International Journal of Economic Studies and Management (IJESM)
ISSN 2789-049X
Int. J. Econ. Stud. Manag. 3, No.6 (DECEMBER-2023)

# The blue economy 3.0: innovation for a sustainable ocean economy in Morocco

**Sanae Hanine**
Faculty of Sciences and Techniques
Hassan First University – Settat - Morocco

**Brahim Dinar**
The Faculty of Legal, Economic and Social Sciences
Hassan II University – Casablanca - Morocco

**Said Meftah**
Faculty of Sciences and Techniques
Hassan First University – Settat - Morocco

**Abstract: Purpose-** Given the importance and role of the ocean for food security, economic growth, as well as the maintenance of life and climate balance. This research deals with the role of innovation in the blue economy and its challenges in Morocco. Research and innovation are strong levers for growing this economic segment. Indeed, innovative solutions are able to enable better knowledge and development of Moroccan coastal and marine ecosystems.
**Design/methodology/approach** - we based ourselves on primary sources of information specialized in the field of innovation in the maritime environment. Günter Pauli's thoughts on "The Blue Economy 3.0" constituted the essential vulgate of the framework of our research.
**Findings -** The research has brought out clusters of innovations that we consider priority and promising to the blue economy in Morocco.

**Keywords:** Blue economy; Innovation; Innovation clusters; Regulation; Strategies; Morocco.

**Digital Object Identifier (DOI):** https://doi.org/10.5281/zenodo.10461861

This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

## Introduction

The blue economy is strategic for nations given the importance of its role for food security, economic growth but also for innovation. Morocco enjoys a significant maritime capital, which covers 1.2 million km2 of the Exclusive Economic Zone (EEZ), with two Mediterranean maritime facades of 3,500 km of coastline covering nine of its twelve regions. With this potential combined with ancestral know-how in the various professions linked to the sea and fishery wealth (17th place in the world in terms of fishery wealth (FAO, 2018) and considerable energy, it has been able to develop several activities linked to the blue economy, particularly in the sectors of fishing, aquaculture, seaside tourism and maritime transport. The fishing sector in Morocco contributed to national growth with 28 billion dirhams in 2022. This same sector contributed up to 45% of agri-food exports. The Moroccan coast represents 52% of the tourist area and 92% of the industrial fabric linked to the fishing and seafood development sectors, port activities and offshore exploration. Port logistics ranks second in Africa after Egypt and 22nd globally (Ministry of Equipment, Transport and Logistics, 2019). Aquaculture, offshore exploration, marine biotechnology, shipbuilding and ecotourism are activities in the emerging phase while presenting significant potential for the development of the blue economy in Morocco. More recently, the Atlantic dimension including the Atlantic facade of the Moroccan Sahara is the subject of a major initiative with an African vocation, which goes from the Strait of Gibraltar to the Cape of Good Hope. The initiative brings together 23 coastal countries representing 46% of the continent's population, 55% of its GDP, and 57% of its trade and contains enormous natural resources (24 billion barrels of oil). Future maritime cooperation will be based on investment in maritime fishing sectors, desalination of seawater for agricultural purposes, Atlantic tourism, and support for renewable energies, in addition to advanced exploration of natural offshore resources (El Houdaigui, 2021). If the richness of the Moroccan maritime space represents considerable opportunities, it is nevertheless threatened by overexploitation and degradation of ecosystems, mainly due to coastalization, urbanization and pollution and the impact of climate change which lead to ocean acidification and warming (IRES, 2020). According to (the Department of the Environment 2021), the coastline is used as an outlet for domestic (450 million m3) and industrial (988 million m3) discharges per year without prior treatment. “Poor governance” is also responsible for this situation (Azaguagh and Driouchi, 2019). These elements put certain species at risk of extinction (bluefin tuna or octopus) and others are seriously threatened (monk seal, bald ibis, red coral or Mediterranean grouper) (CESE, 2018).

(IRES, 2020) emphasized the fact that the model of a Moroccan blue economy must absolutely migrate towards greater sustainability. However, this challenge cannot be met without effective and innovative scientific research contributing to transforming the constraints in opportunities and increase the benefit of the blue economy in Morocco. To this end, innovation is essential to stimulate sustainable economic growth in Moroccan maritime sectors while ensuring the conservation of the marine environment and its sustainability. Innovation must be directed towards the restoration of coastal ecosystems, zero-carbon marine transport, the development of marine biotechnology and securing the livelihoods of local communities (The Economist Group, 2020).

It is therefore urgent and even vital to develop blue economy circularity policies, based on a forward-looking and integrated vision, aimed at protecting marine heritage and developing the country's maritime capital (ESEC, 2018). Hence the opportunity of the blue economy as conceptualized by Günter Pauli since 1990, a Belgian entrepreneur and economist who places maritime activities in a circular economy, through the effect of regeneration. This concept is intended to be biomimetic and inspired by the regenerative forces of nature. According to him, it is possible to continue to exploit the oceans and achieve a “zero waste” objective through technological innovation and the reindustrialization opportunities that it offers.

The (ESEC, 2018) recommended investing in innovation, R&D in all marine activities and their value chains because the potential remains untapped in established and emerging blue sectors such as biotechnology, aquaculture, seaweed farming and renewable marine energies. The development of research programs is necessary to promote the use of innovative methods, which aim to enhance fisheries wealth while meeting environmental imperatives. In this perspective, in this research, we focus on innovation in the field of the blue economy in Morocco based on the thinking of Günter Pauli, which we consider as an inspiring framework of thought for innovations that respond to the challenges of growth and sustainable development in Morocco. Our research aims to answer the following question: How can innovation be a lever to boost the Blue economy in Morocco?

To carry out this research we based ourselves on primary sources of information specialized in the field of innovation in the maritime environment. The thought of Günter Pauli, which he recounts in his books, notably his work "The Blue Economy 3.0" published in 2019, which defends the idea that growth can be achieved with zero waste by drawing inspiration from natural ecosystems, was the essential vulgate of the framework of our research. The objective being to find sustainable solutions to societal issues and needs in relation to maritime professions. We also based ourselves on his work "The Morocco Model" (2021) and which presents his vision of his paradigm of the blue economy for Morocco.

We have structured our research around three major axes. The first axis deals with the theoretical framework, which includes the conceptualization of the Blue Economy and its areas, and we will explain in the same axis the concept of economy 3.0. The second axis deals with the ecosystem of the blue economy in Morocco, in particular the institutional and legal framework, the programs and strategies carried out in this sector as strong points for research and innovation. In the second axis, we dealt with the developmental and environmental issues of the blue economy in Morocco. We focused on the threats to the viability of the oceans and its biodiversity and its economic impact. The third axis concerns innovation and its role in promoting the blue economy in Morocco. In this area, we highlighted the innovation ecosystem in Morocco by analyzing its weak, strong points, and the opportunities available to it. The research has brought out clusters of innovations that we consider to be prioritize and promising for the blue economy in Morocco.

## 1. What about the blue economy?

Initiated by Günter Pauli and first appeared in 2012 during the United Nations Conference on Sustainable Development (Rio+20), the concept was integrated in 2015 into the sustainable development goals of the 2030 Agenda of the Nations. United through SDG 14. According to the conception of Pauli (2018,2021), the blue economy places maritime activities in a circular economy dimension by drawing inspiration from nature and more particularly ecosystems which regenerate and do not produce waste. Based on the mobilization of local businesses and the use of local resources for the recovery of waste, the latter becomes a source of profit to move towards zero waste. The objective is also to promote job creation, with this recycling of waste. According to the World Bank (2017), the blue economy consists of sustainable use of ocean resources for economic growth, improved livelihoods and employment, while preserving the health of ocean ecosystems. Thus, it has aims to ensure the transversality and sustainability of its actions and to contribute fully to the national economy throughout the territory.

The World Bank (2016) states that "the blue economy occurs when economic activity is in balance with the capacity of marine ecosystems to support this activity over the long term and remain resilient and healthy. The blue economy concept helps visualize and develop programs that simultaneously strengthen ocean health and economic growth, consistent with the principles of social equity and inclusion." For its part, the OECD (2016) determines that "the blue economy contains sectors of activity with a link to the sea (maritime transport, fishing, offshore wind power, marine biotechnologies) but also

natural assets and services ecosystems that we owe to it (fishery resources, navigation routes, absorption of CO2, among others). Grimes (2022), demonstrated the complexity of the construct through his definition of the blue economy "a complex multi-actor and activity process, multi-regulations and multi-scales of the maritime and coastal territory, aims firstly to go beyond the antagonism between economic development and the integrity of the sea by seeking operational articulations that promote their compatibility and a lasting relationship. » For (The European Commission, 2021), the blue economy encompasses all activities involved in the extraction and exploitation of ocean resources and the use of coasts and marine space for industrial and recreational activities. It encompasses shipping, fishing and tourism as well as new, fast-growing sectors, such as those driving research and innovation in seabed mining, marine renewable energy, offshore aquaculture and blue biotechnology. (VanHoof & al., 2019) introduce the idea of integrated management "across different sectors, geographic scales and across the land-ocean interface". (Grimes, 2022), considers the blue economy as "a long-term strategy which must support sustainable development and equitable economic growth whose benefits must be felt beyond the maritime and coastal space on the populations of "the hinterland". This type of development is underpinned by sustainable use of coastal areas and their various resources, taking into consideration the economic and social development linked to the presence or proximity of the sea, while ensuring that environmental impacts are reduced as much as possible. The United Nations Environment Program (UNEP) integrates the idea of human well-being and social equity "while significantly reducing environmental risks and resource scarcity". The idea here is to closely combine the notions of protection and investment in order to preserve the ocean while allowing populations to live and feed themselves better.

Since the blue economy is a relatively new approach, the concept is still not stabilized. Its complexity originates from the multidimensional nature of the issues it underlies: economic, legal, institutional, geopolitical, environmental, climatic and socio-cultural. Its definition and precise area of application vary between organizations and researchers. In recent years, the emergence of new concepts (blue biotechnology, blue carbon, blue diplomacy, blue energy, blue finance, blue food, blue innovation, blue justice, blue mind, blue space, blue tech, blue tourism, etc.) has continued the confusion between these two interpretations (IRES, 2023).

**Figure 1:** Sectors of the blue economy

| | |
|---|---|
| Market activities | Fishing and aquaculture, Maritime transport, Offshore exploration, Naval construction and dismantling, Coastal tourism, Seawater desalination, Marine renewable energies, Extraction of marine minerals, Blue biotechnology. |
| Non-market activities | Scientific research, R&D, Education and training, Protection and rehabilitation of marine heritage, Regularization, Maritime security and surveillance, Partnerships. |

### 1.1 The Blue Economy 3.0: the sustainable blue economy, a new field of exploration

(Gunter, 2019), in his book "The Blue Economy 3.0" draws inspiration from natural ecosystems to resolve economic, social and ecological crises based on bio-mimicry and the circular economy. The idea is to draw inspiration from the functioning of natural ecosystems to create new products and new business models that are both profitable and sustainable. Günter Pauli distinguishes between the red, green and blue economy. The "green" economy is designed to meet the objectives of sustainable development and combat global poverty. However, the "green" economy is criticized because it is considered reserved for a wealthy clientele and does not really resolve sustainability issues. The green economy aims to be resilient, but does not necessarily offer a definitive and lasting solution. For (Pauli, 2021) the blue economy 3.0 is based on three axes of reflection and action: 1) to consume and use what is available

locally. 2) generate benefit, not waste, 3) meet the needs of society by including happiness, resilience and health. The goal of blue economy 3.0 is to serve the needs of everyone, including the environment. To achieve this, societal and economic models must be radically changed. More than an economic model, the blue economy 3.0 is closer to an economic and entrepreneurial philosophy, which advocates biomimicry, zero waste production, localism, the sharing economy, open source, etc. The examples presented by Günter Pauli are numerous. They range from using coffee grounds to produce mushrooms to capturing CO2 by producing micro-algae. He cites as an example of an initiative, the transformation of phosphogypsum into biophosphates and biogas while cleaning the ocean of microplastics or the transformation of mining waste can be a resource for stone paper into stone paper...etc. Applied to the maritime space, economy 3.0 aims to accelerate the reduction of the carbon and ecological footprint as well as the acquisition of new knowledge and business and technological solutions for traditional and emerging sectors, in favor of health human rights and the protection of river, marine and ocean ecosystems.

## 2. The blue economy in Morocco: vision, governance and strategic directions

### 2.1 Morocco's blue economy ecosystem: institutions, regulations and regional and international commitments

Morocco aims for a new model of growth and sustainable development of its maritime heritage, which encompasses four types of capital, namely 1) natural capital: fishery resources and biodiversity, 2) produced capital: infrastructure, land, equipment, 3) human capital: skills and expertise, knowledge and knowledge, 4) and institutional capital: governance, laws, and institutions. Since the Agadir Declaration in 2016 on the Blue Belt Initiative, on COP 22, Morocco has invested in the blue economy and more particularly sustainable fishing and aquaculture, innovative and protective of oceans, by facilitating technological and social innovation, the exchange of good practices and social entrepreneurship. Moreover, the New Development Model emphasized Morocco's capacity to develop “coastal clusters” to operationalize the blue economy at the territorial level capable of attracting investments and creating jobs, while ensuring sustainable development. (Report of the Special Commission on the New Development Model, 2021).

#### 2.1.1 Mapping of institutional actors in the blue economy sector in Morocco

Morocco’s maritime space involves actors at several levels (international and regional, national and local). The great diversity of sectors leads to sectorial policies (transport, oil exploitation, fishing, tourism; etc.), which concern different public (agencies, ministerial departments, local authorities) and private (NGOs, professional groups, etc.) actors. Morocco created for the first time a Ministry of Maritime Fisheries and the Merchant Navy in 1981. Currently, institutional actors including the Department of Maritime Fisheries under the supervision of the Ministry of Agriculture and Maritime Fisheries for Rural Development and Water and Forests ensure the management of the fishing sector. The Ministry also supervises the National Agency for the Development of Aquaculture, whose mission is to promote the development of marine aquaculture and the National Institute of Fisheries Research, which conducts research missions in support for the sector. The National Fisheries Office, placed under the supervision of the Department of Maritime Fisheries, has the mission of developing coastal and artisanal fishing, and organizing the marketing of maritime fishing products. Regarding the port aspect, it is supported by the Ministry of Equipment, Transport and Logistics through the Moroccan Agency for the Development of Logistics and the National Ports Agency whose task is the management and maintenance of ports. The Royal Navy and the Royal Maritime Gendarmerie control fishing vessels ensure compliance with legal texts and surveillance of the maritime territory and intervene in search and rescue operations at sea. The Ministry of Energy, Mines and the Environment through the Department of the Environment responsible

for the arsenal of institutional measures to ensure the integrated management of the national coastline including the National Strategy for Environment and Development Sustainable (2030). This strategy, which considers the issue of oceans and coastlines as a priority, aims for a transition towards an inclusive, low-carbon economy by 2030 through a set of political, institutional, regulatory and financial reforms. The Department of National Land Planning, for its part, takes care of the national coastal management strategy.

The Royal Center for Space Remote Sensing's mission is to carry out remote sensing activities and related technologies applied in space oceanography. The National Office of Hydrocarbons and Mines (ONHYM) is also part of this ecosystem for offshore oil and mining exploration and exploitation. Consultative bodies also intervene in the blue economy sector. These are the Chambers of Maritime Fisheries and professional federations, including in particular the Federation of Maritime Fisheries (FPM), the National Federation of Industries for the processing and valorization of fishery products (FENIP) and the National Federation of Agrifood. (FENAGRI). The National Coordination Committee in the fields of Hydrography, Oceanography and Marine Cartography (CNCHOC) established in 2014, contributes to the definition of national policy in the fields of hydrography, oceanography and nautical cartography, to approve development programs in these fields, particularly in the areas of hydrographic surveys, oceanographic research and nautical chart development projects. The Royal Navy Inspectorate, through the Hydrography, Oceanography and Cartography Division of the Royal Navy, provides the secretariat (DHOC, 2019).

### 2.1.2 Legal arsenal

Morocco has a dense legal corpus, which converges towards the sustainability of its blue economy. Its commitment in this direction extends from its laws relating to the maritime domain since 1915.

**Table 1**: Regulations related to the blue economy in Morocco

| Legislation | Object |
|---|---|
| Decree No. 2-15-311 of July 21 (1915) | Fixes the base lines and geographic coordinates allowing the outer limits of maritime spaces to be measured (1915). |
| The maritime commercial code (1919) | Provides the basis for current maritime legislation. |
| Dahir carrying Law 1-73-211 of 26 Moharam 1393 (March 2, 1973) which was modified and supplemented by Law No. 37.17 (Official Bulletin of March 30, 2020). | Fixing the limit of territorial waters and the exclusive Moroccan fishing zone. |
| Dahir No. 1-91-118 of 27, BO No. 4146 of April 15, 1992) which was amended and supplemented by Law No. 27-99. | The law relating to the research and exploitation of hydrocarbon deposits (1992) |
| Law No. 11-03 on the protection and development of the environment (2003). | Stipulates the taking into account of the coastal area to ensure effective protection of the sea against all types of pollution. |
| Law No. 12-03 on environmental impact studies (2003). | Aims to prevent environmental degradation linked to investment projects. |
| Law No. 28.00 relating to waste management (2006). | Stipulates the preparation of a solid waste management plan for various sectors, including ports, and specifies the content of these plans and their frequency of revision depending on the sector. |

| | |
|---|---|
| Law 15-02 relating to ports (2008). | Integrates the environmental dimension into maritime transport. |
| The Maritime Fisheries Development Fund (2009) | Aims to enable the accounting of operations relating to the preservation of fishery resources and the promotion of the maritime fishing sector. |
| Law No. 22-07 relating to protected areas (2010). | Related to protected areas. |
| Framework Law No. 99-12 establishing national charters for the environment and sustainable development (2014). | Integrates the principle of solidarity, which allows the country to reduce vulnerabilities and promote rational, economical and balanced use of natural resources. |
| Law No. 15-12 (2014) | Relating to the prevention and fight against illegal, unreported and unregulated fishing. |
| Law No. 29-05 (2015) | Relating to the protection of species of wild fauna and flora and the control of their trade. |
| Coastal law n°81-12 (2015) | Aims to protect the Moroccan coasts through the establishment of the principles of integrated and sustainable management of the coastline. |
| Decree No. 2-18-722 of September 30 (2019) | Relating to fisheries development and management plans. |
| Order No. 4064-19 of December 20 (2019) | Modifying Order No. 2818-16 relating to the temporary ban on fishing in certain maritime zones of the Atlantic and the Mediterranean. |
| Law No. 69-18 (2021) | Relating to pollution by ships. |
| Law 10-15 on water (2021) | Emphasizes the importance of wastewater management and rainwater, a significant vector of pollutant loads from land to sea. |

### 2.1.3 Strategies and plans related to the blue economy in Morocco

Morocco has put in place a multitude of strategies and plans relating to the blue economy, broken down in (Table 2).

**Table 2**: Blue economy strategies and plans in Morocco

| Action | Object |
|---|---|
| The national monitoring program for the Moroccan Mediterranean coast MEDPOL (1975) | Constitutes the first operational program of the Mediterranean Action Plan (MAP). The program aims to help Mediterranean countries implement three major protocols of the Barcelona Convention. Assessment and control of marine pollution in the Mediterranean region. |
| The National Emergency Plan to Combat Accidental Marine Pollution (1996) | Integrates the information, directives and instructions enabling public authorities to prevent or combat any marine pollution by hydrocarbons and other harmful products, threatening the marine environment and the national coastline. |
| The National Integrated Coastal Management Plan (2000) | Targets the creation of the basic infrastructures necessary for the exercise of fishing activity and the creation of micro-development centers that generate employment and growth making it possible to mitigate the rural exodus. |
| The Ibhar I (2008) and Ibhar II 2011-2014 plans | Aims to upgrade the artisanal and coastal fleet, through the enhancement of catches, the reduction of fishing time, the |

| | |
|---|---|
| | improvement of security conditions and the protection of human lives. |
| The Halieutis strategy (2009-2020) | Concerns the sustainable exploitation of resources and the promotion of responsible fishing, the strengthening of landing and marketing infrastructures as well as the improvement of the competitiveness of the sector. She placed particular importance on innovation. |
| Port Strategy 2030 (2011) | Aims at the development of port infrastructure with a view to giving a strong boost to logistical potential and increasing capacity in terms of competitiveness. Ella also aims to include the dimension of sustainability in maritime transport. |
| The National Strategy for Marine Protected Areas (MPAs) (2013) | Structured around three axes: the conservation and restoration of habitats and species, the promotion of the natural and cultural assets of the network of Sites of Biological and Ecological Interest SIBE, and communication, awareness and education. |
| The Blue Belt Initiative (2016) | Launched during COP22, its objective is to establish mechanisms for cooperation and mobilization of technical and financial support to respond to the challenges of climate change, ocean conservation and sustainable development of fisheries and aquaculture. The initiative focuses on monitoring and risk management to understand marine pollution phenomena and limit health risks.<br>On an operational level, this initiative implements a collaborative platform whose role is to facilitate and catalyze innovative solutions and projects in the fields of activity: fisheries, fishing and aquaculture technologies, processing, biotechnology and operational oceanography. By supporting areas of collaboration between decision-makers, researchers and economic operators, the platform's role is to structure R&D clusters and ecosystems, to give them greater visibility vis-à-vis donors, to facilitate transfers and sharing experiences, and accelerating the emergence of a community of partners around the Blue Belt initiative. |
| The National Strategy for Sustainable Development (2017) | Issue no. 5 of the SNDD emphasized the need to pay particular vigilance to sensitive areas, particularly the coastline. |
| The "Integrated Coastal Zone Management" (ICZM) approach and their protection launched in (2019) | Among its projects, the Integrated Coastal Zone Management Project through the immersion of artificial reefs and the definition of trawling ban zones in the Oriental, carried out in collaboration with the World Bank. The second project concerns the integrated management of the coastal zones of the Rabat-Salé-Kenitra region, and Tangier-Tétouan-Al Hoceima. |
| The master plan for promoting the maritime public domain by 2035 | Decision support tool for the development of investments with high added value in terms of valorization of the Maritime Public Domain (DPM) through the creation of an Atlas of marine and coastal potential and then the definition of an integrated vision management and preservation, translated into a master plan for development by 2035. |
| The Radio Frequency Identification Program for artisanal fishing boats "RFID" (2017) | Awarded in 2019 in the "Tracking Technology" category. |
| The Azur Plan (2013) | Its objective consists of the creation of hotel structures respecting sustainable development standards |

| | |
|---|---|
| The draft National Water Plan 2020-2050 | Plans to diversify sources of supply through the desalination of seawater (one billion meters Cube) and the reuse of treated wastewater to the tune of 340 million cubic meters per year combined with sustainable and rational management of water demand. |
| The Master Plan for the development of port infrastructure dedicated to the naval industry by 2030 | Aims to develop the activity of dismantling and repairing ships on the national fleet with an opportunistic export activity. |
| Regional Coastal Plan (2020) | Based on the following strategic axes: coastal governance, protection and preservation, valorization and territorial development |
| The national blue economy program (2022-2026) | Aims for sustainable development of the resources of marine and coastal areas and better institutional coordination within the sectors concerned. The development of sustainable tourism; aquaculture; professional training; protection and management of ecosystem services; and improving climate resilience in targeted areas. |

### 2.1.4 International and regional mobilization for the integration of the blue economy

Morocco is a member of a host of international organizations, including UNESCO's Intergovernmental Oceanographic Commission (IOC), the International Maritime Organization (IMO), the Food and Agriculture Organization of the United Nations (FAO), the International Commission for the Conservation of Tuna (ICCAT), the General Fisheries Commission for the Mediterranean (GFCM) and the Fishery Committee for the Eastern Central Atlantic (CECAF). Since the Rio Summit in 1992, Morocco has ratified the 1992 United Nations Framework Convention on Climate Change (UNFCCC) in 1995 and the 1997 Kyoto Protocol in 2002. It hosted COP7 in 2001, where the Marrakech Agreement was concluded, and COP22 in 2016, where the Paris Agreement was ratified. In line with this Agreement, Morocco is committed to reducing economy-wide greenhouse gas (GHG) emissions by 17% by 2030 (International Energy Agency, 2019). As a State Party to the United Nations Convention on the Law of the Sea, which it ratified in 2007, Morocco also committed itself to the United Nations Agenda 2030 for Sustainable Development in 2017, and more specifically to the implementation of SDG14. Its commitment to this process has been demonstrated through the revision of the National Biodiversity Strategy and Action Plan (NBSAP), which takes into account the Strategic Plan for Biological Diversity 2011-2020 and the Aichi Targets.

Morocco is also participating in "The International Decade of Ocean Sciences for Sustainable Development 2021-2030" (UNESCO, 2022), a United Nations ocean advocacy program launched in 2019 that aims to encourage the marine research community and other stakeholder groups in efforts to expand, share and apply scientific knowledge about the ocean to promote sustainable ocean development.

**Table 3 :** International maritime conventions ratified by Morocco

| Agreement | Subject |
|---|---|
| Ramsar Convention on Wetlands of International Importance (1971), ratified in 1980 | By 2020, 38 Ramsar sites designated, covering a total area of 316,086 hectares. |
| The International Convention on Intervention on the High Seas in the Event of an Accident Causing or Likely to Cause Oil Pollution Dahir n° 1-76-12 of 26 safar 1397 (February 16, 1977) | Establishes civil liability for oil pollution damage. |
| The United Nations Convention for the Carriage of Goods by Sea or Hamburg Rules. The Convention came into force on November 1, 1992 (B.O. no. 3953 of 19 hija 1408 (August 3, 1988). | Establishes a legal regime applicable to the rights and obligations of shippers, carriers and consignees under a contract for the carriage of goods by sea. |
| The United Nations Convention on the Law of the Sea, known as the Montego Bay Convention (UNCLOS, 1982), ratified in 2007. BO n° 5714 du 05 mars 2009- Dahir n° 1-04-134 du 17 joumada I 1429 (23 mai 2008) | Establishes the sovereign right of States to exploit their natural resources in accordance with their environmental policies and their obligation to protect and preserve the marine environment. |
| Convention on Biological Diversity (CBD, 1992) ratified in 1995 | Emphasizes the importance of biological resources, including ecosystems and living species. |
| Barcelona Convention for the Protection of the Mediterranean Sea against Pollution (1975/1995), ratified in 2004 | Stresses the obligation of all Mediterranean coastal states to manage their coastal regions in an integrated and sustainable manner, to take measures to improve and protect them from pollution and to create conditions conducive to sustainable development. |
| Madrid Protocol No. 7 on Integrated Coastal Zone Management in the Mediterranean (ICZM), ratified in 2008 | Defines the integrated management of coastal areas, taking into account environmental, socio-economic and institutional aspects. |
| Barcelona Convention Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (ASP/DB, 1995) ratified in 2009 | A tool for protecting protected wilderness and coastal areas. |
| Convention on the Conservation of Migratory Species (CMS, 1979) ratified in 1993 | Aims to ensure the conservation of terrestrial, marine and aerial migratory species throughout their range. |
| The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of the Benefits Arising out of their Utilization (ABS) relating to the Convention on Biological Diversity (CBD) 2010. Entered into force in 2014. | Aims at a fair and equitable sharing of the benefits arising from the utilization of genetic resources. One of its objectives is to provide tools to combat bio-piracy (the illegitimate appropriation of genetic resources and indigenous traditional knowledge). |
| The International Convention for the Prevention of Pollution from Ships (M.A.R.P.O.L.) ratified in 1993. | Establishes rules to prevent, reduce and eliminate the various types of pollution caused by ships. |
| The International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (1996), amended by the 2010 Protocol. Ratified in 2003. | BO n° 5158 du 6 November 2003- Dahir n°1-02- 216 of 10 rabii I 1424 (May 12, 2003). Not yet in force |

### 2.1.5 Regional synergies for the blue economy

Morocco is committed to regional cooperation in the field of the blue economy, through initiatives such as "WestMed" and membership of unions such as the Union for the Mediterranean (UfM) and the Atlantic Ocean Research Alliance (AAORIA). The blue economy is also included in the African Union's Agenda 2063 as one of the driving forces behind the structural transformation of the African continent. Morocco is a member of the Ministerial Conference on Fisheries Cooperation between African States bordering the Atlantic Ocean (COMHAFAT) and the three major maritime initiatives adopted by the African Union: the African Integrated Strategy for Seas and Oceans Horizon-2050 (AIM Strategy); the African Charter on Maritime Safety, Security and Development. The gas pipeline project, partly offshore, to link Nigeria to Morocco through 14 countries, which could become a factor of integration, both economically and politically.

**Table 4**: Regional initiatives undertaken by Morocco

| Initiative | Purpose |
|---|---|
| The Union for the Mediterranean (UfM) 2008 | The Union for the Mediterranean's declaration on a sustainable blue economy includes a series of actions aimed at reducing plastic and microplastic pollution in the Mediterranean, in which marine and coastal tourism, fishing and aquaculture must play their part. |
| The OuestMED/WestMED initiative (2021) | Aims to develop the blue economy in 5+5 countries. Activities carried out by Morocco as part of the WestMed Initiative, such as implementation of the Blue Belt Initiative (BBI), creation of marine protected areas, aquaculture capacity building and maritime spatial planning. |
| The SwitchMed program 2014 Launched by the European Union under the leadership of the United Nations Industrial Development Organization (UNIDO). | SwitchMed supports green entrepreneurs and change agents in the 8 Mediterranean countries, including Morocco, by introducing ecological and social innovations to the Mediterranean region.<br>As part of SwitchMed's second phase (2019-2023), a component focusing on the Blue Economy concept aims to identify new business models for the sustainable transformation of maritime economic activities to reduce their impact on marine and coastal ecosystems. |
| The BlueMED 2014 initiative | Promoting a shared vision for a Mediterranean Sea that is healthier, more productive, more resilient, and better known and valued. It aims to strengthen research and innovation through a multidisciplinary approach linking economics, the environment and people. |
| The Malta MedFish4Ever 2017 declaration | Its aim is to save the Mediterranean's fish stocks and support small-scale fishing. |
| The AFRIMED 2017 project | Aims to develop innovative actions to preserve and conserve damaged or degraded macro-algae forests. |
| MSPgloba Project 2019- 2022 | Its aim is to build capacity in Maritime Spatial Planning, creating a team of national MSP. |
| WEST MOPOCO, 2019-2020 | Aims to step up the fight against oil pollution in the western Mediterranean. |
| Atlantic Ocean Research Alliance (AAORIA) | Aims to improve understanding of the Atlantic Ocean and the sustainable management of its resources. The output of this initiative has already led to several results, such as the organization of a stopover in Morocco for the Tara expedition "Mission Microbiome". This arrangement has also enabled Moroccan scientists to be fully involved in the many activities of the Atlantic Ocean Research Alliance. |

## 2.2 The challenges of the blue economy for the economic development in Morocco

In addition to its geostrategic stakes, Morocco's blue economy raises a number of development issues. It encompasses a wide range of socio-economic sectors and public and territorial policies. The growth drivers of the blue economy are divided into market and non-market activities. Market activities include fishing, tourism and maritime transport, which predominate in the Moroccan blue economy. Other activities, such as aquaculture and seawater desalination, are emerging, while some, such as biotechnologies and marine energies, are promising sectors for the future. The energy sector, both in terms of hydrocarbons and offshore renewable energies, represents an under-exploited potential. Similarly, despite the region's leading position in terms of marine biodiversity around the Mediterranean, which offers great opportunities for the development of marine biotechnologies, the sector remains under-exploited despite the high potential of its industrial applications. Lastly, with water gradually becoming a scarce resource, seawater desalination, in conjunction with renewable energies, is now a major blue-economy sector in Morocco. Alongside these various productive sectors, the (CESE, 2018) emphasized the importance of non-market activities that include research, innovation for the protection, maintenance, and development of Morocco's maritime capital. These activities include data collection and processing, education, entrepreneurship, observation and monitoring of maritime spaces, border security and surveillance, and international partnership.

### a) Market activities

**Fishing**: Morocco is one of the few countries in the world to catch more than a million tonnes of fish a year. The leading fish producer in Africa, it ranks 13th worldwide. The fishing industry contributes 2.5% to national GDP, accounts for almost 10% of national exports and 36% of agri-food exports, and is a source of income for 3 to 4 million people. Artisanal fishing is a purely social activity, generating some 60,000 direct jobs at sea. It is practiced by some 17,000 boats in over 150 fishing sites along the Moroccan coastline, 47 of which have been developed as part of the Halieutis strategy. Together with aquaculture, the fisheries sector ensures an annual production of nearly 1.5 million tons and a benefit of 17.3 billion dirhams in 2019, and generates around 22 billion dirhams in foreign currency, contributing 45% to agri-food exports, and 700,000 direct and indirect jobs (DEPF, 2020). According to the same source, despite its strategic role in the country's balance of trade, the fisheries sector makes a modest contribution to national wealth creation.

**Aquaculture:** Morocco's coastline offers favorable conditions for breeding a wide range of species to make aquaculture a high-performance sector in an integrated ecosystem. According to the Agency for the Development of Aquaculture ANDA (2018), the aquaculture sector includes around 20 farms and 5 marine aquaculture development stations. It ensures a production of 510 tons, equivalent in value to 21 million dirhams in 2016 and employs 250 people. Areas suitable for aquaculture, which today cover more than 14,000 hectares at sea. As part of Halieutis, numerous aquaculture projects led by artisanal fishing cooperatives and nearly 500 young entrepreneurs have benefited from ANDA support.

**Port demand in Morocco**: According to the Ministry of Equipment and Transport (2011), port demand has been growing strongly (+6% per year on average over the last 10 years).Several key factors promise strong growth, notably the proximity of Europe, which offers potential for the development of nearshoring activities. In addition, the development of the hub concept (containers, bulk) and a greater openness of the Moroccan economy to the international market could offer numerous domestic and external opportunities. Growth will also affect other port activities: sea fishing, cruises, yachting (Hajj & al., 2017).

**Seaside tourism**: occupies a prime position with 174 beaches. The sector in general generates 7% of GDP and is a significant contributor to employment, with 550,000 direct jobs by 2019. Nevertheless, sustainable tourism is still in its infancy in Morocco, and its impact on ecosystems remains strong. The Taghazout Bay complex bears witness to Morocco's determination to move towards eco-sustainable tourism.

**Offshore oil exploration**: Offshore oil exploration is an emerging sector in Morocco with strong development potential (El Houdaigui 2021). Morocco's Atlantic offshore has a surface area of 400,000 km² and the Mediterranean offshore has a surface area of 50,000 km². To date, 44 wells have been drilled (42 in the Atlantic and 2 in the Mediterranean). According to the Ministry of Energy Transition and Sustainable Development, in 2020, 13 oil companies operated in Morocco in the field of hydrocarbon exploration and production, covering a total surface area of 126,913.28 km², including 8 hydrocarbon production concessions, 54 exploration permits, 26 of which are offshore, and 3 reconnaissance permits, 1 of which is offshore. National hydrocarbon production in 2020 reached 98.25 million cubic meters of natural gas and 4098 tons of condensate. Investments for the same year amounted to 497.218 MDH (Ministry of Energy Transition and Sustainable Development, 2020).

**Marine biotechnology**: Morocco ranks 1st in terms of marine biodiversity, with more than 7,840 species endowed with a very rich, but little valorized, genetic potential (Menioui, 2017). Marine biotechnology remains an under-exploited sector, with less than 2% of the total biotechnology market.

**Seawater desalination**: nine (9) seawater desalination plants have been built, the number set to rise to 30 by 2030. Seawater desalination is set to develop and expand in order to cope with population growth and the risks of shortages that could arise if global warming intensifies.

**The naval industry**: (L'IRES, 2023) describes it as a sector of the future. It is one of Morocco's core businesses, and the country is preparing to acquire a state-of-the-art shipbuilding industry by 2030 (Agence nationale des ports). The plan is to build new shipyards in Safi, Jorf-Lasfar, Kénitra, Nador and Dakhla, and to renovate the Tan-Tan and Agadir shipyards.

**Maritime transport**: 98% of Morocco's foreign trade is by sea (METLE, 2019). Morocco has 43 ports, including 14 international trade ports, 6 passenger ports and 19 fishing ports. Maritime transport is a major provider of international passenger transport (ITF, 2021). According to (Marrakchi, 2021), the port of Tangier Med (2007-2020) is the largest container port in Africa and the Mediterranean. Connected to nearly 180 ports worldwide, Tanger Med can handle 9 million containers, 7 million passengers, 700,000 trucks and one million vehicles. The PERS-certified "EcoPorts" label, awarded by the European Sea Ports Organization (ESPO) in 2020, reflects Tanger Med's commitment to environmental standards and sustainable development. With Tanger Med 2 due to open in 2019, the port of Tanger Med has a capacity of 9 million containers and can accommodate the latest generation of ships. The new port of Nador West Med, currently under construction, will complement Tanger Med. The New Port of Dakhla Atlantique aims to provide the southern regions with a modern, scalable logistics tool to match their development ambitions, in addition to enhancing the value of sea-fishing products (Brini, 2021). The disappearance of the national fleet is costing the Moroccan economy dearly, with more than 22 million Moroccan dirhams lost each year to international ship-owners. Since 2013, national exporters have also suffered from the absence of vessels flying the Moroccan flag (Nachoui, 2018).

**b) Non-market activities: the backbone of innovation**

Non-market activities include R&D, innovation, data collection and processing, education and training, and maritime surveillance and safety. They form the support matrix for commercial activities, and are a key factor in their development. Scientific research and training in marine sciences are essential for the creation of a solid, sustainable blue economy (Hamoumi, 2020). Indeed, observation and monitoring of

maritime areas are essential to support public policies. The science-industry link is important for the development of the blue economy. Ocean sciences, R&D and innovation remain essential elements of the ocean's future in order to foster scientific knowledge improve ocean governance and promote responsible industrial practices. In this context, innovation resulting from effective scientific-industrial partnerships will increasingly determine how the oceans are explored, managed, exploited and protected. Nevertheless, the budget allocated to research and development in Morocco remains very low at 0.8% of GDP. INRH is the national benchmark for oceanographic research. Its scientific exploration vessels at sea, as well as onshore research facilities with specialized or multidisciplinary laboratories, cover a wide range of disciplines, such as marine biology, oceanography, chemistry, aquaculture, genetics, biotechnologies, mathematical modeling, economics and more. The Institute is responsible for monitoring and assessing fishery resources and the fisheries that depend on them, as well as for environmental and oceanographic surveillance, including offshore prospecting, observation using mooring systems and satellite data processing and exploitation. INRH also monitors the health of shellfish production areas and carries out aquaculture research (spat and alvine production trials in experimental hatcheries, zoo-sanitary monitoring, pilot studies of sea farming and zootechnics integrating oceanographic, biological, technological and nutritional aspects) right through to economic feasibility, with a view to eventual technology transfer to operators in the sector. INRH manages the Moroccan Fisheries Observatory. This is an interactive scientific information platform designed to support managers, fishermen, aquaculturists and researchers in the sustainability of their activities.[1] National universities provide blue knowledge. (Hamoumi, 2008) has drawn up an inventory of specialties developed in the Moroccan university sector. These are (marine geology, marine geophysics, marine biology, physical oceanography, chemical oceanography and coastal hydrology).

**Table 5:** Training courses offered by Moroccan universities in the maritime sector

| University | Training offer |
|---|---|
| Abdelmalek Essaadi University Tétouan/Tanger | - Master in Marine Environment/Marine Aquaculture Resource Exploitation<br>- Master Bioressources et Environnement |
| Chouaib Doukkali University El Jadida | - Master in Ecological Engineering, Modeling and Management of Natural Ecosystems<br>- Master in Natural Resource Management and Sustainable Development |
| Mohammed V University Rabat | - Master in Geology, Oceanology, Water and GIS<br>- Biodiversity and Environment course<br>- Specialized Master in Coastal Sciences<br>- Specialized Master's in Coastal Planning and Sustainable Hinterland Development |
| Ibnou Tofail University - Kénitra | - Specialized Master in Climate Change, Adaptation and Sustainable Development<br>- Master in Biology, Health and the Environment, Environmental Sciences option |
| Hassan II University - Ben M'Sick Faculty of Science | - Master in Marine Resources Management and Development<br>- Specialized Master in Marine Environment and Bio-resource Management |
| Hassan-II Agronomic and Veterinary Institute | - Fisheries engineering (Fisheries resources, marine biology, topography and geodesy, Cartography)<br>- Specialized Master in Water and Irrigation Management |

[1] https://observatoire-halieutique.ma/

| University incubators |
|---|
| - The Technological Innovation Center (CIT) at the École Mohammedia des Ingénieurs (EMI).<br>- The Centre d'incubation et d'accueil des entreprises innovantes (CIAEI) at the École nationale de l'industrie minérale (ENIM).<br>- The Resin Incubator created in partnership by the Institut national des postes et télécommunications (INPT) and the École nationale supérieure d'information et d'analyse des systèmes (ESIAS).<br>- Marrakech University Incubator (INMA).<br>- Doukkala University Incubation Center (CUDI) at the El Jadida Faculty of Science.<br>- South regional inter-university incubator at Ibn Zohr University.<br>- Dynamique Est incubator at the FSJES in Oujda.<br>- Béni Mellal FST incubator. |

The vocational training division is made up of 14 maritime training establishments attached to the maritime training division, distributed as follows:

- Higher Institute of Maritime Fisheries of Agadir (ISPM)
- The Merchant Marine School, Institut Supérieur d'Etudes Maritimes (ISEM)
- Institutes of Maritime Fisheries Technology (ITPM) in Al Hoceima, Larache, Safi, Tan Tan and Laâyoune-
- Maritime Professional Qualification Centers (CQPM) in Nador, Tangier, Casablanca, Essaouira, Agadir, Sidi Ifni, Boujdour and Dakhla.

Other institutions participate in maritime research, namely:

**Table 6:** Specialties developed in non-university institutions in Morocco (Hamoumi, 2008)

| Institution | Areas of intervention |
|---|---|
| The National Center for Energy, Science and Nuclear Technology | Sediment dynamics, Marine pollution |
| The National Center for Scientific and Technical Research | Seismology, Marine biology |
| The Royal Center for Spatial Remote Sensing | Physical oceanography, Development of fisheries resources, Pollution, Water quality, Sea dynamics, Monitoring of upwelling, Development of aquaculture, Mapping and analysis of coastal systems, Monitoring of marine risks |
| The National Meteorological Department | Climatology, Environment |
| The Ports and Maritime Public Domain Department | Geomorphology, Physical oceanography, Bathymetric surveys, Water quality |
| National Institute of Architecture and Urban Planning | Coastal management |
| National Institute of Hygiene | Toxicology, Microbiology, Pollution |
| The National Fisheries Research Institute | Fisheries research, Marine biology, Physical oceanography, Chemical oceanography, Water quality, Aquaculture, Marine pollution, fisheries valorization, etc. |
| The National Laboratory for Pollution Studies and Monitoring | Water quality, Environmental data |
| Laboratory for Research and Medical Analysis of the Royal Gendarmerie | Toxicology |
| Public laboratory for trials and studies | Hydrodynamic modeling, Sedimentology, water quality |
| The National Environmental Observatory of Morocco | Impact studies, biodiversity |
| Royal Navy | Hydrography and cartography, Marine pollution |
| The National Ports Agency | Physical oceanography, Pollution |
| The National Office of Hydrocarbons and Mines | Geophysics, Micropaleontology, organic geochemistry, structural geology |

| | |
|---|---|
| The National Society for Strait Studies | Marine geology, Marine geophysics, Physical oceanography |
| The specialized center of valorization and technology on marine products | R&D, innovation in the promotion of seafood products |
| The Haliopole cluster | Fishing performance |
| The Morocco Maritime Cluster | pace for technical, technological and regulatory reflection |

According to the Royal Institute of Strategic Studies (IRES, 2020), Morocco is lagging considerably behind in the state of knowledge of its coastal and marine ecosystems and suffers from a crucial lack of human and material resources. In addition, national financial support, which remains weak. Scientific research should target the development of a system of relevant information, using a concerted, comprehensive and rigorous scientific research program, which will make it possible to study both the seabed, the masses of water and living and non-living resources. Thus, programs in marine science and engineering and climatology should be launched.

### 2.3 Environmental issues

The exponential process of coastalization exerts unprecedented environmental pressure on Moroccan coastal areas. With a rate of 82.6% of industrial production, an urbanization rate of 69% on the Atlantic and 49% on the Mediterranean, the pressure is increasingly strong on the Moroccan coastline. In addition, it is the seat of communication networks and seaside resorts. This generates a multitude of negative externalities, including the advanced degradation of many marine ecosystems IRES (2020), (Benmassaoud, 2020). According to (Menioui, 2021), climate change weakens already vulnerable marine biodiversity with palpable impacts on the reproduction and distribution of stocks. Metallic and organic pollution in the coastline is explained by the dumping of 70% of waste without any treatment into the waters (Hajji, 2017). At the end of 2019, there were only 70 wastewater treatment plants. Ocean acidification threatens the survival of several animal species essential to the food chain (Menioui, 2001). The salinization of deep Mediterranean waters could have a particularly significant impact on Moroccan marine fauna and flora. Morocco is ranked 164th in the Environmental Performance Index for the year 2022 and 164th in the ecosystem vitality indicator, 123rd in the areas of health and environment and the 135th in climate policies. These figures demonstrate that more efforts are necessary for the development of the blue economy in Morocco.

## 3. The role of innovation in promoting the Blue economy

Innovation can help drive the blue economy towards growth while ensuring the protection of the marine environment. The blue economy encourages innovation in technologies, processes and business models. It explores new ways to reconcile economic progress and the preservation of the oceans and their resources. Improving understanding of the seas and technological progress are essential to realizing economic potential in a sustainable manner according to the (European Commission, 2014). This includes the greening of economic activities associated with the intensification of nature-based solutions and the restoration of degraded marine ecosystems as well as strengthening efforts to reduce pollution, develop the sustainable use of water in marine activities. The maritime transport and blue biotechnology sectors are concerned with the transfer of knowledge and technologies between different industries by promoting joint research and innovation actions (European Commission, 2021). A challenge for research and practice is to establish innovative partnerships and governance structures to harness relevant knowledge to co-create innovative ocean solutions and establish blue value chains. Blue innovation is expected to respond to several issues including food security, water availability, energy security, climate change and health. Innovation also includes finding new economic models that make a break with the paradigm of the red economy and the evolution of value chains towards more sustainability. Innovation includes the promotion of ecotourism, shipbuilding based on recycling, clean renewable energy, etc.

Innovation consubstantial with the science-industry nexus, startups that could constitute real drivers of growth, job creation and poverty reduction. “Eco-innovations” are expected to generate environmental benefits such as reducing sulfur emissions from ships through improved on-board exhaust gas cleaning systems and cleaner fuels. Ocean science, R&D and innovation remain essential elements of the future of the ocean to foster scientific knowledge, improve ocean governance and promote responsible industrial practices. In this context, innovation resulting from effective scientific-industrial partnerships will increasingly determine how the oceans are explored; managed, protected and how appropriate regulations are applied. (European Commission, 2021) places research and innovation at the heart of the sustainable development of the blue economy, with targeted investments in three areas of intervention: achieving climate neutrality, preserving and restoring marine and coastal ecosystems, and support innovations in ocean sustainability. (Pace & al., 2023), emphasizes that interdisciplinary research is essential to understand the complex dynamics and interactions of the marine environment and to prioritize research interventions that promote the sustainable use of ocean resources and coastal. There is a need to better understanding how to leverage science and innovation to unlock the potential of the blue economy, bridging the gap between research and commercialization and sustainable development of blue economy activities (European Commission, 2021).

### 3. 1 Blue innovation clusters

#### a) Innovations in marine renewable energies (MRE) and biofuels

With the aim of implementing measures aimed at reducing or even eliminating emissions from maritime transport, sea energies such as installed and floating wind power, wave energy, tidal energy, tidal turbines , floating solar, osmotic and thermal energy from the seas are serious avenues to explore (Spalding, 2016). According to (The Economist Group, 2020), shipping has the opportunity to decarbonize and help other energy-intensive sectors move away from fossil fuels by migrating to zero-carbon hydrogen and renewable electricity. There are a range of cleaner alternatives such as hydrogen, ammonia, electric motors, liquefied natural gas (LNG) and biofuels. The use of LNG, with atmospheric emissions much lower than pollutants, as a fuel with better properties (low CO2, no fine particles). Electricity (batteries) can be a solution, as a hybrid solution. The International Renewable Energy Agency (IRENA) encourages the integration of offshore wind with other renewable energy and technologies, as well as industries such as aquaculture and desalination. It calls for exploring the coupling of ocean energy with other sectors, and seeking complementarities with renewable energies and technologies. According to the GWEC (World Bank, 2019), floating offshore wind is now a mature technology and its deployment around the world is accelerating. This report ranks Morocco in the top 5 countries likely to emerge as global hubs for floating offshore wind. According to (Germa, 2021), Morocco has considerable potential for renewable electricity production. Which places it at the forefront of becoming one of the major producers of e-fuels tomorrow. By mobilizing approximately 5/1000th of the surface area of the Sahara, it is possible to decarbonize almost all of global maritime transport. By 2030/50, e-fuels could make Morocco one of the world leaders in the decarbonization of maritime transport.

(Louis-Dreyfus, 2021) Morocco's capabilities to produce green hydrogen come from the solar, wind and maritime capital it has, which will also allow it to produce green hydrogen from the desalination of seawater, using renewable energy sources. According to Policy Center for the new South (2023), green hydrogen will be produced by electrolysis of water and from electricity from renewable energies. Beyond the national challenges of security of energy supply, hydrogen responds to a triple challenge: decarbonization of light and heavy mobility, improvement of air quality, and job creation. Morocco could by 2030, become an exporter of green hydrogen and its derivatives (green ammonia and methanol), ultimately capturing 2 to 4% of the world market. Innovation also focuses on emerging sustainable energy resources such as algae-based biofuels (see blue biotechnologies).However, (Spalding, 2016) explains

that the exploitation of renewable ocean energy must be weighed against the potential damage it causes to natural habitats (changes in geomorphology and processes, sedimentation, erosion). The same goes for mining, which he believes presents many threats, including the degradation of seabed biomass and column water pollution, which could harm communities that depend on this ecosystem for food.

### b) Blue-tech innovation

Blue Tech innovation means finding technological solutions to maritime problems. It includes a wide range of technologies that aim to encourage and prioritize sustainable ocean activities. (OECD, 2020) notes a growing interest in commercial and scientific applications of new digital technologies for a better understanding of marine ecosystems, their functioning and the requirements for better management. They include artificial intelligence, big data, digital platforms, blockchain, drones, sophisticated sensor networks, satellites, remote sensing, genetics and acoustics. In terms of disruptive technologies, many ocean innovations are developing in particular the Ocean of Things, robotics and big data intended to improve knowledge and technologies. For (Spalding, 2016), the blue technology sector, infrastructures in particular manufacturing of sensors, instruments and platforms, observation systems, software and models, marine robotics etc. Convergent technologies NBIC (corresponds to nanotechnology, biotechnology, information technologies and cognitive sciences) which aims to use innovations and knowledge acquired in each of these areas to create new techniques, products or services.

A new avenue of innovation in the field of marine technologies concerns "the marine cloud brightening (MCB) system" which consists of spraying seawater into the air to create marine clouds and reduce heat around vulnerable areas such as coral reefs (Zhu&al., 2020). Innovation also includes digital or crowdsourcing platforms that constitute knowledge resources to co-create ocean sustainability solutions and share data, analytics and other digital tools to promote sustainable fisheries, ocean health and the resilience of coastal communities.

### c) Blue biotechnologies

Blue biotechnology is defined as "the application of science and technology to living organisms, and their parts, products and models, to modify living or non-living materials to produce knowledge, goods and services" (OECD, 2005). Blue biotechnology research and development of products and drugs based on marine organisms, aiming to exploit their biological and genetic potential. According to Khurshed Alam, this can include all kinds of organisms: microorganisms (micro-algae, bacteria, fungi and viruses or genes…etc.) and larger organisms like marine plants, shells and fish. Marine biotechnology encompasses a wide range of activities and can include everything from bioprocessing harvested materials (fish, algae, etc.) to growing marine microbes or developing an innovative buoy system to monitor ocean pollution. Marine biotechnologies offer an opportunity to highlight the maritime potential derived from fishing and aquaculture products. Its products are integrated into several markets such as food, pharmaceuticals, cosmetics, agriculture, aquaculture, energy, health and plant nutrition or animal health and nutrition. Biotechnology is an area that holds enormous potential for innovation and economic growth. Morocco is advantaged in this regard with a rich and diversified biodiversity, attested by the existence of 7825 species, including 7136 animal forms and 689 plant forms and by the existence of provinces of carbonate mountains with cold-water corals (Menioui, 2021). Bioprospecting and the discovery of new genes and biological compounds in the ocean environment lead to the commercial development of high-value products from non-food marine resources.

Khurshed Alam, cites the example of marine microalgae which can, using sunlight as an energy source and carbon dioxide as a carbon source, produce a range of products (oils, proteins, antioxidants, etc.) without compromising drinking water, because they grow on sea water. Microalgae constitute a

promising source for wastewater treatment and nutrient recovery (Fal & al., 2023). Algae-based bioplastics are a major research theme. Microalgae to capture the CO2 emitted by industrial companies (valorization and storage of CO2 via the cultivation of microalgae). Blue biotechnologies can also be used to develop non-toxic antifouling products, to improve the efficiency of desalination processes, to develop less harmful biopesticides or even to target the destruction of hydrocarbons during an oil spill.

(The Economist Group, 2020) states that algae provide fodder for fish larvae with a dual benefit. First, ocean forest can absorb carbon dioxide in the same way as terrestrial forests and absorb microplastics to produce gas and fertilizer. Second, the process could repopulate the ocean with fish, creating a vast new supply of food. The (Economist Group, 2020) mentioned the potential of algae to absorb greenhouse gases, reduce ocean acidity and allow them to continue to act as a carbon sink. They play a vital role in the balance of the ocean and the climate. They absorb CO2 Thanks to photosynthesis and ensure the production of oxygen, thus contributing to the slowdown of global warming, methane emissions and acidification (IRES, 2023). In its opus "the Morocco 2021 model", (Pauli, 2021) identified promising niches to develop such as algal gas, its biomass as a source of animal feed for livestock, the extraction of agar-agar, used in the sector food and the cosmetic industry, but also for the energy potential represented by certain species of algae. According to him, they offer a solution to the cleaning of plastic waste, the restoration of marine ecosystems, the production of fertilizers, and fresh water as a by-product, which can be used for irrigation in the form of liquid fertilizer. Algal fiber can also be used in the production of clothing as an alternative to cotton that drains water resources and pollutes them with toxins. Similarly, in addition to carbon sequestration, large-scale kelp cultivation projects can produce biodigested methane products that could produce alternative electricity to natural gas.

A new avenue of research is opening up with cellular agriculture (Rubio & al., 2019), it consists of the production of agricultural products from cell cultures rather than from whole plants or animals. The concept of producing seafood from fish cell and tissue cultures is emerging as an approach to address similar challenges with industrial aquaculture systems. Cell-based seafood, as opposed to animal-based seafood, can combine developments in biomedical engineering with modern aquaculture techniques. Developments in biomedical engineering, such as closed-system bioreactor production of land animal cells, are creating a basis for large-scale production of marine animal cells. Aquaculture techniques such as genetic modification and closed-system aquaculture have achieved significant production gains that can pave the way for innovations in cell-based seafood production.

**Table 7:** Summary of innovation clusters in the field of the blue economy

| Cluster | Innovation segment |
|---|---|
| Marine renewable energies (MRE) and biofuels | - Installed and floating wind power, wave energy, tidal energy, tidal turbine, floating solar, osmotic and thermal energy from the seas, and offshore green hydrogen.<br>- Algae-based biofuels<br>- The marine cloud brightening system (MCB).<br>- Convergent technologies NBIC (corresponds to nanotechnology, biotechnology, information technologies and cognitive sciences). |
| Blue-tech | - Artificial intelligence, big data, digital platforms, blockchain, drones, sophisticated sensor networks, satellites, remote sensing, genetics and acoustics. Ocean of Things, robotics and big data, observation systems, software and models, marine robotics and crowdsourcing. |
| - Blue biotechnologies | - Algae biotechnology,Cellular agriculture |

## Conclusion

As saving the oceans is an existential challenge for all of humanity, research and innovation are considered essential to achieve this objective. An innovation ecosystem is able to bring about a new paradigm that exploits maritime wealth in a rational and sustainable way. Although on the right track, the figures show that Morocco has a long way to go to establish a true model of a sustainable blue economy. The construction of this model must be done through a systemic and inclusive approach of all stakeholders: regional councils, civil society, researchers and academics, private sector, international cooperation, etc. Nevertheless, education training is a major axis of this policy through the valorization of Moroccan university human capital recognized by its great competence and the diversification of the training offer in the fields of blue economy professions. Research and innovation that generate blue knowledge must also be encouraged and invest in the sectors of the future (Biotechnologies and genetic resources) that generate blue employment and skills. However, the training provided requires an opening to other specialties and international experiences, in particular to allow both a transfer of technology and expertise and the exchange of North-South and South-South experiences. Foresight approaches that encourage the co-creation of innovative solutions with users deserve to be further explored. The study could be enriched by integrating various users, such as societal and community stakeholders from the marine and coastal space, in the exploration of sustainability futures. Start-ups are also seen playing a key role in innovation processes, exploring innovative business models that can respond to environmental threats within the Blue Economy.

## REFERENCES


[1] A. Faraj,"Morocco and the Sea", Marine & Oceans. Special Issue, 3rd quarter, 124 pages (bilingual FR/EN), 2021.

[2] A. Khurshed, "Developing Blue Economy-Blue Biotechnology", unpublished.

[3] C. Hajji, A.Bendou and M.Hassou,"Management of Moroccan solid harbor waste: comparative analysis and recommendations", J. Wat. Env. Sci, vol1, No. 1, pp.59-76, 2017.

[4] Department of Studies and Financial Forecasts, "The Moroccan fisheries and aquaculture sector: Structural trends, issues and development levers", Report, 2020.

[5] E.Basquin, D.Mercier, Creach A., E. D'Acremont and, S.Lafuerza,"Preliminary diagnosis of the exposure of the Mediterranean coast of Morocco to the risk of tsunami", Bulletin of the Association of French Geographers, 98-3/4, pp.546-565, 2022.

[6] Economic, Social and Environmental Council, "Draft law n°81-12 relating to the coastline", Referral n°13/2014.

[7] Economic, Social and Environmental Council, The blue economy: Pillar of a new development model for Morocco, Report", Auto-Saisine 38/2018.

[8] European Commission, " The EU Blue Economy Report", Publications Office of the European Union, Luxembourg: 2021.

[9] European Commission," Innovation in the blue economy: realizing the job creation and growth potential of our seas and oceans", Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 2014.

[10] FAO," State of the World Fisheries and Aquaculture: Achieving the Sustainable Development Goals", Report, 2018.

[11] Hydrography, Oceanography and Cartography Division of the Royal, " Navy National Report of the Kingdom of Morocco", Hydrographic Commission of the Mediterranean and the Black Sea / 21th MBSHC June 11 to 13, Cádiz, Spain, 2019.

[12] I. Azaguagh, A.Driouchi, " Management of fisheries resources in Morocco and modes of access: The "Anti-Commons" model and the octopus fishery," Rev. Mar. Sci. Agron. Vet, vol 7, No.1, pp. 5-17, 2019.

[13] I. Issa, S. Sebastian Delbru and U. Hamm, " Bioeconomy from experts' perspectives - results of a global expert survey", PLoS ONE, vol 14, N° 5, 2019.

[14] International Energy Agency, " Energy Policies Beyond IEA Countries: Morocco", 2019.

[15] ITF, "Decarbonizing Morocco's Transport System: Charting the Way Forward, International Transport", Forum Policy Papers, No. 89, OECD Publishing, Paris, 2021.

[16] J.M.Germa, "Morocco and the Sea", Marine & Oceans. Special Issue, 3rd quarter, 124 pages (bilingual FR/EN), 2021.

[17] L.A. Pace, "Malta's marine sector", The European foresight-monitoring network Foresight Brief. No, 061, 2006 .

[18] L.A.Pace, O. Saritas, A.l Deidun,"Exploring future research and innovation directions for a sustainable blue economy", Marine Policy, vol 148, 2023.

[19] L.VanHoof, G. Fabib, V. Johansen, J.Steenbergen, X. Irigoien, S.Smith, D.Lisbjergg and G.Kraush, "Food from the ocean:towards a research agenda for sustainable use of our oceans' natural resources," Mar. Policy, 105, pp. 44-51,2019.

[20] M. Nachoui, " History of a Moroccan maritime policy", Geographical Space and Moroccan Society Review, n°24-25, 2018.

[21] M. Voyer, G.Quirk, A. McIlgorm and Azmi K.," Shades of blue: what do competing interpretations of the Blue Economy mean for oceans governance? ," J. Environ. Policy Plan, 20 (5), pp. 595-616,2018.

[22] M.J. Spalding, "The new blue economy: the future of sustainability," J. Ocean Coast. Econ., 2 (2) pp. 81-21,2016.

[23] Ministry of Economy and Finance, Morocco and Agency for the Development of Aquaculture, "Moroccan marine aquaculture: potential and need for development", 2018.

[24] Ministry of Equipment, Transport and Logistics, " Maritime Transport in figures 2018", 2019.

[25] Ministry of Equipment, Transport and Logistics, " Study on the Strategy of the Moroccan Maritime Transport Sector and the development of the National Pavilion in Morocco", 2013.

[26] Ministry of Equipment, Transport and Logistics, "National Ports Strategy", 2010.

[27] N. Hamoumi, " Les sciences de la mer : un outil stratégique incontournable pour le développement durable au Maroc, Prospectives universitaires", N°1, pp. 199-219, 2008.

[28] N. Rubio, I. Datar, D. Stachura, D. Kaplan and K. Krueger," Cell-Based Fish: A Novel Approach to Seafood Production and an Opportunity for Cellular Agriculture", Forehead. Sustain. Food Syst, vol 3, 2019.

[29] OCP Policy Center, " The green hydrogen market: the industrial equation of the energy transition", 2023.

[30] OECD, " The Ocean Economy in 2030", OECD Publishing, 2016.

[31] OECD/ITF, "Decarbonising Morocco's Transport System: Charting the Way Forward", International Transport Forum Policy Papers, No. 89, OECD Publishing, Paris, 2021.

[32] P. Gunter, " The Blue Economy 3.0", The Observatory, 2019.

[33] P. Gunter, K. Jurriaan, "The Morocco Model designing economic growth for the common good, OCP. (2021).

[34] Ph. Louis-Dreyfus, "Morocco and the Sea", Marine & Oceans. Special Issue, 3rd quarter, 124 pages (bilingual FR/EN), 2021.

[35] R. El Houdaigui, "Morocco and the Sea", Marine & Oceans. Special Issue, 3rd quarter, 124 pages (bilingual FR/EN), 2021.

[36] Royal Institute of Strategic Studies, "The future of Morocco's global professions", Summary report, 2023.

[37] Royal Institute of Strategic Studies, "The ocean: global issue and planetary solution", Strategic Report 2022-2023, 2023

[38] S. Fal, A.Smouni and H.El Arroussi,"Integrated microalgae-based biorefinery for wastewater treatment, industrial CO2 sequestration and microalgal biomass valorization: A circular bioeconomy approach", Environmental Advances, vol 12, 100365, 2023.

[39] S. Grimes, " The blue economy, a challenge for the countries of the southern Mediterranean: the case of Algeria", European Institute of the Mediterranean, 2022.

[40] Special Commission for the New Development Model, Report,2021.

[41] T. Marrakchi, “Morocco and the Sea”, Marine & Oceans. Special Issue, 3rd quarter, 124 pages (bilingual FR/EN), 2021.

[42] The Economist Group, “A sustainable ocean economy in 2030: Opportunities and challenges: Opportunities and challenges,“, World Ocean Initiative, 2020 .

[43] UNESCO-IOC,“ The Contribution of the UN Decade of Ocean Science for Sustainable Development to the Achievement of the 2030 Agenda,“ UNESCO, Paris, The Ocean Decade Series, 34, 2022.

[44] World Bank, “Going global: Expanding offshore wind to emerging markets,“ Report, 2019.

[45] World Bank,“Blue Economy Development Program, Environmental and Social Systems Assessment (ESES), Program for Results (PPR) (P172926),“ Interim report, 2022.

[46] Y.Zhu, Z.Zhang, J.Crabbe, “ Extreme climate response to marine cloud brightening in the arid Sahara-Sahel-Arabian Peninsula zone,“ International Journal of Climate Change Strategies and Management Emerald Publishing Limited1756-8692, 2020.

[47] Z.Benmassaoud, B.Ibnkhaldoun, “Integrated coastal zone management: Legal tool for preserving the Moroccan coastline”, Journal of Economy, Management, Environment and Law, vol 3. No.1, 2020.