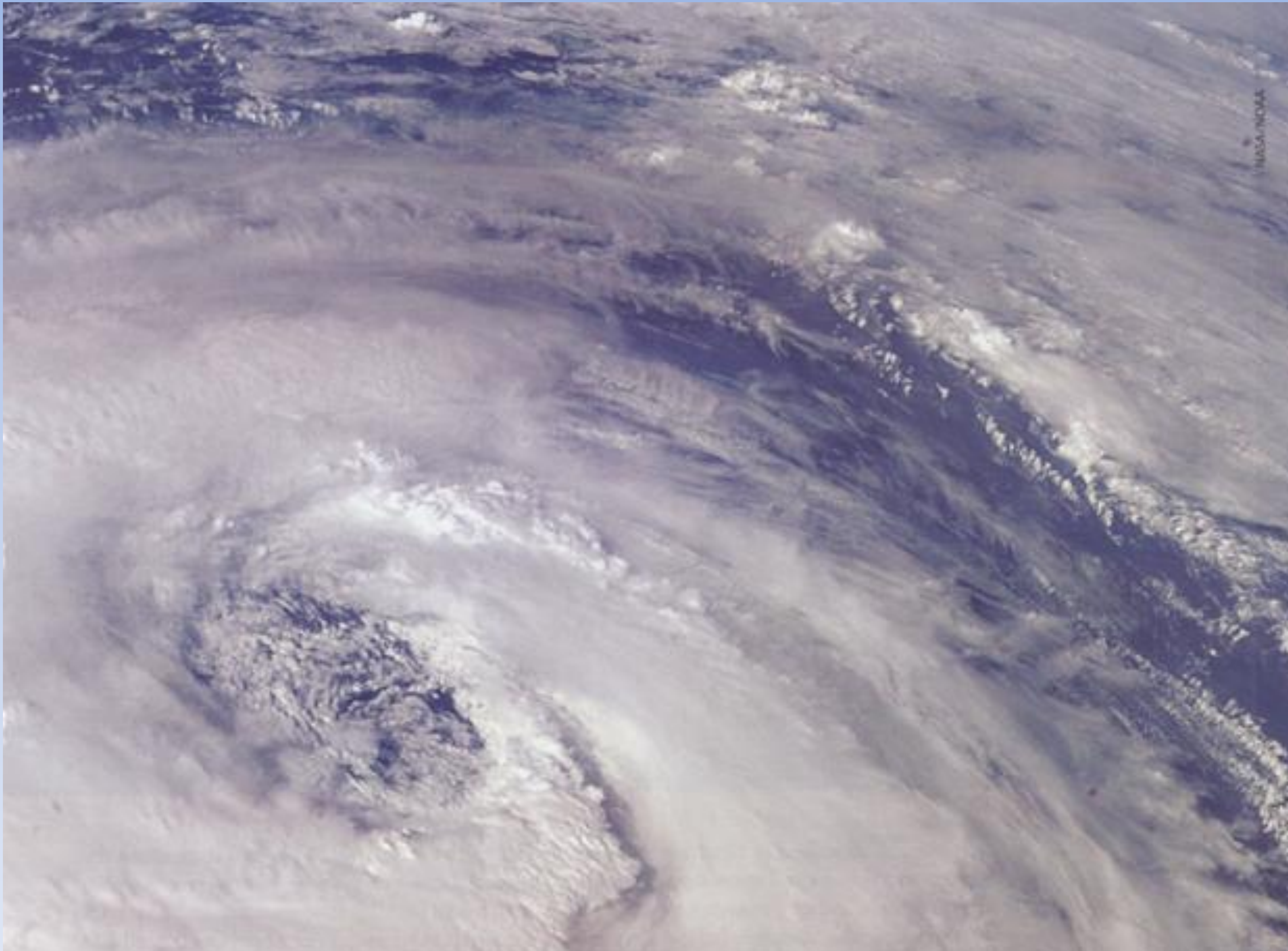
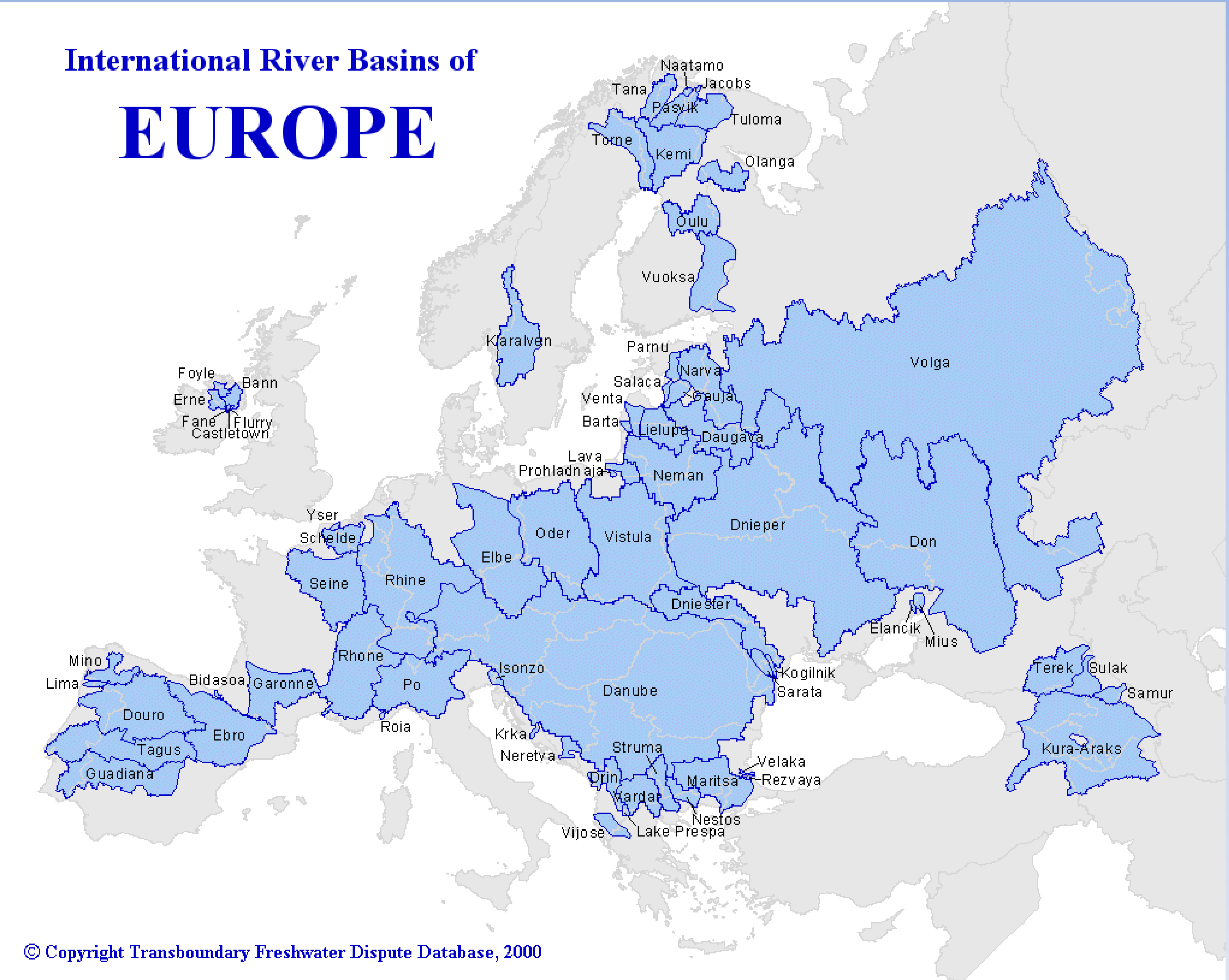
The Importance of Emerging Paradigms in Circum Mediterranean Countries

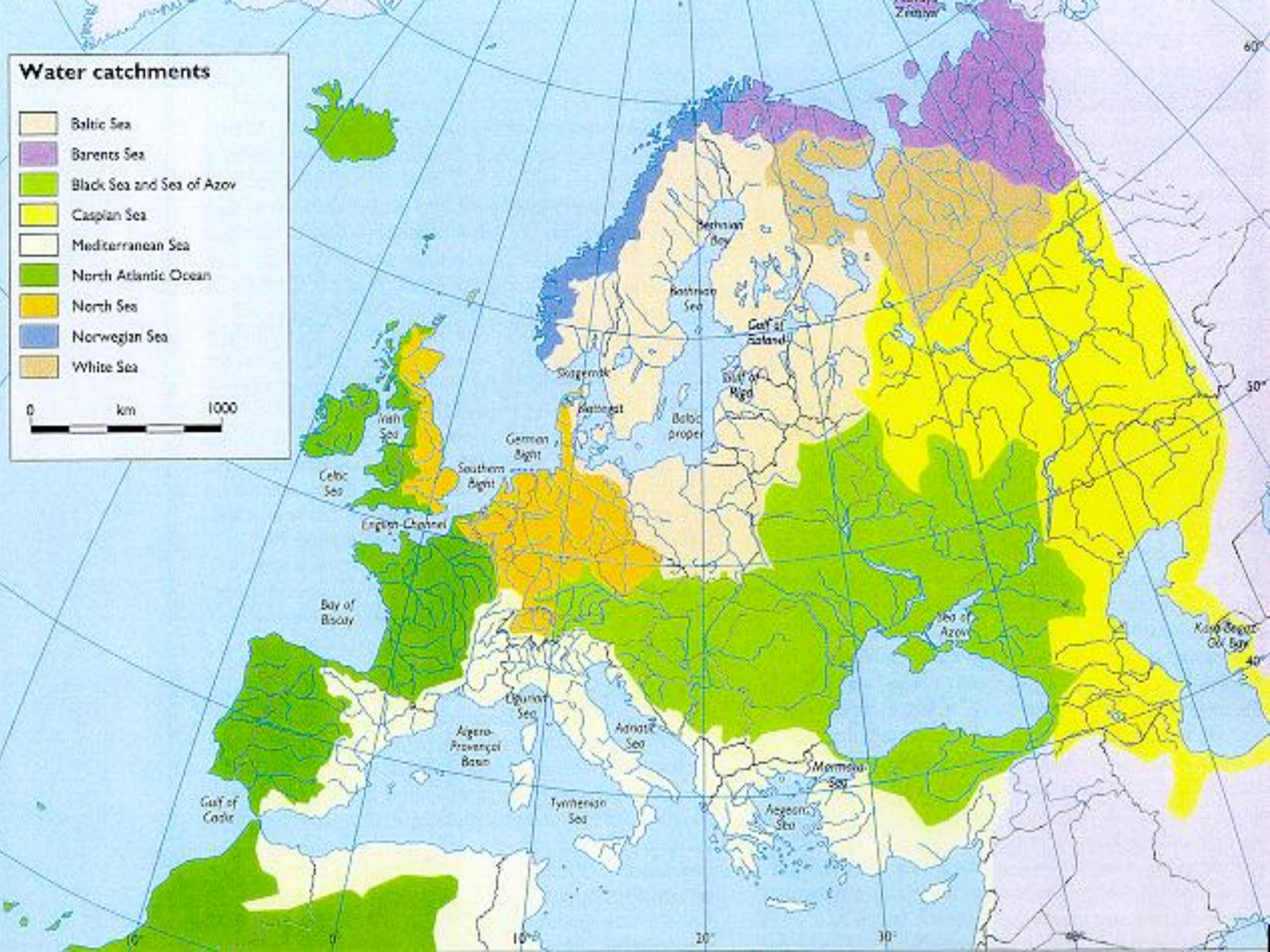
Evan Vlachos
Civil & Environmental Engineering
Colorado State University


NASA/NOAA

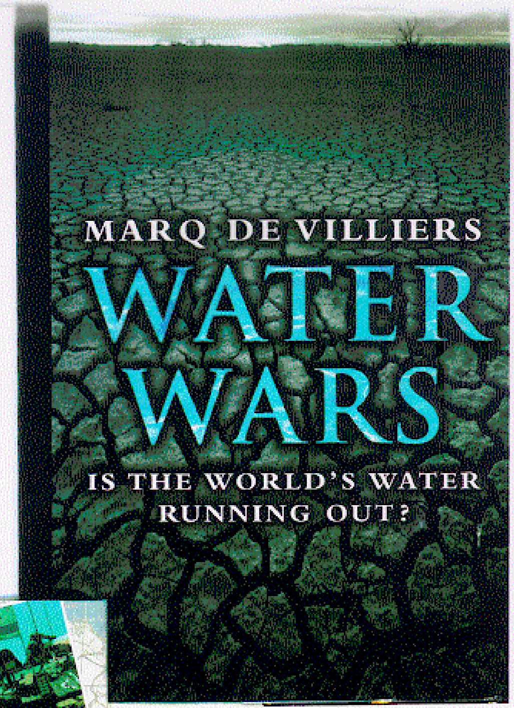
International River Basins of

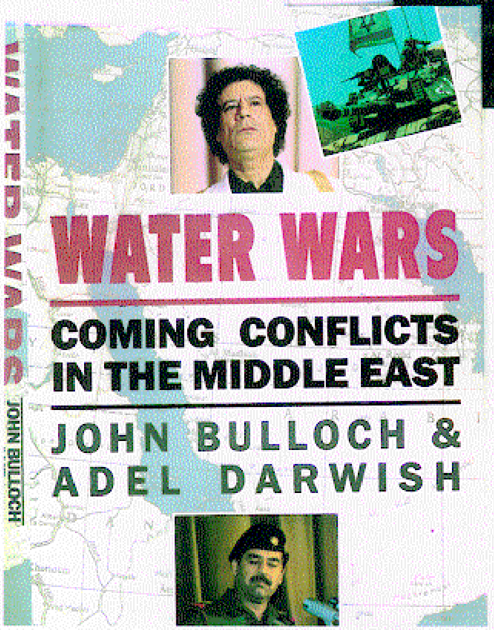
EUROPE

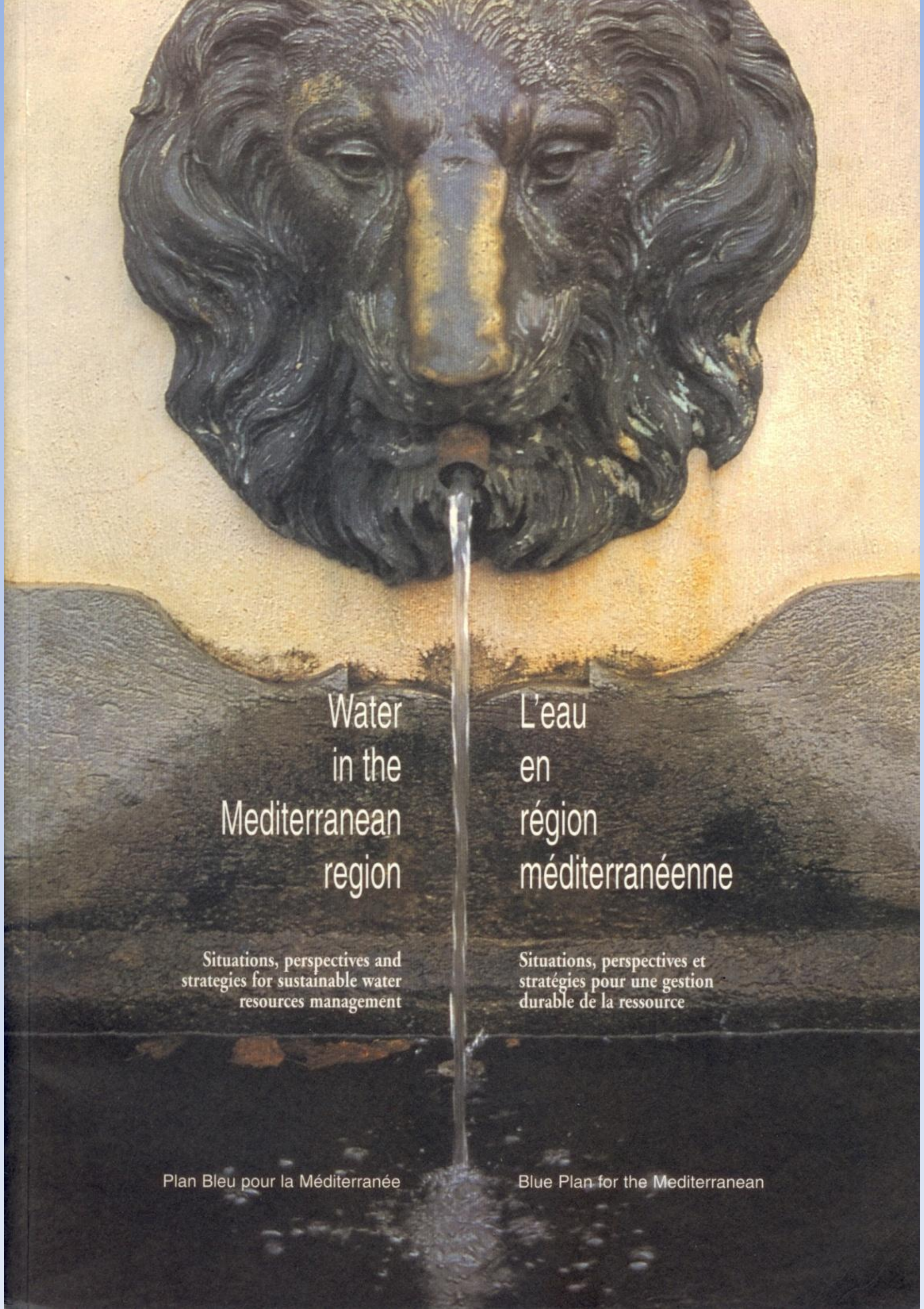



Water catchments
Baltic Sea
Barents Sea
Black Sea and Sea of Azov
Caspian Sea
Mediterranean Sea
North Atlantic Ocean
North Sea
Norwegian Sea
White Sea
0 km 1000
Bothnian Bay
Bothnian Sea
Gulf of Finland
Gulf of Riga
Skagerrak
Kattegat
Baltic proper
Irish Sea
Celtic Sea
German Bight
Southern Bight
English Channel
Bay of Biscay
Ligurian Sea
Algero-Provençal Basin
Adriatic Sea
Tyrrhenian Sea
Aegean Sea
Marmara Sea
Sea of Azov
Gulf of Cadiz
60°
50°
40°
10°
0°
10°
20°
30°

Czech Republic
Slovakia
Austria
Hungary
Moldova
Romania
Slovenia
Croatia
Bosnia-Herzegovina
Serbia
Montenegro
Bulgaria
Albania
FYROM
Greece
400 km


MARQ DE VILLIERS
WATER WARS
IS THE WORLD'S WATER RUNNING OUT?


WATER WARS
COMING CONFLICTS IN THE MIDDLE EAST
JOHN BULLOCH &
ADEL DARWISH
JOHN BULLOCH


Water
in the
Mediterranean
region
Situations, perspectives and
strategies for sustainable water
resources management
L'eau
en
région
méditerranéenne
Situations, perspectives et
stratégies pour une gestion
durable de la ressource
Plan Bleu pour la Méditerranée
Blue Plan for the Mediterranean

Euro-Mediterranean Partnership

European Foundation Centre

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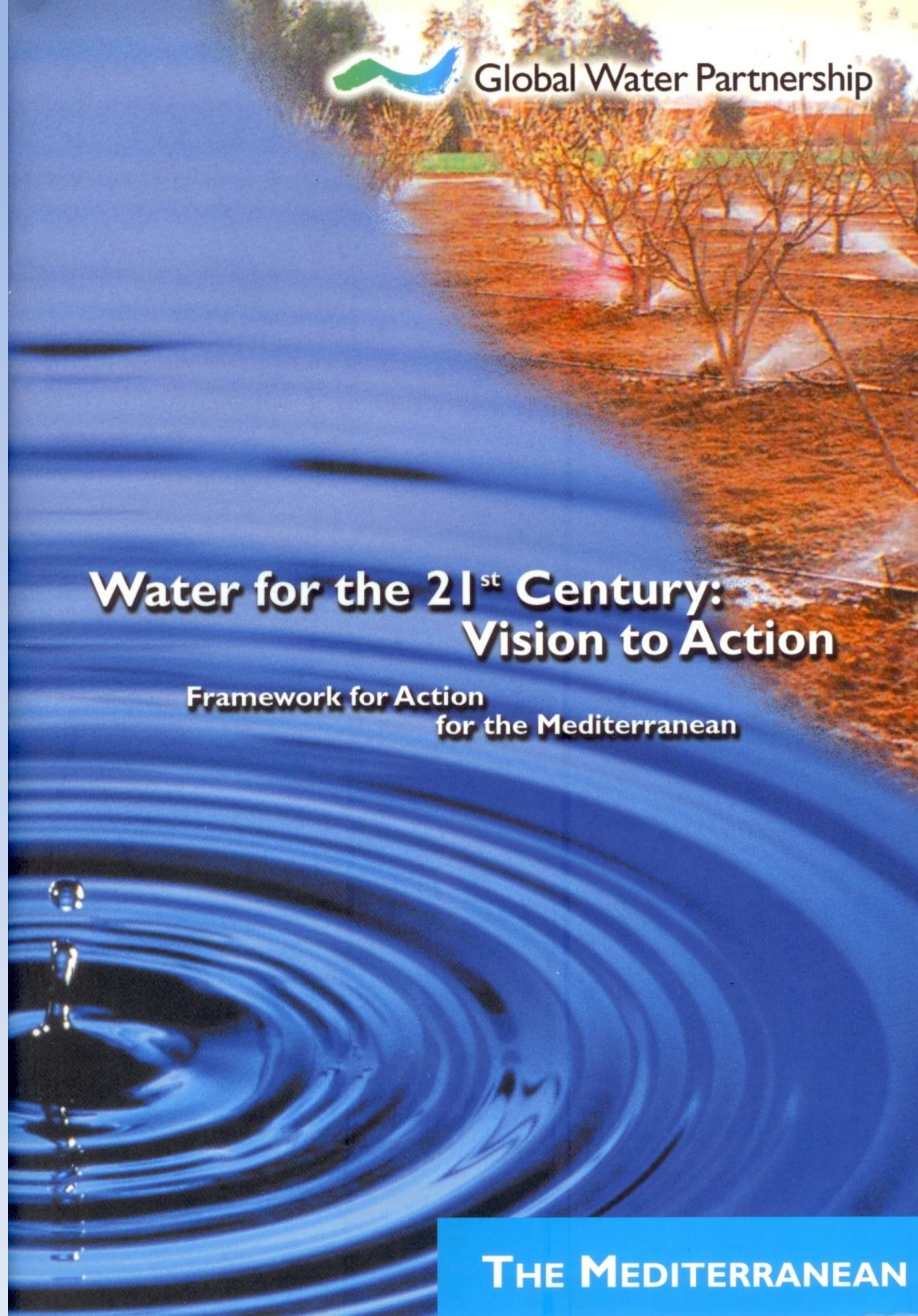
THE TRANS-MEDITERRANEAN CIVIL SOCIETY DIALOGUE

Promoting Philanthropy Across the Greater Mediterranean Region

A European Foundation Centre Programme

Led by Luso-American Development Foundation

Lisbon, Portugal


Global Water Partnership
Water for the 21st Century:
Vision to Action
Framework for Action
for the Mediterranean
THE MEDITERRANEAN

INECO

Guidelines towards the application of institutional and economic instruments for water management in countries of the Mediterranean Basin

INECO ("Institutional and Economic Instruments for Sustainable Water Management in the Mediterranean Basin") is a Coordination Action Project supported by the European Commission through the 6th Framework Programme (Contract No: INCO-CT-2006-517673).

United Nations Environment Programme
Mediterranean Action Plan
Plan Bleu – Regional Activity Centre

A Sustainable Future for the Mediterranean

The Blue Plan's Environment and Development Outlook

Executive Summary

Plan Bleu

Sophia Antipolis,
July 2006

Enough is Enough

Ideas for a Sustainable Economy in a World of Finite Resources

The Report of the Steady State Economy Conference

casse

Economic Justice For All

Towards a Strategy of “Vigilance”

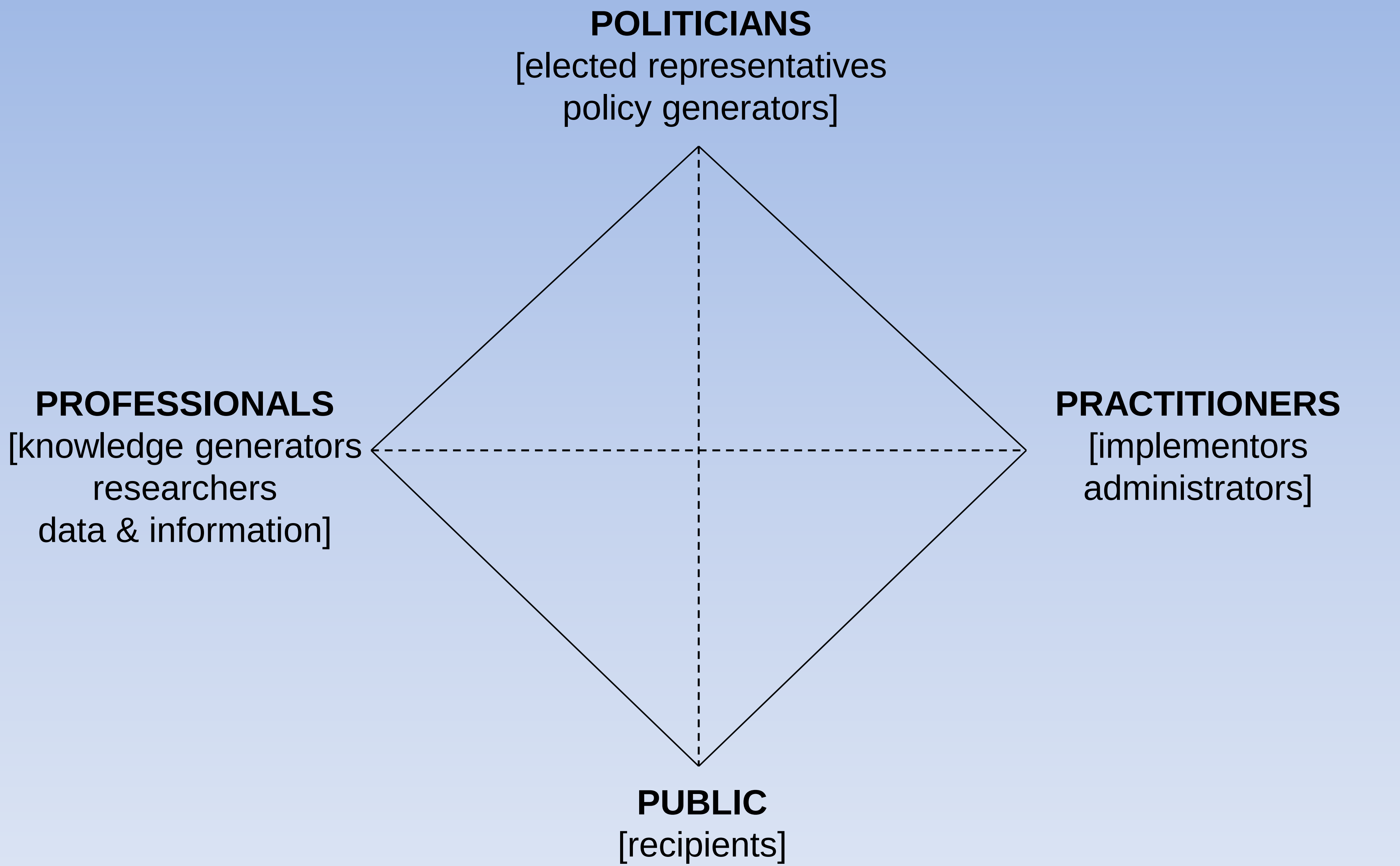
- **Flexible responses**, i.e., operational and strategic flexibility
- **Proactive commitment**, in terms of environmental scanning and through an emphasis on risk rather than crisis management
- **River basin focus** and robust transnational “regimes”
- **Combinations of** global **approaches** and national plans
- **Ecosystemic emphasis** and environmental interdependencies
- **Integrated, comprehensive management**, capacity building and organizational mobilization.

The 3 R's

Rethinking → new paradigms

Reorganizing → organizational mobilization

Retooling → new skills and resources


POLITICIANS
[elected representatives
policy generators]
PROFESSIONALS
[knowledge generators
researchers
data & information]
PRACTITIONERS
[implementors
administrators]
PUBLIC
[recipients]


SOMETIMES YOU HAVE
TO TAKE A RISK
TO MANAGE IT.

THREE KEY ISSUES IN COMPREHENSIVE WATER RESOURCES PLANNING & MANAGEMENT

Governing water
- “Management”
- “Subsidiarity”

Valuing water
- Value
- Price
- Cost

Sharing water
- Reasonable
- Equitable

Table 1: Millennium Development Goals*

To be achieved by 2015

1 Eradicate extreme poverty and hunger
2 Achieve universal primary education
3 Promote gender equality and empower women
4 Reduce child mortality
5 Improve maternal health
6 Combat HIV/AIDS, malaria, and other diseases
7 Ensure environmental sustainability
8 Develop a global partnership for development

*Within the framework of the 8 goals, there are 18 targets (and 48 indicators) to measure progress towards the Millennium Development Goals. Table 2 on page 5 highlights how improved water resources management and access to water supply and sanitation aids in achieving many of these targets.

A. WATER INTERDEPENDENCY “INDEX”

B. COOPERATION/CONFLICT “INDEX”

C. VULNERABILITY “INDEX”

D. SUSTAINABILITY/DEVELOPMENT “INDEX”

A. INTERDEPENDENCY "INDEX"
[Interconnectedness and Interaction]

- Surface/groundwater
- Dependency on inflow from other basins
- Operational/administrative capacity
- Overall water availability
  [water stress-scarcity-poverty]
- Sectoral use of water
- DPSIR interaction

B. Cooperation/Conflict "Index"

[direct and indirect]

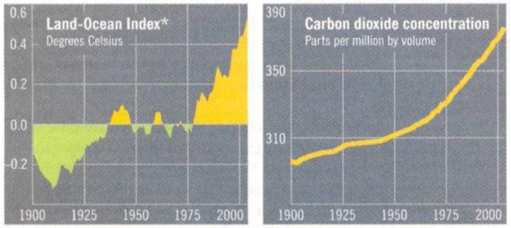
- Mechanisms for water allocation (within)
- Friendship/hostility indicators
- "Conflict resolution" capabilities
- Number of treaties, conventions, etc.
- [cooperative events re: rivers]
- Forms of territorial conflict resolution
- [geographic focus]
- Unilateral projects
- Existence of law for judicious water distribution

C. Vulnerability "Index"

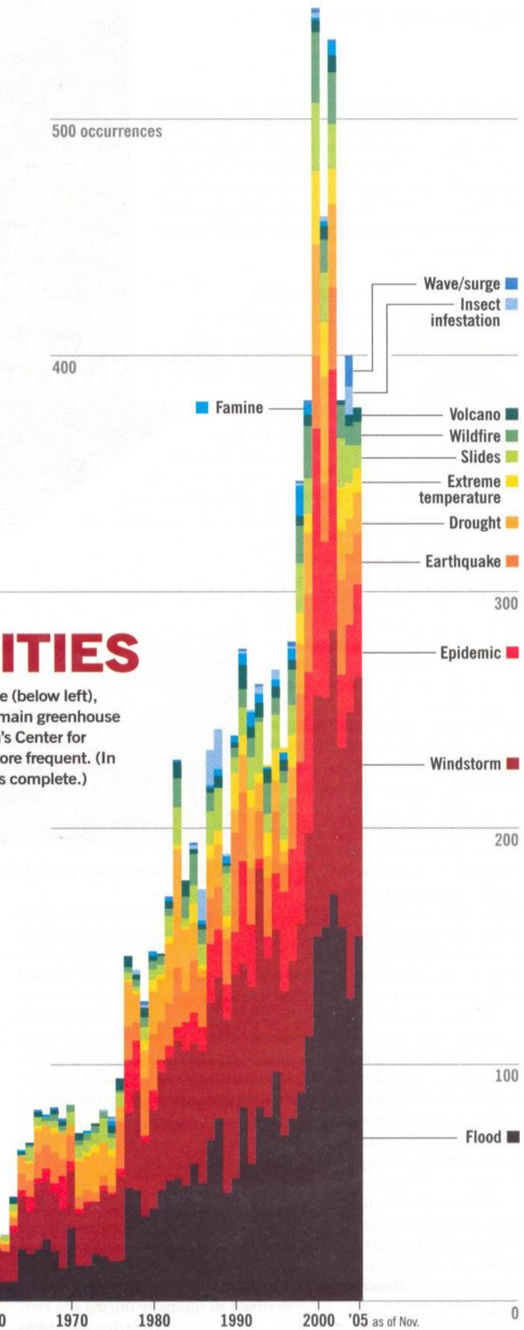
- Volatility or degree of rivalries and contestation
- Fragility, territorial disputes, unstable govts, etc.
- Lack of social resilience (non-robust social system)
- Lack of preparedness, capacity to deal with conflict constructively
- "Water regimes"/ basins at risk, fraction of water originating outside the basin
- Unaccounted for water, esp. in urban areas
- Diminishing water quality

MOUNTING CALAMITIES

Since the 1980s, the Earth's temperature has risen at an increasing rate (below left), probably in response to rising concentrations of CO_2, the atmosphere's main greenhouse gas. Signs of climate change are obvious in data assembled by Belgium's Center for Research on the Epidemiology of Disasters: Calamities have become more frequent. (In part because the center only started in 1974, earlier data may not be as complete.)



*Global annual temperature relative to the 1951–80 mean.



Number of natural disasters recorded each year worldwide
1900–2005

D. Sustainability/Development "Index"

- Conservation measures
- Redistribution mechanisms
- Degree of social cleavages/social cohesion
- Cultural conceptions of the environment [ecocentric vs. anthropocentric]
- Cost recovery
- Social competence for dealing with conflict peacefully

The “Three Paradigms”

[NEPA] National Environmental Policy Act/1970

[WFD] Water Framework Directive/2000

[MDGs] Millennium Development Goals/2000

SOME EXAMPLES OF PARADIGM SHIFT

- From extrapolative to anticipatory thinking and planning
- From elitist to participatory water planning and management
- From supply-driven to demand-driven water policies
- From economic emphasis to water as public good
- Recognition of various types of water such as “Blue Water,” “Green Water,” “Virtual Water,” etc.

Underlying Transformations

VOLATILITY

- Turbulence and Uncertainty

VULNERABILITY

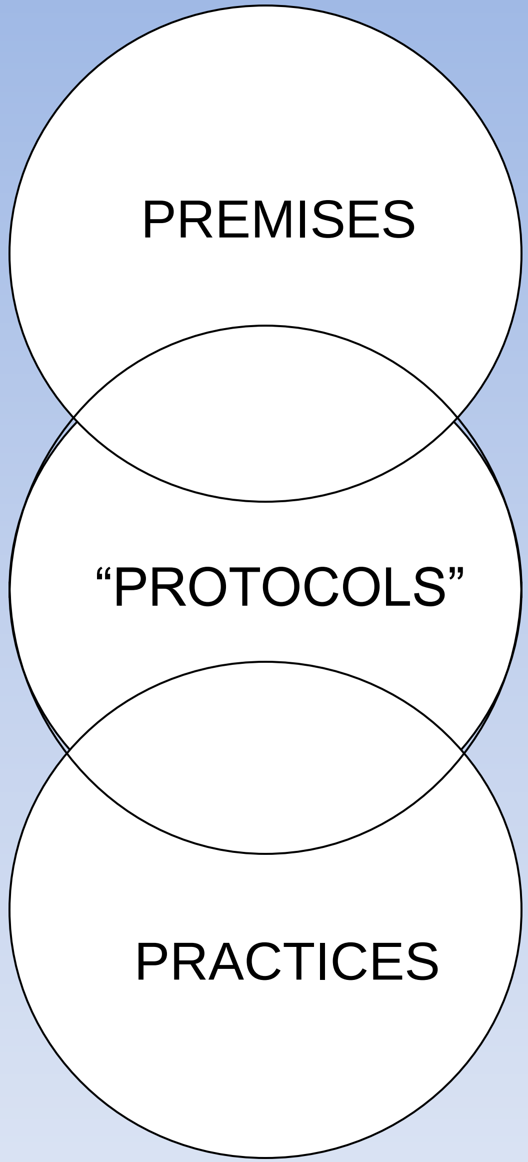
- Interdependencies and Risk

VIGILANCE

- Environmental Scanning and Preparedness

“Visions”
“Declarations”
“Principles”

“Paradigm”



NEPA
WFD
Bilateral
Agreements, etc.

“Models”
“Prototypes”
“Guidelines”
“Manuals”

IWRM
IRBM

Implementation
Measurement
Evaluation

“Stationarity is Dead”

- “Stationarity is a foundational concept that permeates training and practice in water-resource engineering.”
- “Climate change undermines a basic assumption that historically has facilitated management of water supplies, demands, and risks.”

POLICYFORUM

CLIMATE CHANGE

Stationarity Is Dead: Whither Water Management?

Climate change undermines a basic assumption that historically has facilitated management of water supplies, demands, and risks.

P. C. D. Milly,[1*] Julio Betancourt,[2] Malin Falkenmark,[3] Robert M. Hirsch,[4] Zbigniew W. Kundzewicz,[5] Dennis P. Lettenmaier,[6] Ronald J. Stouffer[7]

Systems for management of water throughout the developed world have been designed and operated under the assumption of stationarity. Stationarity—the idea that natural systems fluctuate within an unchanging envelope of variability—is a foundational concept that permeates training and practice in water-resource engineering. It implies that any variable (e.g., annual streamflow or annual flood peak) has a time-invariant (or 1-year–periodic) probability density function (pdf), whose properties can be estimated from the instrument record. Under stationarity, pdf estimation errors are acknowledged, but have been assumed to be reducible by additional observations, more efficient estimators, or regional or paleohydrologic data. The pdfs, in turn, are used to evaluate and manage risks to water supplies, waterworks, and floodplains; annual global investment in water infrastructure exceeds U.S.$500 billion (*1*).

The stationarity assumption has long been compromised by human disturbances in river basins. Flood risk, water supply, and water quality are affected by water infrastructure, channel modifications, drainage works, and land-cover and land-use change. Two other (sometimes indistinguishable) challenges to stationarity have been externally forced, natural climate changes and low-frequency, internal variability (e.g., the Atlantic multidecadal oscillation) enhanced by the slow dynamics of the oceans and ice sheets (*2*, *3*). Planners have tools to adjust their analyses for known human disturbances within river basins, and justifiably or not, they generally have considered natural change and variability to be sufficiently small to allow stationarity-based design.

[1]U.S. Geological Survey (USGS), c/o National Oceanic and Atmospheric Administration (NOAA) Geophysical Fluid Dynamics Laboratory, Princeton, NJ 08540, USA. [2]USGS, Tucson, AZ 85745, USA. [3]Stockholm International Water Institute, SE 11151 Stockholm, Sweden. [4]USGS, Reston, VA 20192, USA. [5]Research Centre for Agriculture and Forest Environment, Polish Academy of Sciences, Poznań, Poland, and Potsdam Institute for Climate Impact Research, Potsdam, Germany. [6]University of Washington, Seattle, WA 98195, USA. [7]NOAA Geophysical Fluid Dynamics Laboratory, Princeton, NJ 08540, USA.

*Author for correspondence. E-mail: cmilly@usgs.gov.

An uncertain future challenges water planners.

In view of the magnitude and ubiquity of the hydroclimatic change apparently now under way, however, we assert that stationarity is dead and should no longer serve as a central, default assumption in water-resource risk assessment and planning. Finding a suitable successor is crucial for human adaptation to changing climate.

How did stationarity die? Stationarity is dead because substantial anthropogenic change of Earth’s climate is altering the means and extremes of precipitation, evapotranspiration, and rates of discharge of rivers (*4*, *5*) (see figure, above). Warming augments atmospheric humidity and water transport. This increases precipitation, and possibly flood risk, where prevailing atmospheric water-vapor fluxes converge (*6*). Rising sea level induces gradually heightened risk of contamination of coastal freshwater supplies. Glacial meltwater temporarily enhances water availability, but glacier and snow-pack losses diminish natural seasonal and interannual storage (*7*).

Anthropogenic climate warming appears to be driving a poleward expansion of the subtropical dry zone (*8*), thereby reducing runoff in some regions. Together, circulatory and thermodynamic responses largely explain the picture of regional gainers and losers of sustainable freshwater availability that has emerged from climate models (see figure, p. 574).

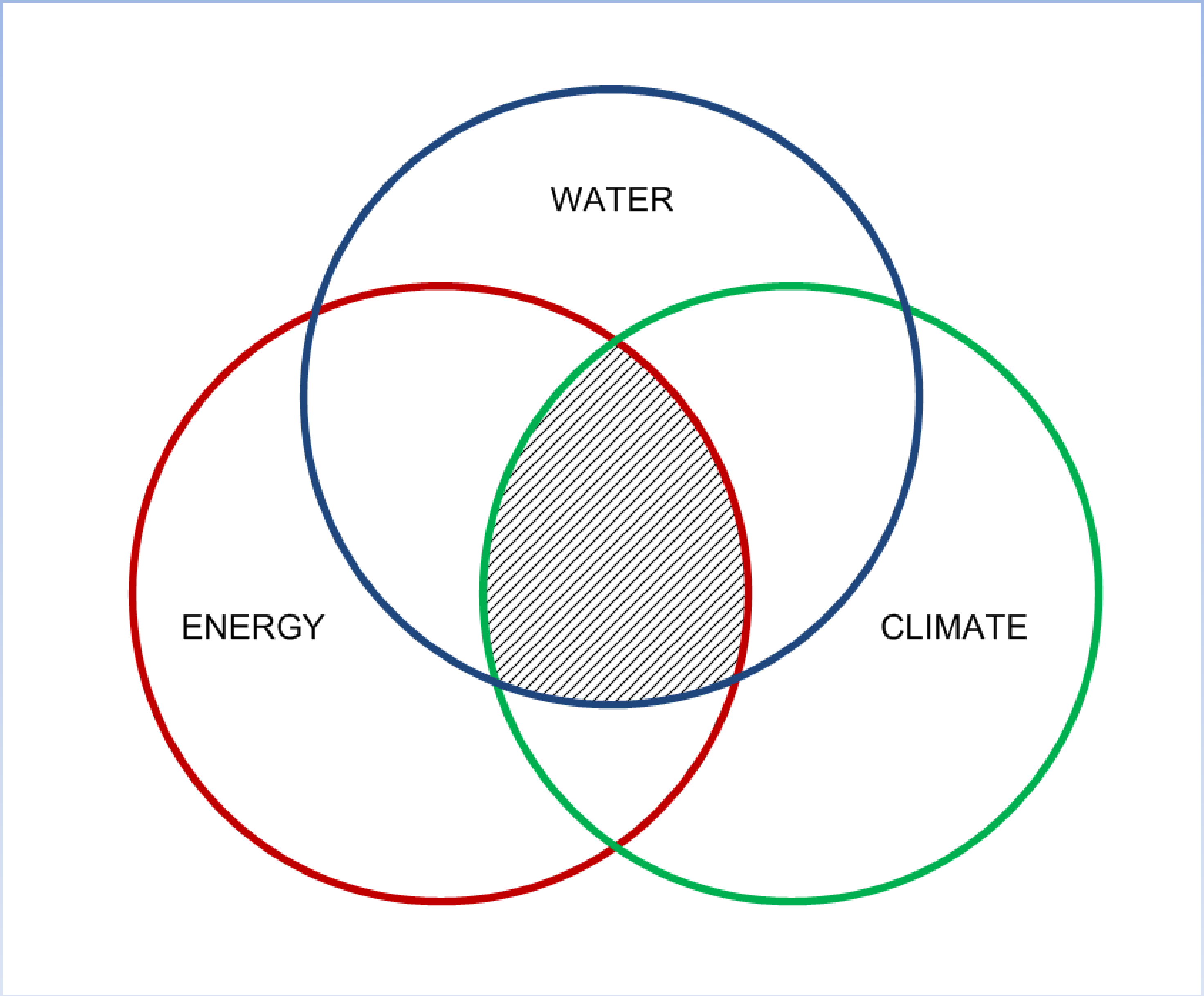
Why now? That anthropogenic climate change affects the water cycle (*9*) and water supply (*10*) is not a new finding. Nevertheless, sensible objections to discarding stationarity have been raised. For a time, hydroclimate had not demonstrably exited the envelope of natural variability and/or the effective range of optimally operated infrastructure (*11*, *12*). Accounting for the substantial uncertainties of climatic parameters estimated from short records (*13*) effectively hedged against small climate changes. Additionally, climate projections were not considered credible (*12*, *14*).

Recent developments have led us to the opinion that the time has come to move beyond the wait-and-see approach. Projections of runoff changes are bolstered by the recently demonstrated retrodictive skill of climate models. The global pattern of observed annual streamflow trends is unlikely to have arisen from unforced variability and is consistent with modeled response to climate forcing (*15*). Paleohydrologic studies suggest that small changes in mean climate might produce large changes in extremes (*16*), although attempts to detect a recent change in global flood frequency have been equivocal (*17*, *18*). Projected changes in runoff during the multidecade lifetime of major water infrastructure projects begun now are large enough to push hydroclimate beyond the range of historical behaviors (*19*). Some regions have little infrastructure to buffer the impacts of change.

Stationarity cannot be revived. Even with aggressive mitigation, continued warming is very likely, given the residence time of atmospheric CO_2 and the thermal inertia of the Earth system (*4*, *20*).

A successor. We need to find ways to identify nonstationary probabilistic models of relevant environmental variables and to use those models to optimize water systems. The challenge is daunting. Patterns of change are complex; uncertainties are large; and the knowledge base changes rapidly.

Under the rational planning framework advanced by the Harvard Water Program (*21*, *22*), the assumption of stationarity was


WATER
ENERGY
CLIMATE