Impact of climate change on Washington metropolitan area water supply

Metropolitan Washington Council of Governments

Chesapeake Bay and Water Resources Policy Committee

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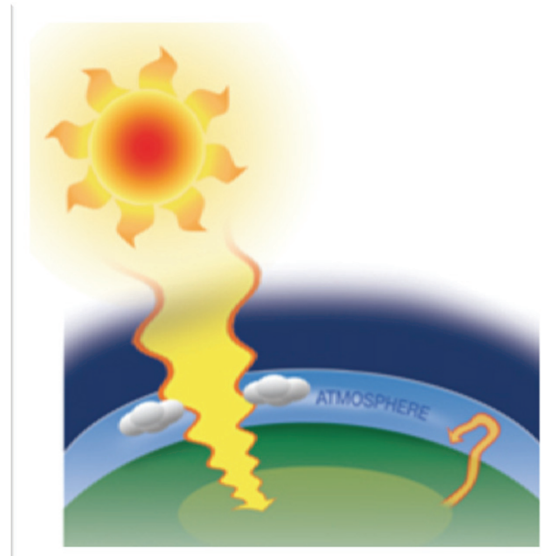
Cherie Schultz, PhD
Interstate Commission on the Potomac River Basin
51 Monroe Street, Suite PE-08 · Rockville, Maryland 20850

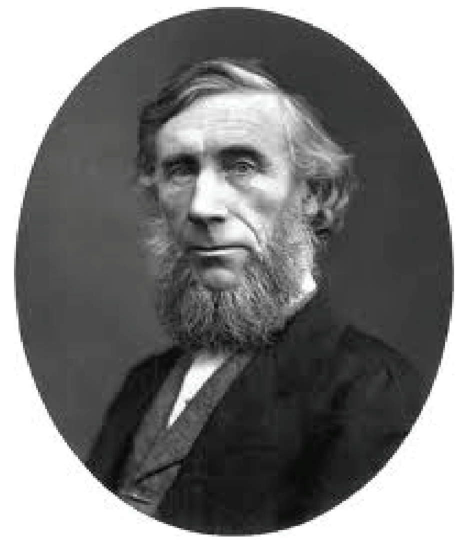
Overview

- A little history
- Washington metro area's cooperative water supply system
- Impacts of climate change
  - On Potomac basin stream flows
  - On annual water budget
  - On reliability of current Washington metro area water supply system



Global Warming - Some History

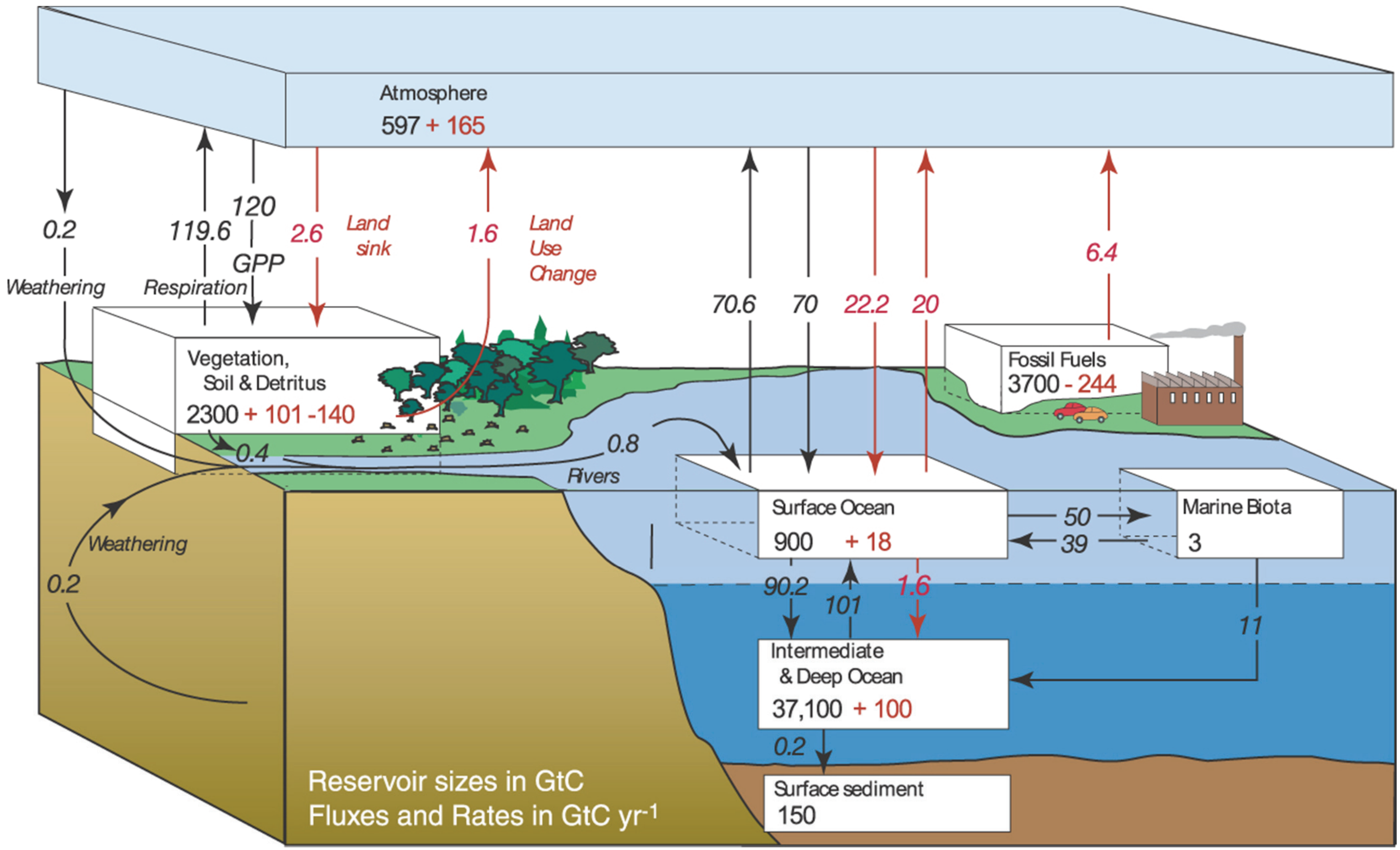
1824: Joseph Fourier found that the earth was far warmer than expected; suggested atmosphere might act as blanket



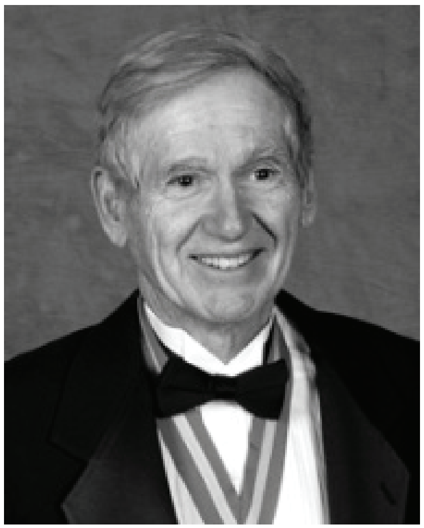
1859: John Tyndall discovered that certain gases block thermal radiation; suggested that changes in composition of atmosphere could cause climate change

1896: Svante Arhennius published first calculation estimating global warming from human emissions of carbon dioxide

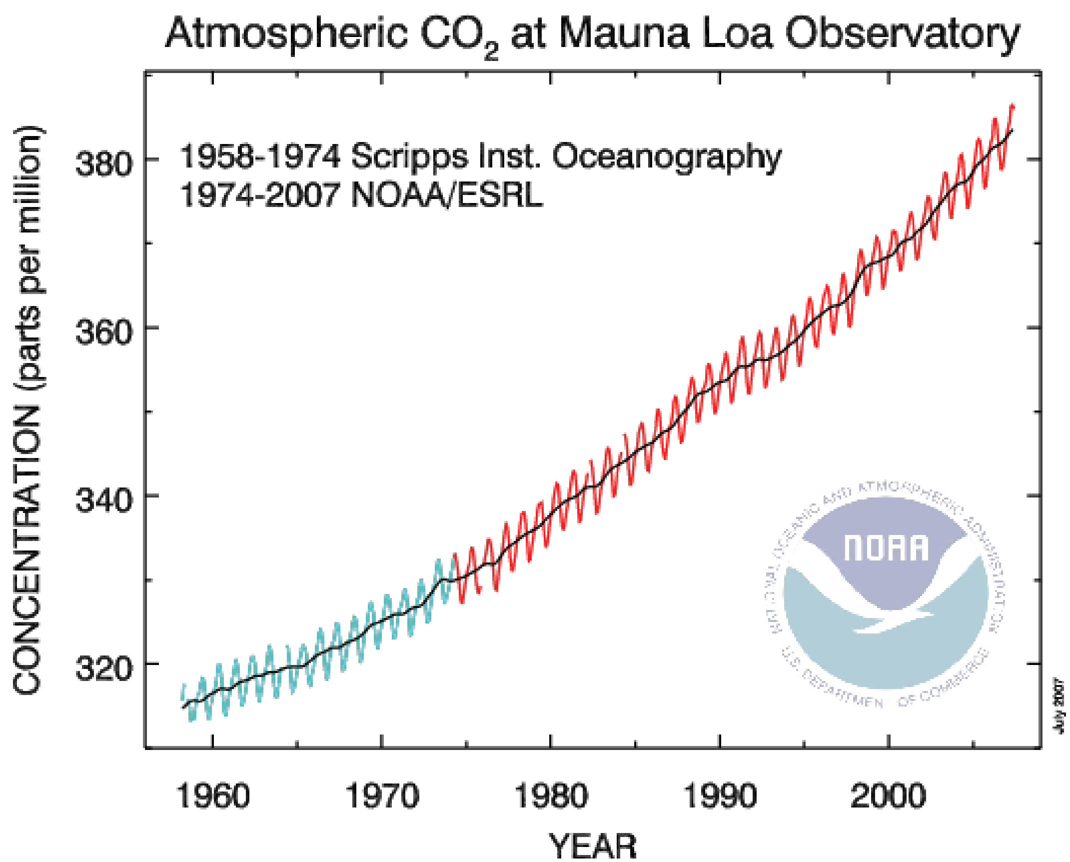
The Carbon Cycle is Very Complex



Is Atmospheric CO_2 Really Rising?



Charles Keeling developed techniques in the 1950's to reliably measure atmospheric CO2



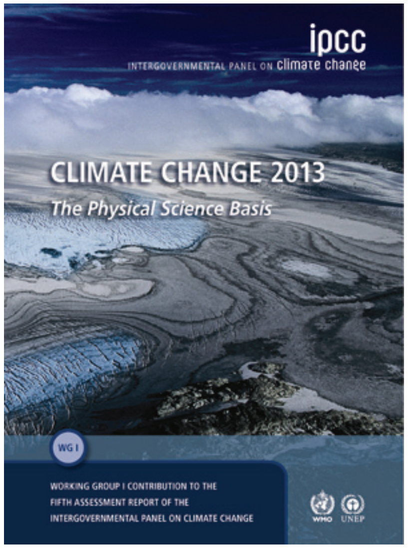
Human-Induced Global Warming – How Much? How Fast?

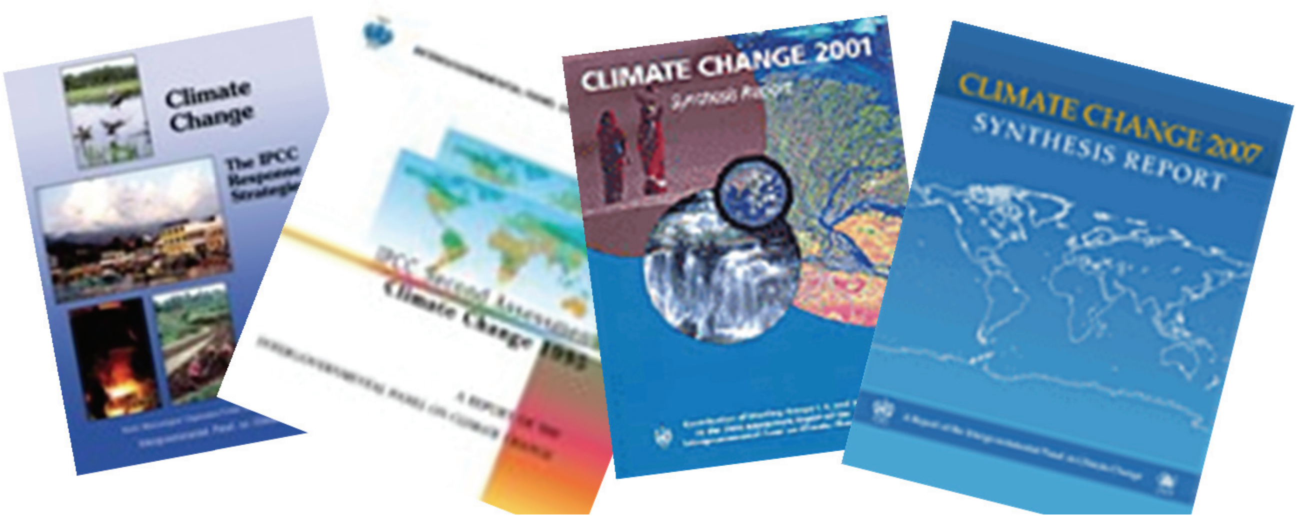
An international modeling effort, including:

- GFDL - Geophysical Fluid Dynamics Laboratory, USA
- NCAR - National Center for Atmospheric Research, *USA*
- Had - Hadley Center (UK's National Weather Service), UK
- BCM – Bergen Climate Model, Norway
- CGCM – Coupled Global Climate Model, Canada
- CSIRO - Commonwealth Scientific and Industrial Research Organisation, Australia
- IPSL - Institut Pierre Simon Laplace, France
- INM – Institute of Numerical Mathematics, Russia
- MIROC - Model for Interdisciplinary Research on Climate, Japan
- BCC – Beijing Climate Center, China

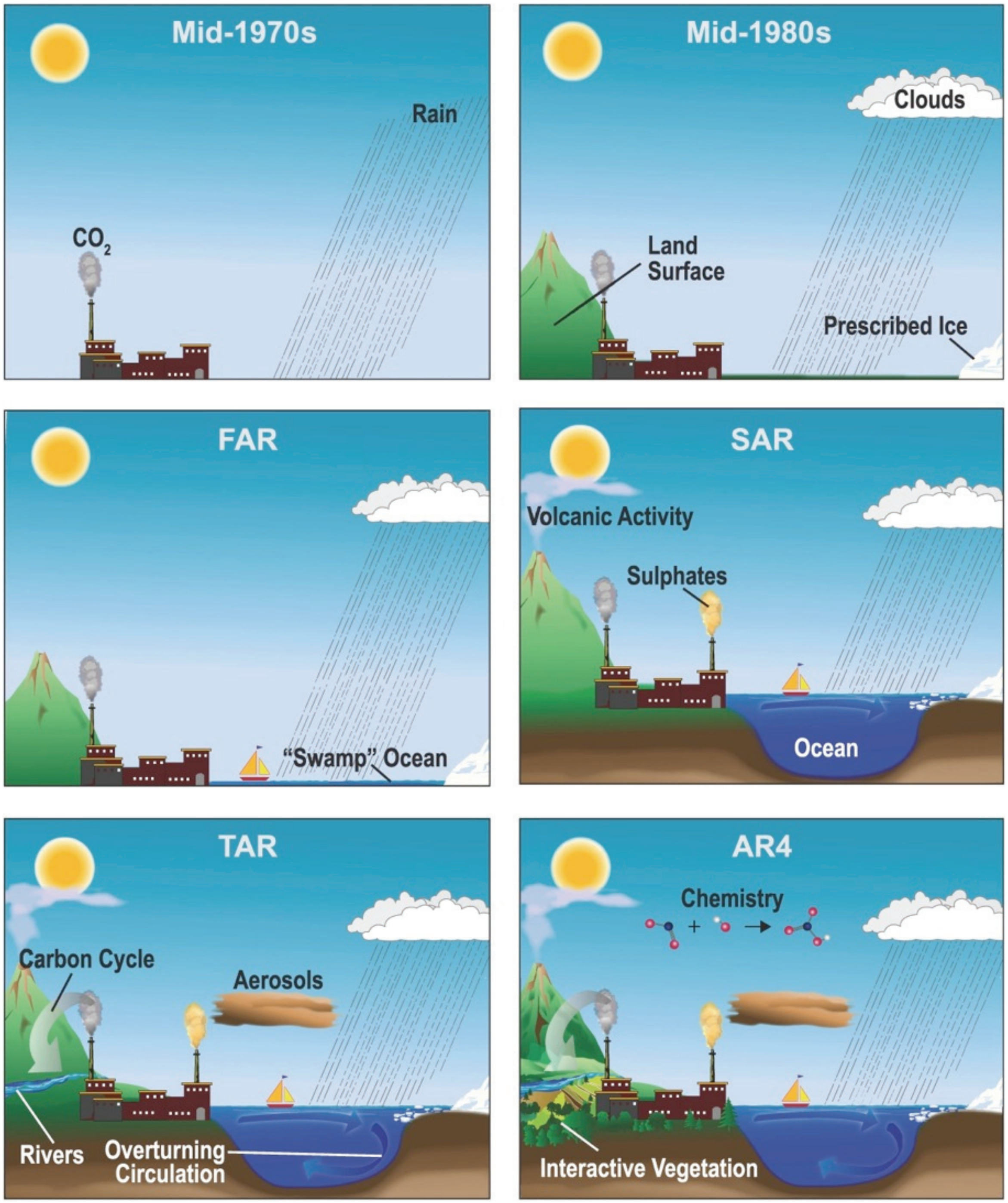
Intergovernmental Panel on Climate Change (IPCC)

- First Assessment Report (FAR) – 1990
- Second Assessment Report (SAR) – 1995
- Third Assessment Report (TAR) – 2001
- Fourth Assessment Report (AR4) – 2007
- *Fifth Assessment Report Final Draft available*

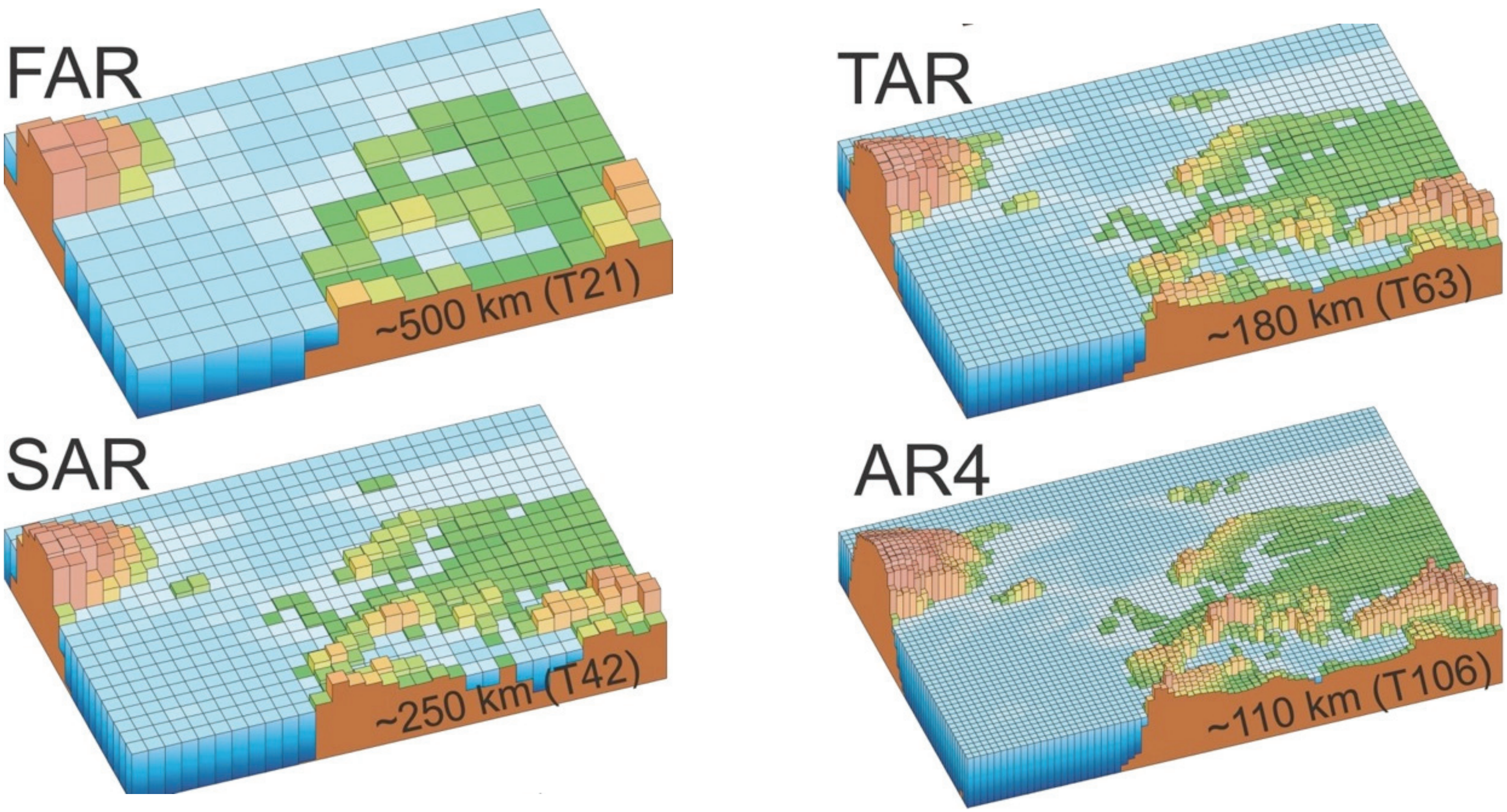




Increasing model complexity

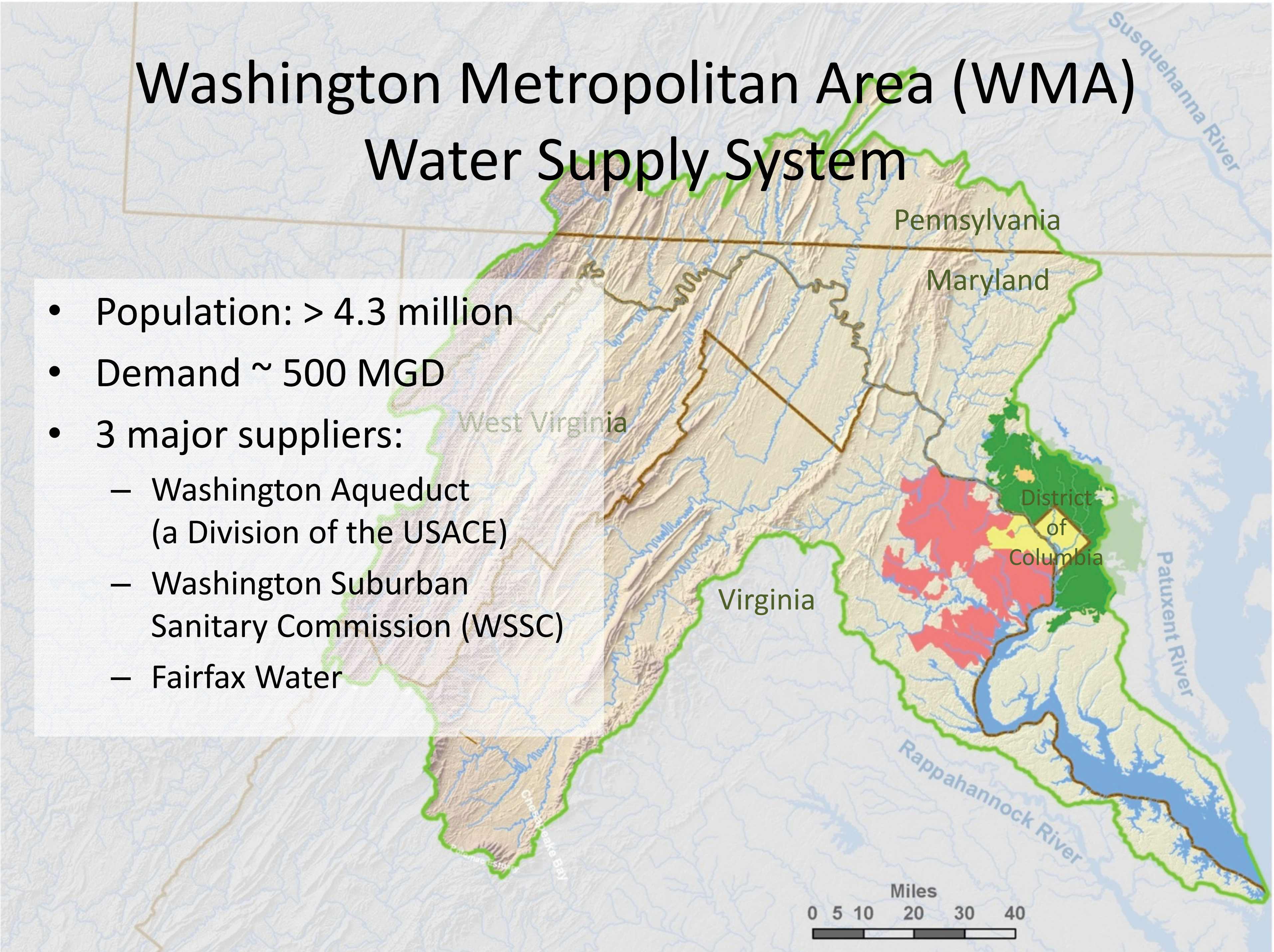


Increasing Spatial Resolution



Washington Metropolitan Area (WMA) Water Supply System

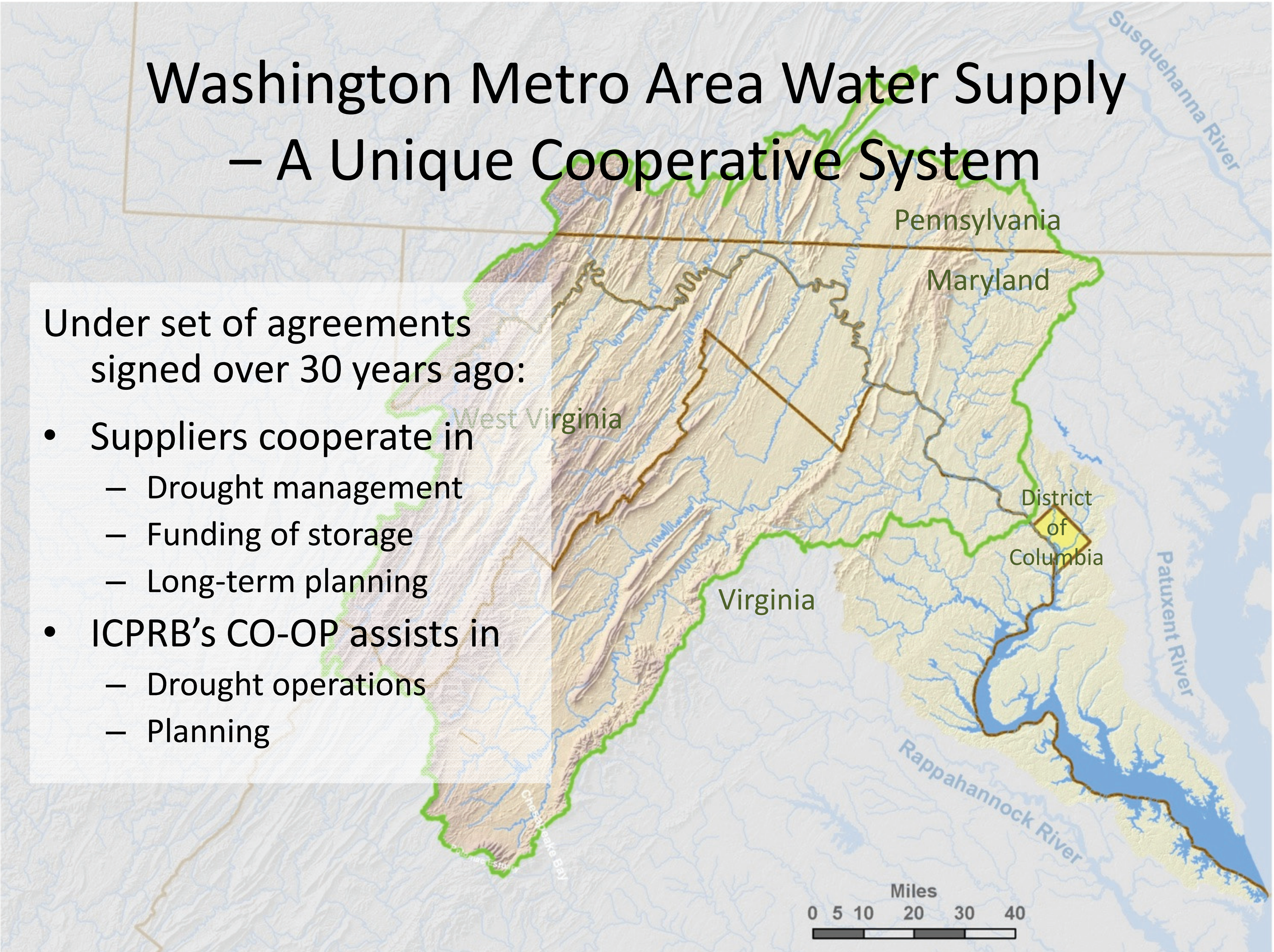
- Population: > 4.3 million
- Demand ~ 500 MGD
- 3 major suppliers:
  - Washington Aqueduct (a Division of the USACE)
  - Washington Suburban Sanitary Commission (WSSC)
  - Fairfax Water



Washington Metro Area Water Supply – A Unique Cooperative System

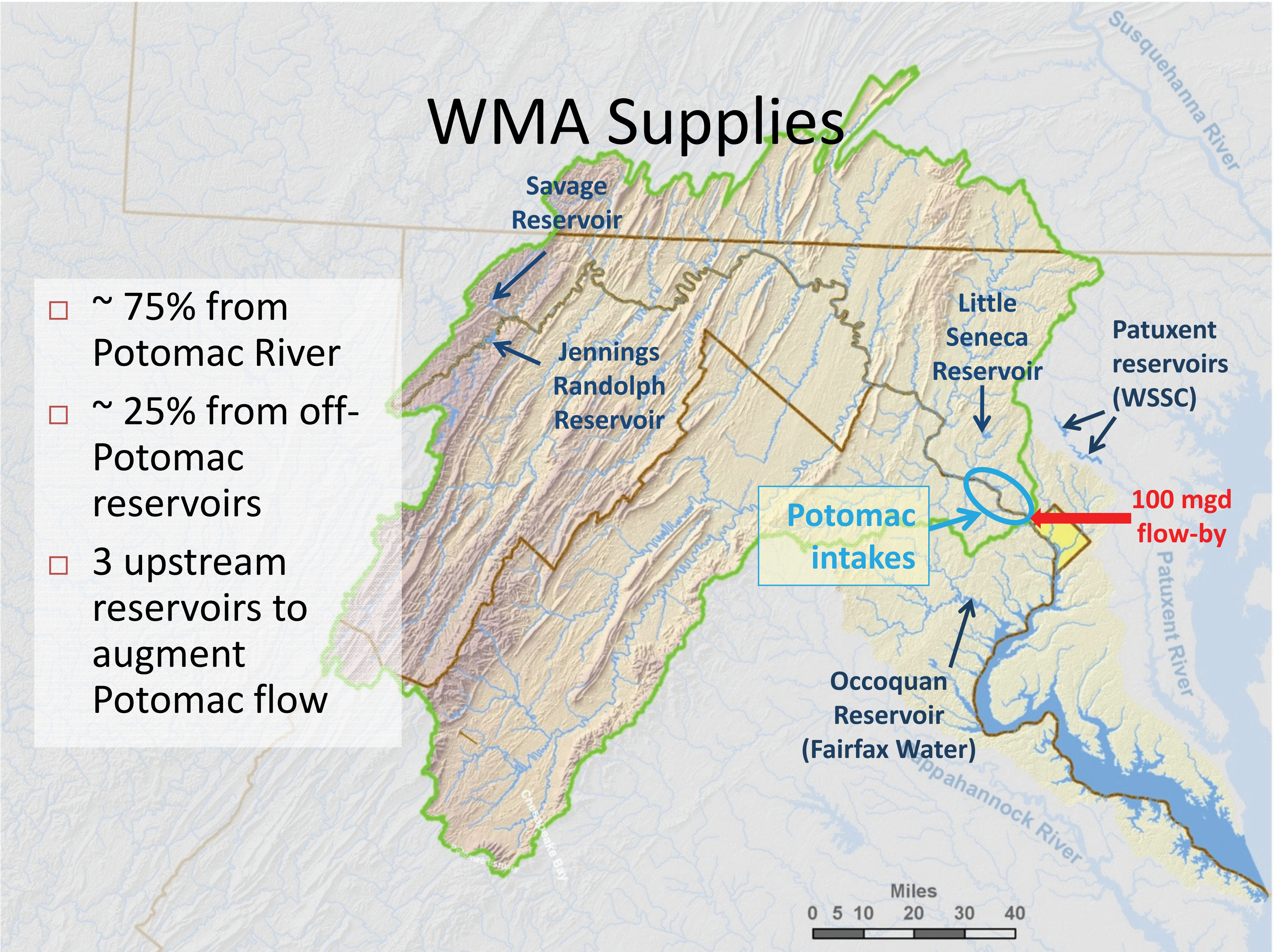
Under set of agreements signed over 30 years ago:

- Suppliers cooperate in
  - Drought management
  - Funding of storage
  - Long-term planning
- ICPRB's CO-OP assists in
  - Drought operations
  - Planning



WMA Supplies

- ~ 75% from Potomac River
- ~ 25% from off-Potomac reservoirs
- 3 upstream reservoirs to augment Potomac flow



2010 Washington Metropolitan Area Water Supply Reliability Study

- <u>Findings of *Part 1* </u>– *Demand and Resource Availability for the year 2040* (based on historical climate)
  - The current system will likely meet demands through 2030
  - By 2040 the current system may have difficulty meeting demands in event of severe drought
  - Summertime outdoor water use may be increasing

- <u>Objective of Part 2</u>: Determine potential impacts of climate change, assuming no management changes.

Climate Trends and Projections

- Most climate scientists agree that <u>globally</u>
  - Levels of atmospheric greenhouse gases have been and will continue to grow
  - Temperatures have been and will continue to increase
  - Sea levels have been and will continue to rise
  - Extreme rain events and droughts will become more frequent

- There is less confidence <u>regionally</u>
  - Flows in most Chesapeake Bay region streams have risen (but summertime Potomac River flows have fallen)
  - Temperatures in the Potomac basin may rise 1 – 2^{o}C by mid-century
  - The Potomac basin may become wetter, … or drier

Partners and Tools

U.S. Geological Survey
Climate Scenarios

USGS

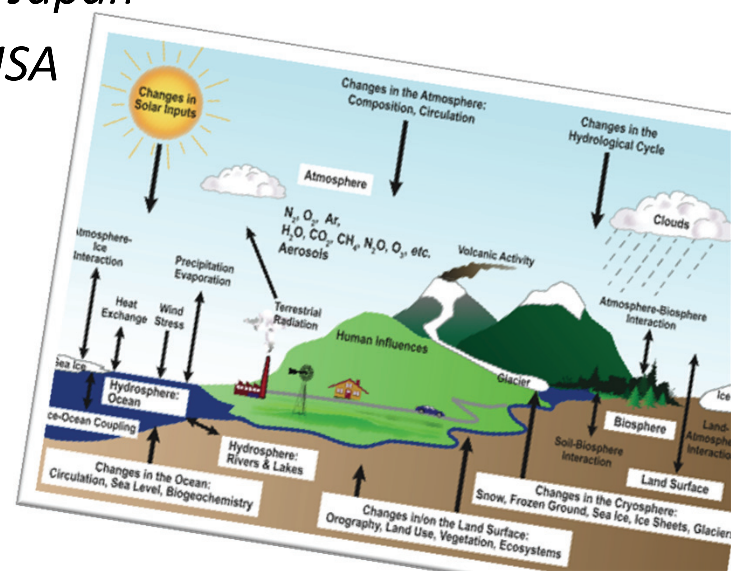
Chesapeake Bay Program
Phase 5 Watershed Model

ICPRB's Potomac River and
Reservoir Simulation Model

Global Climate Models

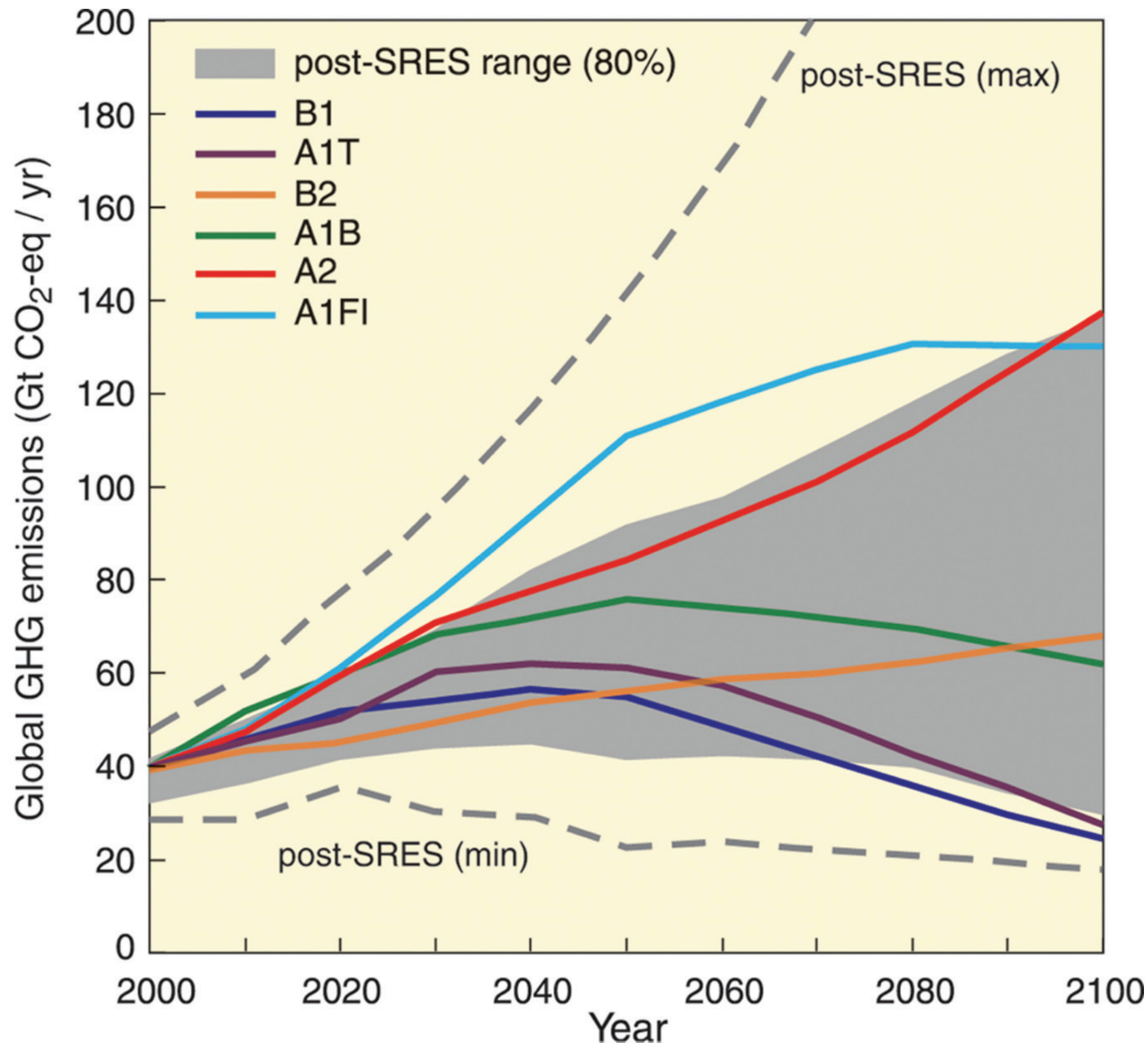
This study used projections from 6 global models:

1. Bjerknes Centre for Climate Research, *Norway*
2. Commonwealth Scientific and Industrial Research Organisation, *Australia (Mk3.0)*
3. Commonwealth Scientific and Industrial Research Organisation, *Australia (Mk3.5)*
4. National Institute for Environmental Studies, *Japan*
5. National Center for Atmospheric Research, *USA*
6. Institute for Numerical Mathematics, *Russia*

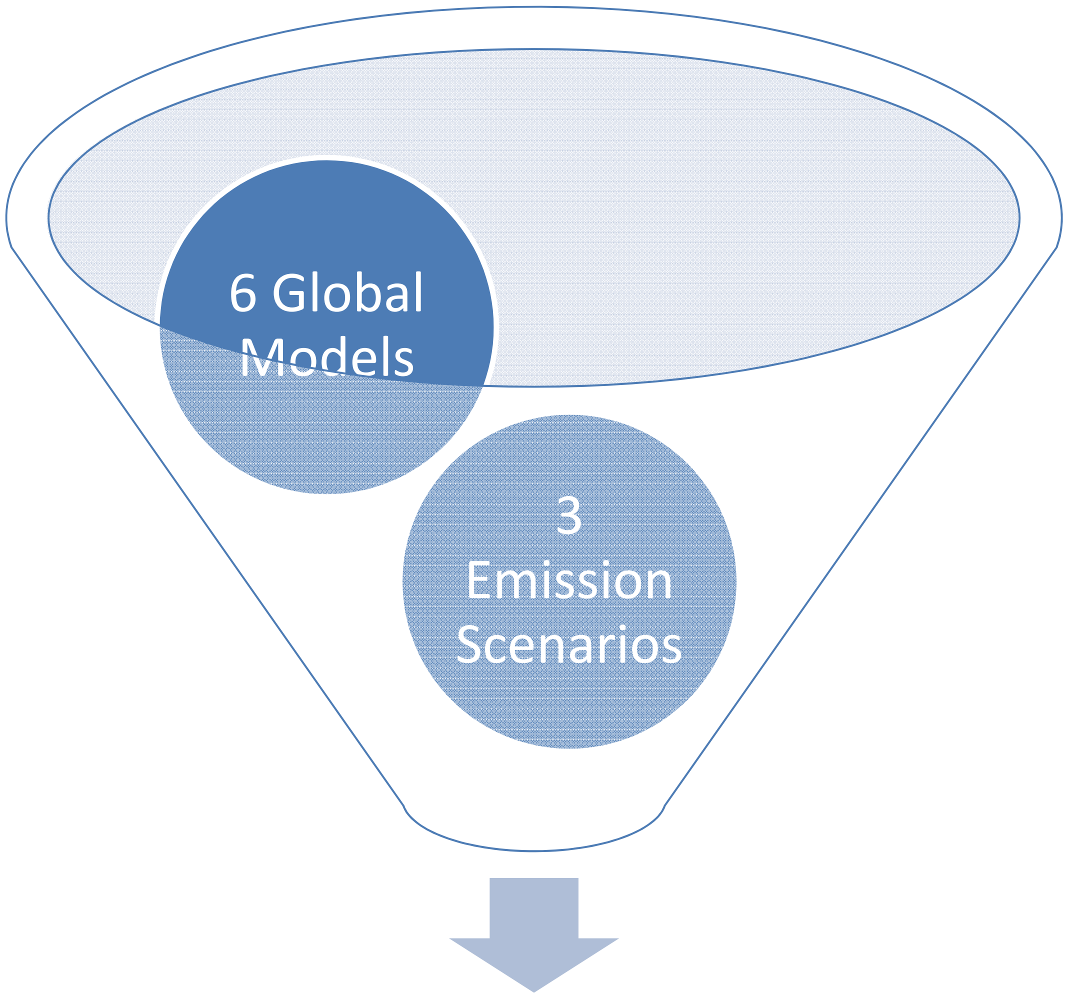


Greenhouse Gas Emission Scenarios

- A2: high population growth & slow technological change
- A1B: rapid growth & and technological change; population peak mid-century
- B1: similar to A1B, but change toward service & information economy

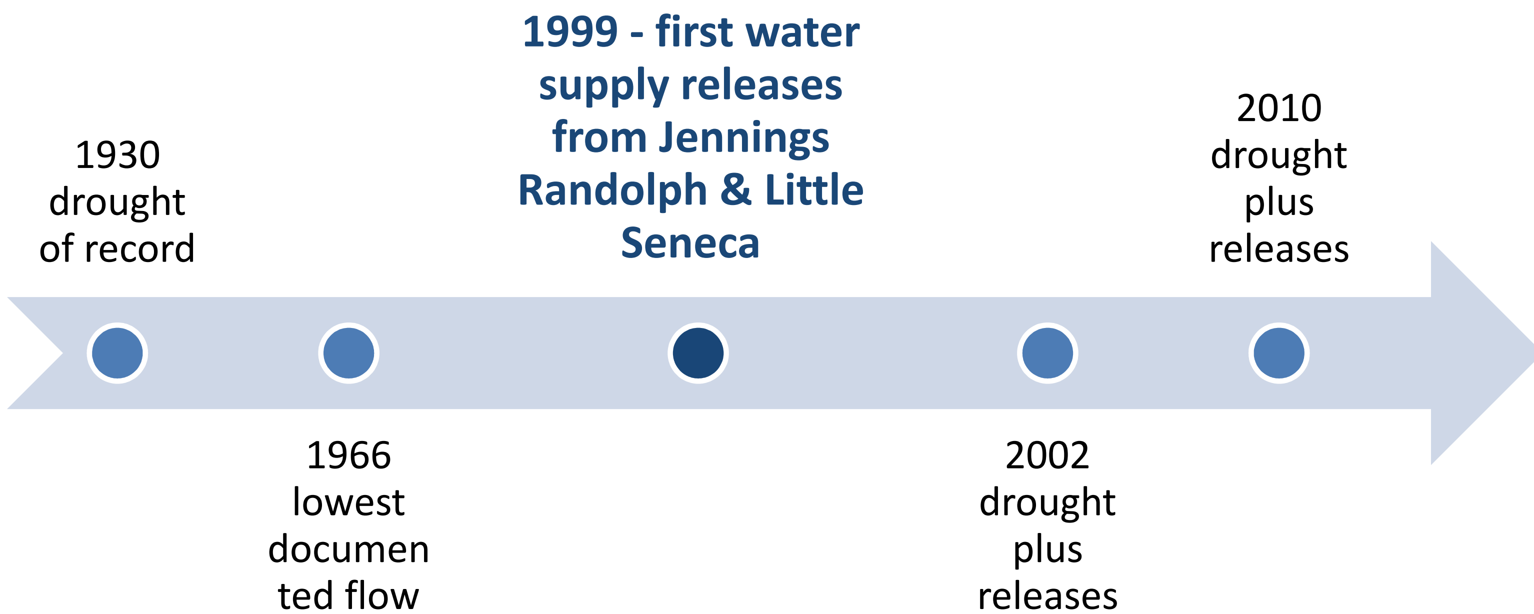


SRES: Special Report on Emissions Scenarios (2000)



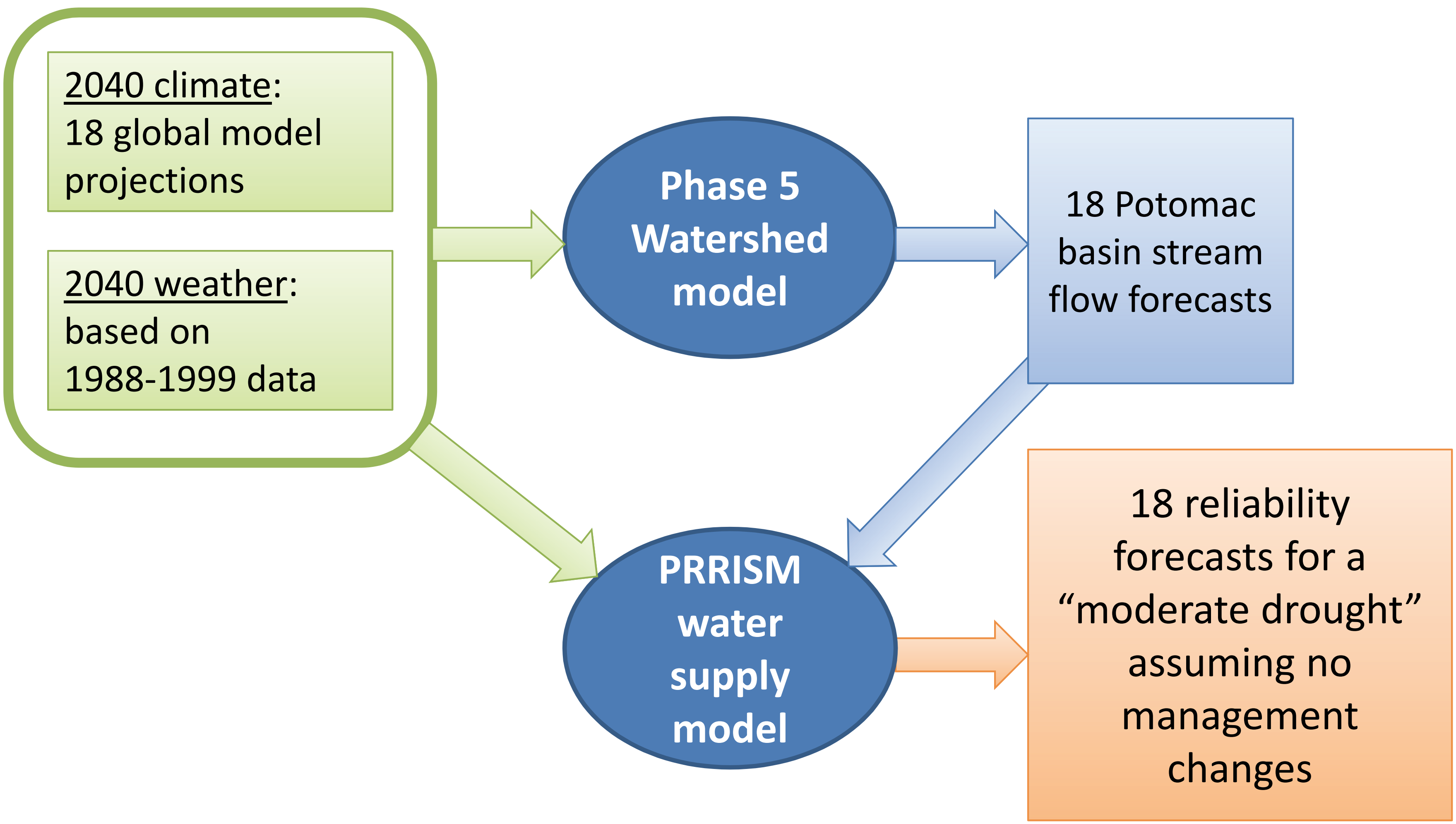
18 Climate Projections

Historical Potomac Low Flow Periods



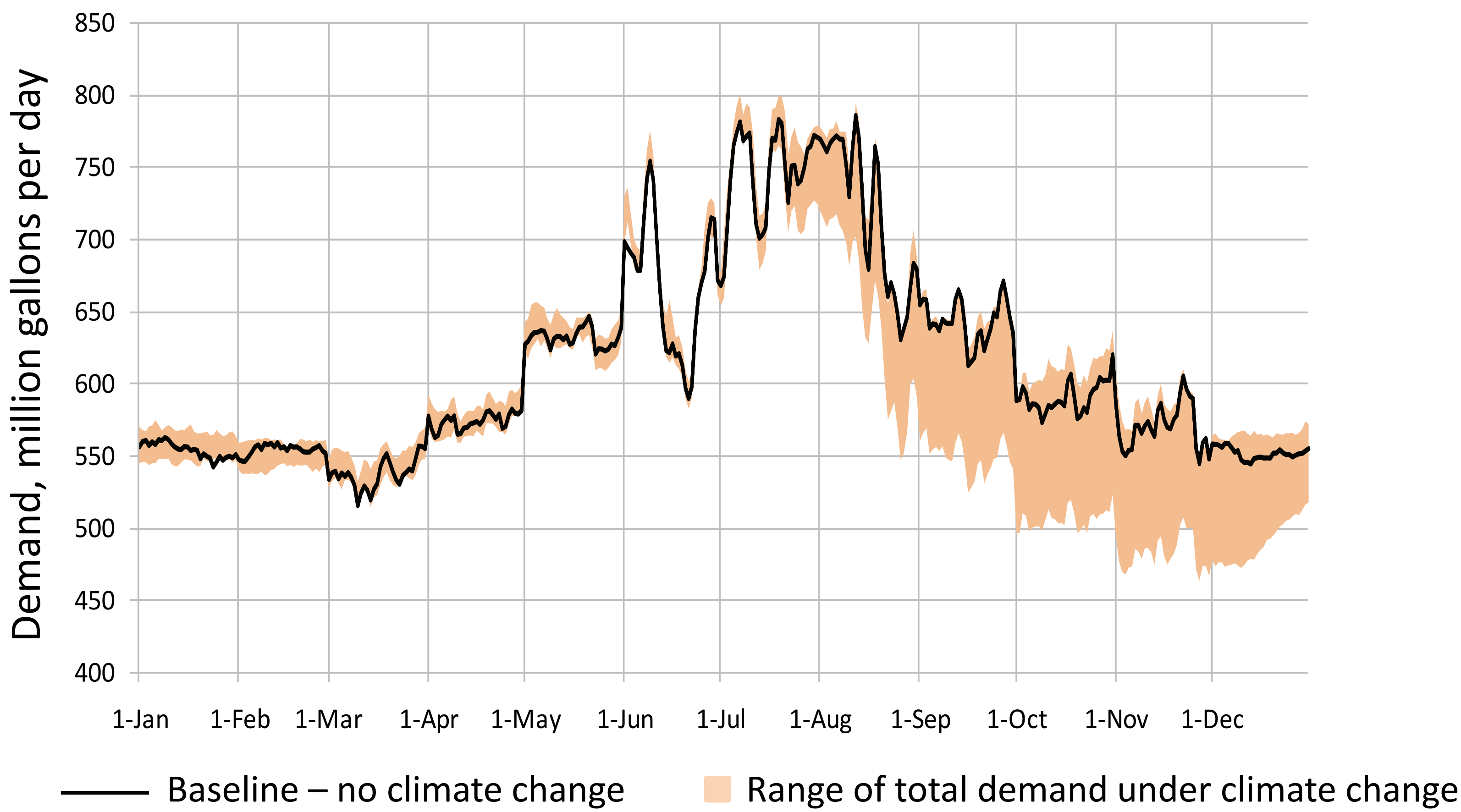
- Most severe droughts were in 1930, 1966, 1999, & 2002
- This study's primary focus: a "moderate" drought, with likelihood comparable with drought of 1999

Approach

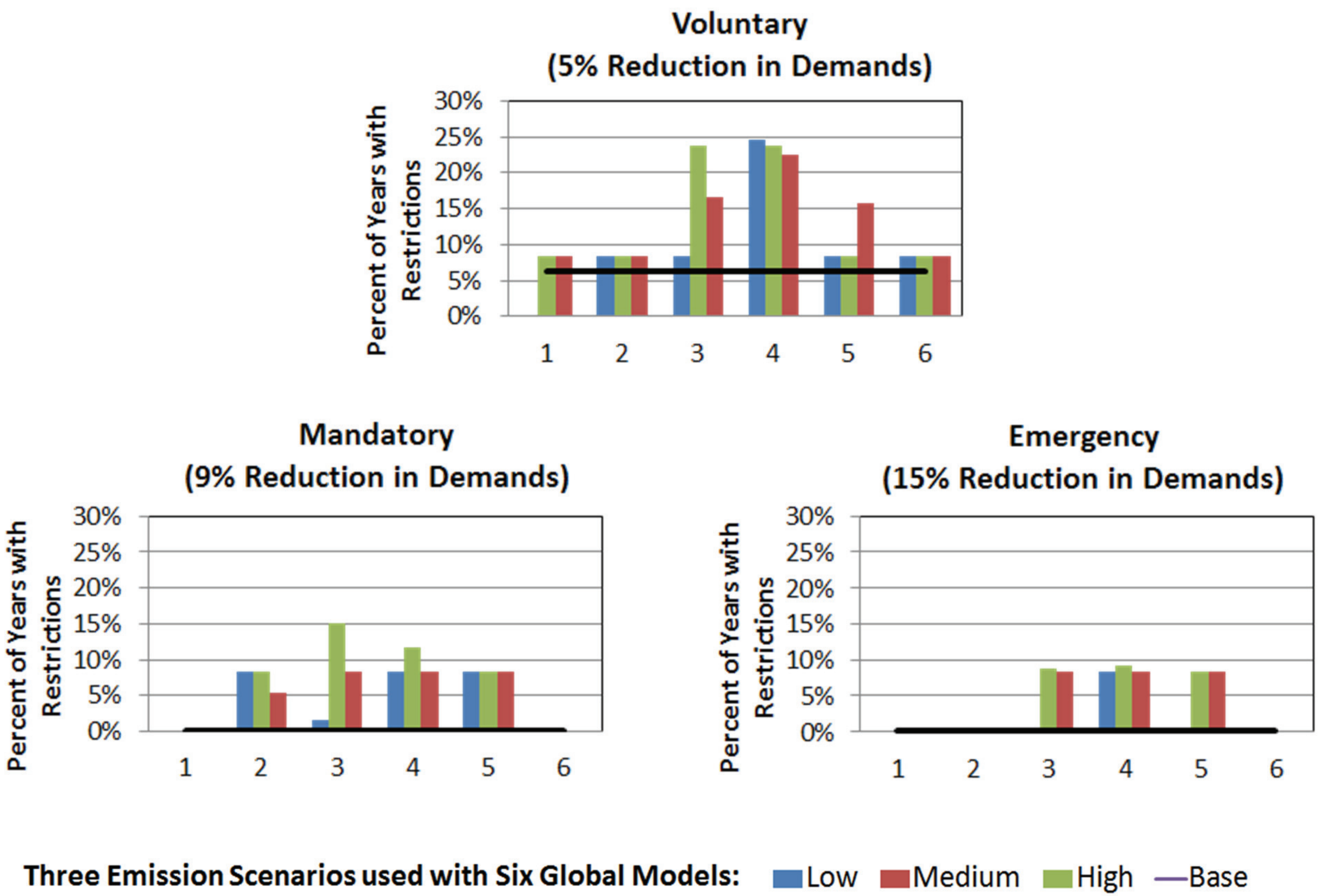

2040 climate:
18 global model projections
2040 weather:
based on 1988-1999 data
Phase 5 Watershed model
18 Potomac basin stream flow forecasts
PRRISM water supply model
18 reliability forecasts for a "moderate drought" assuming no management changes

Daily Water Demands

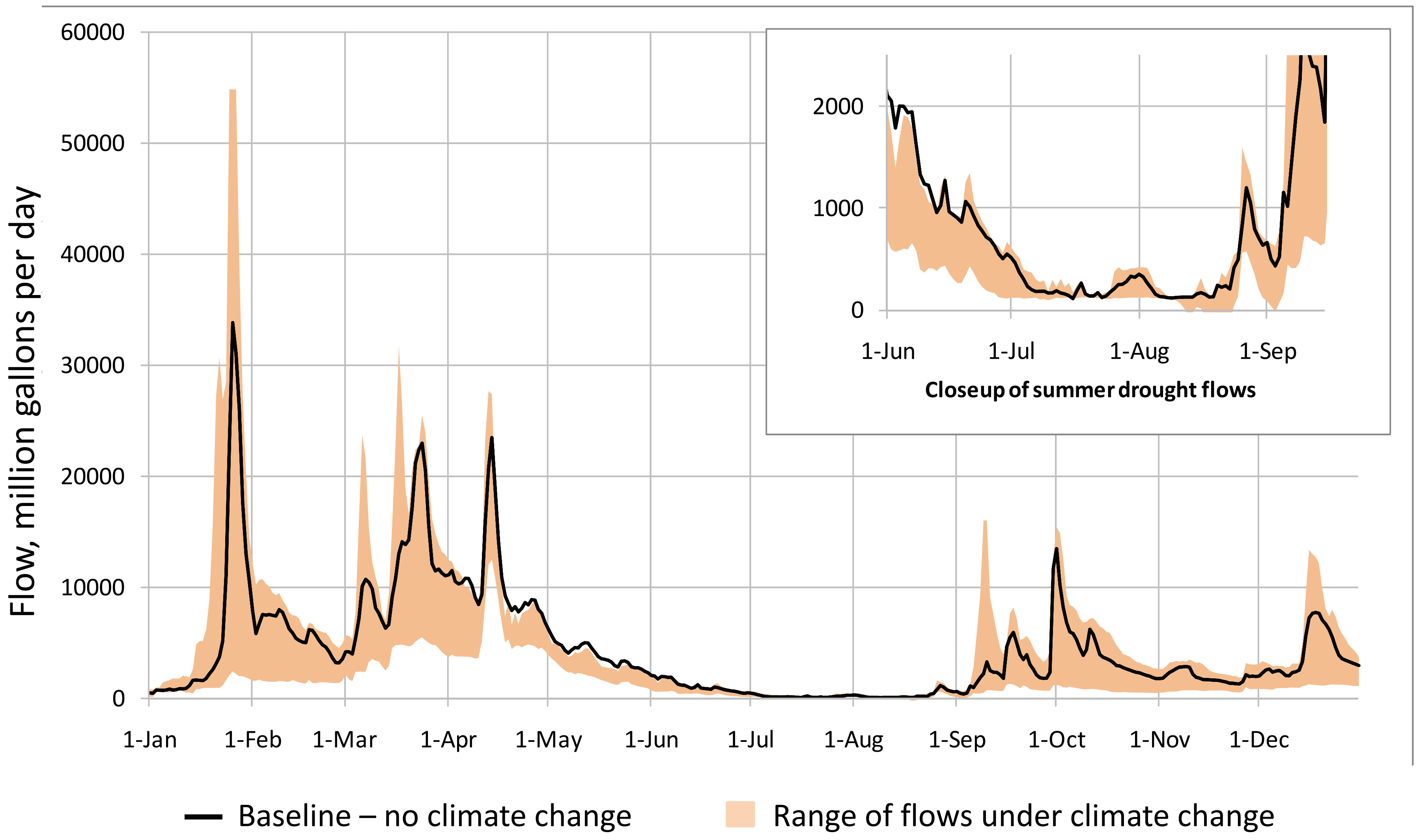
- Daily demand forecasts are responsive to higher temperatures and lower precipitation
- Low reservoir levels trigger water use restrictions, causing demands to drop



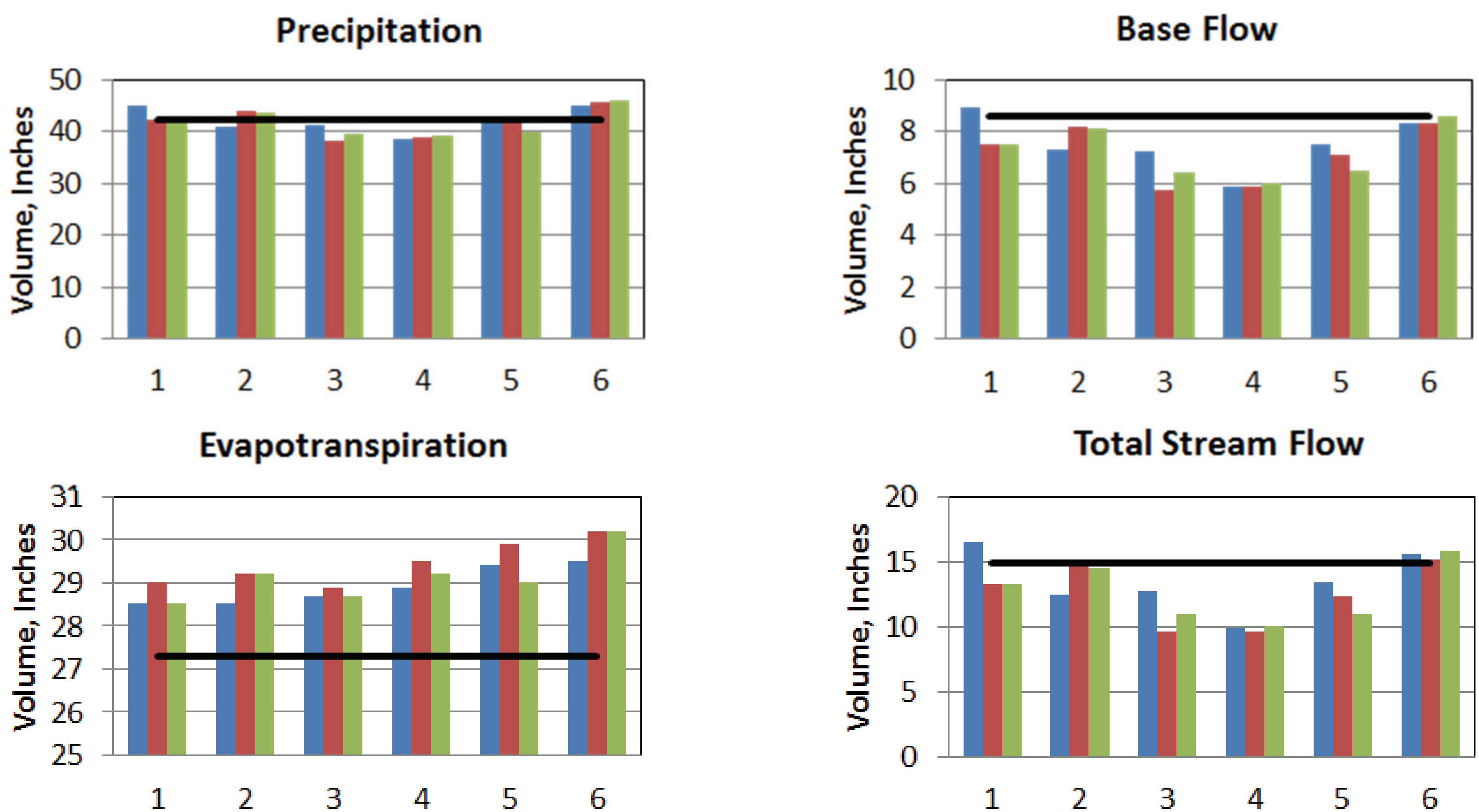
Water Use Restrictions



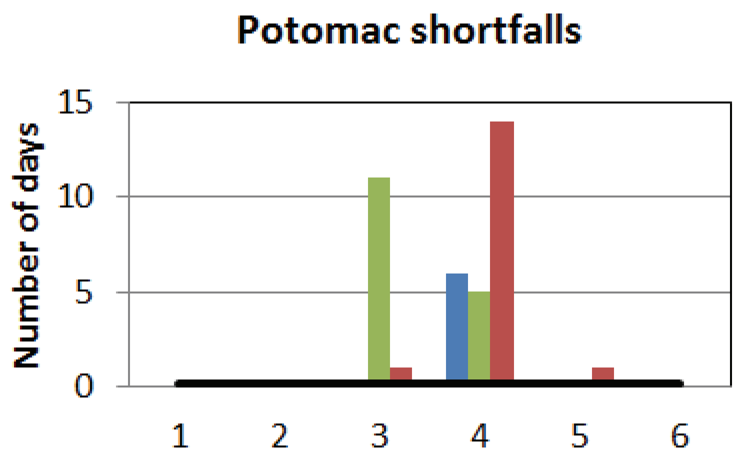
Potomac River Flows

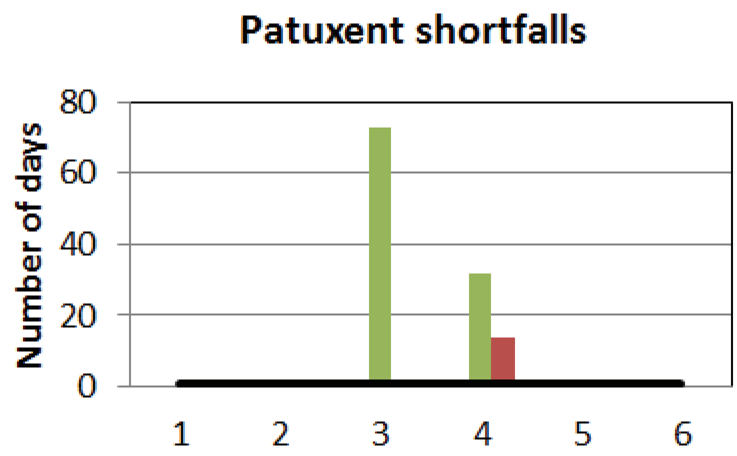


Basin-wide Average Annual Water Budget



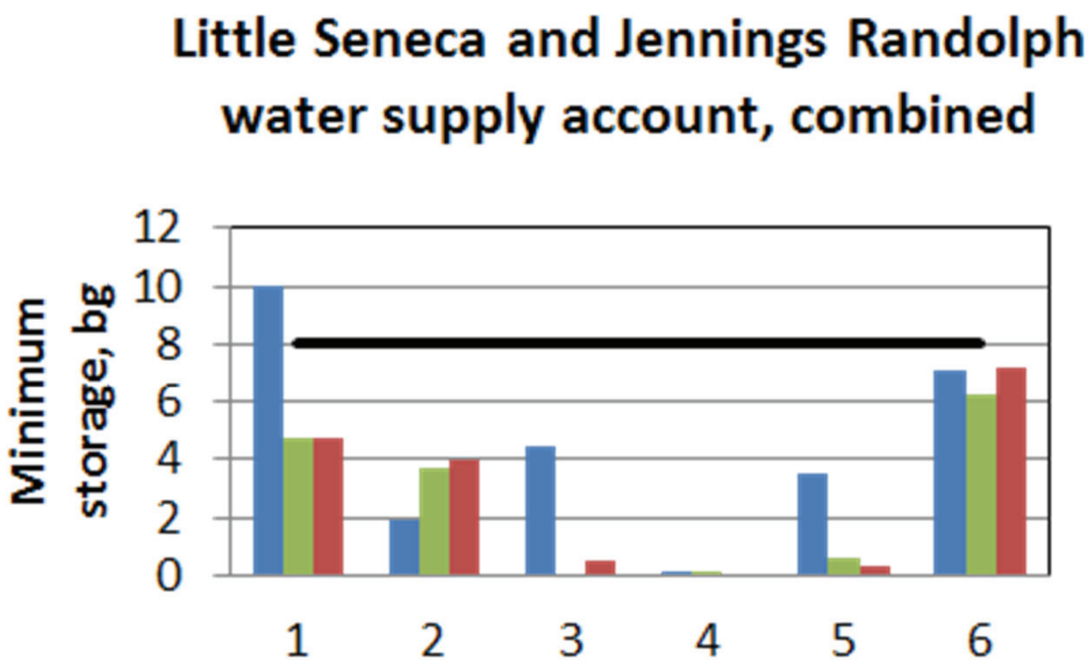
System Reliability





<u>Shortfall definition</u>: demands that must be met or reduced by new changes to the current system management

Storage in Upstream Reservoirs



Study Summary

Uncertainties/Limitations

- Range of projections from global models
- Less confidence in regional predictions
- Variability based on short time period (1988-1999)
- Uncertainty added by watershed modeling

2040 Water Supply Reliability
(moderate drought conditions)

- Best scenarios: little impact
- Medium-impact scenarios: mandatory water use restrictions likely
- Worst-case scenarios: significant management/system changes required

Potential Management/System Changes

(To be evaluated in 2015 water supply reliability study)

- More operational efficiency
- Increased system flexibility
- Earlier and increased water use restrictions
- Additional water supply storage

Potential Use of Retired Quarries

- Loudoun Co. quarries
  - 1.25 BG by 2021
  - additional 4 BG by 2035
  - 20 BG total by 2115
- Vulcan quarry in Fairfax Co.
  - 1.8 BG by 2035
  - Additional 7 to 15 BG by 2085
- Travilah quarry in Montgomery Co. (currently 17 BG)

For More Information

Cherie Schultz

E-mail: cschultz@icprb.org

Sarah Ahmed

E-mail: sahmed@icprb.org