The RETOUCH NEXUS project promotes a cross-sectoral Water–Energy–Food–Ecosystems (WEFE) Nexus approach to support a resilient EU water economy. It ensures that water governance considers ecological, social, and economic dimensions, fostering coherence and effectiveness across sectors and governance levels.

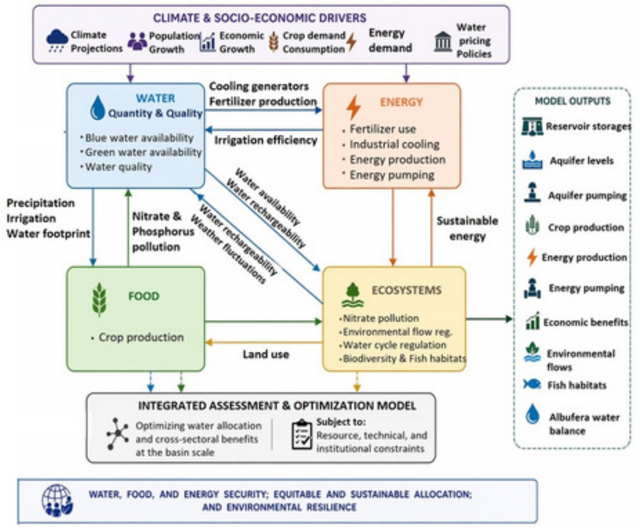
RETOUCH NEXUS 2023 2026

Policy brief | Upscaling of water governance Instruments | Water pricing

This policy brief examines methodological approaches to scaling economic instruments and models for water governance.
Case studies are illustrative, and broader application is possible through context-specific analysis.

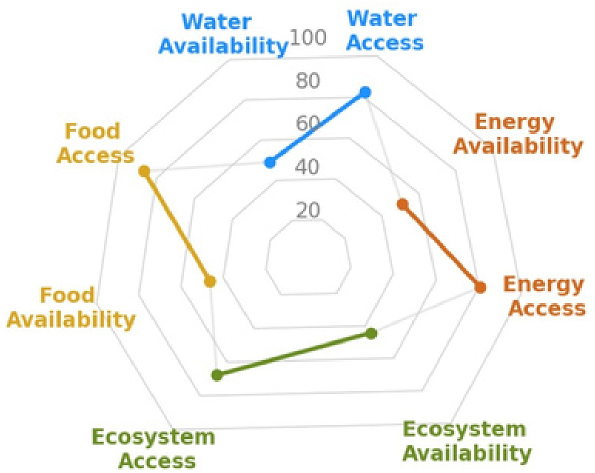
Introduction: traditional water allocation rules fail to reflect the true marginal value of water under scarcity at the river basin scale. As a result, allocation is inefficient, inequitable, and environmentally harmful. Water pricing turns physical scarcity into decision-relevant signals for users and policymakers, incentivising efficient use, supporting ecosystem protection, and revealing the cross-sectoral trade-offs in the WEFE nexus.

Modelling Approach: hydro-economic models integrate hydrological process with economic optimisation evaluating how alternative pricing instruments affect water allocation, sectoral performance, and ecosystem status at the basin scale. Climate projections and socio-economic scenarios provide the forcing conditions. System dynamics further capture feedback loops and non-linear responses across interconnected sectors.



Integrated hydro-ecnomic modelling framework from a WEFE perspective.

RETOUCH NEXUS CASE STUDIES - LESSONS LEARNED



Water Pricing Impact of WEFE Nexus Performance.

RETOUCH NEXUS CASE STUDY

The Júcar River Basin (Spain) uses a hydro-economic optimisation model coupling TETIS hydrology, AQUACROP/CAPRI agronomics, CMIP6 climate scenarios, and habitat suitability curves, testing uniform and dynamic water pricing.
Uniform Water Pricing delivers strong but unequal environmental gains. Dynamic Water Pricing linked to reservoir storage levels and marginal resource opportunity costs achieves a more balanced trade-off. Water pricing strengthens aquatic species resilience.

The Upper Main River Basin (Germany) uses SWAT+ hydrology with system dynamics and stochastic frontier analysis, incorporating shadow pricing.
Shadow water prices increase steadily from 2000 to 2050 across all water demand scenarios. Water quality degradation compounds quantity scarcity, reducing production potential by up to 10–15%.

Indicators (data requirements and resulting insights)

- Scarcity indicators: water scarcity ratio, groundwater depletion rates, reservoir storage levels, WEFE index.
- Marginal water prices to quantify economic scarcity.
- Species resilience metrics: frequency ratio, mean/max duration of habitat stress, severity index.
- Water quality indicators (nitrate concentration) linked to agricultural intensity.

Governance mechanisms

- Basin-wide coordination frameworks aligning WEFE objectives.
- Cross-sector stakeholder platforms for co-decision on allocation rules.
- Adaptive management cycles: regular policy reviews based on monitoring and stakeholder input.
- Shared data systems and open-access dashboards for transparency.

Implications for WEFE Nexus framework

- Water pricing is a key for WEFE integration
- Dynamic pricing better preserves cross-sectoral balance than rigid uniform tariffs.
- Climate uncertainty demands robust, adaptive pricing rather than static tariff schedules.
- Water quality must be explicitly integrated into pricing frameworks to avoid underestimating true scarcity costs.

Potential Economic Instruments

- Volumetric water tariffs (transparent, strong environmental signal, but equity concerns for low-value crops).
- Dynamic/scarcity-based water pricing (tariffs linked to reservoir storage or marginal opportunity cost; more balanced trade-offs).
- Shadow pricing as a planning tool to reveal the marginal value of water under constraints.
- Source-specific tariffs (surface vs. groundwater) and sector.

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SCALING OUT

TO INCREASE IMPACT BY REPLICATING A MODEL IN SIMILAR CONTEXTS, PROVIDING FLEXIBILITY, RESILIENCE, AND COST-EFFECTIVE GROWTH, OFTEN FOCUSING ON SHARED FEATURES.

MODELLING STRATEGY

Hydro-economic modelling with dynamic water pricing

The modular structure of both models enables replication across other European river basins facing similar WEFE challenges.

Example: The dynamic pricing design from the Júcar (storage-based tariffs linked to marginal resource opportunity costs) could be replicated in other Mediterranean basins (e.g., Ebro, Guadalquivir, Segura in Spain; Arno, Po in Italy; Axios in Greece) that share surface-groundwater interactions, irrigated agriculture, and seasonal scarcity.

Scaling out general framework.

Assumptions & potential Risks:

- Assumes availability of comparable hydrological, agricultural, and ecological data.
- Key risks include data gaps, institutional differences in water rights and regulatory frameworks, limited computational capacity, and stakeholder resistance to pricing reforms.

Mitigation measures:

- Build modular model versions that can run with limited data.
- Use proxy or regional datasets where local data are unavailable.
- Engage stakeholders early.
- Provide training and technical support for local teams.
- Apply sensitivity analyses to account for uncertainty.

SCALING UP

TO INCREASE THE COVERAGE, SIZE, CAPACITY, SCOPE, OR OUTPUT OF A MODEL TO A WIDER CONTEXT, ESSENTIALLY MAKING IT BIGGER AND MORE EFFECTIVE. IT'S ABOUT GROWING SUBSTANTIALLY, NOT JUST LINEARLY, TO PROVIDE MORE COMPREHENSIVE INSIGHTS.

Scaling up general framework.

ECONOMIC INSTRUMENT

Comprehensive basin-wide water pricing framework

For the Júcar-style model, farm-level decision-making could be added, along with renewable energy integration, additional species, detailed habitat connectivity, and groundwater-dependent ecosystems; increasing temporal and spatial resolution. The System dynamic model can be extended from the Upper Main to the full Main River basin, or multi-basin comparisons.

Example: moving from basin-specific pricing to a national framework where prices are differentiated by scarcity, environmental externalities, and basin-level objectives. Revenues are reinvested in basin management, infrastructure, and ecosystem protection. Governance shifts from local implementation to system-level coordination.

Assumptions & potential Risks:

- Resolution requires detailed datasets.
- Computational complexity increases significantly.
- Calibration and validation become more demanding.
- Interpretation of results and communication becomes harder.

Mitigation measures:

- Simplify or aggregate non-critical components.
- Employ high-performance computing.
- Apply systematic calibration procedures.
- Focus on key indicators and visualisation tools.

Conclusions / Final Remarks

- **Water pricing** is effective, but only when designed to reflect scarcity.
- River basins with established monitoring systems are well suited for early pilots, and advance modelling can help **identify distributional effects before implementation.**
- **Transparency** is critical for acceptance. Public dashboards linking prices to real-time water availability help build trust.
- The Water Framework Directive enables **cost recovery**, while **hydro-economic modelling** provides the necessary evidence base for sound policy design.

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