Colloquium
To Celebrate Fifty Years
of Environmental Engineering
at Rensselaer Polytechnic Institute

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Sponsored by the
AAEE and AEESP

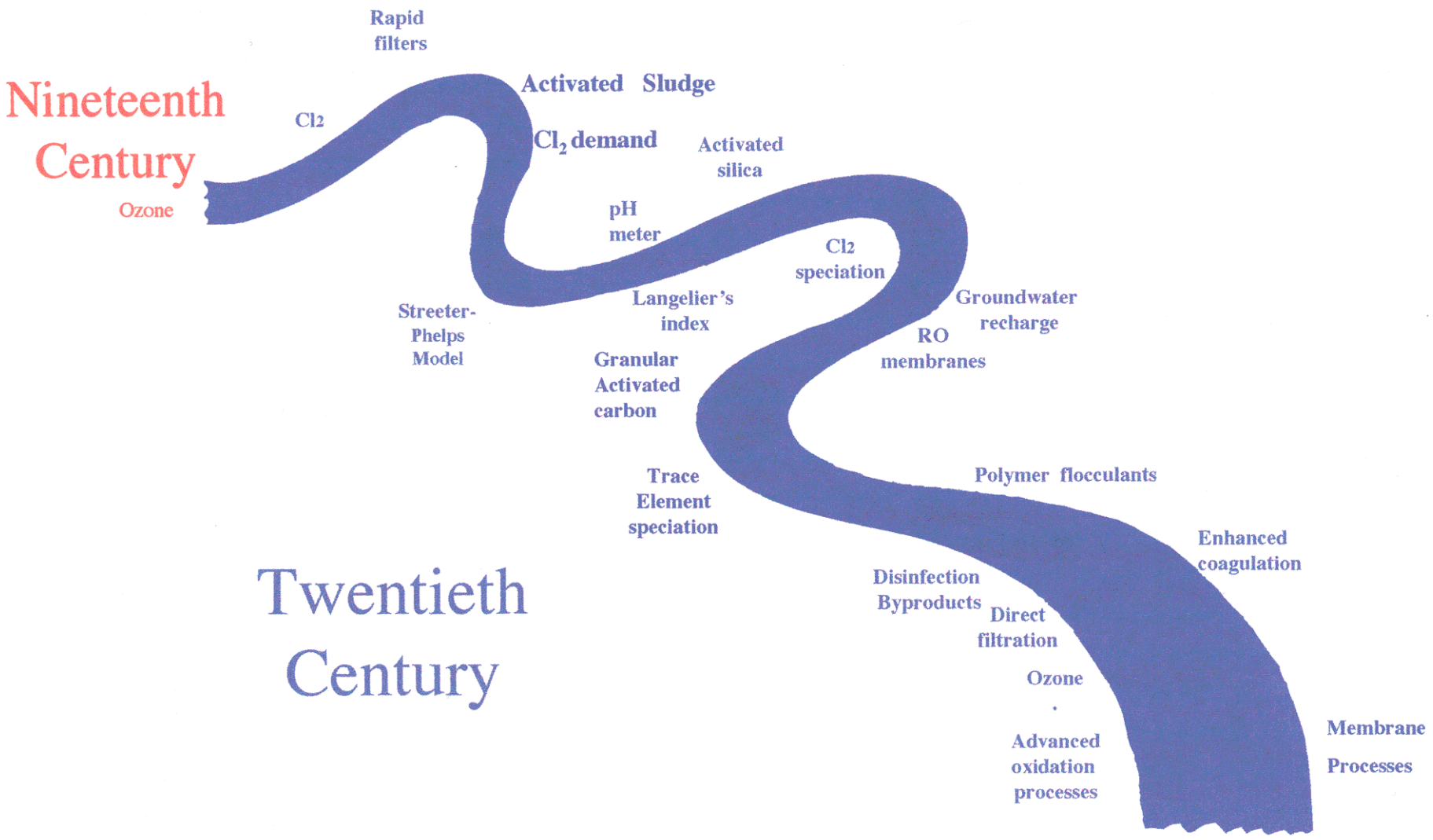
Some Reflections
and Some Predictions

Charles R. O'Melia
Johns Hopkins University

A long the riverrun

Water Supply and Treatment

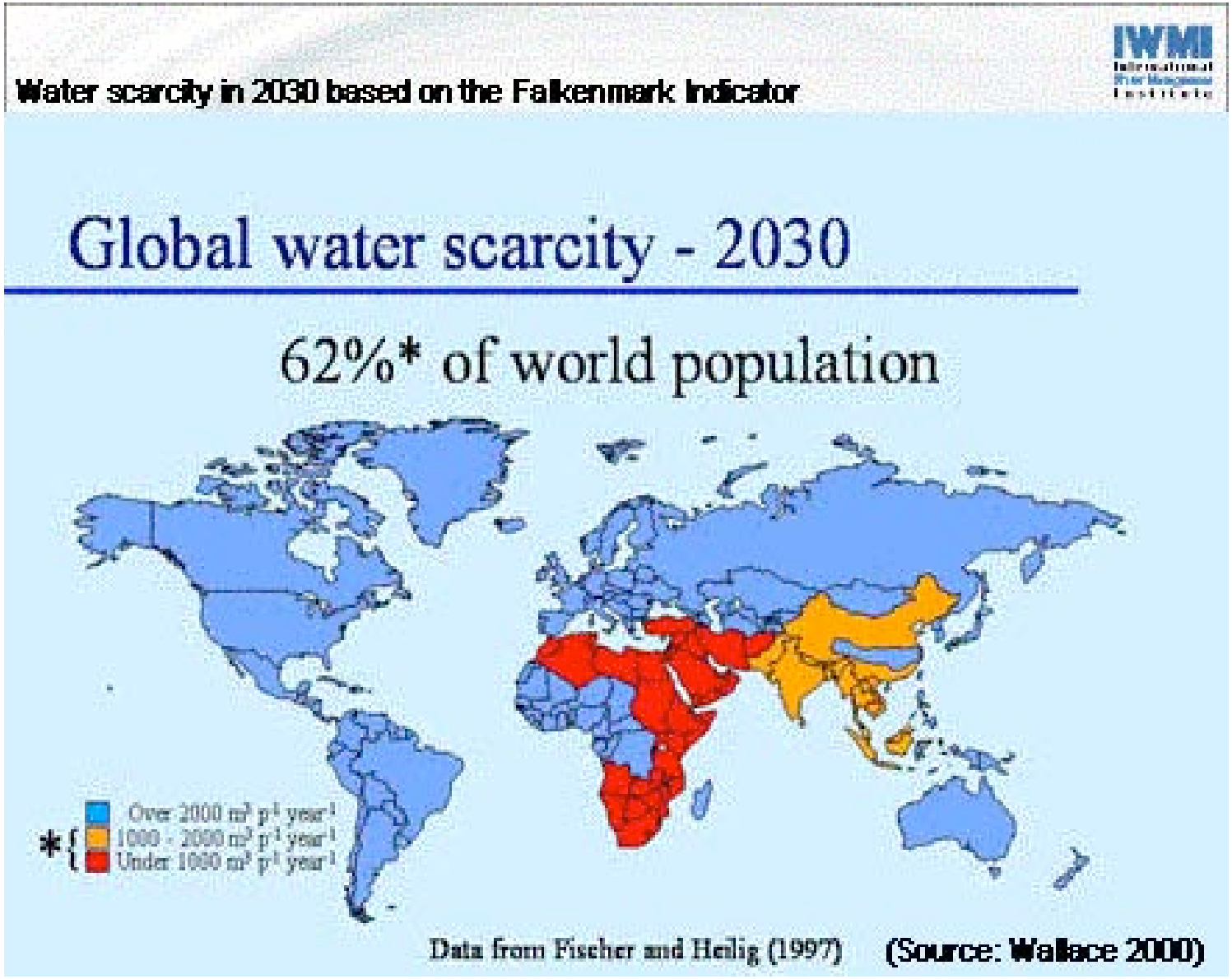
Water Quality Advances



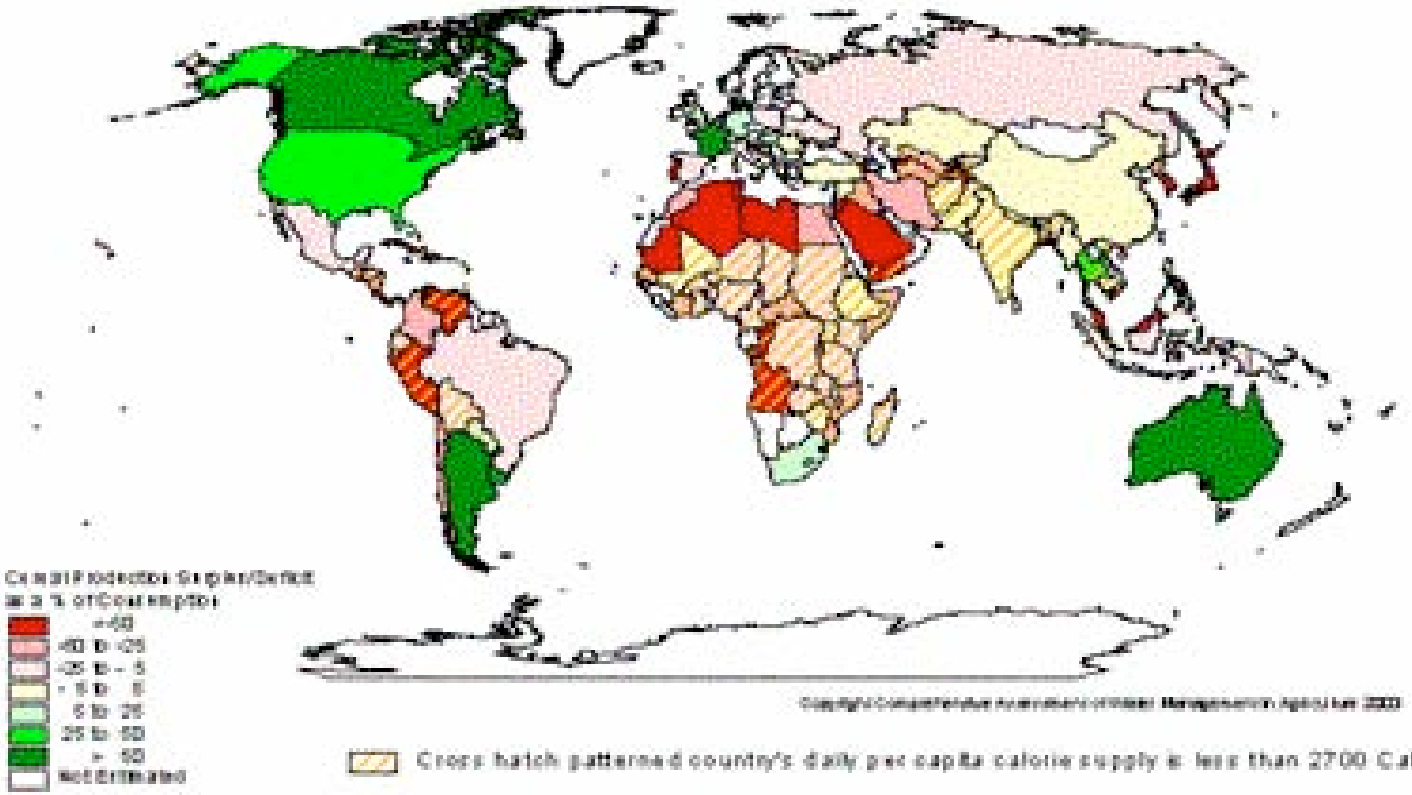
James J. Morgan
January 2004

Water and Agriculture

Water scarcity in 2030 based on the Falkenmark Indicator



Cereal Production Surplus /Deficit (Indicating Trade) as a Percent of Cereal Consumption 1995



Cross hatch patterned country's daily per capita calorie supply is less than 2700 Cal.

Yang et al., A Water Resources Threshold and Its Implications for Food Security, *ES&T*, 2003

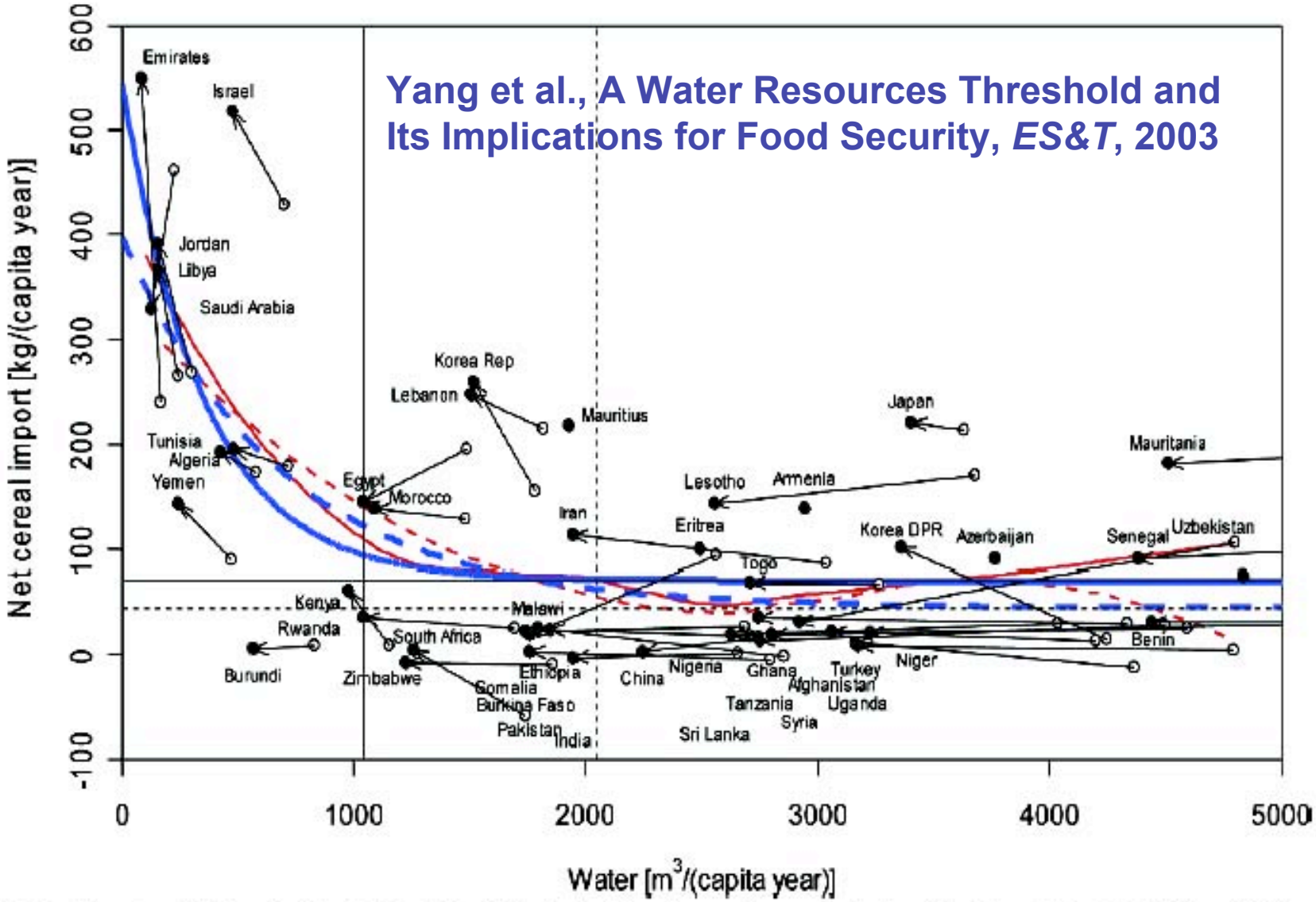


FIGURE 1. Fits of model 1 for the first (1980–1984; thick dashed blue line and open circles) and the last (1996–2000; thick solid blue line and filled circles with country names) investigation periods. Arrows in the diagram indicate movements of the positions of the countries from the first to the last period. The positions of the parameters *a* and *c* of the model are indicated by horizontal and vertical thin lines, respectively (dashed for the first period, solid for the last period). A fit of the nonparametric model (LOESS with span = 0.75) (*13*) shows that the parametric model is adequate (thin dashed and solid red lines, respectively, for the first and last periods). A Monte Carlo analysis suggests that the model results are insensitive to moderate variations in the cutoff value of 5000 m^3/capita.

List of Countries in Africa and Asia Having Renewable Freshwater Resources below the Calculated Threshold of 1500 [m^3/(capita year)] by the Year 2030*a*

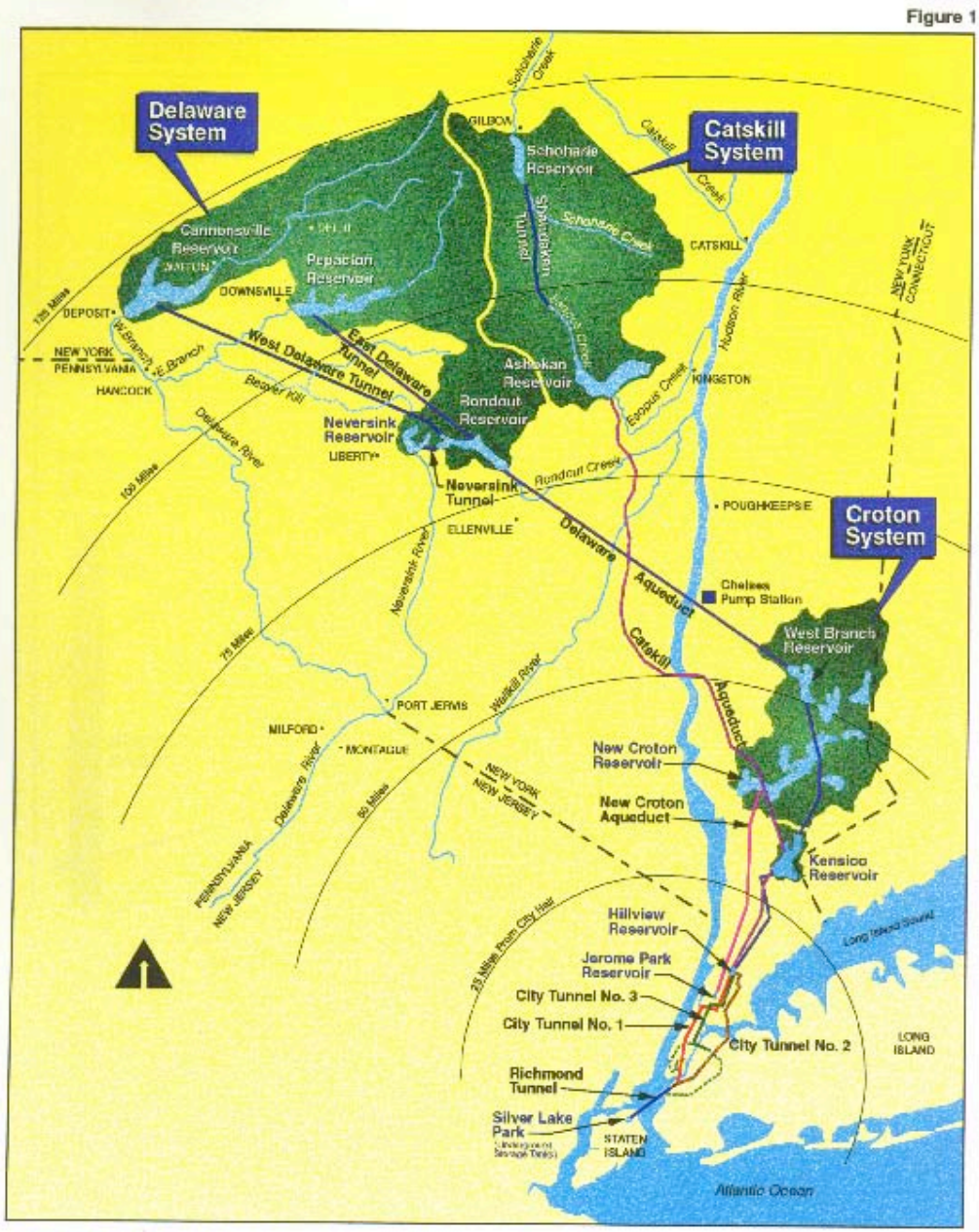
Afghanistan	**Iran**	**Pakistan**
Algeria	Israel	Rwanda
Burkina Faso	Jordan	Saudi Arabia
Burundi	Kenya	**Somalia**
Cape Verde	Korea Republic	South Africa
Comoros	Lebanon	**Tanzania**
Cyprus	Libya	**Togo**
Egypt	**Malawi**	Tunisia
Emirates	Maldives	**Uganda**
Eritrea	Morocco	Yemen
Ethiopia	**Niger**	**Zimbabwe**
India	**Nigeria**	

a Bold names are the countries entering the water deficit country list after the year 2000.

Watershed Management

New York City
Water Supply System

Figure 1



HAZEN AND SAWYER
Environmental Engineers & Scientists

Catskill and Delaware Water Treatment
New York City
Water Supply System

NOM/TOC

Impacts design, operation, and performance of all aspects of a water supply system, from the watershed to the tap, from sensors to system design.

- Determines type and dose of coagulants
- Affects sludge properties, production and disposal
- Precursor for most DBPs
- Impacts adsorber capacity
- Fouls membranes
- Fouls sensors
- Carbon and energy sources for bacterial growth/biofilms in distribution systems
- Impacts watershed planning and management

WATERSHED *PLUS* WATER TREATMENT (TOC/DOC)

- **Sources and Possible Watershed Controls**
  - **Allochthonous [ground water recharge]**
  - **Anthropogenic [wastewater treatment, septic tank upgrades, agricultural BMPs]**
  - **Autochthonous [nutrient removal]**
- **Some Treatment Plant Options [processes to produce low TOC drinking water]**
  - **Enhanced coagulation**
  - **Membranes**
  - **Carbon adsorption**
  - **Biological processes, typically together with ozone**

Membranes

MEMBRANE PROCESSES
Some Possible Applications

- Replace conventional granular filtration
- Replace carbon adsorption
- Water softening
- Rejection of NOM
- Rejection of emerging contaminants, hormonally active agents, pharmaceuticals, etc.
- Improve pathogen removal
- Desalination

MEMBRANE PROCESSES
Some Possible Difficulties

- Fouling
- Residuals disposal
- Possible pretreatment needs
- Regulatory impediments
- Costs
- Impacts on distribution systems (e.g., corrosion)

SUMMARY

- Agriculture - affects water quality and water quantity, including virtual water in global system. Can contribute significantly to needs for water reuse.
- NOM - need to work on both source reductions and removal/destruction in treatment systems
- Membrane processes. They are here. Perhaps more in rapidly industrializing countries than in conventional large systems in USA? Point of use, dual/distributed supplies?

SOME OTHER STUFF

- Automation, process control
- Sensors
- Advanced oxidation processes
- Biological processes
  - For chemicals
  - For pathogens
- Water reuse
- Point of use
- Dual systems
- Corrosion [pipe materials and chemical control]
- Security
- Water sustainability