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WATER SECURITY NEXUS IN NORTH AFRICA

Catalyzing Regional Coordination around Climate Change, Resilience and Migration

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[1] The synthesis report was prepared under the overall guidance of Blanca Moreno-Dodson, by a team composed of Constantin Tsakas, Ines Gasmi and Cyril Gouraud, in cooperation with the International Water Management Institute (IWMI), cewas, the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) and the UK Government.

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Overview

Ensuring the sustainability of water resources is a particularly urgent concern, as more than half a billion people worldwide face "**highly interconnected climate risks**", as noted by the Intergovernmental Panel on Climate Change (IPCC) Working Group II report on climate impacts.[1] In the Maghreb region the situation is even more alarming: warming across the Mediterranean is expected to be about 20 per cent higher than global averages in the decades to come, as the region is experiencing heatwaves, water shortages, loss of biodiversity and risks to food production. Meanwhile, a significant percentage of Mediterranean populations, especially in rural areas, are highly vulnerable to extreme poverty, which weakens their ability to access water, thereby aggravating their vulnerability.

Climate change adds a new complexity to the areas of human mobility and settlement by exacerbating environmental degradation, thus endangering water and food security. It may lead to movements among populations that have no option but to flee from inhospitable water-scarce environments, as well as political conflicts, domestic and/or regional, with countries fighting over scarce water resources. Evidence is still sparse on the relative impacts and interrelations between water availability, access and use, changing climate patterns, agricultural transformation, migration and displacement. However, environmental shocks and long-term trends are shown to be a trigger for population movements, impacting the nature of decision-making in rural communities, including rural-to-urban migration.

This means that the **Mediterranean stakeholders concerned need to be informed** about underlying challenges for their water resilience. Their capacities should be strengthened and they should ultimately be **empowered with adequate "nexus solutions"**.[2] With this understanding, the water security nexus project led by the Center for Mediterranean Integration (CMI) and funded by the UK Foreign, Commonwealth & Development Office (FCDO) examined water security in an interdependent world, building a stronger understanding of cross-sectoral linkages (food, water, environmental, migratory, demographic, etc.) in North African countries and their impacts on human mobility. Throughout this project, a major concern was to avoid a reductionist narrative of the link between climate change, water scarcity and migration. **The objective has been to help researchers to better understand, and policymakers to better address, ways of mitigating the multiplier effects of possible climate shocks, and to put in place more robust policy measures to tackle long-term trends**, in particular regarding youth and rural development. Over the 2020–2022 period, this project has achieved its main outcomes to improve **understanding**, **capacity-building, collaboration** and **engagement**.

- **Understanding**: Organizations, policymakers and citizens in North Africa have been provided with improved access to new **knowledge and data on how water scarcity and drought affect security and stability,** on which they can base and shape policy decisions.

[1] Pörtner, H.O., Roberts, D.C., Adams, H., Adler, C., Aldunce, P., Ali, E. *et al.* (eds.) (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge: Cambridge University Press. In press. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FinalDraft_FullReport.pdf.

[2] Nexus refers to "a connection or series of connections linking two or more things".

- **Capacity-building**: The project has contributed to strengthening capacities **through better awareness, as well as targeting policies and programmes that address water scarcity and drought-management challenges** that have an impact on rural development and human movement.

- **Collaboration and engagement**: Young people, experts and decision makers in North Africa have been successfully engaged to tackle drought management and water scarcity issues through evidence-based solutions and youth-led entrepreneurship.

The purpose of this final document produced by CMI is twofold. Firstly, it seeks **to highlight, in a synthesized and concise manner, the key findings and results from the various outputs** that were produced by CMI and its partners under this project.[3] Secondly, and perhaps most importantly, it **builds on the findings and suggests policy recommendations and orientations** to strengthen policy coherence on the water security nexus, regional cooperation on water and the emergence of more youth-led initiatives. The policy recommendations also include comments from CMI members and partners, as well as feedback from the wider Mediterranean water community, as their views were heard during the numerous consultation events that took place throughout the project, including the CMI Youth Forum (1 March 2022, virtual) and the CMI Water Security Nexus Regional Forum (14–15 March 2022, Marseille).

The analysis addresses the following key question: To what extent does climate change and water insecurity impact migration patterns in the Maghreb region?

After a short explanation of the interlinkages between climate change, water security and migration and of related climate futures (section 1), the water security, climate change and migration nexus is discussed, based on case study results (section 2). This is followed by a presentation of the stakeholder mapping (section 3). The final section (section 4) translates the programme's results into policy recommendations, including how to build government policy coherence regarding the nexus, strengthen regional cooperation and invest in youth initiatives.

1. Introduction

The overall goal of this project and study is to promote regional collaboration and cooperation around the water security nexus, as related to climate-change impacts and the dynamics of migration from areas affected by such impacts. The work programme has incorporated a number of related inputs, including:

- **An analytical framework integrating a regional analysis of the water security, climate change and migration nexus, completed by two case studies per country**[4]

[3] All outputs corresponding to improved understanding, capacity-building, collaboration and engagement are available at the project's web page: https://www.cmimarseille.org/programs/water-security-nexus-north-africa-catalyzing-regional-coordination-around-climate-change#:~:text=The%20water%20security%20nexus%20study,their%20impacts%20on%20human%20mobility.

[4] Nicol, A., Aderghal, M. and Patel, P. (2022). *Difficult Terrain: Water, Climate Change and Migration in Morocco. Review Document and Analytical Framework*. "The Water Security Nexus in North Africa – Catalyzing Regional Coordination Around Climate Change, Resilience and Migration" Project. Marseille: Center for Mediterranean Integration/UNOPS. www.cmimarseille.org.

    - **Tunisia:** *Nebhana watershed in the Governorate of Kairouan and the border area of the Governorate of Jendouba*, and
    - **Morocco:** *Souss-Massa and Oum Er Rbia watersheds*[5]
- **Capacity-building** for young entrepreneurs and water researchers through a youth-dedicated entrepreneurship initiative and youth-led research under the themes “valuing water” and “water and climate change”. In Tunisia, capacity-building was focused on experience-sharing events and technology transfer activities for drought monitoring.

These inputs were integrated into this final report, which provides a summary of lessons learned and potential resources for addressing climate risks and promoting regional cooperation in the area of water.[6]

1.1. A regional overview of the interlinkages between water security, climate change and migration in the Maghreb

The Maghreb is a subregion facing multiple pressures relating to climate-change impacts, access to water and factors involving water stress. To develop a clear understanding of the relationships between climate change, water security and migration, it is necessary to rigorously explore the interactions between different risk factors and drivers. In untangling these complex interactions, the **research under this work programme has identified three related components**:

- One involves the **drivers of migration due to climate change.** These drivers include sudden shocks, such as a rise in food prices and/or an extreme weather event (flash flood or heatwave).
- The second is related to **longer-term demographic trends**, such as population growth, population movements and increases in pressures on land tenure and access to water resources.
- Finally, there are **structural and contextual factors that underlie migration decisions** in a context of scarce water resources, such as marginalization and grievances, youth unemployment, inequitable access to natural resources and government capacity to assess and address climate-change impacts.

1.2. Interpreting climate data in Morocco and Tunisia

Water scarcity and the escalating impacts of climate change pose serious challenges for Maghreb countries that rely significantly on agriculture as a source of growth. Failure to address resource constraints in agriculture could have a substantial and potentially destabilizing impact on government legitimacy as well as vulnerable communities’ livelihoods, particularly in rural areas. Algeria, Morocco and Tunisia, the three countries under consideration, endured severe heatwaves in the summer of 2015, as well as

[5] International Water Management Institute. (2022). *Water Accounting of the Souss Massa River Basin in Morocco.* “The Water Security Nexus in North Africa – Catalyzing Regional Coordination Around Climate Change, Resilience and Migration” Project. Marseille: Center for Mediterranean Integration and UNOPS.

[6] It should be noted that the studies and related programmes have been undertaken in the context of the COVID-19 pandemic, which has impacted some elements of the project, such as local research in Morocco and Tunisia, as well as through the loss of opportunities for regional events. Despite these constraints, the project has been able to produce quality outcomes that have the potential to support the main goals of the work programme and these, in turn, have been supported by related initiatives as outlined in this report.

prolonged droughts.[7] These have damaged the agricultural sector (particularly for smallholders in Morocco), thus affecting rural livelihoods and the country's agricultural gross domestic product, and have served to highlight key sector constraints.

Taking this into consideration, the project was able to **generate climate-change data sets and to assess water use and availability under current and future climate conditions** to help government actors and national stakeholders in Morocco be better prepared and able to better plan ahead for their climate futures. A more developed evidence foundation to support decision-making is needed to help government agencies and other stakeholders establish strategies to adapt to changing climate circumstances.

Within the key organizations, there is a lack of climate-change data sets. The primary goal of this activity was to create a bias-corrected, high-resolution future climate data set that covers the major agriculture and water-management areas of Morocco, with a focus on the effects of climate change on extremely low precipitation, which is linked to water shortages and droughts. Likewise, **an enhanced Composite Drought Index (eCDI) was developed** in the case of Tunisia, also with the view to better inform related stakeholders.

1.2.1. Climate change and a new climate knowledge data set in Morocco

Droughts are becoming costlier, with their impact on food availability, water security and human well-being having socioeconomic effects. Droughts also impact most economic sectors, agricultural systems, water resources and communities. To adapt to these changes, **there is a strong need to support decision-making by generating climate-change data sets that can help in understanding future climate trends**, ultimately assisting government agencies in future planning.

The data sets generated for Morocco show that, based on Representative Concentration Pathway 4.5 (RCP4.5) and RCP8.5 projections, mountain and plain areas will become drier and hotter with a significant decrease in rainfall and greater water scarcity. They also highlight a remarkable increase in precipitation in dry areas, which is to be expected. By the end of the twenty-first century, the temperature is expected to increase by at least 2–3°C in the country's desert and north-east mountain regions, while under the more extreme projection (RCP8.5 scenario), the temperature increase is expected to exceed 5°C. On the other hand, precipitation is expected to decrease by 10 per cent in the desert and mountain regions (by 10–20 per cent in the RCP8.5 scenario). The increase in temperature and evapotranspiration rates will negatively impact soil water storage, affecting crop production and increasing irrigation needs.

1.2.2. Water Accounting Plus

Water accounting methods determine how much water is in a system, where, when and in what quality it is available, how much is needed and consumed at different times and in different locations and how well it is currently managed to satisfy those demands. **The water accounting framework (Water Accounting Plus – WA+) that was selected for**

[7] Verner, D., Treguer, D.O., Redwood, J., Christensen, J., McDonnell, R., Elbert, C. *et al*. (2018). *Climate Variability, Drought and Drought Management in Tunisia's Agricultural Sector*. Washington, D.C.: World Bank. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/318211538415630621/climate-variability-drought-and-drought-management-in-tunisias-agricultural-sector.

implementation in this work programme is designed to be used in data-scarce river basins.[8] It is based on inputs from open-access remote sensing and other spatial data sets (e.g. evapotranspiration and precipitation), which are used to compute the water balance in a given area. In the case of the Souss-Massa river basin, the framework was used to summarize and evaluate the water resource status in a 10-year period (2009–2019) and to obtain projections of water availability under future climate conditions (RCP4.5 and RCP8.5 for the 2030s and 2050s time-horizons).

Due to several factors, the Souss-Massa region is facing increasingly critical levels of water scarcity, including declining and highly variable precipitation, water pollution and increasing demand, fuelled in part by the expansion/intensification of agricultural activities. Given the rising demand across all sectors (domestic, industrial and agriculture) and changing climate conditions, regular and consistent monitoring and reporting is vital to the long-term management of water resources. Besides, the high precipitation variability indicates that precipitation is the principal limiting driver of the hydrologic regime. The **results of the study show that, over the last decade, there has been a decline in water inflow and outflow, with a steady evapotranspiration demand from the Souss-Massa river basin**. In addition, the results show that:

- The residual water available for further use in the basin ranged from 1.45 to 9.24 Km^3 annually, after taking into consideration environmental flow requirements. On an annual basis, between 1.40 and 8.85 Km^3 were used through regulated procedures (e.g. irrigation), leaving only 0–0.4 Km^3 for further allocation. This means that **almost all (95–99 per cent) of the available water is presently being consumed**.
- The excessive demand for water exceeds the sustainable supply, with groundwater filling the gap. On average, existing users in the basin consume more than 97 per cent of the available water annually. Even though there is more water available during the wet season than during the dry season, this is usually insufficient to meet annual demand, and on average **an additional 3.17 Km^3 of water must be drawn from storage (e.g. groundwater) each year to meet this demand**. This is the same amount of water needed to grow citrus on 158,500 ha of agricultural land.
- Due to degraded quality, **a large percentage of the basin outflow (> 90 per cent) is non-recoverable** (i.e. unavailable for use).[9] As a result, water quality issues in the basin are a key concern. Previous studies have linked these to increased salinity caused by seawater intrusion, excessive evaporation and anthropogenic contamination from fertilizers and wastewater, as well as the basin's extensive agricultural operations. Given the basin's water shortage, attempting to improve water quality would enhance good water availability and help to achieve a more sustainable water balance.

[8] From hydrological and meteorological networks.

[9] Liu, C., Kroeze, C., Hoekstra, A.Y. and Gerbens-Leenes, W. (2012). Past and future trends in grey water footprints of anthropogenic nitrogen and phosphorus inputs to major world rivers. *Ecological Indicators* 18, 42-49.

- Overall, the Souss-Massa river basin has witnessed rising water constraints over the last decade, as seen in the water accounts (Table 1 and Table 2, annex 1).[10] **Water scarcity is projected to worsen between the 2030s and 2050s, according to an assessment of the water balance under future climate scenarios.** With the climate extremes expected for RCP8.5, water scarcity will increase and water quality issues will become even more critical.[11] Reduced precipitation is expected to make the basin more water stressed and dry. Seasonal water demand projections for the 2030s and 2050s are unfulfilled, requiring an additional 1.86 Km^3 in the wet season and 0.64 Km^3 in the dry season for the 2030s, and an additional 1.43 Km^3 in the wet season and 0.60 Km^3 in the dry season for the 2050s. During the dry season, evapotranspiration is expected to surpass precipitation by 6–28 per cent in all years, resulting in further unsustainable water withdrawals. Under the forecasted climate scenario, the basin's water balance will remain deficient, with small amounts of water available for additional use.

1.2.3. Composite Drought Index review: an application to Tunisia

Drought is a permanent natural hazard in countries of the Middle East and North Africa (MENA) region. Its severity and ability to cause extensive loss and damage are increasing due to climate change. The relationships between climate-change impacts on agriculture and water systems, particularly during droughts (which are also human induced), are expected to be severely affected by climate-related change in coming years. Water and livelihood insecurity, population growth and mobility, employment and political and geostrategic challenges are all complex and interrelated. Water scarcity and fragility can create a vicious cycle, in which a worsening of one exacerbates the other. Furthermore, the Mediterranean region's future stability and resilience to human-made and environmental shocks are, to a large extent, dependent on the establishment and implementation of transboundary and regional responses to the issues of water and food insecurity, social instability and human mobility.

The enhanced drought monitoring technology (satellite-based eCDI) that was embedded in the water and agricultural ministries in Jordan, Lebanon and Morocco during the past three years through the United States Agency for International Development MENAdrought Programme served as the basis for implementing the same technology in Tunisia. Additionally, as was the case for the other countries, the Tunisian Drought Monitoring Unit, composed of core engineers from the *Direction Générale des Ressources en Eau* [General Directorate of Water Resources], worked with the International Water Management Institute (IWMI) team on drought typology and on testing a prototype of seasonal rainfall forecasting with a 1–3 month lead time. These capabilities can support effective drought

[10] Water accounting provides a set of baseline indicators that can be used to identify potential measures to increase water availability for productive use in a sustainable manner.

[11] The *Agence du Bassin Hydraulique du Souss Massa* [Souss-Massa River Basin Agency] has developed several water resource plans to address some of these challenges. These plans include a groundwater management action plan and plans to establish artificial recharge stations, the reuse of wastewater and seawater desalination.

management by enabling authorities to identify, early on, the presence and evolution of drought.

In terms of future developments, making the eCDI and seasonal forecasting operational within the multidisciplinary and multi-institutional Tunisian Drought Technical Committee (composed of young and capable engineers from meteorology, remote sensing, land, water, agricultural and management backgrounds) will support the country to expand its drought-management ambitions. This work could enrich the Plan National Sècheresse [National Drought Management Plan] supported by the United Nations Convention to Combat Desertification with eCDI-derived triggers, and hopefully become a catalyst for wider evidence-based drought management in the Maghreb region. It could also inspire neighbouring nations to adopt proactive management. Continuing this work across the region would help those countries to adopt unified approaches and learn from each other's experiences for enhancing local economic prosperity through effective drought mitigation, financial remediation and customized water and food security-oriented development programmes.

2. Understanding the water security, climate change and migration nexus

The relationship between the environment and migration has become a prominent discussion in policy circles. The term migration refers to a range of human mobility, some of which may be more forced or voluntary, some mainly domestic and temporary, and others international and more permanent. The specific impact of climate change on migration is hard to discern and is usually part of a range of trends and determinants behind human mobility.

When environmental conditions deteriorate and affect human and livelihood security, the impetus behind migration for some – including those with the actual resources to migrate – may become stronger. However, depending on how widespread the impacts are, environmental degradation may even limit destination choices. In general, when **faced with environmental degradation, migrants tend to move over a smaller distance, staying closer to their home areas**. Many migrants do not aim to abandon their regions or countries, but rather to relocate to areas in their immediate environment where employment opportunities are more available. Long-distance movement would cut them off from important social networks. Most disadvantaged communities are frequently unable to escape environmental degradation altogether due to a lack of resources. It is possible to **categorize environmental migration based on three characteristics**:

- **Duration:** From a brief evacuation to a permanent relocation
- **Level of preparation:** From a hasty evacuation to a well-planned relocation
- **Level of coercion:** Since no migration is ever totally forced (except in a war context) or completely voluntary

The effects of water stress on migratory movements are difficult to predict. Various studies have found that migration decreases during droughts, as families choose to dedicate their available resources to addressing immediate subsistence demands.[12] This demonstrates how, especially in the face of environmental disturbance, migration is often viewed as a luxury available only to the wealthy, while the most vulnerable remain static, putting their lives, health and property at risk.

Water scarcity and desertification have already displaced tens of thousands of people. The trend is most noticeable in sub-Saharan Africa, which is experiencing a large-scale rural exodus that is expected to continue in the future. It is projected that migration from the Sahel to the Maghreb and Europe will increase considerably by 2030.

2.1. Building an analytical framework

This analytical framework was **developed to understand the complex relationship between water security, climate change and migration** in Morocco. It is composed of a series of guided questions on migration drivers, policies and instruments, mechanisms and the impacts on development outcomes at the national and case study levels. It consists of a clustering of climate and non-climate drivers of migration. These drivers are filtered through a series of climate- and non-climate-related intermediating factors, including policy coherence on climate change at different levels, the national focus on migration policy and the attention paid to implementing the Sendai Framework for Disaster Risk Reduction 2015–2030.[13,14]

To understand the degree of complexity of the interrelationships between water scarcity, climate change and migration in Algeria and Tunisia, some modifications were made to the original framework tailored to Morocco. Hence, the original framework has been adapted to be more comprehensive for the cases of Algeria and Tunisia, and has been considered a practical assessment tool to evaluate the state of play of climate and migration policy frameworks (what), the key informants (who), the instruments (how and when) and their performance over time, with a focus on country strategies, related policies and gender implications.

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[12] United Nations World Water Assessment Programme (WWAP) (2016). *The United Nations World Water Development Report 2016: Water and Jobs.* Paris: United Nations Educational, Scientific and Cultural Organization. https://www.unescap.org/sites/default/files/2016%20UN%20World%20Water%20Development%20Report-%20Water%20and%20Jobs.pdf .

[13] Nicol, A., Aderghal, M. and Patel, P. (2022). *Difficult Terrain: Water, Climate Change and Migration in Morocco. Review Document and Analytical Framework*. "The Water Security Nexus in North Africa – Catalyzing Regional Coordination Around Climate Change, Resilience and Migration" Project. Marseille: Center for Mediterranean Integration and UNOPS

[14] "The Sendai Framework for Disaster Risk Reduction 2015-2030 outlines seven clear targets and four priorities for action to prevent new and reduce existing disaster risks: (i) Understanding disaster risk; (ii) Strengthening disaster risk governance to manage disaster risk; (iii) Investing in disaster reduction for resilience and; (iv) Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction. It aims to achieve the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the next 15 years. The Framework was adopted at the Third UN World Conference on Disaster Risk Reduction in Sendai, Japan, on March 18, 2015." United Nations Office for Disaster Risk Reduction (UNDRR) (no date). Sendai Framework for Disaster Risk Reduction 2015-2030. https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030#:~:text=The%20Sendai%20Framework%20for%20Disaster,Investing%20in%20disaster%20reduction%20for. Accessed 14 July 2022.

2.2. Assessment and analysis of case studies

2.2.1. Morocco

The study to model the impact of climate change on water resources shows that according to two scenarios (RCP4.5 and RCP8.5),[15] **there is a large regression of annual precipitation with a significant withdrawal in water resources,**[16] **which calls for an integrated approach to water resources management.** The current situation of water resources that receive continuous pressure due to urban and agricultural overexploitation will drive the Souss-Massa and Oum Er Rbia river basins towards water poverty as a result of extreme water shortages and water stress.[17] This will negatively affect the agricultural sector and other economic activities, and thus impact the population's decision to migrate internally as an adaptation strategy to regions with alternative agricultural[18] and economic activities[19] (possibly towards northern Morocco or Algeria and France in the case of the Souss-Massa population, and towards agricultural and coastal areas, Algeria, France and southern Europe – Spain and Italy – in the case of the Oum Er Rbia population). Specifically, the study observes that:

- In south-western Morocco, the Souss-Massa river basin encompasses an alluvial plain with access to the Atlantic Ocean and a periphery made up of the High Atlas and Anti-Atlas mountain ranges. The plain, which covers 4,150 km^2 and contributes 25 per cent of the Souss River's entire watershed, is a crucial component in the development of water resources for agriculture and urbanization. Future climate change will have an impact on areas that are already vulnerable, modifying human densities and productive activities in response to issues posed by water shortages, depending on the climate scenarios analysed.
- In Souss-Massa, most migrants' private investments are oriented towards cities, particularly Greater Agadir, with very few returning to agriculture. On the other hand, they are active participants in local development, particularly in mountain areas and upstream of the Souss-Massa river basin. Migrants who invest following an individualistic logic detached from their lands (and communities) may put more pressure on water resources and accelerate the deterioration process.
- In Oum Er Rbia, climate change has exacerbated water scarcity, which has significantly impacted various aspects of life. The intensity of such impacts are expected to worsen over time. Since the droughts of the 1980s, surface-water levels have dropped by 30–40 per cent, and most general circulation models anticipate a drier and warmer future for the region, with "an average additional reduction of 20 per cent in rainfall, with the most extreme decreases between -40 per cent and

[15] Center for Mediterranean Integration (CMI) (2020). *Understanding Morocco's Climate Futures: Using National Climate Change Data Sets to Support Planning and Investment.* https://www.cmimarseille.org/sites/default/files/newsite/branded_final-report-iwmi-cmi.pdf.
[16] Groundwater and surface water.
[17] Water poverty is defined as a "situation where a nation or region cannot afford the cost of sustainable clean water to all people at all times".
[18] Intensive irrigation and developed agricultural activities.
[19] Urban and phosphate valorization areas.

zero."[20] This is likely to result in a considerable reduction in surface-water availability (up to -50 per cent) and groundwater recharge, similar to the run-off and recharge losses that have happened since 1980. Migrants' investments were characterized by a wave of construction movement with very intense activity in the construction sector that led to the subdivision of agricultural land.[21] Returning migrants' investments in agriculture are putting more pressure on water resources, especially with the use of subsidized drip irrigation systems. The migratory patterns found at the mesogeographical level and at the local scale of the Oum Er Rbia river basin reveal that climate conditions alone do not function as triggers for major population shifts. Rather, they have a gradual effect. Meanwhile, migration is part of a broader transition in agrarian cultures' adaptive ability, which includes technical and organizational facilities that help with population resource issues. Outmigration can play a dual role in these processes, either strengthening community and family climate resilience through collective action or causing new pressures and speeding up degradation processes.

2.2.2. Tunisia

Tunisia has been subject to repeated political and economic instability, notably after the Arab Spring (2011) which significantly influenced migratory movements. After 2011, the migratory profile of Tunisia has partially transitioned from a country of emigration to a country of transit and/or reception. In addition, the country is strongly affected by climate variability and water scarcity, which directly threaten the economy and well-being of the population.[22]

Therefore, the direct impacts of climate change on the main activities of the rural population drive them to migrate internally (to coastal and extensively agricultural and industrial areas) and/or externally (to Europe), where they can find new job opportunities and guarantee a decent life for themselves and their communities. This intensive migratory movement can also have positive social and economic impacts by improving living conditions for poor communities through remittances and creating new opportunities by sharing experiences. Meanwhile, to better understand the inextricable interlinkages between water security, climate change and migration, a national analysis will be applied to two local case studies: the first downstream of the Nebhana dam in the Governorate of Kairouan, and the second in the border area of the Governorate of Jendouba.

The Governorate of Kairouan is considered one of the governorates most affected by climate change and water shortages in Tunisia. Its economy is based on agricultural activities with 657,700 ha of farmland, which makes it vulnerable to the decrease in water resources and drives the population to leave their communities.[23] To investigate the effects of climate

[20] Center for Mediterranean Integration (CMI) (2020). *Understanding Morocco's Climate Futures: Using National Climate Change Data Sets to Support Planning and Investment.* https://www.cmimarseille.org/sites/default/files/newsite/branded_final-report-iwmi-cmi.pdf.
[21] Related to setting up small businesses (bakeries, Internet cafés, hairdressing salons and Turkish baths).
[22] The population's survival depends on water availability and food production.
[23] This phenomenon affects rural and urban communities equally.

change on the Nebhana watershed in the Governorate of Kairouan,[24] including irrigation supply and demand,[25] the stochastically downscaled general circulation models based on the Coupled Model Intercomparison Project Phase 5 (CMIP5) scenarios were combined with two RCP emission scenarios (RCP4.5 and RCP8.5) for three time periods, 2021–2040, 2041–2060 and 2061–2080. The results of this show an increase in the reference evapotranspiration, which is expected to reach 6 per cent on average, and a reduction in rainfall of up to 8 per cent under the RCP4.5 and RCP8.5 emission scenarios.[26]

Meanwhile, governance issues have arisen in the management of the watershed. However, little work has been done to develop strategic policies and operational directions to ensure the Nebhana dam system's long-term viability in the face of various climate-change scenarios. As a result, the Nebhana watershed no longer meets its water requirements and no rehabilitation measures have been planned. Due to the urgency of the issue, the *Commissariat Régional au Développement Agricole* [Regional Commission for Agricultural Development] implemented interim remedies in the summer of 2015, including the installation of water standpipes on drinking water wells and the distribution of subsidies to farmers so that they could irrigate their trees with towable tanks. The weakness of the agricultural system induced by the low water levels in the dam influenced the lifestyle of the local community, with many choosing to migrate to the fertile part of the watershed (downstream of the Nebhana dam) to guarantee a better life. However, with regard to this downstream migration:

- It involves unskilled people with low levels of education who are compelled to migrate due to the marginalization of the agricultural contribution to stable and adequate earnings and the lack of economic opportunities outside of agriculture.
- Migration in its current form only creates revenue to meet the basic needs of migrants and does not generate savings that may be re-invested in the areas.
- Farmers downstream of the Nebhana dam, notably young farmers, are still looking for ways to adapt to the effects of climate change on water availability. Many adaptive solutions exist, including migration. However, it is a last alternative for addressing livelihood challenges, such as those posed by climate change.
- Other adaptation strategies currently being implemented by farmers (such as greenhouse construction) are not viable in the long term.
- In the not-too-distant future, a game-changing scenario could unfold. Farmers will then have no choice but to forsake their farming operations and seek other options, such as migration.

[24] Sousse, Kairouan, Siliana and Zaghouan are the four governorates that make up this watershed. It is one of three watersheds that drain the southern side of the ridge to the Kairouan plain, along with the Zeroud and Merguellil basins.
[25] In the three governorates of Kairouan, Sousse and Monastir, the Nebhana dam system previously served 11 public irrigated perimeters (PIPs). Over time, the dam system grew to 28 PIPs with a total surface area of roughly 7,125 ha, all connected by a 120-kilometre-long main water pipe.
[26] Allani, M., Mezzi, R., Zouabi, A., Béji, R., Joumade-Mansouri, F., Hamza, M.E. *et al*. (2020). Impact of future climate change on water supply and irrigation demand in a small Mediterranean catchment. Case study: Nebhana dam system, Tunisia. *Journal of Water and Climate Change* 11(4), 1724-1747.

On the other hand, all across the Governorate of Jendouba, and more broadly in the north-western area of Tunisia, migration has been a long-standing occurrence. The border region, in particular, is suffering from a negative demographic dynamic and is a repellent territory with limited chance of population stabilization. Its lack of development is a clear driver for migration. However, as fires become more frequent, the rangelands will deteriorate, reducing livestock and shifting the population. As a result, accelerating the adoption of adaptation policies is crucial. In previous decades, through a well-equipped and qualified team of facilitators and agricultural extension workers, the current *Office de Développement Sylvo-Pastoral du Nord-Ouest* [Office for the Silvopastoral Development of the North-West of Tunisia] was essential in assisting the community to develop income-generating activities.

2.2.3. Algeria

Water scarcity is the key driver of internal migration in North Africa, according to the new Groundswell Part 2 analysis. More than 70 per cent of households polled in Algeria admitted that rainfall is becoming more erratic and that temperatures are increasing. Climate migration is a rising phenomenon in important coastal locations, such the north-west coast of Algeria, which includes Oran. According to the research, "Several places with better water availability, meanwhile, are projected to become climate in-migration hotspots, including important urban centers such as Cairo, Algiers, Tunis, Tripoli, the Casablanca-Rabat corridor, and Tangiers."[27]

Algeria was once a popular emigration destination in the twentieth century, but is now becoming more of a transit country for Sahelian migration. The migrant situation, with movements that have accelerated in the last two years, has strengthened this trend, according to data from the European Frontex agency.[28] Cameroon accounted for 43 per cent of the 150,000 migrants from sub-Saharan Africa living in Algeria, according to a survey released by the non-governmental organization (NGO) Doctors of the World in February 2016, followed by Nigeriens, Nigerians, Malians, Congolese (Kinshasa) and Ivorians.[29] The impact of climate change on these flows is difficult to predict because it is determined by a number of factors, including the severity of climate-change consequences, which will vary depending on the policies developed by the Algerian authorities, the original countries' economic, political and social progress (and thus their ability to retain their populations) and the laws in destination countries.

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[27] Clement, V., Rigaud, K.K., de Sherbinin, A., Jones, B., Adamo, S., Schewe, J. *et al*. (2021). *Groundswell Part 2: Acting on Internal Climate Migration.* Washington, D.C.: World Bank. https://openknowledge.worldbank.org/handle/10986/36248.

[28] Frontex (2016). *FRAN Quarterly.* Quarter 4, October–December 2015. Warsaw. http://frontex.europa.eu/assets/Publications/Risk_Analysis/FRAN_Q4_2015.pdf.

[29] Abane, M. (2016). Alger déplace 1 600 migrants subsahariens à Tamanrasset [Algeria relocates 1,600 sub-Saharan migrants to Tamanrasset], 9 March. *Le Monde*. http://www.lemonde.fr/afrique/article/2016/03/09/alger-deplace-1-600-migrants-subsahariens-a-tamanrasset_4879190_3212.html. Accessed 14 July 2022.

The challenge for Algeria in the coming years will be to balance its efforts between territorial water security while ensuring the protection of migrants from different impacts, including those of climate change.

3. Catalysing stakeholder engagement

Water is a vital and limited resource that is becoming increasingly endangered due to over-abstraction, inadequate management and deteriorating quality. Science, technology and engineering alone will not be enough to keep the region's watersheds, lakes and aquifers alive, while guaranteeing the local population's well-being. Meanwhile, stakeholder engagement and inclusion are crucial to the long-term sustainability of this resource, which is why stakeholders are at the centre of the water security nexus study.

The Maghreb is a region marked by fast political transition and conflicts in various forms. During contested elections, violence between entities claiming jurisdiction over physical space, and low-level challenges to State authority by various social and political groupings mean that countries in the region are facing social and political upheavals. These current political tensions are a reflection of the complexity of the region's political economy.

Climate change complicates human migration and settlement by worsening environmental degradation and extreme weather events, such as floods and droughts, thereby threatening water and food security. These changes put more strain on land tenure and access to scarce water resources, both of which influence whether or not people migrate. In this unpredictable environment, the project's priority is to engage and support science-based research as well as to cooperate with regional stakeholders, with a strong focus on integrating knowledge into capacity-building and policy improvement. A surge in youth employment demands due to structural changes in the agricultural sector as a result of rural-to-urban migration is being observed. To enhance youth engagement, a transversal component with the participation of the CMI Mediterranean Youth for Water (MedYWat) network was therefore included. This is crucial since young people are the vanguard of change in the region.

3.1. Stakeholder mapping: a review of key actors' roles and influence

This activity served as a **baseline for a more in-depth examination of the interrelationships between stakeholders at the organizational and/or managerial levels**. In concrete terms, the mapping centred on the attribution of stakeholders' importance and value, gauging their interest and capacity to engage vis-à-vis the nexus. Some stakeholders were found to have both interest and the means to engage, while others may lack one or the other.

Ultimately, the mapping examined whether or not there is:

- an **existing cooperation** between the actors (the result of research and refining by contact points in the three countries), or
- a **desired collaboration** that could be developed among stakeholders.

The results of this mapping highlighted some common trends (migration, monocentric governance, youth and gender implications, etc.) in terms of the absence of recognition of the multidimensional complexity of migration among powerful and influential State actors such as ministries. The analysis also confirmed that national research centres and educational institutions have some limited influence in the decision-making process, while NGOs are not well represented when it comes to the decision-making process or data fluency.

It is crucial to highlight MedYWat's role in the evaluation and validation of all nations' stakeholder mappings, particularly because they are based in the countries of the study and have a deeper awareness of the role of stakeholders at the local level. As a result, two young experts (MedYWat members) were chosen for each country to provide comments and confirm the mapping and results of the analysis.

3.2. Empowering the next generation of water leaders and entrepreneurs

The programme placed an emphasis on the **need to train and build the capacities of the next generation of water leaders in the region**. A number of tools and activities, such as the Water and Climate Change Entrepreneurship e-Hackathon and e-Bootcamp programmes, helped contribute to achieving this goal. The programme showed how youth actors are also carriers of innovative entrepreneurial ideas that can benefit their local territories/countries. This was especially evidenced by the e-Bootcamp initiative jointly carried out by CMI, cewas and MedYWat, which also jointly implemented a fully virtual e-hackathon with 61 young participants from the Mediterranean region. The three finalist Mediterranean projects, which received financial support from CMI, include:

- A smart dashboard for irrigation water monitoring and analysis (Opti-moo, tested in Egypt), a smart portable device that can be connected to water pipelines and water metres, which aims to help the agriculture sector's users to utilize their water resources more efficiently at an affordable cost.
- A smart, simple, sustainable and economical buried irrigation system (Eco ريّ [Eco Irrigation], tested in France) to control, optimize and regulate the exact amount of water by using sensors in the soil to achieve accurate water consumption (taking into consideration the precise water needed by crops), increase the yield and improve its quality.
- A mobile app (FARMED, tested in Tunisia) for smallholder farmers based in Mediterranean countries, which targets food producers who are limited by water scarcity, creating a tool for them to share experiences and connecting knowledge from farmers, municipal authorities and researchers.

The programme's various elements provided opportunities for young water professionals and researchers to engage in creating evidence-based, quality research focusing on the water sector in the Mediterranean region, and also encouraged youth participation in shaping policies that guide the water sector with support from senior experts and mentors. The programme's goals were achieved through the effective use of digital resources and the commitment of young people to engage with the climate and water agenda in creative ways.

4. Leveraging results into policy recommendations

This section provides policy recommendations and also address some of the cross-sectoral elements of the region, such as accessibility, security and transversal approaches that are relevant to support greater resilience. The policy recommendations have been developed following an in-depth analysis of the study's results and also through consultation events that took place in March 2022, specifically the CMI Youth Forum (1 March 2022, virtual) and CMI Water Security Nexus Regional Forum (14–15 March, Marseille), to validate the results.

The final recommendations from the study can be clustered under the following three categories:

4.1. Building government policy coherence regarding the nexus

The need for concrete laws and a water framework at the national level

As suggested by the findings of the Souss-Massa study, the basin degradation and resulting extreme flood and drought events may be the result of increased salinity from seawater intrusion, anthropogenic pollution from fertilizers and wastewater, and from the extensive agricultural activities within the basin. While countries such as Morocco have made progress in natural resource management and wastewater reuse, it appears important for authorities to draft laws and draw up precise implementing guidelines that would both improve water quality and organize wastewater treatment and reuse.[30]

Ultimately, what matters for the success of a water management strategy is having a well-defined framework for action and a consistent set of economic and environmental policy criteria. Coordination among ministries, levels of government and stakeholders outside government is also essential in order to identify a policy mix that is appropriate to the local conditions.

Governments in the Mediterranean countries can make use of economic instruments (which can include water pricing, pollution charges, marketable permits, subsidies and enforcement initiatives) that have an essential role to play in providing the right incentives to guarantee that decisions concerned with water are coherent and make a real contribution to

[30] United Nations Educational, Scientific and Cultural Organization (UNESCO) and UNESCO International Centre for Water Security and Sustainable Management (2020). *Water Reuse within a Circular Economy Context: Series II*. Global Water Security Issues Series 2. Paris.

sustainable and inclusive development. Economic instruments are also a means to encourage greener behaviour by all water users, mobilize investments in capital and technology towards greener activities and support green innovation.

Depending on the situation, introducing a price for the overexploitation of water sources, for instance through mechanisms such as prices or tradable permit systems, could be a component of the policy mix. In the Mediterranean, the use of water scarcity taxes and tariffs could play a role in green fiscal reforms, taking into account income distribution to protect the most vulnerable. Well-designed regulation that is updated to match emerging needs and effective technology-support policies may also be appropriate.

Governments can also play a key role to improve, and learn from, public participation in water planning and management. Indeed, public participation is essential for effective and adaptive water management, yet it often does not influence final decisions and/or improve knowledge that could help achieve the objectives of the participation process. Blanco and Ballester identified five prerequisites that, when present, can help improve the transformational capacity of such participation, namely:[31]

- political leadership of the participatory process and the affected resulting policies
- a holistic approach to collective problems
- a highly visible engagement process
- significant citizen impact on public policies through the participatory process
- a real cultural change for politicians, bureaucrats and citizens.

Meanwhile, as noted by Ballester and Mott Lacroix, the mere existence of a participatory legal framework may guarantee the development of an inclusive process, and therefore the beginning of a productive interaction between the public and regulators.[32]

Simply put, a shortage of water – whether as a result of drought, which is the most severe kind of water scarcity, or other factors – is frequently regarded as a factor that drives migration, particularly within countries and in some cases regions. Water scarcity, on the other hand, is often difficult to establish as a sole or even direct factor driving migration. Other socioeconomic, political and environmental factors, in combination, are more easily identified as decisive than any single factor acting alone. In the case of Morocco for example, future policy on water management and migration should take account of nexus relationships between rural development, climate trends and water resource management and include them in decision-making.

[31] Blanco, I. and Ballester, M. (2011). ¿Participar para transformar? La experiencia de los presupuestos participativos en la provincia de Barcelona [Modification through participation? Participatory budgeting practice in Barcelona]. *Gestión y Análisis de Políticas Públicas* 5, 117-144.

[32] Ballester, A. and Mott Lacroix, K.E. (2016). Public participation in water planning in the Ebro river basin (Spain) and Tucson basin (U.S., Arizona): impact on water policy and adaptive capacity building. *Water* 8(7), 273.

The need for policies that empower women

As highlighted during the CMI Water Security Nexus Regional Forum in Marseille (14–15 March), there is also a need to mainstream gender-transformative goals into climate-change adaptation and mitigation policies. In Maghreb countries, there is a notable lack of integration between reforms on climate change, migration and gender at a policy level, which often fall within different sectors and are not treated as interrelated issues. Closing the gender gap is essential in these efforts, including access to, use of and control over resources such as land and water, which entails resistance to exclusion and advocacy and civil society mobilization to enable policy change. Empowering women must be a priority in national agendas and not only an aspiration. A structural approach is needed. Quotas in positions related to policy and/or jobs are not enough, given that they do not tackle the sources of the structural discriminations, but tackle only the symptoms. Therefore, national strategies, including on water, must create the conditions that will allow women to fulfil their potential.[33]

At the national level, climate adaptation policies should take into consideration the essential role of women and their contribution to addressing these risks. Meanwhile, policies should focus on building women's and marginalized groups' resilience to climate-related risks through gender-responsive development opportunities such as access to climate-responsive training and finance. Financing opportunities can contribute towards climate resilience by supporting water-efficient technologies, climate-smart agriculture, crop diversification and saving of seeds, which could play a pivotal role in the response to climate change.[34]

4.2. Strengthening regional cooperation

Capitalizing on European Union experience (and financing) to improve water quality in the South and East Mediterranean

The sharing of international experiences and cooperation is very helpful in this context. As an example, the European Union has combined several instruments to improve water quality throughout the continent. For instance, surface-water pollution was reduced through command-and-control instruments, with massive investments made to modernize wastewater treatment plants and enable industrial innovation, which has contributed to the development of phosphate-free detergents. Best farming practices have also contributed to a reduction in nitrate pollution and vulnerable pollution zones were efficiently mapped. While the European Union model of water resource management may not be replicated in a

[33] Moukaddem, K. (2019). *Closing the Gender Gap: Policy-making that Promotes Inclusive Mediterranean Societies*. Forum Euroméditerranéen des Instituts de Sciences Économique (FEMISE) Med Brief 17.
[34] Al-Ajarma, K., Gasmi, I., Madi, A. and Basso, S. (2022). *Migration and Water Resources: Existing Concerns and Proposed Solutions*. EuroMeSCo Policy Brief No. 120. https://www.iemed.org/wp-content/uploads/2022/03/Policy-Brief-No120-1.pdf.

different context in South and East Mediterranean countries, the European Union could certainly be helpful by providing knowledge-sharing and technical assistance with regards to improving water quality.[35]

Financial assistance should also be explored through joint programmes, whether with European or other partners. The region would also benefit from North-South discussions on **financing water security nexus solutions**.[36] In the Maghreb region, countries struggle to meet the financial demands of water strategies and plans. This can be explained by the lack of a solid governance framework as well as by the lack of absorptive capacity at the national and local levels, which in particular prevents attracting the private sector. As stressed during the CMI Water Security Nexus Regional Forum in Marseille, countries in the region must make the most of the opportunities offered by an evolving financial landscape. Mobilizing commercial finance, especially from domestic sources, would in most cases require additional policy reforms to promote efficiency gains and cost recovery, among others.

A reflection is also needed on "where to spend", as there is a tendency to invest in the construction of new hard infrastructure, to the detriment of non-structural "soft" solutions (governance reforms, demand management, land-use planning, etc.), which are more complex to implement.

Round tables on financing water security nexus solutions could be organized at the regional level, and could follow a similar model to that established by the Organisation for Economic Co-operation and Development, the World Water Council and the Netherlands, with the ambition of facilitating increased financing of investments that contribute to water security and sustainability in the Mediterranean.

Setting up a platform for cooperation and knowledge-sharing at the territorial level

In the Mediterranean, the impact of climate change calls into question the attractiveness of territories. It therefore seems essential to place the issue of water management and its nexus at the centre of the territorial cooperation strategy, particularly in the post-COVID-19 era. Overall, a crucial issue for countries in the region lies in **the need to strengthen the skills of local decision makers and of all of their services**.[37] There is also a need to translate scientific knowledge into practice using indicators applied to water resources. Indicators can help stakeholders understand the situation regarding water quality, rainfall, floods and

[35] Ganoulis, J. (2021). *Resilient Mediterranean Agriculture in the Context of Water Scarcity under Climate Change*. Forum Euroméditerranéen des Instituts de Sciences Économique (FEMISE) Med Brief 31.
[36] Tsakas, C. (2022). *Catalyzing Regional Cooperation on Water and Climate Change Nexus Solutions in the Mediterranean*. Center for Mediterranean Integration and Foreign, Commonwealth & Development Office Policy Brief.
[37] Quefelec, S., Augier, P., Pouffary, S. and Tsakas, C. (2018). *Les Gouvernements Infranationaux Euro-Med dans la Lutte Contre le Changement Climatique : Cadre d'Action, Exemple de la Région SUD Provence-Alpes-Côte d'Azur et Opportunités de Coopération à l'Échelle Méditerranéenne* [Euro-Med Subnational Governments in the Fight Against Climate Change: Framework for Action. Example of the Provence-Alpes-Côte d'Azur (Région Sud) and Opportunities for Cooperation at the Mediterranean Level]. Institut de la Méditerranée (IM), ENERGIES 2050 and Forum Euroméditerranéen des Instituts de Sciences Économique (FEMISE). https://www.femise.org/wp-content/uploads/2018/12/Rapport-Climat-Territoires-online-mid.pdf.

droughts, and help establish better responses. Measuring these parameters could be an opportunity for cross-country cooperation, with the new data set generated under the CMI-FCDO project particularly important in this regard, as it offers climate information that could support national and regional climate adaptation efforts.

Water debates are also needed and local stakeholders must be informed about successful examples, as is robust empirical and theoretical work into the benefits that water accounting and new approaches will bring for diverse groups of people in their country/region. Experience-sharing between Mediterranean territories would be needed and **a green transition knowledge and policy dialogue at the territorial level could be facilitated**. The CMI Territorial Resilience and Climate Change Hub could be the hosting platform for such a dialogue. It would act as a structure that centralizes, transcribes and shares knowledge on water issues at the regional level, providing better information for decision makers in South and East Mediterranean territories and increased visibility in the different parts of the Mediterranean water ecosystem. It would also be key to facilitate a rapprochement between scientific results and decision makers, ensuring the latter have access to the latest knowledge on local development and water issues, which need to be tackled in their territories.

As the research on Moroccan climate data sets shows, one specific topic that would benefit from cooperation and knowledge-sharing relates to how to **scale up climate-smart agriculture**. The Maghreb needs to support a broader implementation of the climate-smart agriculture approach, which is proposed as an integrative approach to mitigate ongoing climate change and adapt to its effects, helping achieve food security in the context of stretched resources and reduced agricultural productivity.[38] In 2018, Morocco developed a Climate-Smart Agriculture Investment Plan (CSA-IP) with the support of the World Bank and Food and Agriculture Organization of the United Nations (FAO), to be implemented over the 2020–2030 period and including projects that support zero tillage, irrigation modernization, conservation of soil and water basins, and capacity-building to establish a monitoring system. Morocco has embarked on a broad range of climate-smart agriculture approaches by paying targeted attention to smallholder farmers, aiming to facilitate their access to technologies and services and promoting their integration into the market. There is a great opportunity for the Maghreb countries, and the wider Mediterranean region, to benefit from the experience of Morocco through a knowledge and policy dialogue.

4.3. Investing in youth initiatives

The challenges that young water professionals face in the region are varied.[39] They include limited access to financial capital (financial assets are often managed directly by

[38] Harake, D. (2022). *Climate Futures of Maghreb: Focus on Morocco*. Center for Mediterranean Integration (CMI) and Foreign, Commonwealth & Development Office Policy Brief.
[39] Al-Ajarma, K. (2019). *Youth Water Cooperation in the Mediterranean: Challenges and the Way Forward.* EuroMeSCo Policy Brief No. 103. https://www.euromesco.net/wp-content/uploads/2019/10/Brief103_Youth_water-cooperation-mena.pdf.

supervisors), limited access to decision-making (exclusion from consultation processes and/or management positions), restricted national and international mobility (work permit and visa issues result in missed opportunities) and a lack of youth engagement in policy dialogue on water (policymakers often overlook their perspectives).

Mediterranean policymakers should support and empower their young people to drive the transformation required to improve water security in the region. There are several ways they could do this:

- **Recognizing the role of youth-led organizations and national and international non-governmental youth organizations:** These organizations need to be recognized as key partners with specific responsibilities (acting as multipliers, raising awareness and ensuring outreach to diverse young people, engaging in consultations and follow-up to the implementation process) and rights (receiving technical and financial support, having a voice). International youth organizations include the Water Youth Network, a global and inclusive connector in the water sector with a vibrant community of students and young professionals across disciplines, which receives support from actors such as the IHE Delft Institute for Water Education. Another major international youth actor is the World Youth Parliament for Water, which works with young leaders across borders to implement sustainable and practical solutions to global water issues. Among its members are national youth parliaments, such as the Egypt Youth Parliament for Water, which involves young people in finding solutions for water problems faced in Egypt and Africa. Regional youth networks such as MedYWat, which is supported and funded by CMI, are connecting young water professionals in the Mediterranean region and work on finding practical solutions for real-life challenges related to water scarcity and climate change in the region.
- **Strengthening collaboration with policymakers**: Subnational, national and regional mechanisms should be established to foster closer dialogue and collaboration with young water activists and professionals. Involving youth at all levels, especially in leadership positions related to water management, policymaking and governance, will be key. Youth networks could be key drivers of water diplomacy efforts. A regional training course in the field of transboundary water, nexus solutions and water diplomacy could aim to increase the capacities of youth water experts (training of trainers) and related stakeholders towards achieving peace and sustainable development.[40] **National and subnational working groups on water could be created**, comprising representatives from the ministry in charge of youth, national youth councils, youth organizations/networks, youth researchers and other relevant actors. As suggested during the Marseille Water Security Nexus Regional Forum, youth participation in the decision-making process could also be encouraged by training young people as **“shadow ministers”**. Specifically, they could be involved in

[40] Tsakas, C. (2022) *Catalyzing Regional Cooperation on Water and Climate Change Nexus Solutions in the Mediterranean*. Policy Brief. “The Water Security Nexus in North Africa – Catalyzing Regional Coordination Around Climate Change, Resilience and Migration” Project. Marseille: Center for Mediterranean Integration/UNOPS. www.cmimarseille.org..

the formation of a shadow cabinet that mirrors the positions of each individual cabinet member. Their areas of responsibility, in parallel with official ministers, may be referred to as a shadow portfolio. Members of this shadow cabinet would have the responsibility of scrutinizing the government's policies and actions, as well as offering alternative policies. **National capacity-building could also capitalize on regional youth networks.** Regional networks such as the CMI-led MedYWat also organize actions specific to each Mediterranean country. Local/national training could therefore be led by young water professionals and policymakers could capitalize on them to strengthen their national initiatives and better insert them into the regional context. For example, MedYWat in Morocco is working on solving environmental challenges in the country. It recently organized a workshop in Taroudant (Morocco) to provide information on the use of data analysis tools for successful climate-change management. Currently, there are also ongoing efforts in Jordan, which also depends on receiving the necessary support and guidance from interested stakeholders. As described previously, such youth actors are also carriers of innovative entrepreneurial ideas that can benefit their local territories/countries.

- Initiatives such as those of the Water and Climate Change Entrepreneurship e-Bootcamp would definitely benefit from domestic support, especially of the financial kind, which would allow them to scale up. Mediterranean policymakers will need to **help young people develop the skills and experience needed for both traditional and new jobs**. This would allow young people to not only transform their own lives, but also be drivers of change for their communities, societies and countries, tackling inequalities and creating a safer and sustainable Mediterranean. Provision of such skills could be explored through **joint programmes in association with international graduate water education facilities that** offer accredited MSc/PhD degrees. One such potential partner is the IHE Delft Institute for Water Education, which provides water education and training and works on projects to strengthen capacity in the water sector worldwide. It recently launched an initiative to provide water professionals from seven MENA countries (Djibouti, Egypt, Iraq, Jordan, Lebanon, the State of Palestine and Yemen) and Sudan with MSc-level education on topics relevant to MENA-region water scarcity, including field-based research, and to stimulate cooperation between professionals from different disciplines.[41] Another such partner is the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) Bari, which offers a master's programme with full scholarships to young applicants from South and East Mediterranean and Middle Eastern countries.
- Meanwhile, as highlighted during the Marseille Water Security Nexus Regional Forum, **for young water entrepreneurs (and more generally social and environmental entrepreneurs) to succeed, they need an ecosystem of social and environmental innovation**. Currently, the lack of access to funding, linked to

[41] See https://www.un-ihe.org/mena-cd-fellowships.

legislative barriers, is one of the most significant obstacles. Moreover, the nature and activities of water entrepreneurs limits the attractiveness of their model for potential investors. If water entrepreneurship is to become a key element of development strategies in the Maghreb, it is necessary to develop, or even reinvent, the social and environmental innovation ecosystem, including by **developing adapted financial tools** designed specifically for water, social and environmental enterprises.

- **Facilitating connections between young people and academia and providing financial support to youth-led research:** There is a need for greater support for researchers on water-related topics, such as water-induced migration, the link between water management and food security, how best to support women water entrepreneurs, what financial tools are needed to support water entrepreneurs and the potential of technology and digitalization. Meanwhile, more research projects are needed on how to monetize social and environmental returns. Support can take the form of research grants and regional mentoring programmes that are based on collective intelligence, connecting senior researchers with young water professionals to provide supervision and support for their work. A good example that facilitates such a connection is the collaborative MAGO project (Mediterranean wAter management solutions for a sustainable aGriculture supplied by an Online collaborative platform), which is funded by the Partnership for Research and Innovation in the Mediterranean Area and develops innovative solutions for the integrated management of water resources for a sustainable agriculture. It involves partners from countries such as France, Lebanon, Spain and Tunisia, which serve as a testing ground for proposed solutions aimed at promoting the efficiency of water use in agriculture, the use of alternative water resources and adaptation to climate change. The project actively involves members of the CMI youth network MedYWat from the southern and northern shores of the Mediterranean in capacity-building activities.

Annex 1

Table 1. Mean annual and seasonal water accounting indicators for Souss-Massa over the 2030 time-horizon (2020–2038); values in km^3/year[42]

Description		Annual		Wet season		Dry season	
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Gross inflow		6.58	1.19	5.58	1.13	1.08	0.19
	Precipitation	6.58	1.19	5.58	1.13	1.08	0.19
	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
	Groundwater	0.00	0.00	0.00	0.00	0.00	0.00
Storage change		2.45	0.66	1.86	0.58	0.64	0.12
Net inflow		9.04	1.82	7.44	1.69	1.72	0.24
	Landscape evapotranspiration	6.28	1.03	5.14	0.98	1.20	0.16
	Exploitable water	2.75	0.81	2.29	0.72	0.52	0.12
	Available water	2.52	0.75	2.09	0.68	0.48	0.11
	Utilized flow	2.50	0.73	2.07	0.65	0.48	0.11
	Utilizable outflow	0.02	0.03	0.02	0.03	0.00	0.00
	Non-utilizable outflow	< 0.01	< 0.01	0.00	0.00	0.00	0.00
	Reserved outflow	0.24	0.05	0.20	0.05	0.04	0.01
	Incremental evapotranspiration	0.56	0.03	0.25	0.03	0.31	0.01

[42] International Water Management Institute. (2022). *Water Accounting of the Souss Massa River Basin in Morocco.* "The Water Security Nexus in North Africa – Catalyzing Regional Coordination Around Climate Change, Resilience and Migration" Project. Marseille: Center for Mediterranean Integration and UNOPS.

	Non-recoverable flow	2.38	0.73	2.02	0.66	0.42	0.11
Depletions							
	Consumed water	8.78	1.75	7.22	1.62	1.67	0.23
	Depleted water	6.40	1.03	5.20	0.98	1.26	0.16
Outflow		**2.64**	0.81	**2.19**	0.73	**0.46**	0.13

Table 2. Mean annual and seasonal water accounting indicators for Souss-Massa over the 2050 time-horizon (2040–2058); values in km^3/year[43]The results of this

Description		**Annual**		**Wet season**		**Dry season**	
		Mean	**Standard deviation**	**Mean**	**Standard deviation**	**Mean**	**Standard deviation**
Gross inflow		**5.84**	1.21	**4.75**	1.21	**0.95**	0.22
	Precipitation	5.84	1.21	4.75	1.21	0.95	0.22
	Surface water	0.00	0.00	0.00	0.00	0.00	0.00
	Groundwater	0.00	0.00	0.00	0.00	0.00	0.00
Storage change		**2.14**	0.71	**1.43**	0.63	**0.60**	0.13
Net inflow		**7.98**	1.91	**6.18**	1.82	**1.55**	0.29
	Landscape evapotranspiration	5.73	1.07	4.51	1.07	1.11	0.19
	Exploitable water	2.25	0.85	1.68	0.76	0.45	0.14
	Available water	2.07	0.79	1.54	0.71	0.41	0.13
	Utilized flow	2.04	0.77	1.52	0.69	0.41	0.13
	Utilizable outflow	0.03	0.03	0.02	0.03	0.00	0.00
	Non-utilizable outflow	< 0.01	< 0.01	0.00	0.00	0.00	0.00
	Reserved outflow	0.18	0.06	0.14	0.05	0.04	0.01

[43] International Water Management Institute. (2022). *Water Accounting of the Souss Massa River Basin in Morocco.* "The Water Security Nexus in North Africa – Catalyzing Regional Coordination Around Climate Change, Resilience and Migration" Project. Marseille: Center for Mediterranean Integration and UNOPS.

	Incremental evapotranspiration	0.58	0.03	0.27	0.03	0.31	0.01
	Non-recoverable flow	1.92	0.77	1.46	0.70	0.35	0.13
Depletions							
	Consumed water	7.77	1.83	6.03	1.75	1.51	0.27
	Depleted water	5.85	1.07	4.56	1.07	1.17	0.19
Outflow		**2.13**	0.85	**1.74**	0.77	**0.38**	0.14

Water and Climate Change Entrepreneurship e-Hackathon and e-Bootcamp

In June 2020, CMI, cewas Middle East and MedYWat jointly implemented a fully virtual e-Hackathon with 61 young participants from the Mediterranean region. The participants worked in 10 teams on water and climate-change challenges and received expert guidance to develop innovative solutions. All 10 teams submitted a full solution board including a 2-minute pitch video, short description and draft visuals of their suggested prototype.[44]

A judging panel thoroughly reviewed all 10 solutions and awarded three teams with the best submissions and highest potential for their solution to be developed into an entrepreneurial approach to address water security nexus challenges. Eight teams were also invited to a six-month entrepreneurial e-Bootcamp, where they had the chance to further develop their business ideas, conduct a thorough analysis of the potential and marketability of their solutions and receive in-depth training/coaching time with cewas' entrepreneurship coaches, as well as highly qualified mentors and experts.[45]

The bootcamp activities started in December 2020 with two preparatory webinars before continuing with a series of six mandatory training sessions (value proposition design, finance essentials, pricing, marketing, prototyping and minimum viable product, and sales). These training sessions started on 13 January 2021 and ran until the end of February alongside plenary sessions, interactive sessions, workshops and group work sessions, followed by a coaching and implementation phase from March until May 2021.

The training sessions started with 21 confirmed participants representing eight teams working on their different solutions pitched during the e-Hackathon. By the end of August 2021, only three teams were able to continue the coaching sessions and succeed in implementing their minimum viable product with grants of USD 1,500 each.

After the final pitching session on 1 September 2021, the three teams had left a good impression on the judges, which made deciding which team to award an extra USD 1,500 quite challenging. To better assess where and how the cash prize could be best placed, the different teams were asked to prepare a budget with expected expenditures for the prize money and a short explanation of why it was crucial to their start-up's growth.

From April 2022, two teams (Opti-moo and FARMED) will continue the incubation programme with cewas to continue improving their prototypes and implement and transform their ideas into real projects.

[44] See https://cmihackathon.creation.camp/solutions/.
[45] See https://cmibootcamp.creation.camp/program/.

The Center for Mediterranean Integration (CMI) is a multi-partner institution where international development agencies, national governments, local authorities, and civil society from around the Mediterranean convene to exchange ideas, discuss public policies, and identify regional solutions to address regional challenges in the Mediterranean.

As of July 1st, 2021, and eleven years after its creation, the CMI has officially joined the United Nations (UN), hosted by the United Nations Office for Project Services (UNOPS).

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