ENVIRONMENTAL ECONOMICS • GROUP PRESENTATION

Water Scarcity & *Groundwater Depletion*

in the United Arab Emirates — an economic perspective

Market failure, externalities and the price of a scarce resource.

Environmental Economics • Group Project
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PRESENTATION OUTLINE

What we'll cover today

01

Setting the Scene

Why water scarcity is the UAE's defining environmental and economic problem

02

The Scale of Depletion

Key numbers, falling water tables, and the 2030 warning

03

An Economic Diagnosis

Common-pool resources, market failures and missing prices

04

Economic Consequences

Externalities, opportunity costs and intergenerational equity

05

Policy Response

Desalination, cloud seeding, pricing and the Water Security Strategy 2036

06

Conclusion

Economic takeaways and what comes next

INTRODUCTION

A textbook case of resource economics

The UAE is one of the most water-stressed economies on Earth.

From an environmental economics standpoint, the UAE's water situation is a textbook market failure. Groundwater is a depletable, common-pool resource that has been priced well below its true scarcity value for decades — which has predictably led to over-extraction, falling water tables, and growing reliance on costly substitutes like desalination.

We argue that groundwater depletion — not climate change — is the country's most urgent environmental concern because the costs are concrete, measurable, and accelerating today.

100 mm

annual rainfall, below the global arid threshold

≈ 550 L

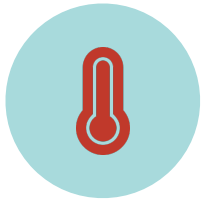
water used per person, per day in the UAE

Top 17

most water-stressed countries worldwide

WHERE THE WATER GOES

Setting the geographic and climatic context



Hot & Arid

Summer temperatures regularly exceed 45 °C, driving extreme evaporation rates.

Almost No Rain

Annual rainfall is below 100 mm, mostly in short winter showers.

No Rivers

The UAE has no permanent rivers or lakes — surface water is essentially zero.

Booming Population

From 0.5 million in 1975 to over 11 million today — water demand has soared.

Put together, the UAE is a textbook hyper-arid environment with one of the largest gaps between natural water availability and human water demand anywhere in the world.

SCALE OF THE PROBLEM

The numbers tell an alarming story

60 m

Drop in groundwater level on average across UAE regions, with some areas falling from 56 m to 96 m in just 15 years.

UAE University study

70%

Share of total UAE water demand historically supplied by groundwater aquifers — most of it for agriculture.

Fanack Water / HRPub

2030

Projected year groundwater supplies could effectively run dry if current extraction continues at present rates.

UAE University projection

Each of these figures alone is concerning. Together, they describe a slow-motion emergency.

Groundwater is a textbook common-pool resource

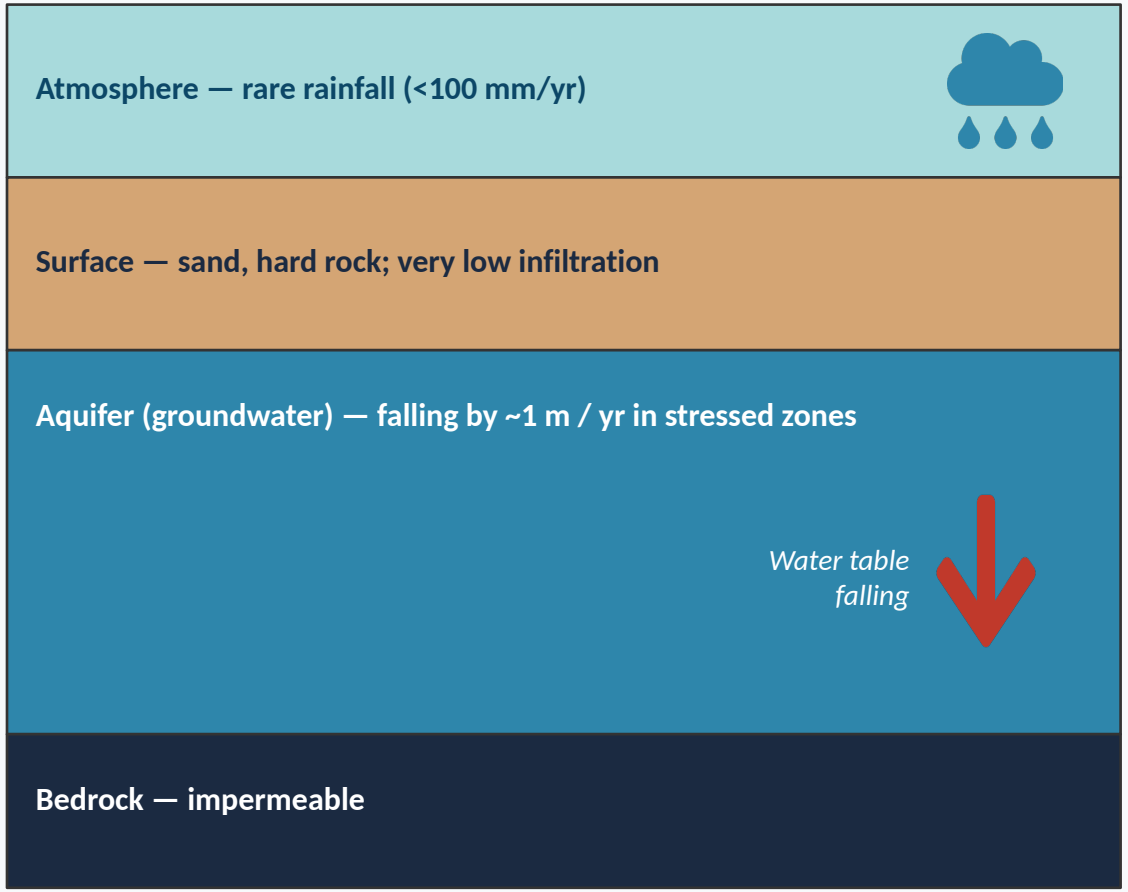
Rivalrous, but non-excludable

Anyone with a pump can extract; one user's withdrawal reduces what's left for others. That combination is the textbook recipe for over-use — what Hardin called the tragedy of the commons.

A depletable stock with near-zero recharge

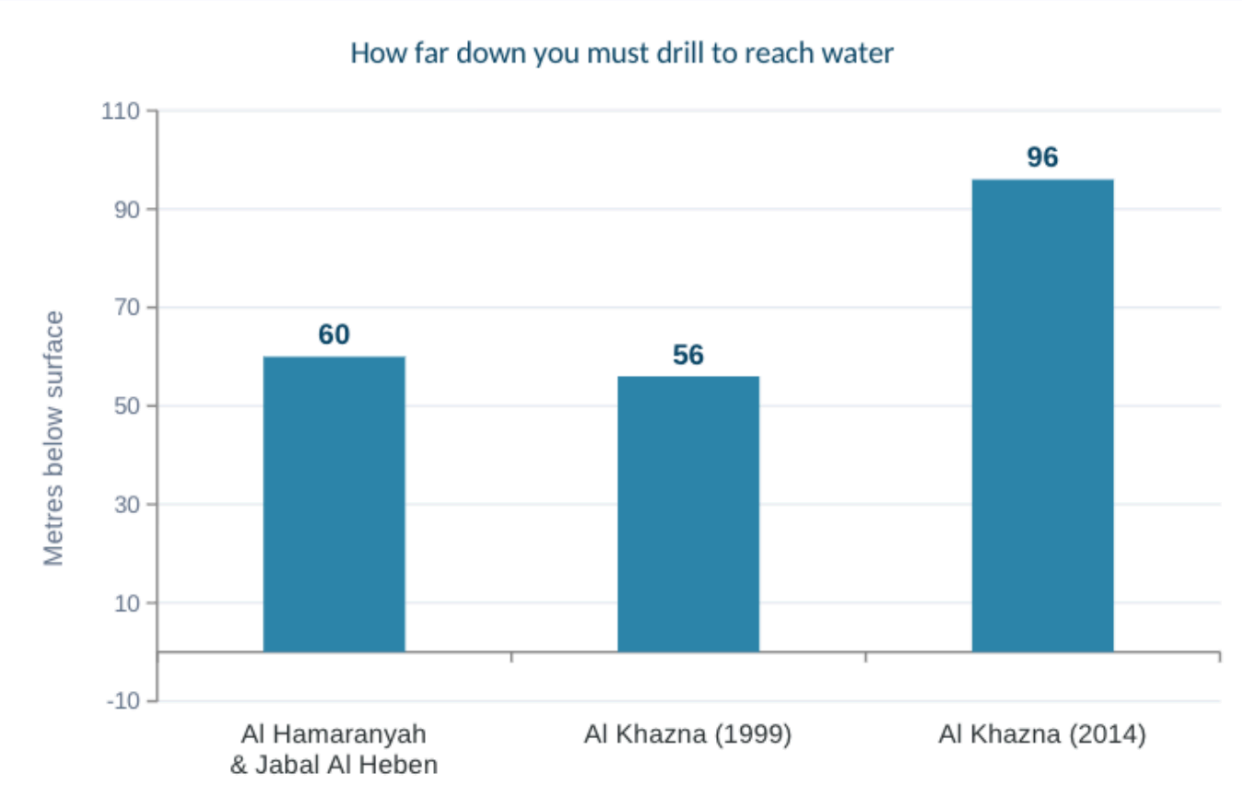
Rainfall under 100 mm/yr means almost no replenishment. Most extracted water is fossil water — effectively an exhaustible resource in the sense of Hotelling.

Result: extraction far exceeds recharge — the aquifers are being mined, not farmed.



EVIDENCE ON THE GROUND

Falling water tables across the country



Key takeaway

At Al Khazna alone, the water table dropped 40 m in 15 years — roughly the height of a 13-storey building.

This is not a normal seasonal fluctuation. It is a structural decline driven by chronic over-extraction, particularly for agriculture and forestry irrigation.

Source: Environment Agency Abu Dhabi data, reported via The National (2015)

WHY IT'S HAPPENING

Five market failures driving over-extraction

Common-pool access

No exclusion

Open-access aquifers + private pumps = classic tragedy of the commons. Each user has no incentive to conserve what others can take.

Subsidised pricing

Price ≪ cost

Water tariffs sit well below the true marginal cost of supply, so consumption signals don't reflect scarcity.

Negative externalities

Cost shifted

Today's extractors don't bear the future cost of falling water tables or seawater intrusion — costs imposed on the next generation.

Distortionary subsidies

≈ 60% to ag

Cheap water plus crop subsidies steer farmers into water-intensive crops in a hyper-arid country — economically irrational without the subsidy.

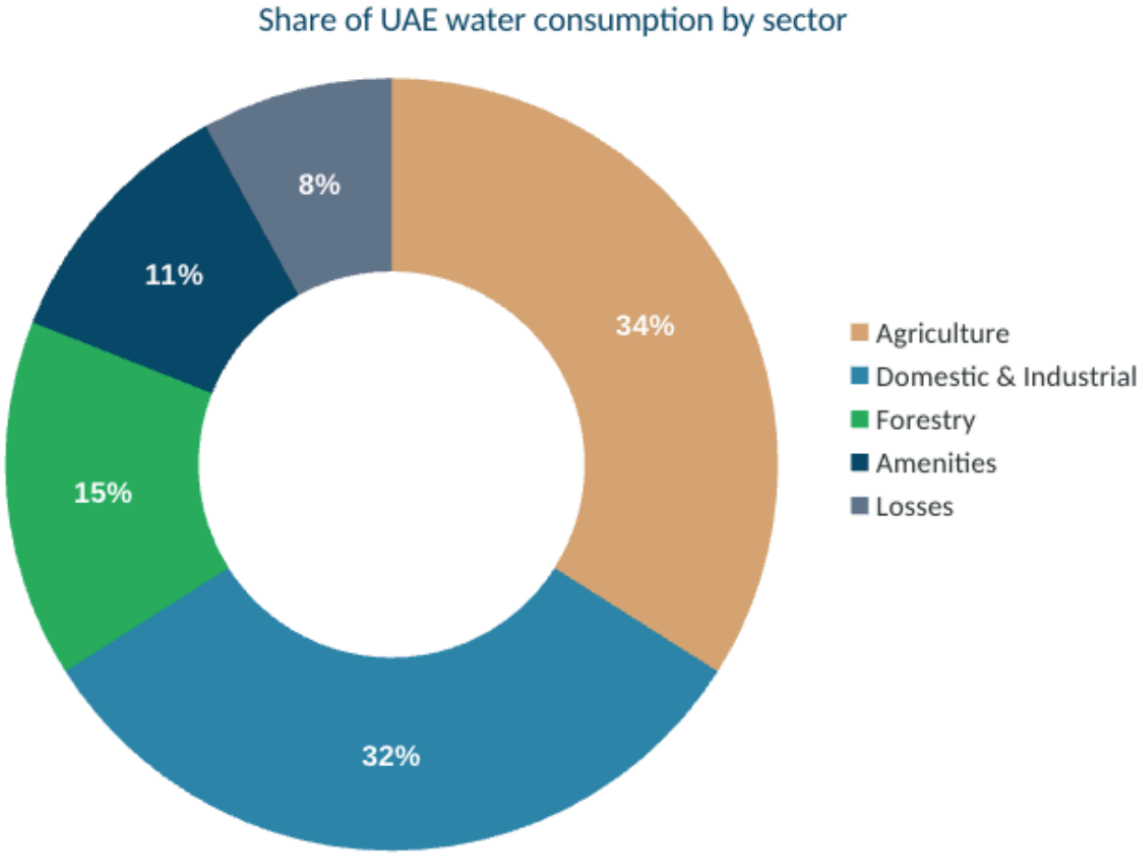
Inelastic demand

550 L/day

When water is nearly free, demand barely responds to small price changes. High income + low awareness keeps per-capita use among the world's highest.

WATER CONSUMPTION BY SECTOR

Where every drop goes



Source figures: UAE University study via The National (2015)

WHAT THIS REVEALS

Agriculture is the single largest user

Roughly one-third of all water goes to farms — almost entirely groundwater.

Combined non-agricultural use is even larger

Domestic, industrial, amenity and forestry use together account for ~58%.

8% is lost before reaching anyone

Leaks in pipes and inefficient systems waste a significant share of supply.

LOOKING AHEAD

2030: when the groundwater could run out

If extraction continues at present rates, the UAE could lose its primary natural water resource within a single generation. Even the country's own Water Conservation Strategy, which sought to hold groundwater use steady, has been overrun by demand growth.

1990

Total water use ~100 mcm/year. Groundwater dominant.

2014

Water tables already down 40 m in some Abu Dhabi areas.

2020

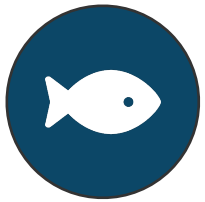
Total water use jumped to ~3,500 mcm/year — 35× growth.

2030

Projected zero usable groundwater for agriculture at current rates.

CONSEQUENCES

Counting the economic costs



Externality: salinization

As aquifer pressure falls, seawater intrudes inland — degrading remaining groundwater and farmland. A textbook negative externality borne by future users.

Food security & imports

With agriculture so dependent on groundwater, depletion forces higher reliance on food imports — adding exchange-rate and geopolitical risk to household budgets.

Rising marginal supply cost

Each cubic metre lost from groundwater must be replaced by desalinated seawater at multiples of the cost — an enormous shift in the national supply curve.

Intergenerational inequity

Fossil groundwater consumed today is unavailable to future generations. Standard economic theory (Hotelling) treats this as a serious efficiency and fairness concern.

PART II

The policy response

The UAE has invested heavily — but each instrument shifts costs and incentives in different ways. We compare four through an economic lens.

POLICY 1: SUPPLY-SIDE

Desalination — buying supply at a price

Scale of the investment

~70 major desalination plants nationwide

≈ 42% of all potable water is desalinated seawater

UAE produces about 14% of global desalinated water

Marginal cost roughly 5–10× that of groundwater

⚖ Economic trade-offs

Benefits

- Secures a near-unlimited backstop supply
- Decouples drinking water from rainfall and aquifer recharge
- Stable, predictable production for planning

Costs & externalities

- Energy-intensive: high private and social cost per m^3
- Brine externality — Gulf waters already 25% saltier than open ocean
- Locks in long-run fossil-fuel demand and infrastructure risk

POLICY 2: SUPPLY-SIDE

Cloud seeding — a low-cost supply boost

What it is

Aircraft and ground generators release hygroscopic salt particles into suitable clouds to accelerate condensation and trigger rainfall.

Cost-benefit perspective

At roughly $8,000 per flight hour and ~900 hours per year, the program costs about $7 million annually for 84–419 million m^3 of usable water — a marginal cost of just a few US cents per cubic metre, an order of magnitude below desalination.

Caveat: weather-dependent — yields are uncertain.

≈ 300

cloud-seeding missions per year

+15%

minimum increase in annual rainfall

84–419

million m^3 of usable water added/year

~$0.05

estimated cost per m^3 of water added

POLICY 3: DEMAND-SIDE

Water Security Strategy 2036 — economic targets

A whole-of-government plan built around explicit economic productivity goals — not just supply.

−21%	$110	−3	95%	2 days
Cut total water demand	Water productivity per m^3	Drop on water-scarcity index	Treated water reused	National emergency storage

Emergency supply benchmarks

In an emergency, networks aim to deliver 91 L per person per day; in an extreme emergency, just 30 L — a stark reminder of how thin the margin is.

Source: UAE Government, 'The UAE Water Security Strategy 2036'

POLICY 4: DEMAND-SIDE MIX

Pricing, reuse and shifting incentives

Tariffs & smart meters

Tiered water pricing and smart metering act as a Pigovian instrument — letting the price reflect scarcity and nudging behaviour change at the margin.

Treated wastewater reuse

Reusing 95% of treated wastewater (the 2036 target) creates a substitute supply for landscaping, cooling and forestry — taking pressure off groundwater.

Modern irrigation

Drip systems, hydroponics and greenhouses raise water productivity per kilogram of food — the very ratio the 2036 strategy targets.

Drought-resistant crops

Research into salt-tolerant and low-water crops (quinoa, Salicornia) shifts agricultural production functions toward less water-intensive output.

IN CONCLUSION

A solvable market failure — if prices catch up

1

It's a market failure, not bad luck

Open-access groundwater + prices below scarcity value + subsidies = predictable over-extraction. The textbook diagnosis matches the UAE perfectly.

2

Supply-side fixes are expensive backstops

Desalination and cloud seeding work, but desalination's marginal cost (and brine externality) makes it a costly substitute. Cloud seeding is cheap per m^3 but weather-dependent.

3

Demand-side reform is where the gains are

Full-cost pricing, tariff reform, water-productivity targets and treated-wastewater reuse get at the root cause — the missing price signal — at lower social cost.

THANK YOU !!

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