

The Global Water Crisis

*Economic Drivers, Institutional Failures,
and Policy Responses in a Changing
Climate*

by

Mohamed Salah Matoussi

The Global Water Crisis: Economic Drivers, Institutional Failures, and Policy Responses in a Changing Climate

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To my wife, Marie-Claude

*For her unwavering support and constant encouragement—
without which this book would never have seen the light of day.*

To my beloved daughters, Selma, Sonia, and Lilia

Your laughter, curiosity, and love inspire me every day.

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Glossary

- ABM** – Age-Based Modeling
- ACI** – Association of Collective Interest
- AHRTM** – Agricultural and Hydraulic Resources Tunisian Ministry
- AI** - Artificial Intelligence
- AMIP** – Atmospheric Model Inter-comparison Project
- AMS** – American Meteorological Society
- ANASIM** – Analytical and Simulation
- ANBS** – Asymmetric Nash Bargaining Solution
- AT** – Average Tariffs
- BCM** – Billion Cubic Meters
- BOD** – Biochemical Oxygen Demand
- CAP** – Central Arizona Project
- CC** – Climate Change
- CI** – Continental Intercalaire
- CMIP** – Coupled Model Inter-comparison Project
- CORDEX** – Coordinated Regional Climate Downscaling Experiment
- CRDA** – *Commissariat Régional de Développement Agricole*
- CWSM** – China Water Simulation Model
- DEA** – Data Envelopment Analysis
- DICE** – Dynamic Integrated Model of Climate and the Economy
- DSM** – Demand Side Management
- EBMs** – Energy Balance Models
- ECS** – Equilibrium Climate Sensitivity
- EMICs** – Earth System Models of Intermediate Complexity
- ETH** – Swiss Federal Institute of Technology Zurich
- ERB** – Euphrates River Basin
- EWM** – Electronic Water Market

- FAO** – Food and Agriculture Organization
- GAA** – German Aerospace Agency
- GAD** – Group of Agricultural Development
- GARP** – Global Atmospheric Research Program
- GCM** – General Circulation Model / Global Climate Model
- GERD** – Grand Ethiopian Renaissance Dam
- GFDL** – Geophysical Fluid Dynamics Laboratory
- GHG** – Greenhouse Gas
- GIC** – *Groupement d'Intérêt Collectif*
- GIS** – Geographic Information System
- GMCR** – Graph Model for Conflict Resolution
- GPS** – Global Positioning System
- GRACE** – Gravity Recovery and Climate Experiment
- GWP** – Global Water Partnership
- HAD** – High Aswan Dam
- HEI** – Hectare Endowment Index
- HEM** – Hydro-Economic Modeling
- HWP** – Harvard Water Program
- IABT** – Intra-Basin Transfer
- IAM** – Integrated Assessment Models
- IAS** – Institute for Advanced Study
- IEBT** – Inter-Basin Transfer
- IHP** – International Hydrological Program
- INS** – *Institut National de la Statistique*
- IWRM** – Integrated Water Resources Management
- IWA** – International Water Association
- JSC** – Joint Scientific Committee
- LCA** – Life Cycle Assessment
- LAREQUAD** – *Laboratoire de Recherche en Économie Quantitative du Développement*
- LTMC** – Long-Term Management Cost

- MCDA** – Multi-Criteria Decision Analysis
MCDM – Multi-Criteria Decision Making
MED – Multi-Effect Distribution
MENA – Middle East and North Africa
MODIS – Moderate Resolution Imaging Spectroradiometer
MOEA – Multi-Objective Evolutionary Algorithm
MRI-AGCM – Meteorological Research Institute Atmospheric General Circulation Model
MSF – Multi-Stage Flash Desalination
NATCOM – National Communication
NRW – Non-Revenue Water
NWSA – Northwestern System Aquifer
OKA – Oued Kheirate Aquifer
PET – Potential Evapotranspiration
RCCI – Regional Climate Change Index
RCP – Representative Concentration Pathway
RFF – Resources for the Future
RO – Reverse Osmosis
RW – Revenue Water
SASS – *Système Aquifère du Sahara Septentrional*
SCEP – Study of Critical Environmental Problems
SCOPE – Scientific Committee on Problems of the Environment
SCW – Soil Conservation Work
SONEDE – *Société Nationale d'Études et de Distribution d'Eau* (Tunisia)
SPEI – Standardized Precipitation Evapotranspiration Index
SPI – Standardized Precipitation Index
SRES – Special Report on Emissions Scenarios
SSO – Sahara and Sahel Observatory
SSWP – Small-Scale Water Providers
SWP – State Water Project (California)
TC – Terminal Complex
TCost – Total Cost

TrWR – Treated Wastewater Reuse

TWR – Total Water Resources

TWS – Terrestrial Water Storage

UNEP – United Nations Environment Programme

UNFCCC – United Nations Framework Convention on Climate Change

WCRP – World Climate Research Programme

WEFE – Water-Energy-Food-Environment Nexus

WGCM – Working Group on Coupled Modeling

WHSI – Water Harvesting and Supplemental Irrigation

WMO – World Meteorological Organization

WRF – Weather Research and Forecasting Model

WTA – Willingness to Accept

WTP – Willingness to Pay

WWTPs - Wastewater treatment plants

La Medjerda

The cover image of this book is the painting *La Medjerda*, by Marie-Claude Matoussi.

Marie-Claude has devoted herself to painting with a passion rooted in her earliest childhood—a quiet and faithful devotion that has never left her. While I immersed myself in the writing of my second book, a deeply personal narrative shaped by the memory of my early years, she inhabited time differently: she painted. Each of us moved within our own world—she in color and form, I in words—like two parallel paths nourished by the same intimate memory.

Then came a singular day. Lost in thought, absorbed in the memories I was striving to anchor on paper, I saw Marie-Claude approach me holding a canvas she had just completed. She presented it silently, without a word.

And suddenly, it felt like a revelation.

Before this seemingly abstract painting, something stirred deeply within me. Behind the shapes and colors, I could discern—dimly yet with striking intensity—the outlines of the Medjerda and those of El Oulja, where the roots of my childhood lie. It was as though Marie-Claude had captured the essence of my memories, giving them form and presence. A secret correspondence emerged between her art and my narrative, between her gaze and my memory.

That is why we chose to name this painting Medjerda. The title imposed itself naturally, as though the work carried within it the imprint of the river and the landscapes of my childhood.

I then thought of placing this painting at the opening of Global Water Crisis. Beyond its aesthetic dimension, it stands as a tribute to Marie-Claude—for her patience, her silent presence, and her unwavering support throughout the years devoted to this work. It is also, quite simply, a way of saying thank you.

The Medjerda is Tunisia's only perennial river, a living ribbon of water shaping the rhythm of the seasons. El Oulja, meanwhile, was far more than a place to me. It was a small cluster of humble rural homes scattered along the riverbanks, where my childhood unfolded and where, quietly, everything began.

In that landscape shaped by water, a deep attachment to rivers and flowing streams slowly emerged within me. It was a silent fascination that time never erased and that still shapes the way I see the world today.

The Medjerda lived within me like a hidden soul. It gave the village water, fertile land, fish, and life itself. I remember it as a wild and enigmatic force whose floods inspired both fear and wonder. Violent though they were, those waters nourished the earth and sustained the fragile world to which we belonged.

The people along its banks learned to live with the river through patience, humility, and ancestral wisdom. Then came the dams, and everything changed. The free and vibrant Medjerda of my childhood was transformed into a controlled canal serving distant cities. Fishing, swimming, the laughter of children along the water, and the old traditions that once shaped the rhythm of our days slowly disappeared, carrying away forever a part of our soul.

General Introduction

From the vantage point of space, Earth appears as a "blue planet," its surface dominated by vast expanses of water. This striking image offers a powerful, yet misleading, impression of abundance. Beneath the surface of this planetary mirage lies a stark truth: water scarcity has become one of the most critical and persistent challenges of the 21st century.

According to widely accepted hydrological criteria, a country is considered chronically water-scarce when annual renewable water availability falls below 1,000 cubic meters per capita. In such contexts, water stress becomes more than a seasonal concern—it takes root as a structural condition, impeding economic development, degrading ecosystems, and threatening human well-being.

This reality raises an immediate and fundamental question: *why do we speak of a global water crisis in an era when the Earth appears to be surrounded by water?*

A Crisis Amid Apparent Abundance

Paradoxically, the global volume of freshwater—though limited relative to total planetary water—is, on aggregate, more than sufficient to meet both human and ecological needs. The hydrological cycle renews approximately 43,000 cubic kilometers of freshwater annually, yielding a global average of 5,375 cubic meters per capita per year. Even when adjusting for losses due to runoff and extreme climatic events, the residual accessible volume—around 2,688 cubic meters per capita per year—remains comfortably above scarcity thresholds.

The state of the planet's water resource

Constituents of Water Resources	Volume in Km³	Availability per capita m³/year
1. The total volume of water on earth	1 360 000 000	170 000 000
2. Total Freshwater	4 080 000	510 000
3. Renewable Freshwater supply	43 000	5 375
4. Total Net Renewable Freshwater	21 500	2 688

Source: Author's compilation based on FAO AQUASTAT, UNESCO WWAP...

And yet, despite this apparent sufficiency, over one billion people live in conditions of absolute water scarcity. More than 17% of the global population subsists on less than 1% of the planet's renewable freshwater—a volume smaller than what is available to the five million citizens of Norway, who represent just 0.06% of the global population. Conversely, roughly 5% of the global population enjoys access to nearly half of the world's freshwater resources.

This disparity is not merely geographic—it is also deeply temporal. In many regions, rainfall is erratic, alternating between catastrophic floods and prolonged droughts. More troubling still, in numerous countries—especially in Sub-Saharan Africa—natural abundance coexists with severe water insecurity due to what economists term economic water scarcity. This arises not from physical shortages, but from inadequate infrastructure, weak institutions, and limited financial and human capital.

A Historical Perspective—and a New Imbalance

Why, then, does this crisis feel so acute today, when humanity has always contended with uneven water distribution?

Indeed, the unevenness of water resources is as old as civilization itself. The earliest human settlements emerged along rivers and in arid basins, their survival predicated on the ability to secure stable water supplies. From the Nile and Tigris to the Indus and Yellow Rivers, history records remarkable hydraulic innovations—from Roman aqueducts to Aghlabid cisterns and North African foggaras—that enabled human flourishing under scarcity.

But today's crisis differs in kind and scale. For much of human history, demand remained modest, constrained by small populations and rudimentary technologies. That balance has now been disrupted. Since the dawn of the 20th century, the world has witnessed an elevenfold increase in population and a more than fortyfold increase in water demand. This has brought us to a pivotal moment of imbalance—one in which natural variability is compounded by unprecedented anthropogenic pressures.

Diagnosing the Crisis: Structural Economic Drivers

The global water crisis is not a natural inevitability. It is a crisis shaped—if not caused—by human choices. The key drivers are structural and deeply economic in nature:

- **Explosive Demand Growth:** Industrialization, urbanization, and population expansion have driven a rapid rise in water use across all sectors—domestic, agricultural, and industrial.
- **Unrestrained Resource Mobilization:** Technological advancement, particularly in the 20th century, led to large-

scale mobilization of water supplies—often with little regard for ecological limits or regeneration. Engineering institutions prioritized expanding supply, frequently subsidized by the state, while environmental sustainability remained a secondary concern.

- **Escalating Public Subsidies:** As easily accessible sources dwindled, the cost of water mobilization rose sharply. Yet water pricing policies remained flat and uniform, requiring increasing subsidies and placing heavy fiscal burdens on developing economies.
- **Environmental Degradation and Climate Change:** Excessive groundwater extraction, wetland loss, and declining river flows now coincide with intensifying climate risks, further straining already fragile ecosystems.
- **Cultural and Political Constructs:** Water holds a unique cultural and moral significance across civilizations. Often seen as a sacred gift rather than an economic good, it has historically been priced below cost or provided for free—reinforcing unsustainable consumption and discouraging conservation.

Toward a New Governance Paradigm

Addressing this crisis demands a profound shift in global water governance. Traditional supply-side solutions—no matter how technologically advanced—can no longer meet ever-growing needs. The path forward lies in managing demand, enhancing efficiency, and embedding sustainability into institutional design.

This shift calls for greater involvement from economists, whose insights into resource allocation, pricing mechanisms, and behavioral incentives are essential for sustainable management. Regrettably, economic scholarship has been slow to fully engage with environ-

mental goods such as water, historically focusing on markets where price signals are more robust.

Today, that must change.

This book seeks to place economic reasoning at the heart of the water policy debate. It does not aim to displace the role of engineers, hydrologists, or environmental scientists, but to complement their work with a rigorous understanding of how economic tools—such as pricing, incentives, regulation, and institutional reform—can help align human behavior with ecological constraints.

Objectives of This Book

In what follows, this work sets out to:

- **Diagnose the Root Causes** of the global water crisis, with particular emphasis on the exacerbating effects of climate change;
- **Map the Geography of Water Stress**, estimating the true scope of populations affected by physical and economic scarcity;
- **Critically Assess Mitigation Strategies**, synthesizing the vast and fragmented literature across disciplines;
- **Contribute New Insights** into demand-side water management, including our original empirical and policy-oriented work on pricing, efficiency, and institutional design.

As we will argue throughout, the global water crisis is not inevitable—it is a challenge shaped by governance choices, economic structures, and societal values. It is, therefore, within our collective power to solve it.

The development of these questions is structured into two main parts.

Part One, comprising two chapters, is primarily dedicated to analyzing the underlying causes of the global water crisis and assessing its magnitude, particularly by estimating the number of people exposed to the severe stress it entails.

Chapter 1 is devoted to examining the *Root Causes of the Global Water Crisis*. This chapter addresses the complex task of identifying and understanding the fundamental drivers of the crisis. These causes are manifold, deeply interconnected, and diverse in nature. Our analysis focuses on the most critical factors, which include:

- The uneven spatial and temporal distribution of water resources;
- The exponential increase in water demand;
- The rising costs associated with mobilizing new water resources;
- The economic inefficiencies and fiscal burdens of water subsidies;
- The overexploitation and degradation of groundwater reserves;
- Inadequate institutional frameworks and misaligned water management strategies, which are ill-suited to current challenges;
- The environmental consequences of large-scale supply-side interventions aimed at meeting surging demand—such as the construction of massive dams, hydroelectric power stations, and river diversions. These projects have often resulted in the destruction of vital riverine ecosystems, with the case of the Aral Sea serving as a particularly stark example.

Chapter 2 is devoted to assessing water-stressed populations, their spatial distribution, and their levels of water endowment in relation to the severity of scarcity. This evaluation is especially critical for policymakers, given the mounting pressures on freshwater resources in the context of accelerating climate change and increasing demographic and economic demands.

The chapter opens with a succinct review of the primary indicators used to measure both physical and economic water scarcity. In the following section, we identify the geographic areas currently experiencing severe water scarcity. These areas include entire countries, specific regions within otherwise water-abundant nations, and transboundary river basins under significant hydrological stress.

During the course of this assessment, we highlight critical limitations in the widely used Falkenmark indicator. Although its simplicity has contributed to its widespread application among water resource experts, we argue that it inadequately distinguishes between fundamentally different types of water scarcity. For example, it equates the scarcity observed in the large hydrological basins of Asia with that in the MENA region—a comparison we contend is analytically flawed.

In many Asian basins, water scarcity is predominantly a result of overexploitation of relatively abundant natural water resources, driven by high population densities and intensive economic activity. Conversely, the MENA region is characterized by structural water stress due to inherently low levels of renewable water availability, stemming from its semi-arid to arid climatic conditions. Although both regions are classified similarly by the Falkenmark index, they exhibit divergent underlying causes and therefore necessitate substantially different management strategies.

To address this methodological shortcoming, we propose an alternative yet equally straightforward metric: the **Hectare Endowment Index (HEI)**. This indicator measures water availability per unit of land area rather than per capita, allowing for a clearer differentiation between scarcity rooted in biophysical constraints and that arising from anthropogenic pressures. Through specific case studies, we demonstrate how the HEI improves our understanding of regional disparities and enhances the capacity to formulate more context-sensitive and effective water management policies.

The final and most analytically substantive section of the chapter presents global estimates of water-stressed populations and their respective resource endowments, based on the criteria we consider most conceptually and practically relevant. This section is organized as follows:

- First, we present the global distribution of populations across water endowment brackets, measured in cubic meters per capita per year. This allows us to quantify the proportion of the global population experiencing absolute water scarcity (defined as $< 500 \text{ m}^3/\text{capita}/\text{year}$) and moderate water stress ($500\text{--}1,000 \text{ m}^3/\text{capita}/\text{year}$).
- Second, we expand the analysis by offering a more granular, tiered categorization of global water endowment, ranging from conditions of absolute scarcity ($< 500 \text{ m}^3/\text{capita}/\text{year}$) to conditions of absolute abundance ($> 30,000 \text{ m}^3/\text{capita}/\text{year}$).

This nuanced classification of water availability is essential for capturing the heterogeneity of water-related challenges across regions and for informing policy responses that are both targeted and contextually appropriate.

The second part of this study addresses a fundamental question: **in the context of an escalating global water crisis—exacerbated by the accelerating impacts of climate change—**"...what strategies can humanity implement to mitigate its effects by harnessing its creative capacity and the scientific and technological advancements accumulated throughout history?"

The answer to this crucial question is organized into two main chapters.

We begin in **Chapter 3** with an overview of the solutions conceived and developed by the global scientific community across a wide range of disciplines—both directly and indirectly related to water resources—in response to this ongoing crisis. The primary objective of this chapter is to provide a synthetic yet comprehensive presentation of the principal strategies that societies have devised and implemented to address the water crisis, which has increasingly manifested in recent decades.

The chapter is structured into three main sections, each corresponding to a major category of responses to the crisis:

1. *Technical and Infrastructural Solutions*

The first section presents the set of solutions advocated by proponents of water supply management. Often referred to as "**hard**" solutions, these rely predominantly on technological and engineering approaches—both traditional and modern—to conserve existing resources and enhance supply. Thanks to remarkable scientific and technological advances, humanity has undertaken massive infrastructure projects to mobilize water from distant basins and reduce the natural variability of supply. Engineers have played a central

role in this effort, devising systems to deliver water to users efficiently and at minimal cost. As demand began to outstrip conventional supply, these professionals further developed sophisticated techniques to optimize conservation and harness non-conventional sources, such as wastewater treatment, rainwater harvesting, and desalination.

2. *Redistributive Solutions through Water Transfers*

The second section addresses strategies aimed at redistributing water resources through large-scale transfers, both within and between basins. These interventions are designed to alleviate water deficits in densely populated and water-stressed regions by transferring water over long distances. While effective in addressing regional imbalances, such projects are often financially and environmentally costly. These "pharaonic" undertakings, typically driven by public authorities and supported by major development agencies, continue to captivate planners and policymakers.

3. *Economic and Institutional Solutions*

The final section focuses on the "soft" solutions, which are primarily grounded in economic and institutional approaches. Contrary to supply-side mobilization, sustainable demand management seeks to curb the rising trajectory of water demand by reallocating already mobilized resources to users and uses that generate the highest value. This section is organized into three subsections:

- The first examines traditional centralized tools, such as command-and-control regulations and optimal pricing mechanisms.
- The second, which constitutes the core of this section, explores decentralized allocation and reallocation mechanisms that promote efficient use of scarce resources.
- The third addresses the growing role of participatory management. In numerous contexts—especially in rural areas of developing countries—water distribution is increasingly managed by user associations. Similarly, the governance of overexploited groundwater resources is progressively being transferred to local users through collective action initiatives.

In this final chapter, we present a synthesis of the major research efforts undertaken over the past fifty years of our academic career, both as a teacher and, more significantly, as a researcher. These studies were carried out either individually or in collaboration with a research team we had the privilege of leading, under various projects funded by our university, international organizations, and development partners.

The overarching aim of this body of work has been to demonstrate the pivotal role economists can play—particularly through the rigorous application of advanced quantitative tools—in addressing the challenges posed by water crises. We argue that the economist's essential contribution lies in the capacity to conceive and implement policy solutions capable of curbing the growing water demand driven by historically unprecedented economic expansion.

This chapter is organized into five sections. The first four provide a concise presentation of research that has been published in inter-

national journals or circulated as working papers. The fifth and final section introduces an original and recently completed study.

Section 1: Systems Analysis and Optimization in Water Resource Management

The 1960s and 1970s marked a period of intense focus on systems analysis and optimization in the field of water management. Our doctoral work was rooted in this tradition, culminating in the development of an optimal water resource management system for arid and semi-arid regions, using the Medjerda River Basin in Tunisia as a case study.

This section presents four key studies from this formative phase:

- *“Integrating Variability and Temporal Allocation: Application to the Medjerda Basin”*
- *“Autoregressive Model with Varying Coefficients: Application to Monthly Synthetic Streamflow Generation”*
- *“Seven-Year Drought-Abundance Cycle: Myth or Reality?”*
- *“Centralized Water Resources Arbitration Model”*

Together, these works introduce innovative methodologies and provide critical evaluations of prevailing water policies, advocating for more efficient and sustainable resource management strategies.

Section 2: Residential Water Demand

The second section focuses on residential water demand—a topic that has generated a substantial body of literature. Our contributions to this domain comprise three empirical studies:

- *“Determinants of Residential Water Demand in Tunisia”*

- *“Residential Water Demand Estimation: A Panel Cointegration Approach”*
- *“Tariff Restructuring and Residential Water Conservation: A Contingent Valuation Approach”*

These studies emphasize the crucial relationship between pricing mechanisms, demand management, and conservation incentives, offering evidence-based insights to inform effective water pricing policies.

Section 3: Sustainable Groundwater Management

Given the centrality of groundwater in regions afflicted by chronic water scarcity, this section addresses the challenge of sustainable groundwater management. Our research includes five key contributions:

- *“Economic Valuation of the Oued Kheirate Aquifer”*
- *“Technical Efficiency in Date Production”*
- *“Comparison of Irrigation Management Systems”*
- *“Crop Conversion Programs for Water Conservation”*
- *“Designing Total Water Use-Based Incentive Schemes for Groundwater Management”*

These studies collectively underscore the necessity of integrating economic analysis into groundwater governance, with a particular focus on incentive-based and efficiency-oriented policy instruments.

Section 4: Interdisciplinary Approaches to Water Policy

During the 2010s, we engaged in several interdisciplinary research projects that broadened our analytical scope to include:

- *Environmental regulation and international trade*
- *Water poverty measurement*
- *The Water-Energy-Food-Environment (WEFE) Nexus*
- *Decentralized water management through water markets*

This section discusses the principal findings from these collaborations and demonstrates how cross-sectoral approaches can contribute to more coherent and adaptive water policy frameworks.

Section 5: Hydro-Economic Modeling and the SASS Aquifer System

A particularly significant part of our recent research was conducted within the framework of a major project coordinated by the Sahara and Sahel Observatory (OSS). Spanning over a decade, this initiative focused on the sustainable management of the North Western Sahara Aquifer System (SASS).

From this collaboration emerged three major studies:

- *“Socioeconomic Aspects of Irrigation in the SASS Basin”*
- *“Hydro-Economic Modeling of an Exhaustible and Transboundary Groundwater Resource: Application to the SASS”*
- *[New Study] “Balancing Extraction and Sustainability in Non-Renewable Aquifers”*

The latter, which we present in full in this chapter, addresses a fundamental question:

Is it possible to balance the extraction of water from an almost non-renewable aquifer with the imperative of long-term sustainability and improved user well-being?

Using recent data from the SASS3 project, the study provides the following key insights:

- Sustainable groundwater management requires cost-reflective pricing, rather than relying solely on public intervention.
- Farmers who bear the full cost of water demonstrate significantly higher efficiency in usage.
- Future policy frameworks must integrate pricing mechanisms, regulatory tools, and targeted conservation incentives to ensure the long-term viability of the aquifer.

Part I.

Diagnosing the Global Water Crisis

Chapter 1

The Deep Drivers of the Global Water Crisis

Water constitutes the foundation of all life on Earth, sustaining human societies, ecosystems, and economic systems alike. Its availability is critical to economic development, social stability, demographic expansion, and urbanization. Although the global hydrological cycle remains relatively stable, water demand has risen sharply over recent decades, driven by rapid economic growth, demographic pressures, and heightened environmental awareness. Consequently, many major urban centers and vast rural regions are already grappling with chronic water stress, with some facing conditions of absolute scarcity. Today, there is broad consensus among researchers and policymakers that the world is confronting a profound water crisis, whose severity and geographical extent are expected to escalate unless comprehensive and adaptive reforms in water management are undertaken.

The roots of this crisis are numerous and deeply interconnected. However, three critical drivers stand out:

- Physical constraints: Water resources possess intrinsic characteristics—such as variability, invisibility in aquifers, and immobility—that complicate their access, mobilization, and management.
- Economic and social dimensions: Unlike most goods, water displays unique economic, social, and cultural attributes, requiring specialized governance and allocation mechanisms.

- Unequal spatial and temporal distribution: Despite its overall global abundance, water availability is highly uneven across regions and seasons, creating acute scarcity in many parts of the world.

Addressing the water crisis effectively requires a thorough understanding of these fundamental drivers. Yet, prevailing policies and user behaviors often remain rooted in outdated paradigms—legacies of an era when water was perceived as plentiful and inexhaustible.

In response to rising water stress, most governments have adopted a relatively uniform strategy based on three pillars:

- Expanding supply: Increasing water availability through large-scale investments in both conventional (surface and groundwater) and non-conventional (desalination, wastewater reuse) sources.
- Improving efficiency: Deploying technical interventions aimed at reducing losses and conserving mobilized water resources.
- Controlling prices: Maintaining artificially low water tariffs, frequently disconnected from actual economic and environmental costs, for political and social considerations.

However, this supply-driven approach is encountering critical limitations:

- Overreliance on technical solutions: Efforts to expand water supply are increasingly constrained by the physical limits of existing sources. While non-conventional options such as desalination offer alternatives, they are associated with significant economic, environmental, and social costs, and

abrupt transitions to these technologies risk destabilizing affected communities.

- Distorted economic signals: Artificially low water prices encourage inefficient usage patterns, promote the cultivation of low-value crops, and impose heavy fiscal burdens on public budgets, undermining the long-term financial viability of water management systems.

Recognizing these shortcomings, many water-stressed countries have launched "water sobriety" programs aimed at:

- Reducing physical losses in supply and distribution networks;
- Enhancing water and soil conservation practices;
- Stimulating investment in non-conventional water sources.

Although such technical measures are indispensable, they are no longer sufficient. It is increasingly evident that sustainable water management depends on fostering profound behavioral changes among users. Policymakers must move beyond purely technical fixes and embrace integrated strategies that combine regulatory reforms with economic incentives, cultivating a pervasive culture of efficiency, conservation, and accountability across all sectors of society.

Recent advances in environmental and institutional economics have illuminated the systemic governance failures at the heart of the water crisis. Chronic underpricing of water, ineffective regulation of common resources, institutional fragmentation, and politically motivated subsidies have collectively undermined efforts toward sustainable management.

Against this backdrop, this chapter seeks to move beyond conventional diagnoses. It begins by examining the physical,