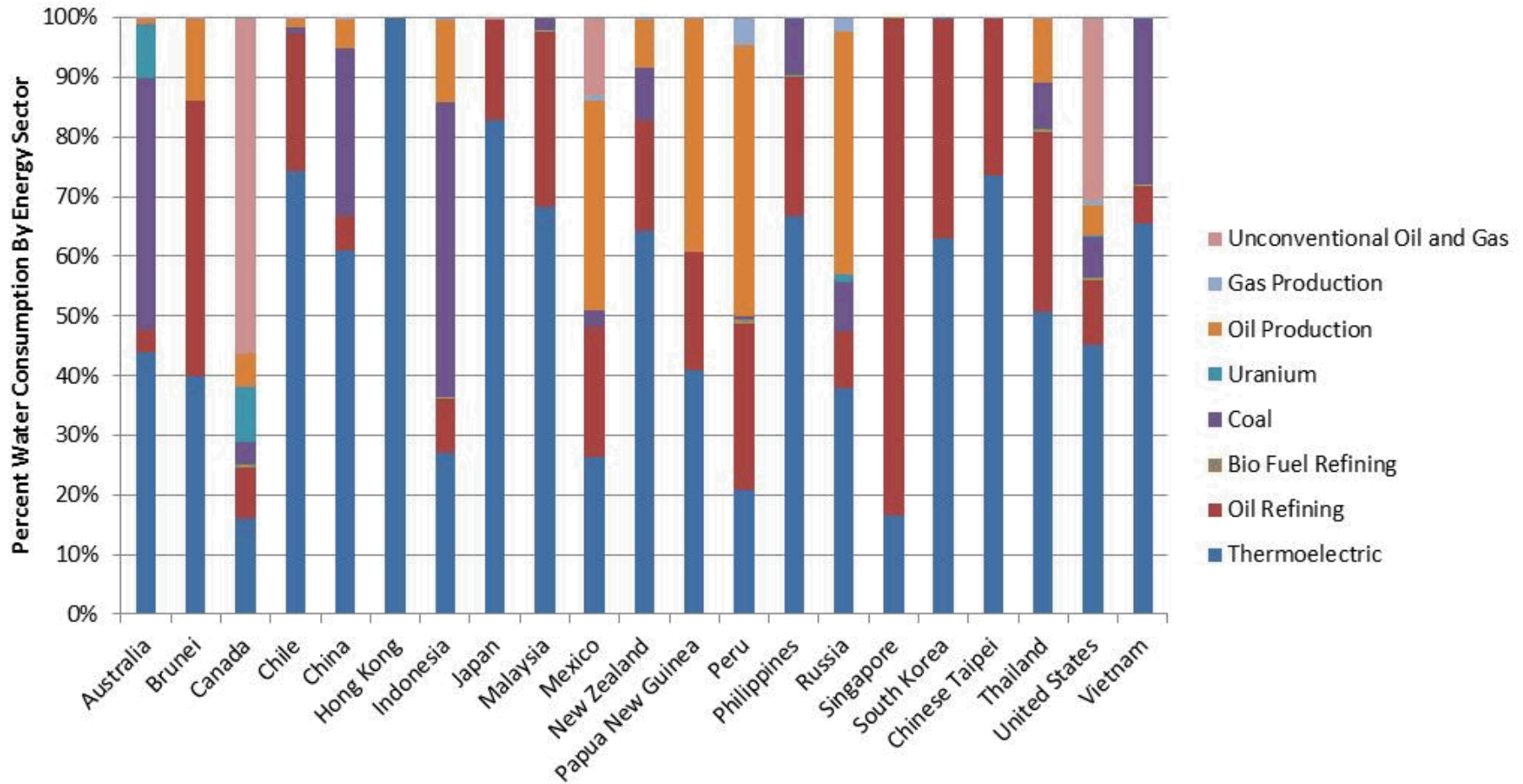
# Energy-Water Risk



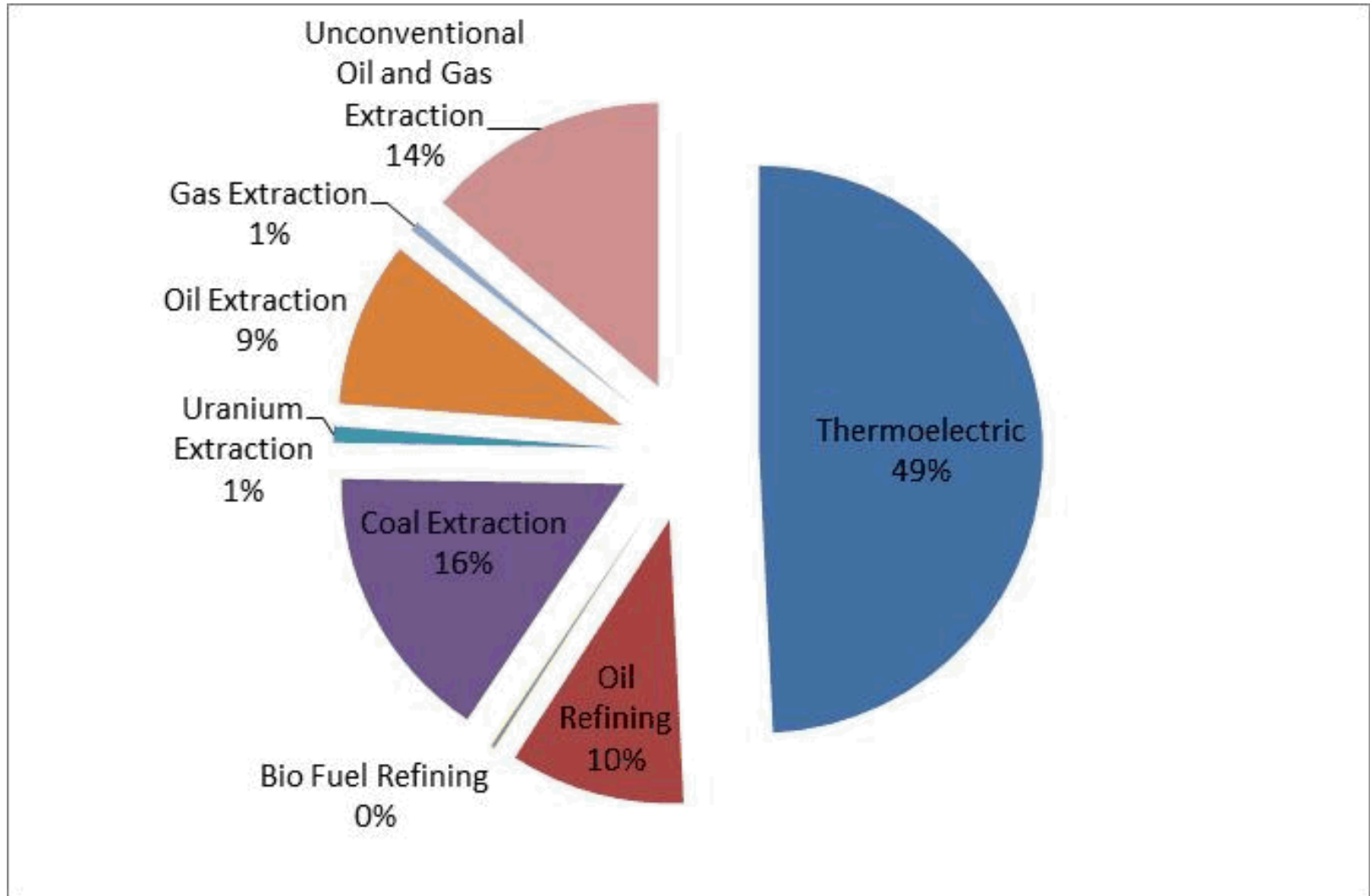
# Water for Energy by Country



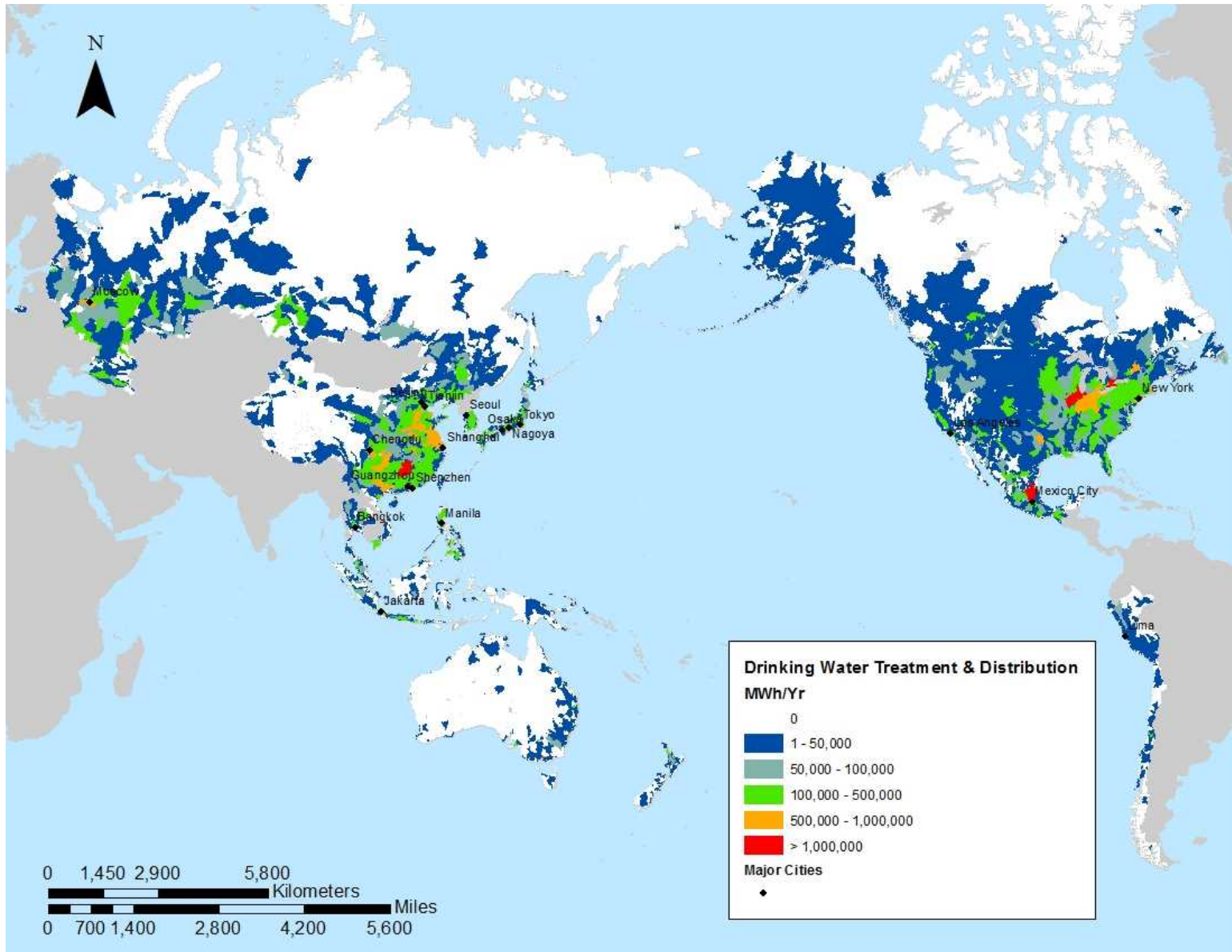
# Water for Energy by Country



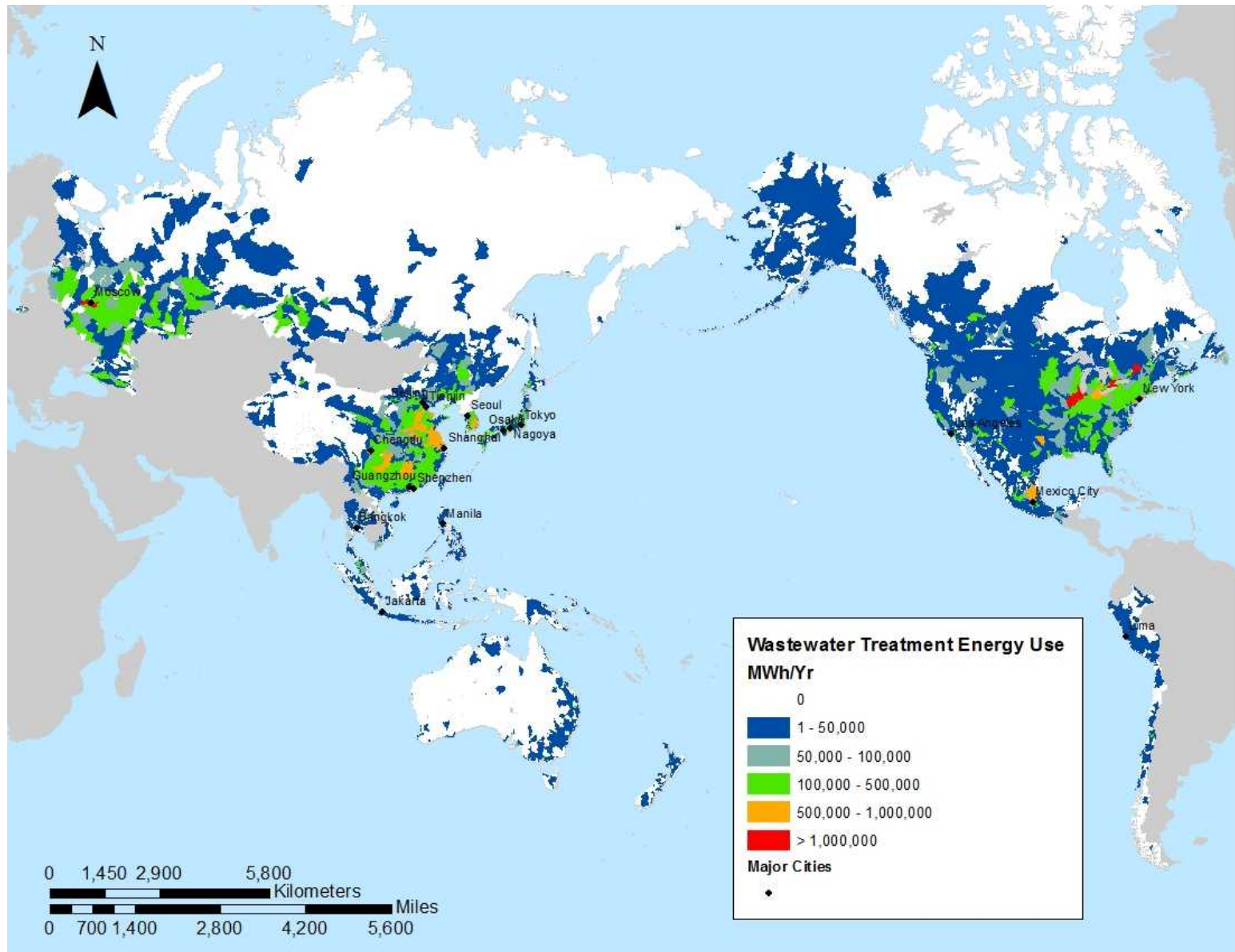
# Water for Energy by Sector



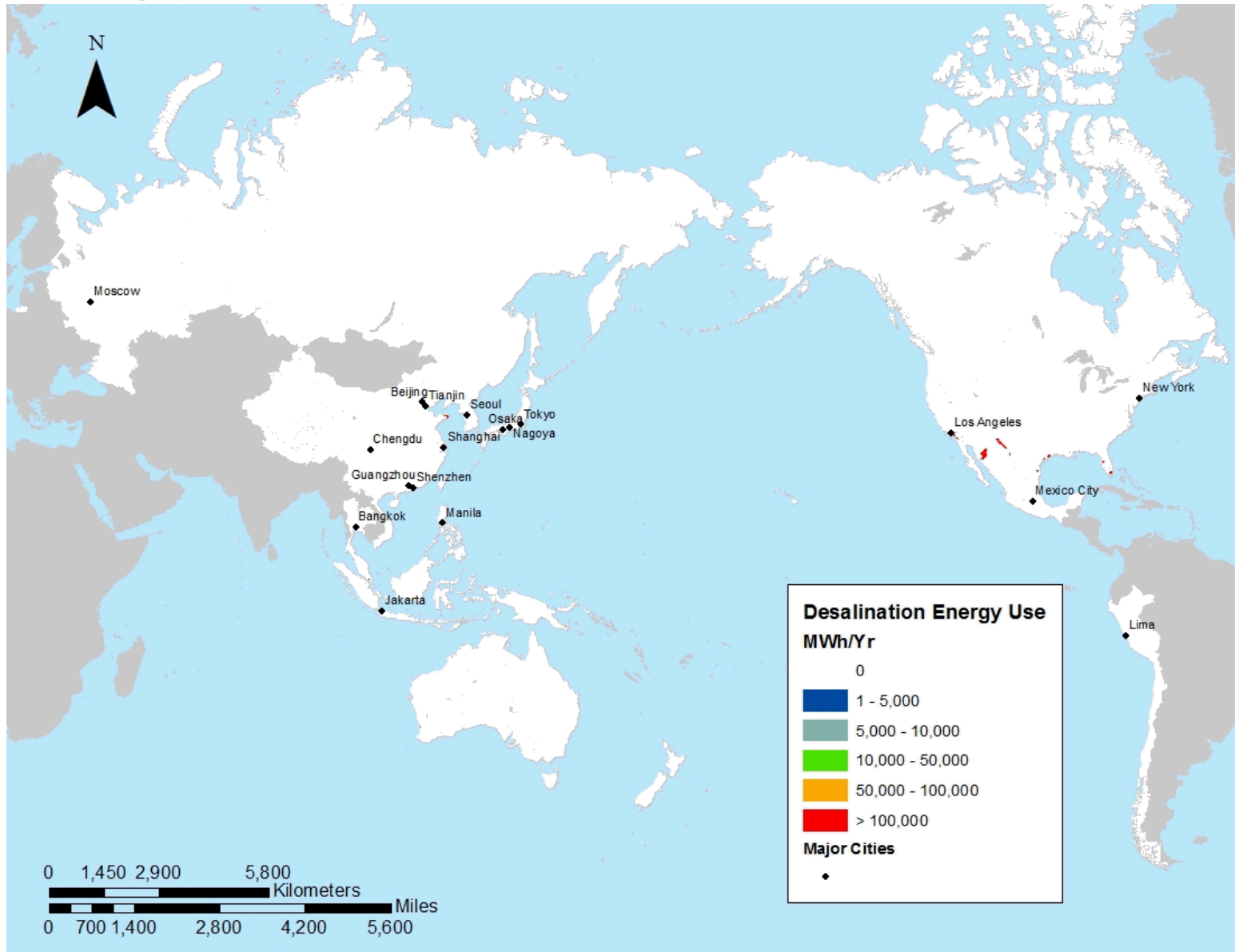
# Energy for Drinking Water



# Energy for Wastewater



# Energy for Desalination



Project data available at:  
[http://energy.sandia.gov/?page\\_id=1741](http://energy.sandia.gov/?page_id=1741)

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The screenshot shows the Sandia National Laboratories website. The main content area is titled "Energy and Water in the Western and Texas Interconnects". Below this, there is a sub-section "Water Scarcity Impacts Energy Production" with a paragraph stating that the energy sector accounts for approximately 41% of daily fresh water withdrawals. This is followed by a list of energy-related uses: hydroelectric power generation, thermoelectric power plant cooling and air emissions control, and energy-resource extraction, refining, and processing. Three images illustrate these concepts: a power plant, a cooling tower, and a wind turbine. A paragraph from the Energy Information Administration projects a 70 million increase in population and a 50% increase in electric power demand by 2030. Another list of challenges includes limitations of surface-water storage capacity, increasing depletion of groundwater, and demands for surface water for ecological uses. The page also features social media sharing options and a "Go To Top" link.

The footer of the website features the tagline "Exceptional service in the national interest" and is organized into five columns of links:

- EC**: About Energy and Climate (EC), Energy Security, Climate Security, Infrastructure Security, Energy Research, Key Facilities, Partnerships.
- EC Highlights**: Sandia Report Presents Analysis of Climate Impacts of Iroquois Solar Power Site, Sandia Wins Award for Best Poster at IEEE Photovoltaic Specialist Conference (PVSC), Sandia Completes Hydrostructural Analysis of Ocean Renewable Power Company's TiGCom's Turbine, The Influence of Rotor Blade Design on Wake Development.
- EC Top Publications**: Solar Energy Grid Integration Systems: Final Report of the Florida Solar Energy Center Team (4.71 MB), Modeling System Losses in PVarray (365.05 kB), Improved Test Method to Verify the Power Rating of a Photovoltaic (PV) Project (319.74 kB), Solar Energy Grid Integration Systems (SEGIS) Productive Intelligent Advances for Photovoltaic Systems (267.26 kB), View all EC Publications.
- Related Topics**: Concentrating Solar Power, CSP EPRC Energy, Energy Efficiency Energy, Security Infrastructure, Infrastructure Security National, Solar Thermal Test Facility, NSTTF photovoltaic, Photovoltaics PV, Renewable Energy solar Solar, Energy solar power Solar, Research Solid-State, Lighting SSLs.
- Contact Us**: RSS, Google+, Twitter, Facebook, LinkedIn, YouTube, Flickr.

# Summary

- Mapped *water for energy* and the *energy for water* for the APEC economies.
- Data limitations challenge estimates of absolute water and energy use; however, confidence in geospatial footprint.
- Significant differences in the energy-water nexus are noted:
  - Among economies,
  - Regionally within economies, and
  - Across different unit processes.
- Numerous cases noted where high water use for energy and water stress coincide.

# Opportunities

- Options to improve energy-water resiliency:
  - Integrated energy and water planning,
  - Choice in energy production technology (e.g., low water use electricity generation),
  - Consider early the energy or water intensity of new projects and site them appropriately,
  - Numerous emerging technologies that can improve interdependencies:
    - Power plant cooling systems,
    - Water treatment technologies, and
    - Energy capture for wastewater streams.