# LIBYA

**CLEAR|** Consolidated Livelihood Exercise for Analysing Resilience

WFP World Food Programme

وزارة البيئة

REACH Informing more effective humanitarian action

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**About REACH**

REACH facilitates the development of information tools and products that enhance the capacity of aid actors to make evidence-based decisions in emergency, recovery and development contexts. The methodologies used by REACH include primary data collection and in-depth analysis, and all activities are conducted through inter-agency aid coordination mechanisms. REACH is a joint initiative of IMPACT Initiatives, ACTED and the United Nations Institute for Training and Research - Operational Satellite Applications Programme (UNITAR-UNOSAT). For more information please visit our website. You can contact us directly at: geneva@reach-initiative.org and follow us on Twitter @REACH_info.

# SUMMARY

The lack of clear evidence-based information on climate change in Libya has resulted in a knowledge gap about the extent of the potential climate-related problems and available solutions. An assessment was carried out by REACH Initiative on behalf of the World Food Programme (WFP), aiming to fill this knowledge gap, considering that other assessments looked at topics affecting agriculture such as desertification, seawater intrusion, and effects from the armed conflict, however, these projects did not explore the sector's possible resilience opportunities.

The objective of the assessment was to inform the design and targeting of development programmes and policies related to climate change adaptation by shedding light on how both current and future climate risks affect the most vulnerable people. For a more detailed overview of the assessment background and design, please refer to the research Terms of Reference available here.

In a first phase, a map was produced outlining the main livelihoods in Libya. Focusing on livelihood means, the priority was placed on communities and what they do for a living. This helped to understand how climate affects people, rather than geographic areas. A second phase of the assessment focused on the vulnerability of those communities to climate change in each livelihoods zone. The resilience profiles of these zones were based on the core indicators of the CLEAR approach. The indicators of food outcomes, climate-sensitivity of incomes, and livelihood diversity were explored through secondary data review, and supported by field data from validation workshops and focus group discussions conducted across the country. In the third phase, meteorological data from 1980 until 2020, as well as climate modelling predictions based on precipitation and temperature were analysed to investigate the possible impact of climate change on the different livelihood zones.

**Key Findings**

The livelihood zones' resilience profiles show varying degrees of resilience against future shocks and stressors, based on the location and characteristics of each area: 6 out of the 16 zones are ranked with low to very low resilience, while 4 other zones were ranked as having moderate resilience. Overall, 10/16 livelihood zones are more vulnerable to extreme climate-related events and will have more adaptation needs without compromising the livelihoods and food security of their populations.

Generally, findings from the assessment show that changes in climate conditions, including precipitation decreases or increasing temperatures, could threaten agricultural livelihoods all over Libya. Zones most affected by such climate-related risks would also be struggling with conditions that could multiply the effects of climate change, such as electricity instability and the lack of access to efficient irrigation systems. The impact of unstable or non-existent electricity is widespread and it contributes to further exacerbating other issues in the agricultural sector, notably the access, and management of water resources. The lack of access to renewable sources in terms of energy and sources will further exacerbate the conditions for least-resilient livelihood zones

The less rainfall there is, the greater the need for irrigation using underground aquifers. Therefore, decreased precipitation due to climate change could lead to further reliance on irrigation but also inability to replenish aquifers, thus, more excessive use of available water resources. Sea level rise and seawater intrusion might further exacerbate the issue, by increasing soil salinity and worsening soil quality, both factors affecting food production. There may also be risks of flash floods due to irregular precipitation patterns by the end of the century.

Findings also suggest that all livelihood zones will be affected by higher temperatures as well as sand and dust storms since all of the MENA region is considered a hot spot for this type of extreme climate events. However, zones in the South of the country, are more likely to be affected by the impacts of these events considering their proximity to the Sahara desert.

Irrigation problems will affect agriculture and other climate-sensitive activities, such as livestock rearing, and as such, livelihood zones relying on climate-sensitive livelihoods, such as rainfed agriculture, will need more resilience capacities to overcome the challenges.

The main challenges within the national legal framework on agricultural activities, the protection of the environment, and the utilization of water are the lack of clarity as well as limited coordination between different authorities in charge of enforcement at the national, regional, and local levels.

Besides direct effects of the climate such as drought, desertification, and floods, there are other aggravating factors that affected the crops of the farmers such as insect infestations and diseases, multiplied by the lack of support from the government. As there is a lack of access to information and awareness-raising related to climate change through official government strategies, the farmers turn to each other for advice, and experience sharing.

# FOREWORD

## Foreword from the Ministry of Environment

The Ministry of Environment was established in 2021, and it became closer to decision-making centers and actively participate in it, as the first official in the ministry (the Minister of Environment) to become a member of the Council of Ministers, unlike the previous one, where the authority (the Public Authority for the Environment) was affiliated with a specific ministry such as health and utilities, and among the most important problems and obstacles that Upon its establishment, the Ministry of the Environment faced:

• challenges to keep up with the amendment of the law on environmental legislation, Law No. 15 of 2003.

• Overlapping terms of reference between the Ministry of Environment, Local Government and Agriculture and the Food and Drug Control Authority.

• Lack of material capabilities to form specialized cadres in various fields of the environment and the lack of fully equipped laboratories to conduct analyses, research and various studies of environmental pollution.

We can only recall the participation of the World Food Program and the Ministry of Environment in many works since its inception as a ministry, and the most important of these works are:

- Signing a memorandum of understanding between the two parties regarding cooperation within the framework of the Interim Qatar Strategic Plan, among the most important objectives of which are:

- Conducting environmental studies and research

- Promote sustainable food systems.

- Participation in the school feeding program.

- Enhancing the Ministry's capabilities through technical support.

Climate Change Assessment carried out by REACH in collaboration and consultation with the Ministry of Environment, the Ministry is pleased to present the results of the Climate Change and Livelihoods Assessment to enhance dialogue and action on climate change in Libya, I hope this report will help the country expand efforts to adapt to climate change and mitigate its effects in the coming months and years by establishing some projects that contribute to reducing the effects of future climate change on livelihoods and solving the difficulties identified in this study.

# CONTENTS

## List of Acronyms

| | |
|---|---|
| **CLEAR** | Consolidated Livelihood Exercise for Analysing Resilience |
| **FAO** | Food and Agriculture Organization |
| **FCS** | Food Consumption Score |
| **FEWSNET** | Famine Early Warning System Network |
| **FGD** | Focus Group Discussion |
| **GMMR** | Great Man-Made River |
| **HH** | Household |
| **IFAD** | International Fund for Agricultural Development |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **LSG** | Living Standard Gap |
| **LZ** | Livelihood Zone |
| **MENA** | Middle East and North Africa |
| **MSNA** | Multi-Sectoral Needs Assessment |
| **OCHA** | United Nations Office for the Coordination of Humanitarian Affairs |
| **WB** | World Bank |
| **WFP** | World Food Programme |

## Geographical Classifications

**Region:** The highest administrative subdivision of Libya below the national level. There are three regions in Libya: the West ("Tripolitania"), the East ("Cyrenaica") and the South ("Fezzan").

**Mantika:** The second administrative subdivision of Libya, or the equivalent of a district or province. Libya currently has 22 mantikas, which are regionally divided as follows, according to the UN COD.[1]

**Baladiya:** The third administrative subdivision of Libya, or the equivalent of a municipality. Libya currently has 100 baladiyas.[2]

**Muhallah:** The fourth administrative subdivision of Libya, roughly equivalent to a neighbourhood. Libya currently has 667 muhallahs.[3]

## Key definitions

**Livelihood**: According to the International Labour Organization (ILO), a livelihood refers to capabilities, material and social resources and activities required for a means of living.[4]

**Livelihood zone:** New division based on predominant livelihood activities in similar geographical conditions, beyond administrative border divisions. A livelihood zone as defined by the Household Economy Analysis (HEA), is a geographic area in which households obtain their basic survival needs, notably food and cash income, in relatively similar ways. On this basis, socioeconomic groupings and asset bases as well as consumption patterns tend to be similar. These similarities apply to both good and bad years, in that household groups' coping strategies in response to shocks are also relatively similar within the same livelihood zone.[5]

**Climate change:** Long-term shift in global or regional climate patterns which is attributed directly or indirectly to human activity or to natural variability, and

[1] OCHA, "Libya Common Operational Dataset," 2017
[2] Ibid.
[3] Ibid.
[4] ILO. Livelihood services.
[5] FEWSNET, SUDAN Rural Livelihood Profiles for Eastern, Central, and Northern Sudan, January 2015

which makes weather patterns less predictable. Climate change induces stresses which refer to the alteration of temperature, rainfall levels and wind, and causes shocks which are "external short-term deviations from long-term trends, deviations that have substantial negative effects on people's current state of well-being, level of assets, livelihoods, or safety, or their ability to withstand future shocks"[6] (e.g., floods, droughts, storms, etc.).

**Resilience:** According to the definition of WFP, along with FAO and IFAD, resilience is the capacity to ensure stressors and shocks do not have long-lasting adverse developmental consequences."[7] The CLEAR approach focuses specifically on climate resilience – in other words people's ability to cope with climate-related stressors and shocks (such as changes in rainfall patterns, climate disasters or glacial melt).

**Climate resilience:** The CLEAR approach focuses specifically on climate resilience – in other words people's ability to cope with climate-related stressors and shocks (such as changes in rainfall patterns, climate disasters or glacial melt)[8].

[6] Mengistu Asmamaw, Seid Tiku Mereta & Argaw Ambelu. Exploring households' resilience to climate change-induced shocks using Climate Resilience Index in Dinki watershed, central highlands of Ethiopia, July 2019

[7] WFP, May 2015, Policy on building resilience for food security and nutrition, Executive Board Annual Session.

[8] WFP, December 2016, The CLEAR approach. The consolidated livelihoods exercise for analyzing resilience, page 16.

# INTRODUCTION

Climate change is a long-term change in the average weather patterns that have come to define earth's local, regional, and global climates.[9] Climate change has altered precipitation patterns, led to rising sea levels, shifts in temperature, and melting sea caps, among others, according to the fifth assessment report by the Intergovernmental Panel on Climate Change (IPCC). In Africa, climate change threats have been noted and increased temperatures are projected to be higher in Africa than the global average while in North Africa, an annual decrease in precipitation is expected to happen at an even more rapid rate than in the rest of the continent. In Libya, these trends, as well as rise in sea levels and increased incidence of extreme weather events has sparked concerns of reduced agricultural productivity, depleting water resources, increased food insecurity, and the safety of coastal communities.[10]

Though there have been studies in Libya focused on the impact of seawater intrusion on agriculture[11], desertification of agriculture land[12], sand dune risk assessment[13], the impact of the armed conflict on the agriculture sector[14] and farmer communities' risk perceptions of climate change[15]; there has been no effort to map the various livelihood zones and the resilience of the communities in these zones to current and future climate shocks across Libya.

Against this backdrop, the World Food Programme (WFP), with support from REACH, conducted this Climate and Livelihoods Assessment in Libya to analyse the effects of some of the climate projections' implications on livelihoods in Libya including:

- Producing a country-scale map of climate-sensitive livelihoods (livelihood zones)
- Assessing the resilience of LZ against climate shocks and stressors
- Analysing historical climatological data and future climate modelling results to obtain a concise picture of climate evolution over the 21st century.

Libya can be broadly classified in two major climate zones: 1) desert or arid areas which represent the largest area of the country (more than 95% of total surface area) but have very low population densities, and 2) Mediterranean areas, which concentrate the vast majority of urban areas and crop land. The livelihoods in these main climate zones differ quite significantly. The desert and arid areas are exposed to warmer temperatures and decreases in rainfall, provoking longer and more severe droughts, while Mediterranean areas are affected by floods, decreases in rainfall and dust/sandstorms affecting urban areas and rural peripheries. Several flash flooding episodes have for instance been recorded in the last ten years, causing important damage to infrastructure and farmland vital for livelihoods, as well as the displacement of thousands of individuals.

It is important to understand the dynamics between the different areas of Libya located in significantly contrasting climate zones, and the underlying effects of their characteristics on the communities populating them. This is itself useful in understanding how these dynamics intersect with findings about effects of climate change on livelihoods, food security as well as the perspectives of the populations on this matter. This assessment aims at addressing communities' perception of climate change and its impact on their livelihoods, which is a precondition for understanding their strategies to absorb, adapt and transform in the face of stresses and shocks.

[9] NASA, What is Climate Change , 2021.
[10] United Nations Economic and Social Commission for Western Asia (ESCWA) et al. 2017. Arab Climate Change Assessment Report – Main Report. Beirut, E/ESCWA/SDPD/2017/RICCAR/Report
[11] Riad, Peter. (2016). Climate Change and Sea Level Rise Impacts on Seawater Intrusion at Jefara Plain, Libya. Nature and Science. 14. 75-81. 10.7537/marsnsj14031611.
[12] Bashir Nwer, Azalarib Ali & Hamdi Zurqani. Soil Salinity Mapping Model Developed Using RS and GIS in Libya, 2013
[13] Biswajeet Pradhan, Ahmed Ali Alazhari Moneir & Ratiranjan Jena (2018) Sand dune risk assessment in Sabha region, Libya using Landsat 8, MODIS, and Google Earth Engine images, Geomatics, Natural Hazards and Risk, 9:1, 1280-1305
[14] WFP. Libya: Agriculture and Livelihood Needs Assessment Report: Study of the Fezzan Region , March 2020.
[15] Ilseven, Serkan & Aslanova, Fidan. (2019). Attitude and risk perception of climate change in farming communities in Tripoli, Libya, Chimica oggi.

# METHODOLOGY

**The Consolidated Livelihood Exercise for Analysing Resilience (CLEAR)** is an analytical approach developed by WFP to better understand how food security is affected by climate risks – whether they be related to extreme events (such as droughts, floods, and cyclones), or to long-term gradual changes (such as shifting rainfall patterns, rising temperatures, or salinity intrusions in coastal areas due to sea level rise).

CLEAR analyses are guided by a common approach, which involves identifying and overlaying three types of information:

1. a map of LZ;
2. a ranking of the resilience of different livelihoods to climate risks;
3. an assessment of the impacts of future climate risks on livelihoods and food security.

In this approach, the analysis follows three main steps that bring together different types of information that give an overview on a country's ability to cope with climate change. In this CLEAR analysis, this involves:

Step 1: The CLEAR method builds on the approach developed by the Famine Early Warning System Network (FEWSNET)[16] for using livelihood zoning and profiling for food security analysis, but with a particular focus on climate risks. This step resulted in producing the Libya livelihood zoning map indicating the distribution of the zones and their characteristics.

Step 2: WFP, along with the Food and Agriculture Organization (FAO) and the International Fund for Agricultural Development (IFAD), defines resilience as *"the capacity to ensure stressors and shocks do not have long-lasting adverse developmental consequences."* [17] Resilience in CLEAR analyses is measured based on these core indicators: poverty, food security, climate sensitivity and livelihood diversity.

Step 3: Based on the CLEAR approach's objective, a synthetic look at temperature and rainfall evolution since the 1980s until the end of the century was carried out to appreciate differences in the territory; a list of natural hazards already taking place in Libya and what these could look like as the climate changes.

The CLEAR approach focuses specifically on climate resilience – **in other words people's ability to cope with climate-related stressors and shocks** (such as changes in rainfall patterns, climate disasters or glacial melt)[18].

- The **climate resilience ranking** developed in this assessment, is the **result of aggregating the scores** attributed to each livelihood zone (LZ) in three indicators:
  - *Food security*, which was based on the Food Consumption Score (FCS) found in the most recent two rounds of (2020, 2021) Libyan Multi-Sectoral Needs Assessment (MSNA) data.
  - *Climate sensitivity of crops and income*, which was informed by a combination of secondary data review and primary data collection and is used to assess communities' dependence on climate-sensitive activities. This is based on the information provided through focus group discussions (FGDs) and workshops on which livelihood activities are the most important to the population, and whether they depend on one or more activities that are affected by climate factors.
  - *Livelihood diversity*, which is the indicator used to analyse communities' diverse options to make a living and their flexibility to adapt their livelihoods activities. The data for this ranking was collected in the field through workshops and FGDs.

[16] Food Security Analysis and Early Warning. Guidance for Famine Early Warning Systems Network (FEWS NET) Representatives and Partners.

[17] For more details on WFP's general approach to resilience, see WFP's Policy on Building Resilience for Food Security and Nutrition, 2015

[18] WFP, (December 2016), The CLEAR approach, the consolidated livelihoods exercise for analyzing resilience, page 16.

## Geographical scope

The geographical scope was initially all of the Libyan territory, however the continuous review of the map and its layers narrowed down the scope of work to focus on more specific LZ in order to measure their resilience and predict the impact of future shocks based on their particularities in terms of location, environment and type of population.

The map of the geographical coverage of the assessment was in and of itself an outcome that was changing throughout the assessment, as more data was collected, boundaries and characteristics were discussed, and the final shapes of the LZ were the result of data collected from SDR and scoping interviews, mapping workshops, as well as FGD data.

## Data collection

Before launching the assessment, 15 scoping interviews were conducted between March and May 2021 with key informants, who are experts or professionals working in the field of meteorology, climate change, and agriculture. These interviews gave general ideas on the topics treated in the CLEAR analysis, such as climate shocks and stresses (i.e. desertification), and livelihoods (agriculture). These were used to get to know the field more and to know the stakeholders who can be involved in the following steps of the assessment.

*Step 1: Data collection through livelihood zoning workshops*

The first step of the project was to classify Libya into different areas of similar livelihoods, independent from the current administrative boundaries. In order to do so, **three mapping workshops** were carried out in Libya in the main cities bringing together experts, academics and ministry professionals in the fields of environment and agriculture and climate change.

*Step 2: Climate resilience data collection through FGDs*

During the second step, the level of climate resilience of the LZ was assessed through FGDs with participants who were selected based on their activity in the main livelihood determined for the specific LZ. The main selection criteria were their knowledge of the field and the livelihood activity and gender. Thus ensuring that the data covers the particularities experienced by women relying on the same activities, as well as women's perceptions of climate change effects on their livelihoods. For this step, 20 FGDs were conducted all over Libya in the predetermined LZ and gathered in each one of them 6-8 participants coming from different backgrounds as needed for the purpose of the project.

*Step 3: Projection of potential hazards in livelihood zones*

Finally, the third step comprised a quantitative analysis of existing historical and future climate data, to establish an overview on the most basic indicators related to climate (precipitation and temperature). During this step, climate data for the last 40 years was analysed and synthesised in graphs and maps. Besides, a synthetic mapping of the main hazards was set up based on current climate-related events and the potential evolution of these linked to the forecasted changes in temperature and precipitation.

## Analysis

The approach enables its users to produce accurate information by using country specific factors to reflect contextual challenges or needs, when relevant in addition to the core indicators (a) relative poverty or food security (b) climate-sensitivity of income or food (c) livelihood diversity. **Each LZ has a score in each indicator, and all the scores are aggregated to make up the overall resilience score for that LZ.**

The three key indicators of the CLEAR analysis used to measure climate resilience in Libya are:

### *Food security*

For this indicator, the Food Consumption Score (FCS) data from the 2020 and 2021 Libya Multi-Sector Needs Assessment (MSNA) [19] was used to layer baladiya-level HH data on the LZ. Per LZ, the proportion of HHs with a borderline or poor FCS was calculated in order to rank the zones based on a severity scale of 1 (least secure) to 4 (most secure), thus expressing indicatively, to what extent people in the assessed livelihood zones are exposed to food access and adequacy issues. This indicator does not cover other dimensions of food security measurement and is only used to proxy food insecurity.

**Table 1: Calculations of Food Consumption Score from MSNA data to resilience ranking**

| % of HHs with 'borderline' or 'poor' FCS scores in the LZ[20] | Rank (1=least secure, 4=most secure) |
|---|---|
| >30% | 1 |
| 20-30% | 2 |
| 10-20% | 3 |
| 0-10% | 4 |

### *Climate sensitivity of food or income*

This indicator allows seeing which livelihoods are dependent on climate factors and to which extent they are affected by them. In order to identify which LZ are the most affected by climate shocks and stressors, it measures how climate-sensitive the LZ is based on the livelihood activities practiced in it. This means this indicator shows which zones relying on which livelihoods are the most affected by changing climate factors.

For this indicator, the analysis explores the main livelihood activity practiced in a zone (per the workshop participants' feedback) in terms of its dependence on factors that could be affected by climatic shocks. Climate-sensitive activities could for instance be any agricultural activities based on water, with rain-fed activities likely being more vulnerable to climatic shocks than activities that rely on irrigation from groundwater. Another factor that could contribute to climate sensitivity, for example, is the proximity of activities to climate-sensitive locations (fishing activities on the coasts where potential hazards may occur).

The ranking of this indicator was based on the following categories:

**Table 2: Table of scores for Climate sensitivity of food or income indicator**

| LZ description | Rank (1=extremely climate-sensitive, 4=not climate sensitive) |
|---|---|
| LZ that depend solely on a few climate-sensitive activities | 1 |
| LZ whose main livelihood activity is climate-sensitive but who also engages in one or two other activities | 2 |
| LZ who derive around one third or up to one half of their income from climate-sensitive activities but have access to other activities on a regular basis | 3 |
| LZ who do not derive any income from climate-sensitive activities. | 4 |

### *Livelihood diversity*

**"Livelihood diversity is a measure of the availability of alternative activities which households can rely on when their main source of food or income is diminished or destroyed by a shock.** *For instance, coastal households for whom*

[19] REACH, "Multi-Sector Needs Assessment (MSNA) Key Findings ", 2021

[20] The calculation of the needs indicator (LSG) relies on critical and non-critical indicators. The critical indicators have been selected through consultations with sector partners. For food security, the FCS (% of respondents with a poor or borderline FCS) was identified as the critical indicator. A respondent with a poor or borderline FCS is immediately classified as being in need. The FCS is calculated based on the quantity of consumption of key food groups in the seven days prior to data collection. Other non-critical indicators include reduced Coping Strategy Index, and Food Expenditure Share. For more on this, please refer to the sectoral factsheets.

*fishing is the only available source of income and food are at very high risk of becoming food insecure if a severe storm or a tsunami hit. On the other hand, fishing communities which also engage in petty trade as an additional income source will be less severely impacted by these climate shocks."*[21]

This diversity also means *"having choice and options to modify behaviour, with advantages such as being able to switch crops or seeds, finding new income sources or changing physical location, which are all identified as important resilience building options."*[22]

The ranking for this indicator from 1 (no livelihood diversity) to 4 (very high livelihood diversity) was as follows:

**Table 3: Table of scores for Livelihood diversity indicator**

| Description of livelihood zone's diversity | 1 (no livelihood diversity) to 4 (very high livelihood diversity) |
|---|---|
| Minimal to no income-generating activities are available to HHs in the livelihoods zone | 1 |
| Few income-generating activities are available to HHs in the livelihoods zone | 2 |
| Other income-generating activities are present in the livelihood zone, but there are some barriers to access | 3 |
| Many other income-generating activities are available to HHs in the livelihoods zone. | 4 |

***On future projections of climate change***

The section on future projections relies on projections from the General Circulation Models provided by NASA's Earth Exchange Global Daily Downscaled Climate Projections dataset (accessed through Google Earth Engine). This data comprises " (…) *downscaled climate scenarios for the globe that are derived from the General Circulation Model (GCM) runs conducted under the Coupled Model Intercomparison Project Phase 5*[23] *and across two of the four greenhouse gas emissions scenarios known as Representative Concentration Pathways"* [24]. The CMIP5 GCM runs were developed in support of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5)."

For convenience and usability, only this data was used, as its data offers enough suitability for the prospect of this report. GFDL-CM3 GCM [25] was chosen for maximum temperature, MIROC5 for minimum temperature, and MPI-ESM-LR for precipitation. Both moderate and high emission scenarios were used.

[21] WFP (2016) The CLEAR approach The Consolidated Livelihoods Exercise for Analyzing Resilience, page 20.

[22] E. Lisa F. Schipper & Lara Langston, (July 2015), A comparative overview of resilience measurement frameworks: analysing indicators and approaches. ODI Working papers, No 422

[23] Taylor, K. E., Stouffer, R. J., & Meehl, G. A. (2012). An Overview of CMIP5 and the Experiment Design, Bulletin of the American Meteorological Society, 93(4), 485-498.

[24] Meinshausen, M., Smith, S.J., Calvin, K. et al. The RCP greenhouse gas concentrations and their extensions from 1765 to 2300. Climatic Change 109, 213 (2011).

[25] Zebaze S, Jain S, Salunke P, Shafiq S, Mishra SK. Assessment of CMIP5 multimodel mean for the historical climate of Africa. Atmos Sci Lett. 2019;20:e926.

## Challenges and Limitations

- Some of the LZ were bigger than municipalities and went beyond mantikas, but both the workshops and FGDs were held in single locations/bigger cities, which might leave some local specificities out of our scope and collected data.
- Although a gender balance was sought during the selection of FGD participants, a gender balance was not met in some locations, mostly due to the nature of the livelihoods activities that were profiled (agriculture, livestock rearing) which are not culturally seen as professions for women. This is a limitation because particularities or differences in the perceptions and knowledge of climate change and its implications on livelihoods based on gender differences might have been overlooked in the assessments.
- The final outcome of resilience profiles, gives an overview on each LZ in terms of the core CLEAR Analysis indicators, but does not provide a basis to put the different LZ in order from low to high resilience, because they each have their own geographic and environmental characteristics and various implications from the different potential hazards.
- The third objective of the assessment concerning the implications of the potential climate hazards on food security and the different livelihoods, might not reflect the most accurate scenarios as the data used in the current assessment can only be indicative, since it is difficult to predict the hazards, the likelihood of them happening in certain regions and at specific times in the upcoming decades.

# FINDINGS

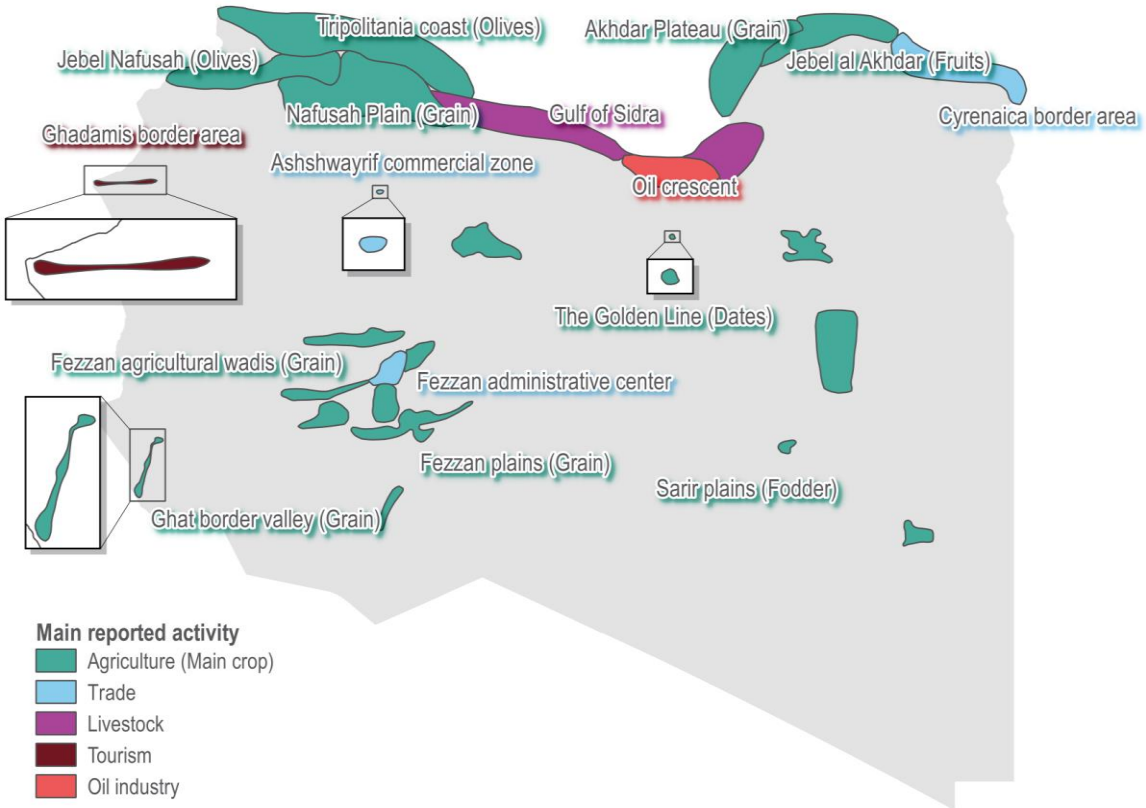
The findings are presented in line with the CLEAR approach, starting with an overview of the assessed livelihood zones, projected on a map, followed by the individual resilience indicators, and climate projections. The chapter ends with an overview of each livelihoods zones, hazard susceptibility and the implications of these hazards in general

## Mapping of livelihood zones

The initial draft of the livelihood zones map in Libya was based on scoping interviews, datasets from other assessments such as the agriculture questions section in the MSNA. All areas without significant human activity were removed. After this step, more layers were added to clarify the boundaries of the separate zones, these additional layers came from secondary data sources such as the MSNA 2019 datasets for HH agricultural characteristics, and included factors such as climate zones, soil and landscape characteristics, proximity to larger cities and, more importantly, agricultural activity data.

To move from the initial map to the final version of the livelihood zoning map, the data collected from the field (the validation workshops with experts) and the outcome of its consolidation made up more layers for the map that allowed for a more accurate representation of the zones in terms of size, location, and link to other livelihoods, with an emphasis on the main characteristics and livelihood activities available in them as well. Information from these steps was consolidated in the LZ presented on map 1, which was used in the following workshops to assess each zone's climatic resilience. Areas in the same colours belong to the same livelihood zone.

**Map 1: The livelihood zoning map of Libya based on the CLEAR approach**



# Overview on current resilience capacities and recent climate change impacts on livelihood zones

## Institutional framework: Laws, policies, awareness-raising, and access to information

The limited Libyan legal framework on agricultural activities, the protection of the environment, and the utilization of water plays an important role in the poor land and water management throughout the country which hinder communities' resilience. The key legal frameworks that are relevant to this assessment are listed below:[26]

- **Law no. 15 of 2003 on the Protection and Improvement of the Environment (which originally to replace law no.7 ):** Constitutes the main national legislative body in the field of the environment. It is concerned with the protection of sea and marine life, water resources, food, sanitation, wildlife, and air pollution. It also includes the necessity of public sharing information on the quality of the environment.
- **Law no. 33 of 1970 on the Protection of Agricultural Lands**
- **Law no. 38/39 of 1975 on the Municipalities' Responsibilities for Environmental Protection**
- **Law no. 3 of 1982 to Organize the Utilization of Water Resources:** It regulates the utilization of water resources and the protection of aquifers.
- **Law no. 15 of 1989 on the Protection of Animals and Trees**
- **Law no. 14 of 1989 on the Exploitation of Marine Resources:** This law focuses on the exploitation of marine wealth and is used to prevent sea pollution.
- **Law no. 3 of 2002 amending Law No (5) of 1969 on the organization and planning of towns and villages:** Regulates the utilization of groundwater sources, including sewage treatment and water quality.

Libya does not have a legal framework on irrigation and drainage and therefore lack clear and transparent ways of defining basic rights and obligations in those two domains.[27]

The main challenges within the national legal framework on agricultural activities, the protection of the environment, and the utilization of water are firstly the lack of clarity. The limited coordination between the several authorities at national, regional, and local level in charge of enforcement (mainly the Ministry of Environment, or previously the General Environment Authority, the General Water Authority[28], the Great Man-Made River (GMMR) authority, the National Centre for Standardization and Specification,[29] as well as the environment protection units[30] in each municipality) has also led to inefficient planning and management of natural resources, especially because these entities lack equipment and trained personnel.[31]

The second is the lack of general public information sharing of the collected data (e.g. on water quality). There has been limited encouragement for farmers to adopt sustainable practices and no compensation exists for the damages or

[26] European Environment Agency, "ENPI-SEIS project: Country Report Libya", 2015

[27] CEDARE, "Libya Water Sector M&E Rapid Assessment Report", 2014

[28] Founded in 1972, the GWA oversees general water policy in Libya. This authority is responsible for managing surface and groundwater resources, as well as wastewater. It carries out studies aimed at improving irrigation networks and has been created to provide users with information on water supply and quality. GWA is also responsible for issuing well drilling licenses and approving the design and construction of dams (CEDARE, "Libya Water Sector M&E Rapid Assessment Report", 2014)

[29] It is responsible for preparing the standards and ensuring quality of products locally produced and imported in Libya. This entity is in charge of certification and inspection in industry and commerce and aims at providing them with training (CEDARE, "Libya Water Sector M&E Rapid Assessment Report", 2014)

[30] These units deal with water supply and quality, wastewater treatment, landfills operations, etc. at the municipal level

[31] CEDARE, "Libya Water Sector M&E Rapid Assessment Report", 2014

losses incurred from their conforming to water conservation legislation[32]. In addition, the rise in the price of highly water-intensive crops such as tomatoes, watermelons, oranges and peanuts have led more farmers to plant them.

According to participants in the majority of FGDs (17/20), the main type of information available for the general public is meteorological information, which they have access to through several means such as weather bulletins, radio, online weather pages, as well as family and friends but not necessarily through structured coordination mechanisms or local authorities that curate this information according to the conditions and needs of the community. Almost half of FGD participants also reported that the meteorological information is usually checked as a preventive measure to understand the impact of possible climate instability. Farmers use it also to know which crops to sow and the best times for that. Accessing information and incentives to do so remain a problem because in some of the FGDs, even the absence of the institutional framework for farmers was reflected. A minority of participants reported that meteorological information is not useful or reliable, while another group highlighted the lack of outreach from such institutions, reporting that they do not have any knowledge of meteorological information or advice.

For example, in Jabal Nafusah, half of the participants highlighted that they do not have any type of contact with the meteorological centre while the other half stated that meteorological information is available elsewhere and not exclusive to the centre. Beyond water management and conservation laws and policies, the communities in most LZ show that the lack of knowledge and implementation of any legal framework by any legislative body is lacking in general: Laws and policies regarding climate change are unknown in more than half of the FGDs (11/20). Those who are aware of these laws (9/20), consider that there is a lack of implementation by the authorities and the citizens themselves possibly due to the lack of encouragement and compensation rewarded to adherence to these policies.

*''Yes, there are laws and regulations dealing with climate change that provide training and guidance on the dangers of climate change. However, they no longer have the required effect due to the absence of regulatory bodies and their failure to perform the duties due to the political and security chaos the country is witnessing'' (FGD Jefara Plain)*

Third, respondents mentioned the lack of awareness raising sessions about the water situation. This exacerbates even further the farmer's ability to look for, find and implement the right practices all while doing so on an individual or a communal level without support from the authorities. In 4 FGDs in the South and West, participants mentioned that in the past there has been training available as a personal effort that some individuals undertake on their own, since all FGD participants agreed that there is no government funded support in the form of trainings and awareness raising sessions except for the courses offered in the past exclusively to ministry employees or agricultural specialists mentioned only in three FGDs.

The field data reflects this frustration with also half of FGD participants reporting that they have needs and issues that affected their activities but cannot be overcome without government interventions

*''Many families had their crops damaged due to rodents, insects and war, which impacted soil and air quality in addition to the absence of the authorities' interventions to deal with such issues. Such events can be overcome if the different authorities cooperate to address these issues and maintain the agriculture and livestock existing in the region, by providing pesticides and veterinary medications, identifying those affected and treating the existing damages" (FGD Sirt)*

The lack of access to support from the relevant authorities, also introduces the farmer to other types of challenges including looking for an efficient and effective alternative. In many cases in the past some associations seem to be the

[32] Abdulmagid Abdudayem & Albert H.S. Scott, "Water infrastructure in Libya and the water situation in agriculture in the Jefara region of Libya", *African J. Economic and Sustainable Development*, vol.3, no.1, pp.33-64.

only source for advice, training and capacity building in the agricultural sector according to 8 FGDs. However, this resource has not improved the situation and still represents a burden for farmers since currently the associations are not as active, and in most cases require fees as shared by one participant:

> *Now we have turned to private agricultural associations and paying fees for fertilizers and seeds also for agricultural consultancy and guidance on the types of suitable crops for the region and the type of soil, there are no livestock vaccination campaigns in the country'' (FGD Bani Waleed)*

Fourth, is the weak implementation of above-mentioned laws, hindering the possibility of sustainable land and water management in Libya.

The only exception to the legislative and practical roadblocks that farmers find on their way to implement sustainable and profitable agricultural livelihoods that can resist climate shocks are initiatives mentioned in Sebha, Al Bawanies and Al Kufra FGDs, where participants mentioned and supported local efforts to combat the potential effects of extreme events, which were city-level afforestation campaign.

Furthermore, Libya signed and ratified several international environmental conventions, including the UN Framework Convention on Climate Change, the Convention on Biological Diversity and the UN Convention on Combating Desertification[33]. However, the same problem applies to these conventions which are not implemented[34] due to a lack of equipment, trained personnel, institutional coordination, as well as the lack of outreach, networking and public awareness raising programs. Based on a report published in 2013, the country is considered to be one of the least Developed Countries in its mitigation and adaptation measures to climate change[35].

## Current and recent changes in climate

During the FGDs, participants recognized some of the changes they have already noticed in their environments or mentioned some extreme climate events that have affected their lives and livelihoods in the recent years. Although many participants did not relate the changes they noticed directly to climate change, the information suggests that some livelihood activities and some areas are already facing new challenges. The main challenges mentioned in the field data range from drought to floods.

Each of the FGDs highlighted the main concerns in terms of climate variability and how it can affect their crops or activities. In coastal Al Jabal Al Akhdhar, for instance, it was agreed that the lands from Qaminis to Ajdabiya and Brega were affected by desertification and water scarcity. These factors caused damage to some crops, such as olive and grapes, which meant their prices increased. With water scarcity already being a problem in the area, and the repeated emphasis on reliance on rain-fed agriculture, this livelihood zone could be facing bigger challenges in the future, when precipitation patterns are expected to decrease and become less and less regular. This means that agriculture can suffer more from water scarcity, consumers might face higher prices for staple foods and farmers will have to adapt their irrigation strategies accordingly. The zone has also witnessed some climate variability that affected the living conditions. It was reported that in Al Abyar, in periods of climate instability, such as extreme cold and temperature, the average time of electricity shortage blackout lasts to up to 4 to 5 hours a day, and although this is not a daily pattern, it could be affecting crop yields when summers are longer and temperatures are higher.

### Drought, sandstorms, and desertification

Many areas are already suffering from drought, along with dust and sandstorms, as reported in the FGD held in Tobruk, these were the main challenges that can affect the livelihoods in the zone, since it is considered a pastoral area, drought and sandstorms will be affecting grazing lands and the situation could be further

[33] CEDARE, "Libya Water Sector M&E Rapid Assessment Report", 2014

[34] There is not any information or report available on these conventions and their enforcement in Libya.

[35] Mannava V.K. Sivakumar, Rattan Lal Ramasamy Selvaraju & Ibrahim Hamdan *(eds.)* (2013), *Climate change and food security in the West Asia North Africa region*, Springer.

exacerbated with higher risks of desertification. The same has been reported in Alshweirif, where reliance on fodder, instead of grazing valleys is a more expensive alternative for livestock breeders, forcing them to raise prices. In Nafusah plain, the FGD participants refer to a ”major drought issue”, where the absence of rainfall throughout the year in the region has significantly affected livelihoods; they reported that agricultural activities have significantly been reduced, especially in valleys with difficult access to irrigation systems, or grazing grass for livestock. Jebel Nafusah LZ has also witnessed some effects of drought according to the FGD held in Nalut, where events were noticed as far as three years prior to the date of data collection, and the most recent year of drought has caused damage to olive trees and other types of crops and even led the participants to diversify their income sources and relying less on agriculture to reduce the risk on their livelihoods (spending savings, selling livestock, pursuing other activities such as trade).

In the South, drought is already a real threat, affecting water usage practices, as water consumption becomes a concern especially in the summer due to the lack of precipitation and higher temperatures. Crop input is also affected as one of the FGD participants in the Fezzan Administrative Centre reported having to use drought-resilient crops that can withstand the environmental conditions of the area since his livelihood depends entirely on agriculture.

**Floods**

Floods were mentioned in some FGDs as a recent event or potential threat. Some of the main floods that were mentioned are: flooding of Wadi Jardinah in the Qaminas area in Coastal Jabal Al Akhdhar. In Tobruk, in 2007, a flood occurred on the Wedyen road and it caused the death of livestock in the valleys, however this type of threat is almost excluded now in the area, due to its desert climate and limited precipitation in it. In the South, the main reported incident was the 2019 flash flood in Ghat that ravaged farms, killed livestock and damaged equipment through the zone. Although Ghat does not belong to an area prone to floods, the damage this event has caused had repercussions on the farmers’ livelihoods that did not have the infrastructure need to prevent this kind of event from damaging their crops or livestock. This was echoed in the South, around the Fezzan administrative centre, where FGD participants reported that the area lacks reliable infrastructure to face heavy rains, or floods in general since the region is predominantly a desert. However, in Fezzan plains, one of the FGD participants reported that the dam protecting one of the areas has been damaged by the floods.

To prevent these losses and to protect the populations from torrents, heavy rains and floods, building the dam in Wadi Wishka has proved effective while also providing the agricultural areas with water supply as reported in the Al Jufra FGD; however, this is not the case everywhere in the zone, since floods have also destroyed houses with poor infrastructure.

## Support infrastructure: social networks, assets, and financial services

Although not all LZ have already witnessed major climate shocks, some are already coping with some events that occur seasonally or in specific areas. When dealing with effects of extreme climate events that cause loss or damage to crops, livestock and equipment, people start to look for ways to sustain their everyday life but also to compensate for the loss or bounce back to the same level. For this, they need significant resources, which is why the support infrastructure is vital in resilience measurement. In this assessment, the LZ dwellers have limited options, starting with social safety nets (family and friends), and ending with reliance on their own assets and savings as the access to financial services such as insurance is rare according to their experiences.

**Social Networks**

In the majority of FGDs (13/20), participants reported prioritizing their social networks when they are looking for help to recover from losses in their agricultural activity. In 12/20 FGDs, they reported that they usually start by relying on borrowing money from family, neighbours or friends before turning to savings and assets.

> *"Through previous experiences with crop spoilage, I did not find any support from any party. It was resorting to family and good people, or depending on oneself as much as possible" (Marada FGD)*

Social networks are the first available option for many participants, however some of them are open to other types of networks. In one of the FGDs (Jalou), some mentioned the role of local NGOs in providing support. In another FGD (Derna), the idea of establishing another reliable social network in the form of a farmer's union was also suggested. There is no government social safety net that can provide support for livelihoods in the same way.

**Assets and savings**

When facing financial challenges, many participants in the FGDs, reiterated that other than their social networks, they do not receive any support from government bodies or authorities of their sector therefore, the only other option they usually turn to is their own assets and savings. This was highlighted by the participants in the majority of the FGDs (17/20) who face climate shocks effects by spending their savings as an emergency fund, reinvesting them in their agricultural project to compensate for what was lost or provide input in the following season. While it being a common option among some FGD participants, others also highlighted the difficulty of building up savings, as the cost of living is already much higher due to the economic instability in the country. This explains why some turn to selling assets which include land plots, livestock or other properties to recover from the crisis. This was the option mention by many participants, even those coming from low-income groups facing higher risks, as they do not own many assets. Two FGD participants explained this thoroughly.

> *"In the event of disasters or circumstances that prevent the access to necessities of life, I reduce my daily consumption to a minimum, and I start spending my savings and selling even private assets. However, for long term disasters, I am unable to face them". (AlKufra FGD)*

> *"In the event of natural disasters, my monthly salary is not affected. However, I face difficulty with the raising prices due to the disaster. I cannot deal with that because I do not have any assets to sell, and there is little local support that is not enough, and even the value of my monthly salary has lost some of its value to due to the inflation caused by the disaster, and there is no incentive from my job". (AlKufra FGD).*

**Insurance and financial support**

The inability to find financial support is an obstacle that participants from different backgrounds are dealing with, so not only low-income groups find it difficult to access resources, but sometimes bigger scale farmers are in the same situation due to the lack of support from authorities. One of the FGD participants highlighted this and explained how it can lead to debts and financial constraints:

> *"I am considered one of the largest livestock breeders in the region and we did not get any support in this drought, we are losing a lot because of drought and lack of rain, and we have a real problem, and no one is paying attention. I'm now facing a lot of debts and no one is supporting us." (Nafusah Mountain FGD)*

In over half of FGDs (13/20), participants reported that there is no access to any financial or insurance services. In nearly one third (6/20), they mentioned the role of the Libyan Agricultural Bank (present and active in Libya mainly between 1960 and 1990) and brought it up as an effective and reliable financial support mechanism in the past. As reported by one of the participants in the Coastal Jabal Al Akhdar LZ, the bank had an important role in supporting families affected by disasters including a specific event he recalls:

> *"For example, in 1963 after the earthquake that took place in Marj the bank supported the citizens and farmers who were affected by the disaster. Since 1998, the Bank has ceased to support families affected by disasters" (Benghazi FGD).*

In 4 out of 20 FGDs, some participants mentioned social assistance, through the Social Solidarity Fund. As for insurance, it seems to be rarely used by the participants, if and when it is available. Most of the experiences mentioned in the FGDs refer to this service as an option that is no longer available or only concerned with some aspects of compensation. In fact, only one FGD participant in Benghazi mentioned insurance of farms and agricultural machinery. In Ghat, one participant noted that "previously in the 1970s or the 1980s such services were available but they ceased to exist or are hard to access". While another participant from the Fezzan Wadis LZ said:

> "I am a government employee. Previously, I registered for optional disaster insurance on the farm where I have dates, vegetables, and sheep. In case of disaster, the insurance company is not forced to pay."

However other participants, in almost all the LZ, agreed that they are not aware of any insurance services that cover natural disasters.

## Loss of crops, threatened livelihoods and cultures

The issue of loss of crops was brought up in the FGDs under different circumstances, some participants recalled specific incidents when they had to look for financial support when they faced the crisis and others mentioned it as one of the outcomes of the obstacles they face in the sector especially with access to electricity, irrigation and infrastructure. These occurrences are a threat to the livelihoods, specifically those who are already at lower resilience livelihood zones.

The reasons behind loss of crops are diverse. In addition, to direct effects of the climate such as drought, desertification and floods, there are other aggravating factors that menaced the crops of the farmers such as insect infestations and diseases, multiplied by the lack of support from the government which was highlighted in both cases. Two of these major events were mentioned in the FGD held in Benghazi:

> *"There is a disease that affects palm trees, it came all the way from Saudi Arabia to Egypt and then to Libya, it destroyed 34,000 trees in Jalou and Aujla. The state did not do anything regarding this epidemic [...] when a disaster came and destroyed 34,000 palm trees, there were only four people who treated these things [...] because the disaster that came is very strong and kills the palm tree, regardless of its age or length."*

> *"There's also an insect that came in from Argentina and settled in the Middle East that is destroying the crops and the*

*shrubs, and the state did not move a muscle to address this issue. In short if you have a climate problem, you solely depend on yourself and your family".*

Against a backdrop of limited to non-existent government support or any type of financial service to compensate for the losses, extreme events like these can lead to losses of livelihoods, not just losses of yields in a season. The FGD participants echoed the need for support on these issues because usually overcoming them is a costly process and not all farmers have the possibility to reinvest savings, sell assets or obtain loans to resume their activities; some of them in some cases have to turn to other income-generating activities, if not relocate to undertake any type of activity.

**Loss of culture and potential displacement**

The loss of crops leading to loss of entire livelihood sources, not only threatens the socio-economic status of the populations but it can have a cultural impact too. Although it was only limited to a few FGD participants, loss of culture is another concern raised by the effects that climate change is having on the LZ. The loss of culture is tightly linked to loss of livelihoods because it can mean losing ancestral heritage and knowledge as expressed by one of the participants in the FGD of the Fezzan Administrative Centre LZ:

*"I have no activity other than farming on my own land and raising a few poultry for self-sufficiency and means of earning a living. As the other participants mentioned, the land is a legacy of our ancestors, and we have always worked in it." (Sebha FGD)*

It is also the case for livestock breeders in a different LZ who consider this activity to be their only source of income that they inherited, and that might be threatened by new climate shocks.

*"As breeders, we do not have other reliable sources of livelihood to earn a living. From ancient times we inherit the trade of raising and herding livestock, and we depend entirely on them for our livelihoods. Thus climatic factors and disasters caused by bad weather cause us a lot of crises and losses" (Ashwerif FGD)*

Migration from rural to urban areas, is one of the cases imposed by the encroaching urbanisation that is affecting arable land, and agricultural projects. Farmers who face heavy losses and do not receive compensation choose to move to other cities for better livelihood opportunities or better, living standards. In addition, another way populations move was reported in one of the FGD and it is a direct result of extreme climate events affecting traditional lifestyles.

*"There are many traditional houses with traditional roofs made of plank and iron cannot withstand even a normal rain. If a disaster happens, most of these houses would be damaged and people would have to move elsewhere." (Al Kufra FGD).*

The data from FGDs revealed that although there is a lack of access to information and awareness-raising related to climate change through official government strategies, the farmers turn to each other for advice, and experience sharing. They are adapting to the changes through exchanging experiences and expertise among themselves, helping each other to reduce the negative effects of climate change.

## Access to climate resilient infrastructure, reliable electricity, and irrigation systems

The objective of this analysis is to shed light on some of the most important data points collected in the field and have either implicitly or explicitly affected the scores attributed to each livelihood zone and the resilience measurement results in general. This information might not adhere to rules of ranking to show which zones belong to which category, but it highlights some of the main obstacles faced by the communities regardless of their location and, even beyond their main source of income.

Lack of access to stable electricity is a commonly experienced issue across the country with all FGDs reporting between 3-5 hours a day and 6-8 hours of power outage a day. A minority throughout the sample report blackouts of even more than 9 hours to a few days but, it is agreed that frequency and duration and effects on livelihoods are usually worse in the summer, when temperatures are much higher. However, there are exceptions, only noted on a local level at this point, with half of the participants in Ubari FGD mention that they do face less electricity cuts in Ubari city centre not affecting HHs as widely as in other cities within the municipality and similarly participants in Elsrir field report that power cuts are shorter and only last to up two or three hours.

The impact of unstable or inexistent electricity is widespread and it contributes to further exacerbating other issues in agricultural sector, notably the access, and management of water resources. The large majority of FGDs (17/20), thus reflecting the majority of the LZ reported that power cuts lead to crop failure, spoil stocks (stored crops) and impact production rates regardless of the type of crops, because if failure does not happen in the production phase, it can occur when the crops are stored. The majority of livelihood zone dwellers participating in FGDs (13/20), reported that power cuts damage storage equipment, machinery, devices and water pumps, thus causing irrigation problems, which can spoil the crops. The yield can be spoiled when in storage when refrigerators are shut off due to frequent or long power outages that last for several hours, if not days.

Such findings lead to the discussions about irrigation problems and access to low-water use systems; there is a need for them as alternative systems, since most of the LZ do not rely on rain-fed agriculture and need appropriate ways to irrigate their crops. This is not always possible: 7 out of 20 FGD participants reported having no or difficult access to irrigation networks. Those who do have access, do so to different extents since access to irrigation systems varies between regions: In LZ in the South, it is possible to access drip irrigation and sprinkler machines as 5 of the 9 FGDs reporting easy access are located in the South, which might not be the case for other LZ located elsewhere.

The lack of access to stable electricity throughout the days and seasons exacerbates the capacities of the farmers and in general of people involved in climate-sensitive livelihood activities. This means that with projected increase in temperature and potentially longer summers, their capacities could be depleted, especially with higher chances of partially or completely losing crop yields and higher costs of inputs, even for the typical production cycle. As reported by FGD participants, it can be a financial burden, to find alternatives for stable electricity sources, thus ensuring a more sustainable access to water sources and to specific irrigation systems. Their low adaptive capacity shows through their experiences, in half of the FGD, where they highlight the cost to replace electricity networks with generators and in 5 others, participants mentioned the problem of the high cost of water cars used during the interruptions in irrigation. The effects of these electricity-related problems could result in having less people engage in agricultural livelihoods, and more people that could face higher risks of food insecurity since not only their income would be affected but those who used to consume their own products could lose that food source as well.

These experiences and perceptions of the impacts of the difficulty to access stable electricity as well as water sources and irrigation systems was echoed throughout the discussion about sustainable infrastructure as well. For the large majority (17/20), infrastructure able to withstand climate shocks does not exist in their area. Those who have access to any type of infrastructure do highlight that usually, it is no longer reliable for different reasons such lack of maintenance, deliberate destruction, or lengthy or delayed construction. This can be caused by the political instability of the state as reported in the FGDs, and many farmers

state this as the reason why there are several challenges in the agricultural sector. This is especially relevant for participants in three of the FGDs, who consider that disaster preparedness and infrastructure construction are affairs of the state, especially because they are costly projects which they cannot undertake on their own. Problems with capacities to withstand future shocks and stressors, come in different forms depending on the location of the LZ and the climate hazard related to it. In four FGDs, out of which three are located in the West, it is highlighted that even existing infrastructure might not be adequate to resist new types of climate shocks.

> *''If there is a flood, which has never been the case in the history of the city at all, some neighbourhoods with mud soil and a lower altitude, would be flooded and submerged'' (FGD Alkufra).*

## Adaptation attempts, community-based initiatives, and maladaptation

Climate change is already affecting some of the livelihood activities to some extent, and the resilience of the livelihood zones does not depend exclusively on the current capacities of the LZ dwellers, it also depends on how and if they are adapting to the changes in the climate and the effects it has on their activities. Although the data shows a lack of access to information about climate change and awareness-raising session to deal with the issue, some participants in the FGDs highlighted a few initiatives or attempts to adapt to the new climate events they are facing.

Beyond livelihood diversity and crop diversification which are key indicators of resilience in this assessment, some community-based initiatives and individual projects can be highlighted as some of the efforts to adapt to the new reality of climate change. In Ghat, the local-level initiative presented by one of the FGD participants is holding afforestation campaigns to plant wind barriers, planting trees and scattering seeds of wild herbs to help re-grow and restore the vegetation cover, thus help facing heavy rainfall and flooding periods. The second potential adaptation strategy initiated by one of the participants in the same FGD was aquaculture. Despite the high cost of the equipment, the participant confirmed that it has proven to be reliable and economical in terms of water usage, as opposed to traditional irrigation methods preferred by other farmers in the community. Considering more low-use irrigation systems are needed and better management of water resources is an important step for many LZ, facing issues with access to water, this initiative could be an alternative. The same intention of saving irrigation water was echoed by another participant who emphasized the importance of intercropping, especially for those who use traditional methods. He also highlighted the usefulness of some plants that are considered repellent and can contribute to keeping insects away and reducing the use of insecticides. On the other hand, the same strategy of intercropping was highlighted in Al Jufra because it is used there, however the improved imported seeds are used there due to the lack of the original seeds. The respondent also reports that the production and improvement of local seeds are neglected.

In general, implementing strategies to adapt agricultural activities and different types of livelihoods is not depicted as a priority in the FGDs. In the Fezzan Plains, one of the participants explained that implementing strategies are often done by large-scale farmers only, because agriculture represents a strong source of income for them. This might not be the case for other farmers who undertake farming or livestock rearing as one of the income-generating activities they have, or those who rely on agriculture only as a secondary livelihood source when needed.

## Food security

In the 2021 MSNA in Libya, 13% of assessed Libyan HHs were found to have a food security living standard gap (LSG), [36,37] meaning that they likely have unmet food security needs. In general, MSNA findings suggested that food security needs are mainly driven by **economic factors** (income, expenditure, scarcity), which were impacted by the COVID-19 pandemic, government policies, the security situation, and the value of money[38].

The map below shows the ranking of LZs based only on the FCS calculations from the 2020 and 2021 MSNA data. It can only be used indicatively as it does not cover all the dimensions of food security such as availability, production and usefulness, rather it captures HHs' food access and adequacy.

**The overall map (see map 2 below) is diverse and reflects the variety of obstacles met in the South in terms of food security, which are based on several factors such as access and cost, and not only on climate sensitivity**. The map shows that most of the coastal areas are ranked from "highly" to "most secure" based on FCS, notably Tripolitania Coast, Jebel Nafusah, Nafusah Plain the Oil Crescent, Jebel Al Akhdar and Cyrenaica Border Area. **The high score noted on the coast can be explained by the following, natural and socio-economic factors.** These coastal zones, receive the most rainfall in the country,[39] are known as the most arable lands of Libya (Jebel Al Akhdar and Tripolitania coast)[40], and provide the possibility to undertake fishing, these conditions are favourable for specific livelihood activities, which is why the same zones are home to more than 80% of the country's agricultural production. Easy access to imported goods, considering the proximity to ports, and to the markets of the largest cities in the country, is also another factor facilitating access to food in general, along with other economic factors related to employment opportunities and income level.

Apart from zones located in the South and East, the coastal zone of Al Akhdar plateau in the North was also found to be least food secure – based on the FCS – which can be explained by the effects of security concerns leading to higher numbers of displaced persons and refugees in the cities of this livelihood zone.[41] Meanwhile difficulties in the Southern zone, Fezzan Agricultural Wadis could be related to the difficulties imposed by the longer distances both from the markets of the larger cities of the coast as well as the capital of the South and the Fezzan Administrative Centre, Sebha.

Problems with access could also indicate difficulties due to higher costs of transportation and security concerns along the way. Although agriculture is the main livelihood activity in the zone, access to food produced locally can be affected by any irregularity in the yields due to irrigation problems since the sector in the Southern region relies only on groundwater resources. Lack of access to stable electricity is a common issue across the country with all FGDs reporting between 3-5 hours a day and 6-8 hours a day. However, half of FGD participants in Ubari FGD mention that they do face less electricity cuts in Ubari city centre not affecting households as widely as in other cities within the municipality, thus in the livelihood zones surrounding them. Participants in Elsrir field report that power cuts are shorter and only last to up 2 or 3 hours.

[36] LSG calculations are based on critical and non-critical indicators identified through consultation with the sectors. For more information about the calculation please refer to the MSNA's methodology overview.

[37] The calculation of the needs indicator (LSG) relies on critical and non-critical indicators. The critical indicators have been selected through consultations with sector partners. For food security, the FCS (% of respondents with a poor or borderline FCS) was identified as the critical indicator. A respondent with a poor or borderline FCS is immediately classified as being in need. The FCS is calculated based on the quantity of consumption of key food groups in the seven days prior to data collection. Other non-critical indicators include reduced Coping Strategy Index, and Food Expenditure Share. For more on this, please refer to the sectoral factsheets.

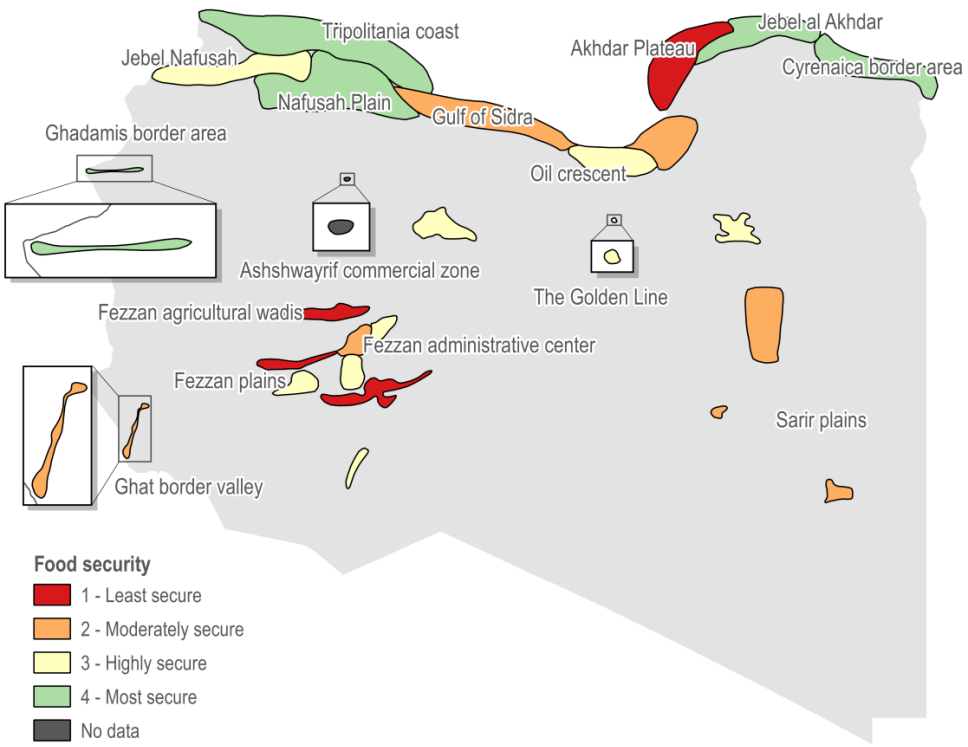
[38] REACH, "Multi-Sector Needs Assessment (MSNA) Qualitative Findings Presentation on Food Security, Cash & Markets, Livelihoods", 2022

[39] CDI, 2012. Agribusiness development in Libya A fact-finding mission.

[40] Shwerif, N., Elghammudi, A., Abosnena, S., & Alfaid, A. (2020). Effect of Different Types of Soil on the Growth & Productivity of Tomato Solanum lycopersicum var. Rio Grande in Libya. International Journal of Plant & Soil Science, 32(16), 26-32.

[41] FSC, WFP, July 2020, Libya Food Security Sector Bulletin.

**Map 2: Food security based on the FCS**




## Climate sensitivity of incomes

This indicator allows seeing which livelihoods are dependent on climate factors and to which extent they are affected by them. Sensitivity of agricultural livelihood activities depends on the type of farming system (i.e., rain-fed or irrigated), the water source used for it and their timing (changes in season for rainfall can affect specific crops that need a certain amount of rainfall at one point during the year and can spoiled if timing changes). This information was gathered, whenever possible, in mapping workshop in the beginning of the assessment to allow us to identify characteristics of each LZ and to facilitate ranking them according to this indicator.

| Livelihood zones | Climate sensitivity of livelihoods |
|---|---|
| | Rank (1=extremely climate sensitive, 2=highly climate sensitive, 3=moderately climate sensitive, 4=not climate sensitive). |
| Tripolitania Coast | 2 |
| Jebel Nafusah | 2 |
| Nafusah Plain | 3 |
| Gulf of Sidra | 1 |
| Oil Crescent | 2 |
| Ghadamis border area | 4 |
| Ashshwayrif commercial zone | 4 |
| The Dates' Golden Line | 2 |
| Akhdar Plateau | 3 |
| Jebel al Akhdar | 3 |
| Cyrenaica Border Area | 3 |
| Fezzan Agricultural Wadis | 2 |
| Fezzan Administrative centre | 2 |
| Fezzan Plains | 3 |
| Ghat Border Area | 3 |
| Sarir Plains | 4 |

Following a holistic approach to address climate sensitivity, data collected in FGDs about the crop diversification strategy, was used to further explain the findings of the climate sensitivity indicator. The underlying assumption is that, when agricultural livelihoods activities are sensitive to potential natural hazards, communities' resilience is shaped by their strategies to cope with the potential impact of a hazard, such as crop diversification. To ensure a continuous income,

communities rely on adaptive strategies such us crop diversification. Farmers can use different crops throughout the seasons (rotating the crop that work ideally with the conditions of each season) or rely on intercropping to produce different types of crops instead of relying on one type which can be partially damaged or lost.

The adaptive capacity or lack thereof can either enhance the ability of the population to deal with the climate shocks or add to their vulnerability. A focus on the adaptive capacities of LZ and an understanding of the strategies populations are *already* using to deal with climate sensitivity of their crops or incomes in general.

One participant in the Benghazi FGD emphasised the impact of climate change on crop production and price increases by expressing:

> *"The lands from Qaminis to Ajdabiya and Brega were greatly affected by climatic factors. Desertification and water scarcity caused damage to some crops, such as olive and grapes, therefore the prices for such products have increased. For example, last year olive oil was sold for 7 Libyan dinars, now it has reached 14 Libyan dinars." (FGD Benghazi)*

This participant has already noticed how some of the stresses of climate change (desertification and water scarcity) have impacted the crops and the markets; since the olives and grapes have been partially damaged, market prices of olive oil, considered a staple good, have reportedly doubled compared to the previous year. This demonstrates how climate-sensitive crops, when damaged, can have long lasting effects on the community.

The Gulf of Sidra livelihood zone has the lowest score of 1 on the climate sensitivity indicator, meaning it is highly sensitive, since the populations present in the zone appear to rely solely on a few climate-sensitive activities. Indeed, during the mapping workshop, the main livelihood activities mentioned by the participants were climate-sensitive, with some of the participants estimating that up to 50% of HHs' income is derived from agriculture. Overall, participants reported that the zone is mostly dependent on activities such as livestock rearing, agriculture, and fishing. This was also reflected in the FGD conducted in Sirt, where the primary sources of income for all the FGD participants themselves, were sheep breeding, camel breeding, poultry and sheep production, sheep, and goat farming, as well as grain and feed production.

In the mapping workshop, public sector jobs were also mentioned by participants as a livelihood activity, though ranking as the least important among the available livelihood activities in the Gulf of Sidra livelihood zone. This is due to Sirt being one of the main cities in the zone and is considered an important administrative centre for the dwellers of the Gulf of Sidra. In this livelihood zone, it seems that the population relies on a combination of activities, including mainly agricultural activities and government salaries which might not cover all their needs, especially in the case where government salaries is their only income. This was highlighted by one of the FGD participants:

> *"Many of us have a government salary that can be relied upon to meet some of our domestic and personal needs, but it cannot be relied upon if our main livelihoods are compromised by natural disasters and climate change.' (FGD Sirt)'*

## Livelihood diversity

| Livelihood zones | Livelihood diversity |
|---|---|
| | Rank (1= no livelihood diversity, 2= low livelihood diversity, 3= moderate livelihood diversity 4= very high livelihood diversity) |
| Tripolitania Coast | 2 |
| Jebel Nafusah | 3 |
| Nafusah Plain | 4 |
| Gulf of Sidra | 2 |
| Oil Crescent | 2 |
| Ghadamis border area | 1 |
| Ashshwayrif commercial zone | 2 |
| The Dates' Golden Line | 2 |
| Akhdar Plateau | 4 |
| Jebel al Akhdar | 4 |
| Cyrenaica Border Area | 4 |
| Fezzan Agricultural Wadis | 2 |
| Fezzan Administrative Centre | 4 |
| Fezzan Plains | 4 |
| Ghat Border Area | 2 |
| Sarir Plains | 1 |

Overall, 2 of the mapped LZ were categorised with a livelihood diversity score of 1, which is the lowest score, indicative of minimal to no income-generating activities being available for HHs in the area. The first of these areas is the Timhert Hamada Border Area zone; HHs in this zone reportedly relied mainly on limited dates production. The second area scoring 1 is Al Sarir plains, which is due to this area mainly housing a large-scale agricultural project with neighbouring mining and oil projects, without many permanent residents in the area, apart from a small percentage of those who are there solely for work purposes.

Seven LZ (see opposite table) scored 2 on the livelihood diversity ranking, meaning they generally have only a few income-generating activities available to the HHs. In these zones, the main type of livelihoods mentioned in the FGDs with livelihood zone dwellers was reliance on government pensions or salaries (mentioned in 13 of the 20 FGDs), despite the irregularity of payments and frequent delays. While public sector pensions or salaries emerged as one of the main livelihood activities in all the zones, there were slight differences in the rest of the activities.

Another reported type of livelihood diversity was trade and private business activities in fields such as cars, gold, and electronics (7/20). While people in the transit commercial zone do engage in livestock grazing, they are more inclined to generate income from activities like manufacturing and trade since the area is a transit which creates a need for more commerce-oriented activities. Female participants particularly highlighted other income sources such as knitting, tutoring, and pastry making as other source of income ensuring income diversification which means they do not rely only on one source and rely on several at the same time or at different times of the year.

Other than public sector jobs, activities in the agricultural sector are privileged in zones such as Tripolitania Coast and the Gulf of Sidra where primary data reveals that farming, livestock rearing, and fishing are the main sources of income for most of the participants involved in the assessment, with them pursuing a combination of two or more of the mentioned activities. Moreover, another way, populations choose to cope with the need for diverse sources of income they reported is that they remain in the agricultural sector but prioritise producing a new type of crop that is different from the one they usually produce. Two examples mentioned were farmers producing dates, who are also interested in

producing fruit trees, fodder, and grains, while other farmers are interested in producing tomatoes and fruits in addition to their current production of wheat and barley. Some of the FGD participants also mentioned another manner to recover from financial difficulties while remaining in the sector, is to still sell their crops or livestock at a lower price, which was mentioned in 2 FGDs.

Whereas in Fezzan Wadis, the populations combine their agricultural activity with work in quarries and the extraction of natural resources in general which is possible due to the nature of their region. Similarly, the Oil Crescent livelihood zone, which despite it being a large actor in the oil export process through its ports, many of its dwellers, are also active in agriculture with rain-fed grain production as well as diverse livestock breeding activities (camels, cows).

However, findings suggest that some of the populations of 7 LZ particularly rely on just one main livelihood activity and they complement it with activities based in the same field as well. In the Dates' Golden Line as the name implies, the population is mostly active in palm and dates production, in addition to palm-based industries and handicrafts. A change in the conditions (different temperature) or in the available resources (groundwater) would impact the main activities in these areas (date production and derived products in the case of the aforementioned LZ) that would require a sudden change of income-generating activities or a move. Depending on one resource leads to a higher vulnerability in a changing environment.

Jabal Nafusah's score was a 3, indicating that income-generating activities are present in the LZ but there are some barriers to entry. In this case, both mapping workshops and FGD data revealed several livelihood activities in the zone, such as agriculture, through producing mainly olives and almonds, as well as livestock breeding. However, participants have also highlighted the many obstacles they find when undertaking these activities. The most reported problems were related to access to water sources, due to the mountainous nature of the area, and access to reliable water infrastructure. Other arguments related to effects of the drought the zone has been experiencing were also indicated as a barrier, to diversifying and accessing many income generating activities.

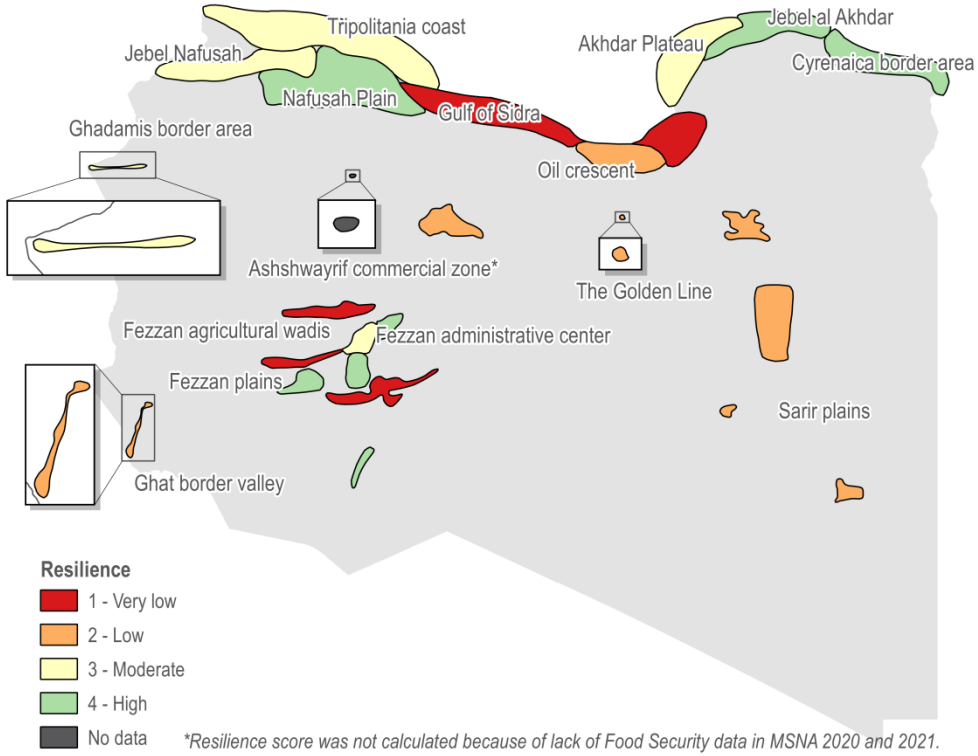
Lastly, several zones were ranked with a score of 4, which indicates that communities in those zones have access to various diverse income-generating activities. The zones do not combine their livelihood activities in any particular method, each zone and each HH combine the different income-generating resources in ways suitable for their needs, however this does not mean that they do not sometimes rely on one or more livelihood activities that can be extremely climate sensitive.

## Resilience capacities

The map opposite shows the LZs' climate resilience index, which is based on the three main indicators selected for this CLEAR assessment: 1) food security, 2) climate sensitivity of food or income, and 3) livelihood diversity. The map is the outcome of classifying the zones in the different categories of each indicator and of their scores on the relevant indicators. Each LZ has a score in each indicator, and all the scores are aggregated to make up the overall resilience score for that LZ. The resilience score is the sum of all the scores the LZ has in each indicator. It also reflects the key findings of the 3rd phase of the assessment related to climate change predictions and their impact on livelihoods, the map shows moderate to high resilience of most of the LZ on the coast where there is high diversity of income options and around the most densely populated regions.

As demonstrated by step 3 findings, the map also shows 3 areas recording low to very low resilience, primarily due to their location on the flattest and most seismically active area in the Mediterranean while also relying on highly climate sensitive incomes and limited livelihoods activities. In the inland region, the results are as diverse: regions in the east were mostly categorised as having low resilience, in addition to being in an area that will experience changes in temperature levels in the future. Among the LZ concentrated in the south, high resilience was found in the Fezzan agricultural wadis, due to the region's highly diverse livelihoods, yet the Fezzan agricultural wadis were found to be on the other side of the spectrum in terms of food security, with the lowest FCS affecting the overall rank, despite having moderate scores in other indicators (climate sensitivity of income, and livelihood diversity).

**Map 3: Climate resilience index of assessed livelihood zones**



# Potential hazards and implications on livelihoods and food security

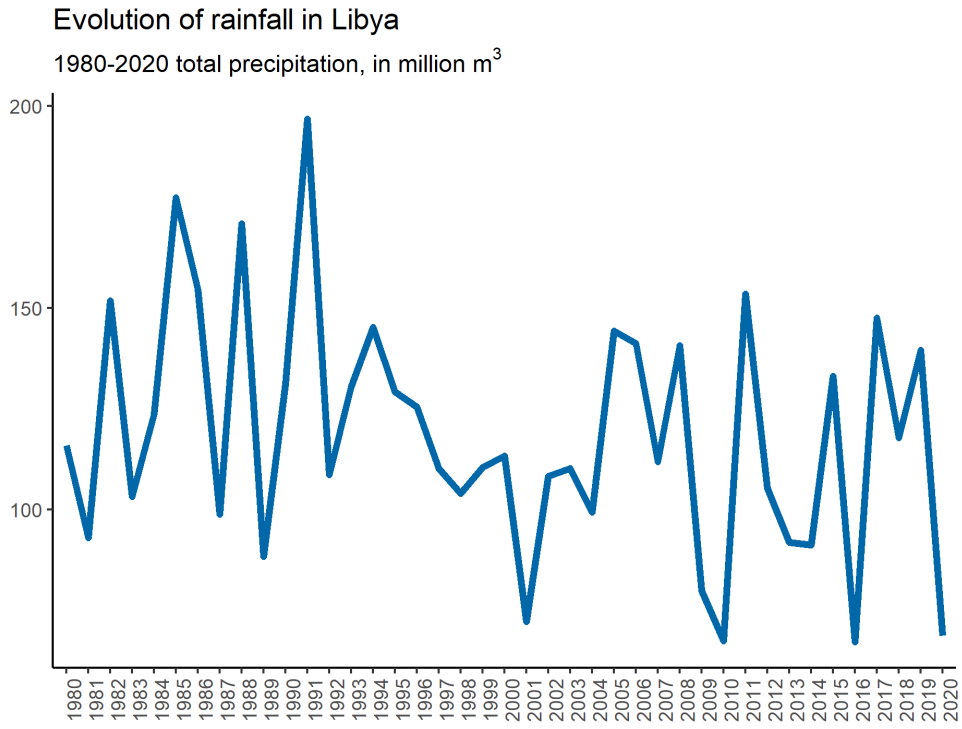
## Current climate and recent evolution

As stated in the general introduction of this assessment, Libya's environment is characterised by its aridity, with an average annual rainfall of 56 mm, and 93% of the land receiving less than 100 mm/year[42]. Two different climatic zones can be distinguished: the coastal band, with a Mediterranean mild climate, and a hot, hyper-arid desert that spans most of the Libyan territory. In addition, two distinct main reliefs can be also described, namely, plains and mountains. The country contains virtually no surface water and very little vegetation.

### Precipitation

Secondary literature sources do not appear to agree on the evolution of precipitation in recent years[43], but most of them point to a certain stability or slight decrease. However, the graph below, beyond that apparent stability, shows two distinct patterns since the 1980s (see figure 1, opposite). The first clear pattern is the volatility of precipitation between 1980s and 1990s as well as since the 2000s, with the total amount of precipitation being higher in the 80s than in the post-2000 period. The second identified precipitation pattern is a continuously stable reduction in precipitation for the period of 1990s to 2000.[44] It is relevant to point out though that these values are merely indicative; considering the whole territory, especially such an arid and big one, is not the right approach for climate studies, but it can show the dynamics.

**Figure 1: Evolution of rainfall in Libya, 1980s – 2020 total precipitation, in million m3**




### Temperature

Much clearer is the trend on temperature (see figure 2 below). A clear rise appears to have been happening since the 80s, with the highest values having been measured in the last few years, which appears to align with the literature[45, 46, 47].

[42] AO. 2016. AQUASTAT Country Profile – Libya. Food and Agriculture Organization of the United Nations (FAO). Rome, Italy

[43] El-Tantawi, 2005; Climate Knowledge Portal (WB)

[44] Values should be considered indicative as information is only possible to obtain for Libya as a whole and not per livelihood zones that represent arid and dual land zones

[45] Cos, Josep & Doblas-Reyes, Francisco & Jury, Martin & Marcos, Raül & Bretonnière, Pierre-Antoine & Samsó, Margarida. (2021). The Mediterranean climate change hotspot in the CMIP5 and CMIP6 projections..

[46] Zittis, G., Bruggeman, A., & Lelieveld, J. (2021). Revisiting future extreme precipitation trends in the Mediterranean. *Weather and climate extremes*

[47] Lelieveld, J. & Proestos, Yiannis & Hadjinicolaou, Panos & Tanarhte, Meryem & Tyrlis, Evangelos & Zittis, George. (2016). Strongly increasing heat extremes in the Middle East and

**Figure 2: Evolution of mean temperature in Libya 1981-2020 in C°**

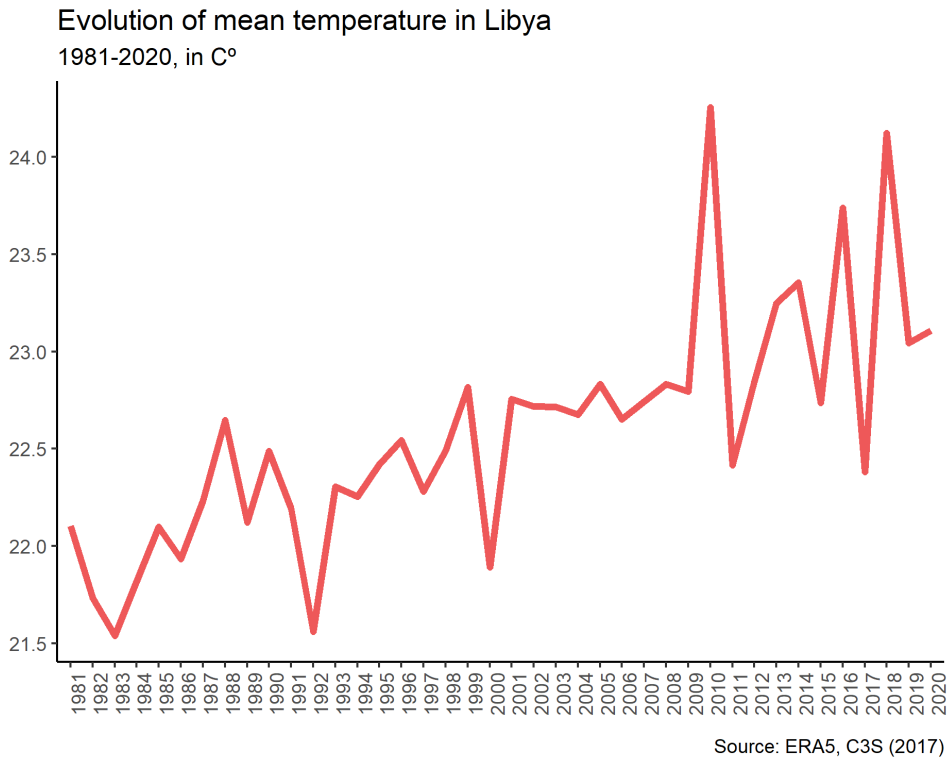
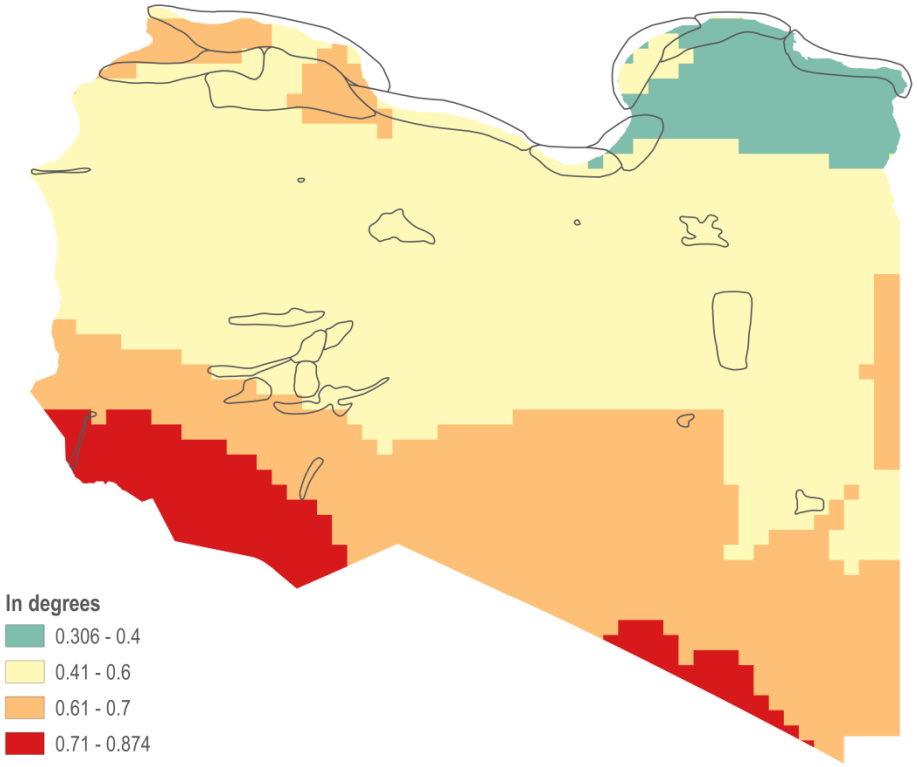



Figure 3 opposite shows where the highest rises in mean temperature have happened; between a 1980-2000 average and a 1990-2020 average, all pixels show increasing values of less than a degree, albeit with differences in the spatial span. In general, the southern Fezzan and the Jefara and Nafusah plains show higher temperature increases than the rest of the country, while the Djebel Al-Akhdar ridge, where the highest precipitation values were registered, shows the smallest temperature increase. In addition, given stable rainfall and increasing precipitation, indicators such as humid relativity and potential evaporation will also change accordingly.

North Africa (MENA) in the 21st century. Climatic Change.

**Figure 3: Mean temperature increase 1980-2000 vs. 1990-2020**




## Overview on current weather-related risks

Libya is prone to a handful of climate-related risks. Severe heat waves affect the whole country, with effects on crops and human health, causing even schools to close. [48] Linked to the heat waves, are fires; with higher temperatures and same-to-lower precipitation, the number of wildfires is expected to rise. Heat waves are already felt considerably, particularly in the urban areas, where the effects of

[48] Libya (State of) | World Meteorological Organization (wmo.int)

heat waves are multiplied; the so-called "heat islands" [49] appearing in urban areas are known to have negative health effects, especially in high-risk groups.

In addition, Libya is affected by soil degradation. Salinisation and wind and water erosion, among other variables, negatively affect the soil; during the scoping of this assessment, climate and agriculture experts particularly highlighted the impact of such processes on productive lands in the north.

The northern coast, where most of the precipitation falls, is home to recurrent high precipitation episodes that entail different potential risks, like flash floods and damages to crops and property. They usually happen in autumn and winter. However, similar events can also happen in the South (the most recent example happened in Ghat in 2019) with considerable consequences due to the unpreparedness. Zittis *et al.*, 2021, predict an increase in maximum daily precipitation for of 50 years.

Dust and sandstorms (*ghibli* in its most extreme form) contribute to a loss of vegetation in the northern plains as reported by scoping interviews with key informants. They can cause troubles with different communications signals.[50]

Sea level rise is expected to affect the country's flattest coastal areas, including the Oil Crescent (Gulf of Sidra) and Benghazi [51] as well as Zwara and Ajdabiya[52], which could see an increase in sea level between 10cm and 25 cm by 2050.[53] It is worth remembering that water-related basic infrastructure (desalination plants), are absolutely essential to the development of the country and are already in a dire state, will likely be affected by this rise. In addition to that, and more importantly, it will exacerbate already existing issues like the salinisation of shallow coastal aquifers, which, on the other hand, is an old existing and recurrent problem with Tripoli reportedly already having problems with salty water in wells [54].

On the other hand, given the fact that the country relies little on rain for agriculture, changes in precipitation will not affect much the country, though it will further increase its dependency on finite underground resources (WFP, 2016). Indeed, Libya will depend more and more on groundwater. A growing population and an ageing desalination infrastructure means that, at the moment, groundwater is the obvious and only answer to water needs. It is not, on the long term, a sustainable source, when most of the water comes from fossil non-renewable aquifers. Besides that, the biggest aquifer, the Nubian Sandstone Aquifer System, is spread over four countries (Libya, Sudan, Egypt, and Chad). Some of them are already involved in water-related geo-political tensions (Nile reservoirs). It is expected that, even if a coordination body[55] were to be created and has real enforcing power, tensions over this resource are inevitable [56] There are conflicting reports about when the fossil aquifers may run out but these vary between 200 and 300 years[57]– and the causes are mainly anthropogenic[58]. Already some areas in south-eastern Libya have seen sinkholes starting to appear[59].

[49] . This is due to the heat absorbing properties of concrete and asphalt and the lack of shade and evaporative cooling from vegetation. This phenomenon is known as the "heat island effect"; FAO. 2019. Handbook on climate information for farming communities – What farmers need and what is available. Rome. 184 pp.

[50] Abuhdima, Esmaeil & Saleh, Ibrahim. (2010). Effect of sand and dust storms on microwave propagation signals in Southern Libya.

[51] Brubacher, M. (2021), Climate-Fragility Risk Brief: Libya, Adelphi research.

[52] Galassi, Gaia & Spada, Giorgio. (2014). Sea–level rise in the Mediterranean Sea to 2050: Roles of terrestrial ice melt, steric effects and glacial isostatic adjustment. Global and Planetary Change.

[53] See https://www.savemedcoasts.eu/ for a map showing these.

[54] Passon, J., Braun, K. (2020). Navigating and Mapping the "White Spot". In: Braun, K., Passon, J. (eds) Across the Sahara. Springer, Cham.

[55] Reportedly some implementation is currently happening and there is already a Joint Authority for Study Development of the NSAS (since 1992) (https://www.nsasja.org/) FAO, 2016

[56] Bindra, Abulifa, Hamid, Al Reiani, Khalifa Abdalla, Assessment of impacts on groundwater resources in Libya and vulnerability to climate change, Scientific Bulletin of the „Petru Maior" University of Tîrgu Mureş Vol. 10 (XXVII) no. 2, 2013

[57] Brubacher, M. (2021), Climate-Fragility Risk Brief: Libya, Adelphi research.

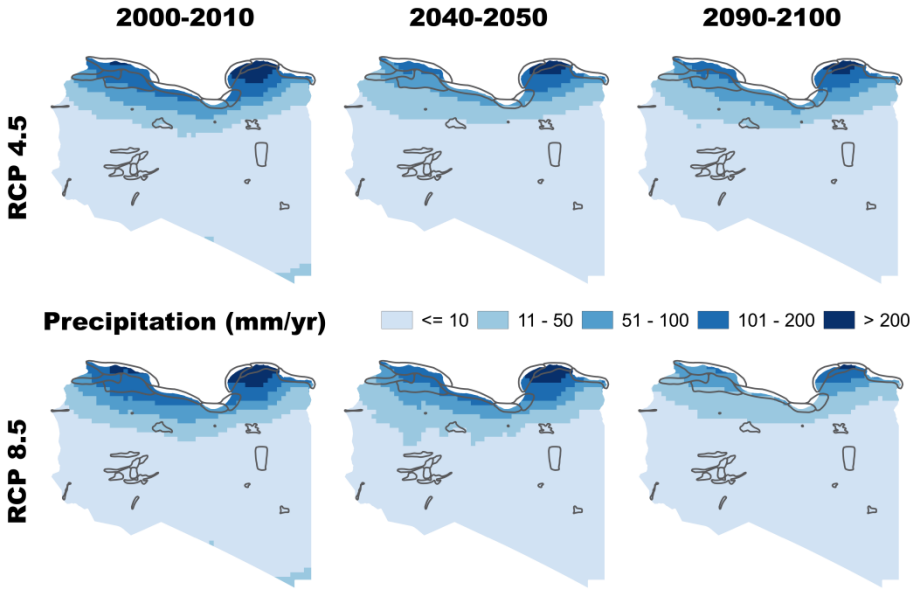
[58] Mazzoni, Annamaria & Heggy, Essam & Scabbia, Giovanni. (2018). Forecasting water budget deficits and groundwater depletion in the main fossil aquifer systems in North Africa and the Arabian Peninsula. Global Environmental Change.

[59] Alfarrah, Nawal & Berhane, Gebremedhin & Huwaysh, Abdalraheem & Walraevens, Kristine. (2017). Sinkholes Due to Groundwater Withdrawal in Tazerbo Wellfield, SE Libya. Ground water.

# Future projections

## Precipitation

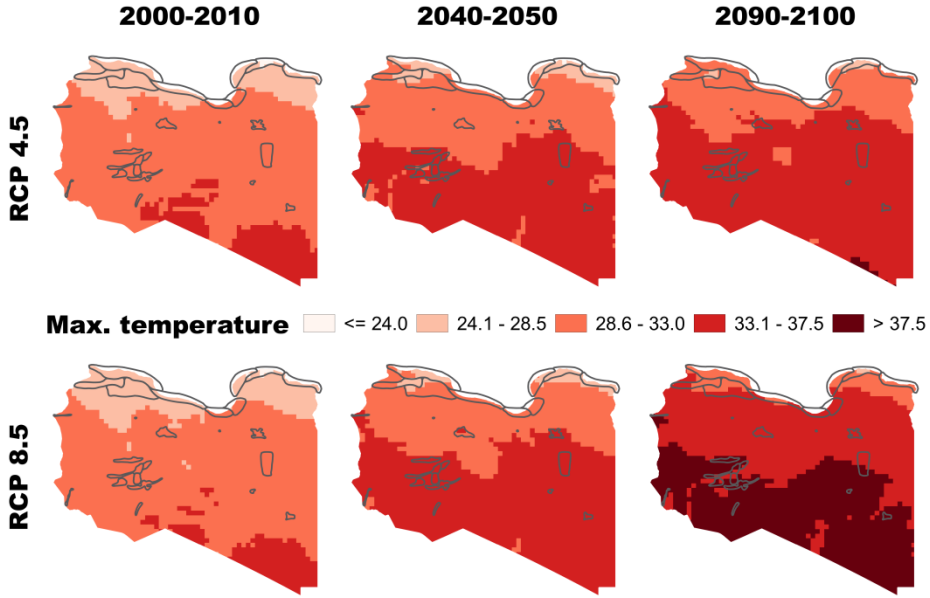
Figure 4: Precipitation changes 2000-2100




Future evolution of rain, as with current trends previously presented, is not clear[60,61]. In any case, both pathways, very similar, show a slight increase in precipitation around mid-century and then a decrease that will leave similar yet inferior values as of today. It is assumed, indeed, that a decrease in total precipitation will occur in coming decades, with more certainty for the end of the century[62]. However, precipitation must be considered along temperature where the trend is clearer.

## Temperature

Figure 5: Maximum temperature changes 2000-2100




## Maximum temperature

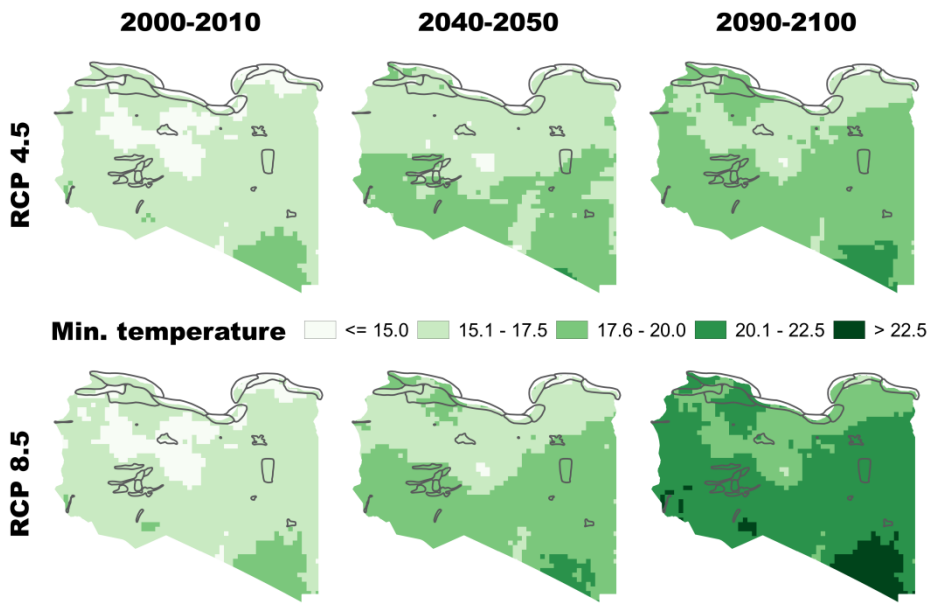
As indeed can be seen in the above figure, the case for maximum temperature is very clear, both in terms of temporal evolution and scenario forecasting. Both pathways show similar modelled situations for the past decade, both a northward displacement of the isotherms for mid-century too, yet the displacement is more pronounced for the high-emission scenario. Finally, for the end of the century, both scenarios are very different: the situation has more or less stabilised for the optimist scenario; the temperatures have dramatically increased in the case of the high-emission scenario.

[60] Cos, J., Doblas-Reyes, F., Jury, M., Marcos, R., Bretonnière, P.-A., and Samsó, M.: The Mediterranean climate change hotspot in the CMIP5 and CMIP6 projections, Earth Syst. Dynam., 13, 321–340,.

[61] Price, R.A. (2017). Climate change and stability in North Africa. K4D Helpdesk Report. Brighton, UK: Institute of Development Studies

[62] Zittis, G., Bruggeman, A., & Lelieveld, J. (2021). Revisiting future extreme precipitation trends in the Mediterranean. *Weather and climate extremes*, *34*, 100380.

Figure 6: Minimum temperature 2000-2100




### Minimum temperature

The evolution is similar in case of the minimal temperature evolution. It is important to note, though, that in this case the isotherms are not so well organised in bands, due to the high thermal range characteristic of desert areas. But in any case, the dynamic is similar to that of the maximal temperature: good correlation found for the last decade, a similar forecast for mid-century and a great divergence for the end of the century depending on which scenario is considered.

## Implications of changes in precipitation, temperature, and water resources

Although findings on changes in precipitation are not conclusive, there appears to be a consensus[63] that there will be a decrease in the total amount of rainfall in the coming decades. The current overview on the precipitation indicator, shows that the decrease will affect some areas particularly more than others, since only 5% (located on the coast) of the entire area of Libya exceeds 100 mm annually.[64] This has direct implications on precipitation-related matters such as rain-fed agriculture, but it also poses other problems related to water resources in general.

Libya is a country that only partially relies on agriculture to provide food for its population (agriculture makes up only 3% of the Libyan GDP in 2011) [65]. Precipitation is concentrated in the northern coastal areas of the country, namely Jabal Al Akhdar and Jabal Nafusah, and it directly affects these highlands where most of rainfed agricultural activity resides. In fact, these 2 areas account for more than 80% of the country's agricultural production[66] . Therefore, direct effects of changes in precipitation might not be the main concern for rainfed agriculture, which represents only a small proportion of the agriculture sector, however the effects of the decreased amount of rainfall can affect other sources of water that Libyans rely on heavily, for general consumption needs and especially in irrigated agricultural activity.

*"Water shortage is one of the most limiting factors affecting agricultural production in the country. Libya is one of the driest countries in the world with a limited annual rainfall combined with high rates of evapotranspiration and little*

[63] Schilling, J., Hertig, E., Tramblay, Y. et al. Climate change vulnerability, water resources and social implications in North Africa. Reg Environ Change 20, 15 (2020) a
[64] Brika, Bashir. 2018. "Water Resources and Desalination in Libya: A Review" *Proceedings* 2, no.11.
[65] FAO, 2019, Libya The impact of the crisis on agriculture Key findings from the 2018 Multi-sector Needs Assessment.
[66] *Heemskerk, W., Koopmanschap, E. (October 2012). Agribusiness development in Libya: A fact-finding mission. Centre for Development Innovation (CDI).*

*surface water resources available. Non-renewable groundwater provides the bulk of water needs for the country. Falling water tables caused by over-irrigation is creating a long-term ecological threat.* (WB, 2011)[67]".

Libya has already exceeded the renewable freshwater resources[68] and therefore combines several sources (desalination, groundwater) to meet the needs of the population. Many livelihoods (farming, livestock rearing) rely on irrigation, particularly shallow and fossil aquifers. This suggests that the decrease of precipitation can worsen the situation, since these sources are recharged by rainfall at a rate of approximately 650 million $m^3$ per year, while the withdrawn amounts seem to have already exceeded the replenishment rate by approximately 4 times.[69] So even the renewable sources of groundwater (the aquifers of Jefara plain, Al Hamda, Al Jabal Al Akhdar) are exposed to the risks of the lower precipitation rates in the coming decades. The difficulties accessing usable water resources for overall consumption or for agriculture specifically are further exacerbated by the excessive use of groundwater sources[70]. In addition, these resources are also affected by other issues such as the higher soil salinity caused by seawater intrusion and seal level rise. [71]

While seawater intrusion is expected to increase[72], its effects on the salinity of water can already be noticed in some of the basins. Studies have shown that, with a seawater interface inland advance of 1-2 km from 1950 to 1990, the salinity of coastal aquifers has increased from 150 ppm to approximately 1,000 ppm.[73] It is suggested that even with the most optimistic scenario of climate change and irrigation, by the end of the century, Libya would not be able to meet its irrigation water requirement.[74]

In terms of food security, these expected fluctuations in amounts and times of precipitations and their effects on other sources of water mean that there will repercussions on food availability in the country. Libya already imports most of its needs in terms of grains (importing 90% of cereal for its consumption requirements in 2015; while the country has the lowest per capita production, it also has the highest dependency on cereal imports[75,76]). This high dependence on imports is mainly due to political unrest in the previous years[77], however other reasons and expected changes, such as soil quality degradation, lack of access to useable water sources, higher water salinity and lack of precipitation could negatively affect crop yields, and thus push for more reliance on imports. This has an economic dimension as well, with losses of crops and difficulties maintaining livelihoods in agriculture, in addition to continuous increases in food prices (lack of local level production, higher prices of imported items – which can be caused by political conflict or natural factors such as conflicts or climate change in source markets), population and specifically more economically challenged groups could be at a higher risk of food insecurity.

It is suggested that climate change effects will have an impact all four dimensions of food security: availability, access, stability and utilisation of food.[78] Considering the access dimension, potential impacts could vary from direct impact on HHs' loss of agricultural livelihoods or lower income from such activities, to higher

[67] Ibid
[68] Sowers, Jeannie & Vengosh, Avner & Weinthal, Erika. (2011). Climate change, water resources, and the politics of adaptation in the Middle East and North Africa. Climatic Change.
[69] Abagandura, Gandura & Park, Dara. (2016). Libyan Agriculture: A Review of Past Efforts, Current Challenges and Future Prospects. Journal of Natural Sciences Research.
[70] Schilling, J., Hertig, E., Tramblay, Y. et al. Climate change vulnerability, water resources and social implications in North Africa. Reg Environ Change 20, 15 (2020).
[71] Sowers, Jeannie & Vengosh, Avner & Weinthal, Erika. (2011). Climate change, water resources, and the politics of adaptation in the Middle East and North Africa. Climatic Change.
[72] Abagandura, Gandura & Park, Dara. (2016). Libyan Agriculture: A Review of Past Efforts, Current Challenges and Future Prospects. Journal of Natural Sciences Research.
[73] Abagandura, Gandura & Park, Dara. (2016). Libyan Agriculture: A Review of Past Efforts, Current Challenges and Future Prospects. Journal of Natural Sciences Research.
[74] Schilling, J., Hertig, E., Tramblay, Y. et al. Climate change vulnerability, water resources and social implications in North Africa. Reg Environ Change 20, 15 (2020).
[75] Ibid.
[76] FAO, 2020. GIEWS global information and early warning system on food and agriculturem Libya Country Brief.
[77] Ibid.
[78] WFP, Jobbins, G., & Henley, G., 2015. Food in an uncertain future: the impacts of climate change on food security and nutrition in the Middle East and North Africa. Overseas Development Institute, London / World Food Programme, Rome.

costs of production making it more difficult to find or purchase staple food items within the HHs. This could be affected directly by the lack of availability of the yields on a national level or by the higher costs of imported foods. Barriers to access food could be related to displacement, which can be a result of extreme weather events due to climate change in the region.

Considering Libya belongs to one of the dustiest areas in the world which is the MENA Region, the effects of increasing risks of dust and sand storms on the environment and health of the population are to be considered when addressing future climate projections and their implications on populations. Although some of the main drivers of sand and dust storms are anthropogenic (such as land use changes), the main effects to consider are health risks for the populations (respiratory and cardiovascular illnesses and other infections).[79]

Extreme climate events, related to increase in temperature will have considerable effects on food security, meaning not only food production will be difficult but food availability can be jeopardised since one of the expected consequences of increases in temperature is a considerable decline of 20-55% in key cereals yield in part of the MENA region[80] . This is according to a projected scenario, where there is an increase of 3C° by mid-century.

Data about the continent can also be considered when addressing the climate change question, since there is still lack of country-specific evidence concerning Libya's projected climate shocks. There is a projected yield reduction of up to 40% in Africa, across all crop types and sub-regions, although this is a generalised finding, it could be an indicator to the magnitude of the effects that climate shocks will have on crops in the upcoming decades.[81]

Certain population groups, especially those who are already affected by the variability of prices of food items and those who have limited access to markets, to means to obtain food items, will then be dealing with limited access to and availability of food while potentially struggling with lower or no incomes from agricultural livelihoods. In addition, other compounding factors, such as changing food prices and poor infrastructure, or heat-stress related health problems, might further impact people's ability to utilise the food safely and could for instance also create food storage problems.

[79] World Bank. 2019. Sand and Dust Storms in the Middle East and North Africa Region—Sources, Costs, and Solutions. Washington, DC.

[80] WFP, Jobbins, G., & Henley, G., 2015. Food in an uncertain future: the impacts of climate change on food security and nutrition in the Middle East and North Africa. Overseas Development Institute, London / World Food Programme, Rome.

[81] Jerry Knox et al 2012. Climate change impacts on crop productivity in Africa and South Asia. Environ. Res. Lett. 7

# CONCLUSION

## Recommendations

### Institutional framework: Laws, policies, awareness-raising, and access to information

Although access to meteorological information is available via different channels (social media, radio and television), the use of these channels is not covering the need to raise awareness on climate change in general. A more effective communication around the potential hazards of climate change or new policies to tackle climate change could be done through these channels to ensure that populations have access to information.

The current legal framework on water management has had a limited effect on changing of behaviour in Libya towards more efficient water usage.[82] Information campaigns to raise awareness on sustainable use of water resources can be one way forward for spreading awareness and addressing inefficient use of water. Information campaigns targeting farmers could focus on the benefits of changing from the dominant sprinkler irrigation system to drip irrigation.[83] Overall, a legal framework that incentivises the use of low-use irrigation systems, and efficient water use activities (intercropping, aquaculture) could help the sector adapt to the growing challenges of water scarcity.

### Current and recent changes in climate

Considering climate change is already affecting livelihood activities and agricultural practices of some populations, the experiences of the affected populations can be integrated into the adaptation process. Populations have noticed drought, desertification and faced floods in their communities. All these events had an impact on their crop production, livestock, and assets, which means they can be a reliable source of information on how best to react to these events, and which types of support are needed according to the specificities of the region and the livelihood activities involved.

### Support infrastructure: social networks, assets, and financial services

Although most of the data in the field shows the importance of social networks in countering losses caused by climate change, the formal support infrastructure needs improvement. Many of the affected farmers turn to savings and assets whenever possible, but a reliable financial support structure could be vital, especially in the upcoming years when extreme climate events could become more frequent and the time to compensate and bounce back from them will be shorter. The lack of insurance services dedicated to farmers and to the different elements involved in the sector is problematic, especially to low-income populations. More resilience in livelihood zones could be achieved once these support services are implemented so that agricultural livelihoods are not lost entirely when affected by climate change.

[82] Abdudayem A. and Scott, A. H. S., "Water infrastructure in Libya and the water situation in agriculture in the Jefara region of Libya", African Journal of Economic and Sustainable Development, vol. 3, issue 1, 33-64, 2014

[83] Brubacher, M., "Climate-Fragility Risk Brief: Libya", 2021

## Access to climate resilient infrastructure, reliable electricity, and irrigation systems

In order to address the complexity of infrastructure-related problems, a focus on improving the existing structures can be the starting point. In Libya, this can be done by taking advantage of multiple opportunities. First, more efficient and adapted urban planning should be implemented since the population is already noticing that urbanisation is encroaching on agricultural land, meaning any new additions will have to take into consideration the need of the region and will have to adapt to the existing ecosystem. Second, the rebuilding of housing affected by the conflict and reconstruction of damaged climate-resilient infrastructure (dams damaged by the floods) can both be opportunities to redesign what these entities look like or what roles they play in the livelihood zone. The focus on climate-resilient infrastructure and rebuilding energy-efficient housing and cities can help to manage the climate crisis.

Electricity being a pivotal problem in Libya and specifically affecting agriculture is another area of adjustment; however, it can easily be exacerbated in the future if not developed further. The immediate need is to have more access to more stable electricity and to provide connections to electricity networks in all LZ, but with an emphasis on those who rely exclusively on irrigation to ensure the continuity of their agricultural projects. Population in these areas rely on electricity for daily living needs but their livelihoods also depend on their access to stable electricity to safely store their crops during or after production.

More importantly, this problem needs to be addressed by providing more sustainable solutions especially because the climate projections show higher temperatures and longer summers which translate into more pressure on the existing electricity systems. Therefore, renewable energy alternatives should be prioritised in the upcoming years, to ensure easy and widespread access of all livelihood zones to effective power sources. Resilience of the livelihoods will be tightly linked to the resilience of the power systems; therefore the alternatives must be considered and implemented in urban planning immediately. This is also a priority because Libya and North Africa more broadly are at an advantage considering the possibility to rely easily on solar energy.

In order to improve water-use efficiency and manage the available natural resources more effectively, a shift to low-use irrigation systems must be managed in all livelihood zones, regardless of the type of agricultural activity in it. This means that all livelihood zones, including those currently relying on rainwater, will adjust their systems, and shift to drip irrigation. The same is true for livelihood zones where the use of traditional irrigation systems such as flood irrigation is preferred as these practices will no longer be viable when precipitation is much lower, and underground aquifers are overexploited.

## Adaptation attempts, community-based initiatives, and maladaptation

In general, beyond awareness raising and providing information to all population groups, there is a need to strengthen knowledge of irrigation alternatives. Resilience cannot be limited to the current capacities, it is critical to include more adaptive strategies in the dialogue around climate change, as well as in the plans set to face potential climate shocks. This component relies on incorporating changes at a practical level, meaning mainstreaming the climate change dialogue and including it for instance in media stories and education programmes, in addition to the legislation.

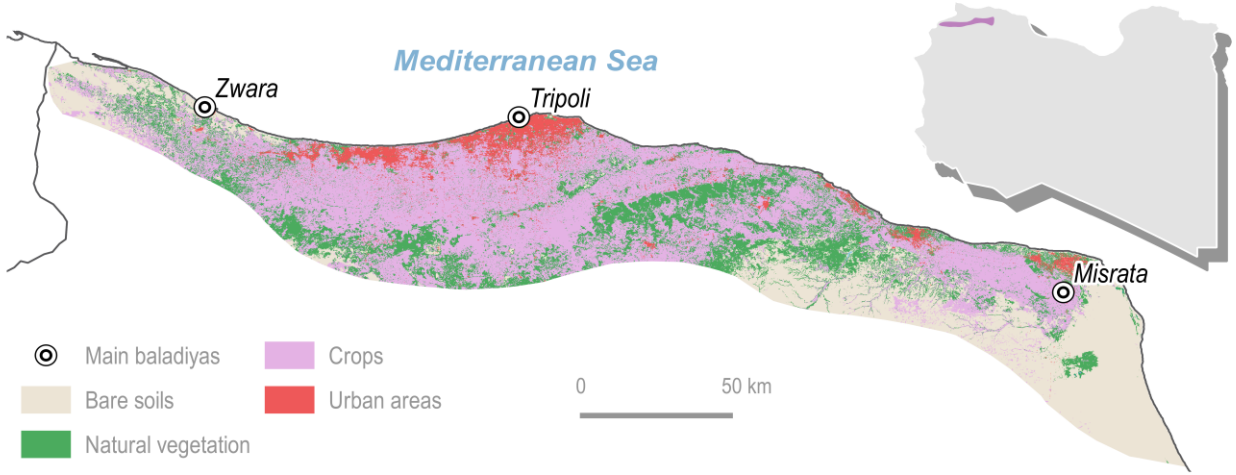
# ANNEXES

## Overall resilience scores

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| | Rank (1=extremely climate sensitive, 2=highly climate sensitive, 3=moderately climate sensitive, 4=not climate sensitive). | Rank(1= no livelihood diversity, 2= low livelihood diversity, 3= moderate livelihood diversity 4= very high livelihood diversity ) | Rank (1=extremely insecure) (2= severely insecure) (3= acceptable) (4= least insecure) | |
| Tripolitania coast | 2 | 2 | 4 | 8 |
| Jebel Nafusah | 2 | 3 | 3 | 8 |
| Nafusah Plain | 3 | 4 | 4 | 11 |
| Gulf of Sidra | 1 | 2 | 2 | 5 |
| Oil Crescent | 2 | 2 | 3 | 7 |
| Ghadamis border area | 4 | 1 | 4 | 9 |
| Ashshwayrif commercial zone | 4 | 2 | #N/A | #N/A |
| The Dates Golden line | 2 | 2 | 3 | 7 |
| Akhdar Plateau | 3 | 4 | 1 | 8 |
| Jebel al Akhdar | 3 | 4 | 4 | 11 |
| Cyrenaica border area | 3 | 4 | 4 | 11 |
| Fezzan agricultural wadis | 2 | 2 | 1 | 5 |
| Fezzan administrative centre | 2 | 4 | 2 | 8 |
| Fezzan plains | 3 | 4 | 3 | 10 |
| Ghat Border Area | 3 | 2 | 2 | 7 |
| Sarir plains | 4 | 1 | 2 | 7 |

# Assessed livelihood zones' profiles

## 1. Tripolitania coast




**Map 4: Tripolitania coast**

### Livelihood zone characteristics

This livelihood zone is located on Jefara plains and ranges from the coast to the mid-ranges of the Jebel Nafusah, the coastal plain of northern Africa, on the Mediterranean coast of north-western Libya and south-eastern Tunisia.[84] It is the most populated zone in Libya, with roughly about 1.5 million people distributed between the three main cities: Tripoli, Misrata, and Zwara. [85]

In the mapping workshop, in addition to government salaries, the main reported current livelihood activities in Tripolitania coast were livestock rearing, farming, and commerce. Due to the presence of archaeological sites, tourism was also identified as a livelihood activity during the mapping FGDs.[86] As expected in an urban continuum such as this area, stretching from Zliten to Misrata, the livestock sector is more or less industrial and focuses mostly on poultry, though extensive sheep and goat cattle is more dominant in some areas. It is reported in this zone that access to markets is easy; and the production is sold in local markets.

The regions' agricultural activities are both rain-fed and irrigated, with olives reportedly being the main crop, followed by almonds, fruits, and vegetables. The GMMR remains the main water source for domestic consumption, a supply endangered by fuel shortages, power outages, and irregular connections to the water network.[87] The main reported obstacles to making a living were the local water sources, that are a part of the Al Jefara aquifer located in the area, which are subject to salinsation, as well as the limited availability of climate-resilient infrastructure and the retreating agricultural livelihoods due to urban encroachment.

### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Tripolitania coast | 2 | 2 | 4 | 8 |

[84] Britannica, The Editors of Encyclopaedia. "al-Jifārah". Encyclopedia Britannica, 20 Jul. 1998,
[85] Source: **Worldometer** (www.Worldometers.info). Elaboration of data by United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2019 Revision. (Medium-fertility variant).
[86] Step 1 of Libya CLEAR Assessment, *November 2021.*
[87] The Libya Observer, February 2022, MMRA announces maintaining a water leak in Gharyan

**Table 4 Key of colours for resilience profile tables**

| Food security | Climate sensitivity of food/income | Livelihood diversity | Climate resilience |
|---|---|---|---|
| Least secure | Extremely climate sensitive | No diversity | Very low |
| Moderately secure | Highly climate sensitive | Low diversity | Low |
| Highly secure | Moderately climate sensitive | High diversity | Moderate |
| Most secure | Not climate sensitive | Very high diversity | High |

**Potential hazards**

FGD corresponding to this livelihood zone, participants were some of the few in the assessment reporting that their area/city had never experienced disasters such as floods, they suggest that since this has been their environment, the current infrastructure they have might not be able to withstand shocks, especially events they consider "new" to their area. This is another factor to consider in assessing the resilience of the zone, since it will potentially be facing different types climate shocks. The Tripolitania coast falls within the areas with: The highest precipitation values and mountainous landscapes, so potentially recurrent heavy precipitation events will cause a series of consequences[88] as well as precipitation that is expected to be more erratic in the future and diminish by the end of the century.

The Tripolitania coast scores 4, hence, most secure on the Food Security indicator with merely 8.3% of HHs with a poor or borderline Food Consumption Score (FCS).[89] Thus, food security in the livelihood zone's food access and adequacy could be less affected than other zones with a lower score on this indicator.

On the crop and livelihood sensitivity ranking, the Tripolitania coast scores a 2, indicating the zone is relatively sensitive to climate threats. This is due to the main reported livelihood activities other than government salaries being climate-sensitive activities, such as livestock rearing, farming, and tourism. Commercial activities were also mentioned as a main activity, but they are used to in combination with other activities. At the mapping workshop, participants also mentioned fishing as an additional livelihood activity. Hence, only commercial activities in the livelihood zone are non-climate-sensitive.

In terms of livelihoods diversity, the Tripolitania coast zone was categorised as a 2 meaning it belongs to the group of livelihood zones where a few income-generating activities were available to HHs. During the mapping workshop, participants reported that there are at least 3 livelihood activities other than government salaries; 1 grazing-ranching 2 farming, 3 commerce. Participants in the Jefara plains FGD mentioned that they engage in at least 2 livelihood activities as their main source of income, with livestock breeding and agriculture emerging as the most frequently reported combination.

[88] World Meteorological Organisation,

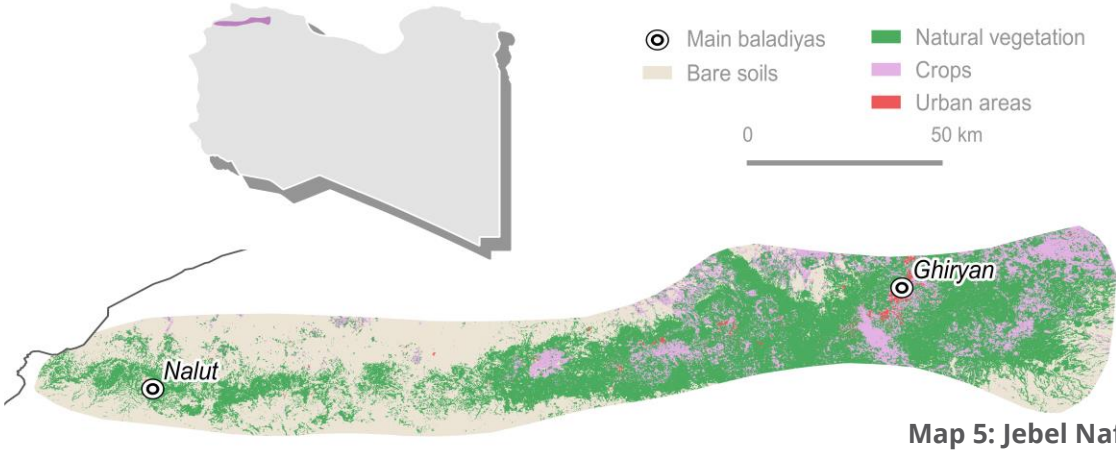
[89] REACH, "Multi-Sector Needs Assessment (MSNA) food security dataset", 2021

# 2. Jebel Nafusah

### Livelihood zone characteristics

This livelihood zone is located in the Nafusah Mountain, in the northwest of Libya. Jebel Nafusah is a hilly limestone massif that extends between the Jefara plains and Al Hamra Plateau and runs in a curve from the Tunisian borders to the hills on the Mediterranean coast. The heights of the mountain range from 460 to 980 meters. Rainfall in this area varies from 51 to 406 mm[90]. The population of its two main towns (Gharyan and Nalut) combined, is over 111,000 people[91].

This hilly area east of the country with steppe climate is characterized by the presence of different livelihood activities, first, agriculture in medium sized rain-fed farms, then caprine extensive cattle, followed by trade and local industries. Olive is the main reported crop in the workshops. The water sources for household consumption are local sources and the GMMR. Access to markets is reportedly easy with some security issues highlighted during the workshops.




Map 5: Jebel Nafusah

### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Jebel Nafusah | 2 | 3 | 3 | 8 |

### Potential hazards

Considering this LZ belongs to the area with highest precipitation values and mountainous landscapes. There will be a series of precipitation related consequences, including thunderstorms and hail, heavy rains, snow as well as flash floods. Changes mainly in precipitation will start as erratic but eventually decrease at by the end of the century. Although, these are more long term changes, this LZ will mainly be affected in terms of livelihoods, since most agricultural activity is located here and most of the yields of crops come from its farmlands, both rainfed and irrigated by groundwater. This means that populations can face unemployment, if the circumstances become too difficult to undertake agricultural activities in terms of environmental factors or because of high costs of production inputs. This also puts residents of the zone, as well as other population groups who consume the food items produced from this region, at risk. This can jeopardize the access to food for those who rely on local markets to respond to their HHs needs.

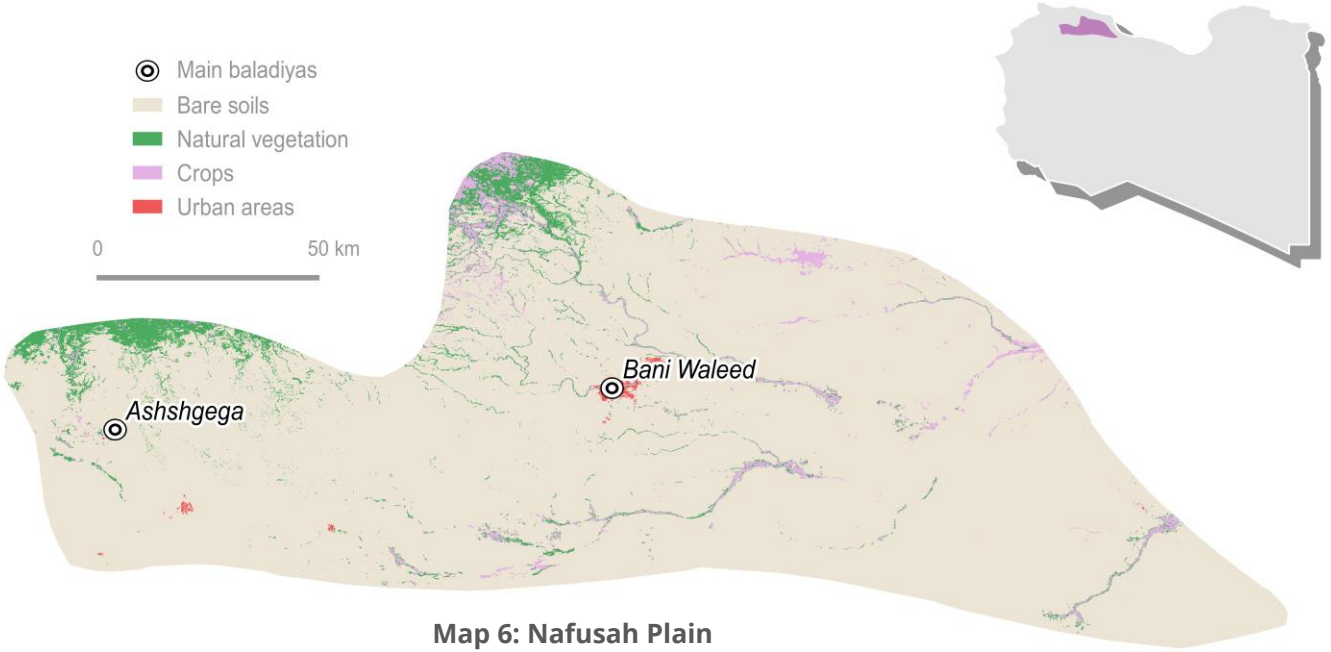
[90] Britannica, T. Editors of Encyclopaedia (2015, July 3). Nafūsah Plateau. Encyclopedia Britannica.
[91] Population of Cities in Libya (2022), World population review.

# 3. Nafusah Plain

### Livelihood zone characteristics

During the workshop, participants changed this livelihood zone by expanding it to include all of Alshgega. It is located in the plains around the Nafusah Mountain. It does not contain any major cities and is drawn around the balaldiya of Bani Waleed with a population of 46,350 [92].

Though receiving more rain than most of the country, the dominant climate here is desert. The main reported activity is rain-fed agriculture, producing grain and olives in medium-to-big average plots. Industry was also mentioned as an important source of livelihoods with reference to the resources in woollen industry such as the carpet factory as well as the military industry factory and handicrafts in general. For the domestic water supply of this rural area different sources are used, from GMMR to desalination plants.




**Map 6: Nafusah Plain**

### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Nafusah Plain | 3 | 4 | 4 | 11 |

### Potential hazards

Based on the climate of this area and the average precipitation values it usually receives, the potential hazards to consider could be heavy rainfall.

[92] Population of Cities in Libya (2022), World population review.

# 4. Gulf of Sidra

### Livelihood zone characteristics

The Gulf of Sidra is a desert coastal band home to cities as Sirt and Ajdabiya, with a population just over 250,000 people in the 2 cities combined, but otherwise with a rural character. Livestock is predominant over agriculture, with camels, sheep and goats as the main reported cattle, besides state-owned cow farms. Regarding agriculture, rain-fed fodder and grain are the main reported crops. As for domestic water consumption, a mix of local underground, GMMR and desalination waters are used.

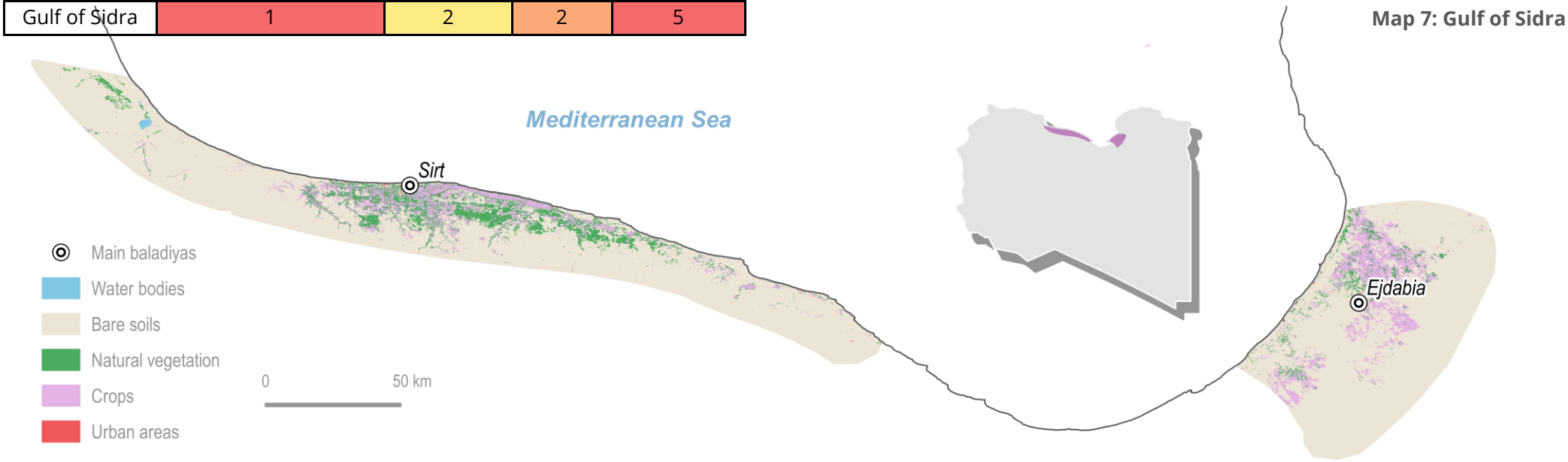
### Potential hazards

The main hazard this LZ faces is the sea-level rise. Indeed, it is a low-lying flat area with populations and infrastructure concentrated in the coast. The rise will happen, but the magnitude remains to be seen, and it depends on many variables to be determined or monitored with precision. It is also noticeable that this and the following LZ are part of the most seismically active area of the Mediterranean (see part III of the report) and, though the probability is extremely low, a seism and the subsequent tsunami is part of the hazards this LZ faces.

### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Gulf of Sidra | 1 | 2 | 2 | 5 |

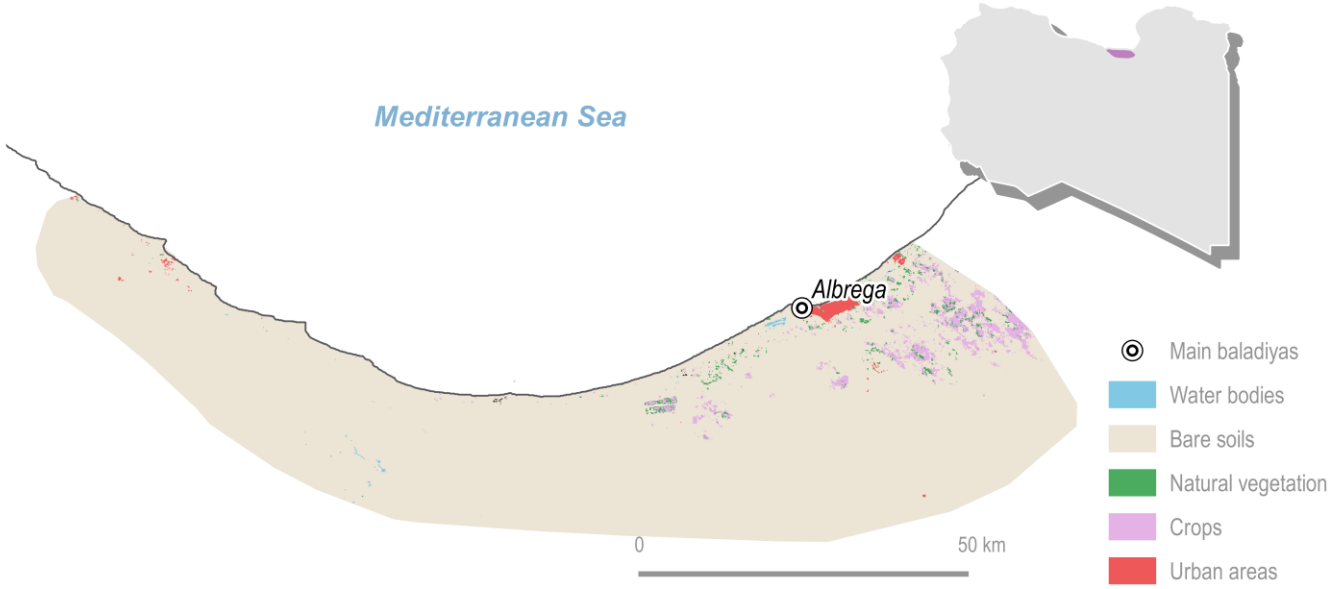
**Map 7: Gulf of Sidra**



# 5. Oil Crescent

### Livelihood zone characteristics

The Oil Crescent usually refers to the whole Gulf of Sidra. Here it has been reduced to the area with a major concentration of industry and infrastructure related to oil. Caprine and camel breeding is also mentioned as a prominent livelihood activity. GMMR is mentioned as the sole water source.




Map 8: Oil Crescent

### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Oil Crescent | 2 | 2 | 3 | 7 |

### Potential hazards

Considering this livelihood zone belongs to the same areas as the other LZ with critical consequences related to rainfall and sea level rise on the coast, the potential hazards it may face in the future could be a tsunami.

# 6. Ghadamis border area

### Livelihood zone characteristics

This area concentrates historical ruins and archaeological sites that make tourism the main source of livelihoods mentioned in the workshops. It is located in the border with Tunisia and Algeria and Ghadamis (population of 7000 residents) is the main city. The main reported crop for those who are active in agricultural activities, is dates. Groundwater is the main source of water for any use.

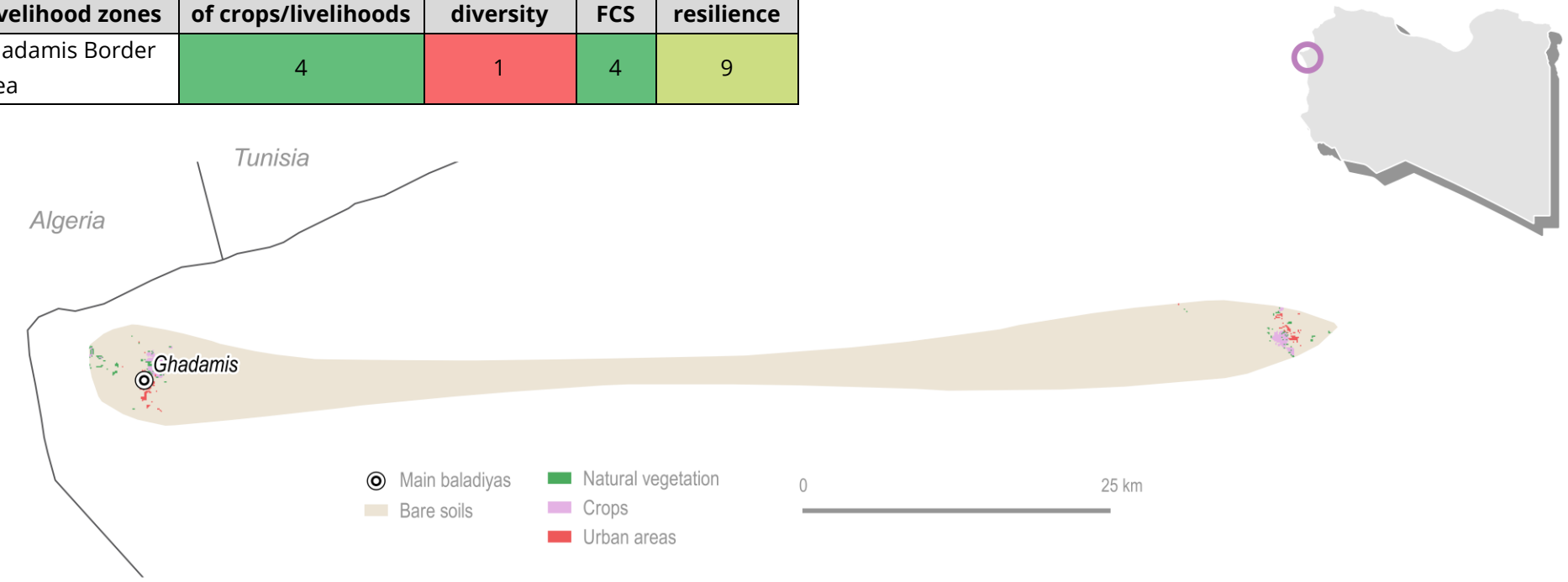
### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Ghadamis Border area | 4 | 1 | 4 | 9 |

### Potential hazards

This livelihood zone falls under the category which will be going through a gradual shift in climate which will change its characteristics in the long term. This transition area where the LZ is located, is nowadays in the >10 mm rainfall belt. By the end of the century, it will not be thus, and the conditions will be rather like current southern Libya.

**Map 9: Ghadamis border area**



# 7. Ashshwayrif commercial zone

### Livelihood zone characteristics

This relatively smaller livelihood area is, as its name points out, a mandatory transit point between the west and the south. Therefore it relies on the subsequent trade as a source of income. Livestock is also mentioned as an important livelihood activity. Some obstacles related to the needs in terms of support for livestock breeders during periods of lack of precipitation and the case of drought were also reported in this sector by workshop participants. The main urban area in the zone is Ashshwayrif municipality. As for water sources, the GMMR pipes going northward supply Ashshwayrif and bordering areas. Access to markets is considered easy due to the nature of the livelihood activity, despite the long distances in some locations.

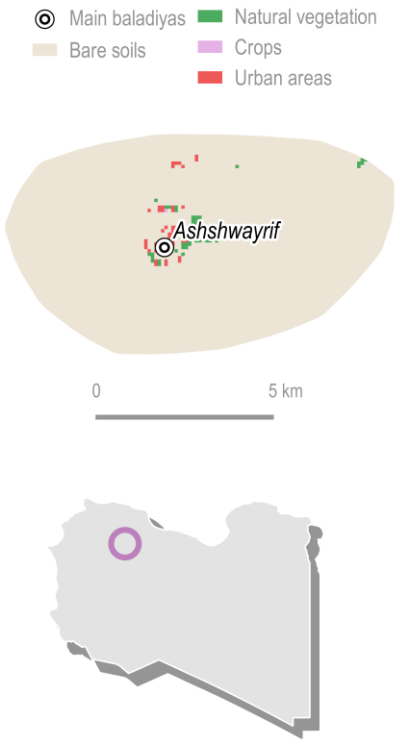
### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Ashshwayrif commercial zone | 4 | 2 | N/A | N/A |

### Potential hazards

This livelihood zone falls under the category which will be going through a gradual shift in climate which will change its characteristics in the long term. This transition area where the LZ is located, is nowadays in the >10 mm rainfall belt. By the end of the century, it will not be thus, and the conditions will be rather like current southern Libya.

**Map 10: Ashshwayrif commercial zone**



# 8. The Dates Golden Line

### Livelihood zone characteristics

The name comes from the fact that it is the optimal climate for dates as reported in the workshops and FGDs. Therefore, dates production is the main reported activity. A particular race of sheep[93] is also raised in Aljufra. Besides, historical sites are to be found in the area. Plantation size is usually small however there are larger government owned projects such as Awjilah / Jallo Agricultural Project and Abubaker Younis Jaber palm tree project reported around Al Wahat. Water for irrigation and consumption is supplied by underground resources. There is also an emphasis on service-based livelihoods (Public Service Companies (logistics), rental of cars or trucks, financing the oil fields) since there are oil and gas fields around Jalou.

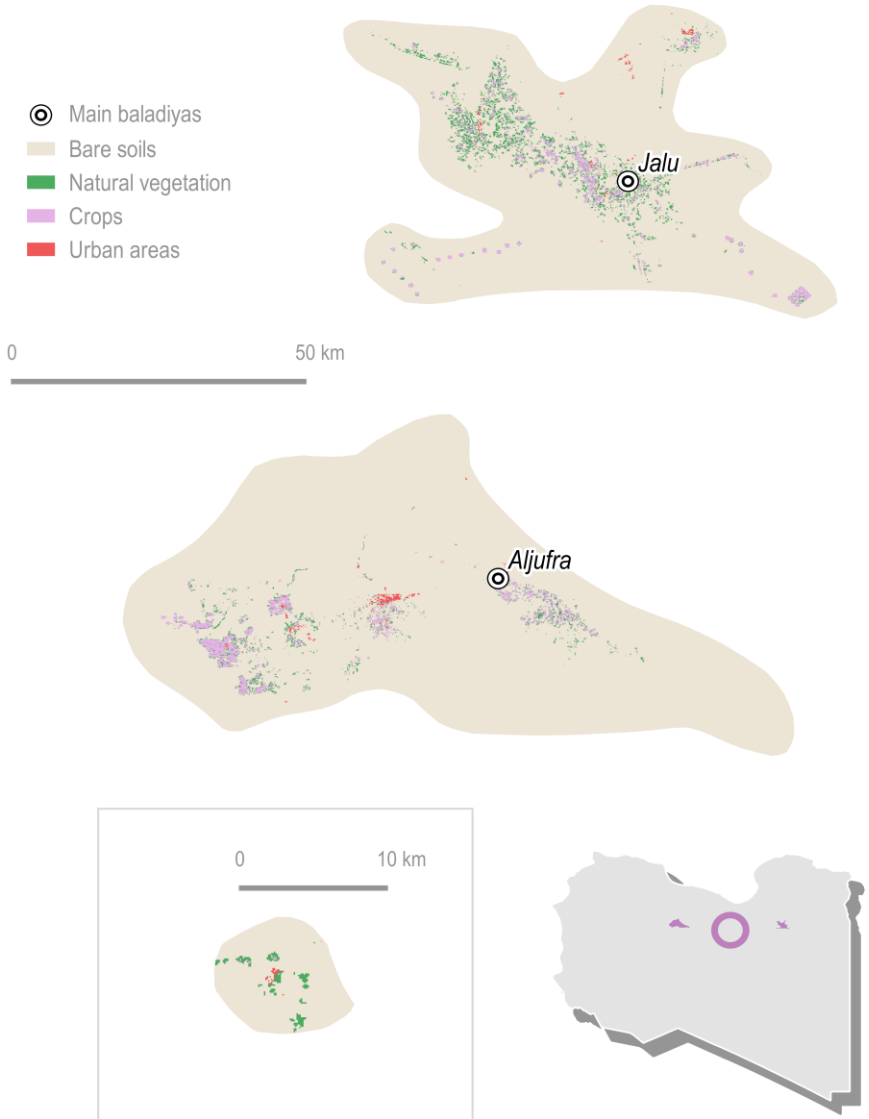
### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| The Dates' Golden line | 2 | 2 | 3 | 7 |

### Potential hazards

Potential hazards that threaten this are the ones affecting the transit area going from the current climate to more southern-like climate within the next years by the end of the century.

**Map 11: The Dates Golden Line**




[93] The area has Barbary sheep, Genre: Ammo tragus. It's a rare animal breed.

# 9. Akhdar Plateau

### Livelihood zone characteristics

Located in the northeast of Libya, this livelihood zone lies between the coast of the Mediterranean and the Jebel Al Akhdar mountain range. It includes Al Marj plains and ranges from there down to Benghazi and its surroundings which is the second most populated city in the country, home to more than 650,000 residents and an important service and transportation hub, with its harbour and airport. The main livelihood activities mentioned in the workshops are agriculture, followed by livestock rearing as well as fishing and the participants also refer to the biological diversity of the area and the presence of several private projects in a variety of sectors: poultry farms and products project poultry farms and products project olive oil extraction, beekeepers, flour mills, textiles, tanning. Both irrigation and rainfed agriculture are present in this zone and the main crops are grains and vegetables.

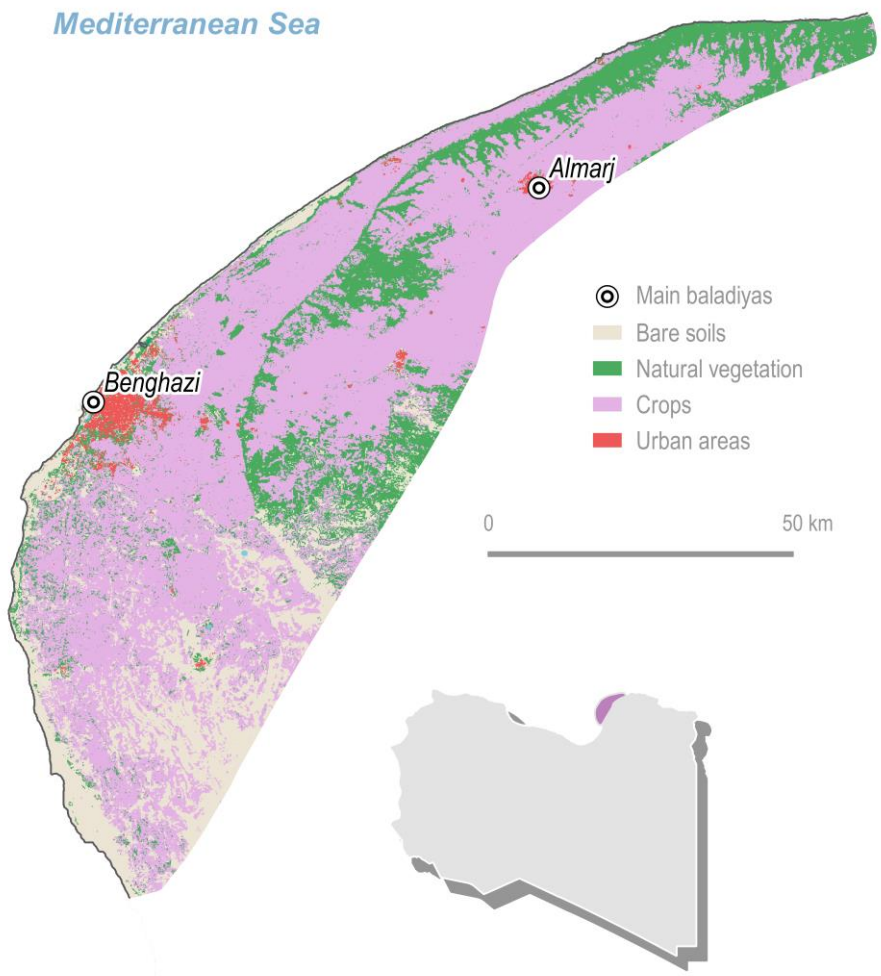
### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Akhdar Plateau | 3 | 4 | 1 | 8 |

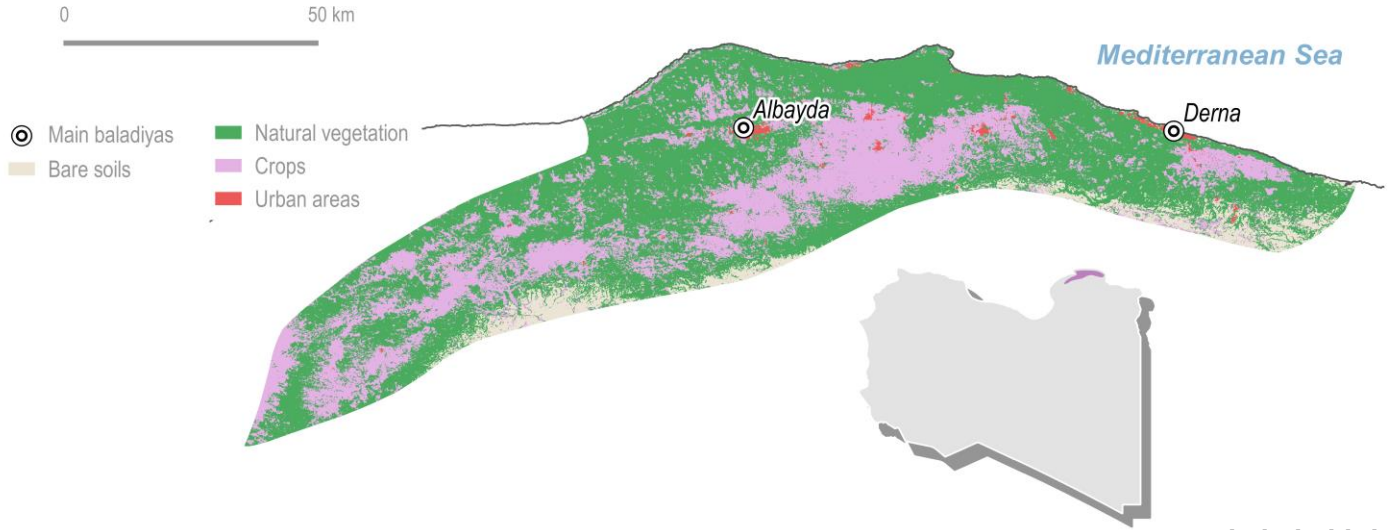
### Potential hazards

The livelihood zone of Al Akhdar plateau, belong to the areas with highest precipitation values and mountainous landscapes. This means it is also threatened by recurrent heavy precipitation events that can cause a series of consequences. Precipitation is expected to be more erratic in the future and diminish by the end of the century.

**Map 12: Akhdar Plateau**



# 10. Jebel Al Akhdar




Map 13: Jebel Al Akhdar

### Livelihood zone characteristics

With its Mediterranean climate, and lying at up to 900 meters of altitude (880 m in Sidi AlHamri area this zone is consists of the Akhdar mountain located in north-eastern Libya on the coast and ranging from the city of Derna, towards Al Marj. [94] The population of its two main baladiyas combined reach more than 150,000 residents.

As the map shows crops being cultivated all around the zone, agriculture is one of the main livelihood activities along with commerce. The workshop participants also mention other activities such as livestock production, beekeeping, fishing, tourism but they consider the most important ones to be public sector jobs, agriculture then commerce. For agriculture, rainwater, groundwater, and desalinated sea water are used. As for crops, they are diverse and include fruits, vegetables and grains. The livestock sector has the typical animals such as sheep, goats, cows and camels but in this zone, participants also add beekeeping, and bird breeding and horses to the list. They also report selling their products in the easily access markets nearby.

### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Jebel al Akhdar | 3 | 4 | 4 | 11 |

### Potential hazards

Being one of the zones located on highland, the Jebel Al Akhdar livelihood zone is threatened by the same potential hazards affecting zones with the same geographic characteristic. Considering this zone has comparatively high rainfall (375–500 mm annually)[95], the effects of recurrent heavy precipitation events will cause a series of consequences in the region. In addition, it is expected that precipitation will be more erratic in the next decades and diminish by the end of the century, so the zone will be affected by the consequences of both of these changes.

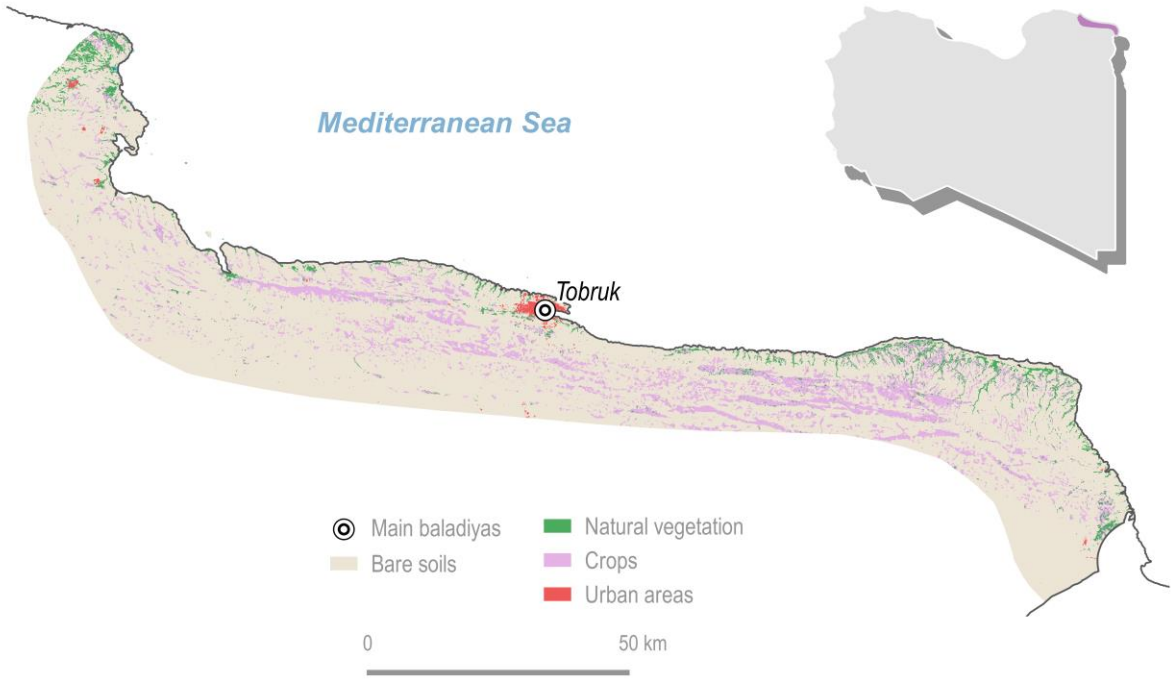
[94] Britannica, T. Editors of Encyclopaedia, Akhdar Mountains.

[95] Ibid.

# 11. Cyrenaica border area

### Livelihood zone characteristics

This border area, in the northeast of Libya, is home for Tobruk, the city's port, and its 121,052 residents[96]; it is a high plateau area where commerce is the main livelihood activity, followed by agriculture, hunting and other income sources such as government jobs and custom fees since this zone is located on the border. Water sources used for the different activities are groundwater, rain water as well as desalinated water; agriculture in this area relies on these sources to produce mainly fruits (watermelon, figs) as well as wheat and barley. The products are sold in markets, which are easily accessed.




**Map 14: Cyrenaica border area**

### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Cyrenaica border area | 3 | 4 | 4 | 11 |

### Potential hazards

Considering the location of this zone, being on a comparatively higher region with relatively higher precipitation values, it is classified with the livelihood zones that will face the hazards produced by the changes in the climate in terms of precipitation. Recurrent heavy precipitation events cause a series of consequences. Precipitation is expected to be more erratic in the coming decades and diminish by the end of the century.

[96] Population of Cities in Libya (2022), World population review.

# 12. Fezzan Agricultural Wadis

### Livelihood zone characteristics

Located in the Fezzan region, South of Libya, this livelihood zone is composed of three different areas with similar geographic characteristics. The main baladiyas in each of them are Brak (population: 39,444), Ubari (population: 42,975) and Murzuq (population: 43,732)[97]. In the Fezzan region, characterized by the traditional agriculture that has been carried on for millennia, this zone's main livelihood activities as mentioned by the workshops participants are: agriculture, livestock production, extractive industries and trade. As reported in the workshop, besides the historical heritage and cultural events of the region which create opportunities for tourism, this livelihood zone is also characterized by its fertile land.

Though grain and fodder remain the most economically important crops, dates are also produced in the zone. Poultry and caprine livestock productions are among the mentioned activities and the water used for all of these operations is groundwater.

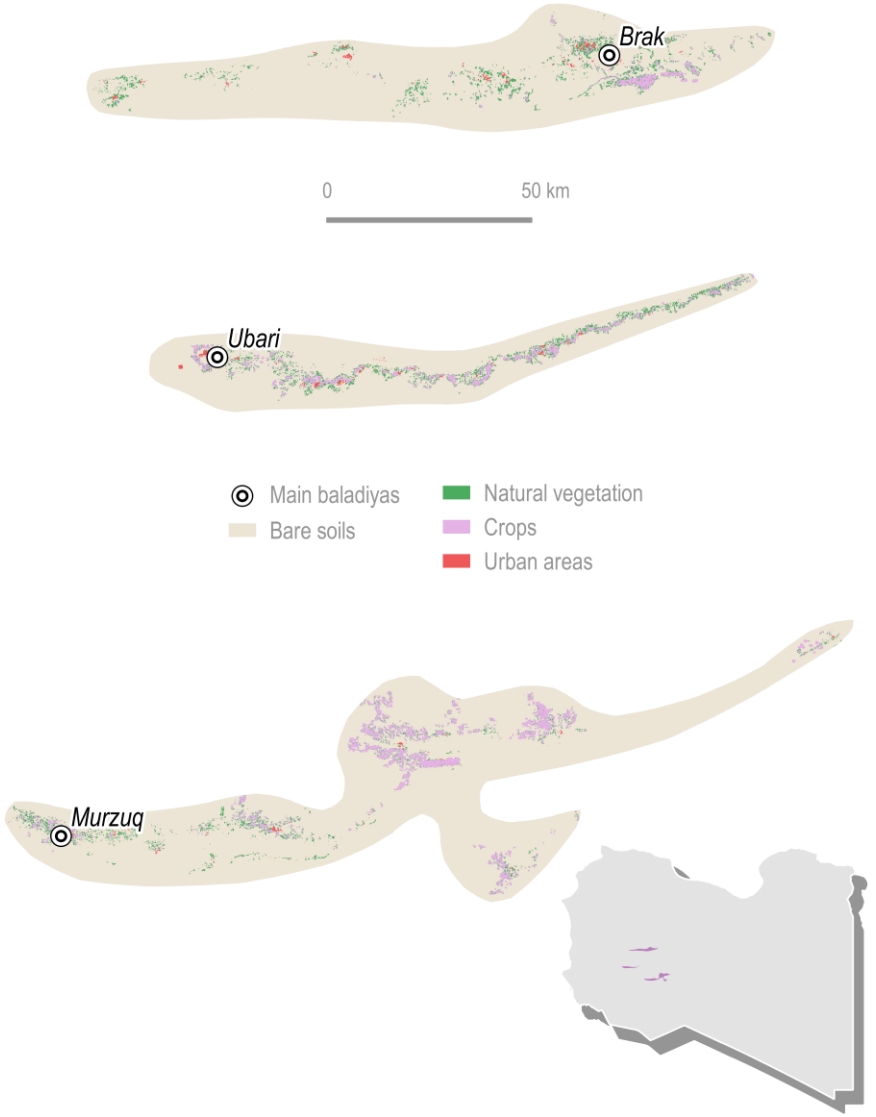
### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Fezzan agricultural wadis | 2 | 2 | 1 | 5 |

### Potential hazards

The main climate hazard affecting the South of Libya will be the rising temperatures and the consequences it entails.

**Map 15: Fezzan Agricultural Wadis**




[97] Population of Cities in Libya (2022), World population review.

# 13. Fezzan Administrative Centre

### Livelihood zone characteristics

According to the workshop data, this zone is considered “the undisputed capital of the south, and it contains most health, educational and even administrative services of the southern region”. This area is dominated by Sebha (130,000 residents). It concentrates the administration, services and skilled jobs positions in the southern region. Besides government jobs, agriculture is also present as one of the main livelihood activities with small family farms producing mainly grains and fodder, as well as olive and dates. It is followed by the breeding of caprine livestock and camels and quarries in some parts of Sebha. Groundwater is the only source of water available for the different activities.

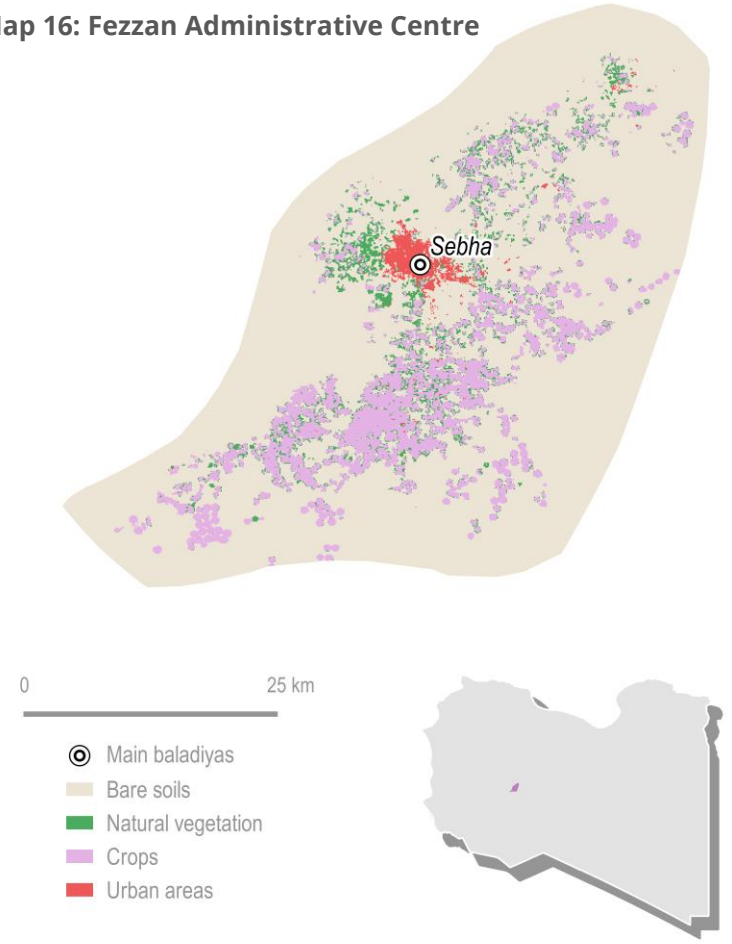
### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Fezzan administrative centre | 2 | 4 | 2 | 8 |

### Potential hazards

The main climate hazard affecting the South of Libya will be the rising temperatures and the consequences it entails.

Map 16: Fezzan Administrative Centre



# 14. Fezzan Plains

### Livelihood zone characteristics

This livelihood zone is composed of 4 areas, all located around the Fezzan administrative centre and in proximity to Fezzan agricultural wadis. It brings together the areas located in the plains of the Fezzan region, similar in environment as well as in livelihood activities. The main reported activities in this zone are agriculture, livestock production, which are followed by either trade, or quarries depending on the different locations. The main crops produced are mainly grains and fodder, then fruits and vegetables. All the components of the zone rely on groundwater for all of their activities. However, access to markets is reportedly challenging in most of the zones in the South, mainly due to security issues, decayed roads and lack of fuel, causing high cost of transportation.

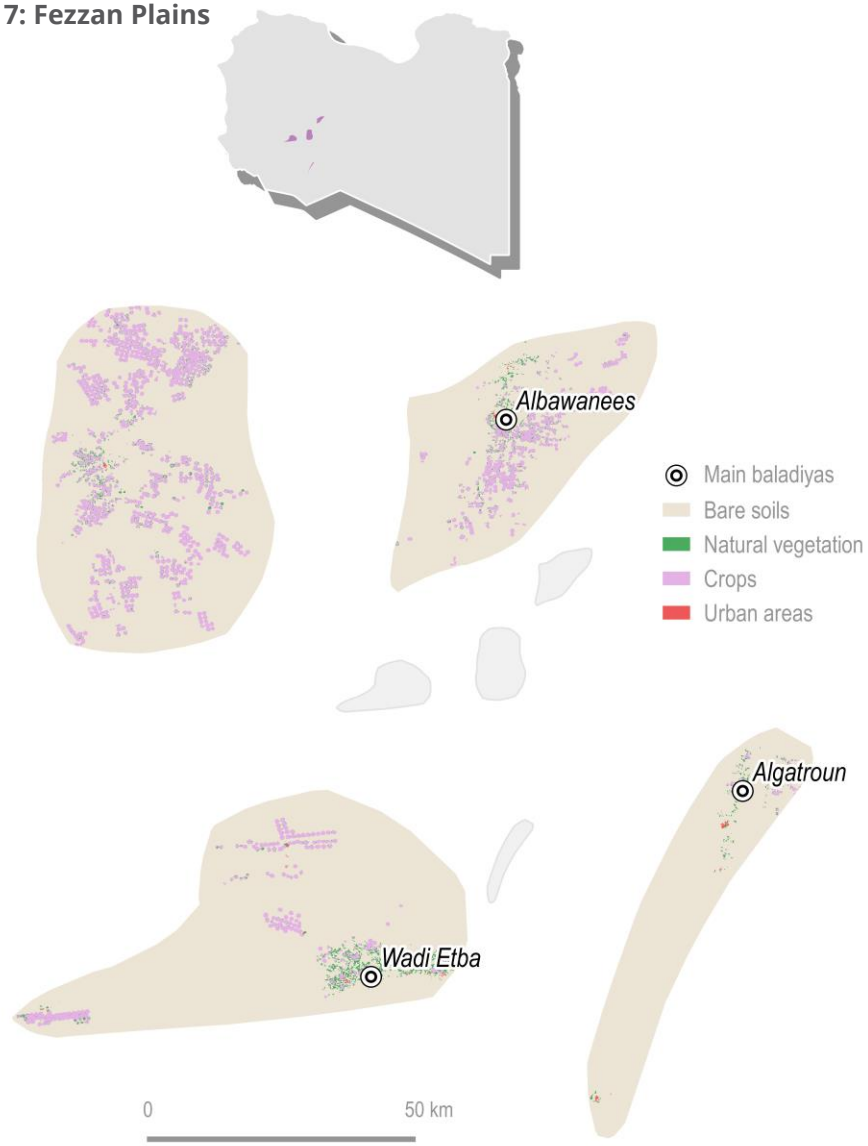
### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Fezzan plains | 3 | 4 | 3 | 10 |

### Potential hazards

The main climate hazard affecting the south of Libya will be the rising temperatures and the consequences it entails.

**Map 17: Fezzan Plains**



# 15. Ghat Border area

### Livelihood zone characteristics

Drawn around Al Ghat (24,347 residents), this mountainous valley in the border with Niger is characterized by the good quality of its soil and the abundance of water, as reported in the workshop. This is potentially why the main livelihood activity is agriculture. This area's main crops are grain and fodder. The second livelihood activity is livestock production which includes: sheep, goats, poultry and camels, cows. This area is also a tourist destination. Despite agriculture being its main livelihood activities, experts in the workshop reported reluctance towards agriculture and find that the production rate is low.

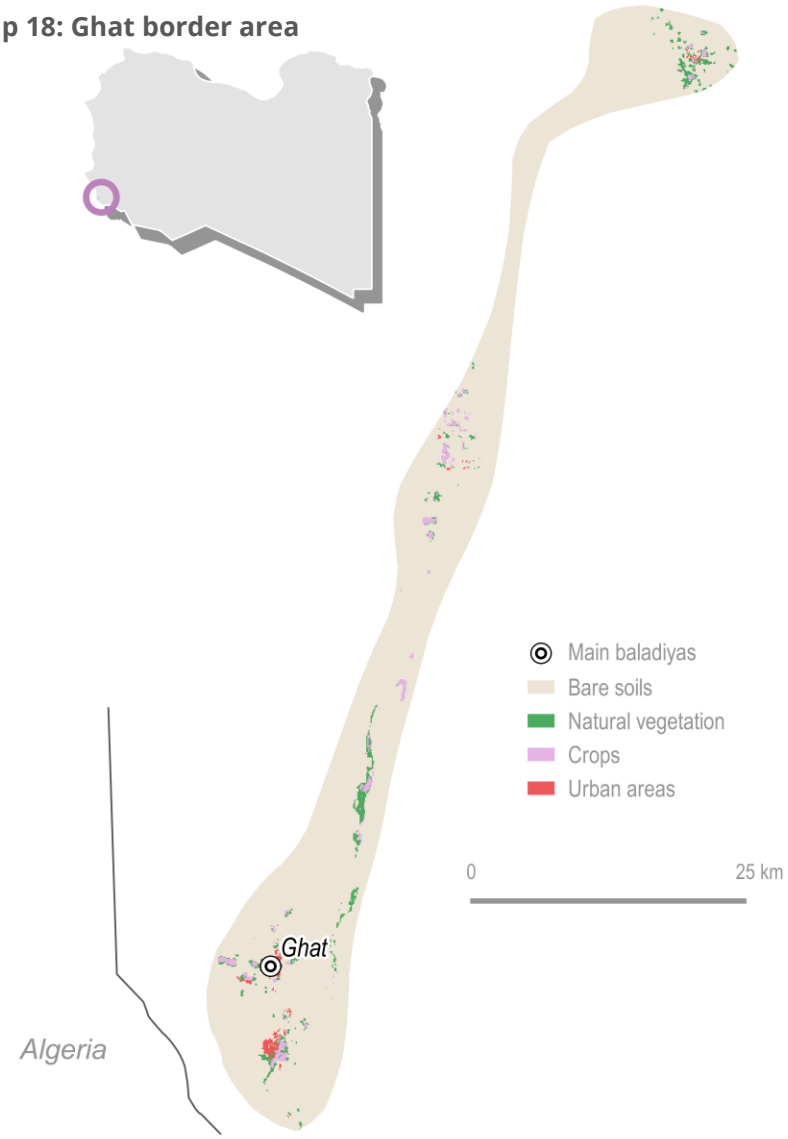
### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Ghat Border Area | 3 | 2 | 2 | 7 |

### Potential hazards

The main climate hazard affecting the South of Libya will be the rising temperatures and the consequences it entails. In this particular area however, the recent events show that one of the potential hazards would be flash floods. In 2019, the zone faced a wave of heavy rainfall and thunderstorms that hit the south-western region of Ghat from 28 May till 6 June, causing flooding and damage in several locations of the region. The floods affected over 20,000 people with over 5,075 people displaced[98].

Map 18: Ghat border area




[98] Libya Food Security Sector, 2019 Year in Review.

# 16. Sarir plains

### Livelihood zone characteristics

Located in the Libyan desert, this livelihood zone in the East of the country also combines three different locations. Two are drawn around two baladiyas, namely Al Kufra and Tazirbu, while the third component is a large-scale agricultural project in Al Srir Field. In Al Srir Field, there are no permanent residents, only those who are there for professional purposes. This is also why the main livelihood activity besides agriculture is the service sector, catering to those working there in the oil and gas industries mainly. Groundwater in this region is used for all types of consumption.

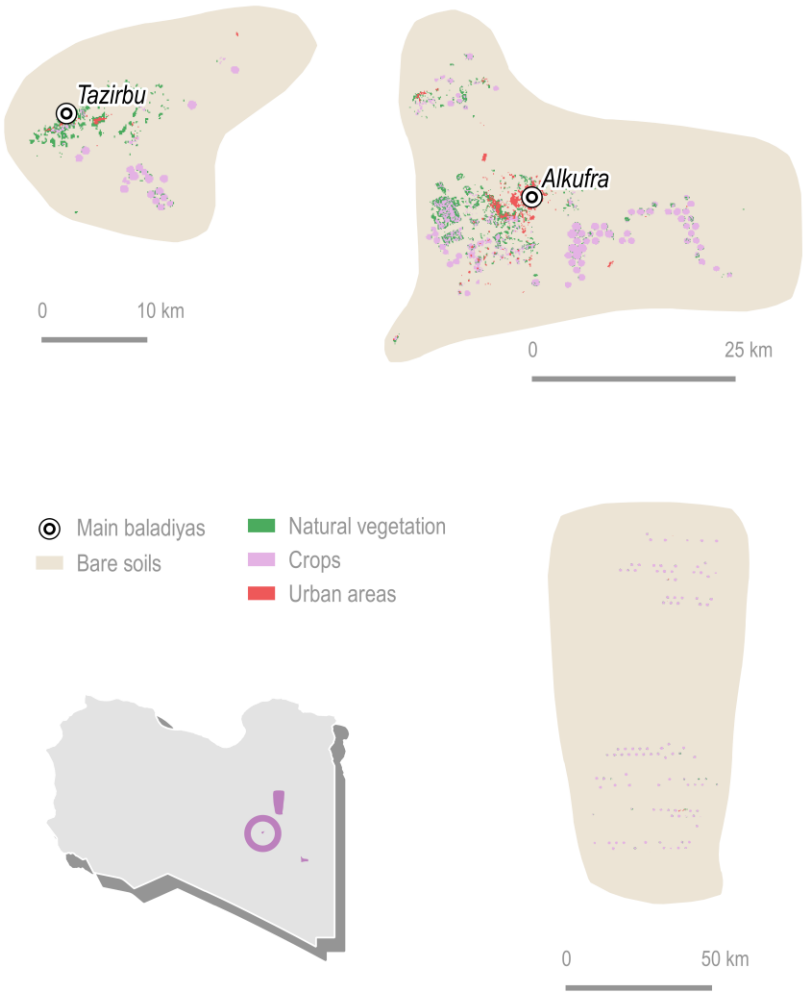
### Resilience profile

| Livelihood zones | Climate sensitivity of crops/livelihoods | Livelihood diversity | FCS | Climate resilience |
|---|---|---|---|---|
| Sarir plains | 4 | 1 | 2 | 7 |

### Potential hazards

The main climate hazard affecting the South of Libya will be the rising temperatures and the consequences it entails.

**Map 19: Sarir plains**



| Livelihood zones | Baladiyas | Source to use for FCS |
|---|---|---|
| Tripolitania coast | Azzawya<br>Janzour<br>Hai Andalus<br>Swani Bin Adam<br>Abusliem<br>Qasr Bin Ghasheer<br>Tripoli<br>Suq Aljumaa<br>Ain Zara<br>Tajoura<br>Al Aziziya<br>Tarhuna<br>Zliten<br>Misrata<br>Tawergha | 2021 MSNA |
| Jebel Nafusah | Nalut<br>Kabaw<br>Alharaba<br>Baten Aljabal<br>Azzintan<br>Yefren<br>Thaher Aljabal<br>Kikkla<br>Alasabaa<br>Ghiryan | 2020 MSNA |
| Nafusah Plain | Ashshgega<br>Nesma<br>Bani Waleed<br>Abu Qurayn | 2020 MSNA |
| Gulf of Sidra | Sirt<br>Ejdabia | 2021 MSNA |
| Oil Crescent | Albrega | 2021 MSNA |
| Ghadamis border area | Daraj<br>Ghadamis | 2020 MSNA |
| Alshshwayrif commercial zone | Ashshwayrif | NO DATA |
| The Dates' Golden line | Aljufra<br>Marada<br>Aujala<br>Ejkherra<br>Jalu | 2021 MSNA |
| Akhdar Plateau | Toukra<br>Al Abyar<br>Benghazi<br>Gemienis<br>Suloug | 2021 MSNA |
| Jebel Al Akhdar | Derna | 2021 MSNA |
| Cyrenaica border area | Tobruk<br>Umm arrazam<br>Bir Alashhab<br>Emsaed | 2020 MSNA |
| Fezzan agricultural wadis | Edri<br>Brak<br>Ubari<br>Alghrayfa<br>Murzuq<br>Alsharguiya | 2021 MSNA |
| Fezzan administrative centre | Sebha | 2021 MSNA |
| Fezzan plains | Wadi Etba<br>Algatroun | 2021 MSNA |
| Ghat Border area | Ghat | 2021 MSNA |
| Sarir plains | Tazirbu<br>Alkufra | 2021 MSNA |

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