New York City Water Supply <u>1800s – local dug wells and small</u> reservoirs (population ~ 22000)

Length 1450 ft

119 38 (38

38C 3C (E4 38C



This magnificant bridge of stone, forms a part of the intmense works crected to bring the water of the froten river to the fity of New York. ____ The length of the aqueduct from the froten river to the fity Ilall, is 4414 miles, and cost about \$ 13,000,000. ____

11 14

HARLEM. N.Y.

Height 114 fb

New York City Water Supply <u>1700s – Manhattan Company provided</u> water to the city through owned wells.

Murray Hill Reservoir completed 1842

nnattan. (moto by

New York City Water Supply Late 1800s – Croton System





New York City Water Supply Early 1900s – Expanded to Catskill/Delaware Watersheds

storage NYC Current Consumption >1000 Million Gallons per day (125 gallons

per person)

1 year

Delaware System (50%) 4 Reservoirs

Catskill System (40%) 2 Reservoirs

Croton System (10%) 12 Reservoirs



The Delaware River Basin Commission

New York
New Jersey
Pennsylvania
Delaware
The United States 1961



Water tanks



New York City Water Supply Impact on local babitat









New York City's Concern: Sustainable Water Supply







The Upper Delaware and Its Wild Trout





Flooding on the Delaware





Delaware River water is diverted to New Jersey's Canals



A Population in Decline: Delaware Bay Oysters





As if that was not enough ...



The Dwarf Wedge Mussel

Mussel Site 3. The Delaware at Callicoon, NY



What the Fishermen Want to See: Cannonsville Release > 300 cfs



What was Happening: Low Delaware Flows Year after Year





Summer 2003

Summer 2004 Reservoir at 83% full, release of 45

Stakeholders -Competing Users



Above the Reservoirs
1. NYC wants to hold as much water as possible in anticipation of droughts.

2. Wants to ensure that the reservoirs refill by **June 1**.

Below the Reservoirs

- 1. The river is one of the finest wild trout fisheries habitat. It is dependent on cold water releases from the bottoms of the dams.
- 2. Conservationists want increased releases of cold water.
- 3. Communities want the NYC dams to be used for increased flood protection.

Measurements - how much water is flowing



Paleo Reconstruction





CROSS SECTION of a CONIFER



1928

1999

Reservoir



$$S_t = S_{t-1} + Q_t - E_t - Div_t - Con_t - Dir_t$$

$$0 \le S_t \le S_{\max}$$

 $Spill_{t} = S_{t} - S_{\max} \forall S_{t} > S_{\max}$ $Deficit_{t} = -S_{t} \forall S_{t} < 0$

Reservoir Simulation – Defining Drought



- Daily releases are based on Flexible Flow Management Plan (FFMP) release matrix
- 2. Release based on daily storage levels...

Drought Curves as % combined storage



Reservoir Simulation

Questions

1. What is the probability the system approaches drought state based on the current FFMP plan?

2. Is the 1960s drought the worst?

3. Are the FFMP release rules overly conservative?

http://www.nyc.gov/html/waterforthefuture/index.s html

Hydroclimatology, Data Science, and Water Risk Analytics from climate to water risk

Naresh Devineni, Assistant Professor, Civil Engineering and CUNY-CREST



The City College of New York



Mapping Projections of Climate Variability and Change to Hydrology at multiple space and time scales.

Improving and applying innovative data science tools to space-time analysis and water management.

A Dynamic Risk Framework for