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XIX WORLD WATER CONGRESS  
International Water Resources Association (IWRA)  
Marrakech, Morocco | 1-5 December 2025

Kingdom of Morocco



Ministry of  
Equipment and Water

# From Forecasts to Action: Building Resilient Urban Water Systems under Climate Uncertainty in Varied Urban Contexts

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# Urban Water Systems Under Pressure



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- Rising climate variability and hotter droughts
- Rapid urbanization and growing demands
- Increasing reliance on groundwater and conjunctive use
- Stresses on governance, financing, and coordination
- Need for actionable, accessible early warning systems



# Seasonal to Sub-seasonal Forecasts (S2S)



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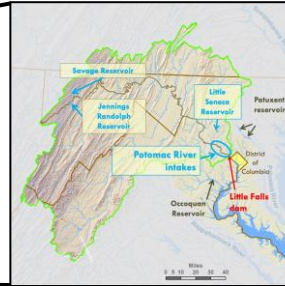
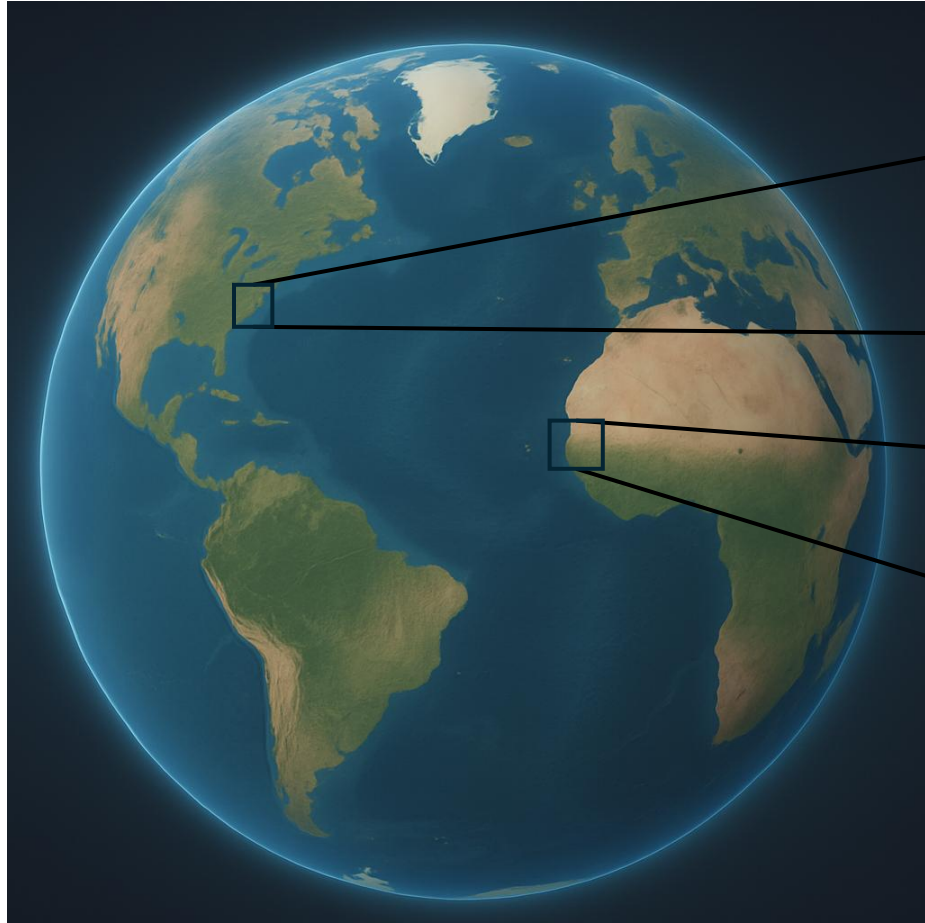
- Hydrologic responses emerge across different timescales: days → seasons → years.
- S2S forecasts offer early signals for drought, low flows, and heat extremes.
- Utility for water supply planning depends on lead time, skill, and local context.
- Bridging climate and hydrologic tools improves operational decision-making.



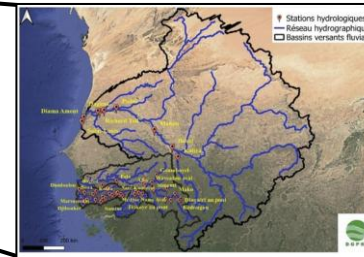
# Seasonal to Sub-seasonal Forecasts (S2S)



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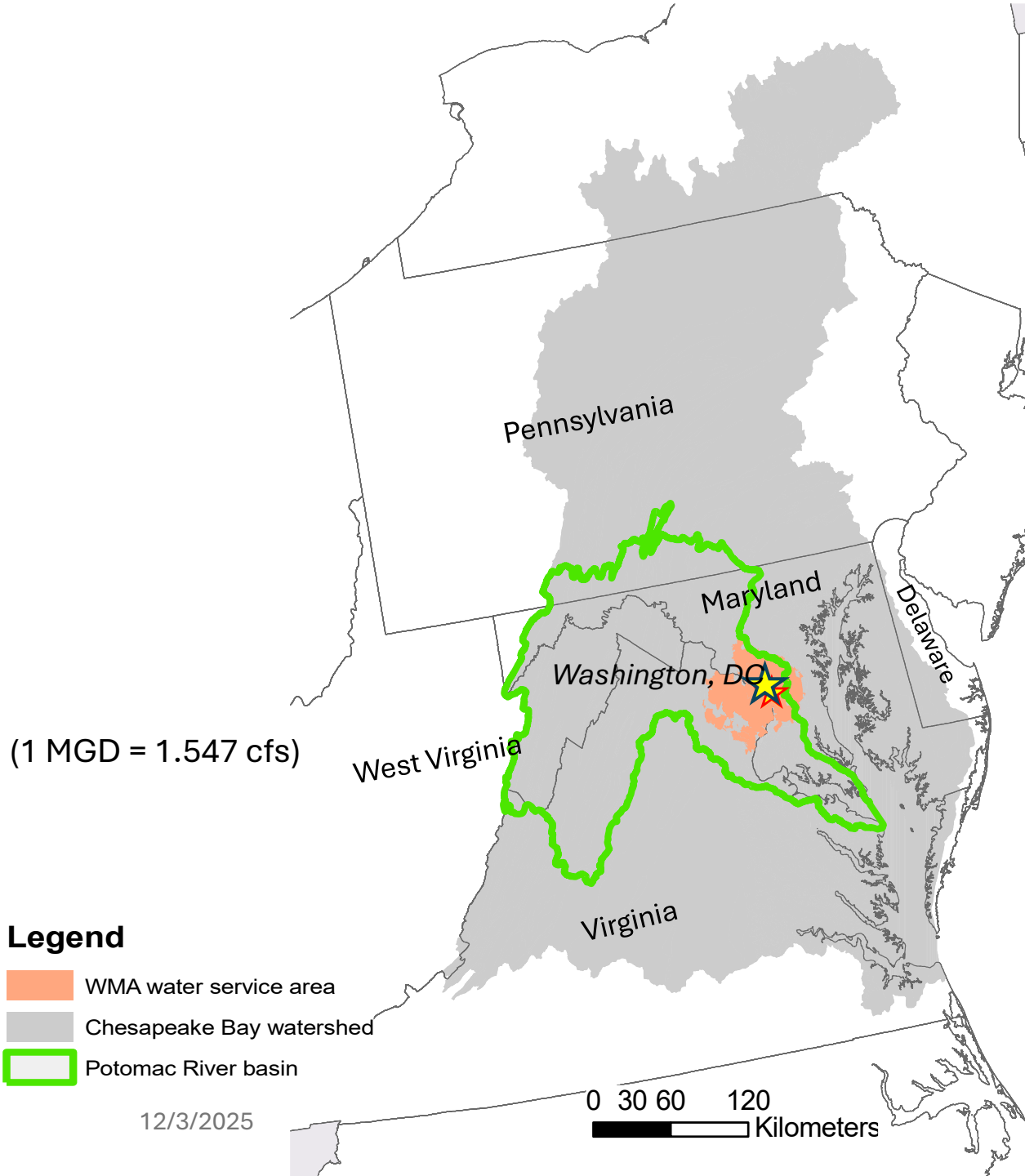
**Washington, DC, US  
(WMA)**



**Dakar, Senegal**



# Potomac River Basin



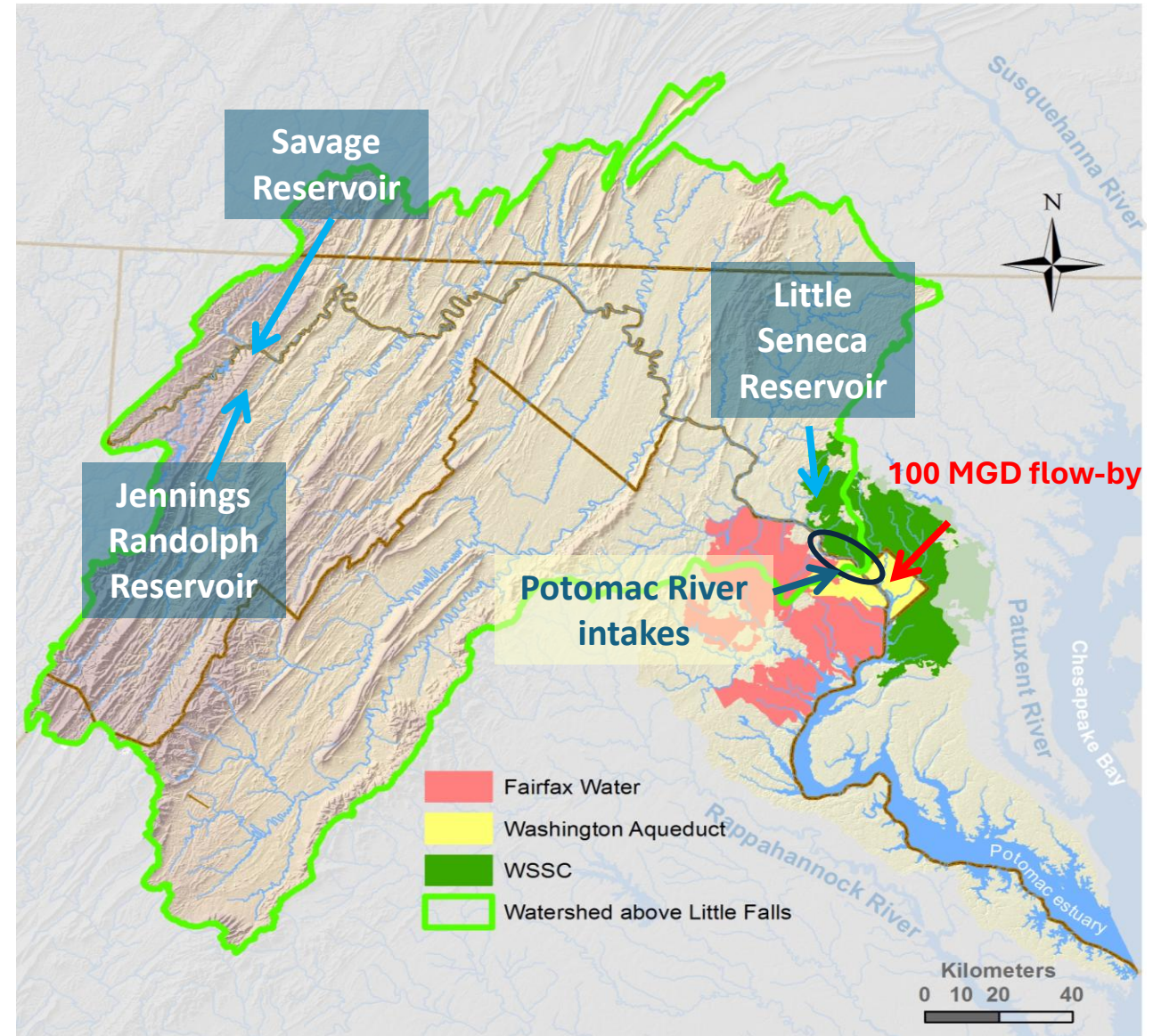
- Basin area: 14,670 mi<sup>2</sup> (~38,000 km<sup>2</sup>)
- Basin population: 6.1 million
- Potomac River flow above WMA intakes - in August
  - Median: ~2000 MGD (7.6 million m<sup>3</sup>/day)
  - 5<sup>th</sup> percentile: ~900 MGD (3.4 million m<sup>3</sup>/day)
- WMA average demand ~400 MGD (1.5 million m<sup>3</sup>/day)
- WMA demand in August ~600 MGD (2.3 million m<sup>3</sup>/day)

***Is Hot Drought a Risk in the US Mid-Atlantic? A Potomac Basin Case Study***, by C. Schultz, A. Seck, S. Ahmed. *JAWRA*. (2025)

***Evaluating time-lagged relationships between groundwater storage and river discharge using GRACE-based data: insights from the Potomac Basin***, by Villaruel, A. J., A. Seck, C. Schultz. *Env. Res. Comm.* (2025).

# WMA water supply system

- Shared funding of storage
  - Suppliers in 3 states
    - Fairfax Water – VA suburbs
    - Washington Aqueduct – primarily DC
    - WSSC Water– MD suburbs
  - 17 BG of storage upstream (~64 million m<sup>3</sup>)
- Cooperative management
  - Coordinated operations during drought
  - Regular joint planning studies



# CO-OP System Overview: Governance



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- Low Flow Allocation Agreement (LFAA), 1978  
Governs allocation in case of emergency shortage
- Water Supply Coordination Agreement (WSCA), 1982  
Coordinated drought operations via ICRPB's CO-OP section and an Operations Committee  
Forecasts of water demand and availability every 5 years
- Metropolitan Washington Water Supply and Drought Awareness Response Plan, MWCOCG, 2001  
Provides drought stages for water use restrictions



# WMA CO-OP System



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## Goals:

- Meet demands

- Maintain 100 MGD flow-by at Little Falls

- (0.4 million m<sup>3</sup>/day)

## Responsibilities:

- Forecast future river flows

- Determine reservoir release & withdrawal rates

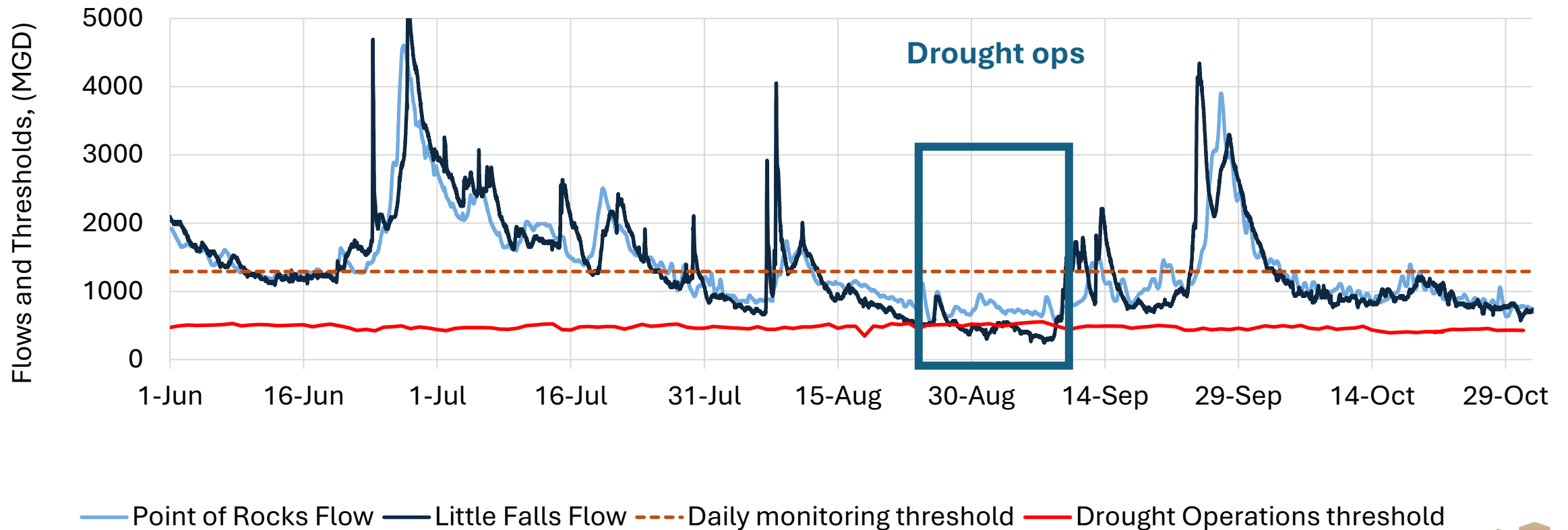
- Keep stakeholders informed



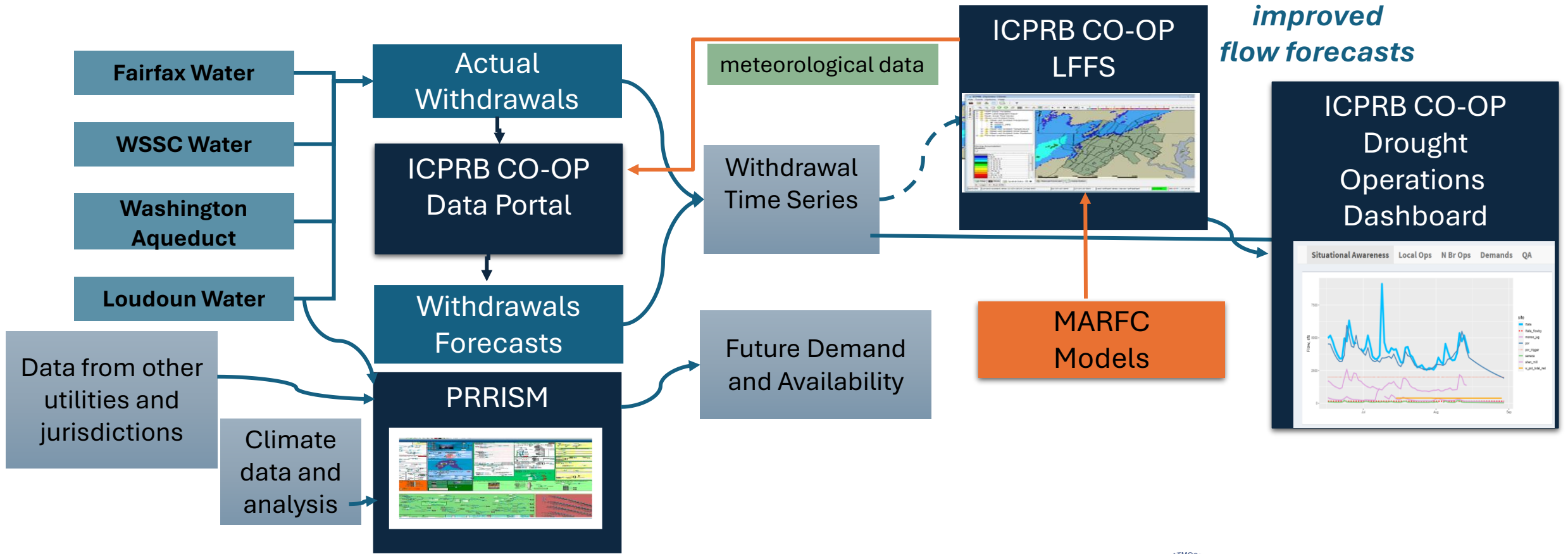
# WMA COOP System



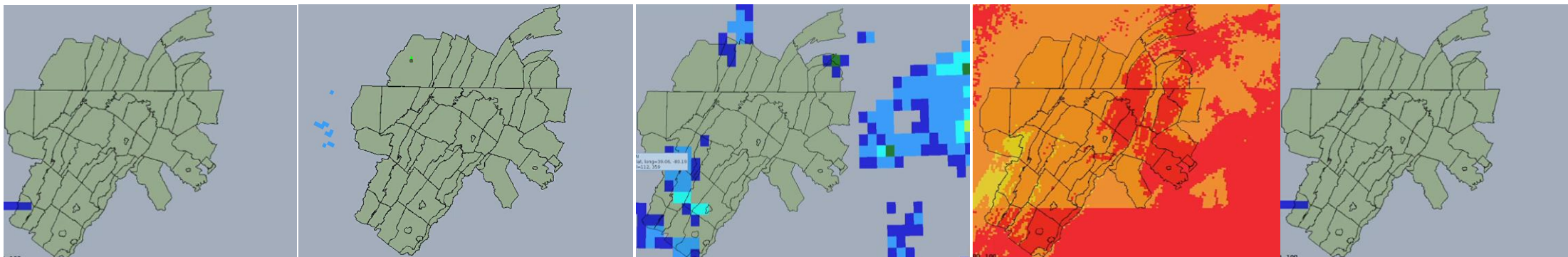
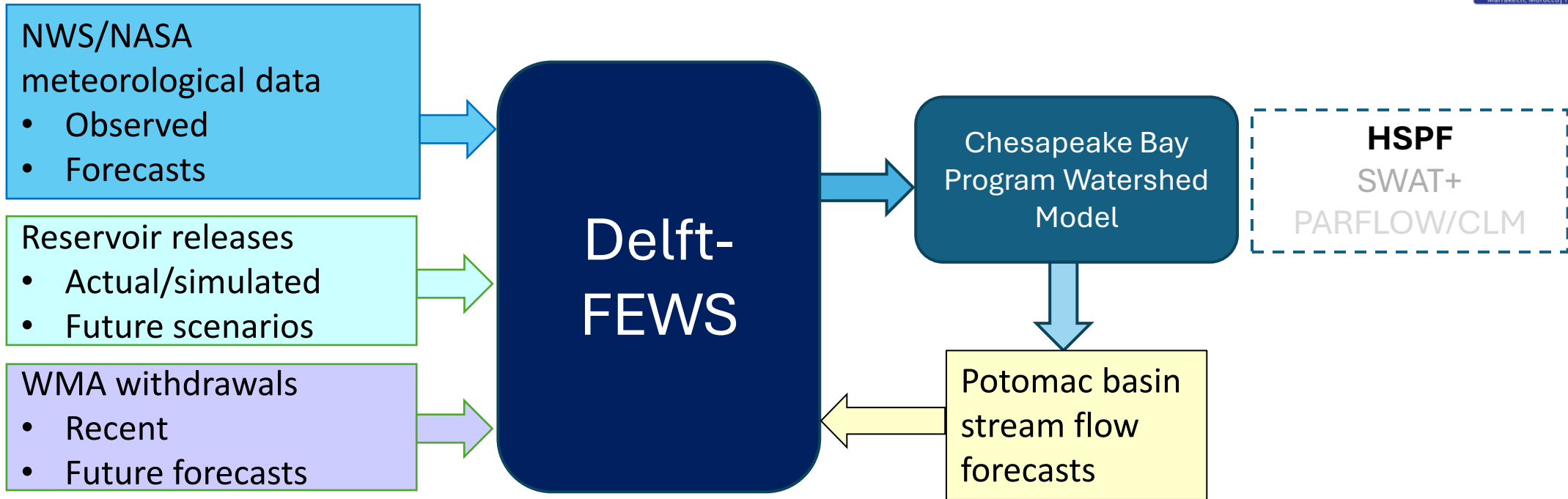
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# A collaborative effort



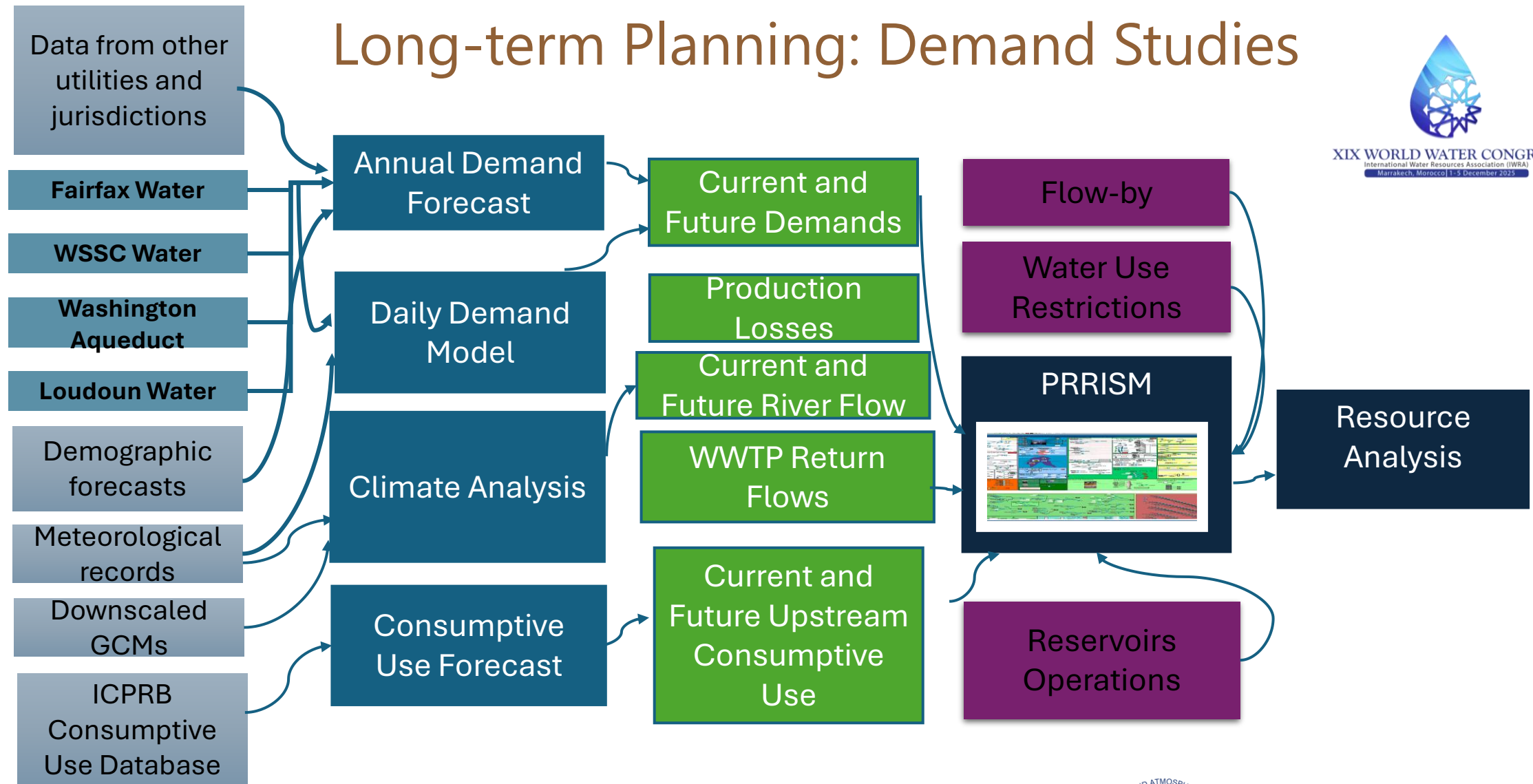
# Low Flow Forecast System



# Long-term Planning: Demand Studies



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# Long-term Planning: Emerging Sectors



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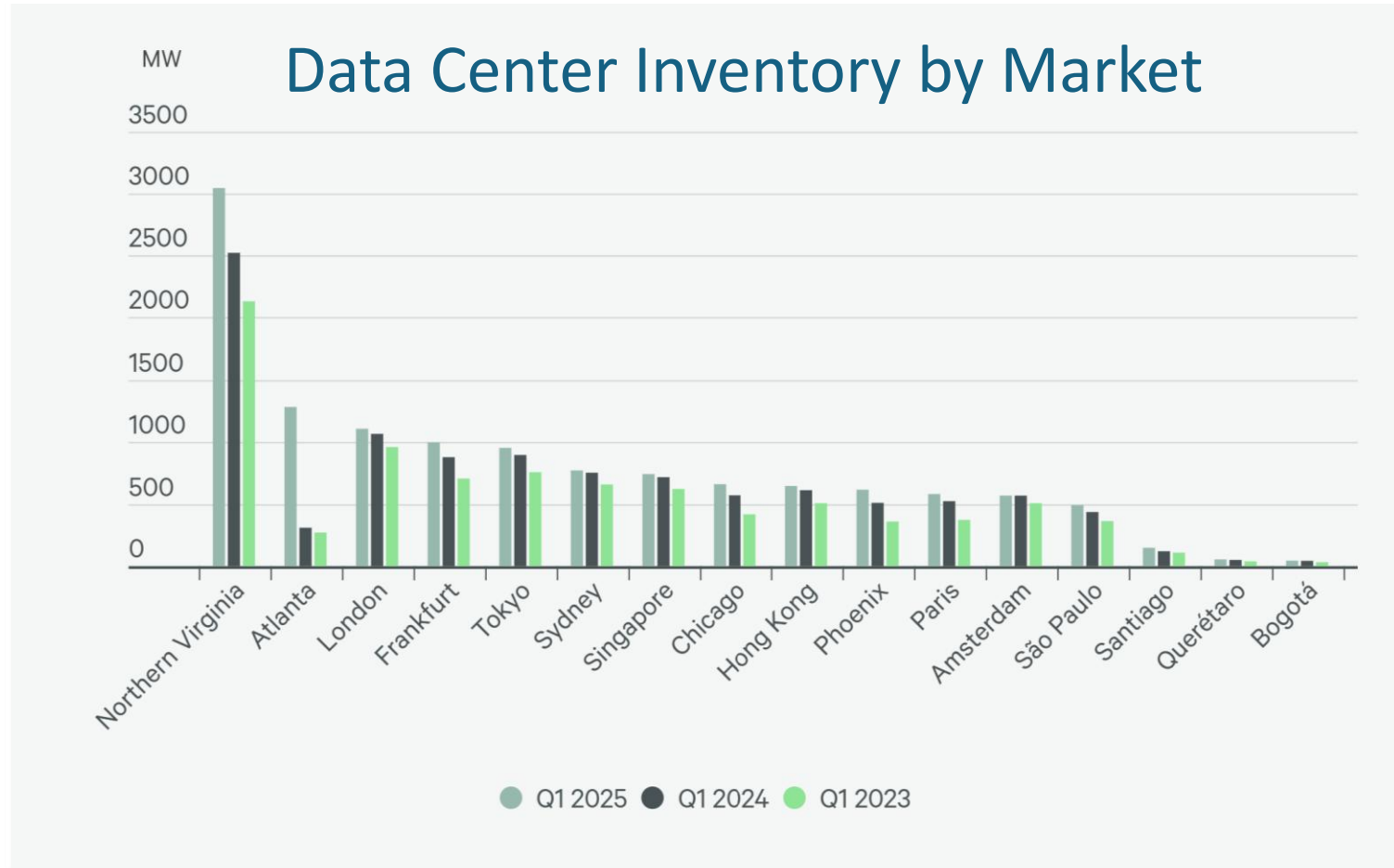
Source: Google. Data center in The Dalles, Oregon.



# Long-term Planning: Emerging Sectors



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# Long-term Planning: short and long-term supply challenges



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Year	Future Climate									No change in climate		
	Higher Flows			Medium Flows			Lower Flows					
	Low Demands	Medium Demands	High Demands	Low Demands	Medium Demands	High Demands	Low Demands	Medium Demands	High Demands	Low Demands	Medium Demands	High Demands
2030	Green	Green	Green	Green	Green	Red	Red	Red	Red	Green	Green	Green
2045	Green	Green	Green	Yellow	Red	Red	Red	Red	Red	Green	Green	Red
2050	Green	Green	Yellow	Red	Red	Red	Red	Red	Red	Green	Yellow	Red



# Drought Preparedness



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- Drought exercises
  - Yearly
  - Practice and test operations
  - Practice communications
  - Staff Training
  - After-action meeting and report
- Monthly Water Supply Outlooks



# Greater Dakar Region

- Serves ~4 million people, with demand of ~400,000–450,000 m<sup>3</sup>/day.
- Lac de Guiers (>300 million m<sup>3</sup>) supplies ~40% of Dakar's water through a 250 km transfer system.
- Remaining supply from regional aquifers experiencing declining levels and salinization.
- Growing demand and water-quality risks at Lac de Guiers highlight vulnerability during dry years.



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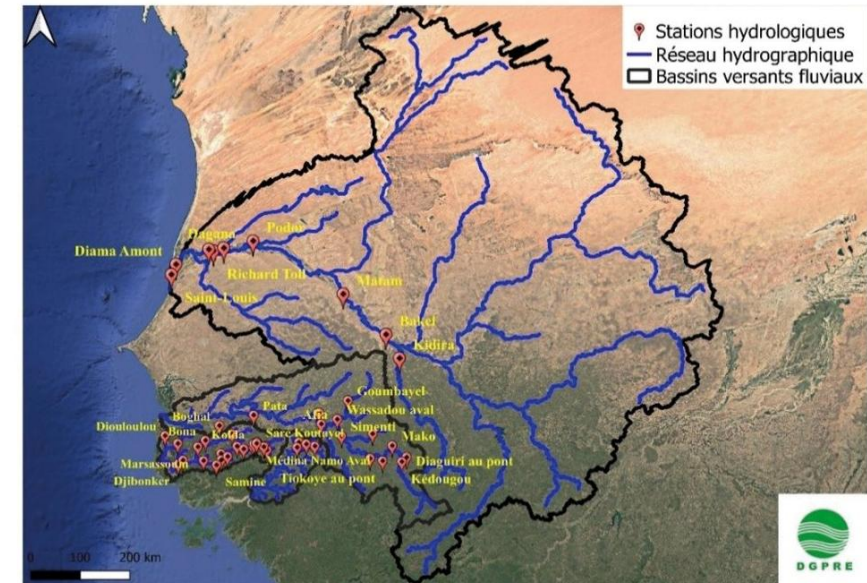


Figure 1 : Localisation des bassins fluviaux suivis (Sénégal, Gambie et Casamance).



# Greater Dakar Region



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- Rapid urban expansion and land-use pressures are increasing exposure to urban flooding.
- Drainage and stormwater limitations make the city highly sensitive to short-duration, high-intensity rainfall events.
- Benefits from long history of institutional coordination regionally (OMVS, ANACIM, and DGPRE).
- Growing opportunities to further integrate climate information into day-to-day urban decision-making.

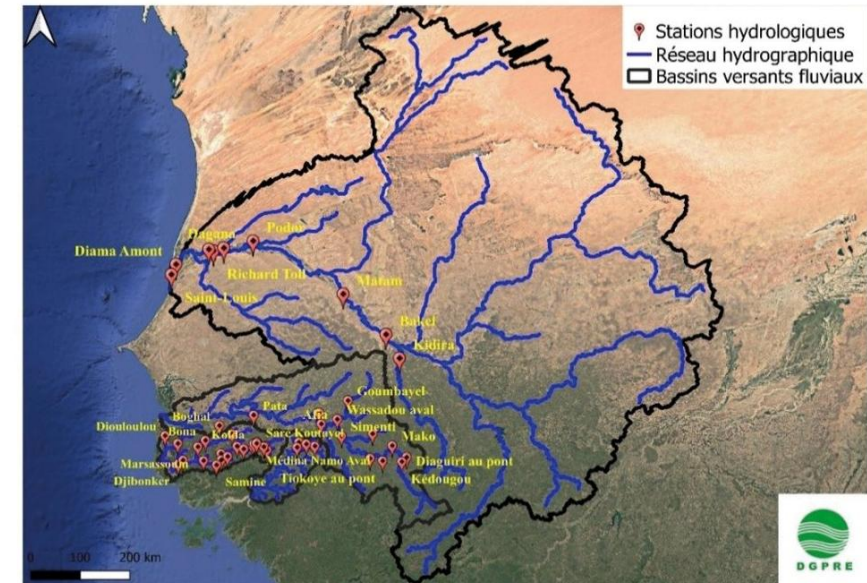


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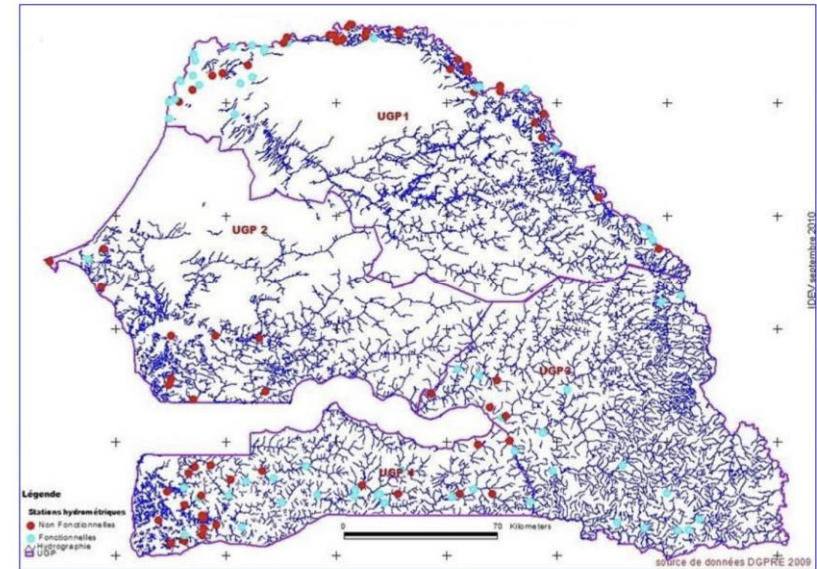


# Institutional Landscape Supporting Climate-Informed Planning



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- ANACIM provides seasonal and sub-seasonal rainfall and temperature forecasts for government and sectoral planning.
- Forecasts guide preparedness for floods, seasonal water availability, and public health risks.
- Collaboration with partners strengthens modeling capacity and access to climate information.



# Future Directions and Opportunities



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## Levers for Resilience



- Strengthen early warning systems to expand access to S2S and hydrologic forecasts.
- Integrate forecasts and associated uncertainty into operations through clear, actionable decision pathways.
- Continue investments in monitoring and data systems to improve rainfall, groundwater, and flow observations.
- Deepen institutional collaboration by building on existing regional and local coordination frameworks.



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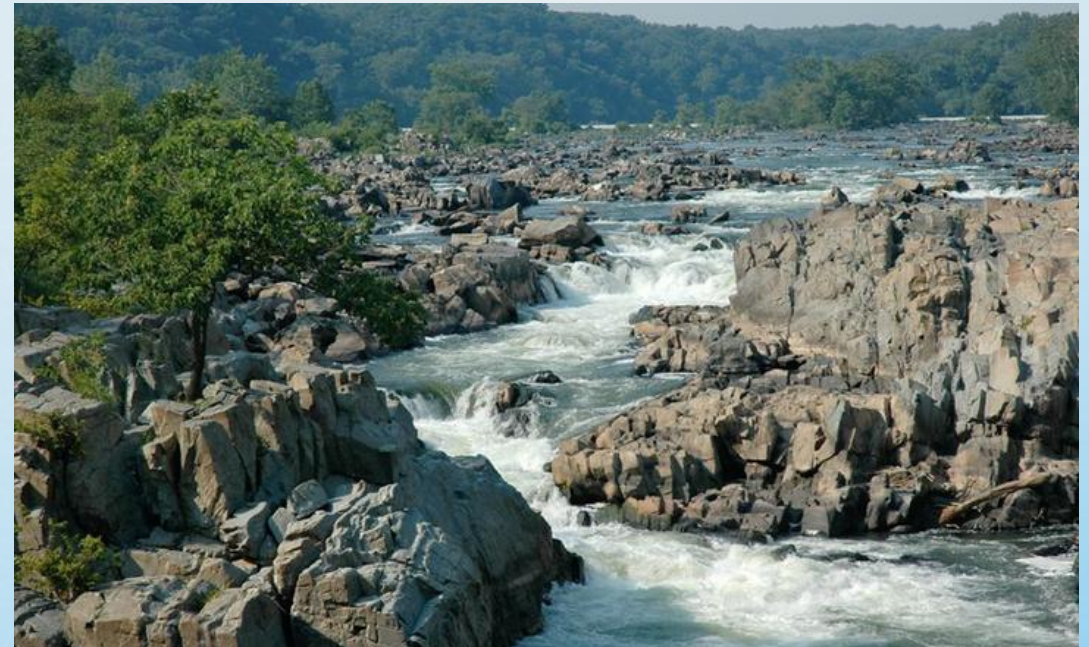


Thank you!

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[www.potomacriver.org](http://www.potomacriver.org)



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