



AG-WaMED | Advancing non conventional water management for innovative climate-resilient water governance in the Mediterranean Area

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Mediterranean policy document for the integration of land and water governance

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Abstract	This document supports Deliverable 4.3.2, “Mediterranean policy document for the integration of land and water governance” (M36). Its overarching aim is to analyse the principal governance challenges that hinder integrated water–land management across the Mediterranean and to identify opportunities to expand the equitable uptake of non-conventional water (NCW) as part of adaptation to increasing scarcity.			
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Introduction

This document supports Deliverable 4.3.2, “Mediterranean policy document for the integration of land and water governance” (M36). Its overarching aim is to analyse the principal governance challenges that hinder integrated water–land management across the Mediterranean and to identify opportunities to expand the equitable uptake of non-conventional water (NCW) as part of adaptation to increasing scarcity.

Methods

Based on the proposed objective, the selected methods for the preparation of this report are qualitative in nature and rely on an analysis of water governance and NCW’s challenges and opportunities at the mediterranean level.

The first part of the report analyzes, synthesizes, and presents the results of the *map of land and water allocation* (deliverable 5.3.1. *Analysis of quantitative results at regional, country, and local levels*) at the Mediterranean scale. Specifically, it draws on the contributions from Section 2, *Estimation of current and future water needs in the Mediterranean*; Section 3, *Water balance analysis*; and Section 4, *Water scarcity analysis*. In addition to reviewing and systematizing the results of the *map of land and water allocation* developed by WP5, this section also presents the findings of deliverable 3.2.1, *Multi-objective programming solutions, alternative scenarios, and choice of best solution by LL*. This deliverable, using different versions of Mathematical Programming, analyzes the socioeconomic effects of varying levels of irrigation water availability in the project's Living Labs (LLs). The purpose of this section is to highlight the key results of the modeling conducted by WP5 on water scarcity, as well as the socioeconomic assessments of NCW use carried out by WP3 for the Mediterranean region.

Part II moves from the regional modeling to the local scale, exploring how the scenarios and policy options identified in Part I are perceived, adapted, and implemented in the AG-WaMED Living Labs (LLs). It draws exclusively on three sets of project-generated sources for each LL: (i) transcripts from LL presentations at the 4th AG-WaMED GA meeting in Madrid, (ii) Integrated Water Management Plans (Deliverable 4.2.1.) and Policy Briefs prepared by each LL, and (iii) National Policy

Documents for NCW Upscaling (Deliverable 4.2.2). Through this material, the section reconstructs the voices of local stakeholders and experts to identify initiatives, capacities, and limitations for integrated land–water governance that promotes NCW, while also noting, where available, local perspectives on crop reallocation strategies.

Part III scales the discussion back up to the Mediterranean level, articulating the findings of Parts I and II with regional-level debates and policy considerations. It is based on three main sources: (i) a targeted review of academic literature on water scarcity, crop reallocation, and integrated land–water governance in the Mediterranean; (ii) eight semi-structured interviews with representatives of regional civil and state organizations active in Mediterranean water policy; and (iii) previous WP4 deliverables related to integrated governance. This section identifies key cross-cutting challenges and opportunities, reflects on the enabling conditions for policy integration at the Mediterranean scale, and formulates recommendations for advancing an inclusive, multi-level governance framework that can address both local realities and regional imperatives.

By linking quantitative modeling, local stakeholder perspectives, and regional policy debates, the deliverable offers a multi-scalar, evidence-based foundation to inform future Mediterranean policies that address water scarcity through the joint management of land and water resources, with a particular emphasis on the role of non-conventional water sources and adaptive agricultural strategies.

Part I. Climate Change, Water Scarcity, and Agricultural Adaptation Strategies in the Mediterranean

This first part of the Mediterranean policy document for the integration of land and water governance (Deliverable D4.3.2) integrates and synthesizes the results of three previous studies developed within the AG-WaMED project, with the aim of providing a coherent, multi-scale view of climate change and water scarcity scenarios in the Mediterranean region, and their implications for agriculture. The analysis brings together the findings of Deliverable 5.3.1 (Analysis of quantitative results at regional, country, and local levels), Deliverable 3.2.1 (Multi-objective programming solutions, alternative scenarios, and choice of best solution by Living Labs), and Deliverable 5.2.1 (Optimal Crop Allocation and Water Use in the Mediterranean).

The starting point is Deliverable 5.3.1, which presents a map and a quantitative analysis of land and water allocation in the Mediterranean region, disaggregated at regional, national, and basin scales, and incorporating climate change projections. Its results are organized into three main components: (i) estimation of current and future irrigation water needs; (ii) water balance analysis; and (iii) water scarcity assessment. This provides the basis for identifying areas and production systems most vulnerable to scenarios of reduced water availability.

Deliverable 3.2.1 builds directly on this diagnosis by examining, at the local scale, the effects of varying irrigation water availability on specific agricultural systems. Through the analysis of Living Labs in different Mediterranean contexts, and using multi-objective mathematical programming models, it evaluates the implications of different water supply levels for production, income, employment, crop diversification, and the use of non-conventional water (NCW) sources. This approach highlights the trade-offs and synergies between economic, social, and environmental objectives that arise when managing scarcity.

Building on these diagnoses, Deliverable 5.2.1 introduces a forward-looking approach aimed at reducing pressure on blue water—surface and groundwater used for irrigation—through optimal crop reallocation. This modelling exercise explores how to redistribute crops spatially to maximize the use of land suitable for rainfed

agriculture and minimize BWconsumption, while keeping total production and total agricultural area constant. It also assesses the potential of NCW, including treated wastewater reuse, desalination, and the use of brackish water, as complementary adaptation measures.

Taken together, these three deliverables make it possible not only to characterize the magnitude and distribution of water scarcity in the Mediterranean region, but also to analyze its socio-economic impacts and explore technical and governance strategies to address it. This chapter develops this integration following a sequence that moves from the general Mediterranean panorama, through concrete examples at basin and Living Lab scales, and concludes with adaptation proposals based on crop reallocation and NCW use.

1.1. Mediterranean-Scale Climate and Water Scarcity Scenarios

In Deliverable 5.3.1, scenarios of water availability and demand in the Mediterranean were assessed under different climate and socio-economic assumptions. The analysis focused on two main Shared Socioeconomic Pathways (SSPs): SSP3–7.0, a “regional rivalry” scenario with high greenhouse gas emissions and limited cooperation, and SSP5–8.5, a “fossil-fueled development” scenario with very high emissions and energy-intensive growth. Across these pathways, the results confirms that irrigation is the dominant water-consuming sector, with a current average demand of 29.35 km³/year of blue water. Urban water demand was also analyzed: although much smaller in magnitude, projections indicate a steady increase of about +7% by mid-century and up to +18% by the end of the century, with the sharpest rises in North African and Middle Eastern countries. Projections therefore show that both irrigation and urban sectors will contribute to intensifying water stress, though agriculture remains by far the main driver.

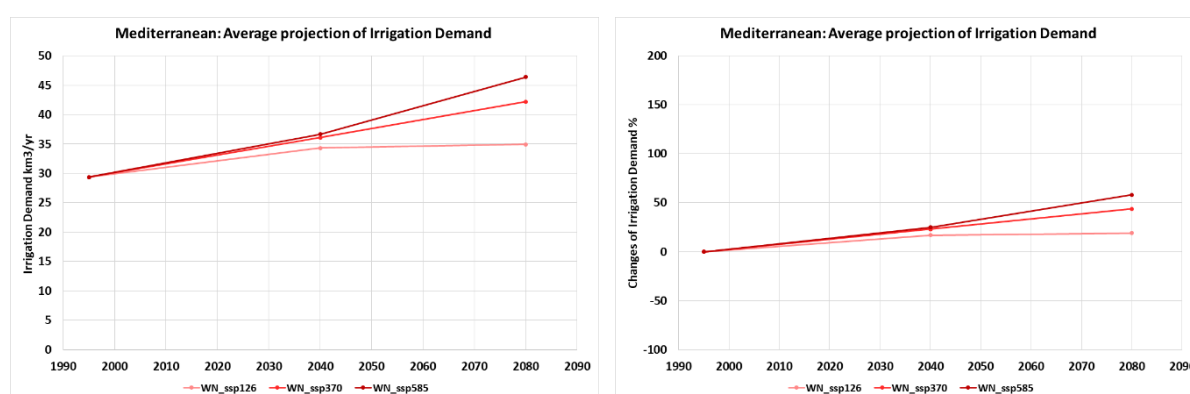
Projections show that this figure will increase significantly in the coming decades: by mid-century the rise ranges from +16% to +25%, and by the end of the century it may reach +19% to +58%, depending on the emission scenario. This demonstrates that irrigation will remain the main driver of regional water stress.

Table 1. WatNeeds surface irrigation demand for the Mediterranean basin, in km³/yr

Scenario	present 15-19	ssp126 41-59	ssp370 41-59	ssp585 41-59	ssp126 81-99	ssp370 81-99	ssp585 81-99
WN_present	29.35						
WN_gfdl		31.83	36.24	35.13	34.12	42.09	44.98
WN_ipsl		34.92	34.91	37.83	34.84	41.96	49.27
WN_mpi		36.17	37.05	36.99	35.83	42.57	44.93
mean WN	29.35	34.31	36.07	36.65	34.93	42.21	46.39

Source: D.5.3.1. Analysis of quantitative results at regional, country and local levels v1.0.

Figure 1. Summary of results obtained for the Mediterranean in the simulations of the WatNeeds model for surface irrigation demand. Left: Average surface irrigation demand. Right: Average changes in surface irrigation demand



Source: D.5.3.1. Analysis of quantitative results at regional, country and local levels v1.0.

The evolution is not homogeneous across countries. In Egypt, the results already confirm a structural deficit, with negative balances between availability and demand that worsen under high-emission scenarios. In Spain—particularly in the Segura basin—the balance deteriorates markedly, suggesting that competition between agricultural and urban uses will intensify. In Italy, sharp internal contrasts are observed: while some northern basins maintain a degree of resilience, central and southern areas—including the Po—show a clear increase in exposure to scarcity. In the Maghreb, Morocco and Algeria present negative balances under intermediate and severe scenarios, while Tunisia remains on average positive but with a declining trend.

Table 2. Water balance between total demand and potential water availability by country obtained in the simulations of the baseline model run, in km³/yr

Country	Area 1000 km ²	obsclim 80-19	historical 75-14	ssp126 20-59	ssp370 20-59	ssp585 20-59	ssp126 60-99	ssp370 60-99	ssp585 60-99
Italy	233.50	14.05	14.31	8.81	8.82	7.33	9.66	4.68	-1.95
Turkey	198.66	11.89	12.61	10.42	8.89	8.35	10.09	3.97	4.23
Libya	195.51	0.67	0.58	0.53	0.52	0.49	0.51	0.42	0.45
Spain	160.49	8.11	7.89	5.42	4.83	4.50	5.56	2.86	-0.12
Greece	151.18	5.24	6.19	4.70	3.33	3.14	4.13	0.86	-0.01
Algeria	120.81	2.12	2.32	1.44	0.96	0.80	1.07	-0.28	-0.40
France	118.36	13.63	14.13	11.32	11.22	11.08	11.94	9.32	7.68
Egypt	68.53	-15.49	-15.50	-16.34	-17.07	-16.86	-16.42	-18.69	-17.74
Tunisia	63.38	2.06	2.27	1.85	1.52	1.53	1.48	0.83	0.54
Morocco	59.83	0.49	0.52	0.27	0.21	0.13	0.21	-0.05	-0.15
Albania	37.91	1.32	1.45	1.03	0.77	0.85	1.06	0.34	0.27
Syria	20.49	-0.40	-0.39	-0.42	-0.47	-0.51	-0.47	-0.69	-0.64
Croatia	13.35	1.50	1.54	1.37	1.35	1.34	1.39	1.20	1.07
Israel	6.43	-0.07	-0.07	-0.09	-0.10	-0.11	-0.12	-0.14	-0.16
Cyprus	4.48	0.10	0.10	0.08	0.08	0.06	0.09	0.05	0.04
Lebanon	2.15	-0.05	-0.04	-0.06	-0.06	-0.07	-0.06	-0.08	-0.08
Bosnia	1.78	0.43	0.46	0.43	0.41	0.41	0.42	0.37	0.34
Macedonia	1.34	0.03	0.04	0.03	0.03	0.03	0.03	0.01	0.01
Montenegro	0.91	0.10	0.10	0.09	0.09	0.09	0.09	0.08	0.07

Source: D.5.3.1. Analysis of quantitative results at regional, country and local levels v1.0.

At the basin scale, some cases emerge as particularly critical. The largest relative increases in irrigation demand (>120% in SSP585 by the end of the century) are recorded in the Tiber (Italy), Muluya (Morocco), Vardar (Greece), La Macta (Algeria), Strymon (Greece), and Ebro (Spain). Moreover, basins such as Hmeimat (Syria) and Orontes (Turkey) already show negative balances in the reference scenario, indicating that scarcity is not only a future threat but also a present reality.

Table 3. Water balance between total demand and potential water availability by basin obtained in the simulations of the baseline model run, in km³/yr

Basin	Country	Area 1000 km ²	obsdim 80-19	historical 75-14	ssp126 20-59	ssp370 20-59	ssp585 20-59	ssp126 60-99	ssp370 60-99	ssp585 60-99
Rhone	France	95.75	13.04	13.54	10.86	10.77	10.70	11.47	8.97	7.58
Ebro	Spain	84.63	5.93	5.85	3.93	3.52	3.37	4.22	1.96	-0.03
Maritsa	Greece	52.48	1.31	1.55	1.02	0.72	0.46	0.85	-0.24	-0.36
Po	Italy	73.33	6.28	6.84	3.31	3.61	2.78	4.00	1.49	-1.89
Muluya	Morocco	54.19	0.34	0.35	0.26	0.22	0.17	0.20	0.07	0.05
Bayy al Kabir	Libya	52.36	0.05	0.04	0.04	0.04	0.05	0.04	0.03	0.05
Cheliff	Algeria	44.31	0.64	0.68	0.53	0.36	0.32	0.41	0.05	0.01
Vardar	Greece	24.49	0.82	1.05	0.86	0.67	0.67	0.85	0.38	0.24
Capraz	Turkey	23.73	1.30	1.37	1.26	0.95	1.01	1.17	0.48	0.55
Medjerda	Tunisia	23.13	1.30	1.45	1.19	0.96	0.96	0.94	0.53	0.32
Jucar	Spain	21.38	1.01	0.94	0.82	0.74	0.71	0.74	0.59	0.38
Strymon	Greece	16.78	0.12	0.14	0.02	-0.08	-0.11	-0.02	-0.28	-0.36
Menderes	Turkey	24.33	1.89	2.10	1.72	1.39	1.44	1.69	0.77	0.75
Dufan	Libya	29.37	0.11	0.09	0.08	0.08	0.07	0.07	0.06	0.06
Cayhan	Turkey	21.20	2.61	2.45	2.02	2.03	1.73	2.01	1.03	1.03
Seyhan	Turkey	20.72	1.73	1.75	1.37	1.30	1.14	1.36	0.65	0.64
Qurayn	Libya	28.92	0.01	0.01	0.00	0.00	0.00	0.00	-0.01	0.00
Orontes	Turkey	23.68	0.11	0.13	-0.01	-0.09	-0.18	-0.07	-0.49	-0.46
Segura	Spain	16.57	0.20	0.16	0.06	0.03	-0.01	0.04	-0.05	-0.22
Adige	Italy	14.42	1.49	1.37	0.93	0.95	0.85	1.02	0.55	0.11
Bojana	Albania	17.18	0.87	0.92	0.78	0.68	0.69	0.78	0.48	0.42
Tiber	Italy	16.69	0.44	0.47	0.32	0.28	0.20	0.34	0.19	-0.24
Semeni	Albania	6.13	0.20	0.23	0.15	0.09	0.11	0.15	0.00	-0.01
El Arish	Egypt	23.72	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01
Gediz	Turkey	16.76	0.85	1.07	0.88	0.63	0.72	0.87	0.26	0.25
Halk el Menzel	Tunisia	15.25	0.15	0.14	0.09	0.07	0.07	0.08	-0.02	-0.04
El Brega	Libya	16.43	0.10	0.09	0.08	0.07	0.07	0.07	0.06	0.06
La Macta	Algeria	14.58	0.04	0.04	-0.08	-0.12	-0.13	-0.09	-0.25	-0.26
Neretva	Croatia	5.93	0.71	0.74	0.63	0.62	0.62	0.63	0.53	0.48
Haliaomon	Greece	6.76	0.87	0.97	0.87	0.70	0.72	0.80	0.50	0.39
Hmeimat	Syria	13.09	-0.17	-0.16	-0.19	-0.21	-0.23	-0.21	-0.34	-0.30
Aoos	Albania	6.81	0.19	0.23	0.18	0.14	0.16	0.18	0.10	0.09
Aspropotamos	Greece	5.67	1.39	1.52	1.40	1.20	1.25	1.26	0.94	0.80
Arno	Italy	9.13	0.21	0.22	0.14	0.16	0.07	0.17	0.08	-0.19

Source: D.5.3.1. Analysis of quantitative results at regional, country and local levels v1.0

The impact on irrigated areas is equally significant: currently, 41% of the irrigated area is already under water stress; under a high-emission scenario, this share could exceed 67% by the end of the century (D.5.3.1; 96). In absolute terms, this implies an increase from approximately 2.4 million hectares affected today to more than 4 million in the coming decades. These results reveal how water stress is intensifying both in magnitude and spatial extent, putting at risk the sustainability of agriculture and food security in the region.

Overall, the findings of this deliverable highlight that water scarcity in the Mediterranean will be widespread, but with differentiated impacts across countries and basins. This uneven character calls for context-specific policy responses that combine improved irrigation efficiency, diversification of sources—including non-conventional water—and governance mechanisms capable of managing growing competition between sectors and territories.

1.2. Socio-Economic Impacts of Water Availability and Crop Changes in Agricultural Systems

The analysis of the socio-economic impacts of water availability, presented in Deliverable 3.2.1, focuses on the AG-WaMED Living Labs (LLs) and evaluates how different levels of irrigation water supply affect agricultural production systems across diverse Mediterranean contexts. Using multi-objective mathematical programming, the modelling examines a set of scenarios in which water availability is progressively reduced, assessing trade-offs and synergies between economic, social, and environmental objectives.

The model incorporates multiple objectives simultaneously: maximization of farm gross margins, employment generation, and water use efficiency, while also accounting for the potential integration of non-conventional water (NCW) sources. Each LL has a specific configuration of crops, irrigation systems, and socio-economic characteristics, allowing the analysis to capture the heterogeneity of impacts across territories.

Results show that reduced water availability has differentiated impacts on agricultural performance. In the case of Spain LL, high-value vegetables and citrus are progressively replaced by crops with lower irrigation needs, such as almonds and olives, when water cuts exceed 30%, with a 40% reduction leading to more than 35% loss in farm income and comparable seasonal employment declines.

In Italy LL, reductions in rice and maize area are observed even under moderate scarcity, with substitution by rainfed cereals and industrial crops. When NCW is available, income losses remain below 10%, highlighting its potential as an adaptation strategy.

In Tunisia/Algeria LL, forage and cereal crops are the most affected under scarcity conditions in Tunisia, being replaced by more drought-resistant fruit trees; this has downstream impacts on the livestock sector due to reduced feed availability. In the case of Algeria, irrigated vegetables and citrus decline markedly, while olive cultivation expands as a lower-water-demand alternative.

Finally, in Egypt LL, rice area contracts significantly, replaced by less water-intensive cereals and horticultural crops, with potential effects on export volumes and farm-level incomes.

The integration of NCW into the scenarios mitigates some of these negative effects. In LLs with feasible infrastructure and regulatory frameworks for treated wastewater reuse, partial substitution of conventional irrigation water helps to maintain both production levels and farm employment under moderate scarcity conditions. However, the effectiveness of NCW integration varies widely depending on local technical capacities, water quality standards, and farmers' willingness to adopt these sources.

Overall, the modelling demonstrates that water scarcity impacts are highly context-specific, shaped by crop composition, technological capacity, market orientation, and access to alternative water sources. The observed crop substitution patterns under scarcity scenarios offer a clear bridge to adaptation strategies based on optimal crop reallocation, which are explored in the following section.

Table 4. Socio-economic modelling results by country

Country / Living Lab	Current system characteristics	Main modelling results
Spain LL	Intensive irrigated system with predominance of high-value vegetables and citrus.	- Under reduced water availability, high-demand crops (vegetables and citrus) decrease, while almonds and olives expand. - Significant income and employment losses occur in severe scarcity scenarios.
Italy LL	Dominated by rice and maize in irrigated areas.	With reduced water, rice and maize areas shrink, while rainfed cereals and industrial crops expand. Income losses remain moderate; NCW use mitigates impacts.
Tunisia LL	Agriculture based on cereals, forages, and fruit trees.	Cereals and forages are most affected under scarcity, replaced by more drought-resistant fruit trees. Indirect impact on livestock due to reduced feed availability.

Algeria LL	Irrigated vegetables and citrus cultivation.	Under scarcity, irrigated vegetables and citrus decline, while olives expand as a lower-water-demand alternative
Egypt LL	System with high presence of rice in irrigated areas.	Rice cultivation strongly contracts, replaced by less water-demanding cereals and horticultural crops. Impacts on farm incomes and potential exports.

Source: Deliverable 3.2.1. Multi-objective programming solutions, alternative scenarios and choice of best solution by LLs (WP3).

Overall, the modelling demonstrates that water scarcity impacts are highly context-specific, shaped by crop composition, technological capacity, market orientation, and access to alternative water sources. The observed crop substitution patterns under scarcity scenarios offer a clear bridge to adaptation strategies based on optimal crop reallocation, which are explored in the following section.

1.3. Adaptation Pathways: Optimal Crop Reallocation and Non-Conventional Water Sources

The modelling of *optimal crop reallocation* presented in Deliverable 5.2.1 builds on the type of crop substitution patterns already observed under water scarcity scenarios in the LLs but applies them systematically at the national scale. Using an optimization approach, the model compares two scenarios: i) a reference scenario, reflecting current crop distribution and associated water use (distinguishing between irrigated and rainfed systems), and ii) an optimal reallocation scenario, in which crops are redistributed within each country to maximize the use of land suitable for rainfed production and minimize BW consumption, while keeping total production and total cultivated area constant.

This reallocation is subject to key constraints: maintaining national production volumes for each crop, avoiding the conversion of non-agricultural land, respecting agroecological suitability classes, and preserving net export levels.

At the Mediterranean scale, the optimization indicates that by reallocating crops to minimize BW consumption, the irrigated harvested area decreases by 78% and BW consumption is reduced by 84%, while keeping overall production levels constant. This reduction is mainly achieved by reallocating crops in a way that fully utilizes

rainfed cropland and minimizes BW consumption. The highest savings are associated with soybeans, fruit trees, nuts, cereals, tubers, and pulses.

Table 5. Percentage variation between the crop reallocation scenario and the baseline, in terms of irrigated and rainfed harvested areas, green (GW) and BW(BW) consumption (km3) per crop for the Mediterranean area.

Crops	Variation %			
	Harvested irrigated area (%)	Harvested rainfed area (%)	BW (%)	GW (%)
Cereals	-78%	5%	-84%	-8%
Fruit trees	-83%	-11%	-91%	-32%
Nuts	-79%	138%	-86%	29%
Vegetables	-67%	64%	-62%	-4%
Pulses	-66%	27%	-79%	1%
Soybeans	-100%	-12%	-100%	-24%
Olives	-10%	2%	-78%	1%
Groundnuts	-41%	58%	-46%	60%
Sugar Crops	-44%	57%	-66%	25%
Tubers	-40%	103%	-81%	32%
Oil Palm	—	—	—	—
Total	-70%	9%	-81%	-7%

Source: Deliverable 5.2.1, Optimal crop allocation in the Mediterranean region. Pp.12.

At the national level, results align closely with the patterns identified in the LLs analysis but reveal the magnitude of change if applied countrywide (Table 2.)

Table 6. National results from optimal crop re-allocation analysis

Country	Results from the modelling of optimal crop reallocation
Spain	•Irrigated harvested area decreases by 62%, with sharp declines in high-water-demand crops: cereals, fruits, nuts, vegetables, sugar crops, and tubers. •Under the optimized scenario, irrigation accounts for only 9% of the total harvested area, and BW use represents 5% of the total crop water requirement.

	● Overall, BW demand decreases by 88% while maintaining constant agricultural productivity.
Italy	● Irrigated harvested area decreases by 87%, while BW consumption is reduced by 99%. ● Under the optimized scenario, almost 100% of current production could be sustained by rainfed cropland. ● Only small areas in the northern regions (Friuli Venezia Giulia and Trentino Alto Adige) remain under irrigation, while the rest of the cropland is cultivated under rainfed conditions
Algeria	● Irrigated harvested area decreases by 71%, while BW consumption is reduced by 94%. ● The largest reductions in irrigated area (and BW use) occur in nuts, vegetables, groundnuts, and fruits. ● Under the optimized scenario, rainfed cropland is entirely cultivated and optimally allocated across the territory.
Tunisia	● Total irrigated harvested area decreases by 45%, while rainfed harvested area contracts by 4%. ● BW consumption falls by 60%; GW consumption slightly decreases by 3%. ● Main reductions in irrigated land are observed in cereals, fruits, nuts, and pulses. ● Strong compensations appear in rainfed crops: nuts and vegetable oils. ● Irrigation becomes concentrated in vegetables and nuts, while rainfed land is dominated by cereals and oil crops.
Egypt	● Irrigated harvested area decreases by 55% compared to the baseline, while rainfed remains roughly stable. ● BW consumption is reduced by 71%, and GW by 50%. ● The largest relative declines in irrigated land occur in fruits, nuts, vegetables, and cereals. ● Some crops show sharp reductions in BW use: nuts, fruits, cereals, and tubers. ● Certain categories expand marginally in rainfed form (e.g., cereals and vegetables) but remain small in absolute terms. ● Overall, the reallocation scenario points to a drastic contraction of irrigated production in Egypt, with reliance shifting toward limited rainfed options and significant reductions in BW demand.

Source: Deliverable 5.2.1. "Optimal crop allocation in the Mediterranean region" (WP5). Pp. 11-50.

The assessment of non-conventional water (NCW) in Deliverable 5.2.1 highlights its role as a complementary measure to crop reallocation, capable of alleviating but not fully resolving the structural water challenges facing Mediterranean agriculture. Among the three NCW sources analyzed—treated wastewater, brackish water, and desalinated seawater—their potential and limitations vary across countries.

Treated wastewater is identified as the most promising option in North Africa, particularly in Tunisia and Algeria, where urban wastewater treatment plants generate relatively stable volumes located near peri-urban agricultural zones. This creates opportunities to support irrigated agriculture close to major cities. However, weak monitoring systems, insufficient infrastructure for safe distribution, and farmers' reluctance to adopt these practices constrain its broader use.

Brackish water is also recognized as a relevant source in Mediterranean contexts. In Spain and Italy, its use has already been integrated into irrigation systems, providing a critical complement to conventional resources, especially in intensive horticultural areas. Nonetheless, the need for pre-treatment to avoid soil salinization and the significant energy requirements for pumping and treatment limit its wider expansion.

Desalinated seawater emerges as another alternative, particularly in Spain and Italy, where it has potential to support high-value agricultural production in coastal zones. Its main advantage is that it is independent from rainfall variability, but its high energy intensity and costs are major barriers. In other regions, such as Egypt, desalination is mainly confined to urban and industrial uses, with limited application in agriculture.

The deliverable also emphasizes that the role of NCW must be assessed considering projected climate change impacts. As it is mentioned in before, Mediterranean countries are expected to face rising temperatures, declining precipitation, and more frequent droughts, trends that will exacerbate existing water scarcity. Under these conditions, treated wastewater reuse in peri-urban areas of Tunisia and Algeria could become an indispensable buffer for local food systems. In Spain and Italy, brackish and desalinated water are likely to continue playing a role in high-value agriculture, though their expansion will remain constrained by economic and energy costs.

Deliverable 5.2.1 suggests that combining optimal crop reallocation with targeted NCW use could reduce blue water demand while cushioning the socio-economic impacts of reduced irrigation. This dual approach connects the local-scale adjustments observed in the Living Labs with broader system-wide strategies to enhance resilience under future climate and water scarcity scenarios.

1.4. Integrated Conclusions and Policy Insights

The integrated assessment of Deliverables 5.3.1, 3.2.1, and 5.2.1 provides a coherent picture of the challenges and opportunities facing Mediterranean agriculture under climate-induced water scarcity. The combined results confirm that reductions in irrigation water availability driven by climate change scenarios will have significant and uneven impacts across the region, shaped by existing cropping patterns, technological capacity, and access to alternative water sources.

At the Mediterranean scale, modelling shows that without adaptation, water scarcity will lead to substantial losses in agricultural production value and employment, especially in irrigation-intensive systems. The spatial distribution of impacts reflects structural differences: countries with higher shares of irrigated high-value crops (e.g., Spain, Italy, Tunisia) face steeper declines, while those dominated by rainfed agriculture (e.g., parts of Algeria) are less affected in relative terms but still experience important localized shocks.

At the national and basin level, socio-economic modelling demonstrates that the effects of water scarcity are not linear. In some contexts, moderate reductions in water availability can be partially offset through improved allocation and targeted crop substitutions, as illustrated by the Po basin in Italy and Cap Bon in Tunisia. However, once reductions become more severe, such as in the Segura basin in Spain or in Tunisia's and Algeria's Wadi Lekbir basin, production and employment losses accelerate sharply. These impacts are compounded in regions where water scarcity affects strategic crops that underpin rural employment and agro-food value chains.

The crop substitution patterns observed under scarcity scenarios in the LLs align with the optimal crop reallocation results modelled at the country scale. By systematically shifting high-BW-demand crops (e.g., rice, maize, citrus) to rainfed-suitable areas or replacing them with lower-water-demand crops (e.g., olives, almonds, certain cereals), BW use could be reduced by up to 78% region-wide without reducing total output. This confirms the potential of reallocation as a proactive adaptation measure, building on reactive adjustments already visible in water-stressed systems.

The integration of non-conventional water (NCW)—treated wastewater, desalinated water, and brackish water—emerges as a key complementary strategy. While NCW alone cannot offset the scale of projected deficits, it can play a decisive role in maintaining production and employment in high-value irrigated areas, particularly in peri-urban zones and coastal regions. Its feasibility, however, depends on infrastructure investment, quality assurance, regulatory frameworks, and farmer acceptance. From a policy perspective, the combined evidence from Deliverables 5.2.1, 5.3.1 and 3.2.1 underscores the need for integrated land and water governance that first, optimizes crop spatial distribution to reduce pressure on scarce water resources, using tools such as the optimal crop reallocation modelling to guide shifts from high-BW-demand crops toward those better adapted to rainfed conditions or with higher water productivity. Second, invests in alternative water sources, prioritizing NCW development where it can deliver high economic returns per unit of water, particularly in strategic irrigated areas facing recurrent shortages. Third, ensures socio-economic resilience by incorporating the potential impacts on rural employment, farmer incomes, and agro-food value chains into all adaptation strategies, avoiding disproportionate harm to vulnerable farming systems. Fourth, embeds water scarcity scenarios into agricultural planning at both national and basin scales, ensuring that climate projections inform crop planning, infrastructure investments, and land use policies. And fifth and finally, strengthens data and modelling capacities to support continuous adaptation planning, integrating climate, hydrological, agronomic, and economic dimensions in a unified decision-support framework.

Figure 1. Core components of an integrated land & water governance framework



These measures, applied in combination, form an adaptation pathway for Mediterranean agriculture—linking resource efficiency, technological innovation, and socio-economic stability in the face of intensifying water scarcity. The modelling results from WP5 and WP3 provide a strong evidence base for such integrated strategies, highlighting the pathways through which agricultural systems can remain productive and competitive in an increasingly water-scarce Mediterranean.

1.5. Benefits of Integrated Water and Land Governance for Women

Integrated water and land governance, incorporating crop reallocation, non-conventional water sources, and coordinated planning, offers a comprehensive strategy for addressing world water scarcity while advancing gender equality. This holistic approach optimizes resource efficiency, promotes sustainable agricultural practices, and creates opportunities for inclusive decision-making that can transform traditional power structures affecting women's participation in resource management

The success of such integrated policies fundamentally depends on designing gender-responsive instruments that overcome not only technical and economic barriers, but also the institutional and cultural obstacles that limit women's access to land ownership, water rights, and agricultural decision-making (Niasse, 2017).

Participatory mechanisms become crucial for ensuring social acceptance and territorial equity, as they provide platforms for women's voices to be heard and their

traditional knowledge to be valued in resource allocation decisions. When women gain meaningful participation in integrated governance frameworks, they contribute to more sustainable resource stewardship while simultaneously advancing their economic empowerment and leadership capabilities (Rizzo et Al., 2024).

Gender-inclusive integrated governance creates multiple benefits: reducing women's time burdens through improved water access, enhancing their control over agricultural production through secure land tenure, and strengthening their resilience to climate change through diversified livelihood strategies. This approach transforms women from passive beneficiaries to active agents of sustainable development, ensuring that policy transitions promote both environmental sustainability and gender equity across Mediterranean territories.

Building on the analysis of water scarcity scenarios, the modelling of optimal crop reallocation, the identification of key elements for an integrated land–water governance framework, and the importance of introducing a gender perspective in the analysis of water and land governance, the next section turns to the perspectives of local stakeholders in each Living Lab.

Part II. The Bottom-Up Construction of Regional Policy for NCW: Initiatives, potentialities and limitations.

The aim of this second part of the deliverable is to understand how the regional and national-level scenarios identified in Part I, are interpreted, adapted, and contested at the local scale, and to capture stakeholders' views on the opportunities and constraints associated with implementing an integrated land and water policy that actively promotes the use of non-conventional water sources. This stakeholder-based analysis provides essential insights into the feasibility, acceptability, and potential pathways for translating modelling results and policy frameworks into locally grounded action.

To achieve the objective, the analysis draws on multiple sources of evidence that reflect both technical assessments and local perspectives. These include: i) the presentations and discussions held by representatives of each Living Lab (LL) during the 4th AG-WaMED General Assembly (GA) meeting in Madrid, which provided first-hand accounts of challenges and opportunities at the local level; ii) the policy briefs prepared by each LL, based on the national policy documents for NCW upscaling, which identify opportunities/ drivers, barriers, and—in some cases—strategic elements for policy design at the national scale; and iii) the national policy documents themselves (Deliverables 4.2.2) and the Integrated Water Management Plans (4.2.1.), which compile formal governance frameworks, policy gaps and strategies for the short and medium term in relation to non-conventional water use. Furthermore, to incorporate a gender perspective at the territorial scale, we examined the policy documents of the five countries that comprise the LL, with the aim of identifying the role attributed to gender within the formulation of strategies for water and land governance.

By triangulating these sources, this section reconstructs the voices of stakeholders and experts at LL level to identify key initiatives, potentials, and limitations for advancing an inclusive governance of land and water that promotes NCW use. The analysis situates these local insights within the broader scenarios outlined in Part I, considering both the promotion of NCW and the reallocation of crops as

complementary strategies to respond to projected water scarcity in the Mediterranean.

2.1. Spain – Campo de Cartagena: Consolidating NCW Use through Integrated Land and Water Governance

The Campo de Cartagena Living Lab operates in a context of high pressure on water resources, where irrigated agriculture—focused on citrus, vegetables, and other intensive crops—depends heavily on external resources such as the Tajo–Segura water transfer and on non-conventional sources like desalination and the reuse of treated wastewater. In their presentation at the 4th AG-WaMED meeting in Madrid, LL representatives stressed that *“In Campo de Cartagena, the sustainability of irrigation inevitably depends on diversifying sources and optimizing the use of non-conventional water”*. They also noted that recent changes in the water transfer operating rules have created *“a scenario of uncertainty that forces us to plan in the medium term with realistic assumptions of lower availability”*.

Regarding initiatives and installed capacities, Campo de Cartagena has one of the largest desalination and wastewater reuse infrastructures in Europe, managed by the Mancomunidad de los Canales del Taibilla and the Regional Entity for Wastewater Treatment and Reuse (ESAMUR). According to the policy brief, *“The region has invested in a treatment and regeneration system that allows water for irrigation to be available practically all year round, even under drought conditions”*. These infrastructures supply both urban and agricultural uses, enabling a partial substitution of BW with NCW. High-efficiency drip irrigation systems, irrigation modernization programs, and measures to reduce saline return to the Mar Menor have also been implemented. Within the LL, participatory workshops and modelling exercises—as mentioned in Part I of this document—have explored the feasibility of combining adjustments in cropping patterns with greater NCW use, including *“shifting high-demand crops to areas with better availability of regenerated water”* (4th AG WaMED GA Meeting).

From a governance perspective, the IWMP stresses that ensuring sustainable and affordable irrigation, connecting NCW sources with irrigated areas, addressing the environmental crisis of the Mar Menor, and overcoming regulatory and price

instability are among the most pressing issues for the region. Medium-term strategies proposed by both the IWMP and the policy brief build directly on these challenges. They include:

- Aligning hydrological and land-use planning to incorporate NCW
- Reducing the energy and carbon footprint of desalination and regeneration
- Creating economic incentives and regulatory mechanisms for stable blending of different sources
- Investing in research on water-efficient crops
- Strengthening inter-administrative coordination and participatory governance
- Promoting awareness and training to build confidence in NCW
- Reforming regulatory frameworks to ensure price stability and facilitate investment.

Nevertheless, limitations and barriers remain significant. Technical and economic constraints include the high energy cost of desalination, insufficient storage and distribution capacity for NCW, and the need for investment to integrate these sources seamlessly into agricultural operations. As LL representatives stated: *“Having regenerated water is not enough; we need to be able to deliver it where it is needed, with the right quality and at the right time”* (4th AG WaMED GA Meeting). Institutional challenges stem from tensions in managing the Tajo–Segura transfer, divergences between national and regional policies, and the continued separation of territorial and hydrological planning. Finally, while social acceptance of NCW is generally high, concerns persist regarding water quality and the potential impacts of crop changes on agricultural employment and agri-food value chains.

In sum, the Campo de Cartagena LL stands out as a Mediterranean reference in infrastructure and NCW experience. Its consolidation as a model for integrated land and water governance will depend on overcoming technical, economic, and institutional barriers, as well as capitalizing on identified strategies to effectively combine crop reallocation with the expansion and optimization of non-conventional water use, in a way that also addresses environmental impacts and socio-economic resilience.

2.2. Italy – Val d’Orcia: Governance Challenges and Strategies for NCW and Water Storage

The Val d’Orcia Living Lab, located in the Tuscany Region, is increasingly exposed to water stress due to recurrent summer droughts, declining winter rainfall, and competition among agricultural, domestic, and environmental uses. Stakeholders have stressed the urgency of expanding water storage capacity through Small Agricultural Reservoirs (SmARs) and of improving institutional coordination in water governance.

The barriers to NCW promotion are not only regulatory and technical, but also institutional and social. Authorization processes for new infrastructures are long and complex, involving overlapping competences between regional and national administrations, combined with strict environmental and landscape regulations (D.4.2.1 & D.4.2.2.). Uncertainty regarding the legal status of treated wastewater and aquifer recharge further discourages adoption. Financial and technical constraints limit the capacity of small farms to invest in SmARs without subsidies or collective arrangements. Sedimentation reduces the capacity of reservoirs and requires costly interventions, while governance fragmentation between farm-level systems, irrigation consortia, and public infrastructure hinders coordination at the basin scale (IWMP Italy). In addition, the LL experience in the Italian case, showed that the difficulty of engaging different stakeholders—particularly local farmers—affects the co-design of integrated plans. While observed in the Living Lab, this lack of participation can be extrapolated as a broader obstacle for the formulation of NCW promotion policies at the regional scale.

At the same time, several opportunities or drivers can support change. Specially, a growing recognition of the need to expand storage, the advocacy role of farmer associations and reclamation consortia, and national and regional policy instruments such as Piano Invasi, Decreto Siccità, and the Tuscany Rural Development Program (D4.2.2.). The idea of shared reservoirs for smallholders is also considered promising, if rules for water allocation are clearly defined to prevent conflicts.

The Integrated Water Management Plan and the LL process outlined medium-term measures to address these challenges, in order to “*move from emergency*

interventions to a more preventive planning logic” (4th AG-WaMED GA). Among the most relevant measures were:

- simplifying procedures for new reservoirs by embedding them in Basin Plans and shifting from emergency to preventive planning
- strengthening technical assistance for SmARs with advisory services coordinated by consortia and farmers’ associations
- promoting land and soil conservation practices to mitigate sedimentation
- advancing alternative irrigation sources, particularly treated wastewater and aquifer recharge, through partnerships with research centers, universities, and utilities
- developing models of shared reservoirs for small farms with clear conflict-prevention mechanisms
- reinforcing multi-stakeholder platforms, aligned with the Water Framework Directive, to embed NCW into broader governance strategies

Although this document does not propose a formal crop reallocation strategy, discussions within the LL acknowledged the need to link crop choices to water availability. Evidence from the IWMP shows that unmet irrigation demand is particularly significant for vineyards and also relevant for olive groves, suggesting that priority could be given to high-value, less water-demanding perennial crops, while reducing irrigated cereals under conditions of scarcity (IWMP Italy).

In sum, the Val d’Orcia case illustrates that technical solutions such as SmARs, treated wastewater reuse, and soil conservation require supportive regulatory and institutional conditions to be effective. Adaptation to water scarcity demands not only the expansion of water supply, but also a reorientation of agricultural production and the strengthening of cooperative governance. The future of these initiatives will depend on sustained institutional support, improved stakeholder engagement, and stronger linkages between local innovations and national and regional policy frameworks.

2.3. Egypt – Naghamish and El-Kheir Wadi Living Lab: NCW Strategies and Governance Challenges in a Rainfed System

The Naghamish and El-Kheir Wadi Living Lab, located on Egypt's north-western coast, exemplifies the severe water scarcity that characterizes arid agricultural systems. Average rainfall in the basin is about 130 mm/year, which makes agriculture highly vulnerable to climatic variability. Local production is largely rainfed, focusing on olives, figs, and cereals, while farmers rely on small dikes, cisterns, and runoff harvesting to secure water for domestic and agricultural use. Groundwater potential is limited and often affected by salinity, which further constrains water availability. These conditions turn water scarcity into a governance challenge, since inequalities in access, limited infrastructure, and weak user participation exacerbate local vulnerabilities (D.4.2.1.).

Within the Living Lab, participatory workshops and modelling exercises illustrated both the urgency of the problem and the limits of current practices. Stakeholder engagement was challenging, particularly with Bedouin farmers who were not familiar with scientific modelling tools, which reduced the possibility of developing a genuinely co-designed plan. Cultural resistance to the use of treated wastewater also emerged, as local actors questioned its appropriateness for agriculture. Another governance barrier is the exclusion of women from decision-making, which participants themselves recognized as a limitation that undermines inclusive water governance and the legitimacy of proposed strategies (Egypt LL, 4th GA Meeting).

To address these challenges, the IWMP and the Policy Brief for Egypt propose three main lines of action for the medium- and long-term strategy:

- expanding and rehabilitating rainwater harvesting structures (dikes and cisterns)
- piloting the safe reuse of treated wastewater for agriculture
- implementing soil and water conservation practices to protect fragile soils and maximize limited runoff
- Crop diversification was also recommended, particularly by promoting drought-tolerant olive varieties and gradually reducing barley and wheat in areas where declining rainfall undermines their viability.

At the national scale, the policy document stresses the strategic importance of expanding treated wastewater reuse and desalination as part of Egypt's 2030 and

2050 water strategies. These represent key drivers, reinforced by donor support and strong political prioritization of NCW. Yet barriers remain significant: technical constraints include the high costs and logistical demands of desalination and wastewater reuse; economic obstacles stem from the limited ability of small farmers to invest without subsidies; and institutional fragmentation continues to hinder effective policy implementation.

In synthesis, the promotion of NCW in Egypt is enabled by national strategies, political commitment, and donor support, while local rainwater harvesting traditions provide additional entry points. However, progress is constrained by technical and economic costs, regulatory fragmentation, and cultural resistance to wastewater reuse. In the Naghamish and El-Kheir Wadi LL, these broader obstacles are compounded by difficulties in farmer engagement and the exclusion of women from decision-making, highlighting the governance challenges that must be overcome if NCW is to become a viable pillar of water security.

2.4. Tunisia–Algeria – Wadi Lekbir Living Lab: Managing Water Scarcity through NCW and Cross-Border Cooperation

The binational Living Lab of the Wadi Lekbir basin, spanning Tunisia (Gafsa) and Algeria (Tébessa), highlights the shared challenges of water scarcity and the management of transboundary aquifers. The area is characterized by irrigated and rainfed agriculture under highly variable climatic conditions. As underlined during the Madrid meeting, “we tried to explore the climate change scenarios for 2050... precipitation was heavily reduced from almost 200 millimeters to 72 millimeters... we know that there is certainly a climate change with reduced precipitation, but also more potential evapotranspiration exceeding 2000 millimeters” (Tunisia–Algeria LLs 2, 4th GA Meeting). This scenario projects a critical reduction in rainfall and increased evaporative demand, threatening both crop viability and aquifer recharge.

In this context, non-conventional water (NCW) emerges as a strategic alternative. On the Tunisian side, the legal framework is more consolidated, and about one-third of treated wastewater is already reused, mainly in fodder, olive groves and green areas. On the Algerian side, despite a wide network of treatment plants, the volume effectively reused in agriculture remains low due to quality, distribution and

acceptance issues. The LL also documented the dual role of the wastewater treatment plant located at the lower end of the watershed: “at the end of the watershed we have at least a wastewater plant... it’s a tertiary level, so it’s relatively clean water and safe to be used for irrigation... for the moment it is partly used for irrigation and the rest is diverted and indirectly recharging the aquifer” (Tunisia–Algeria LLs 2, 4th GA Meeting).

The Integrated Watershed Management Plan (IWMP) sets out a package of medium-term measures, including:

- rehabilitation of water harvesting and soil conservation infrastructure
- expansion of agricultural reuse of treated wastewater, with stronger quality monitoring
- pilot projects on blending water sources and artificial aquifer recharge
- diversification towards less water-demanding and salt-tolerant crops
- and strengthening binational coordination in the management of shared aquifers.

The participatory process involved a wide range of actors, including authorities, development agencies, farmers, research teams and students. While women represented around one-third of participants, they remain underrepresented in decision-making spaces on water management, illustrating a persistent limitation of inclusive governance in the basin.

Drivers differ between the two sides. In Tunisia, they include a consolidated legal framework for wastewater reuse, the integration of NCW into national soil and water conservation strategies, and the availability of subsidies and tariff incentives. In Algeria, state investment in treatment plants and political support for expanding their agricultural use stand out, alongside opportunities for technical cooperation with Tunisia.

Barriers are also significant: lack of effective coordination between water, agriculture and environment sectors; financial limitations for expanding distribution networks; cultural resistance and mistrust toward the agricultural use of treated wastewater; and the absence of stable mechanisms for binational cooperation. As recalled in the

IWMP presentation, “the plan has to be presented in the same way as the national strategy, so it needs alignment with the national programs for soil and water conservation” (Tunisia–Algeria LLs 2, 4th GA Meeting), reflecting the need to link local initiatives to national regulatory and financial frameworks to ensure sustainability.

In sum, the Wadi Lekbir LL illustrates differentiated but complementary trajectories: Tunisia with stronger institutions and effective reuse of NCW, and Algeria with extensive installed capacity that remains underutilized. Both countries face technical, economic, institutional and social limitations, but also share opportunities to move towards integrated governance that combines soil conservation, wastewater reuse, and effective transboundary cooperation.

2.5. Concluding Insights: NCW and the Governance of Water Scarcity Across Living Labs

Across all cases, the promotion of non-conventional water (NCW) use emerges as a critical adaptive strategy, yet its implementation is conditioned by technical, economic, institutional, and social factors that vary widely between contexts. In Italy, the debate on water scarcity highlighted the complexity of regulatory frameworks and the difficulty of engaging farmers in co-design processes, pointing to governance gaps that limit the effectiveness of Small Agricultural Reservoirs and wastewater reuse unless accompanied by preventive planning and institutional coordination. In Spain, the Campo de Cartagena case underscored how NCW infrastructures can reach high levels of maturity, yet their integration is hampered by the fragmentation between water and land-use planning, price instability, and persistent tensions around major transfers—illustrating the need to embed NCW in broader governance frameworks that ensure environmental sustainability and social acceptance.

The Egyptian Living Lab, located in a hyper-arid context, demonstrated how reliance on traditional rainwater harvesting is no longer sufficient, and how wastewater reuse and desalination must become pillars of adaptation. Yet it also showed how social acceptance, financial limitations for smallholders, and the exclusion of women from decision-making represent barriers that cannot be overlooked if governance is to become truly inclusive and effective. Finally, the transboundary case of

Tunisia–Algeria highlighted the importance of scale: while both countries are investing in NCW, their trajectories diverge—Tunisia with a more consolidated legal framework and higher reuse rates, Algeria with extensive but underutilized treatment capacity. The absence of formal mechanisms for cross-border governance underscores how institutional fragmentation remains a structural barrier when water systems transcend national boundaries.

Taken together, these locally grounded perspectives underline that effective integrated governance depends on aligning NCW promotion with crop management decisions, territorial planning, and socio-economic resilience. They also demonstrate that technical solutions alone cannot secure adaptation: what matters is the capacity to engage stakeholders, build trust in NCW, ensure coherence between local plans and national strategies, and address equity and inclusion—especially in contexts where marginalized groups or border regions are at stake.

2.6. The integration of the gender dimension into land and water governance: a policy review

Gender mainstreaming involves integrating gender perspectives systematically into all stages of policy development, from design to evaluation, to ensure equitable outcomes for women and men. This strategic approach recognizes that policies are not gender-neutral and requires deliberate analysis to address existing inequalities while preventing the creation of new disparities (European Commission, 2008).

In land policies, gender mainstreaming addresses the reality that women globally hold fewer land rights despite their significant agricultural contributions. Implementation strategies include reforming inheritance laws, establishing joint land titling, ensuring women's representation in land administration bodies, and creating accessible dispute resolution mechanisms (FAO, 2021). Water policy mainstreaming recognizes women's disproportionate responsibility for water collection and vulnerability to water safety while having limited decision-making authority. Gender-responsive approaches require designing infrastructure that reduces time burdens, ensuring women's meaningful participation in water user associations, and collecting sex-disaggregated data for monitoring impacts (Seager, 2015).

The analysis of the policies in the 5 countries of the living labs from a gender mainstreaming point of view, highlighted that they have not been developed on the basis of the country situation regarding gender equality. This is often a consequence of a lack of sex disaggregated data informing the policy makers.

Egypt's policy framework for water and land management reveals significant gender-neutral approaches that fail to address women's distinct roles and challenges in resource governance (Ibrahim Huber, n.d.). While the Ministry of Water Resources and Irrigation (MWRI) has acknowledged the need for greater women's involvement in water resource allocation, distribution, operation, and maintenance, no specific policies or regulations mandate female participation in water user associations. The executive regulations for irrigation improvement programs do not stipulate female membership requirements, resulting in male-dominated water user associations even in areas with female landowners (El Kady et al., 2004).

Land management policies do not take into account the fact that women are responsible of water management at domestic level and that cultural norms often prevent them from own and inherit land, with consequences on access to water for irrigation.

Policy gaps are particularly evident in institutional frameworks. Despite establishing gender units in every ministry to work with the National Council for Women (NCW), these units remain isolated, under-resourced, and lack mandates to mainstream gender across sectoral activities (El Kady et al., 2004). Additionally, agricultural policies fail to recognize women's substantial contribution (comprising 45% of the official workforce and over 50% engaged informally) in national statistics and resource allocation decisions (FAO, 2023).

A notable exception in gender inclusion appears in "The National Implementation Plan for Persistent Organic Pollutants" (Law 4 of 1994), which represents a more progressive approach by explicitly incorporating gender dimensions within broader environmental planning. The plan mandates cooperation with "women's groups" and childhood associations in developing, implementing, and updating implementation strategies. It emphasizes targeted public awareness campaigns, particularly for women and children, regarding persistent organic pollutants (POPs) and their health

and environmental impacts. The framework includes comprehensive training programs for workers, scientists, women's organizations, and administrators on POP management protocols. Significantly, the National Implementation Plan Review and Update Committee incorporates members from the NCW, ensuring institutional gender representation in environmental policy oversight and revision processes.

Recent legislative developments show mixed progress. While Law No. 144 of 2020 mandates 25% female representation in the House of Representatives, similar quotas are not applied to water governance bodies. The absence of gender-sensitive agricultural policies that comply with Article 14 of CEDAW remains a critical gap, despite FAO recommendations for institutional arrangements addressing rural women's empowerment (FAO,2022). Water user associations interventions have achieved only 15% female membership despite targeting 25%, highlighting the persistence of structural barriers that policies have yet to address through comprehensive gender-responsive frameworks (Ibrahim Huber, n.d.).

Algeria's policy framework for water and land management demonstrates limited explicit gender integration despite institutional commitments to women's advancement. The country established the Ministry for Family Affairs and the Advancement of Women reporting directly to the head of government, with mandates to develop women's capacities and foster their participation in political, economic, social and cultural life. In 2008, Algeria adopted the "National Strategy for Promotion and Integration of Women" which confirms the country's commitment to women's participation in all development processes and their role in family stability and social cohesion (Global Water Partnership & UNEP-DHI Centre on Water and Environment, 2021).

However, water and agricultural legislation remain largely gender-neutral. Despite the comprehensive Water Law 05-12 (2005) establishing integrated water resource management principles, no specific provisions mandate women's participation in water user associations or irrigation management bodies. Agricultural policies similarly lack gender-responsive frameworks, despite women comprising a significant portion of the agricultural workforce, particularly in rural areas where feminization of agriculture has increased due to male out-migration (FAO,2024).

Tunisia's formal adoption of the National Gender and Climate Change Action Plan in 2022 represents a significant milestone, developed collaboratively by the Ministry of Local Affairs and Environment, Ministry of Family, Women, Childhood and Elderly Affairs, and UNDP. The plan employs an intersectional feminist political analysis framework combined with socio-economic analysis, recognizing that climate impacts affect women and men differently due to existing social, economic, and cultural inequalities (Achakpa et al., 2023).

Key policy innovations include gender-responsive budgeting mechanisms. The Ministry of Finance has demonstrated commitment through the "Gender Budget Analysis Report (2010-2021)" and "Guidance Note on Climate-sensitive Budgeting" (2024), indicating systematic efforts toward gender-sensitive financial planning (Gestion du Budget par Objectifs, 2024).

However, significant implementation challenges persist. The implementation of gender mainstreaming in water policies remains fragmented. The Water Code of 1975 and subsequent regulations lack specific gender provisions, despite women's crucial roles in rural water management (FAO, n.d.).

Traditional governance structures and cultural barriers continue to limit women's participation in decision-making processes, particularly in rural water management and agricultural planning.

Critical gaps remain in translating policy commitments into concrete outcomes. While the framework prioritizes institutionalizing gender-sensitive practices and ensuring women's representation in planning bodies, practical mechanisms for enforcement and accountability require strengthening. The challenge lies in overcoming entrenched gender inequalities while building institutional capacity to implement comprehensive gender mainstreaming across climate and resource governance sectors (Besser et al., 2025).

Italy demonstrates significant institutional commitment through its first National Strategy for Gender Equality 2021-2026, providing overarching framework for gender integration across governmental sectors (Presidenza del Consiglio dei Ministri, Dipartimento per le Pari Opportunità, 2024).

Water sector integration remains limited with domestic water legislation lacking explicit gender provisions.

Legislative Decree 152/2006, which regulates various environmental matters, is based on a constitutional framework that explicitly requires regional laws to promote equality between men and women (Presidenza del Consiglio dei Ministri, n.d.).

Spain demonstrates the most advanced legislative framework among Mediterranean countries. Environmental policies show innovative gender integration through the 2020-2024 Just Transition Strategy, ensuring equal opportunities in ecological transition with gender clauses in public calls and targeted female entrepreneurship support (European Institute for Gender Equality, 2024).

Law 45/2007 on the Sustainable Development of the Rural Environment represents an attempt at social integration, providing for “preferential attention to women, young people and the elderly, as key population groups for the future of rural areas.” (FAO, n.d.) However, this wording remains generic, without specific implementation mechanisms for women’s participation in rural decision-making processes (Sutherland et al., 2018).

Water policy shows limited explicit gender integration despite comprehensive legal frameworks providing strong foundations for addressing persistent inequalities.

Both Spain and Italy demonstrate significant progress in integrating gender equality within the Common Agricultural Policy 2023-2027, marking the first time that gender mainstreaming has been explicitly included as a specific objective across European CAP Strategic Plans (European Commission, 2023).

At the same time, the two countries face persistent implementation challenges despite progressive frameworks. Research confirms that women farmers in both Spain and Italy encounter systemic barriers accessing rural development programs, with female participation rates remaining below 30% in many initiatives despite comprising significant portions of agricultural workforces (Pérez-Morote et al., 2024; Adinolfi et al., 2020).

Building on the localized and situated understanding, the next section shifts the focus from the local to the regional scale, exploring the Mediterranean-wide constraints and potentials for advancing integrated water and land governance policies that incorporate NCW as a central component.

Part III. From Local Insights to a Mediterranean Perspective on Integrated Land and Water Governance

Building on the locally grounded findings from Part II, this section scales up the analysis to the Mediterranean region, seeking to articulate how the lessons, challenges, and opportunities identified at the Living Lab (LL) level resonate and interact at the regional scale. The objective is to provide a broader perspective on the prospects for an integrated land and water governance framework that actively promotes the use of non-conventional water (NCW) across the Mediterranean.

Three main sources inform this regional synthesis: (i) the systematic review and synthesis of existing literature on crop allocation and its implications for water governance in Mediterranean contexts, (ii) the analysis of semi-structured interviews conducted with key regional stakeholders and experts involved in water policy, transboundary management, and sustainable agriculture, and (iii) the insights and comparative policy gaps identified in previous WP4 deliverables. By integrating these inputs, the section aims to reconstruct a regional overview that identifies shared opportunities, systemic constraints, and potential policy pathways for upscaling integrated land and water governance that incorporates NCW into adaptation strategies for increasing water scarcity.

3.1. Literature Review: Water Scarcity, Crop Responses, and Governance in the Mediterranean

This literature review opens Part III and frames the discussion in dialogue with the modelling evidence presented in Part I (WP5). It is organized in two complementary axes: (1) studies that assess future water scarcity and crop responses in the Mediterranean—covering irrigation requirements, supply–demand reliability, and measurement issues; and (2) contributions focused on governance—examining institutional architectures, allocation and drought rules, multi-level coordination, decision-support tools, and conditions for scaling non-conventional water (NCW). This structure grounds policy analysis in empirically documented resource constraints before turning to the institutional mechanisms through which those constraints are managed.

3.1.1. Future water scarcity and crop impacts in Mediterranean agriculture

A growing body of work documents how warming and more frequent extremes increase pressure on Mediterranean farming systems, with implications for irrigation requirements and yields (Soares, Paço, & Rolim, 2023). At the European scale, the Commission's PESETA agriculture assessment (Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis) identifies Southern Europe as particularly constrained by irrigation water availability—even when adaptation is considered—underscoring water's centrality for maintaining agricultural activity (Iglesias, Garrote, Quiroga, & Moneo, 2009). Basin- and reservoir-scale applications reinforce this picture by showing how climate and land-use pressures can erode supply reliability and raise irrigation demand, increasing the likelihood of supply-limited years and compounding water-quality risks (Nunes, Jacinto, & Keizer, 2017).

Methodologically, studies rely predominantly on deterministic modelling to translate climate signals into irrigation demand and yield effects, and they differ in how they represent crop calendars and adaptation behaviour. Reviews highlight that contradictory results can arise depending on scenarios and approaches, so uncertainty should be treated explicitly rather than inferred from single model point estimates (Soares et al., 2023). At the system scale, basin–reservoir applications in Mediterranean settings reach consonant conclusions: scarcity outcomes hinge on storage, network connectivity, operating rules, and land-use interactions, which jointly shape supply–demand reliability and water-quality risks (Nunes, Jacinto, & Keizer, 2017).

On the agronomic side, two families of responses recur. First, deficit-based irrigation aims to save water while keeping yield losses within acceptable bounds. In deficit irrigation (DI) farmers apply less water than the full crop requirement over the season; in regulated deficit irrigation (RDI) they concentrate the shortfall in growth stages that are less sensitive, protecting critical phases; and in partial root-zone drying (PRD) they alternately irrigate one side of the root zone and then the other. Reviews show that, when carefully scheduled and monitored, these strategies can improve water productivity (more output per cubic metre) and, in perennial crops such as fruit trees and vines, sometimes even enhance product quality; however,

they require reliable information on crop water status and timing to avoid undue yield penalties or soil salinity risks (Ferreles & Soriano, 2007; Chartzoulakis & Bertaki, 2015). Second, phenology and management adjustments—for example, shifting sowing dates, adopting earlier-maturing cultivars, or integrating supplemental irrigation where appropriate—are widely cited as feasible ways to moderate irrigation growth and contain climate-induced yield losses. Their effectiveness is context-specific (crop, soil, and local climate), which is why comparative reviews recommend presenting results as ranges that reflect plausible management rather than single point estimates (Soares, Paço, & Rolim, 2023; Chartzoulakis & Bertaki, 2015).

Methodological Comparability and Governance Implications

Cross-study comparability is hindered by non-uniform metrics and divergent management assumptions. To make reported “savings” and productivity gains auditable across territories, measurement should be anchored in actual crop evapotranspiration (ET)—that is, the consumptive water flux leaving the system as soil evaporation plus plant transpiration—rather than in volumes applied at field level; ET-based accounting ensures that efficiency gains correspond to system-level water savings (Katerji et al., 2008). Projections should be communicated as scenario bands with explicit management assumptions (e.g., status-quo vs. adaptive calendars), and those bands can be translated into allocation and drought rules via clear triggers (Soares et al., 2023; Iglesias et al., 2009). Since scarcity outcomes also depend on system design—storage, interconnections, operating priorities, and land-use interactions—institutions need monitoring, advisory and decision-support capacities to operationalize scheduling and reliability constraints at basin–reservoir scale, and to integrate non-conventional water (NCW) without unintended quality or equity effects (Nunes et al., 2017; Chartzoulakis & Bertaki, 2015).

3.1.2. Governance dynamics shaping land–water integration and NCW uptake in the Mediterranean

This section sets out the main contributions of the academic literature regarding the governance challenges of water and land in the Mediterranean region. In this regard, the findings draw on elements previously highlighted in Deliverable 4.1.1, focused

primarily on: difficulties in the application and enforcement of regulations; limits and ambiguities of existing rules; strategic uses of regulation; regulatory absences; and NCW-specific challenges (quality standards, costs/pricing, implementation constraints, public distrust).

A first group of contributions situates Integrated Water Resources Management (IWRM) as the prevailing paradigm, while documenting uneven implementation. The NOSTRUM-DSS initiative is emblematic: it sought to link science–policy–society, foster stakeholder involvement, and co-develop best-practice guidelines for decision-support systems (DSS) to make IWRM actionable in Mediterranean countries (north and south). Yet, the same assessments stress that DSS potential remains underused due to weak interaction between policymakers and researchers and the persistence of centralized, engineering-centric planning cultures; consequently, participatory DSS tools are rarely embedded in actual decision processes (Sgobbi & Fraviga, 2007). In parallel, progress towards IWRM has been partial: legal reforms exist, but monitoring/enforcement strategies are often unclear and overlapping institutional competences hamper effective implementation.

A second line of work highlights political-economy trade-offs in irrigation modernization. Evidence compiled in the Mediterranean overview by Sanchis-Ibor et al. (2020) points to the “paradox of modernisation”: higher on-farm water-use efficiency can be accompanied by higher energy demand and contentious cost-recovery dynamics in collective schemes (e.g., Valencia), raising distributional and financial sustainability questions for users and operators; desalination appears as a strategic source in south-eastern Spain but introduces further governance debates around pricing and allocation across sectors. These patterns resonate with older IWRM diagnostics about incomplete shifts from supply- to demand-side policies, limited participation, and reluctance to full cost recovery (Sgobbi & Fraviga, 2007).

A third set of studies documents scalar mismatches between formal rules and everyday practice. Using a Social-Ecological Systems (SES) lens in southern Portugal, Homobono et al. (2022) find deficits in integrated development strategies and communication among actors, few durable science–practice networks, and conclude that place-based, tailored policies are needed to bridge national/regional

frameworks and municipal realities. They further note that national or regional management has not accounted for municipal specificities, reinforcing the call for inter-municipal coordination and locally grounded cooperation within large basins.

At regional scale, the governance architecture remains fragmented. Argemí Ribalta (2022) argues that States tend to use the Union for the Mediterranean (UfM) to strengthen national agendas rather than to build a collective governance framework, which weakens region-wide coordination and leaves cooperation mainly to state-to-state diplomacy; suggested improvements include greater national ownership paired with broader actor inclusion to raise accountability and commitment.

Across the Mediterranean, the literature converges on a common set of NCW governance challenges: a demanding regulatory architecture—notably the EU water-reuse framework, which introduces quality classes, monitoring, and risk-management plans—whose practical implementation strains local administrative capacity (European Union, 2020; Efthimiou, Giotis, & Ragkos, 2025); cost and pricing constraints that shape feasibility for reuse and desalination and raise distributional questions in collective schemes (Efthimiou et al., 2025; Sanchis-Ibor et al., 2020); implementation gaps and coordination needs across water, agricultural, and environmental authorities (Efthimiou et al., 2025); and public acceptance hurdles that hinge on risk perception and trust and require sustained communication and engagement (Fielding, Dolnicar, & Schultz, 2019; Chartzoulakis & Bertaki, 2015). In Spain, for example, these tensions are especially visible in debates over desalination's socio-environmental impacts and user perceptions of reclaimed-water quality, which condition uptake despite the strategic role attributed to NCW (Sanchis-Ibor et al., 2020).

Across these sources, three conclusions recur. First, governance reform is decisive: allocation/pricing rules and enforcement capacity determine whether efficiency gains become system-level savings and equitable access. Second, institutional integration remains partial and often centralized, with participation uneven and competences overlapping, conditions that blunt adaptation measures, including NCW. Third, place-based coordination and data-supported deliberation (DSS within IWRM) are

enabling conditions to align day-to-day practice with basin- and Mediterranean-scale objectives.

3.1.3. Gender and Resource Governance in the Mediterranean: Literature Review and Regional Insights

Finally, a group of works centers gender within resource governance—particularly of water and land—at the scale of the Mediterranean. These documents show that participation, authority and knowledge are not gender-neutral: who is represented, whose practices are recognized, and how benefits and burdens are distributed directly shape the feasibility and equity of allocation and drought rules, demand-management instruments, and the uptake of non-conventional water (NCW). Introducing this lens clarifies how institutional arrangements condition adaptive capacity and the social legitimacy of land–water decisions in the region.

Mediterranean governance literature indicates that gender is a cross-cutting determinant of how land–water decisions are made and by whom.

The inclusion of gender perspectives within land and water governance is increasingly recognized as a cornerstone of effective and sustainable resource management in the Mediterranean region (Hamdy et al., 2024). The literature demonstrates that resource governance structures often reflect (and perpetuate) deep-seated gender inequalities, which influence women's access to land, water, decision-making power, and the distribution of benefits from natural resources (UN WOMEN & OHCHR, 2013). Policies and institutional mechanisms commonly remain “gender-blind”, underestimating the unique expertise and use-practices women bring to the stewardship of land and water (Taing et al., 2022)

Empirical insights from both southern European and North African contexts highlight the multi-layered nature of gender disparities. For example in the Middle East and North Africa (MENA) region, and specifically in Egypt, despite growing international attention towards gender inclusion in water resource management, local policies and practices struggle to translate this approach into concrete actions. This delay is attributed to a lack of analytical tools, a comprehensive conceptual framework, appropriate implementation plans, and gender performance indicators, in addition to the weak role of irrigation institutions and agencies (Minoia, 2007).

Women's vulnerabilities and perceptions about resource management are not considered in determining the contents of the water and land policies.

The absence of gender-sensitive approaches in resource governance is not merely an issue of equity; rather, it poses a significant barrier to the long-term sustainability and resilience of rural systems (Amulya Jeevanasai et al., 2023).

Studies across the Mediterranean repeatedly demonstrate that women possess essential local knowledge regarding land fertility, crop cycles, and water conservation, yet their exclusion from governance processes undermines the efficacy of management strategies and restricts innovation. Furthermore, when projects adopt transformative gender mainstreaming, moving beyond symbolic inclusion, they succeed in fostering social cohesion, economic opportunity, and improved resource outcomes (Quagliariello et al., 2016) (Seghirate, 2017).

In sum, the literature underscores that integrating gender perspectives from policy-making to practical implementation is critical for delivering on the Mediterranean's commitments to social justice and the sustainable management of land and water resources. Meaningful change requires not only legislative reforms and institutional support, but also ongoing engagement with local communities to challenge ingrained biases and empower women as active agents of governance and innovation.

On the basis of the systematization conducted, an emerging field of debate can be identified around: (i) future water-scarcity scenarios and associated agricultural change; (ii) the governance challenges these dynamics pose for land–water management and, specifically, for the use and promotion of non-conventional water (NCW); and (iii) the gender gaps that persist in these sectors at both regional and local scales. This synthesis closes the review and provides the frame for the subsequent sections of Part III.

3.2. Perspectives from Mediterranean Water Governance Actors

This section aims to complement the literature review presented earlier by incorporating the perspectives of key actors from Mediterranean organizations engaged in water policy and management. This section draws on semi-structured

interviews with members of European and Mediterranean organizations responsible for water and environmental management (3), representatives of non-governmental organizations working on water issues in the region (2), and academic experts in water governance (3). It synthesizes their evaluations of the current state of integrated land–water governance in the Mediterranean and its near-term prospects. The analysis focuses on their assessments of current governance structures, perceived obstacles, potential opportunities, and concrete recommendations for overcoming existing gaps—particularly in relation to water scarcity, crop reallocation, and the promotion of non-conventional water sources (NCW).

3.2.1. Diagnosis of Land and Water Governance in the Mediterranean

Across interviews, there is broad agreement that integrated governance of land and water in the Mediterranean remains more an aspiration than an operational reality: *“Integration is often mentioned in policy documents, but it is rarely embedded in the institutional routines that determine how land and water decisions are actually made”* (Interview to European organization on water and environment, 03 July 2025). In practice, **decision-making is still sectoral and frequently centralized**: water administrations work through hydrological planning instruments (river basin management plans, flood risk management plans, special drought plans), while land-use planning follows separate legal procedures and calendars under territorial authorities. Lack of transparency in hydrological planning and unclear allocation of responsibilities are repeatedly noted as limiting coordination and accountability, which makes day-to-day articulation with territorial planning uneven (Deliverable 4.1.1).

These misalignments become most visible when authorities try to synchronize planning cycles across sectors, which, as one interviewee stressed, *“operate to different timelines and follow different priorities”* (Interview to Mediterranean organization on water, 7 July 2025). Even where methodological harmonization exists within the water domain (e.g., common instructions for basin planning), multi-level competences and divergent procedural requirements still make alignment demanding in practice (Deliverable 4.1.1).

3.2.2. Main Obstacles

Institutional fragmentation and scale mismatches. Stakeholders unanimously identify fragmentation—horizontal (across ministries and agencies) and vertical (local–regional–national)—as a primary obstacle. Country syntheses document overlapping competences and, in several southern contexts, **centralized decision cultures** that restrict local participation; in northern settings, sector-specific procedures complicate cross-sector coordination and blur accountability. As one interviewee put it, *“when water management is addressed separately from land management, you miss the opportunity to align incentives and avoid conflicts”* (Interview to Mediterranean organization on water governance, 11 July 2025).

Institutional inertia and short political cycles. Interviewees pointed to slow adaptation of governance structures and shifting priorities under electoral cycles: *“short-term political agendas rarely match the long-term horizon needed for integrated water and land planning”* (Interview to European organization on water and environment, 03 July 2025). In parallel, notably special drought plans, are activated recurrently. Although drought/scarcity indicators have been standardized more recently within basin organizations, embedding longer-horizon adaptation into routine planning remains challenging (Deliverable 4.1.1).

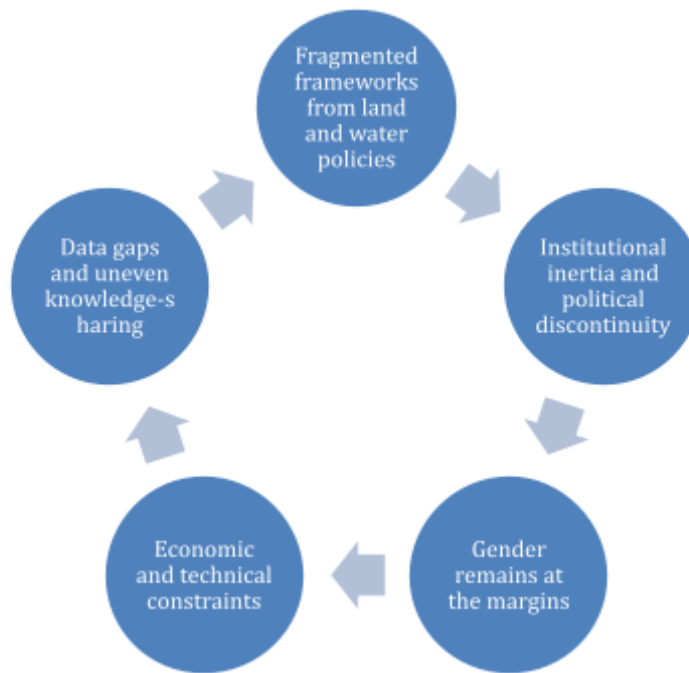
Data transparency and indicator harmonization. Interviewees emphasized disparities in data availability and access: *“some countries still treat water data as a politically sensitive resource”* (Interview to Mediterranean organization on water governance, 11 July 2025). To clarify what “harmonizing indicators” entails in practice, Spain’s recent approach is illustrative: river basin authorities apply a unified system that distinguishes (i) a prolonged-drought index (climatic–hydrological signal based on precipitation, inflows, storage) and (ii) scarcity indices calculated at the level of supply systems (operational units within each basin) reflecting supply–demand balance. Indices are published monthly, linked to four operational states (normal, pre-alert, alert, emergency), and trigger predefined measures in Special Drought Plans; they are also tied to common methodological instructions in basin hydrological planning. This has improved temporal and cross-basin comparability and reduced discretion in activating measures, though differences

persist in sub-basin granularity and open-data practices across demarcations (Deliverable 4.1.1).

NCW promotion: costs, quality standards, implementation capacity and acceptance. *“You can’t promote reuse or desalination without simultaneously investing in storage, distribution, and quality monitoring,”* an NGO interviewee noted. (Interview to NGO on water governance 28 July 2025). Region-wide patterns align with this view. For wastewater reuse, strict quality parameters and extensive monitoring raise costs and complicate implementation, with cost-sharing between municipal services and agriculture often unresolved; trust and acceptance hinge on credible certification and risk communication (Deliverable 4.1.1). For desalination, energy intensity and socio-environmental externalities (e.g., brine disposal) remain central concerns; under-utilisation risks and tariff pressures emerge where agricultural uptake is limited, and distributional tensions surface as reliance on desalination grows (as documented in south-eastern Spain). As deliverable 4.1.1 showed, In North Africa, strategies highlight renewable-energy coupling for desalination, while over-exploitation of brackish aquifers constrains alternative NCW pathways—underscoring the need for enforcement and on-site control capacity (e.g., wells, meters) to make schemes executable.

Gender as a marginal but consequential dimension. Despite growing recognition in development agendas, interviewees observed that gender remains *“rarely mainstreamed”* in planning. Quantitative indicators and qualitative accounts show low female participation in state structures and user associations in Algeria and Tunisia, and concerns over representation in basin and irrigation-community leadership in parts of Spain; parity is framed as a condition for more democratic decision-making and fair burden-sharing under scarcity (Deliverable 4.1.1).

Figure 2. Main obstacles identified by interviewees for an integrated water and land governance in the Mediterranean



3.2.3. Opportunities and Potentialities

A growing regional momentum

Stakeholders underline that water scarcity is now widely acknowledged as a strategic threat in the Mediterranean, opening a “*window of opportunity*” to advance integrated governance. In this sense, regional frameworks (e.g., the Union for the Mediterranean’s water agenda) offer platforms to promote cross-sector and cross-border cooperation; at the same time, within the EU there is already a dense architecture of planning instruments—river basin management plans, flood-risk plans and special drought plans—that can be mobilized more coherently to bridge the water–land divide. Recent moves toward methodological harmonization demonstrate that standardization and transparency are feasible at scale and can reduce discretion in crisis management.

Technological and operational pathways already in place

Existing NCW experiences—advanced wastewater treatment and reuse, and large-scale desalination—provide operational references for scaling. Interviewees converged on the idea that “*we don’t need to start from zero; the challenge is scaling*”

and adapting these models to diverse national contexts” ((Interview to NGO on water governance 5 August 2025)). Country analyses compiled in the comparative review show, for instance, that wastewater reuse is already integrated into urban–agricultural supply mixes in south-eastern Spain, while renewable-energy coupling is entering desalination strategies in North Africa; both trajectories point to learning curves that can be leveraged if cost-sharing, quality assurance and monitoring are clarified (D4.1.1).

Leveraging networks for collective impact

The Mediterranean hosts a dense web of basin organizations, professional associations and thematic partnerships. According to one interviewee *“these networks can act as amplifiers, accelerating the adoption of integrated approaches if they are mobilized with clear goals and resources.”* (Interview to Mediterranean organization on water governance, 11 July 2025). The comparative assessment notes that transparent information tools—for example, proposals to regularly publish water-trading data and to standardize drought/scarcity indicators—can strengthen those networks’ capacity to coordinate and build trust across sectors and territories (D4.1.1).

Concluding synthesis: opportunities, obstacles, and an equity-centered pathway

Taken together, the interview evidence and the documentary record point to a favorable conjunction of policy windows, methodological standardization (e.g., drought/scarcity indicators and basin planning tools), and operational precedents in NCW that can accelerate a shift from aspiration to practice in integrated land–water governance. Yet realizing this potential requires tackling persistent obstacles—institutional fragmentation, uneven administrative capacity, cost and pricing constraints, data opacity, and public trust—that otherwise convert promising pilots into isolated experiences with limited spillovers.

A further, cross-cutting caveat is essential: crop reallocation under scarcity and the scaling of NCW are not socially neutral. Without an explicit justice lens, supply-side expansions (e.g., desalination, reuse) and spatial shifts in cropping can exacerbate

socio-economic and environmental inequalities—through tariff pass-throughs that displace costs onto smallholders, concentration of benefits in high-value export chains, energy burdens and local externalities (e.g., brine disposal), or displacement effects on downstream users and ecosystems. Likewise, reallocating crops without considering food sovereignty and local diets, or promoting NCW without parallel demand-side governance (allocation caps, ET-based auditing, triggers in drought plans) risks deepening inequities rather than alleviating them.

An equity-centered roadmap follows from this diagnosis. First, pair any NCW deployment or crop-mix adjustment with ex-ante distributive assessments and procedural safeguards (co-design with users, including women and smallholders; transparent criteria for who receives what water, at what quality and price). Second, align supply measures with binding demand rules—clear allocation priorities, scenario-based triggers, and monitoring anchored in actual evapotranspiration—so that reported “savings” translate into system-level benefits. Third, use fit-for-purpose pricing and cost-sharing (e.g., targeted support for vulnerable producers, gradual tariff pathways, polluter-pays where applicable) to avoid exclusion while maintaining fiscal viability. Fourth, ensure recognitional justice through sustained communication, extension, and gender-responsive capacity building that values local knowledge and labour. Framed in this way, technological and scientific advances become levers for greater—and not lesser—equity, turning regional momentum into durable improvements in both performance and fairness of land–water governance across the Mediterranean.

Recommendations to advance integrated water–land governance and a (just) uptake of NCW

As a bridge from the diagnosis and interview findings to policy design, the following recommendations translate the evidence on water scarcity, governance constraints, and NCW uptake in the Mediterranean into operational steps. They aim to move from declarative “integration” to enforceable arrangements that connect water and land-use governance, harmonize data and methods, strengthen institutional and field capacities, incorporate gender as a specific governance requirement, guide investment toward viable portfolios, and mobilize regional networks for diffusion. The

set is designed to be modular and scalable across diverse contexts (north–south, basin and administrative levels), anchored in verifiable indicators and trigger-based rules for decision-making under uncertainty, and framed by distributive and procedural justice so that NCW deployment and shifts in production support greater equity and resilience rather than reproduce existing asymmetries.

1. Institutional alignment

Integrated governance requires moving beyond ad-hoc coordination to binding, routine procedures that connect water authorities and land-use planners across local, basin, regional and national scales. Alignment means synchronised planning calendars, shared mandates, and co-decision on measures that affect both domains (e.g., drought restrictions, zoning, NCW source mixing). Triggered rules translate scenarios into operational choices and reduce discretion in crises, while continuity clauses protect agreements from political turnover. A light but authoritative technical centre of gravity is needed to arbitrate overlaps and ensure follow-through.

1.1. Key actions

- Create permanent intersectoral committees (with legal mandates) and a water–land technical secretariat to resolve overlaps.
- Co-sign basin plans, drought plans, and land-use plans, with continuity clauses beyond political cycles.
- Embed trigger-based allocation rules (thresholds for priorities, restrictions, and source mixing, including NCW).

2. Data harmonization and transparency

Cooperation depends on comparable metrics, shared methods, and open information. A Mediterranean core of indicators—anchored in actual ET for water balances and complemented by standard drought/scarcity indices—allows auditable cross-basin comparisons and credible activation of measures. Public dashboards on NCW quality and risk management increase trust and shorten coordination times, while open-data portals enable independent checks and reuse by practitioners and researchers.

2.1. Key actions

- Adopt a Mediterranean core indicator set, including actual ET-anchored water balances.
- Operate standard drought/scarcity indices with periodic publication and predefined operational states/measures.
- Publish NCW quality dashboards (classes, risk plans, monitoring) and maintain open-data portals.

3. Capacity building and technical support

To turn policy into practice, governments must invest in the people and routines that run systems—not just in infrastructure. A governance-oriented approach means setting minimum operating standards, funding regular training for basin agencies, utilities and farmer organizations, creating mobile support teams and peer-learning arrangements, and ensuring a basic, independent quality-assurance function. These measures reduce implementation risk, speed up response in droughts, and make allocation and NCW rules enforceable and credible.

3.1. Key actions

- Launch a national/basin training programme for operators, inspectors and extension agents, with recurring courses and performance-linked maintenance budgets.
- Set up mobile technical assistance and twinning between experienced and emerging organisations, with practical checklists and playbooks.
- Strengthen farm advisory services on scheduling under scarcity, soil salinity management, and calendar adjustments, backed by simple monitoring tools and publicly available satellite information.

4. Gender mainstreaming (focused recommendation)

Gender is a specific governance requirement that improves effectiveness and fairness when embedded systematically rather than treated as an add-on. Minimum representation thresholds and gender-impact assessments ensure that allocation, drought rules, pricing and NCW deployment reflect differentiated roles, constraints

and benefits. Sex-disaggregated data—aligned with UNESCO WWAP guidance—plus targeted training, mentoring and leadership programmes enable women’s real decision authority in institutions that shape water and land.

4.1. Key actions

- Ensure minimum 30% women’s representation in intersectoral bodies and require gender-impact assessments for integrated policies.
- Systematically collect and publish sex-disaggregated data on access, costs/benefits, and decision roles (align with UNESCO WWAP); report progress openly.
- Launch targeted technical training, mentoring, and leadership programmes for women in water, land and NCW institutions.
- Apply gender-responsive budgeting in plans/projects and design participation mechanisms that grant real decision authority (addressing time, care and mobility constraints).

5. Targeted investment strategies

NCW should be financed as part of a portfolio, coupling infrastructure with enabling conditions so schemes are viable and fair. Packages must integrate treatment, storage, conveyance, metering and labs with regulation, monitoring and operation and maintenance, while life-cycle evaluation anticipates energy use and externalities (e.g., brine). Public funds, Co-financing and tariff design can protect vulnerable users, and renewable—desalination coupling improves fiscal and environmental performance where feasible.

5.1. Key actions

- Finance complete, service-oriented packages, not isolated assets—pair investments with clear accountability and multi-year maintenance funding.
- Protect affordability and equity through fair pricing and targeted support for vulnerable users, so NCW doesn’t exclude smallholders.

6. Mobilizing networks

Basin organizations and professional alliances can amplify adoption by standardizing practice, sharing evidence and building legitimacy. Demonstration pilots with independent evaluation generate transferable protocols; peer exchanges reduce duplication; and open repositories make successes—and failures—visible. Youth and early-career engagement accelerates innovation and acceptance across diverse Mediterranean contexts.

6.1. Key actions

- Fund demonstration pilots of integrated governance/NCW with independent evaluation and public learning reports.

7. Cross-cutting principles of justice and effectiveness

Put fairness and real-world results at the center of every decision. New supply (including NCW) and crop shifts should not leave vulnerable groups worse off. Before acting, make clear who benefits, who pays, and who bears the risks, bring affected users into the conversation early, and check that promised “savings” and service improvements actually happen and are visible to the public.

7.1. Key actions

- Identify winners/losers and set safeguards (e.g., targeted support or compensation) where needed.
- Link new supply to basic demand rules: agree simple, public rules for sharing water in dry times and for keeping use within limits; publish short “water balance” updates showing targets vs. outcomes.
- Promote participatory mechanisms: create an easy complaints/ombuds channel and hold an annual public review of rules and tariffs to adjust what isn’t working.

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