

LOCAL 2030
KNOWLEDGE AND SCIENTIFIC NETWORK

From Restoration to Conservation, Advancing *Posidonia oceanica* Ecosystem Recovery in Tunisia

Policy Paper – 2026



14
LIFE BELOW
WATER



11
SUSTAINABLE CITIES
AND COMMUNITIES



13
CLIMATE
ACTION



8
DECENT WORK AND
ECONOMIC GROWTH

Prepared by
Nada Abdelkader, PhD,
Laboratory of Diversity,
Management, and Conservation
of Biological Systems, Faculty
of Sciences of Tunis -
University of Tunis El Manar,
Tunisia



From Restoration to Conservation, Advancing *Posidonia oceanica* Ecosystem Recovery in Tunisia

Nada Abdelkader, PhD,

Laboratory of Diversity, Management and Conservation of Biological Systems, Faculty of Science of Tunis - University of Tunis El Manar, Tunisia

Published by the United Nations Human Settlements Programme (UN-Habitat).
First published in Nairobi in September 2026 by UN-Habitat Copyright © United Nations Human Settlements Programme, 2026.

All rights reserved.

United Nations Human Settlements Programme (UN-Habitat) P.O. Box 30030,
00100 Nairobi GPO, Kenya Tel: 254-020-7623120 (Central Office)
www.unhabitat.org

Disclaimer

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the secretariat of the United Nations concerning the legal status of any county, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries regarding its economic system or degree of development. Excerpts may be reproduced without authorization, on condition that the source is indicated. Views expressed in this publication do not necessarily reflect those of the United Nations Human Settlements Programme, the United Nations and its member states

PREFACE

Achieving the 2030 Agenda requires more than translating global goals into national targets – it demands that sustainable development be rooted in the realities, needs, and capacities of local territories. Local and regional governments are indispensable actors in this process: they deliver essential services, address inequalities on the ground, and turn policy commitments into concrete actions. Yet this critical role is only fully effective when backed by strong evidence, meaningful knowledge exchange, and coherent governance across levels.

The Local2030 Knowledge and Scientific Network (KSN) was established within the UN Local2030 Coalition precisely to respond to this need. As a dynamic global platform, KSN connects young researchers, policymakers, community leaders, and practitioners around a shared mission: to harness science for sustainable development with local impact. It does so by aligning academic inquiry with the specific priorities of local development stakeholders, while amplifying research findings as inputs to SDG-related global processes.

Central to this approach is the understanding that research must not only be produced – it must be translated into policy and action. KSN promotes a more dynamic and responsive model of academia, one that co-creates scalable solutions rooted in scientific evidence and community priorities, and that empowers local actors with the skills, tools, and institutional support needed to engage in evidence-based decision-making and influence policy. Through its Country Pilots – sponsored by the Italian government and implemented by UN-Habitat and the Centro Studi di Politica Internazionale (CeSPI ETS) – and Innovation Labs, the network operationalizes this vision by connecting universities and students with local policymakers, enabling interdisciplinary collaboration and capacity-building in territories across Africa, Asia, and Latin America and the Caribbean.

Action-research is the methodological backbone of this work. Territories are engaged not as passive subjects of study, but as spaces for experimentation and learning, where sustained interaction between researchers, local governments, civil society, and communities drives learning, adaptation, and co-creation. By combining quantitative and qualitative methods – data analysis, spatial assessments, stakeholder engagement, and participatory approaches – this process generates a comprehensive and grounded understanding of local dynamics, inequalities, and development opportunities.

This policy paper is the result of that process. It reflects the outcome of collaboration between academic research, territorial analysis, and multi-stakeholder dialogue, in

the spirit of the KSN's core objective: translating research into policy and action. Its aim is to offer context-sensitive analysis and practical policy recommendations that can inform SDG localization at the local level — bridging the gap between global agendas and the communities that will ultimately determine their success.

TABLE OF CONTENTS

SUMMARY 1

1. INTRODUCTION AND PROBLEMS DEFINE 2

**2. CASE STUDY: THE LINK BETWEEN THE LAND AND THE SEA IN
KERKENNAH ARCHEPELOGO GUIDE TO *Posidonia oceanica* RESTORATION 5**

3. LOCAL POLICY AND GAPS..... 11

4. MUNICIPAL POSITIONING VISION AND ACTION RECOMMENDATIONS.. 13

**5. COASTAL RESTORATION: TRANSITIONING FROM LOCAL PILOT TO
NATIONAL, REGIONAL AND INTERNATIONAL INITIATIVES 17**

6. FUNDING 20

7. KEY MESSAGES AND RECOMMENDATIONS 22

8. CONCLUSION 25



SUMMARY

This policy paper responds to the urgent need to restore *Posidonia oceanica* meadows in Tunisia and the Mediterranean, while linking ecological conservation to community livelihoods, cultural heritage, and sustainable development. Drawing on the pilot restoration project in the Kerkennah archipelago, the paper identifies practical and transformative actions that integrate scientific knowledge, traditional practices, and participatory governance to generate positive ecological, social, and economic outcomes.

Section 1 presents the Kerkennah Archipelago case study, emphasizing the integration of local knowledge, traditional fishing practices, and ecological assessment in designing restoration techniques. The pilot project demonstrates how participatory mapping, community engagement, and women-led production of palm-based restoration materials can create inclusive, culturally grounded, and ecologically effective interventions.

Section 2 reviews existing policy frameworks and institutional arrangements in Tunisia, highlighting gaps in legal protection for seagrass ecosystems, fragmented governance, and the limited role of municipalities, which constrain the scaling-up of restoration initiatives despite successful pilots.

Section 3 proposes a municipal vision and action plan for Kerkennah, emphasizing the strategic role of local authorities in integrating coastal conservation and restoration with sustainable development, community empowerment, cultural heritage, and blue/green economy activities.

Section 4 explores the transition from local pilots to national, regional, and international initiatives.

Section 5 addresses the financing challenges of long-term restoration initiatives, proposing diversified, sustainable funding mechanisms aligned with development donor frameworks and the cost-effectiveness of medium-scale pilot projects.

Section 6 distills key messages and recommendations, showing how locally driven projects can bridge local realities with national and international goals.

By linking science, community, culture, and policy, this paper provides a roadmap for scaling seagrass restoration in Tunisia and the Mediterranean, demonstrating how local initiatives can advance ecological resilience, biodiversity conservation, and sustainable development simultaneously.

1. INTRODUCTION AND PROBLEMS DEFINE

Seagrass meadows rank amongst the planet's most valuable and productive ecosystems, offering vital ecosystem services that support human well-being and biodiversity (Campagne et al., 2015; Nordlund et al., 2016). In the Mediterranean Sea, the indigenous species *Posidonia oceanica* serves as a keystone habitat-forming species, establishing extensive meadows that support ecological and socio-economic systems. These flowering plants support the resilience of coastal environments by attenuating waves and currents, retaining sediment, stabilizing shorelines, sequestering carbon, and producing primary products. Seagrasses support cultural and traditional activities in addition to their ecological roles, especially in small island and coastal communities that depend on marine resources for their livelihoods.

Despite their significance, *P. oceanica* meadows face mounting threat despite their significance. In addition to climate change and invasive species, human activities such as habitat fragmentation, eutrophication, pollution, overfishing, and trawling caused their decrease. An estimated 2–5% of seagrass meadows disappear globally each year (Waycott et al., 2009; Short et al., 2011), with profound ecological and socioeconomic consequences (Vassallo et al., 2013). With estimations of area ranging from 1,332 km² (Pergent-Martini et al., 2021) to over 6,300 km² (Traganos et al., 2022), Tunisia is home to some of the biggest *P. oceanica* meadows in the Mediterranean. However, nutrient contamination and destructive trawling have caused these meadows to significantly decline, especially in the Gulf of Gabès. As a result, *P. oceanica* and *Cymodocea nodosa* have completely disappeared in certain regions.

Recognizing biodiversity loss as a key threat to the future of humanity, countries worldwide are working to protect and restore our ecosystems. In 2022, a flagship agreement was made when 196 nations agreed to restore 30% of degraded ecosystems by the year 2030 and protect 30% of the world's ecosystems ("30 × 30", Kunming Montreal Global Biodiversity Framework Targets 2 and 3).

The international community is increasingly exploring the use of Nature-based Solutions (NbS) to maximise the synergies between ecosystem health and human wellbeing, while also offering attractive economic benefits. Both research and cases of early adoption have presented evidence of the value and multiple benefits of NbS.

The International Union for Conservation of Nature defines nature-based solutions (NbS) as "actions to protect, manage and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits." (IUCN 2016) Seagrass restoration falls under this category. Therefore, the previously mentioned concept of NbS is related to or combines with other approaches like Ecosystem-based Adaptation (EbA), where adaptation policies and measures are focused on managing the natural environment (ecosystems) in order to reduce society's vulnerability to climate change (Vignola et al. 2009). The Intergovernmental Panel for Climate Change (IPCC) claims that while the concepts of EbA and NbS are similar or related (both strategies seek to manage nature or ecosystems to produce positive outcomes, ecosystem services or benefits for society (Nesshoeven et al. 2017), NbS encompasses a wider range of strategies with safeguards, such as those that support adaptation and mitigation (IPCC 2022).

Restoring seagrass become urgent.

The ecosystem restoration, is defined by the process of helping degraded, damaged, or destroyed ecosystems recover (SER, 2004). It is becoming more widely acknowledged as a crucial strategy to preserve biodiversity, strengthen ecosystem integrity, and increase resilience to climate change (Aronson and Alexander, 2013). In contrast to other ecosystems like mangroves, the use of seagrass restoration in the context of NbS is still restricted worldwide (e.g., Gijsman et al. 2021; Quevedo et al. 2021b).

A crucial gap: whereas *Posidonia* conservation and restoration are becoming more and more important at the scientific and governmental levels, community involvement and participatory governance are ultimately necessary for their success. However, despite the wide acceptance of many sustainability goals like the Post-2020 Global Biodiversity Framework and the Sustainable Development Goals (SDGs), scholars are increasingly highlighting the necessity of bridging top-down regulatory frameworks with bottom-up, community-driven action (Reid 2015; Fernández-Giménez et al. 2019). Restoration and conservation measures for *Posidonia oceanica* meadows, which are under increasing pressure from damaging fishing practices, coastal development, and climate change (Boudouresque et al., 2009), call for more than just ecological monitoring. As a result, a number of restoration initiatives have come to light around the Mediterranean, with the goal of replanting damaged meadows and testing cutting-edge transplanting methods. While *Posidonia* meadow ecological restoration is getting attention in the northern Mediterranean, there are still few and weakly managed projects in the southern Mediterranean (Pansini et al., 2022). To guarantee long-term success and compatibility with sustainable development goals, these initiatives place an increasing emphasis on community engagement and nature-based solutions.

Typically, before initiating restoration efforts to rehabilitate degraded areas, a country implements both direct and indirect conservation measures, supported by policies, legal frameworks, or regulations. In Tunisia, however, there are no specific regulations directly protecting seagrass meadows of all species, particularly *Posidonia oceanica*.

The Kerkennah archipelago represents one of the country's first pilot restoration experiences for *Posidonia oceanica*. The selection of restoration sites and the techniques employed depend on multiple factors, which are detailed in the associated scientific literature.

The conceptual framework underpinning restoration and conservation goes beyond technical interventions, linking ecological restoration with engaged citizenry and local knowledge. It emphasizes the essential role of local actors in decision-making and long-term monitoring. Community groups contribute to restoration processes through participatory choices informed by ecological data and enriched by documentation of resource use, historical observations, and local practices that directly affect seagrass meadows.

This policy paper advocates for an integrated approach that bridges scientific research, community practices, and policy integration to strengthen the continuum from restoration to conservation. It highlights local initiatives, particularly in Kerkennah, as laboratories for SDG localization, demonstrating how municipalities can embed marine ecosystem restoration into territorial planning and sustainable development strategies.

2. CASE STUDY: THE LINK BETWEEN THE LAND AND THE SEA IN KERKENNAH

ARCHEPELOGO GUIDE TO *Posidonia oceanica* RESTORATION

The Kerkennah archipelago is situated about 20 kilometers off the coast of Sfax, southeast of Tunisia. Covering an area of 150 km², it comprises two principal islands, Chergui and Gharbi. The archipelago has a variable width of up to 14 km and stretches around 35 km from northeast to southwest (DGEQV, 2012). Of its about 174 km of shoreline, 171.5 km are deemed stable. Due to the Kerkennah population's strong migratory habits, the permanent population of the archipelago has not grown significantly during the past few decades. Seasonal population pressure is significant, though. Summertime brings a temporary tenfold increase in the population as immigrants return from both overseas and continental Tunisia, especially from Sfax and Tunis.

In the past, the Kerkennah archipelago's primary sources of income were agriculture and fishing. The palm tree held a special ecological, economic, and cultural place in the community, and the majority of fertile land was routinely farmed. A. Louis referred to the palm tree as "the king of trees in Kerkena: it defines the landscape, giving it its charm and originality" as early as 1945. In contrast to southern Tunisia, where dates are valued mainly for their nutritional price, Kerkennah considers the palm tree for its many purposes. Traditional fixed fisheries, fish traps, and daily activities relied on palm fronds and trunks. The most iconic and historically significant is Charfia (plural: Cherafi). Charfia is the mainstay of traditional fixed fishing in Kerkennah where it has been practiced for more over 500 years. Despite being located within the maritime public domain, many charafi and octopus stone areas are privately owned. Attempts to regularize this situation date back to 1929, when the Bey (meaning: The Bey of Tunis was originally a governor representing the

Ottoman Empire in Tunisia) proposed 60-year concessions, followed by an additional 39-year concession granted by Tunisian authorities in 1989. Public charafi are currently operated through annual tenders managed by fisheries services. Seasonal maintenance, biological rest intervals, and the use of biodegradable materials, primarily date palm byproducts, are all part of the stringent social and ecological constraints that characterize charfia fishing. However, these practices are increasingly being abandoned, with palm-based structures are being replaced by Plastic, Nylon and metal components, enabling installations to stay in place for several years without the need for ecological recovery periods. Both traditional knowledge and marine biodiversity are at risk due to this change.

Kerkennah is one of the most vulnerable sites in Tunisia and the broader Mediterranean to the effects of sea level rise, owing to long-standing ground subsidence processes that date back to antiquity Low-lying agricultural regions are more impacted by saltwater incursion as sea levels rise, hastening soil salinization and vegetation degradation. Palm tree remnants are now found within sebkhas and salicornia-dominated ecosystems, which are unmistakable signs of increasing salinity and environmental stress, according to field observations that support this trend.

Halophilic vegetation gradually spreads into areas that were previously dominated by agricultural and palm-based landscapes as palms recede. This deterioration is made worse by anthropogenic forces. The economic worth of palm trees has decreased due to the decline of conventional fixed fisheries, which has decreased the incentives for their protection. Palm groves are being removed more often in order to achieve immediate financial goals. In order to remove palms and replace them with olive plantings, landowners now frequently rent large machinery.

Although there are immediate economic and food-related advantages to olive farming, there are substantial environmental costs associated with this change in land usage. Palm trees stabilize soils, act as natural windbreaks, and regulate regional microclimates. Their loss promotes land deterioration, increases susceptibility to wind erosion, and destabilizes already delicate ecosystems, functions that olive trees are unable to sufficiently replace. This shift is indicative of a larger governance issue in Kerkennah, where long-term environmental sustainability is frequently subordinated to short-term economic reason. As a result, many family groups have been forced to abandon agriculture and intensify fishing activities to meet growing survival needs. As a result, the economy has changed from being mostly self-sufficient or semi-open to being entirely focused on the market. Nowadays, the majority of fisheries products is sent to commercial markets, making fishing the main, and sometimes the only, source of income for the locals.

The statistics that are now available show that any increased fishing effort, whether motorized or not, has an immediate detrimental impact on local productivity, even if they are still incomplete (especially because fleets operating beyond the archipelago are not included). This drop is caused by a number of factors:

- The widespread usage of nets with improper mesh sizes, which results in the catch of young fish;
- The growth of motorized boats, many of which are still unregistered (Rhouma & Labidi, 2006), particularly after the post-revolutionary period;
- Trawling operations are becoming more intense, including illicit "kiss" trawling in shallow water;
- Increasing disputes and a lack of tolerance between various fishing categories;
- Illegal, unreported, and unregulated fishing activities

Fish populations have been severely disrupted and the marine ecosystems, especially *Posidonia oceanica* meadows, of the Kerkennah archipelago are profoundly unbalanced as a result of the combined consequences of excessive fishing effort, the deployment of improper and harmful gear, and ongoing regulatory non-compliance. Since Kerkennah is a crucial component of the Gulf of Gabes, one of the most productive but rapidly deteriorating marine regions in the Southern Mediterranean, these local constraints are nested within a larger regional context.

Significant ecological and financial losses have been caused by the destruction of *Posidonia oceanica* meadows at the Gulf of Gabes scale. Roughly 90% of the *Posidonia* meadows' surface area vanished from the Gulf between 1970 and 2014 (El Zrelli et al., 2020). The ecological services that seagrass meadows offer, such as fish nursery habitat, coastal protection, carbon sequestration, and nutrient cycling, have drastically decreased as a result of this loss. By combining use and non-use values, the overall economic loss linked to the decline of *Posidonia* ecosystem services in the Gulf of Gabes was calculated. The total economic loss by 2014 was nearly €105 million, or roughly 511 €/ha (El Zrelli, et al., 2023). Remarkably, decreases in the productivity of small-scale fisheries and the loss of natural fertilizer services provided by seagrass detritus were shown to be responsible for approximately 90% of this loss. These numbers demonstrate how local livelihoods are directly impacted by seagrass loss, especially in coastal communities like Kerkennah that rely heavily on marine resources.

The planned establishment of a future Marine and Coastal Protected Area (MCPAs) on the northern islets of the Kerkennah archipelago appears as a strategic and

urgent solution within this socio-ecological context. This project is part of the national MCPA network created under the program started by the Agency for the Protection and Management of Coastal Areas (APAL) and is completely in line with national efforts to protect and restore marine and coastal ecosystems. The MCPA seeks to protect important ecosystems, including as seagrass meadows, while bolstering the resilience of traditional fishing systems by combining biodiversity protection with sustainable resource management.

For *Posidonia oceanica* in particular, the observed decline in meadow extent and structural integrity signals the need for immediate and targeted intervention. In addition to threatening natural processes, ongoing decline also affects Kerkennian society's cultural and economic foundations. Addressing this decline requires urgent, coordinated action combining protection measures, restoration initiatives and the revitalization of traditional practices that are better adapted to the ecological characteristics of the marine environment. The potential of scientifically informed interventions to restore *Posidonia oceanica* meadows has been shown since 2024 by a pilot restoration project run by the Tunisian Association of Taxonomy (ATUTAX) in the region designated as a future Marine and Coastal Protected Area (MCPA) (Abdelkader et al., in press). Planning, carrying out, overseeing, and managing transplants were all part of the systematic restoration process. Key Lessons from this pilot project highlight the need of careful site selection, which continues to be the most crucial element in any transplanting effort's success. Following the identification of eligible locations, the procedure include choosing the right restoration techniques and figuring out what kind of plant material to utilize.

The restoration of *Posidonia oceanica* meadows requires a methodology that integrates ecological assessment with community engagement, recognizing that both environmental conditions and local socio-cultural factors influence successful management. Our approach combined field-based ecological evaluation with qualitative engagement of local stakeholders, structured in two complementary phases. Local knowledge and community participation were placed at the core of the restoration process from the outset. The first phase focused on gathering insights through focus groups, semi-structured interviews, and participatory mapping exercises involving fishermen, scientists, female artisans, farmers, eco-tourism start-ups, local NGOs, and the co-managers of the future Marine and Coastal Protected Area (MCPA), namely the Coastal Protection and Development Agency (APAL) and the Kraten Association for Sustainable Development, Culture, and Leisure (AKDDCL). These exchanges documented perceptions of seagrass meadow condition, historical changes, resource-use practices, and levels of community interest in restoration activities. Participatory mapping workshops enabled stakeholders to identify degraded, threatened, or historically significant *Posidonia*

oceanica meadows. By spatially locating these areas and recording narratives associated with past ecological conditions, the process integrated local memory into restoration planning. The outcome was a shared and inclusive knowledge base that directly informed site prioritization, restoration strategies, and community-driven management approaches.

Building on this collective groundwork, ecological evaluations were subsequently conducted to assess the feasibility and effectiveness of restoration interventions. Historical data were combined with in situ field assessments to evaluate meadow health, spatial coverage, sediment characteristics, and exposure to stressors such as pollution, anchoring, and trawling. Only sites with documented historical presence of *Posidonia oceanica* and where major stressors had been reduced or eliminated were retained for restoration. Considerations of scale were also integrated to ensure that interventions would generate meaningful ecological benefits. Field samples collected during this phase were then analyzed in the laboratory to establish baseline conditions and guide decision-making.

The final pre-restoration phase focused on selecting an appropriate method to anchor seagrass cuttings securely to the seabed. At this stage, the project deliberately bridged scientific protocols with local traditional knowledge. An innovative restoration model was developed by drawing inspiration from the traditional fishing technique known as *Drina*, historically used by fishermen and crafted using natural materials, and from *Charfia*, an ancestral fixed fishing system recognized by UNESCO as part of humanity's intangible cultural heritage. This hybrid approach resulted in a nature-based, culturally grounded anchoring model designed specifically for local environmental conditions. The restoration structures were crafted by local artisan women, and formal authorization was obtained from marine parcel owners to ensure long-term protection of restored sites (Abdelkader et al., in press). Following transplantation, a post-restoration monitoring phase was carried out to assess ecological performance and inform adaptive management. Monitoring focused on shoot survival and mortality rates, primary production, and associated fauna over time. This evaluation framework allowed for continuous learning and adjustment to optimize long-term restoration outcomes.

The initiative aimed to provide larger socio-economic and governance advantages in addition to ecological goals. Activities aimed at improving awareness among fishermen, civil society actors, and local management focused on the effects of damaging fishing methods on fish populations, ecosystems, and biodiversity. The experiment showed how restoration could improve fisheries output, increase coastal resilience, and promote the growth of ecotourism. Improved biodiversity, higher ecosystem resilience, and increased livelihood security for populations based on healthy marine ecosystems were among the significant beneficial effects that was

expected and seen. The direct involvement of local women in producing restoration materials created new income opportunities while reinforcing the value of traditional knowledge. Students' and volunteers' involvement promoted knowledge transfer and long-term stewardship, while capacity-building initiatives improved local NGOs' abilities in seagrass restoration, monitoring, and species identification.

By combining local knowledge with ecological assessment, this integrated approach provides a practical framework for targeted, community-supported restoration of *Posidonia oceanica* meadows. It underscores the importance of engaging local stakeholders, protecting historical meadows, and aligning restoration efforts with ecological realities, creating a model for sustainable coastal management.

3. LOCAL POLICY AND GAPS

Numerous administrative and scientific organizations are mobilized by the numerous conventions that Tunisia has ratified and signed pertaining to the preservation of biodiversity and the development of the country's coastline in order to regulate and ensure the implementations of these protocols and legal texts. Responsibility for biodiversity protection is therefore distributed across several ministries, primarily the Ministry of Agriculture, Fisheries, and Water resources and the Ministry of the Environment.

The relevant agencies include the Directorate General for the Environment and Quality of Life (DGEQV), the Directorate General for Forests (DGF), the National Environmental Protection Agency (ANPE) and the International Center for Technology Environment of Tunis (CITET); as well as the Coastal Protection and Planning Agency (APAL), the lead authority for coastal and marine management. The National Bank of Genes contributes to the identification of species, including rare and / or threatened species. Tunisia is also home to the Specially Protected Areas Regional Activity Centre (SPA RAC). Other research institutions (INSTM, INAT, Faculties of Science) provide support and contribute in collaboration with the departments of the Ministry to the conservation of biodiversity. In this sense, many research works, several seminars and workshops have been carried out on the state of biodiversity in wetlands, marine and terrestrial areas. Several other bodies are created: the Environment and Sustainable Development Observatory (OTEDD), the Coastal Observatory based at APAL whose main task is the creation of a database on sensitive, wet and coastal areas, and the Observatory of the sea based at INSTM, which works in collaboration with INAT and other academic institutions. Likewise, there are several Non-Governmental Organizations (environmental NGOs and scientific NGOs) which are very interested in biodiversity. On the other hand, Tunisia has led efforts and carried out several works aimed at the conservation of marine and coastal biodiversity.

While this wide range of institutions reflects Tunisia's strong institutional capacity in biodiversity governance, responsibilities relating specifically to seagrass ecosystems remain diffuse. In practice, APAL acts as the primary authority for coastal and marine spatial planning and for the management of marine and coastal protected areas, while ANPE is responsible for regulating environmental impact assessments. Research institutions, and universities provide scientific expertise and ecological monitoring, while NGOs and local communities contribute to awareness, field activities, and community engagement.

The improvement of the legal framework for marine and coastal protected areas has

been greatly boosted in recent years. In this context, the national legislative framework was enriched by the creation of the National Council of Marine and Coastal Protected Areas (meeting for the first time in June 2017), and by the approval of decrees and regulatory texts N° 2014 - (1844 to 1848) as of May 19, 2014, relating to law N° 2009-49 as of July 20, 2009 (relating to MCPAs and CNAMCPs). With the creation of the CNAMCPs, the MCPA regulatory texts (ministerial decrees as of May 2014), and the MCPA law N° 49-2009, Tunisia now has access to a very powerful legislative tool that many other Mediterranean nations would benefit from adopting.

The process of restoring seagrass meadows is now complicated by the lack of laws in Tunisia that specifically protect them. Although seagrass meadows are not specifically included in national legislation, this environment may benefit indirectly from other laws and regulations. International conventions and directives provide indirect protection, while national or regional laws provide direct protection. The legal protection afforded to some marine phanerogam species in the Mediterranean somewhat compensates for the lack of explicit references to seagrass meadows in environmental impact assessment (EIA) protocols (Pergent-Martini et al., 2006). When combined, the structural flaws in impact assessment processes and the absence of direct legislative protection for seagrass meadows make it more difficult to effectively restore and conserve these vital maritime ecosystems. Coordination remains a key challenge: there is no dedicated results framework or monitoring system for seagrass, so restoration efforts rely on isolated projects rather than a coordinated national strategy.

At the local level, municipalities in Kerkennah do not have direct authority over marine areas, as this responsibility falls under the Agency for the Protection and Management of Coastal Areas (APAL). Municipal development plans do not openly include seagrass meadows, thus local governments lack a clear obligation or mandate to take action. This limits the ability of local authorities to actively support or initiate restoration actions, even when local stakeholders are motivated to participate. Consequently, despite successful pilot restoration initiatives, the scaling-up of seagrass conservation and restoration in the archipelago remains constrained by institutional fragmentation, unclear mandates, and limited local governance integration.

4. MUNICIPAL POSITIONING VISION AND ACTION RECOMMENDATIONS

The primary goal is to strengthen the municipality's leadership in integrated coastal and marine management by connecting ecological restoration to sustainable local development, cultural heritage, and community involvement.

Expected Results:

1. Increased municipal involvement in seagrass and coastal restoration project planning, coordination, and oversight.
2. Increased community ownership and active participation.
3. Associated blue/green economic activities that empower women economically.
4. Enhance ecological indicators, including the health and coverage of *Posidonia oceanica* meadows and coastal palm groves, to strengthen resilience against sea-level rise

A strategic approach that incorporates local knowledge, strengthens municipal capacity, encourages community participation, and establishes robust mechanisms for monitoring, evaluating, and scaling successful interventions is needed to close the current gaps in seagrass conservation and restoration in Kerkennah and Tunisia. By involving several stakeholders in decision-making at each level of restoration, the pilot restoration project offers a paradigm for participatory procedures. By actively mapping stakeholders in real time, evaluating their requirements, interests, and capacities, and promoting cooperation across land and sea domains, municipalities may play a key role.

The integration of land and marine operations, which acknowledges the interdependence of coastal ecosystems, is a unique aspect of this project. Municipalities might have a big impact through land-based restoration components, especially in the management and use of palm trees, even though they may not have much direct control over maritime areas. Palm trees have historically been essential to local fisheries and lifestyles, serving both ecological and cultural purposes, such as traditional knowledge and craft applications. However, due to causes including

soil salinization, lost indigenous knowledge, shifting land-use patterns, and underutilization of palm resources, their ecological and cultural worth has decreased in recent decades.

A thorough study of the existing distribution, density, and health of palm groves throughout the archipelago is necessary for future restoration projects that use palm-based ecological strategies. The development and implementation of programs for the conservation, restoration, and sustainable management of these palm groves can be greatly aided by municipalities working closely with nearby farmers and community organizations. Replanting degraded regions, including palms into farming systems, and encouraging sustainable harvesting methods are a few examples of such approaches. Additionally, palm waste products will be utilized in resource-efficient restoration techniques that encourage the restoration and anchoring of *Posidonia oceanica* meadows, improve coastal resilience, and protect cultural heritage.

In addition to enhancing ecosystem connectivity and resilience by connecting terrestrial and marine interventions in this way, the project shows how local natural and cultural resources may be used by towns to actively and strategically participate in integrated coastal and marine management. This strategy emphasizes how crucial it is to match ecological restoration with sociocultural practices in order to guarantee that interventions are socially inclusive, sustainable, and locally relevant. Long-term sustainability requires community involvement. In order to promote a sense of ownership and guarantee social legitimacy, local schools, artisans, and fishermen should be actively involved in the planning, execution, and monitoring processes. A concrete opportunity exists for the municipality of Kerkennah to strengthen women's empowerment by working hand in hand with the existing local women's groups established on the island. As a first step, the municipality could support targeted training programs for women on the fabrication of drina models, ensuring that this traditional know-how is preserved and does not disappear. These trainings would combine technical skills related to ecological restoration with the transmission of local cultural practices, reinforcing both environmental and cultural heritage. Beyond capacity building, the municipality could facilitate the integration of this activity into a local micro-economic cycle by recognizing drina production as a community-based green/blue economic activity. This could include support for small-scale equipment, coordination with restoration projects scientists, and NGOs, and the inclusion of women-led production units in municipal environmental initiatives. Such an approach would directly advance SDG 5 (gender equality) by strengthening women's economic autonomy, SDG 8 (decent work and economic growth) by creating sustainable, locally rooted green/blue jobs, and SDG 11 (sustainable cities and communities) by embedding inclusive, community-driven

economic activities within municipal development strategies.

It is necessary to carefully record, communicate, and formally incorporate traditional palm management expertise into municipal development plans. Municipality of Kerkennah can show environmental leadership and directly support Sustainable Development Goals, by incorporating restoration goals into local governance frameworks. Kerkennah's seagrass restoration presents a special chance for local governments to take the lead in accomplishing SDG 14 (Life Below Water) and other related sustainable development objectives. Municipal-level initiatives foster local synergies that support other SDGs, such as SDGs 11 and 13, much as SDG 14 is closely linked to other SDGs at the national and international levels. For municipal interventions to be successful and transformative, it is crucial to acknowledge and take use of these relationships.

The municipality can identify priority measures that yield multiple advantages by mapping these interlinkages at the local level. In addition to promoting marine biodiversity, restoring *Posidonia oceanica* meadows strengthens fisheries, improves coastal protection, lessens the effects of climate change, and enhances community livelihoods. In the same way, including palm-based sediment stabilization in terrestrial regions improves agroforestry techniques, protects cultural heritage, and enhances the sustainability of coastal restoration initiatives. In order to maximize intervention techniques and concentrate resources where they have the greatest impact, municipal authorities can map these ecological, social, and economic linkages by working with scientists, local farmers, fishers, and artisans.

By establishing ideal conditions that release community capacity, eliminate obstacles, and promote dynamic stakeholder interactions, municipalities can also serve as accelerators for local SDG implementation. For example, municipality can encourage community engagement by incorporating restoration and conservation objectives into their development plans. The impact of municipal interventions is further increased by participatory approaches, which actively involve local stakeholders in planning, execution, and monitoring. These approaches also improve social legitimacy and knowledge co-production. Municipality planning should incorporate adaptive management techniques, ongoing monitoring of restoration results, and thorough documentation of local ecological knowledge in order to optimize transformative outcomes. By doing this, towns show leadership in environmental governance while ensuring the ecological efficacy of seagrass restoration and bolstering the resilience of nearby populations and marine ecosystems. This local strategy is an example of how local governments may turn the interconnected vision of SDG 14 into useful, situation-specific action, establishing a model for sustainable coastal management that unites traditional knowledge, science, and policy.

When it comes to controlling land-ocean interactions, pollution, water scarcity, and biodiversity conservation, usually coastal cities and intermediary towns are at the forefront. Kerkennah municipality may lessen land-based stresses on the sea and increase the resilience of marine ecosystems by combining land-use planning, coastal management, and *Posidonia* ecological restoration. A comprehensive, integrated strategy that connects local policies with SDG 14 (Life Below Water) while utilizing synergies with related goals, such as SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action), is necessary for effective municipal action. Municipality can find solutions that provide several advantages by mapping these connections at the local level.

In order to promote inclusive, equitable, and participatory methods to marine governance, local authorities are also crucial. Ownership, legitimacy, and long-term sustainability are ensured by involving communities and local stakeholders in the co-design and co-implementation of restoration and conservation projects. In addition to encouraging circular economy principles, blue economy and sustainable resource management, municipalities should support natural solutions like seagrass restoration and palm-based coastal stability.

5. COASTAL RESTORATION: TRANSITIONING FROM LOCAL PILOT TO NATIONAL, REGIONAL AND INTERNATIONAL INITIATIVES

In order to maintain and restore marine ecosystems, municipalities can play a crucial role in connecting scientific research, traditional knowledge, and local governance, as demonstrated by the Kerkennah pilot restoration project. Municipalities can serve as coordinators of participatory procedures at the local level, involving community organizations, schools, artisans, and fishermen in the design, implementation, and monitoring of restoration projects. The project combines ecological restoration with cultural heritage preservation by utilizing local resources like palm trees through the integration of land and sea actions. In addition to ongoing scientific monitoring, mapping damaged seagrass meadows and nearby palm groves guarantees that solutions are socially acceptable, evidence-based, and adaptable. While adapting interventions to their unique ecological and cultural contexts, municipalities around Tunisia can implement participatory frameworks. For instance, if palm-based methods work well in Kerkennah, other areas might have different plant species or coastal materials that serve comparable ecological purposes. To successfully repeat restoration initiatives, national-level coordination, scientific advice, and standardized monitoring techniques are necessary to guarantee consistency in data collection, adaptive management, and ecological outcome evaluation. Municipal development plans that incorporate restoration goals enable national authorities to guarantee continuity, offer technical assistance, and establish opportunities for general community involvement. Additionally, the Kerkennah project is a useful testing ground for identifying best practices that can be included into national conservation and restoration plans.

At the regional level, integrated policies for the Mediterranean and other coastal regions can be guided by lessons learned from Tunisia's experimental programs. Local environmental, social, and economic issues can be addressed through context-specific adaptation made possible by the exchange of scientific insights, restoration

methods, and best practices between cities and nations. Scientists are essential to this process because they choose appropriate materials, create restoration plans, and use monitoring techniques that are specific to each region's ecological features. In addition to providing cities with access to resources, technical assistance, and knowledge networks, regional cooperation enhances multi-level governance by coordinating local initiatives with more general biodiversity, climate, and sustainable development goals. The EU Biodiversity Strategy 2030 and the Nature Restoration Law, which seek to restore degraded ecosystems in the EU by 2050, are two broader regional initiatives and policies that can benefit from Tunisia's pilot experience. In addition to improving marine biodiversity in recently restored *Posidonia oceanica* meadows, pilot project can act as models for implementing these plans locally, especially in situations where guidance is still missing. Additionally, the project is in line with the UN Sustainable Development Goals' more general goals for biodiversity and climate resilience. In addition to promoting SDGs 14 (Life Below Water) and 13 (Climate Action) by boosting CO2 absorption rates in restored areas, the initiative offers a potent nature-based option for mitigating climate change by restoring seagrass meadows, which store nearly 20% of oceanic carbon.

Additionally, by bolstering the network of Marine Protected Areas, advancing Good Environmental Status through ecosystem-based management, addressing land-sea interactions, and promoting sustainable development, the project supports regional governance frameworks like the Barcelona Convention–Mediterranean Action Plan (MAP). Participating in high-level capitalization events, international peer-learning initiatives, and regional awareness-raising campaigns guarantees that the pilot's knowledge and experiences are widely disseminated, increasing the impact and visibility of seagrass restoration initiatives across the Mediterranean.

To resume, scaling the Kerkennah pilot restoration initiative is expected to yield several tangible outputs and broader outcomes national-level. Key outputs include the adoption of the restoration model by additional municipalities, the development of standardized monitoring protocols and technical guidelines, the delivery of trainings to municipal staff, local communities, and NGOs, as well as workshops and peer-learning events that facilitate knowledge exchange. These outputs are anticipated to produce significant outcomes, including improved status of *Posidonia oceanica* meadows and coastal palm trees at new sites, integration of restoration practices into national coastal and marine plans, strengthened multi-level governance and stakeholder engagement, and enhanced community participation and ownership of restoration initiatives.

At the regional-international level, the Kerkennah pilot adds to a process of collaborative learning because *Posidonia oceanica* is a shared biological resource throughout the Mediterranean. The adoption of successful restoration techniques is

accelerated and regional cohesion is strengthened when results, techniques, and monitoring data are shared with other Mediterranean nations and global. This common knowledge base facilitates the harmonization of methods while enabling each town or nation to modify methods utilizing locally accessible resources, such as palm fibers or other materials, or context-specific ecological structures that have been recognized through scientific evaluation.

At the regional-international level, the scaling of the Kerkennah pilot is expected to produce tangible outputs, including the dissemination of policy briefs, technical reports, and best-practice guidelines to regional partners, as well as participation in international conferences, capitalization events, and awareness campaigns. These outputs are anticipated to result in meaningful outcomes, such as the adoption of successful restoration methods by additional Mediterranean municipalities, harmonization of restoration techniques across the region, improved ecological connectivity and resilience of coastal ecosystems, and strengthened regional and international capacity for multi-level governance and climate adaptation.

6. FUNDING

The unsustainability of funding for initiatives related to conservation, restoration, and development at the level of biodiversity hotspots is one of the main issues. The first results of conservation efforts (management of MPAs, biological rests, habitat restoration, management/control IAS, etc.) typically do not materialize and cannot be quantified (monitoring/evaluation of conservation and management actions), as well as the financial monitoring of projects only in the medium or even long term. In fact, these actions are funded on an as-needed basis or on short terms via international, intergovernmental, subregional, regional (Mediterranean) projects.

Today, a number of frameworks at the Mediterranean level provide regular funding opportunities for (national) plans, (national) programs, projects, and actions for sustainable management and biodiversity protection. sustainable development and/or natural resources. suggestions that promote the diversification of funding sources and mechanisms (such as trust funds) and those that seek to establish medium- and long-term projects, as well as to guarantee consistent and sustainable funding for initiatives and actions targeted at pollution control, MPA management, and biodiversity conservation. We specifically include the MedFund, the CEPF, and the Horizon 2020 program (EU) among these projects. The French Development Agency (AFD) and the French Global Environment Fund (FFEM) are two other traditional donors that are now collaborating on this new strategy for long-term projects and sustainable finance. Through the European Investment Bank (EIB) (through the EU's Horizon 2020 program), the German Agency for International Cooperation (GIZ), the UfM, the UN agencies and numerous other international cooperation organizations and donors, further financing sources can be investigated and utilized.

Clarity on the organizational and financial requirements needed to convert local ingenuity into investable and repeatable action is also important for scaling the Kerkennah restoration experience. Budgetary requirements at the municipal level must be closely related to quantifiable restoration results and well-defined coastal issues, such as sea level rise, sediment instability, seagrass degradation, or loss of traditional ecological practices. Municipalities and partners can establish reasonable intervention costs using this problem-solution-impact logic while still having the freedom to modify methods and resources to suit local circumstances. In terms of funding, this policy paper describes an investment logic that is consistent with development donor frameworks rather than suggesting a set budget. The study offers a reliable cost framework representative of medium-scale pilot projects, usually costing between €70,000 and €250,000, by specifying a particular problem, a set of focused activities, and anticipated ecological and social outcomes. This range

communicates ambition, realism, and scalability without limiting the design of future projects. It represents the kind of catalytic investment that development partners frequently employ to evaluate, improve, and expand SDG localization initiatives.

7. KEY MESSAGES AND RECOMMENDATIONS

This pilot project, which builds on the Kerkennah experience, shows how locally driven projects that address particular territorial requirements may concurrently support national goals and international agendas. The study demonstrates how *Posidonia oceanica* meadow conservation and restoration are processes that intrinsically link local, national, and international levels of governance rather than discrete environmental initiatives. Particularly with regard to coastal degradation, fisheries sustainability, climate adaption, and biodiversity loss, the project finds problems and solutions that are symbolic of larger national concerns through a participatory diagnosis grounded in local reality. The Kerkennah initiative can establish communities as important entry sites for the 2030 Agenda's implementation in the future within the context of SDG localization. SDG 14 (Life Below Water), SDG 13 (Climate Action), and SDG 11 (Sustainable Cities and Communities) are among the national development priorities and global objectives that are directly aligned with local needs identified through community engagement, such as erosion control, declining fish stocks, and loss of traditional ecological knowledge. This alignment shows how localized action may ensure relevance, ownership, and effectiveness on the ground while operationalizing global commitments.

The strength of this experience lies in its multilevel connectivity. Local governments oversee collaborative restoration initiatives including fishermen, farmers, artisans, scientists, and civic society. The initiative offers a nationwide trial ground for restoration techniques, governance structures, and monitoring procedures that can influence sectoral strategies and national conservation/restoration programs. The project links with worldwide scientific and policy frameworks on a global scale, adding real data and field-based perspectives to broader conversations about ecosystem restoration, coastal resilience, and nature-based solutions. These relationships serve as strategic hubs of exchange where information, techniques, and policy lessons are shared across scales and are not restricted to partnerships.

Finding and using the right tools and coordinating modalities is a crucial part of this experience. These include spaces for information sharing with worldwide networks and conventions, consistent monitoring procedures, and agreed indicators for social and ecological effect. By facilitating consistency between regional and national policy frameworks and local experimentation, these tools guarantee that restoration efforts are comparable, transportable, and context-adaptable. A key component of

this multilevel approach is monitoring and assessment. The Kerkennah program combines social criteria like community involvement, information transfer, and institutional cooperation with ecological indicators like carbon sequestration, sediment stability, and seagrass recovery. Impact evaluations help determine how successful policies and restoration methods are over time, while community-identified needs provide a baseline for assessing project relevance. Lessons learnt can direct future initiatives, improve public policies, and assist evidence-based decision-making thanks to this dual ecological and socio-institutional assessment approach.

Integrating and harmonizing scientific goals within this larger framework is equally crucial. Scientific research is integrated with social, economic, and governmental systems rather than functioning in a vacuum. Restoration design, site selection, and adaptive management are informed by a combination of ecological data, traditional knowledge, and policy analysis. In the end, this integrated approach strengthens the validity and scalability of restoration interventions by ensuring that scientific rigor is preserved while being sensitive to community demands and policy needs.

The Kerkennah experience therefore serves as an example of how a locally based, scientifically informed, and collaborative restoration project may serve as an important link in a system of multilevel authority. The initiative offers a reproducible approach for expanding seagrass restoration that is both context-sensitive and internationally relevant by connecting municipal action to national planning and global goals under the 2030 Agenda.

To resume the recommendations are:

- 1. Protect and conserve existing seagrass meadows:** Municipalities, national authorities, and APAL should implement measures to prevent further degradation of *Posidonia oceanica* meadows, including regulating anchoring, fishing practices, and coastal development. These actions will safeguard biodiversity and ecosystem services while providing a foundation for future restoration efforts.
- 2. Establish multilevel stakeholder platforms:** Municipalities, supported by NGOs and research institutions, should coordinate collaborative restoration and conservation planning that actively involves fishermen, farmers, artisans, scientists, and civic society. Strengthened stakeholder engagement will enhance governance, community participation, and cross-level coordination.
- 3. Develop standardized monitoring and assessment tools:** Scientists and municipalities, guided by national authorities, should adopt ecological and social indicators, including seagrass recovery, carbon sequestration, sediment stability,

and community engagement. Standardized monitoring will enable comparable, evidence-based assessments and support adaptive management over time.

- 4. Integrate scientific research, traditional knowledge, and policy analysis:** Restoration design, site selection, and adaptive management should be informed by ecological data, local practices, and policy analysis. Scientists, municipalities, and local knowledge holders must ensure that interventions are scientifically robust, context-sensitive, socially inclusive, and scalable.
- 5. Scale the Kerkennah pilot to national, regional, and international strategies:** National authorities, regional policymakers, and municipalities should document lessons learned, produce technical guidelines, and share findings through workshops, conferences, and regional and international networks. This approach will facilitate the adoption of successful restoration methods, harmonize techniques across the Mediterranean, and promote Tunisia as a global leader in seagrass conservation. It will also strengthen multi-level governance, enhance coastal ecosystem resilience, and contribute to international commitments on biodiversity, climate action, and nature-based solutions.
- 6. Promote seagrass as a national pride and build community capacity:** Municipalities, NGOs, and community organizations should actively engage local community in training and knowledge sharing, positioning *Posidonia oceanica* meadows as a symbol of Tunisia's natural heritage. These initiatives will strengthen community ownership, celebrate traditional ecological knowledge, and generate socio-economic benefits, including women's empowerment and sustainable livelihoods, while fostering a collective sense of pride in protecting the nation's unique coastal ecosystems.

8. CONCLUSION

The marine environment of the Kerkennah archipelago, and the traditional fishing systems adapted to its unique characteristics, is now in a state of profound crisis. Socio-ecological resilience has been compromised by the increase of unsustainable fishing methods, the breakdown of palm-based farming-fishing connections, and the degradation of terrestrial systems. The significance of integrated land-sea governance techniques is highlighted by the rising awareness of the pressing need to preserve both marine ecosystems and traditional practices. In light of climate change and other environmental challenges, the planned AMCP offers a vital chance to balance cultural heritage, biodiversity protection, and sustainable lifestyles. Importantly, this policy paper is intended to serve as a bridge. It links practical project development and finance tools with academic research and scientific evidence. It converts complicated ecological information into useful policy insights through participatory approaches, field testing, and peer-reviewed research. As a result, it supports co-development processes with municipalities, national authorities, UN agencies, and financial partners by acting as a gateway for upcoming concept notes and project proposals.

The underlying theory of change is clear: ecological recovery of seagrass meadows can be accomplished in conjunction with improved governance, community ownership, and SDG localization if municipalities are given the authority to organize participatory, science-based restoration projects rooted in local contexts. Key stakeholders, including local government officials, scientists, farmers, fishermen, craftsmen, civil society, and foreign partners, are mobilized by the project around common goals, distinct responsibilities, and flexible monitoring systems. Improved ecosystem functioning and carbon sequestration, increased coastal resilience, restoration of traditional knowledge, and more alignment between local action and national and international commitments are just a few of the benefits this strategy produces. In this regard, the current policy paper and the Kerkennah pilot together constitute a strategic analytical initiative with significant transformative potential. A practical, scalable, and context-anchored paradigm for resolving SDG localization issues is provided by this study. This paper establishes the framework for investment, relationship building, and the development of future restoration initiatives that can have a durable impact on the environment and society by serving as a fundamental discourse document.

Overall, this pilot project showed that restoring *Posidonia oceanica* in the Kerkennah archipelago may provide socioeconomic advantages, cultural preservation, and ecological recovery all at once. It offers a scalable, policy-relevant approach for incorporating community development, local knowledge, and conservation into

frameworks for Mediterranean coastal management.

ACKNOWLEDGMENT

The authors wish to sincerely acknowledge the contributions of Dr. Rym Zakhama Sraieb, Assistant Professor at the Department of Fundamental Sciences, High Institute of Biotechnology of Sidi Thabet, and researcher at the Laboratory of “Diversity, Management, and Conservation of Biological Systems” LR18ES06, Faculty of Sciences of Tunis for her supervising, her invaluable input in writing and brainstorming this article.

The authors wish to sincerely acknowledge the contributions of Prof. Mohamed Sghaier Achouri, Professor at the Department of Fundamental Sciences, the Laboratory of “Diversity, Management, and Conservation of Biological Systems” LR18ES06, Faculty of Sciences of Tunis for his supervising.

The authors also extend their gratitude to the Tunisian Association of Taxonomy (ATUTAX) for making this work possible through the PPKER, PALMKER, and CoBioKer projects in the Kerkennah Archipelago. From technical support to logistics and financial investment, this research greatly benefited from these projects, as well as the dedication of all ATUTAX office members and volunteers.

Special thanks go to Ms. Salma Zribi for her significant contribution to the fieldwork, workshops, and scientific activities, and to Mr. Akrem Dridi for his involvement in fieldwork and activities with the local community. The authors are also deeply grateful to the local NGO Kraten Association for Sustainable Development of Culture and Leisure (AKDDCL) and its members for their collaboration as co-managers of a future Marine and Coastal Protected Area (MCPA) in the northern islands of Kerkennah.

The authors wish to warmly thank the municipality of Kerkennah and all the staff for their support and help, and people of Kerkennah, fishermen, artisan women, schools, farmers, local NGOs, private sector partners, and all others who facilitated this work. Without their support, none of this would have been possible.

A special thanks to the Research Laboratory “Diversity, Management, and Conservation of Biological Systems” LR18ES06, Faculty of Sciences of Tunis, University Campus EL Manar, Tunis, Tunisia.

Finally, the authors acknowledge the KSN project for ensuring the continuity of this work and for managing the project data.

LOCAL 2030

KNOWLEDGE AND SCIENTIFIC NETWORK

Connect with Nada!



nadaabdelkader5@gmail.com



nadaabdelkader



Learn more
about the Local2030
Knowledge and
Scientific Network!