DESK REVIEW

COUNTRY REPORT ON MIGRATION, ENVIRONMENT, AND CLIMATE CHANGE IN LIBYA

IOM
UN MIGRATION

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Cover photos: First assesments of the devastating impact caused by the floods in Derna @IOM 2023/MOAIAD Tariq

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ACRONYMS

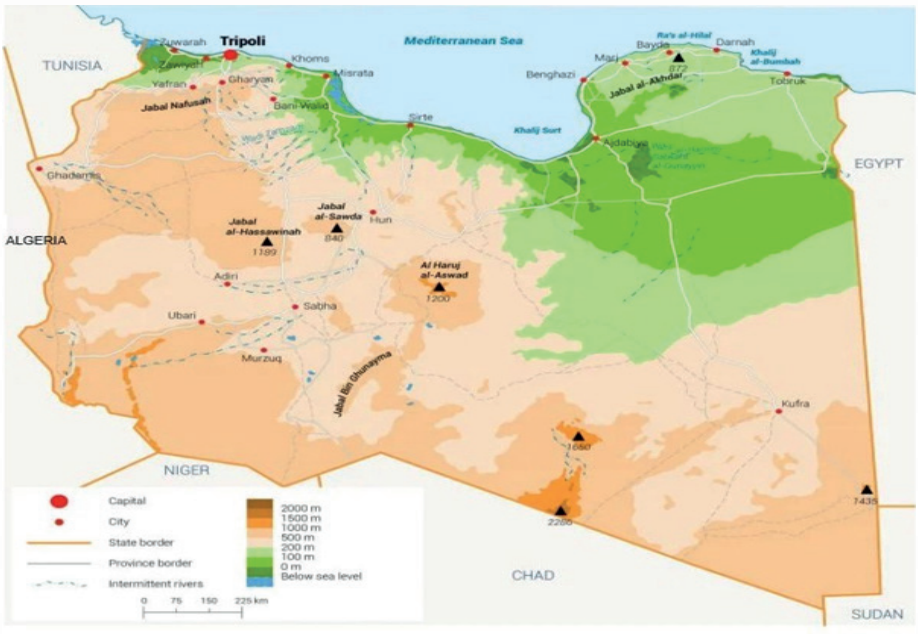
DSC	DEPARTMENT OF STATISTICS AND CENSUS
DTM	DISPLACEMENT TRACKING MATRIX
EPA	ENVIRONMENT PUBLIC AUTHORITY
GNS	GOVERNMENT OF NATIONAL STABILITY
GUN	GOVERNMENT OF NATIONAL UNITY
GDP	GROSS DOMESTIC PRODUCTION
UNICEF	UNITED NATIONS INTERNATIONAL CHILDREN'S EMERGENCY FUND
IOM	INTERNATIONAL ORGANIZATION FOR MIGRATION
IPCC	INTERNATIONAL PANEL ON CLIMATE CHANGE
MEDECC	MEDITERRANEAN EXPERTS ON CLIMATE CHANGE AND ENVIRONMENT CHANGE
MECC	MIGRATION, ENVIRONMENT, AND CLIMATE CHANGE
NACC	NATIONAL COMMITTEE FOR CLIMATE CHANGE
NMC	NATIONAL METEOROLOGICAL CENTER
PPM	PARTICLE PER MILLION
PWA	PUBLIC AUTHORITY FOR WATER
UN	UNITED NATION
UNDP	UNITED NATIONS DEVELOPMENT PROGRAMME
UNSMIL	UNITED NATIONS MISSION IN LIBYA
OCHA	UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS
WB	WORLD BANK

1 BACKGROUND

1.1 The Context

Libya is a North African country located on the Mediterranean coast, between Egypt, Tunisia and Algeria, and ranks fourth as the largest African country in terms of land area with about 1.759,540 km2, and its land border with its neighboring countries is about 4,348 km (Wikipedia 2023), while its Mediterranean coast extends for more than 1900 km, with maritime territorial waters of up to 14 nautical miles, about 22.2 kilometers (Assad 2023). Desert and semi-desert lands cover about 80% of the country's area, characterized by limited surface water resources. Libya is one of the driest places on earth, with low rainfall rates and the absence of rivers or surface runoff dramatically. Approximately 96% of the country's area receives rainfall below 100 mm/year. The highest rainfall occurs in northwestern regions, such as the Nafusa Mountains and the Jafara Plain, and in the north eastern most regions, such as Jabal Akhdar. Low rainfall rates and limited surface water resources put pressure on the extraction of groundwater, which is the main source of water consumption, of which the agricultural sector consumes about 80% (Mohamed 2019). Libya is mainly characterized by vast deserts covering about 85-90% of the country's area. The topography of Libyan territory is characterized by extreme differences between the highest peak at the Tibesti Mountains, which tobacco is about 2266 meters above sea level, and the lowest subsea point at Sabkha Ghazil, about 47 meters below sea level and located about 150 km south of Ajdabiya. Along the extension of the south of the coastline towards the central regions, scattered grasslands can be found, separating the desert from the coast. The rest of the southern regions are dominated by arid deserts, hills and sand dunes, (Figure 1), (Braun and Passon 2020).

Figure 1. Topographic Map of Libya (Sadeg, Al-Samarrai, and Rashrash 2023).



Libya's population numbered 5,323,991 in 2006, and approximately 6,872,624 in 2020, distributed in regions as shown in (Table 1), the estimated population of the country is 7.3 M people as of 2023, with a relatively low population density due to its vast desert expanses (well over 80% of its population lives along the Mediterranean coast). Arabic language is the official langue of the country. Around 80% of the population is concentrated in urban communities, with the remaining percentage residing in suburban and rural areas.

Table 1.Population Census by Region (Bureau of Statistics and Census, 2023).

Region	Population 2020	Region	Population 2020
Tobrq	195,088	Tripoli	129,3016
Derna	201,639	Aljfara	548,855
Aljabel Alakder	250,020	Alzawya	351,306
Almarj	227,658	Gath	27,675
Benghazi	807,255	Aljabel Algrbi	374,911
Ajdabya-Alwahat	213,728	Nalot	113,886
Alkofra	55,495	Sabha	153,454
Sirt	170,869	Wadi Alshati	95,294
Aljofra	60,853	Wadi Alhaya	91,749
Misurata	663,853	Murzq	94,088
Almrgeb	532,227	The rest of the regions	349,755
Total: 6,872.674			

Libya relies almost entirely on oil and gas revenues, which account for 97% of fiscal revenues, but in recent years has been hit by numerous crises that have weakened the economy, which will have far-reaching economic and social implications. Other sectors in the country not contributing significantly to the country's GDP. The labor market is characterized by high unemployment, with an official rate of 19.6 percent. More than 85 percent of those who work are employed in the public and informal sectors(CIA 2023).

The political system in Libya has witnessed significant fluctuations since 2011with a lengthy transition phase intended to conclude with presidential and parliamentary elections on December 24, 2021. However, due to the deepening political crisis in the country and the intensification of conflicts, the electoral process faced obstacles In February 2022, the postponement of the elections scheduled to be held under the auspices of the UN in December 2021 indefinitely led to a sharp political division, resulting in the splitting of authorities between two governments. One, in the west of the country, was formed through a round of dialogue and the Libyan Political Agreement held in Geneva in 2021, under the name of the Government of National Unity (GNU), based in Tripoli, and the other in the east of the country under the name of the Government of National Stability (GNS). Currently, political crisis between the two rival governments persists, which has exacerbated conditions related to tribal and regional conflicts and undermined overall stability (Batelli 2023)

1.2 General climatic features

The impact of geographical location, topographical variation, and coastline orientation is reflected in the climate of Libya, which represents a combination of maritime and desert climates. The climate in Libya is characterized by diverse features. In the northern regions of the country, it is subject to the influences of the Mediterranean climate, while the central areas fall within the semi-arid climate zone, and all southern regions are subject to the harsh impacts of the desert climate (Hajjaji 1967) . The predominant characteristics of the Libyan climate can be summarized as mostly a hot, dry climate in the summer, with warm and rainy conditions in the winter. The coastal strip along the Mediterranean Sea, however, experiences relatively cooler temperatures and higher humidity compared to the central and southern parts of the country during the summer months, and it tends to be warmer in the winter months. Additionally, there is a significant temperature variation between day and night across the country (Zekry, 2005).

1.3 Risk Management

According to the Risk Management Index managed by European Union, UN agencies and various other organizations, Libya is classified as one of the most vulnerable countries in recent years, ranking 18th globally according to the 2022 results. Nevertheless, this ranking represents a relative improvement over the past two years compared to previous years. In 2021, Libya was categorized as having extremely high risks, and this improvement is attributed to the relative stability in political and security conditions, with the risk exposure rate decreasing from 8.8 in 2020 to 6.9 in 2022 (OCHA 2021).

Human-induced hazards scored 10 points, the highest on the index, while hazards resulting from natural disasters scored 3.7 points, reflecting risks posed by floods, pandemics, droughts, and water scarcity. Coastal floods are classified as high risks with an expected occurrence in the next ten years. Water scarcity and forest fires also pose high risks, while drought is considered the most severe, with an expected occurrence every five years on average. In the overall risk indicator, the vulnerability element decreased from 7.2 to 4.3, leading to a change in the country's ranking in the general risk classification. Social and economic vulnerability scored 2.8, and vulnerability of migrants and other affected population categories scored 5.5 out of 10 on the scale, highlighting the ongoing challenges faced by vulnerable groups (European Commission 2023).

This underscores the persistence of political, economic, social, and environmental threats and highlights the risks faced by affected groups, whether they are due to human-induced hazards or environmental degradation and climate change. There remains an urgent need to focus on the protection of women, children, and vulnerable populations, especially in the absence of security and the gender-based violence, in addition to displacement resulting from wars and the degradation of the environment and the impacts of climate change (OCHA, 2022c).

Presently, Libya grapples with a multitude of pressing environmental concerns. Among these challenges is the increasing encroachment of desertification, which poses a serious threat to the country's ecosystems and agricultural productivity (and thus, food security and human health). The scarcity of natural freshwater resources compounds the issue, necessitating innovative solutions to address water scarcity. It is among the top 10 most water-stressed countries in the world with its agricultural sector facing serious challenges. Rainfall throughout the country is non-uniform and high temperatures result in high evaporation rates, which reduce groundwater availability and agricultural production consumes about 80% of the groundwater resources (Mohamed 2019).

The Manmade River Project is one of the largest irrigation projects in the world and seeks to alleviate this crisis by channeling water from extensive aquifers beneath the Sahara to the coastal urban centers. Nonetheless, water pollution has emerged as a critical issue with far-reaching ramifications. The cumulative impact of untreated sewage, oil byproducts, and industrial waste endangers both Libya's coastline and the delicate balance of the Mediterranean Sea (McFee, 2023).

The harsh climatic conditions imprint distinct characteristics on all Libyan regions, particularly in the interior and southern areas where arid and semi-arid climates prevail. This is characterized by high temperatures, low rainfall rates, increased dust and sandstorms, seasonal floods, heatwaves during the summer and fall, and cold waves during the winter months. All these factors contribute to elevated risk levels faced by the country, resulting in impacts and consequences that affect people's lives, stability, and negatively influence economic and social conditions, as well as the infrastructure and the availability and quality of services. The climatic conditions in Libya are characterized by variability, subject to the Mediterranean climate in the north, semi-arid climate in the central regions, and harsh desert climate in the south. This results in a sudden transition of weather from one place to another and from time to time (Hajjaji 1967).

In terms of human mobility dynamics, Libya serves as both a destination and a transit point for economic international migrants. Its proximity to southern Europe and relaxed border controls makes it a key hub for migration to Europe. Although the number of IDPs in Libya has decreased in recent years, over 134,000 remain in displacement situations that are generally harder to resolve. Moreover, Libya is a major host and transit country with over 12% of its population comprised of international migrants; a total of 705,746 migrants from over 44 nationalities in the 100 Libyan municipalities during round 47 of data collection (March - April 2023). The largest migrant populations identified by DTM during round 47 of data collection were in the coastal regions of Tripoli (16%), Benghazi (12%), Misrata (10%), Ejdabia (8%), Azzawya (6%) and Almrgeb (6%) (IOM, 2023a). The coastal area is home to the majority of Libya's urban settlements and crop land, while the rest of Libya (more than 95% of the total area) is mainly desertic or arid areas. Thus, the interlinkages between climate change, environmental degradation, and human mobility in Libya are highly complex (McFee, 2023).

Libya is grappling with escalating impacts due to increasing pressures and risks associated with environmental degradation and climate change. It understands the linkage of these effects and their impact on people's lives, livelihoods, mobility, and displacement. Migration represents one of the strategies for adapting to these environmental and climatic impacts. Additionally, political, economic, and social conditions exert another influential pressure on the overall situation in the country. This creates the context and provides opportunities for migration and displacement, as witnessed by the country in recent years with external migration flows and internal displacement. On the other hand, these challenges are crucial for the present and future of the country and should not remain hostage to time. The need to develop strategies, programs, plans, allocate resources, and create mechanisms has become a necessity and a priority to address the impacts of environmental degradation and climate change, along with the associated social and institutional instability. Difficult conditions push people towards mobility and migration as an alternative option for adapting to these adverse effects.

1.4 Environment, Climate Change, Migration Nexus

Libya is facing a real environmental and climatic crisis that impacts economic and social life, threatening living standards, civil peace, resilience, and stability. The impact of this crisis is further exacerbated by the state of political instability and institutional divisions that the country is experiencing. Libya relies on agriculture and exports to meet its food needs, and it faces a genuine crisis in water resources in terms of sources, supplies, and management. The magnitude of depletion has led to a water deficit, especially in the northern regions of the country, resulting in a continued decline in groundwater levels exceeding 2.5 meters annually. The deterioration of water quality is also evident due to the intrusion of seawater into coastal areas. All these challenging environmental conditions create serious challenges and limit available alternatives, imposing restrictions on income sources and living standards (Al-Baroni, 2020).

Climate change and environmental degradation result in significant losses that affect all aspects of life, impacting people's lives, safety, service levels, and the mechanisms to respond and adapt to the consequences. This is attributed to both natural and human factors, including the vastness of the country, population and urban growth, weak institutional performance, political instability, and financial issues.

The deterioration of agricultural and pastoral environments, the limitation of water resources, floods, droughts, desertification, sand and dust storms, heatwaves, the decline of vegetation cover, and biodiversity loss are all present and influential environmental and climatic challenges in Libya. These challenges are directly linked to people's ability to remain in their original habitats and their resilience. At the same time, they force them to seek alternatives, with migration and displacement at times being a strategic choice to adapt to harsh environmental and climatic impacts.

1.5 Environmental Legislation

In Libya, the Environment Improvement Law issued in 2003, and prior to that, the Environmental Protection Law No. 7 of 1983, defined the environment as the habitat in which humans and all living organisms exist. This habitat encompasses air, water, soil, and food, whether in residential, occupational, or other settings. Libya faces multifaceted environmental challenges including desertification, drought, water scarcity, decreased rainfall, limited arable land, and sand dune encroachment, particularly in central and southern regions (Gremida, Ben-Mahmoud, and Elkekli 2022). These issues significantly affect the nation's humanitarian, political, economic, and social spheres, impacting living standards, stability, resilience, and development aspirations.

In recent decades, the state has focused on environmental conservation and managing various challenges through the enactment and continuous refinement of environmental laws. However, there has been an incomplete understanding of environmental issues and their wide-ranging impacts across different sectors. Historically, environmental concerns were primarily linked to health, particularly environmental sanitation, neglecting other aspects. This has given rise to health laws addressing specific environmental issues, while broader environmental impacts remained unaddressed until the 2003 Environmental Protection Law, for a list of Libyan laws containing provisions related to health and/or environmental protection (Table 2), (Gremida et al. 2022), (Sharkasi 2017).

Over the past decades, progress in practically addressing environmental issues in the country has been extremely limited and largely timid.(Gremida et al. 2022). This has led to an exacerbation of environmental threats and increased losses resulting from them. Several factors contribute to the worsening challenges, including Libya's vast land area, the failure of governmental policies to address environmental developments, the lack of prioritization of environmental issues in national transformation programs, the absence of comprehensive government plans and programs, as well as insufficient allocations for environmental projects and programs addressing impacts, mitigation, and adaptation.

Furthermore, the structural and institutional instability in the environmental sector has led to repeated transfers of its oversight to multiple authorities. The sector has been linked to various legislative and executive bodies, including the Ministry of Health, the Ministry of Oil, municipalities, a Technical Center for Environmental Protection, the General Environmental Authority, it has also been linked to legislative bodies previously, and finally, the Ministry of Environment. These shifts have scattered the sector's authority, all in the absence of a clear national vision and a stable national strategy, coupled with an inability to harness scientific and technological advancements in this field.

Libya has actively engaged in international environmental protection efforts and climate change mitigation. The country signed the UN Framework Convention on Climate Change on June 29, 1992, ratified it on September 12, 1999, approved the Kyoto Protocol on August 24, 2006, and signed the Paris Agreement on April 22, 2016, ratifying it in August 2021 (Gremida et al. 2022). Additionally, Libya is a member and partner in various international environmental protocols and conventions.

Table 2. Laws Related to Environment Issues

Environmental Laws	Year of Issue	Environmental Laws	Year of Issue
Law No. 27 on Forests and Pastures Protection.	1968	Law No. 17 on the regulation of pastures	1985
Law No. 33 on Agricultural Lands Protection, amended by Law No. 4 of 1973	1970	Law No. 14 on Marine Resource Exploitation.	1989
Health Law No. 106, which includes provisions related to certain environmental issues (at that stage, the environment was dealt with solely as a matter related to environmental sanitation).	1973	Law No. 22 on Industrial Regulation.	1989
Law No. 8 of 1973 on Prevention of Marine Pollution by Oil		Law No. 13 on Meteorology and Early Warning.	1991
Law No. 93 on Industrial Security and General Safety.	1976	Law No. 15 on the Protection of Agricultural Land	1992
Law No. 2 on the Regulation of the Use of Ionizing Radiation and Protection against its Hazards.	1979	Law No. 7 on Environmental Protection and its amendments, leading to Law No. 15 of	1982
Law No. 12 Regulating Ionizing Radiation and Protection from Dangers Law No. 3 of 1982 on the Regulation of Water Resources Utilization	1982	Law No. 15 on the protection and improvement of the environment	2003
Law No. 5 on Forests and Pastures Protection	1982	Law No. 17 on the Regulation of Radioactive and Nuclear Activities and their Control	2023
Law No. 13 with Special Provisions for Public Sanitation.	1984		

1.6 Government Policies in Addressing the Effects of Climate Change

Within the framework of classifying governmental policies and programs aimed at mitigating environmental degradation and coping with the consequences of climate change, the First and Second Five-Year Development Plans implemented from 1970-1975 and 1975-1980 were the most effective and successful in executing projects that served environmental requirements and alleviated their adverse impacts (Hamad 2006). It involved large-scale land reclamation, agricultural projects, expansion of vegetation cover, water provision, dam constructions, seed and fertilizer supply, and infrastructure development in various regions across the country. Libya's environmental mitigation and adaptation efforts were curtailed due to shifting priorities and political crises, leading to the suspension of developmental plans and exacerbating environmental degradation. This, in turn, severely impacted the national economy, infrastructure, and ecological systems, hindering substantial developmental progress.

Additionally, conflicts and instability over the past twelve years (2011-2023) worsened environmental conditions, amplified climate change challenges, and made the impacts and threats more extensive. For decades little progress has been made in addressing environmental issues and adapting to the effects of climate change, despite the threat it poses to development, stability, and livelihoods. This understanding reflects the absence of a clear, comprehensive and integrated national strategy and the inability to create effective capacity to address the impacts of climate change (Gremida et al. 2022). Key challenges include preventing further degradation of terrestrial and marine ecosystems and protecting against desertification and rising sea levels to mitigate increasing soil salinity, which adversely affects agricultural production (UNDP, 2023).

Libyan environmental legislation lacks explicit integration of definitions and provisions from the Climate Convention, Kyoto Protocol, and Paris Agreement, addressing specific environmental issues without adequately focusing on climate change mitigation and adaptation. However, Act Law No. 15 of 2003 on the Protection and Improvement of the Environment introduced provisions relating to air pollution. However, the absence of an overarching legal framework to address climate change hampers a country's ability to meet domestic and international obligations in binding international agreements(Gremida et al. 2022). Libya's effectiveness in submitting national carbon inventories and technical reports on climate change mitigation and adaptation is constrained by political, economic, and structural challenges. Although Libya established the National Committee on Climate Change in 1998 and participated in international environmental efforts, this initiative was unsuccessful due to various factors to be discussed in the next section.

The country is a party to several international agreements, including the UN Framework Convention on Climate Change, the UN Convention to Combat Desertification (1994), the Convention on Biological Diversity (1992), the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention) and its amendments (1977), the Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships (1977), the Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances (1979), the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean (1989), the Protocol on Integrated Coastal Zone Management (1996), the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (1980), the Protocol on Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil in the Mediterranean (2005), the Protocol on Pollution from Land-Based Sources and Activities (1996), the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (2001), the Stockholm Convention on Persistent Organic Pollutants (2005), the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (2004), the Minamata Convention on Mercury (2014), the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer (1990), the African-Eurasian Migratory Waterbird Agreement (2005), the African-Eurasian Waterbird Agreement (2002), the Convention on the Conservation of Migratory Species of Wild Animals (2002), the Ramsar Convention on Wetlands (2002), among others.

1.7 The National Committee for Climate Change

The National Committee for Climate Change, established in 1989 and initially chaired by the Minister of Energy, included members from various sectors such as Industry, Transportation, Agriculture, Economy, and Foreign Affairs. It underwent several restructurings: first under the Oil and Gas Minister, then moving to the General Authority for the Environment in 2005, where it expanded its focus to include ozone layer protection initiatives. In 2012, it was restructured again, incorporating members from the National Center for Meteorology, the Ministries of Electricity and Renewable Energy, and Water Resources, along with two academic experts in atmospheric sciences and climate change(Gremida et al. 2022).

In 2020, the cessation of the National Committee for Climate Change's activities—due to issues with membership qualifications, resources, administrative structure, and political and security conflicts—led to the Presidential Council forming an advisory committee under the General Authority for the Environment. This committee was tasked with evaluating the National Committee's work, proposing restructuring amendments, and improving its functionality (Eljadid and Al-Tayari 2020).

The advisory committee provided a detailed assessment and comprehensive recommendations for restructuring the committee that addressed challenges with meaningfully incorporating climate change-related issues into the state's plans, policies, and public programs, except in limited instances (Gremida et al. 2022), (Eljadid and Al-Tayari 2020). Conclusions included the following:

1. Absence of specialized units within institutions for climate change issues.
2. Lack of an integrated administrative system and inter-institutional coordination on climate matters.
3. Inadequate financial resources to fulfill regional and international commitments.
4. Absence of clear regulations defining roles in climate change committees and involvement of relevant parties.
5. Insufficient coordination between the climate change committee, public entities, and within entities.
6. Limited understanding of the significance of negotiations and roles of national climate committees.
7. Restricted comprehension of the scientific and technical requirements for the committee's operations.
8. Inconsistency in supervisory responsibilities for climate change management across different entities.
9. Suboptimal engagement and commitment from some officials in addressing climate change.

2. KEY CHALLENGES: ENVIRONMENT, CLIMATE CHANGE, AND HUMAN MOBILITY

In Libya, there is strong evidence linking migration to the environment and climate change, and negative environmental and climate developments will continue to be a direct cause of forced migration and displacement. This forced migration related to the environment and climate change will push migrants to make great efforts to adapt to new conditions that they may not know much about. For example, sudden and rapid onset events, as in the case of floods, storms and severe storms drive many to move quickly in search of safe places and better conditions. In Libya, sudden floods and severe dust storms that lead to the encroachment of sand, have often catalyzed mobility decisions. In 2019, floods occurred due to a severe rainstorm in the areas of Ghat and Mrzq. More recently, a devastating flood hit the coastal city of Derna in September 2023. In both cases, these sudden climatic conditions caused the loss of lives and livelihood and large-scale displacements (OCHA, 2019a),(OCHA, 2023).

2.1 Strategic, Political, Social, and Environmental Drivers of Migration to Libya

Over the years, migration in Libya has become a growing and continuous phenomenon, influenced by the following range of factors (Aboksheem, Gazali, and Morgoni 2014), (Abozyed 2019), (Al-Hawat 2007),(Aboksheem 2018).

1. Libya's geographical positioning, in close proximity to the coasts of Italy and Malta, plays a significant role in its status as a transit point for migration flows towards Europe. Challenges with maintaining control over borders have been further complicated by the current security dynamics within the country. Additionally, there is an observed need for strengthening institutional capacities to effectively manage migration. This includes the development and enforcement of comprehensive migration regulations, the protection of migrants' rights, and their integration into the legal framework in a manner that is consistent with international standards and practices. Factors such as economic constraints, limited employment opportunities, and challenging living conditions are identified as key elements influencing migration trends. These conditions often lead individuals to explore opportunities for improved living standards and stability in different locations.
2. Developmental challenges and the dynamics of population growth can create circumstances where individuals or communities seek environments that offer better prospects for personal and familial development.
3. Political representation and participation, as well as the pursuit of political rights partially influence migration patterns.

Challenges related to administrative efficiency and governance can motivate people to migrate in search of systems that offer more stability and transparency. The evolving environmental landscape, characterized by changes in climate and natural conditions, has been a factor in people's decisions to relocate in search of more stable and hospitable environments. Furthermore, rapid changes in environmental conditions have necessitated adaptation and resilience strategies.

In general, the dynamics of displacement in Libya can be categorized in three phases: The first phase, which is the largest, was in 2011, and included all the western, central and southern regions, The second was in the year during the years 2012 to 2014, and the eastern regions of Libya were affected more than other regions. The third: mid-2014 to the beginning of 2016, and included areas in the east, center, west and south of the country. The period from 2016 to 2020 witnessed a stabilization in the number of displaced people, followed by a significant decline and improvement in the displacement situation since the beginning of 2022. These decreases coincided with the improvement of the security situation, which helped the continued return of the displaced to their areas of origin, as well as peacebuilding efforts and national reconciliation initiatives gaining momentum among Libyans, with the support and encouragement of the international community.

Studies indicate that most migrants to Libya, particularly from African countries, are gathered at meeting points within each country. Smuggling networks transport them by bus to coastal cities. From there, their transportation continues across the Mediterranean to the coasts of Malta and Italy (Omer, 2022; Qassim, 2018). Zwara, located on the far western coast of the country, is considered one of the most suitable places for these operations, as its coasts are no more than 150 nautical miles from the Italian coasts in a journey that takes approximately one day. Migrants heading to Libya through the desert face significant security and life-threatening challenges – i.e., food and water scarcity, insecurity, and crime. Additionally, some migrants from Libya are exposed to the dangers of drowning in the Mediterranean Sea (Aboksheem 2018; Omer, 2022).

Data and statistics on migration indicate that Libya is a destination for migrants from neighboring Arab and African countries, in smaller numbers compared to those from the Middle East and Southeast Asia. According to the IOM, the number of migrants in Libya as of April 2023 reached 705,746, spread across 100 municipalities and 639 Libyan regions. Western Libyan municipalities absorb the highest proportion of migrants at 55%, followed by the eastern regions with 33%, and the southern regions with 12%, (IOM, 2023a). This distribution is attributed to the availability of employment opportunities in both the western and eastern regions and their proximity to the Mediterranean, which are attractive factors for migrants seeking to settle in Libya or continue their journey to Europe. Conversely, living conditions in Libya's southern regions and the harsh desert environment, coupled with challenging climatic conditions, discourage migrants from settling and remaining there. Migrants in Libya are distributed among the regions as shown in (Table 3).

Table 3. Distribution of Migrants by Cities

REGION	NUMBER OF MIGRANTS	% BY REGION	REGION	NUMBER OF MIGRANTS	% BY REGION
Tripoli	111,516	14	Sabha	21,820	3
Bengazi	84,513	12	Al jabel Al Akhdar	19,600	3
Misrata	71,750	10	Derna	19,285	3
Ajdabiya	57,850	8	Alkofra	18,960	3
Alzawya	45,080	6	Wadi Alshati	14,633	2
Almrgeb	42,182	6	Ubari	13,550	2
Aljfara	41,885	6	Almarj	13,010	2
Zwara	28,361	4	Sirt	12,350	2
Al Jabel Algarbi	26,552	4	Aljufra	10,950	2
Murzq	22,710	3	Nalut	3,920	1
Tobruk	21,914	3	Ghat	3,355	<1
Total: 705,746					

The distribution statistic of migrants in Libya by gender indicate that males are the largest by about 78% of the total migrants, while females constitute 11%, and children account for the remaining 11%, including 7% accompanied by their mothers and 4% unaccompanied, approximately 50% of migrants come from Sub-Saharan Africa, 42% from North African countries, and the remaining 8% from Middle Eastern and Asian nations. The top origin countries of migrants in Libya are as follows: Niger with 172,907 migrants, Egypt with 160,163 migrants, Sudan with 131,207 migrants, Chad with 84,989 migrants, and other countries contributing smaller numbers, ranging from 5% to 0.2% of Libya's total migrant population (IOM, 2023a).

The (IOM) monitors migrant movements in 14 municipalities and 8 regions across Libya. Key transit points include Tajora in western Greater Tripoli, a significant gathering area with stable migrant numbers, and Sabratha in the south, which recently saw a slight decrease in migrants. Bent Bayh in southern Libya also maintained stable migrant numbers. However, eastern regions like Tobruk and Ajdabiya, west of Benghazi, have experienced increases in migrant numbers, indicating shifting patterns and concentrations in migrant flows across the country (IOM, 2023a).

2.2 Internal Migration and Displacement Due to Environmental Effects and Climate Change

Environmental effects and climate change in Libya constitute a significant and direct challenge, particularly in recent decades, leading to displacement and migration. Libya is vulnerable to many environmental impacts and climate change factors, including extreme weather events and slow-onset events, such as high temperatures, low rainfall, sudden monsoon floods, increased droughts, sandstorms, high evaporation rates, as well as other environmental consequences such as desertification, land degradation and water scarcity. All of these factors have significant implications for people's lives, livelihoods, resilience and survival. In many cases, under the pressure of extreme climatic and environmental conditions, people in affected areas are forced to leave their areas in search of safety and livelihoods, and forced movement and displacement are a mandatory option for many who find themselves facing the challenges of survival, driven by the search for safety and more adequate shelter (Omer, 2022).

In Libya, assessing the precise number of migrations attributed to climate change and environmental degradation is challenging due to data limitations. However, such migrations are occurring, driven by factors like floods, droughts, desertification, and water scarcity. These environmental and climatic changes, including extreme temperatures, drying conditions, and sea-level rise, often prompt migration and displacement. Additionally, climate change can intensify resource competition, impact employment, and reduce resource access, influencing migration patterns that are distinct from, though nevertheless intertwined with, those driven by other motivations. (IOM 2022).

2.3 Mobility in the Context of Implementation Challenges with Environmental Plans and Policies

Despite the increasing evidence and indicators that environmental degradation and climate change have a negative impact on various aspects of life, livelihoods, stability, resilience, migration, and displacement, the response remains underdeveloped along several axes.

Environment deterioration and climate changes effects everyone without exception, but certain groups are more vulnerable to their interactions, including women, children, and those in need. This vulnerability is due to the difficulty of earning a livelihood, reduced opportunities for employment, especially in desert and remote areas (UN Women, 2022). Furthermore, the challenge of accessing healthcare, protection, and clean drinking

water adds to the complexities. Consequently, migration and displacement become adaptive strategies that individuals resort to in order to cope with the changes and impacts they face.

In this context, Libya collaborates with the international community, including key organizations like IOM, to adapt and respond to emergencies and environmental events, such as floods and droughts, that drive migration and displacement due to both human factors and climate change. However, national and local policies and programs require strengthening to address the effects of environmental degradation and climate change and the ways in which it acts as a contributing factor to migration and displacement, especially in the face of high living costs and severe economic challenges. Underdeveloped policies and inconsistent implementation can compound the negative effects of environmental degradation and climate change. This can lead to conflicts over natural resources and means of livelihood, which further undermine stability (Kok et al. 2007).

2.4 Countries of immigration and transit mechanisms

Migrants travelling to Libya use various modes of transport, including by land and air, and can cross on foot. However, those crossing the Mediterranean route to European countries rely primarily on small-sized naval vessels as well as rubber boats. according to data from the IOM, the total number of migrants heading to Malta and Italy in the current year, 2023, reached 48,051. Arrivals to Italy and Malta numbered 42,293, while 4,819 migrants were intercepted and returned to Libya, and 939 migrants lost their lives at sea during these journeys(IOM, 2023c).

In terms of migration flows to Libya, approximately 66% of immigrants come from North African countries, with fewer numbers from Asia, especially Bangladesh and Syria. approximately 50% of migrants come from Sub-Saharan Africa, 42% from North African countries, and the remaining 8% from Middle Eastern and Asian nations, noting that Syria was formed about 5% of this group by 25,887 migrates. The top origin countries of migrants in Libya are, Niger with 172,907 migrants, Egypt with 160,163 migrants, Sudan with 131,207 migrants, Chad with 84,989 migrants, and other countries contributing smaller numbers, ranging from 5% to 0.2% of Libya's total migrant population (IOM, 2023c). Around 12% of African immigrants settle in southern regions, while the rest are dispersed in western and eastern coastal areas, with smaller numbers in central regions. Meanwhile, most immigrants from the Middle East and North Asia tend to be drawn to coastal areas,

As of last April 2023, the DTS revealed that, the total number of migrants arriving to Libya through various routes is approximately 705,746, distributed across 100 municipalities and 639 regions in Libya. Municipalities in Western Libya accommodate the highest percentage of migrants at 55%, followed by Eastern regions at 33%, and Southern regions at 12%. This distribution is attributed to the availability of employment opportunities in both the western and eastern regions and their proximity to the Mediterranean, which are attractive factors for migrants seeking to settle in Libya or those aiming to continue their journey to Europe, pending favorable conditions for migration. Conversely, living conditions in Libya's southern regions and the harsh desert environment, coupled with challenging climatic conditions, discourage migrants from settling and remaining there. Migrants distributed in the northern regions from the city of Zwara in the far west to Tobruk in the far east, passing through central coastal areas, and until April 2023. The distribution statistic of migrants in Libya by gender indicate that males are the largest by about 78% of the total migrants, while females constitute 11%, and children account for the remaining 11%, including 7% accompanied by their mothers and 4% unaccompanied, (IOM, 2023c).

3. KEY CHALLENGES: LIBYA AND CLIMATE CHANGE

3.1 Overview of Climate Change Indicators

According to IPCC reports (IPCC, 2023), North African countries like Libya are highly vulnerable to climate change impacts, affecting lifestyles, living standards, migration, and displacement. Factors including temperature rises, solar radiation, heatwaves, droughts, changing rainfall patterns, storms, and high evaporation rates are notably impacting northern, central, and southern regions of Libya.

Recent years have witnessed the increased intensity and frequency of extreme weather events as well as advancement of slow-onset events. In a related context, based on the results of the assessment report on climate change risk in the Mediterranean countries (UNEP, 2018), there is strong evidence to suggest that the countries of the Mediterranean basin, including Libya, are suffering from the effects of climate change manifested in extreme weather events and other environmental challenges and their associated negative impacts on livelihoods, stability, resilience, mobility, displacement, service sectors, food and water availability, etc. It is also vulnerable to future developments in sudden and slow climatic factors due to the expected rise in average annual temperatures on both land and sea across the Mediterranean basin, which is expected to increase by up to 1.5°C compared to pre-industrial levels.

Drawing on nationally scientific studies and international reports, there is compelling evidence that Libya is facing the effects of climate change, additionally, several climate scenarios have projected a significant decrease in precipitation in Libya by up to 40%, and an increase in climate extremes such as flash floods and exceptionally high heatwaves in terms of severity and frequency. These changes involve significant alterations in other climate factors like air pressure patterns and associated elements and require response systems that operate both in terms of time and location (UNEP, 2018). For example, salinity changes, heat waves, floods and severe storms have become more frequent over the years, as evidenced by the drying up of the Wadi-Kaam Dam Lake in 2021.(UNEP, 2018), the devastating floods that occurred in both Ghat and Mrzq during the year 2019, and the recent flooding of the Wadi Derna Dam.

Adequate and precise monitoring, continuous and direct tracking of developments occurring in both slow and sudden climate phenomena are still needed. Furthermore, rapid response and adaptation capabilities for the multiple impacts that exert pressure also require strengthening. More studies and data collection efforts are needed related to the examination and evaluation of the environmental situation in the country.

The climate in Libya is experiencing significant changes: 1) Increasing temperature extremes, with higher summer heat and more intense cold in winter, particularly in mountainous and central regions, 2) heightened occurrences of extreme weather events like dust and sandstorms, rainstorms, and droughts, impacting different regions variably, and 3) coastal areas face rising sea levels and erosion, alongside a general decrease in annual rainfall and the number of rainy days, affecting the entire country. These changes are accompanied by an increase in solar brightness and Mediterranean storms, and a potential rise in whirlpools and water flares along the Libyan coasts (Gremida et al. 2022),(UNEP, 2018), (El-Baroni 2015). Each will be covered in turn in the following sections.

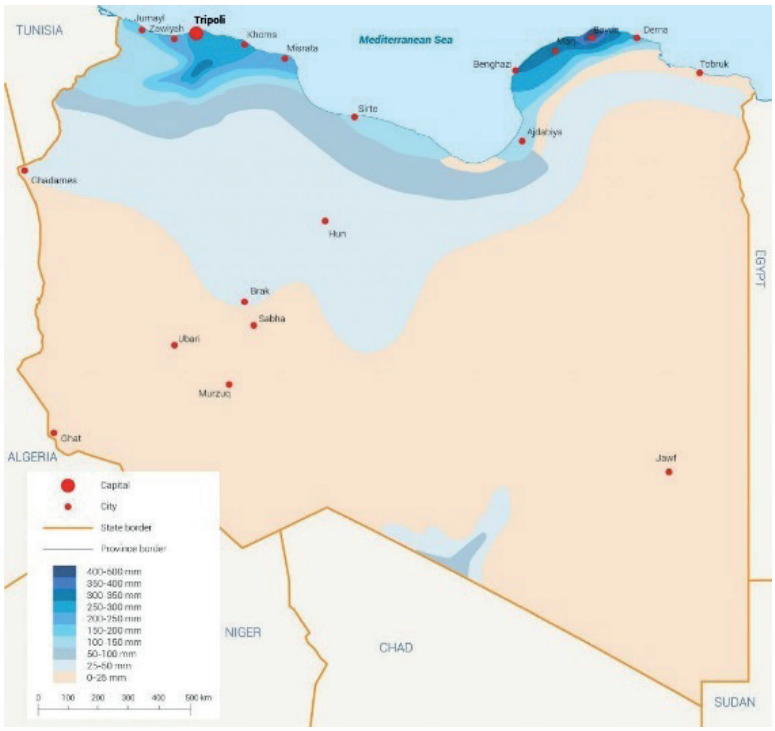
3.2 Sudden Onset Events and Their Effects on Human Mobility Patterns

3.2.1 Rainfall and Storms

Libya experiences a rainy season from September to May, with the peak in December and January. Rainfall is unevenly distributed, being highest in the northeast (265-550 mm/year) and much lower in central and southern regions, with the far south receiving almost no rain, (Figure 3). On average, Libya receives about 43 billion cubic meters of rain annually, but there has been a steady decline in rainfall, averaging a 13% decrease since 1901, with the periods from 2001-2010 and 2011-2020 being particularly dry(El-Baroni, 2022a), the northwest regions receive an annual average of 400 mm, making them with north east regions the most rain-prone areas in Libya with averages ranging from 100 mm in central regions Until it is completely absent in the far south where the Sahara desert, This harsh distribution of precipitation makes the area receiving rainfall not exceed 8% of the total country's area. (Zekry, 2005).

Rainfall variability significantly impacts Libyan agriculture, pastoral activities, and groundwater replenishment, which are vital for the country's water supply and population's standard of living. The declining and irregular rainfall patterns pose a threat to these critical resources and activities, potentially affecting the overall quality of life and sustainability in Libya.

Figure 2. Annual average Rainfall (Sadeg, et al. 2023)



3.2.2 Floods

Flooding typically accompanies rainy seasons characterized by heavy rainstorms, leading to surface runoff in wadis and inundating low-lying areas and cultivated fields the plains. Furthermore, they inundate cities, while also causing road closures, particularly when the infrastructure is inadequate and drainage systems are insufficient.

Libya experiences seasonal floods, which are often numerous and limited in impact. However, in recent decades, floods have become more frequent, recurrent, and impactful, primarily due to the increasing occurrence of Mediterranean rainstorms resulting from climate change-related weather extremes. The impact of floods in recent years has been further amplified by the growing population density in cities, urban expansion, and agricultural sprawl. In the flood records, there are more than 26 impactful floods occurred during the period from 1961 to 2010, in addition to four floods in the last decade in 2014, 2018, 2019 and 2023. In 2014, floods hit the northwestern regions of the country due to a severe rainstorm in the Mediterranean, it did not result in significant damage in terms of lives, its impact was limited, affecting primarily property and infrastructure (El-Baroni, 2022a). In the year 2019 witnessed a devastating flood in the city of Ghat in the southwestern part of Libya, causing the death of 4 people(El-Mohajr 2019), along with losses in livestock and more than 4.000 people is displaced, and property damage affecting more than 20,000 residents (OCHA, 2019b). In the same year, 2018, floods affected parts of the northwestern regions for similar reasons, although they did not cause human casualties or displacement. Nevertheless, they submerged some cities, including the capital, Tripoli, and its suburbs, disrupted road traffic, and had impacts on the affected areas for several days.

Finally, during this year in 2023, a devastating flood hit the port city of Derna in the northeastern part of the country due to a Mediterranean storm. This flood is the largest disaster resulting from devastating floods in the history of the country, both in terms of loss of life and damage to property, according to (World Bank, 2023), the heavy rainfall resulting from Hurricane Daniel in 2023 led to the collapse of two dams, resulting in the death of over 4,000 people , and more than 9,000 missing until October 2023 (OCHA, 2023). The storm caused significant damage to more than 884,000 people in five districts, namely Derna, Al-Beyda, Sousse, Al-Marj, Shahat, Taknes, Batta, Tomina, Brsis, Tokra and Al-Abyar. (OCHA, 2023), according to DTM statistics the number of displaced people from the city reached 40,018 in September and increased to 43,421 by October 13, 2023. Some 410 families were reportedly displaced from Al Beyda city, and more than 1,000 were displaced from the Al Mkhali area (IOM, 2023b).

3.2.3 Sand and Dust storms

Libya is prone to sand and dust storms, primarily influenced by its extreme temperature variations and active wind conditions in conjunction with the country's sandy soils. About 90% of the year experiences varying wind speeds, often leading to sandstorms, especially from southern winds. These storms cause significant disruptions, including flight delays, traffic accidents, and damage to infrastructure, agriculture, and ecosystems. The central and southern regions are most affected, with dust concentrations in some areas reaching extremely high levels, severely impacting air quality and visibility (Eddenjal 2015). Sand and dust storms are more frequent in the spring season and, when desert dust reaches high concentrations, horizontal visibility, air quality and public health are negatively affected. Resulting sand encroachment poses significant health and environmental risks, as well as destroys crops, kills livestock, and affects ecological systems in the aggregate (Eddenjal 2015).

The intensity and frequency of these storms are exacerbated by climate change. Studies show a link between severe sandstorms and wind speeds exceeding 17.5 knots, with southern Gibli winds being predominant. Additionally, climate change is causing variations in wind patterns, with increased wind speeds in many regions. This lack of predictability, coupled with insufficient monitoring infrastructure, makes managing these storms challenging (Balag and Ali blqasim 2021). More is needed in terms of measurement infrastructure as there remains a gap in specialized data and studies.

Sandstorms occur throughout the year, but they intensify during the spring and autumn seasons, with peak activity typically observed in the months of February and June each year. In the summer, these storms are relatively stable and occur mainly within the circulation of air currents that carry dust vertically into the upper atmospheric layers. During the winter season, the occurrence of sandstorms is significantly reduced. Generally,

sandstorms are less active and less frequent in the northeastern areas and around the Green Mountain, while they are more prevalent and recurrent in the northwestern regions. The highest and most intense sand and dust storms occur in the central and southern regions of the country (Zekry, 2005).

Sand and dust storms are among the extreme weather phenomena that affect Libya, along with heat waves, sudden torrential rains, and fog. These storms are often caused by strong monsoon winds that pick up dry, exposed particles of dust from the ground and carry them through the atmosphere for many kilometers, sometimes even reaching other countries and continents. The dust from the Sahara Desert travels as far as the Caribbean on journeys that can take several days, carrying approximately 60 million tons of dust particles (Ibrahim 2023).

3.3 Slow Onset: Events and Their Effects on Human Mobility Patterns

The IPCC expects climate change to increase displacement, and as noted previously, this is already a reality in Libya. On a global scale, including North African countries, including Libya, between 2008 and 2020, droughts and extreme temperatures caused more than 3.5 million new displacements, and planned relocations of entire communities due to slow-onset degradation are already taking place in over 60 countries and territories (IPCC 2020). Slow climate phenomena represent crucial aspects in understanding the impacts of climate change on displacement and migration. These phenomena can be significant factors in migration and displacement decisions, as rising temperatures, dust storms, reduced rainfall, drought, and rising sea levels all create harsh environmental conditions. These conditions negatively affect agriculture, grazing, soil fertility, result in water scarcity, and limit employment opportunities. Additionally, they impact people's ability to withstand continuous deterioration in natural and economic resources, leading to a loss of traditional livelihoods. This weakens resilience, forcing individuals to seek alternatives, with migration becoming an available means to adapt to the effects of climate change.

3.3.1 Temperature Increases and Heat Waves

Libya frequently experiences severe heatwaves, especially during the summer months, with temperatures often exceeding annual averages. Between 1982 and 2021, 94 severe heatwaves were recorded, predominantly in June, July, and August, and less frequently in October, April, and May. Temperatures during these heatwaves can reach 40-44°C, especially in the central and southern regions. The extent of temperature extremes in coastal regions can reach up to 5.1°C above the annual averages, with pronounced extremes in the central and southern regions (Al-Muzogi 2020). Furthermore, several studies related to heatwaves and thermal domes in Libya indicate that, the country is consistently exposed to scorching and exhausting hot weather due to its susceptibility to atmospheric high-pressure systems(Al-Shebani 2022).

The increasing frequency and intensity of heatwaves in Libya are widely demonstrated and directly associated with climate change, causing significant health and environmental impacts (Abdulmajid 2022),(Sleem 2016), (Abogrsa 2014), (Otman, Abrahim, and Alshrif 2023), (Al-Muzogi 2020). Studies also suggest that there is an increasing trend of the annual and seasonal temperature variations in Libya, along with longer durations of heatwaves over time, resulting in escalating environmental and health impacts. For example, high temperatures and relative humidity contribute to various health issues, including sunstroke, allergic diseases, and respiratory problems. The National Center of Meteorology reports that temperatures in the southeastern, western, and southern regions, influenced by the Sahara Desert, are particularly susceptible to these increases(NMC, 2020). Additionally, studies indicate that Libya's exposure to atmospheric high-pressure systems and the Omega block pattern intensifies these heatwaves, leading to longer durations and escalating impacts over time (Al-Shebani 2022).

During late spring and early summer, Libya experiences severe heatwaves, locally known for the hot southerly winds called "Ghibli." These winds result from the formation of a thermal low-pressure system over the southeast region of Algeria and above the Red Hamada. This system causes the arrival of intensely hot continental tropical air, moving slowly from west to east, leading to significant temperature increases throughout the country, including coastal cities. Temperatures often exceed 40 degrees Celsius for extended periods. Under such scorching conditions, Libya recorded the highest temperature on Earth in September 1922, reaching 58 degrees Celsius in the shade in the region of Al Aziziya, located to the west of the country. This area is approximately 45 kilometers from the coast and situated at an elevation of 120 meters above sea level (Zekry, 2005).

3.3.2 Drought

Droughts in Libya, primarily influenced by climatic conditions, vary across regions and months. The western part of the country experiences the most frequent droughts, linked to fluctuations in temperature, humidity, and seasonal rainfall(Al-Wahsh and Ahseen 2020). Historically, Libya, an arid to semi-arid region, has undergone severe drought phases, with notable dry periods recorded between 1901 and 2021. The country's climate is characterized by alternating wet and dry periods, with some dry spells lasting up to five years (El-Baroni, 2022a).

Climate change exacerbates the drought situation in Libya, posing serious threats to development and food security. Drought affects water resources, arable lands, crops, and livestock, leading to decreased yields and complete loss of water-sensitive plants(Masaoud 2022). Recurrent droughts, constituting about 85% of climatic disasters in Libya, have caused severe damage and forced population displacement, particularly among farmers and pastoralists(El-habti 2017). The years 2009 and 2010 were among the driest in recent decades, with droughts lasting up to eight consecutive years in some cases, illustrating the significant impact of these events on the country. The last ten years are considered among the driest in the country's history since 1901(Abofayed 2015).

3.3.3 Desertification

Desertification in Libya is significant and expanding, affecting 24-35% of highland areas and around 80% of pastureland s(Elgasas 2020) This is due to extreme climatic conditions like high temperatures, low rainfall, and increased wind speed, along with human activities such as overgrazing and improper land use (e.g., intentional burning, charcoal production) (Gremida et al. 2022). Wind erosion and drifting due to floods, as well as urban expansion are also contributing to the loss of Libya's forests. These factors have led to severe land degradation, particularly in agricultural and pastoral regions.

Factors such as drought, hot winds, high temperatures, and increased evaporation rates, coupled with human-induced causes like deforestation, forest fires, and overgrazing, are accelerating the processes of desertification in Libya. This is particularly acute in the fertile agricultural zones along the western, central, and eastern coasts and the impacts are most pronounced in the autumn season(Farkash, Alzobaidy, and Mohamed 2007). Desertification not only degrades land but also leads to the loss of flora, fauna, and exacerbates harsh environmental conditions (Al-Hshani 2020).

3.3.4 Water Scarcity

Libya faces severe water scarcity, ranking among the most water-stressed countries globally. The nation relies heavily on groundwater, which provides about 97% of its water needs, yet faces a significant annual deficit (Emhanna and Edris 2021). The Man-Made River, constructed in 1983, supplies approximately 70% of water to

coastal regions, with the remainder sourced from artesian wells, desalination plants, and treated wastewater used for agriculture. The country's water distribution is primarily from six major aquifers, Table 6, with the Kufra, Sareer, and Murzq basins being crucial for the Man-Made River system (Alfutasi 2015).

Despite a total annual rainwater potential of about 45 billion cubic meters, the per capita water availability is alarmingly low, exacerbating due to population growth and agricultural demands (El-Baroni, 2022b). Historically, over extended periods of time, the scarcity of water has been a catalyst for migration and movement, particularly for nomadic pastoralists who are compelled to seek water sources for their livestock and themselves (Mrsaal 2020)., and recent environmental changes and armed conflicts have intensified this trend – e.g., armed conflicts have interrupted the water supply to the Man-made River pipelines, which transport water to the northern cities, cutting off the water for several weeks (UNICEF 2019). Disruptions in the water supply, particularly to the Man-Made River system, aggravate the situation, especially affecting vulnerable populations. Such conflicts also impact the infrastructure for oil and gas extraction, essential for powering water supply systems like desalination plants and wells, and can result in power outages in areas reliant on river water, artesian wells, and desalination plants. Additionally, environmental and climatic conditions often forced herders to relocate their livestock in search of water.

Urban water consumption, though smaller than agricultural use, is significantly higher in cities than in rural areas, and this has seen a steady rise over recent years. Major cities like Tripoli and Benghazi show increasing per capita water needs. Domestic use accounts for 12.4% of total water use, with industry using about 3.8%, predominantly in the oil sector(El-Baroni 2015).

The water situation in Libya, as indicated by the data in (Table 5), shows that there is a high demand for water in the fields of agriculture, drinking, and industry, far exceeding the available quantities of water. The water deficit reached its maximum in 1990 at a rate of 688%, decreasing to 146% in the year 2000 due to the utilization of the Man-Made River water. However, this deficit has been continuously rising in recent years due to population growth, increased demand, and consumption. It is expected to reach 206% by the year 2025 (Zekry, 2005).

Table 4. Water Situation in Libya 2000 - 2025 (Zekry, 2005).

YEAR	1990	2000	2010	2020	2025
USED WATER	4757	5579	6576	7784	8965
AVAILABLE WATER	604	2269	2881	2914	2934
WATER SHORTAGE	4153	3310	3695	4870	6031

Long-term studies by the Man-Made River Project suggest that aquifer depletion rates are currently manageable, but concerns remain over water quality. Coastal aquifers are contaminated with seawater intrusion, and groundwater near oil fields is polluted, impacting the ecosystem and agriculture (e.g., the destruction of citrus and fruit trees) (UNICEF 2019).

The relationship between climate change and water scarcity in Libya is complex and deeply intertwined. Environmental changes and increasing temperatures contribute to higher water consumption, particularly in the agricultural sector, which has seen a steady rise over the years. Water pollution, driven by factors such as seawater intrusion and industrial waste, degrades the quality of available water, affecting both the ecosystem and agricultural productivity (Sadeg, et al. 2023).

These challenges are compounded by the management and financial constraints faced by the key institutions responsible for water supply and management: the Great Man-Made River Project Execution and Management

Agency, the General Desalination Company, and the General Water and Sanitation Company experience capacity challenges in meeting the quantitative and qualitative needs of consumers. A summary of these challenges can be found below (UNICEF 2019):

1. Great Man-Made River Project Challenges:
    - Damage from armed conflict and legal non-compliance.
    - Financial issues, including decreased resources and difficulty in opening letters of credit.
    - Inability to collect revenue from water sales.
    - Power outages and fuel shortages.
    - Continuous maintenance needs of the project's infrastructure, hampered by funding shortfalls.
    - Difficulty in protecting widely distributed infrastructure in remote areas.
    - Challenges in replacing or procuring unique, project-specific components.
    - Corrosion in concrete conduits due to damage to the protection system and component theft.
    - Lack of technical assistance following the departure of specialized foreign entities since 2011.
2. General Company for Seawater Desalination Challenges:
    - Operational and maintenance supply shortages due to revenue deficits.
    - Difficulty in opening letters of credit for imports amid hard currency scarcity and high exchange rates.
    - Frequent power outages and fuel shortages.
    - Reluctance of foreign firms and experts to provide technical assistance in Libya.
    - Absence of infrastructure for transporting water from desalination plants.
    - Aging desalination stations needing refurbishment, leading to operational issues.
3. Challenges of the Water and Sanitation Company:
    - Impacts of armed conflict, including damages and general insecurity.
    - Operation across a vast geographical area with limited resources.
    - Outdated, poorly maintained infrastructure resulting in weak maintenance programs.
    - Oversized staff, some lacking specialized skills.
    - Insufficient revenue for necessary operations.
    - Accumulated debts to water suppliers like the Man-Made River Project and General Desalination Company.
    - Unstable power and fuel supplies.
    - Overall financial instability and lack of training and qualifications.
    - Low pricing of desalinated water, not covering high desalination costs.
    - Illegal connections on water transmission lines, exceeding their capacity without expansion.

Taken together, these critical challenges within the country's water sector represent a major threat to its populace, severely disrupting daily life and hindering developmental progress. These issues compromise the nation's growth potential and undermine key pillars of stability and resilience, such as access to food and water, employment opportunities, and the prospects for a future that guarantees a life of dignity.

3.3.5 Sea Level Rise

Sea level rise poses a significant global threat, with particular risks to the Mediterranean Sea, including the Libyan coast. The IPCC warns of increasing vulnerability in these areas, leading to potentially devastating environmental and societal impacts(IPCC 2020). In Libya, rising sea levels are expected to cause catastrophic environmental consequences, such as coastal erosion, leading to the potential displacement of populations, threats to urban infrastructure, water supplies, and livelihoods. By 2100, Libyan coasts could be substantially submerged due to current global warming trends, with a 0.2 cm sea level rise severely impacting low-lying areas. Approximately 11% of Libya's coastlines are at risk of erosion, potentially resulting in the loss of 3.2 to 12.8 km^2 of land(Westley et al. 2023).

A specific study on Benghazi Plain, a vulnerable low-lying area, indicates a steady increase in sea levels, accelerating from an average rise of 1.7 mm annually (1901-2006) to 3.3 mm annually (2006-2018). By 2100, sea levels could rise by up to 1.01 meters. This rise is expected to cause significant coastal erosion, inundating about 5,192 hectares (4% of the city's area) of Benghazi. The impact would affect buildings, roads, and farmlands, leading to issues like seawater intrusion, groundwater contamination, soil salinization, and reduced agricultural productivity. Consequently, these adverse effects on ecological and living systems may force population migrations and displacements (Brebish and Ali Othman 2023).

3.3.6 Land Degradation

As noted previously, the effects of climate change and water scarcity significantly impact agricultural land use in Libya, adversely affecting both the quantity and quality of arable land. The majority of Libya's cultivable land, located in coastal regions like the Jfara and Benghazi Plains and the Green Mountain, is experiencing a reduction due to factors such as water scarcity, decreased rainfall, heightened drought conditions, rising temperatures, and elevated evaporation rates. These conditions particularly affect high-altitude farming areas known for fruit trees and grains (Elalam, Ben Amara, and Edribika 2017).

The agricultural sector, involving both public and private entities, is facing challenges. The private sector, which contributes around 380,000 hectares to grain cultivation reliant on rainfall, is particularly affected. Studies have shown a worrying trend of chemical soil degradation across various depths, with widespread salinity issues leading to increased desertification and rendering land unproductive (Sheba, Aboazom, and Almtnani 2019).

Furthermore, the adverse effects of climate change and environmental degradation are diminishing the suitability of land for agriculture. Rainfed crops struggle to cope with the challenges posed by higher temperatures, more frequent droughts, sand encroachment, dust storms, and water scarcity. These factors contribute to the decline in vegetation cover and the increasing unsuitability and salinization of the soil. Research from 1978 to 2015 indicates a consistent shrinkage of agricultural land due to these environmental stressors. Soil salinity, a major driver of desertification, negatively impacts the quantity and quality of agricultural crops, leading to a continuous decline in arable land (Elalam, et al. 2017).

3.3.7 Pasturelands

Pasturelands are crucial in Libya, especially for livestock needs, a key livelihood in central, eastern, and southern regions. Covering 13-15 million hectares, these lands vary in vegetation quality, with 1-4% to 4-15% having poor to very poor vegetation. Water availability and climatic factors significantly influence pastureland expansion and productivity. The annual productivity north of the 50mm isohyet fulfills only 16% of the livestock feed requirements in Libya. This results in a substantial deficit equivalent to 55% of the actual feed requirements, often necessitating external imports to meet shortfalls, particularly during holiday seasons (Mahmoud, Alhendawi, and Russe 2012). The 2019 statistics from the Ministry of Agriculture and Animal Wealth report significant numbers of sheep, goats, cows, and camels, totaling 24,513 breeders.

Climate change severely impacts Libyan pasturelands, already affected by a reduction in grazing areas due to water scarcity and other climatic factors. Adverse weather conditions like low rainfall, heatwaves, hot gusty winds, dust storms, and drought, coupled with overgrazing and deforestation, detrimentally affect these pastures and herders. Decreased rainfall below 50 mm leads to weakened vegetation cover, desiccating wild trees, and causing the disappearance of many plants. While fertile pastures can support a range of livestock, from cows to gazelles and sheep, camels often inhabit the poorest pastures. The acceleration of climate change will widen the gap between actual livestock needs and pasture productivity, leading to reduced rangeland areas, vegetation degradation, decreased productivity, and land deterioration (Ahmemmed 2022).

3.3.8 Vegetation

The vegetation cover in Libya encompasses various species, varying in density based on environmental, climatic, and natural conditions. Three patterns of vegetation cover are evident in the country. The first pattern is found in the coastal strip along the sea, representing the northeastern areas and the Green Mountain in the northeast, extending from Misratah to the Tunisian border in the west, including the elevated parts of the Western Mountain. In these regions, suitable soil for agriculture, favorable climatic conditions, and sufficient rainfall supports perennial green plants, forests, and trees. The second pattern of vegetation cover appears in areas south of the Green Mountain in the east and regions south of the Western Mountain, in addition to the coastal area extending from Sirte in the central coastal strip to Benghazi in the east. These areas do not feature perennial green plants or dense grass but instead host seasonal, lightweight plants suitable for grazing. The third pattern of vegetation cover is evident in the desert regions, which constitute the largest part of Libyan territory. Some scattered desert plants form in certain areas, while vegetation is entirely absent in vast stretches of the extensive desert, characterized by harsh environmental and climatic conditions. These regions are largely barren, covered with sand dunes and arid desert, where rainfall is entirely absent (Zekry, 2005).

Libya's vegetation cover, constituting less than 11% of its total land area, is diverse but limited. The majority of the land is arid, with features like deserts, sand dunes, and salt flats, especially prevalent in the central and southern regions. Vegetation is more common in the north, where conditions are less harsh. The vegetation mainly includes grasses, shrubs, forested trees, and cultivated areas, with the latter primarily located in the northwest and east. These cultivated zones account for about 29% of Libya's total vegetation cover, whereas rain-fed agriculture occupies the majority of the land (Elalam, et al. 2017).

Climate change and human activities are causing a significant decline in Libya's vegetation cover, particularly in the western, southern, and eastern regions. Key factors contributing to this decline include drought, extreme temperatures, urban expansion, overgrazing, deforestation, pollution, overfishing, and soil salinity (EPU, 2010). The decline has been severe, with substantial reductions in forest land and pastures. This loss of vegetation contributes to desertification, which in turn reduces soil fertility, crop and livestock yields, and plant biodiversity. The resulting environmental degradation is forcing rural populations to migrate to urban areas, impacting the national economy and the livelihoods of those dependent on agriculture and pastoral activities (Abdu Salam et al. 2016).

3.3.9 Biodiversity

Libya's biodiversity, while diverse, faces severe challenges due to environmental degradation. The country is home to around 1,750 plant species across 744 genera and 118 families, and a significant number of animal species, including vertebrates and invertebrates (AL-Ahreer 2014). Vascular plants constitute about 75% of Libya's biodiversity, with 50 species identified as rare and endangered. The animal biodiversity includes over 4,000 species of invertebrates, a variety of fish, amphibians, reptiles, mammals, and a rich diversity of bird species. However, land degradation, desertification, and drought, along with soil destruction, pollution, and encroachment on protected areas, are major threats that have led to the loss of natural species and increased the risk of extinction (Elalam, et al. 2017).

Climate change has amplified the effects of the harsh environmental conditions and contributed to species loss. The increasing severity of weather conditions, coupled with human-induced factors like soil and water pollution, poses critical threats to biodiversity. These changes have led to a decline in the survival of many species (Elalam, et al. 2017), highlighting the urgent need for conservation and sustainable management to protect the country's natural heritage.

3.3.10 Deforestation

Forests, covering only about 0.4% of the total land area, are intricately linked to climate, with meteorological factors influencing their expansion and decline. Most remaining forests are located in the Jabal Akhdar region. However, there has been a significant reduction in forest areas and vegetation cover between 1989 and 2019. This decline is coupled with a notable increase in barren lands and water areas, indicating an ongoing and worrying trend of deforestation(Al-Ashheb, Aqdora, and Algoayl 2021).

Human encroachment, particularly urban sprawl, is a primary cause of this deforestation. Urban expansion, often unplanned and at the cost of agricultural lands, has led to a significant decrease in these areas, posing a threat to the country's food security. The decline in agriculture and the expansion of barren land (57.25% of the total area in the studied region) highlight the severity of the situation. Additionally, political instability and government challenges since 2011 have exacerbated the situation, hindering effective land management and law enforcement. These political dynamics, along with environmental and climatic challenges, significantly contribute to the degradation of agricultural land and forests, raising concerns about future complexities and the sustainability of land resources(Al-Ashheb et al. 2021).

4. CLIMATE CHANGE AND VULNERABILITIES

4.1 Migration and Immigration

The nexus between climate change and migration is increasingly evident. Environmental degradation and extreme climate events, compounded by economic, social, and political challenges, are major drivers of both internal and external migration(Mrsaal 2020). Climate-induced hardships, such as droughts and changing weather patterns, exacerbate living conditions, leading many Libyans to migrate in search of better opportunities and stability. Libya's role as a transit country for migrants from sub-Saharan Africa and North Africa is also influenced by climate factors. Environmental pressures in these regions, along with Libya's geographical positioning and resources, contribute to its status as a hub for migrants aiming to reach Europe(Omer, 2022).

Over the decades, and since the extraction of oil in 1961, Libya has been considered both a destination and a transit country for migration. The majority of migrants come with the purpose of work and residence, driven primarily by reasons related to improving economic conditions, job opportunities, education, and managing the necessary financial resources to meet life's requirements. Economic, political, environmental, and social conditions have consistently been factors that push many to migrate to Libya. Additionally, the border regions of Libya have always been a destination for migration associated with the movement of nomads and herders searching for water and pastures.

According to the study (Diab 2019), most Egyptian migrants to Libya as a destination country are males, primarily youth, with artisans constituting 47%. Educated migrants with higher education make up approximately 29%, followed by a significant percentage of illiterates at 27%. Those holding a medium qualification constitute 22%. The largest numbers of migrants heading to Libya for living and working come from Egypt, Sudan, Tunisia, and Morocco. Additionally, smaller numbers come from Syria, Somalia, Chad, and Bangladesh.

4.2 Climate-Induced Displacement

The relationship between climate change and environmental displacement is starkly evident. These dynamics are particularly acute in the central and southern regions, compared to the north. Environmental issues such as desertification, water scarcity, extreme temperatures, and erratic weather patterns are major drivers of displacement and migration. Young people, in particular, are compelled to move due to the lack of job opportunities, diminished prospects for growth and development, and deteriorating services. The search for better livelihoods, employment prospects, and access to quality services in more favorable environments is a significant factor in this migration trend.

Furthermore, the loss of arable land and the degradation of water resources directly impact employment in agriculture and herding, leading to food insecurity and a lack of potable water. Consequently, many rural and desert inhabitants are forced to relocate to urban areas (Omer, 2022). This climate-induced migration is intertwined with other political, economic, and social factors. The convergence of these challenges makes migration a forced option for many, particularly from less developed regions, driving them to seek better conditions and opportunities in more prosperous environments (Anadol, 2023).

4.3 Gender Implications

The primary themes of the gendered effects of and experiences with climate change and its mobility consequences can be summarized as follows:

1. **Gender-Specific Effects of Climate Change**: Climate change in Libya disproportionately affects women and men due to differing roles and responsibilities. Women, often responsible for securing water and food, face greater challenges with declining rainfall and arable land, exacerbating water and food security issues. Additionally, women's traditional roles in healthcare expose them to higher health risks, especially during pandemics, pregnancy, and childbirth (Saadeh, and Crane 2022).
2. **Impact on Education and Employment**: Climate change adversely affects women's and girls' education and employment opportunities. Responsibilities for family care, heightened by climate-induced challenges, often restrict their access to education and work (IOM, 2023d).
3. **Specific Threats to Women**: Environmental degradation and climate change pose unique threats to women, particularly in rural areas of central and southern Libya. In addition to the abovementioned challenges securing food and water, conditions of violence also increase their vulnerability to violence and displacement (IOM, 2023d).
4. **Data Scarcity and Need for Inclusive Research**: There is a notable lack of data on the impact of climate change on women and girls and a gap on involving women in climate research and providing education on environmental issues (Saadeh, and Crane 2022).
5. **Gender Disparities in Labor Market and Migration**: Gender significantly influences employment opportunities for migrants in Libya. Male migrants have better job prospects and a wider range of opportunities compared to women, who are often confined to domestic work, crafts, and garment making. There is a particularly marked employer preference for male workers especially in the agriculture and construction sectors (IOM, 2023d).

Taken together, women face more challenges than men due to combined political, economic, and environmental factors. These pressures lead to job discrimination, limited resources, and societal barriers, intensifying the impact of environmental and climate factors on women, girls, and children.

4.4 Education Sector

Climate change and environmental factors in Libya have significantly impacted the education sector, exacerbated by armed conflicts and extreme weather events. Schools and higher education institutions have faced multiple disruptions due to heavy rains, floods, windstorms, and heatwaves. These extreme weather events, along with wars and conflicts, have transformed educational facilities into shelters and displacement centers, severely affecting the education system's functionality and students' academic achievements (OCHA, 2022b). As a result of these and other factors, funding shortfalls have dramatically impacted the education sector and many educators have been forced to seek alternative employment, affecting the regularity of classes and overall quality of education. This complex relationship underscores the need to consider climate change as a fundamental factor affecting resilience and stability in the education sector,(UNEP, 2020).

4.5 Public Health

The public health sector faces multiple strains resulting from climate change and environmental degradation, particularly during natural disasters and violent incidents. The healthcare system has struggled under the pressures of climatic extremes like heatwaves, dust storms, floods, and conflict-related disruptions. Many healthcare facilities, including clinics and hospitals, have ceased operations or suffered damage, especially those near conflict zones. These conditions have also disrupted pharmaceutical supplies.

Furthermore, the extreme weather conditions have led to infrastructure issues like road closures and bridge collapse risks, hindering emergency healthcare services, including surgeries and rescue operations (OCHA, 2022a). Frequent power outages further exacerbate the healthcare crisis, impairing the functionality of healthcare institutions.

Additionally, the sanitation infrastructure faces significant challenges. Although over 70 wastewater treatment plants have been built, only 14 are fully operational (Table 7), and many require maintenance or have expired. This has resulted in the treatment of only a small fraction of the required water volume (El-Baroni 2015). The malfunction of these plants leads to the disposal of untreated water into the sea, posing a grave risk to public health(Boras et al. 217AD).

Table 5. Currently Operating Sewage Plants

STATION	Design Capacity M^3/day	Total Quantities processed M3/day	Usage Purposes and Notes
Tripoli (first stage) and Tajora	28,000	28,000	Agricultural Purposes
Anjelah and Janzour	6,000	2,400	Drainage in public lands
Ghryan	3,500	3,600	Drainage in public lands
Yfren	1,750		Drainage in public lands
Msallata	6,000	8,000	Agricultural Purposes
Terhuna	3,200		Agricultural Purposes
Misrata	24,000	24,000	Agricultural Purposes
Sirt	26,000	24,000	Agricultural Purposes
Aljabel Al-Akder	17,500	12,000	Agricultural Purposes
Derna	17,500	800	Drainage in public lands
Tobrq	17,500	28,000	Drainage in public lands
Aljgbob	17,500		Drainage in public lands
Sbha	15,000	15,000	Water specifications are not good
Total		145,800	

Finally, environmental degradation, particularly in coastal areas, has led to severe water pollution. Coastal waters in major cities like Khoums and Tripoli are contaminated with sewage, carrying pollutants like bacteria, viruses, and various waste materials. This pollution has resulted in turbid waters and the spread of foul odors along beaches, resulting in a critical public health hazard(Boras et al. 217AD).

4.6 Effects of Climate Change on Agriculture

In the harsh environmental conditions and extreme climate changes, the agricultural sector in Libya faces numerous challenges in terms of quantity and quality. Agriculture is crucial for Libya's food security, with irrigated areas covering 350,000 to 400,000 hectares across the country. Key crops like fruits, vegetables, citrus trees, and grains rely on irrigation, which consumes varying amounts of water across regions. Water demand for agriculture in northern Libya has risen steadily, leading to an expansion of irrigated land and increased water consumption. This growth, from 350,000 hectares in 1995 to 600,000 hectares in 2022, has escalated water usage from 3,367 million cubic meters to 5,790 million cubic meters over the same period(Masaoud 2022),(Abedi and hamouda 2015).

As noted throughout this report, Libya's agricultural sector has been deeply impacted with reduced crop quantity and quality due to harsh environmental conditions. Factors like water scarcity, desertification, drought, decreased rainfall, rising temperatures, and increased evaporation pressure the agriculture industry. Rain-fed crops like wheat and barley have large production fluctuations based on rainfall patterns. However, dry periods also adversely affect these crops' yields(Masaoud 2022). Studies show a general inverse correlation between climate change and agricultural productivity, negatively impacting most crops, except for some increases in wheat and barley yields under higher temperatures(Abedi and hamouda 2015).

Libya's agricultural labor force has also undergone changes, particularly after oil discovery in the 1960s led to rural-urban migration. To address labor shortages and rising food demand, the government initiated agricultural projects and employed foreign workers. However, these state-managed projects have seen a decline in productivity due to environmental, structural, and financial factors (Mohamed, Mosa, and Alfitori 2016). Finally, both public and private sectors play a significant role. State-managed irrigation projects are vital for production, while private sector cultivation during rainy seasons is crucial for grain production (Mohamed et al. 2016).

4.7 Food Security

Libya has experienced critical threats to food security since the mid-1970s due to the increasing demand for agricultural products, demographic growth, and a significant rise in revenue after oil extraction in the 1960s. The situation was further complicated by increasing global food prices and a gradual decrease in focus on the agricultural sector, coupled with financial challenges. These issues intensified food shortages, leading to greater dependence on imports to meet the gap between domestic demand and supply. The contribution of agriculture to the Gross Domestic Product (GDP) remained modest, at no more than 10.6%. The study observed a limited growth in the agricultural sector, only 1.81%, and a significant reduction in workforce participation, declining from 22.6% in 1990 to 2.3% in 2015. Additionally, it was noted that government strategies over the years have not adequately secured food security for the population(Alazrq 2020).

Increasingly, Libya's food security is increasingly threatened by climate change, resource scarcity, and environmental degradation. Factors like land degradation, labor availability, and water supply shortages, exacerbated by population growth and displacement, hinder achieving food security, especially in conflict situations (Al-Baroni, 2020). The population has faced difficulties in securing essential food items, such as flour, multiple times, leading to increased demand and unjustified price hikes. In Libya, these challenges are pronounced, with heavy reliance on food imports due to agricultural policy shortcomings and environmental factors like desertification and drought. The country's agricultural sector has seen minimal growth and reduced workforce participation, necessitating government intervention in land preservation, water supply, and agricultural production. Additionally, urban migration and mismanagement of water resources further strain food availability, and food shortages can result in families selling their savings and taking their children out of school to push them into the labor market (Al-Qmati and Al-Misrati 2021).

5. DATA GAPS AND RESEARCH PRIORITIES

Through reviewing the results of specialized studies and interviewing stakeholders, as well as considering expert recommendations, It is clear that there is a need to do more in terms of collecting data related to the environment and climate change and ensuring their quality and sharing, and the need to establish a digital repository in which all data collected by institutions and concerned authorities are integrated, as well as the need to activate early management systems and improve response programs and adaptation to effects, in addition to developing data collection systems related to the service sectors, especially agricultural and water, and in the same context, the expansion of scientific research and the implementation of specialized and accurate research projects remain necessary to help understand The reality of environmental and climate developments and the associated human mobility, not to mention their various social and economic effects.

6. CONCLUSION

Libya is grappling with significant environmental and climate challenges that exacerbate its already complex political, economic, and social dynamics. The negative effects of climate change and environmental degradation are increasingly evident, manifesting in frequent and extreme climate events, droughts, desertification, land degradation, and declining water levels. These changes have led to a loss of arable land, extinction of flora and fauna, and strains on water and food security, compelling many to migrate as a means of adaptation. The country has seen a notable influx of refugees and migrants due to a combination of political, economic, environmental, and climate factors, leading to increased internal displacement and added pressure on national services, the economy, and growth. More data and research are needed to better understand and provide an empirical basis for programs and policies that address both the causes and effects of these intersecting dynamics, including the factors driving migration as a response to the harsh climatic and environmental realities.

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