CLIMATE CHANGE AND SOCIAL VULNERABILITY | PART 1 | MARCH 2023

Using multi-sectoral indicators to assess compound drought risk and social vulnerability in Jordan

SDG-CLIMATE FACILITY
Human Security in the Arab States
Arab Water Council
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Disclaimer: This product is one of the outputs of the **'SDG-Climate Facility: Climate Action for Human Security'** Project. With financial support from the Swedish International Development Agency (Sida), the Project is a multi-partner platform focusing on the impacts of climate change on human security in the Arab region, especially in the context of countries in crisis. It brings together the League of Arab States (LAS), Arab Water Council (AWC), United Nations Development Programme (UNDP), United Nations Environment Programme - Finance Initiative (UNEP FI), World Food Programme (WFP), United Nations Office for Disaster Reduction (UNDRR), and United Nations Human Settlements Programme (UN-Habitat), to deliver climate-oriented solutions that address climate challenges and bring co-benefits across the SDGs. In doing so, it aims to scale up access to and delivery of climate finance, including through innovative partnerships with the private sector.

LIST OF ABBREVIATIONS

AWC	Arab Water Council
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station
DOS	Jordanian Department of Statistics
ECWMF	European Centre for Medium-Range Weather Forecasts
ESA	European Space Agency
FAO	Food and Agriculture Organization of the United Nations
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Center
LAS	League of Arab States
MENA	Middle East and North Africa
MOA	Jordanian Ministry of Agriculture
MODIS	Moderate Resolution Imaging Spectroradiometer
MOE	Jordanian Ministry of Environment
MWI	Jordanian Ministry of Water and Irrigation
NDVI	Normalized Difference Vegetation Index
ODC	Open Data Cube (WFP customization of Open Source Geospatial Data Management and Analysis Software)
PNG	Polar Geospatial Center, the University of Massachusetts
RBG	Jordanian Royal Botanic Garden
RICCAR	Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region
RSCN	Jordanian Royal Society for the Conservation of Nature
SDI	Spatial Data Infrastructure
SDGs	Sustainable Development Goals of the United Nations
TNC	Third National Communication on Climate Change
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNESCWA	United Nations Economic and Social Commission for Western Asia
UNHCR	UN High Commissioner for Refugees
WAD	World Atlas of Desertification
WFP	World Food Programme of the United Nations
WFPS	Western Federation of Professional Surveyors
WorldPop	WorldPop Population Data

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EXECUTIVE SUMMARY

1 EXECUTIVE SUMMARY

This study contributes to the development of integrated and multi-sectoral methodologies to measure and address climate change impact, looking particularly at the way in which climate change intersects with social vulnerability. Climate change is often described as a threat multiplier (UNDP, 2020), amplifying other risks and vulnerabilities, including social vulnerability.

The connection between climate change and social vulnerability remains under-researched. Research on climate change impact currently lacks a clear understanding of how its risks intersect with pre-existing vulnerabilities in societies and communities (De Sherbinin et al., 2019; Gerlak and Greene, 2019; Jagarnath et al., 2020). In the Arab region, there is a lack of evidence on the complex relationship between climate change and social vulnerability (Arab Water Council, 2021b). Pre-existing social vulnerabilities may include poverty, unemployment, lack of access to public services, education, and structural inequalities based on ethnicity, migration status, gender, disability and health. All of these factors may impact a community's exposure, sensitivity, and adaptive capacity to climate change-related risks. In the Arab region, there is a need for methodologies that help capture and unveil the multi-sectoral indicators of climate change to generate a regional understanding of climate change as compound risk (AWC, 2021b).

An insufficiently clear understanding of climate change as compound risk creates policy gaps. Climate change policies in the region often overlook the importance of social vulnerability as a component of climate risk. Due to the absence of sufficiently integrated data, policy-makers are missing much-needed evidence on the complex intersectionality of risks that climate change can trigger or exacerbate, and that also shape community responses to climate change (AWC, 2021b). In a region that is already facing resource scarcity, the intersecting risks associated with climate change, water and resource scarcity, food security, human security, and social security, can erode social cohesion and become the root causes of competition over resources, disputes, and even conflict (Blurr and Collins, 1995; De Châtel, 2014; Erian et al., 2010; Maystadt et al., 2015; Okpara et al., 2015). In this way, climate change can become a security risk, leading to a lack of what is referred to as climate security (AWC, 2021a). Current policies do not sufficiently protect Arab citizens against the multi-sectoral impacts of climate change on their livelihoods, particularly those of already vulnerable groups.

The objective of this study is to advance the understanding of the interrelationship between climate change and social vulnerability in the Arab region, focusing particularly on drought impact in Jordan. To this end, the Arab Water Council and the World Food Programme jointly developed a methodology that enables researchers and policy-makers to study climate change impact and social vulnerability in an integrated manner. A range of multi-sectoral and composite indicator indices using GIS-based mapping were used to determine hotspots of both climate change and social vulnerability by ensuring that climate risk analyses assign greater weight to social indicators. This methodology was piloted with a focus on drought impact at the national level in the country of Jordan.

A multi-sectoral approach to climate change risk analysis

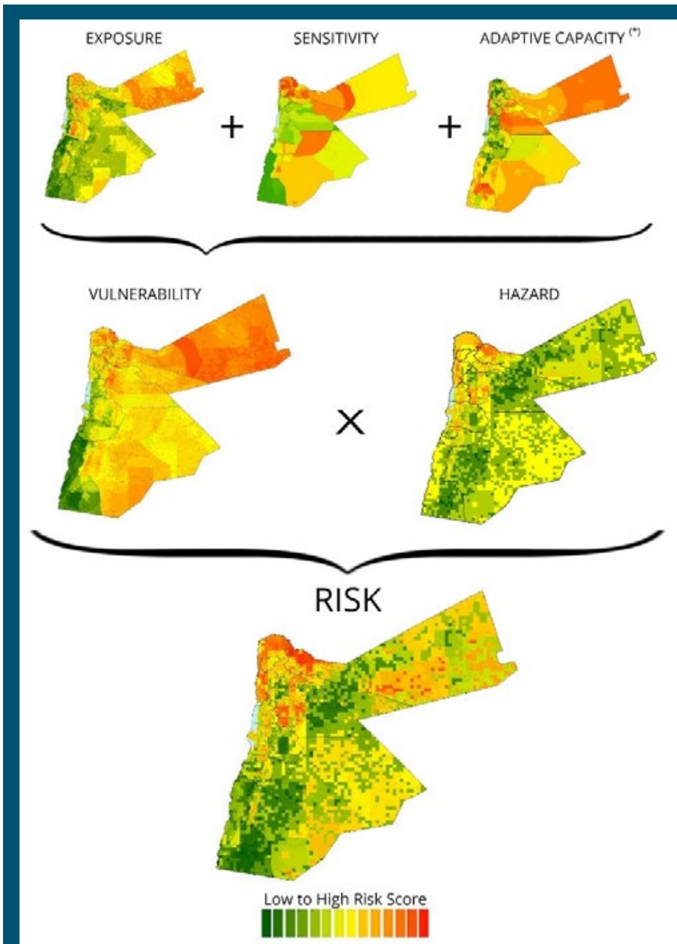
Couched within the literature on climate change and social vulnerability, the study explores the multi-sectoral nature of drought risk and considers what indicators of social vulnerability should be included in an integrated drought risk assessment. By incorporating indicators ranging from poverty and unemployment through household asset ownership, living standards, numbers of migrants and refugees hosted, health and disability, education, female-headed households, food security, access to public services, and insurance status into the sensitivity and adaptive capacity sections of the assessment, this study significantly broadens the scope of social vulnerability assessment in drought risk analysis. These social indicators were cross-referenced with drought indicators including composite drought layers, data on rainfall, temperature, natural water resources, climate change impact, biodiversity and ecosystem adaptive capacity. The methodology also entailed participatory sessions with Jordanian experts and multiple classification and weighting exercises. It generated over 100 output maps on hazard, exposure, sensitivity, adaptive capacity, vulnerability and risk for the country of Jordan. These maps are presented based on raster-based grid as well as on the basis of administrative boundaries. All national level output maps are presented in section 11 of this report.


Credit: © Tina Jaskolski

In order to develop a more nuanced understanding of drought impact on local communities, an additional case study was carried out in the village of Deir El Kahf in the Northern Badia District in Mafraq Governorate. Using a fieldwork methodology that combines both quantitative and qualitative methods, the research team conducted key informant interviews that captured both qualitative and quantitative data, observations, and participatory stakeholder workshops in the village. Georeferencing the interview locations permitted the mapping of local indicators as well an interactive online presentation of the mapped results, which can be found here: https://gis.jor.wfp.org/ccsv/casestudy.html.

As the analysis shows, expanding the number of social indicators in the climate risk analysis significantly broadens the scope of results. The more complex sensitivity and adaptive capacity layers used in this study add an element of information that is not only important to climate scientists, but also to policy-makers. As can be seen in the results, the hazard and exposure maps alone under-estimate the vulnerability of communities, while studies using a small number of sensitivity and adaptive capacity indicators do not capture the full complexity of social vulnerability. The comprehensive list of social indicators used here produces more nuanced and complex results that help understand climate change impact on communities in more holistic ways. Based on these refined maps, presented here at both pixel and administrative level, policy-makers can identify hotspots of social vulnerability to drought that may need particular attention in the implementation of social protection and resilience policies.

All mapping results at the national level are presented in section 11, while the final risk analysis can be found in section 11.3. Figure 103 shows an overview of the mapping results at national level (shown in the box below). For more detailed information on the mapping results based on administrative boundaries at different levels, please visit section 11.3.



BOX 1:
Recap of Figure 103 (presented in section 11.3)

Generating local evidence on climate change impact

The case study research conducted in the village of Deir El Kahf in Mafraq Governorate provides an insight into the real-life, on-the-ground impact of climate change. The case study sheds light on how local communities in Jordan experience drought, how drought impacts their livelihoods, and what strategies they use to adapt. Deir El Kahf is a village that suffers from poverty and unemployment as well as from a lack of economic development investment and employment opportunities. Most of the community depends on rainfed agriculture and livestock production. Due to drought, lesser green pastures, a delayed rainfall season, and simultaneous increases in production prices, many have had to give up some or all of their farming and livestock operations in recent years. As the research shows, several years of drought pushed the livelihoods of many residents of Deir El Kahf beyond the limit of sustainability. In response to losing their agricultural livelihoods, residents look out for new jobs and sources of income, thus diversifying their livelihood. Simultaneously, Syrian refugees coming to the village as seasonal agricultural workers have created an intensified competition on the local job market. As solutions, the residents suggest improving water harvesting infrastructure, investing in the area to create jobs in the secondary and tertiary sector, and enhancing social protection and government support systems. The story of Deir El Kahf shows that local communities face an intersectionality of risk, including pre-existing social vulnerability, structural inequality, poverty, livelihood vulnerability, and a lack of support, which then intersects with the impact of drought. The story of Deir El Kahf helps generate the kind of nuanced, local understanding that will build the evidence policy-makers need to inform integrated climate change responses. It seems that in Deir El Kahf, drought impacts are felt more strongly on the ground than the national maps may suggest. For this reason, it is important to expand local level research across localities in Jordan – perhaps starting with some of the drought risk or vulnerability hotspots identified in this report. More details about the case study can be found in section 12.

From research to policy action

Climate change has to be understood as compound risk, and as a multiplier of a variety of existing risks and vulnerabilities. Only by using integrated, multi-sectoral, and multi-scalar research tools can climate research in the Arab region generate the nuanced evidence needed to develop climate change policies that address the complexity of compound risk.
As this mapping project shows, widening the scope of social vulnerability analysis in climate risk research helps with identifying hotspots of climate change risk in a way that also integrates the various facets of social vulnerability. Knowing where hotspots of both climatic impact and social vulnerability are, is a fundamental pre-requisite for an integrated climate response. More research of this kind is needed in order to study the link between climate change and social vulnerability. Refining data sets and indicators, testing and validating results, ensuring that the right kind of data is collected, making data more available across ministries and to external users, as well as the continuous sharing of methodologies and results are all important research steps will generate better climate impact evidence.

The outcomes of this research will help develop a tailored policy tool for policy-makers to design evidence-based, targeted, and integrated social protection and climate change resilience programs. Importantly, many of the policy programs designed to foster resilience may not first and foremost address the environmental impact of climate change, but may in fact be social or economic in nature. For this reason, integrated climate change planning requires multi-ministerial, collaborative, and integrated responses. In this way, the phenomenon of climate change can be addressed with the kind of multi-layered policy responses that pay respect to the complexity and multi-directional nature of climate change impacts. Moving from integrated research to integrated policy approaches will not only advance regional climate responses to climate change, but also help achieve the Paris Agreements as well as the Sustainable Development Goals in the region.

2

INTRODUCTION

2 INTRODUCTION

As a case study on climate change and social vulnerability, this study investigates social vulnerability to drought in Jordan. Drought is one of the most severe climate change impacts that is already well under way in the Arab region, with many Arab countries already reporting a higher incidence in drought events (RICCAR, 2017). As the Arab Climate Change Assessment Report (RICCAR, 2017, 37) published by the United Nations Economic and Social Commission for Western Asia (UNESCWA) emphasizes, "[d]rought is the most prevalent climate hazard; its impacts on livelihoods are severe and cause the highest human losses. Its effects include decreased water supplies, as well as loss of harvest and livestock, which, in turn, threaten food security and often cause widespread malnutrition". The Drought Initiative developed under the United Nations Convention to Combat Desertification's (UNCCD) (no date) paints a similarly devastating picture of drought impacts:

"Droughts are one of the most feared natural phenomena in the world; they devastate farmland, destroy livelihoods and cause untold suffering. They occur when an area experiences a shortage of water supply due to a lack of rainfall or lack of surface or groundwater. And they can last for weeks, months or years".

Climate change, which causes "long-term shifts in temperature and weather patterns" has been directly linked to the occurrence of intense droughts (UN, no date). With intensifying global warming, such climate change effects may spiral out of control and lead to cascading risks. IPCC's Sixth Assessment Report on Climate Change, released in April 2022, raises the alarm on the necessity of immediate action on climate change mitigation in order to keep the global temperature rise below 1.5°C by the end of the century (IPCC, 2022). In response to this report, UN Secretary-General, Antonio Guterres, released a video message referring to a future marked by "unprecedented heatwaves, terrifying storms, widespread water shortages and the extinction of a million species of plants and animals," if no immediate action was taken (UN, 2022).

Although there is considerable scientific effort in the MENA region to study and model climate change, such studies often fail to investigate climate change impacts from a nexus perspective and in its integration with other types of risks (AWC, 2021b). The present study approaches the topic of climate change-induced drought impact with a focus on social vulnerability to drought. To this end, pre-existing conditions of social vulnerability, as well as conditions that render communities more susceptible to risk and harm from climate change are studied in parallel to, and integration with, drought hazard and exposure variables. As emphasized in UNDRR's (2021, x) most recent special report on drought, "[t]he risks that drought poses to communities, ecosystems and economies are much larger and more profound than can be measured. The impacts are borne disproportionately by the most vulnerable people."

Ensuring that climate change-related drought assessments take into account the most vulnerable populations and livelihoods, this study makes a conscious effort to boost the importance of social vulnerability indicators in climate change and drought assessments as part of the design of complex, multi-sector indicator index. The research sets out to develop our understanding of social vulnerability in the context of climate change, to expand the range of social vulnerability indicators considered when measuring climate change, and to explore the experiences of socially vulnerable communities with drought impact. Testing an innovative methodology that combines quantitative and qualitative methods with GIS technology, this study paves the ground for future climate change assessments based on nexus thinking and an integrated understanding of risk. Jordan was selected as a case study because it is a country that significantly suffers from drought and water scarcity. This study complements research work on climate change and flood impacts carried out by the Arab Water Council in Sudan in 2021.

Carried out as a partnership effort between the Arab Water Council and the World Food Programme's offices in Cairo and Amman, this work forms part of the SDG-Climate Facility. Financially supported by the Swedish International Development Agency (Sida), the SDG-Climate Facility is a multi-partner platform that focuses on the impacts of climate change and human security in the Arab region. Led by UNDP, the partnership brings together the League of Arab States (LAS) and the Arab Water Council with several UN agencies (UNDRR, UNEP-FI, UN-Habitat and WFP). The partners work together on regional, climate-oriented solutions to address climate challenges that will also bring co-benefits to the implementation of the Sustainable Development Goals (SDGs) in the Arab region. This study represents an initiative to generate innovative knowledge and evidence from the ground on climate change effects in the Arab region. As the results of this study will include the development of policy briefs and decision-making tools for the region, the research will work towards bridging the gap between research and policy-making in the region.

3

SOCIAL VULNERABILITY AND CLIMATE CHANGE

3 SOCIAL VULNERABILITY AND CLIMATE CHANGE

Social vulnerability remains an under-researched component of climate research. Social vulnerability, generally refers to "potential harm to people" (UNDP, 2016). The Arab Water Council (2017, 8) defines social vulnerability as "the inability of people, organizations and societies to withstand adverse impacts from multiple stressors to which they are exposed… and the ability to cope with or recover from their impact". The social characteristics of communities play an important role in the way they are affected by and can react to climate change impact. As Eriksen et al. (2020, 27), emphasize, "there is broad empirical evidence showing that the social characteristics of people and communities—including their social marginalization—have an indisputable influence on the severity of a disaster."

Social vulnerability provides an overarching lens through which to view the potentially disproportionate impacts that climate change may have on communities and individuals worldwide Lynn et al., 2011). Communities facing pre-existing vulnerabilities can have a particularly hard time coping with climate change as an additional impact and burden. Climate change may not only exacerbate their vulnerability, but also hamper their resilience. While some vulnerability approaches focus only on the predisposition of a place or community to be adversely affected (this is an approach initially taken by the DRR community), other approaches include human capacity to adapt (IPCC, 2015, Cutter et al., 2016) and to respond and recover from the impacts of hazards (Cutter and Finch, 2008). The current study takes the second approach, viewing **adaptive capacity to climate change as an intrinsic part of social vulnerability**. This approach is ultimately more forward-looking, highlighting the ability of communities to recover from adverse climate change impacts (Orindi, 2006).

Certain groups and livelihoods are more vulnerable to climate change than others. As Cutter et al. (2003, 243) note, "[s]ocial vulnerability is partially the product of social inequalities—those social factors that influence or shape the susceptibility of various groups to harm and that also govern their ability to respond." Population groups experiencing pre-existing structural inequality, poverty, unemployment, gender inequality, migration, and have limited access to education, information, resources, public services and lack social protection, may have to cope with considerable livelihood impacts caused by extreme events. For example, communities affected by poverty that pursue undiversified livelihood strategies, for example subsistence farming or fishing, experience a disproportionately high risk of climate change impact (Mogomotsi et al., 2020). This means that climate change protection may start with eliminating inequalities that may not seem immediately connected with particular climate change risks.

In the Arab region, a range of conditions intensify social vulnerability to climate change. Arid countries in the Middle East, especially Jordan, suffer from drought and intensified water scarcity, which are coupled with water management challenges, migration and the hosting of refugees, a lack of social protection mechanisms, and livelihood vulnerabilities (Rajsekhar and Gorelick, 2017; Al-Qdah and Lacroix, 2017). These conditions may place certain population groups in positions of higher vulnerability to climate change. State fragility, the dysfunctionality of public institutions, as well as conflict, which can be found across the Arab region, exacerbate social inequalities and vulnerability (Arab Water Council, 2017). Such conditions can directly impact human health and safety, compromise the ability of states to protect, react, and distribute resources, intensify poverty and resource insecurity, limit access to educational facilities and information, and trigger migration and displacement.

So how can **social vulnerability** be distinguished from **vulnerability**? Vulnerability is concerned with "[t]he degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" (IPCC, 2001, 995, emphasis added). In this context, "[v]ulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC, 2001, 995, emphasis added). While vulnerability is concerned with a system as a whole, social vulnerability particularly addresses the social drivers of vulnerability and the social attributes that describe vulnerability.

There are, however, definitions of vulnerability that place a strong emphasis on the social realm. Wisner et al. (2004, 11) define vulnerability as "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard (an extreme natural event or process)." The United Nations Development Programme (UNDP) defines vulnerability in its global report of reducing disaster risk as "a human condition or process resulting from physical, social, economic and environmental factors, which determine the likelihood and scale of damage from the impact of a given hazard" (UNDP, 2004). UNDP (2014) refers to vulnerability as "an exposure to a marked decrease in standard of living".

Thus, vulnerability is not solely caused by environmental impact or hazard (exposure), but also by **underlying and systemic social and economic inequalities** and vulnerabilities. The theoretical approaches of Political Ecology and Political Economy have focused on the "complex interactions between both biophysical and social processes that produce vulnerability" (Gerlak and Greene, 2019, 101, based on O'Brien et al., 2007 and Tschakert, 2007). The so-called **coupled vulnerability** approaches, of which there are several sub-categories[1], "promote policies and programs that reduce exposure to climate hazards as well as responses that focus on livelihood diversification, reduce social inequities, and address power relations" (Gerlak and Greene, 2019, 102, based on O'Brien et al. 2007, emphasis added). Coupled vulnerability approaches, such as the one pursued by IPCC,

"situate vulnerability within a broader social context (e.g., O'Brien et al., 2007), and as a product of economic and social relations (Taylor, 2013; Turner, 2016). These coupled vulnerability approaches push beyond household poverty as an indicator of vulnerability, urging consideration of multiple social categories such as gender, age, religion, wealth, ethnicity, and education, and how these different identities intersect with each other to produce differential climate vulnerability " (Gerlak and Greene, 2019, 102).

The means that it is important to include **non-climatic drivers of vulnerability**. To ensure this, studies on mitigation and adaptation to climate change are adopting more integrated and multi-sectoral approaches. Birthisel et al. (2020, 2183) note that convergence research is emerging as a research paradigm that "encourages a holistic approach to climate change mitigation and adaptation research," for example by integrating climate science, agriculture, aquaculture, forestry, and social factors. Moreover, by placing more emphasis on "the ways in which vulnerability and adaptation are embedded within a local context"[2] (Gerlak and Greene, 2019, 102, based on O'Brien, 2007), climate risk assessments can help shed light on how climate change is impacting local livelihoods, access to resources, as well as social processes on the ground.

1 These include contextual vulnerability, outcome vulnerability, vulnerability as a pre-existing condition, and vulnerability as a threshold, as summarized in Gerlak and Greene (2019).

2 Examples of this can be found in Carr and Thompson, 2014, Turner, 2016, Eriksen and Simon, 2017 and Nagoda and Nightingale, 2017 (Gerlak and Greene, 2019, 102).

4

FROM SOCIAL VULNERABILITY TO CLIMATE SECURITY

4 FROM SOCIAL VULNERABILITY TO CLIMATE SECURITY

Especially within the context of sustainability and peace, it is becoming increasingly important to understand how environmental processes can create and intensify social vulnerability and inequality, impact livelihoods, and contribute to the erosion of social cohesion. An increase in competition over resources in the absence of social cohesion may lead to political unrest and conflict. For example, scholars have carried out research on the connection between prolonged drought and growing political instability in Syria (De Châtel, 2014; Erian et al., 2010). In South Sudan, local warming, drought, and famine have been connected with the escalation of violent conflict (Blurr and Collins, 1995; Maystadt et al., 2015). Research at Lake Chad suggests that climate change and social vulnerability provide an interlinked basis for increased water conflict and terrorism insurgency (Okpara et al., 2015). Thus, Okpara et al., (2015, 311) propose that "vulnerability perspectives can offer an important lens for assessing the complex interactions between environmental issues and security."

In this way, climate change impacts and vulnerability relate to climate security, a concept that addresses the way in which climate change impacts act as threat multipliers on other types of security, including water security, food security, human security, social security, or, in extreme cases, even national security. As defined in a regional multi-stakeholder workshop,

> **"the term climate security is used to describe and understand the combined impacts of climate-related change on natural resources, ecosystems, socio-economic well-being, and political stability of a country and, therefore, of a region. It recognizes the catalytic effect of climate-related change as a risk multiplier that can lead to multiple threats on human welfare, economic resilience and national security that most immediately affect vulnerable groups. The approach informs and requires integrated, cross-sectoral mitigation and adaptation efforts" (Arab Water Council, 2021b).**

The region will only be climate-secure when tailored mitigation and adaptation strategies, social protection and climate change support mechanisms, as well as sustainable resource management, are in place, ensuring that the impacts of climate change will not disrupt water security, food security, human security, or national security, nor lead to competition, the disruption of social cohesion, conflict or even war (Arab Water Council, 2021c). In the interest of long-term climate security in the region, it is critical to foster a better understanding of social vulnerability and social protection in the context of climate change.

This study makes a conscious effort to anchor climate change research in the Arab region more firmly in the social, economic, and political context of vulnerability, thus playing tribute to the multi-sectoral nature of social vulnerability and addressing an emerging research gap.

5 THE RESEARCH GAP

5 THE RESEARCH GAP

A review of the relevant literature shows that, in the context of studies on climate change and environmental hazards, **exploring the role of social vulnerability remains a research gap**. As Cutter et al. (2003, 243) contend, "[s]ocially created vulnerabilities are largely ignored, mainly due to the difficulty in quantifying them…". Studying climate change-related urban heat stress, Jagarnath et al. (2020, 809, based on Romero- Lankao et al., 2012 and Bao et al., 2015) emphasize that "there are limited studies which aim to improve our understanding of both the climatic change and socio-economic drivers." In addressing social vulnerability, studies have focused more on people's individual characteristics including social markers such as age, race, health, income, types of housing and employment / unemployment rather than systemic inequalities (Cutter et al., 2003). Such **systemic inequalities** are politically institutionalized and may be rooted in healthcare, education, welfare, social protection, or migration systems, as well as culturally and politically engrained gender roles. A broader scope of social vulnerability indicators is needed to address the complexities of such social vulnerability drivers. Gerlak and Greene (2019, 110) claim that "with a few exceptions" the process of "identifying climate vulnerabilities…does not meaningfully engage in the complex social processes that contribute to differential vulnerabilities."

A more **nuanced understanding** of social vulnerability is often missing in the study of future climate impacts, as well as in the field of disaster risk reduction. De Sherbinin et al. (2019) note that most climate-related vulnerability studies that rely on future climate projections do not engage socio-economic projections in parallel, and thus fail to conceptualize the linkages between the two. Thus, such climate projects do not capture the full and multi-sectoral complexity of the climate change impact and limit the scope of policy responses to climate change projections.

In the field of disaster risk reduction, which is also crucially linked to climate change, Eriksen et al. (2020, 26) also note substantial gaps in relation to social vulnerability:

> **"In the past decades, disaster risk reduction (DRR) policy has evolved from a sole emphasis on the mechanical and structural aspects of hazard mitigation to the guiding principle of disaster resilience. Resilience puts a strong emphasis on distributed capacities for disaster prevention, preparedness, and recovery, and explicitly recognizes the need for social vulnerability analysis (Wisner et al., 2004; Pelling, 2007; Tierney, 2014; UN, 2015; UNDRR, 2015; Oliver-Smith et al., 2017). Nevertheless, challenges remain in how we engage in meaningful ways with historical, subjective and relational aspects of social vulnerability."**

To understand the complex interplay of different inequalities and the interconnectivity of risk, the concept of intersectionality as well as a systems perspective that integrates environmental and social indicators play central roles in the study of climate change vulnerability. As outlined in the most recent UNDRR (2021, xiv) report, "[v]ulnerability assessment requires a socioecological systems perspective that can consider the susceptibility of ecosystems and deficits in coping capacities of the communities depending on them". Devkota et al. (2020, 1079) refer to their integrated approach to studying adaptation to climate-related floods as a "hydro-social analysis" combining (natural science-focused) "scientific and socio-economic knowledge." Such a socioecological systems perspective that considers the intersectionality of risks is oftentimes missing from climate risk and climate impact assessments.

In the **MENA region**, research on climate change often does not factor in complex social indicators (Arab Water Council, 2021b). Recent studies on drought vulnerability in Jordan include population, poverty, water access, health, public services as social vulnerability indicators (GoAL

WaSH and UNDP, 2019; Al-Bakri and Al-Qinna, UNDP, 2019a). Indicators such as gender, disability, female-headed households, migration and refugee status, household assets, education and access to information, debt and access to social protection are rarely included in vulnerability studies, which are predominantly carried out by environmental and climate researchers.

In addressing this research gap, this study contributes to a global effort of trying to understand how social vulnerability is connected to social inequalities anchored in place, environment, livelihood and economy, and how different localities compare in terms of their complex social vulnerabilities to climate change (Gerlak and Greene, 2019). It does so by drawing on the following questions:

- What regions and communities are most vulnerable to climate change – in this case, drought in Jordan?
- What social vulnerability indicators should be integrated in climate risk research? How can we develop complex and compound indicator indices that factor pre-existing social vulnerability as well as adaptive capacity into climate risk?
- How do structural inequalities and vulnerabilities affecting climate change sensitivity and adaptive capacity intersect with hazard and exposure to climate risk?
- What are the determining factors and indicators for adaptive capacity, and how does social vulnerability limit adaptive capacity?
- How can we ground climate change responses more firmly in local evidence and situated knowledge, including indigenous and local knowledges, as well as the knowledge of both men and women?
- What adaptation strategies are communities pursuing locally, and what can policy-makers learn from them?

Using these questions as basis for its scientific approach, the present study works towards inserting social vulnerability measurements and assessments more firmly into drought assessment work. It also emphasizes the importance of local communities and their situated knowledges (Ford-Norgaard, 2020) for evidence-based policy-making on climate change.

6

SIGNIFICANCE OF THE RESEARCH

6 SIGNIFICANCE OF THE RESEARCH

The present study has the potential to make an important contribution to advancing the complexity of analysis when it comes to social vulnerability in relation to climate change impact. This report is the first in the region that studies climate change impacts and **complex social vulnerability indicators** in an integrated way by mapping national data and conducting research at the local level, thus addressing the issue at multiple geographical scales. As a knowledge product of the SDG-Climate Facility, this study brings together themes that play important roles under two international policy agendas – the UN Sustainable Development Goals and the Paris Agreement – pursuing the kind of integrated and cross-sectoral assessment that is required for creating synergies between those agendas (Arab Water Council, 2021b).

This research project takes a **multi-disciplinary, mixed-methods, as well as a participatory and socially inclusive approach**. Utilizing methodologies of the natural and social sciences, as well as both quantitative and qualitative data sets and methods, this study attempts to break down some of the well-established silos in climate change research and policy-making. The research is the collaborative work of scientists and experts working at regional and national levels. Bringing together climate change experts, water management experts, socio-economic experts, social scientists, as well as GIS experts, the multi-disciplinary team behind this project made it a point to bridge both methodologies and research approaches by using a multiplicity of datasets. The outputs are based on globally available satellite data, statistics, data, maps, and information obtained from various ministries in Jordan, the opinion of Jordanian experts engaged in studies on drought and social vulnerability, as well as that of members of Jordan's National Drought Committee. This study follows a participatory approach, taking into account the feedback from local experts and adjusting data and methodology throughout many months of data exchange, technical discussions, and workshops.

For its case study, the current study also includes voices from the ground, developing a better understanding of the lived impact of **climate change in local communities**, thus helping to ground-truth the national data sets. Through highlighting the experiences and stories of drought-affected farmers in Jordan, the study seeks to include farmers and their lived experiences in the regional dialogue about drought impact and social vulnerability. UNDPs (2018) study on climate change adaptation in the Arab region shows how a collection of case studies can help obtain a grasp of best practices and lessons learned from the region. In fact, the lack of inclusion of diverse voices and opinions from communities, vulnerable groups, as well as parts of societies that feel marginalized was identified as an important shortcoming of climate change and climate security research and policy-making in the Arab region (Arab Water Council, 2021b).

In developing an innovative methodology, the study aims at breaking the ground for **new approaches to drought assessment**. The development of a complex and multi-disciplinary drought and social vulnerability index does not only enhance our understanding of the integrated impacts of the two, but also provides concrete approaches for researchers and policy-makers to assign a firm place to social vulnerability in their climate change assessments. This study takes a first stab at developing an integrated methodology that may be refined, adjusted, and improved through future research efforts. In testing this new methodology, this research project aims to generate knowledge on, as well as a new understanding of, the social vulnerability aspects of climate change in the MENA region. The methodological work, the data and evidence will enable the development of policy implementation tools that address climate change impacts in multi-dimensional and integrated ways.

7

CREATING SYNERGIES AMONG GLOBAL AGENDAS

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Global agendas such as the **SDGs and the Paris Agreement** cannot be addressed and implemented in isolation. There are important **overlaps and synergies** between the two agendas that, if well understood and harnessed, can help to improve research methodologies and policy designs. The SDG-Climate Facility supports policy-makers and entities across the region in making connections between these two agendas, and to lever synergies towards the achievement of both agendas across the region.

As a threat multiplier, climate change has an impact on the implementation of the SDGs in the region. Exactly how climate change will affect the ongoing efforts to realize the SDGs needs further and better understanding, as well as appropriate mitigation and adaptation efforts on regional and national levels. This study addresses a particular climate change impact that is projected to be one of the most prominent climate change effects in the MENA region: drought. In its adverse impact on livelihoods, especially the farming sector, climate change-related drought will impact SDG 1 (no poverty) and SDG 2 (zero hunger). As people living in climate change-affected regions and communities may struggle to access sufficient and nutritious food, may lose their homes, businesses and livelihoods, and may have to cut down on essential livelihood expenses, it also impacts SDG 3 (good health and well-being). As gender-based indicators play an important role in social vulnerability to climate change, SDG 5 (gender equality) is of critical concern to drought assessments.

Drought impacts can significantly affect equal and continuous access to water, for both farms and households, thus having implications for SDG 6 (clean water and sanitation). With drought-affected communities experiencing closures of businesses, destruction of livelihoods, and loss of jobs in certain sectors, drought has relevance for SDG 8 (decent work and economic growth). When droughts hit communities, those experiencing pre-existing and structural vulnerabilities are often most-afflicted, which means that drought can exacerbate inequalities, thus hindering the implementation of SDG 10 (reduced inequalities). As a prime climate change impact, drought has heavy implications on mitigation and adaptation strategies designed under SDG 13 (climate action), in the context of farming it is particularly life on land (SDGs 14) and the functioning and integrity of land-based ecosystems that play an important role. While the region is working towards realizing the goals of the Paris Agreement, keeping CO_2 emissions well below 2 degrees Celsius, and if possible even below 1.5 degrees Celsius, mitigation and adaptation strategies should be designed to work in line with the implementation of the SDGs. To this end, we require a better understanding of how these agendas affect each other. Moreover, better policy responses are needed that can address climate change impacts in integrated and multi-sectoral ways. Figure 1 shows some of the SDGs that are directly affected by climate change-related drought.

Figure 1: The Sustainable Development Goals relevant to climate change-induced drought (Source: UN, 2015).

8

FOCUSING ON DROUGHT

8 FOCUSING ON DROUGHT

8.1 Drought and Social Vulnerability

For the present climate impact study, the research team decided to focus on the impact of drought on the agricultural and agropastoral sectors in Jordan. The hazard posed by drought is defined as "[a]bnormally dry weather or an exceptional lack of water compared with normal conditions" (UNDRR, 2021, xi). Drought is different from aridity, water scarcity, or a mere lack of precipitation in a particular location. "It is a failure of whatever system drives the hydrological balance. This can include reduced rainfall over a certain period, inadequate timing or ineffectiveness of precipitation, and/or a negative water balance due to an increased atmospheric water demand following high temperatures or strong winds" (UNDRR, 2021, xi). When assessing drought, a distinction should be made between meteorological drought, agricultural drought (soil moisture deficits), and hydrological drought (reduction in stream flows) (Rajsekhar and Gorelick, 2017). As a slow-onset climate change impact, drought and its impacts are hard to measure. This is why long-term data and assessments are particularly important.

Climate change can lead to more frequent and intensified drought events, which, in turn, impact social vulnerability. First, communities are differently vulnerable to drought and its effects. Second, droughts might intensify already existing social vulnerability, for example through negatively impacting livelihoods and amplifying structural inequalities. "Drought risk and the considerable threat posed to people, societies and environments arise from the potential for dry weather to cause harm", according to the UNDRR's (2021, xi) most recent special report on drought. UNDRR (2021) emphasizes that drought can lead to conditions of compromised health and wellbeing, mental health problems and disease outbreaks, physical harm and even death, particularly among the elderly and other vulnerable population groups. Droughts can have the following detrimental effects on life systems:

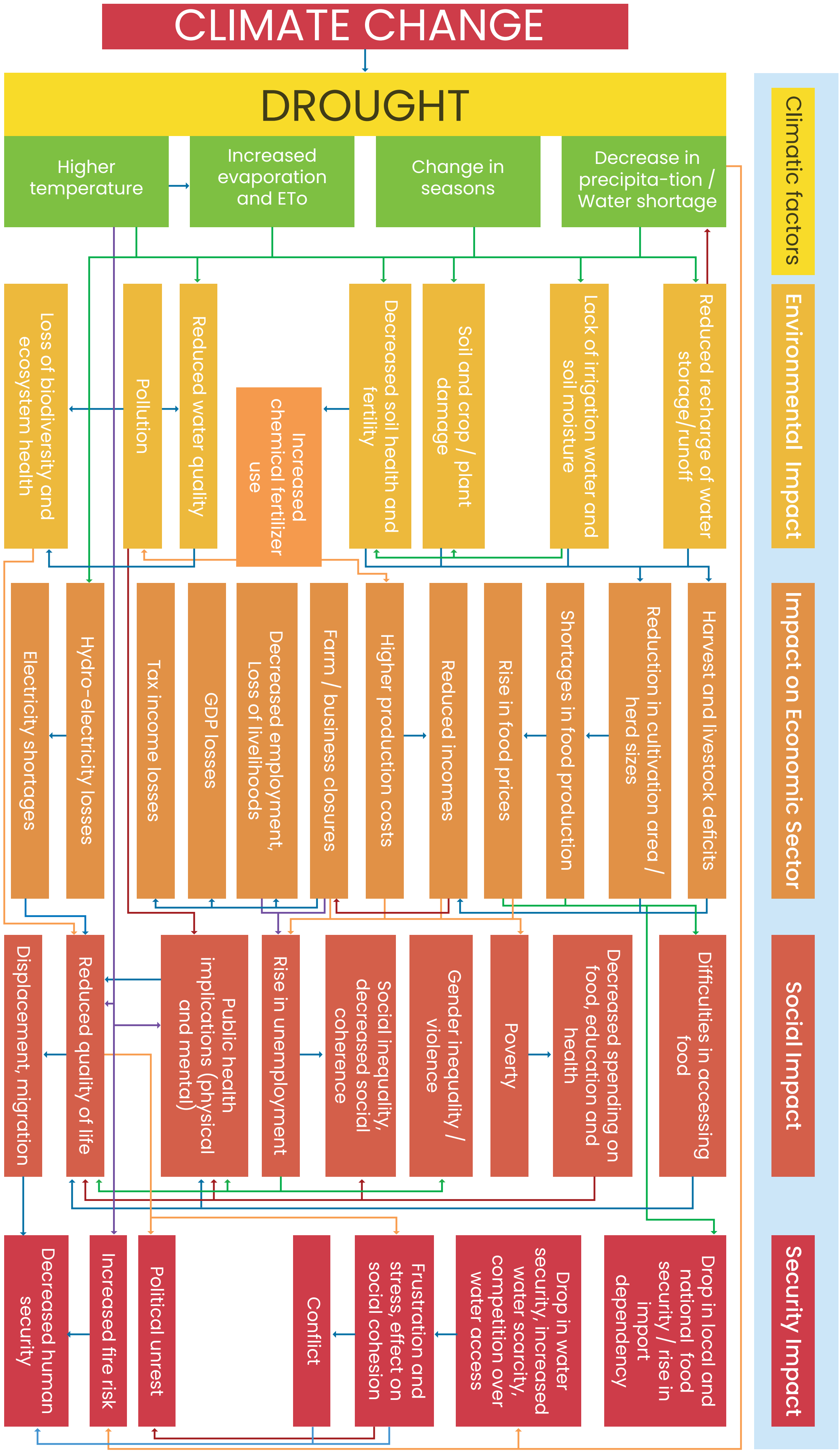
> **"A drought becomes hazardous when water demands are no longer met. A drought becomes a risk when the drought hazard affects exposed and vulnerable societies and ecosystems with inadequate capacity to cope with the lack of water. Failure to manage this risk can result in dangerous consequences for lives, livelihoods, the economy, and ecosystems. The size of the risk and thus the impacts of the realization of drought risk are dependent on the levels of exposure and vulnerability" (UNDRR, 2021, xiv).**

Agricultural and agropastoral communities are directly dependent on sufficient rainwater or freshwater for farming and irrigation. For this reason, drought is a particular risk factor in the livelihoods of these communities and may act as a driver of increased social vulnerability. At the same time, there might be social causes for drought (for example mismanagement or distribution problems), which a social vulnerability lens may uncover (Muyambo et al., 2017). Existing, systemic social vulnerabilities may compromise the ways in which communities can adapt to intensified and more frequent droughts. On a global scale, "[t]he impacts are most substantial in those countries with high reliance on rural economies and with large vulnerable populations" (UNDRR, 2021, x).

Climate change is also having an increasing impact on public health and human well-being. Heat waves are causing health problems, particularly for older parts of the population and those with underlying medical issues, with risks often being distributed in uneven ways, especially across urban spaces (Aboulnaga and Mostafa, 2019; Inostroza et al., 2016). Droughts impact human health through dustier weather conditions that cause air pollution, as well as indirectly through the impact of droughts on agriculture and livestock production and therefore food security (GAR, 2021). Weather extremes such as hotter and colder climate can adversely impact living comfort and necessitate higher expenses for cooling and heating. Drought-enhanced water scarcity, in turn, can impact water access and lead to additional household spending on water, for example for additional tanks, or for digging additional groundwater wells. Poorer and less protected households are often more vulnerable to such climate change impacts, with migrants, women and children being particularly vulnerable groups. "Reports show that in climate change-fueled disasters, women are 80% more likely to be displaced than men, and women and children are 14 times more likely to die than men" (Hassan et al., 2021, 7, based on UNDP, 2016 and UN Women, 2021). Crop failure, fuel shortage, and water scarcity often create an additional workload for women, who in many parts of the region are household water managers, fetch fire wood, and gather food and fuel resources. Women are also traditional care-givers for those suffering from climate-related health issues and suffer from less protection and more violence during climate-related conflict and displacement (FAO, 2017).

8.2 A Climate Impact Chain for Drought

The complex and multi-dimensional impact of drought can be presented in the form of a climate impact chain (Figure 2). Drought impacts, which can be perceived as a decrease in precipitation, higher temperatures, increased water shortage and evapotranspiration, as well as a change in seasons (for example dry and rainy seasons) has an immediate impact on soils, the state of surface and groundwater resources and ecosystem functions. Water scarcity and reduced soil health impact agricultural livelihoods through decreased productivity, but also have an impact on urban living and household water availability. Impacts on the economy, including agricultural and pastoralist systems, include a drop in household incomes and business revenues, tax incomes, national GDP, value chains, and employment. These impacts, in turn, can lead to an increase in poverty and unemployment, as companies will have to let their employees and workers go. Continued drought can even lead to a complete loss of livelihoods for communities. These effects can be felt differently by different population groups, based on existing social inequalities. For example, a daily laborer with a migration background may be more immediately affected by job reductions in the agricultural sector than the owner of a farm. Similarly, a farm owner who owns considerable assets and a larger piece of land may have more financial flexibility and better access to bank loans, and is thus more resilient to drought impact than a small farmer with limited land and assets. Poverty and unemployment are also linked to gender equality, violence, access to education and health services, while drops in agricultural production impact food security and health. As resources become scarcer and the socio-economic impact more defined, there may be an increase in local negotiations over resource access, potentially leading to competition and conflict. The impact chain presented in Figure 2 shows the complex and interrelated processes that drought phenomena can trigger and intensify.



FOCUS: AGRICULTURAL / AGRO-PASTORAL SECTOR

Figure 2: Climate impact chain for drought (Arab Water Council, 2022).

9

SOCIAL VULNERABILITY AND DROUGHT IN THE ARAB REGION

9 SOCIAL VULNERABILITY AND DROUGHT IN THE ARAB REGION

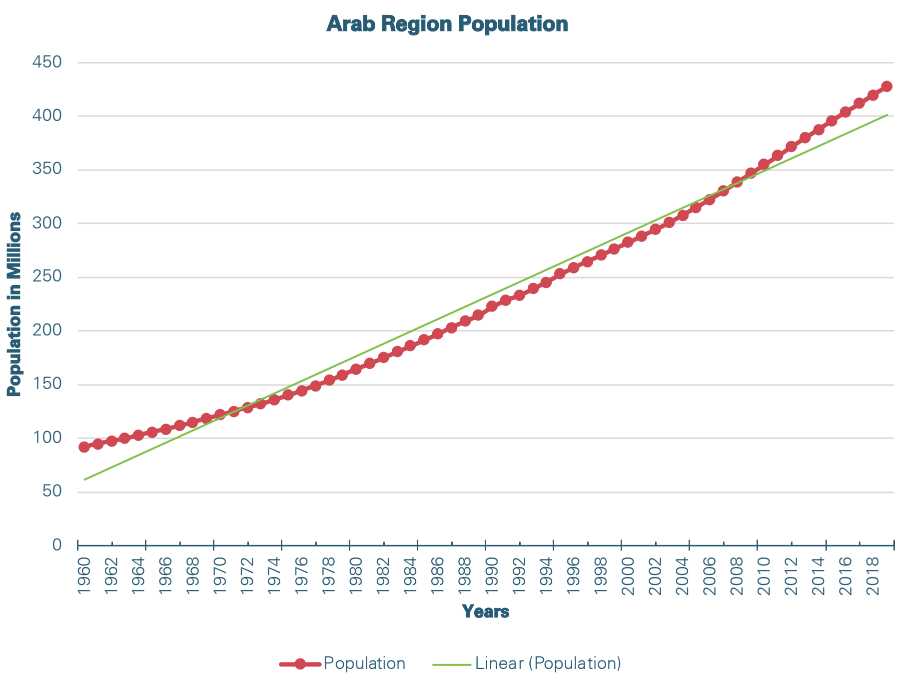
Social vulnerability is a key issue in the Arab region. It is driven by a wide variety of factors, including systemic social inequalities, poverty, gender, ethnicity, migration status, unemployment, and access to essential public services, but also political stability, economic growth and other environmental and geopolitical factors. In many Arab countries, fast population growth, poverty, unemployment, waves of regional migration, as well as a lack of social protection systems, enhance the social vulnerability of their residents. State fragility, conflict, and political turmoil, as can be found in several countries of the region, further intensify pre-existing social vulnerabilities. Importantly, climate change and its various impacts on human lives and livelihoods can also act as a reinforcing factor on social vulnerability, acting as a threat multiplier (UNDP, 2020). In the Middle East, climate change is expected to intensify water scarcity, food insecurity, destroy livelihoods, contribute to the migration of people, and potentially lead to resource competition and conflict (Arab Water Council, 2021a). Climate change and social vulnerability are linked to the implementation of the Sustainable Development Goals and to the achievement and maintenance of peace – a connection that becomes particularly important in the developing and politically unstable countries of the region (Arab Water Council, 2021b; Day, 2019).

9.1 Population Growth in the Arab Region

Countries of the Arab Region are experiencing fast population growth. The size of the Arab population was 427 million in 2019 (World Bank Group, 2020). As shown in Figure 3, population growth in the region has exceeded the linear growth that characterized the time period between 1960 and 2017. The Arab region should continue to experience high population growth rates well into the 2030s and is expected to reach a total population of 488 million by 2030 (World Bank Group, 2020). The projection of the average annual population growth rate for the region for the period of 2015-2020 stands at 2.09 percent, compared to a global average annual growth rate of 1.12 percent for the same period (World Bank Group, 2020).

As shown in Table 1, population growth varies between the different countries of the Arab

Figure 3: Population of the Arab region (1960-2019) (Source: World Bank Group (2020), illustration by the Arab Water Council).



Region. Growth was particularly rapid in countries like Egypt (with a population increase of 20 million between 2010 and 2019 the country with the highest population number in the region), but also Iraq and Yemen. Population growth in the Gulf States is due to the expansion of the expat communities hosted by these countries, while increasing populations in Jordan and Lebanon can be partly explained by the hosting of large numbers of refugees, for example from Syria.

Table 1: The population of Arab Countries (2010-2019) in millions (Source: Raw data from The World Bank Data Center)

Country Name	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Egypt, Arab Rep.	82.76	84.53	86.42	88.40	90.42	92.44	94.45	96.44	98.42	100.39
Algeria	35.98	36.66	37.38	38.14	38.92	39.73	40.55	41.39	42.23	43.05
Morocco	32.34	32.78	33.24	33.72	34.19	34.66	35.13	35.58	36.03	36.47
Sudan	34.55	35.35	36.19	37.07	37.98	38.90	39.85	40.81	41.80	42.81
Iraq	29.74	30.73	31.89	33.16	34.41	35.57	36.61	37.55	38.43	39.31
Saudi Arabia	27.42	28.27	29.16	30.05	30.92	31.72	32.44	33.10	33.70	34.27
Yemen, Rep.	23.15	23.81	24.47	25.15	25.82	26.50	27.17	27.83	28.50	29.16
Syrian Arab Republic	21.36	21.08	20.44	19.58	18.72	18.00	17.45	17.07	16.91	17.07
Tunisia	10.64	10.74	10.85	10.95	11.06	11.18	11.30	11.43	11.57	11.69
Somalia	12.04	12.38	12.72	13.06	13.42	13.80	14.19	14.59	15.01	15.44
Libya	6.20	6.25	6.29	6.32	6.36	6.42	6.49	6.58	6.68	6.78
Jordan	7.26	7.66	8.09	8.52	8.92	9.27	9.55	9.78	9.96	10.10
Lebanon	4.95	5.20	5.54	5.91	6.26	6.53	6.71	6.81	6.85	6.86
United Arab Emirates	8.55	8.95	9.14	9.20	9.21	9.26	9.36	9.49	9.63	9.77
West Bank and Gaza	3.79	3.88	3.98	4.08	4.17	4.27	4.37	4.45	4.57	4.69
Mauritania	3.49	3.60	3.71	3.82	3.93	4.05	4.16	4.28	4.40	4.53
Oman	3.04	3.25	3.50	3.76	4.03	4.27	4.48	4.67	4.83	4.97
Kuwait	2.99	3.17	3.35	3.53	3.69	3.84	3.96	4.06	4.14	4.21
Djibouti	0.84	0.85	0.87	0.88	0.90	0.91	0.93	0.94	0.96	0.97
Bahrain	1.24	1.28	1.30	1.32	1.34	1.37	1.43	1.49	1.57	1.64
Qatar	1.86	2.04	2.20	2.34	2.46	2.57	2.65	2.72	2.78	2.83
Comoros	0.69	0.71	0.72	0.74	0.76	0.78	0.80	0.81	0.83	0.85

Crucially, population growth rates are highest in the least developed Arab countries (LDCs), including the Comoros, Mauritania, Sudan, and Yemen; and in countries affected by conflict and ongoing crises, such as Iraq, Palestine, and Somalia (ESCWA, 2015). While fertility rates are decreasing in the region, overall (from 4.47 children per woman between 1990 and 2000 to 3.37 children for the period 2010-2018), they remain above the world average (2.67 children per woman) (World Bank Group, 2020).

Fast-growing populations can have a catastrophic effect on resource availability per capita, especially in resource-scarce countries. The population dynamics in the Arab region, namely, its population growth, urbanization, changing age structure and migration flows, significantly expand the water demand in an already water-scarce region (ESCWA, 2015). Slowing population growth in the region can thus contribute to decreasing the pressure on ecosystems and natural resources, facilitating the management of land and water resources, and improving the chances of achieving a more equitable distribution of energy, particularly in urban areas (UNFPA / UN DESA, 2012).

9.2 Economic Development, Unemployment, Poverty, and Inequality

9.2.1 Economic Development

The Arab region has seen slower economic growth in recent years, even before the onset of the global COVID-19 pandemic in 2020. Economic recession can lead to higher unemployment rates as well as lower household incomes, which exacerbates the social vulnerability of households. The Survey of Economic and Social Developments in the Arab Region 2018-2019 (ESCWA, 2019) observes that the Arab region experienced an economic recovery with a growth rate of 2.3% in 2018, up from 1.7% the year before. Lower-than-average growth (2.2 percent) could be seen in the Gulf Cooperation Council (GCC) countries, a drop to 1.8 percent in Lebanon, Morocco and Tunisia, and higher-than-average growth in the region's developing countries (4.4 percent).

The global Coronavirus pandemic has intensified economic recession in many countries around the world, negatively affecting industries, businesses, agriculture, and particularly the tourism, travel and services sectors. Measures to curb Covid-19 have heavily impacted employment and poverty numbers, particularly in developing countries. According to the regional economic outlook updates for July 2020 for the Middle East and Central Asia Department (MCD) (IMF, 2020), some countries in the region reacted to the global COVID-19 pandemic with swift and stringent measures that have saved lives. However, these policies have also had a large impact on domestic economic activity. A sharp decline in oil prices, together with production cuts among oil exporters and disruptions in trade and tourism, added further headwinds. As a result, regional economic growth was projected at –4.7 % in October 2020, 2 percentage points lower than in April 2020, which was just before lockdowns in many Arab countries started (IMF, 2020). According to the World Bank (2021), the MENA region's economies contracted by 3.8% in 2020. In terms of GDP losses, the total accumulated cost of the pandemic in the region is estimated at $227 billion (World Bank, 2021).

9.2.2 Unemployment

The MENA region suffers from a comparatively high unemployment rate. According to International Labor Organization (ILO) estimates, the total unemployment rate of the MENA region has been fluctuating between 9% and 12.5% between 1995 and 2020, with peaks of over 12% in the mid-1990s and early 2000s. The year 2020 saw a sharp increase of unemployment compared to 2019, from just over 9.5% to over 10.5%. The global Coronavirus pandemic may have well played a role in this increase in unemployment. The youth unemployment rate of the MENA region (% of the labor force aged 15-24) meandered between 22 and 27.5% between 1995 and 2019 (World Bank, 2021, citing ILOstat). Women in the Arab region have a particularly low participation in the labor force with a high representation in the informal sector of the labor market.

9.2.3 Poverty

Poverty in the MENA region has been rising over the past few years. According to the IMF (2017), 53% of the population in the Arab region lived on 4 USD per day or less in 2017. World Bank data shows an increase in poverty in the MENA region for both the 3.20 USD / day and 5.50 USD / day thresholds between 2014 and 2018 (Figures 4 and 5, green line) (World Bank Group, 2021). Meanwhile, the rate of extreme of poverty in the region rose from 3.8% in 2015 to 7.2% in 2018 (World Bank, 2020a). According to ESCWA's recent updates on poverty in the Arab Region after the COVID-19 pandemic, there are 101 million people living under the poverty line, while 52 million are considered undernourished (ESCWA, 2020a).

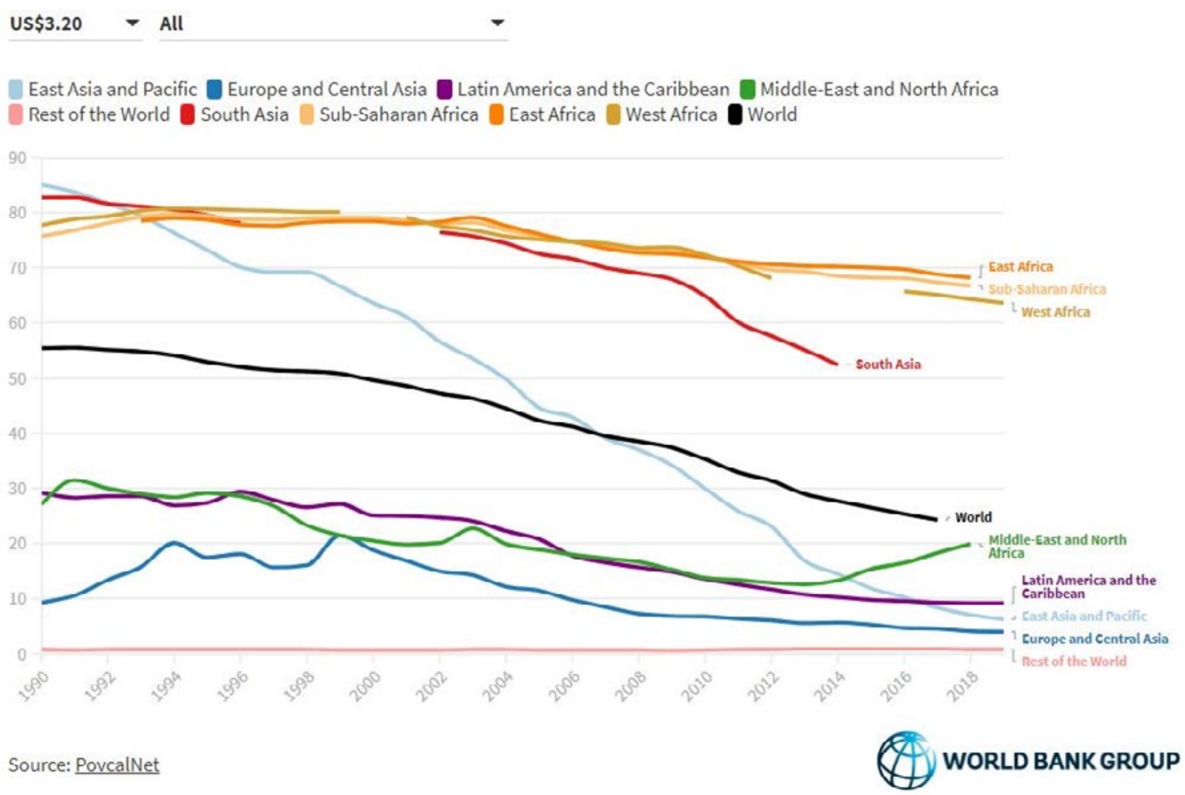


Figure 4: Global poverty rates based on USD 3.20/day scenario (Source: World Bank Group, 2021).

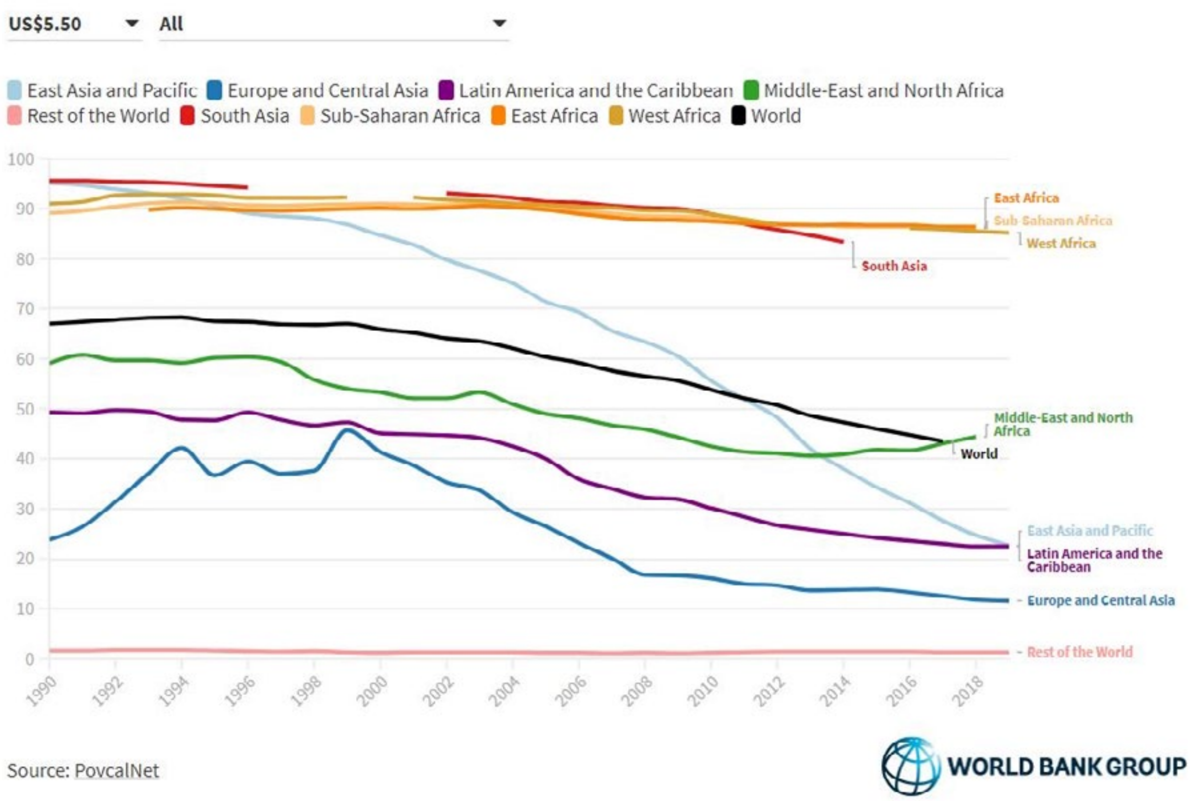


Figure 5: Global poverty rates based on 5.50 USD/day scenario (Source: World Bank Group, 2021).

9.2.4 Social and Gender Inequality

In terms of income distribution, the Middle East has been referred to as the "most unequal region worldwide," as data comparisons between 1990 and 2019 suggest that the top 10% captured 56% of the average national income in 2019 (World Inequality Database, 2020). Moreover, inequality levels in the region have "remained unchanged over the last three decades", a trend that is driven largely by "extreme levels of within-country inequality" (World Inequality Database, 2020). An important inequality factor in the region is gender inequality, for example in the context of land and resource access. While, globally, women own less than 20% of the world's land (Villa / World Economic Forum, 2017), female land ownership in the MENA region is much lower. The percentage of female agricultural holders reached only 4.1 percent in Algeria, 5.2 percent in Egypt, 4.4 percent in Morocco, 3 percent in Jordan and 7.1 percent in Lebanon according to a 2011 FAO study (Martini and Dey de Pryck, 2014). Women's economic and public participation in the MENA countries is the lowest in the world (OECD, 2015). Social systems influenced by patriarchy and gendered power relations affect women's land ownership, as well as family roles and decision-making about resources and spending within the household in the region, although such gender regimes are dynamic and changing (Moghadam, 2020; Rap and Jaskolski, 2019). In terms of access to the labor market, a process of feminization of agricultural labor has been observed in the Arab region, with the share of Arab women in agriculture increasing from 30% in 1980 to 45% in 2010. In countries such as Jordan, Libya, Syria, and Palestine, this number even exceeded 60% (Martini and Dey de Pryck, 2014). With a large percentage of women working in the informal sector, their social vulnerability exceeds those of men, as they are less eligible for social protection, health insurance, and pension plans, also suffering disproportionately from the effects of COVID-19 (UN Women, no date; Wandera et al., 2021).

9.2.5 Conflict and Migration

Another factor that plays an important role in the assessment of socio-economic standards in the region is the factor of migration. As the International Organization for Migration (IOM) (2020, 2) states:

> **"The MENA region is one of the most conflict-affected regions globally. It has faced – and continues to face – interlinked challenges stemming from protracted crisis situations and prevalent socioeconomic, political, natural resource management and climate-related issues. Such factors, among others, have led to increasing patterns of mobility, including displacement."**

Political instability, civil war, resource scarcity socio-economic impasses, unemployment and the prospect of job opportunities elsewhere have triggered waves of migration across the region and beyond – Syria, Sudan and Somalia being regional examples (UNDP, 2018). Climate change impacts, for example prolonged droughts, are increasingly being linked to migration movements, at least as contributing factors (De Châtel, 2014; Erian et al., 2010). Out of 40.5 million new displacements in 2020, 30 million were related to weather, including 320,000 to drought (IDMC, 2021, cited in UNDP, 2022). Climate change impacts need to be considered in the context of both the locations of origin of migration movements, but also the destinations that are absorbing larger numbers of migrants, particularly urban environments (Adger et al., 2021). Egypt, Iraq, Jordan, Lebanon, Tunisia, and Sudan are hosting millions of forcibly displaced people from conflict areas. The number of refugees hosted by countries across the region places an additional strain on already scarce natural resources and stretched public services, impacting labor markets and potentially affecting social cohesion in host communities. Jordan, a country already suffering from a lack of natural resources, has accommodated 2 million refugees from Syria, Libya, Iraq, and Yemen. This influx of migrants has placed a strain on host the communities, where 80% of refugees are housed. These communities face the additional burden of having to serve both the migrant populations and the Jordanian community members (Faristha, 2014; Simpson and Abo Zayed, 2019; Stephens, 2016; Yamamoto, 2019).

9.3 Water Scarcity

9.3.1 Aridity and Precipitation

Water scarcity is a key challenge in the Arab region that is linked to both its arid climate and its population growth. A total of 13 out of the 22 Arab States already fall below the absolute freshwater scarcity threshold of 500 mł per capita per year (ESCWA, 2020b). In fact, 13 are among the world's 19 most water-scarce nations (Gassert et al., 2015). The Arab region is nearly 13,000 km¸ in size and covers 10 percent of the world's area. However, according to the Arab Water Council's 3rd Report on Water in 2015 (Arab Water Council, 2015), the region only receives about 1.5% of the global average annual precipitation volume. The total precipitation volume of the Arab region was 1,462 (billion cubic meters (BCM) in 2015, with an average precipitation depth of 270 mm among the countries. This amount was higher than the 1,383 BCM measured in 2012 for the same area (Arab Water Council, 2015).

The region's scarce precipitation varies widely in both location and time (Figure 6). Most of the rain occurs as seasonal showers at the African equatorial belt and along the Mediterranean coastal zones. Heavy precipitation, however, can cause flash floods in arid and hyper arid wadis of the Arabian Peninsula, the Red Sea mountains, and the Maghreb systems. Annual precipitation in the Arab region varies from zero in the Sahara Desert, to 600 mm in the Lebanese highlands, and is even in excess of 2,100 mm in Comoros. Direct and indirect beneficial water uses account for less than 15% of the total rainfall received by the Arab Region, compared to a global average that exceeds 50%. This reflects the extreme aridity prevailing throughout most of the Arab countries, which directly affects access to water. Water shortages, inequalities in water access, and transboundary water struggles can create challenges with agriculture and food production, affect the sustainability of livelihoods, and even compromise human security (Abu-Zeid, 2021a; Abu-Zeid, 2021b). Figure 6 shows the annual precipitation volume across Arab countries, while Figure 7 displays the change in rainfall across the region comparing the years 1961-1990 to 1991-2014. As Figure 7 shows, especially the southern parts of the region have been receiving more rain, while large parts of the Sahara Desert, Levant and Saudi-Arabian Peninsula received between 0 and 50 mm of rain less in 1991-2014 as compared to 1961-1990.

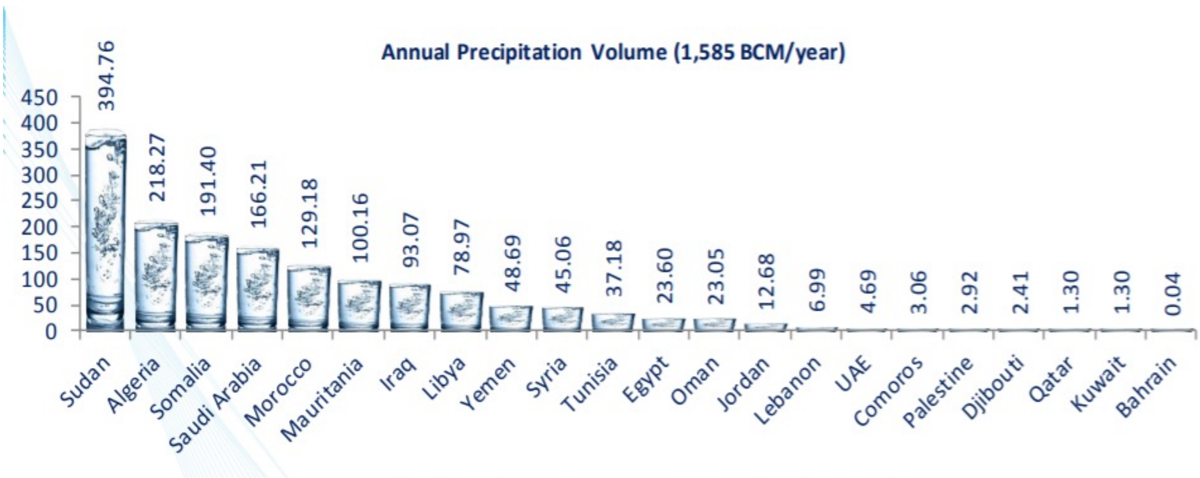


Figure 6: Annual precipitation volume received by Arab countries in billion cubic meters (BCM) / year, based on CHIRPS, 2015 (Source: Arab Water Council, 2015, 38).

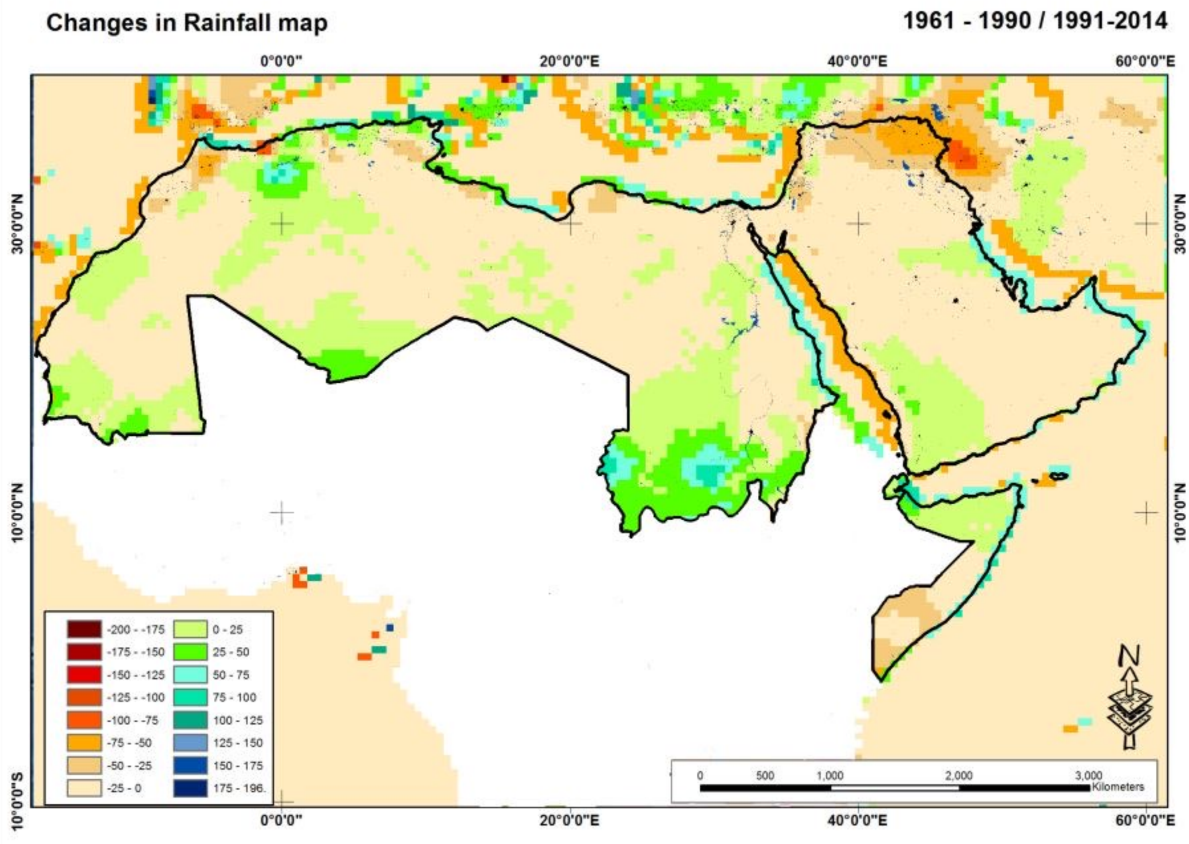


Figure 7: Change in rainfall across the region, comparing the study period 1961-1990 to 1991-2014, in mm (Source: AGIR / LAS-Arab Water Council, 2019, 12).

The region's annual internal renewable water resources amount to only 6% of its average annual precipitation, against a world average of 38%. During the period from 2005 to 2015, annual per capita freshwater availability in the region dropped by about 20 percent, from about 990 to 800 mł/capita/year. The world average of 7,525 mł/capita/year was about ten times higher (Saab, 2017). The countries most vulnerable to water scarcity and water stress are those that depend on rainfall or rivers (UNEP, 2016). As UNDP (2018, 26) predicts: "With growing populations and increasing per capita water use, water demand in the Arab region is projected to increase by 60 percent by 2045, while climate change is expected to reduce water runoff by 10 percent by 2050".

Water stress is increasing the pressure on groundwater resources in the region. In the last 10 years, groundwater levels in the Arab region have decreased by 1 to 2 m annually, depending on rainfall (Saab, 2017). Groundwater exploitation, mainly as an irrigation source for agriculture, has caused a deterioration of water quality, most notably salinization. Due to salinization of freshwater, water scarce regions will have even fewer water resources to support their industries and populations. Growing populations in the Arab region heavily depending on natural resources for their survival. After several decades of improper management, many Arab countries were alarmed by the loss of valuable groundwater stocks and implemented policies that restrict groundwater extraction and curtail agricultural activities based on groundwater. For example, Jordan has restricted groundwater abstraction and stopped issuing licenses for drilling wells in the Amman-Zarqa basin after water levels in aquifers dropped by several meters following years of excessive abstraction (Verner, 2012).

9.3.2 Water and Livelihoods

Water is not only a crucial pillar of life, health, livelihoods, and food security, but also of sustainable development in the Arab countries. Particularly agricultural livelihoods are sensitive to changes in the availability of water. Over 80% of the region's freshwater resources are used for agriculture (FAO/IWMI, 2019). There are 59 million ha of rainfed agricultural land and 9.8 million ha of irrigated agricultural land in the region (Arab Water Council, 2015), which means over 80% of agriculture in the region depends on rainfall. Figure 8 shows the distribution of rainfed agriculture across the region's countries (Arab Water Council, 2015, 80). At 30-45%, the irrigation efficiency in the region is comparatively low (UNDP, 2018, citing UN and League of Arab States, 2013). Achieving SDG 6 in the context of such aridity is a particular challenge and requires a rethinking of the management of water in the region. As emphasized by His Excellency Dr Mahmoud Abu-Zeid (2021a), President of the Arab Water Council and former Minister of Water Resources and Irrigation of Egypt, water is only renewable if we manage it correctly, given high population growth in water stressed countries. Moreover, water is at the core of sustainable development and critical for ecosystems, humans, development, health and productivity, thus playing a truly cross-cutting role in regional development. Water also plays an important role in terms of building resilience in the face of unpredictable change (Abu-Zeid, 2021a).

Regional water management calls for improved diplomacy and transboundary water management. There is significant inequality in terms of water access across the region, based on levels of rainfall, negotiations over access to transboundary resources, and the national spending capacity to develop water infrastructure. Water sharing of transboundary water sources, such as rivers or groundwater aquifers, remains an important aspect of peace, equality, and sustainability in the region (Abu-Zeid, 2021b). Addressing water scarcity with expensive technology, for example desalination technology, has become a prominent response in the Gulf countries, but is still much less implemented in other countries of the region (Arab Water Council, 2015). Therefore, tackling water scarcity on a regional level, advancing regional data sharing and promoting joint, regional policy approaches are important aspects of regional water security (Arab Water Council, 2021b).

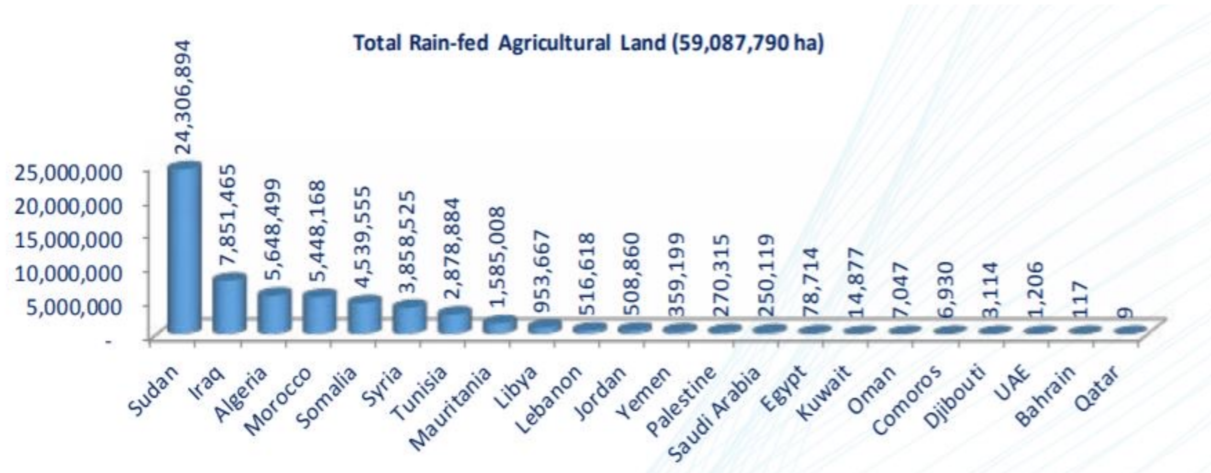


Figure 8: Total area of rainfed land by country (Source: Arab Water Council, 2015, 80).

9.3.3 Water and Sanitation

Beyond the availability of water, access to water and sanitation services in the Arab region remains a challenge on the path towards achieving sustainable development, well-being, and social equity. Important achievements to improve water access have been made in recent years. As ESCWA (2019, 41) reports, "between 2000 and 2015, access to basic water services increased from 80 to 87 percent, and access to basic sanitation services from 75 to 81 percent" in the region. However, according to the same report, 51 million people (11.5%) in the region are suffering from lack of access to basic water services, and nearly 74 million (16.5%) to basic sanitation services. Important contributing factors to household water access are state fragility, geopolitical reasons, and the disparity of services between rural and urban areas. According to the Human Needs Overview 2020, 1.8 million Palestinians need proper water, sanitation, and hygiene (WASH) services, due to their geographical area of residence, inadequate proper infrastructure, and climate change (UNOCHA, 2020a). According to ESCWA (2019), 23%, or 37 million people, in rural areas are suffering from proper access to basic drinking water service, compared to only 6%, or 13 million people, in urban areas. The disparity is even greater for sanitation services, with 32%, or 51 million people, in rural areas lacking basic services, compared with 10%, or 22 million, in urban areas (ESCWA, 2019).

9.4 Food Security

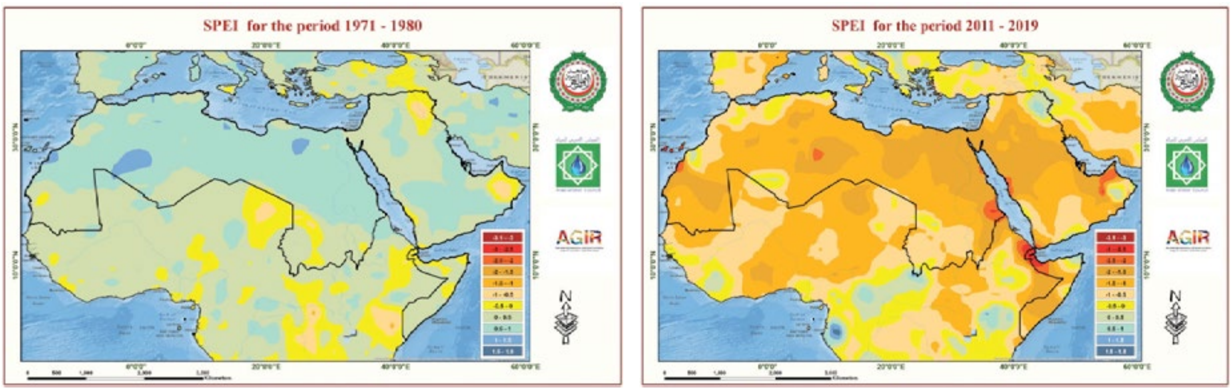
Food security is an aspect of social vulnerability closely interlinked with water scarcity and drought, and a particularly challenging topic in the arid and water-scarce MENA region. Arable land is generally scarce in the region, limiting the geographical scope for food production. Combined with high population growth, this is creating a critical situation for food security. Agricultural land per capita has already fallen below 0.1 ha per person in Egypt, Lebanon, the UAE, Qatar, and Kuwait (Doelman / IFPRI, 2018). As food production resources such as water and arable land are dwindling, agricultural productivity needs to be enhanced drastically, given that in the current global food production system, 1 farmer already needs to feed 265 people (Abusabaa, 2021). This does not only require rethinking how we grow food, but also represents a transportation challenge from producers to consumers, given the global urbanization trend. A total of 68% of the global population is projected to live in cities by 2050 (UN DESA, 2018). With future population growth, increased water scarcity, and climate change impacts looming, ensuring that safe and nutritious food is available and accessible to all residents remains a sustainability challenge in the region.

To ensure food security, countries of the region depend on imports to meet much of their food needs. Agricultural production in the Arab region has not kept pace with population growth and meets only half of the region's food requirements, while the other half is imported from the international market (Arab Water Council, 2017). In 2014, 33 million people in the region lacked adequate access to nutrition and 5% of children were stunted in their development (WFP/ ODI, 2015). As undernutrition and hunger prevail, particularly in countries facing conflict such as Yemen or Sudan, malnutrition and stunting remain significant problems across the region. There are vast differences in economic wealth between countries of the region, for example the Gulf Countries and countries battling poverty and conflict, which means that their ability to secure food security through imports and agricultural investment abroad varies. However, the impact of COVID-19 has also triggered a trend towards local food production in countries that lack arable land, such as the UAE. The recent war in Ukraine is placing an additional strain on food security, as several countries in the region heavily depend on the import of grains from Russian and Ukraine for their national supplies.

Food security is closely intertwined with human security, public health, sustainable development, but also peace and climate security, as climate change and its impact on agricultural systems is expected to directly impact food security in the region. According to WFP/ ODI (2015, 8), "[c] limate change will affect all four dimensions of food security – the availability of food, and access to, stability, and use of food supplies." Reduced yields, higher production costs and an increasing dependence on world market prices are expected to increase food prices, thus reducing the accessibility of food, particularly for the more vulnerable parts of the population. This may cause a further negative impact on nutrition levels and public health among the population of the region, again disproportionally affecting vulnerable groups.

9.5 Climate Change Impact and Droughts in the Arab Region

Climate change in the Arab region, as in the rest of the world, is well under way. Scientists have been measuring and modelling a range of climate change impacts in the region, including rising temperatures, changes in precipitation patterns, higher frequency and intensity of drought, more frequent extreme weather events, floods and flash floods (RICCAR, 2017; AGIR/LAS-Arab Water Council, 2019; Arab Water Council, 2021a). According to RICCAR's (2017, 29) Arab Climate Change Assessment Report, these impacts are "felt largely on the quantity and quality of freshwater resources and the ability of the region to ensure food security, satisfy energy demand, sustain rural livelihoods, protect human health and preserve ecosystems". Drought is among the most serious climate change impacts in the region. Droughts can cause a serious imbalance in water cycles that changes the precipitation and evaporation processes, atmospheric water vapor circulation, and soil moisture availability, which affect food, water, and proper access to energy (Payus et al., 2020). The Arab Geographical Information Room AGIR (AGIR/LAS, 2019) has been performing long-term assessments of drought across the Arab region. Figure 9 shows the Standardized Precipitation Evapotranspiration Index (SPEI) for the period 1971-1980 as compared to 2011-2019. SPEI changes in precipitation patterns measured across the region and a decrease in overall precipitation causing changes in the stream flows of water bodies have an impact on agricultural production and food security across the region. Drought has quantifiable effects on livelihood and economies in the region. According to AGIR-LAS (2019), droughts led to production losses of over 12% in the region (Figure 10), a figure that is expected to double by the year 2025. Due to their significant impact on people's livelihoods, droughts can become a trigger for migration movements. In 2016-2017, droughts displaced more than a million people in Somalia, which is one of the most vulnerable countries in the world to climate change, with an expected increase in temperature of up to 4.3°C by the end of the century (IDMC, 2020; SMoNR, 2013). Prolonged droughts in Syria and Sudan and recent years, in combination with political instability, conflict, and a range of socio-economic factors have led to considerable migration movements (GAR, 2021; Gleick, 2014). Thousands of Syrian farming families have been forced to move to cities in search of alternative work after two years



The average SPEI value is 0, the standard deviation is 1. In the Arab Region, the SPEI between the two measured periods decreased from between 0 and 1 in most places to between -1 and -2, indicating increased drought.

Figure 9: The Standardized Precipitation Evapotranspiration Index (SPEI) for the Arab Region for the periods 1971-1980 and 2011-2019 (AGIR/LAS-AWC, 2020, 122 and 130).

of drought and failed crops. Besides the hardship of migration, the suffering of those unable to migrate and being left behind in drought-affected also have to be considered (Erian et al., 2010). Jordan, Syria, and Palestine are also considered vulnerable to droughts (Gassert et al., 2015).

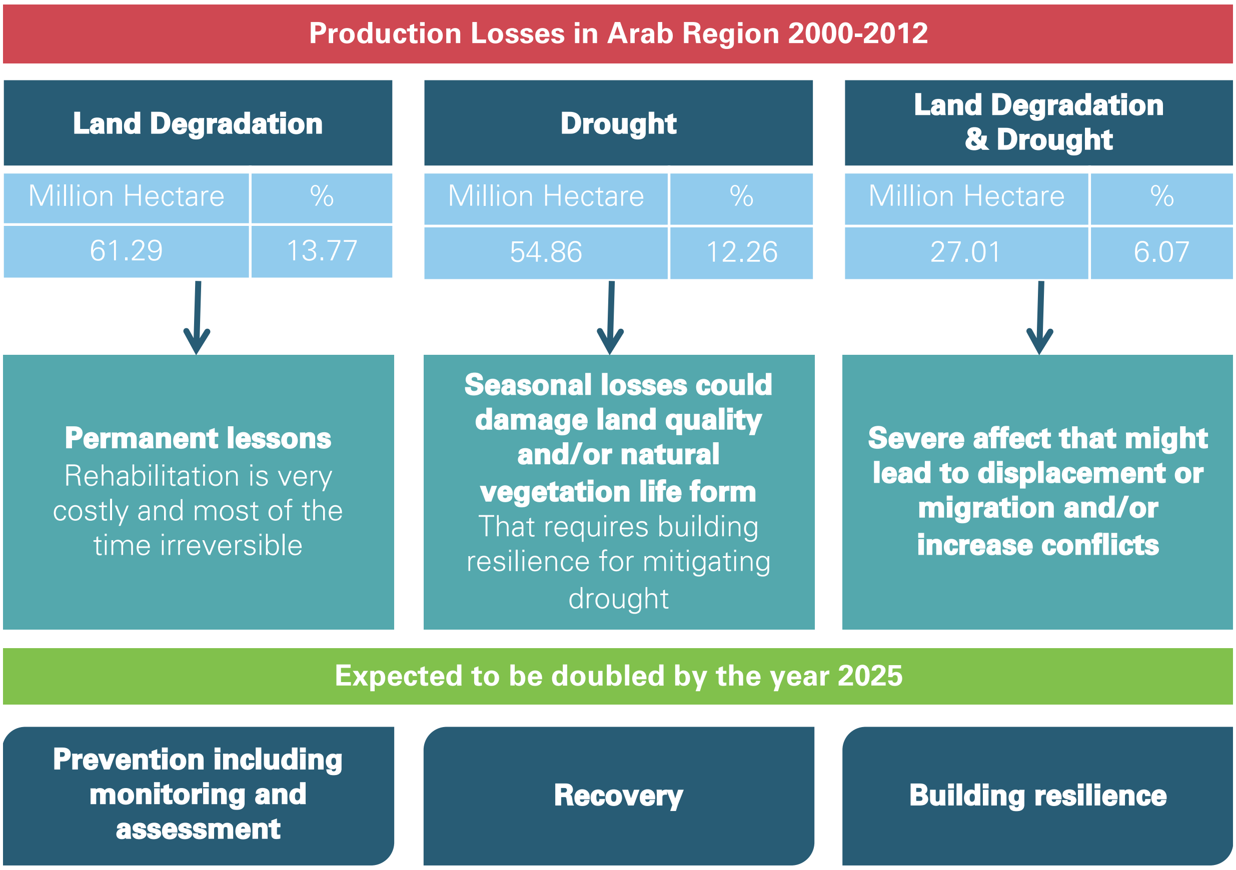


Figure 10:
Summary of agricultural production losses due to drought in the Arab Region, 2000-2012 (Source: AGIR / LAS-AWC, 2019, 24).

9.6 Social Vulnerability, Climate Change, and Policy-Making in the Arab Region

9.6.1 Climate Change and Social Protection in the Arab Region

Problematically, growing social vulnerability in the region, intensified by climate change and resource scarcity, is coupled with a lack of social protection programs that could help protect citizens cope with compound risk. As indicated in UNDP's 2014 Arab Human Development Report (Jawad, 2014, 43), "the region does lag behind in terms of the administrative structure of some of its social protection programs, which are underperforming in terms of reducing poverty and inequality rates." At the time of publication, only 30-40% of the Arab population were benefiting from social protection programs. Arab countries fell short on offering universal protection schemes including minimum income guarantees or tax-funded mechanisms of social policy financing (Jawad, 2014). ILO's World Social Protection Report 2020-2022 (ILO, 2021, 15) concludes that "[i]Investment in social protection is insufficient in the region" with only 39.5% of the MENA region's population being covered by effective social protection programs. This figure is less than the world's average of 46.9% (ILO, 2021) and does not reflect a significant improvement from figures presented in UNDP's 2014 report. ILO (2021) concludes that social protection spending in the region disproportionately covers public sector employees, for example through pension schemes, creating an inequitable coverage that enhances inequalities (ILO, 2021). Figure 11 shows the percentage of population covered by social protection schemes as well as the percentage of social protection expenditure as part of the GDP (ILO, 2021). In Jordan, less than 30% of the population are covered, while spending on social protection is high.

In terms of social protection programs, climate change as emerging risk does not only require boosting social protection coverage in the region, but also developing more targeted and integrated social protection mechanisms that address compound risk. Thus, these links are underrepresented in the context of already insufficient social protection mechanisms in the region. Most social protection mechanisms lack specific climate change policies, while climate change policies fall short on addressing social vulnerability and social protection. "Climate change-smart" social protection programs should target groups that are most vulnerable to climate change, and least able to access social protection mechanisms. Migrants and refugees are identified as having limited access to social protection programs. Moreover, women, who in the region are often either outside the labor force or part of informal sector employment, are disadvantaged in their access to social protection (ILO, 2021).

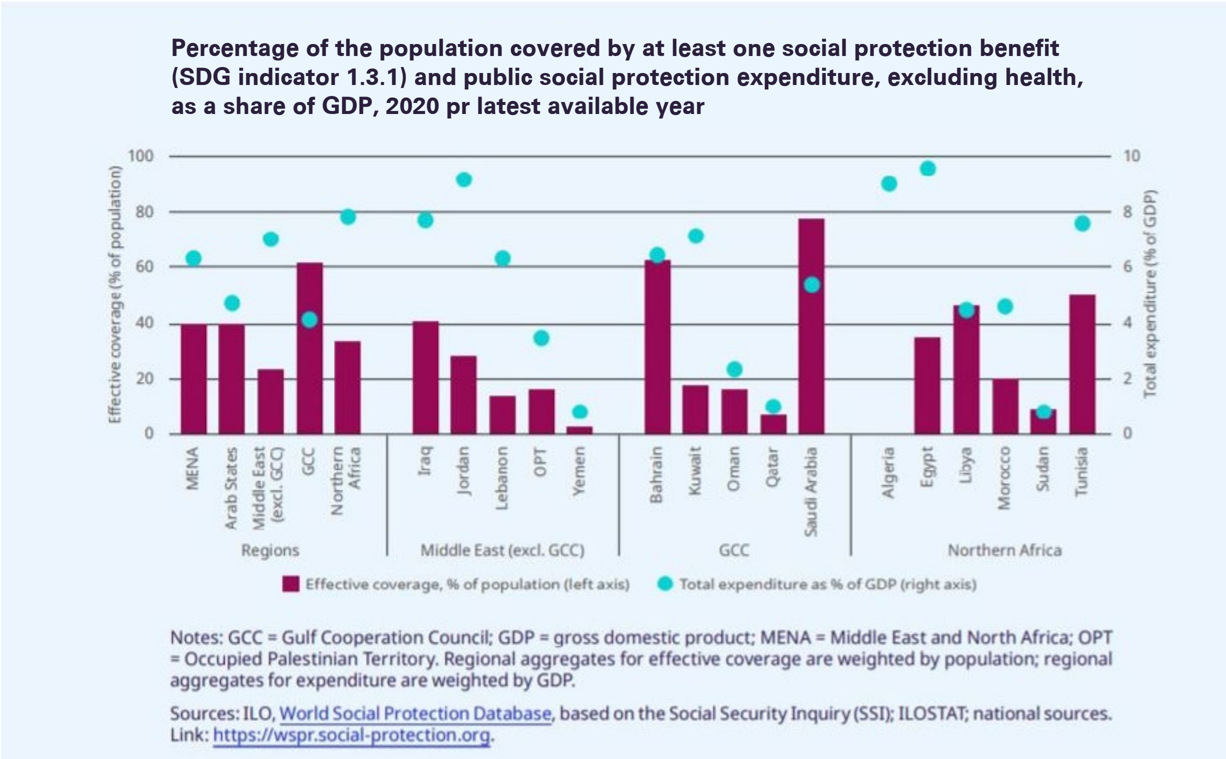


Figure 11:
Social protection coverage in the Arab region (Source: ILO, 2021, 16).

9.6.2 Intersectionality of Risk

An important concept to consider in the design of social protection programs is intersectionality. Women often face an intersectionality of structural inequalities (Nightingale, 2011), for example with respect to gender, class, education, employment status, and migration status. Another layer of risk in this regard is the threat of climate change impact, which can weigh heavier on women who are already faced with an intersectionality of other risks – especially given the pronounced gender inequality in the Arab region. For example, female-headed farming households are often identified as particularly vulnerable to drought impacts, due to a triple burden: gender disparities in the labor market, a higher level of care exerted for dependent children and the elderly, and the double burden of having to be breadwinners and simultaneously managing domestic duties

(Muttarak, 2016). Female-headed households also show lower resilience levels (Fuller and Lain, 2019). Meanwhile, women's experiences of climate-induced migration processes vary from those of men. Research carried out by the Arab Water Council and UN Women (2022) in Jordan and Sudan shows that the climate, migration, and energy nexus is not only under-researched in the region, but that also needs to be addressed by policy-makers in a much more concerted and integrated effort. Social protection programs that are based on an understanding of climate change as compound risk and that assign a central role to social vulnerability, should be designed to address the intersectionality of risk.

9.6.3 Political Instability and State Fragility

As climate change and conflict converge, new forms of social vulnerability may emerge (UNDP, 2018). In parts of the Arab Region, this is particularly the case in fragile states, for example in the face of violent conflict and a lack of proper governance in Iraq, Libya, Syria, Somalia and Yemen (Arab Water Council, 2017). Conflict can also lead to increased dysfunctionality of already inefficient or malfunctioning governance and public service provision processes. As Kivimäki (2021) shows, state fragility can cause development shortcomings and violence, while grievances and resulting conflict, in return, can contribute to state fragility. The Fragile State Index (FSI), a global assessment carried out by The Fund for Peace (FFP), measures the level of state fragility on a range of quantitative and qualitative pressure, assessing whether a range of pressures that states experience exceed their ability to cope and function[1]. This includes socio-economic data, but also experiences of displacement, social tension, gender inequalities, physical and mental health, access to public services, as well as feelings of risk and insecurity. Table 2 shows the Fragile State Index for Arab countries (a lower score indicates less fragility). The FSI varies significantly between Arab countries with the Gulf countries being the least fragile states in the region and Yemen, Somalia, Syria, and Sudan being the most fragile. While Syria's fragility index has increased sharply since 2011 as a cause of the civil war, the other countries' FSIs have remained high over the past decade. It is important to note that, besides armed conflict, FSI indicators also include the state of public service sectors such as improvement and development in telecommunication networks, public transportation facilities, and access to essential services, as well as group grievances, demographic pressure, refugees and IDPs. As can be seen in Table 2, Jordan can be found at the end of the top half of the table.

1 The FSI is calculated according to the improvement of 12 main indicators, and 2 sub-indicators. The sum of scores for these 12 indicators leads to a ranking. The methodology integrating both quantitative and qualitative indicators provides interesting inputs for the development of complex social vulnerability indices in relation to climate change mitigation, adaptation and risk prevention based on regional quantitative data sets and both quantitative and qualitative data collected in the field (Fragile States Index, 2020).

Table 2: Fragile State Index (2011-2020) (Source: Fragile State Index, Arab Water Council calculations)[2]

COUNTRY / YEAR	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
United Arab Emirates (UAE)	50.4	48.9	47.3	47.6	46.2	44.5	43.7	42.8	40.1	38.1
Qatar	49.5	48.0	47.1	48.9	46.3	45.1	44.0	48.1	25.3	43.7
Oman	49.3	51.7	52.0	53.1	52.0	51.6	52.5	52.6	18.0	48.0
Kuwait	59.5	58.8	59.6	59.0	57.5	58.5	58.5	55.9	93.5	50.9
Bahrain	59.0	62.2	62.9	64.7	64.4	63.4	64.9	64.4	63.8	63.9
Tunisia	70.1	74.2	76.5	77.5	75.7	74.6	74.2	72.1	70.1	68.1
Saudi Arabia	75.2	73.4	72.7	73.1	71.6	72.2	71.2	70.2	71.1	68.8
Morocco	76.3	76.1	74.3	74.4	74.6	74.2	74.9	74.0	55.3	71.2
Algeria	78.0	78.1	78.7	78.8	79.6	78.3	76.8	75.8	75.4	74.6
Jordan	74.5	74.8	75.7	76.7	76.9	78.0	78.7	76.8	34.3	75.4
Comoros	83.8	83.0	84.0	85.1	83.3	83.8	84.8	82.6	81.7	81.2
Palestine	83.0	84.3	84.8	88.0	86.8	87.8	87.6	86.4	83.9	82.0
Djibouti	82.6	83.8	85.5	87.1	88.0	89.7	88.9	87.1	85.1	82.7
Lebanon	87.7	85.8	86.3	86.9	88.1	89.6	88.2	86.8	43.9	84.7
Egypt	86.8	90.4	90.6	91.0	89.9	90.2	89.8	88.7	88.4	86.0
Mauritania	88.0	87.6	91.7	93.0	94.9	95.4	93.7	92.2	34.5	88.7
Libya	68.7	84.9	84.5	87.8	95.3	96.4	96.3	94.6	90.2	95.2
Iraq	104.8	104.3	103.9	102.2	104.4	104.7	105.4	102.2	83.0	95.9
Sudan	108.7	109.4	111.0	110.1	110.8	111.5	110.6	108.7	84.0	104.8
Syria	85.9	94.5	97.4	101.6	107.8	110.8	110.6	111.4	111.5	110.7
Somalia	113.4	114.9	113.9	112.6	114.0	114.0	113.4	113.2	81.9	110.9
Yemen	100.3	104.8	107.0	105.4	108.2	111.5	111.1	112.7	113.5	112.4

According to The Fund for Peace (2020), "[t]ensions can deteriorate into conflict through a variety of circumstances, such as competition over resources, predatory or fractured leadership, corruption, or unresolved group grievances." The effects of climate change can contribute to these sources of conflict and act as a multiplier of existing risks and vulnerabilities in already fragile states, causing, for example, waves of migration.

9.6.4 Political Responses

Global and regional political agendas already emphasize the importance to address environmental change and social vulnerability in concerted ways. The 2013 Cairo Declaration, which emerged from the 20-year review of the International Conference on Population and Development for the Arab States, carried renewed emphasis on the interaction between population and the environment to achieve sustainable development, water and food security. The declaration specifically states that regional and local climate change response measures need to consider the distribution, vulnerability and resilience of the targeted populations (ESCWA, League of Arab States, Economic Commission for Africa and UNFPA 2014). The 20-year review of the implementation of the International Conference on Population and Development (ICPD) Program of Action in Arab Countries revealed that, while 16 out of 19 signatories of the total 22 Arab countries had acted to promote environmental resource management, only ten countries had undertaken concrete action targeting the needs of people living within or on the edge of fragile ecosystems [3].

2 Fragile State Index 0 – 120 (0 is the best – 120 is the worst condition): measured by 12 indicators: Security Apparatus, Factionalized Elites, Group Grievance, Economic Decline, Uneven Economic Development, Human Flight and Brain Drain, State Legitimacy, Public Services, Human Rights and Rule of Law, Demographic Pressures, Refugees and IDPs, External Intervention

3 List of countries that took concrete actions: UAE, Qatar, Oman, Kuwait, Bahrain, Tunisia, Saudi Arabia,

In the context of implementing the UN Sustainable Development Goals, Arab States submit regular voluntary national reports on sustainable development progress. Often, these progress reports provide separate updates on the achievements under the various SDGs and fall short on demonstrating synergies and connections between the goals, as well as an awareness of nexus thinking and planning. Climate change and social vulnerability, for example, are cross-cutting themes that affect various SDGs, but are seldom discussed in such an integrated manner. In addition to the SDG update reports, Arab countries release national communications on climate change report impacts as well as mitigation and adaptation efforts in response commitments made under the Paris agreement. In Jordan, for example, the first National Communication on Climate Change was released as early as 1997 – two additional documents were published in 2009 and 2014 (The Hashemite Kingdom of Jordan, 1997, 2009, and 2014). An updated National Communication is currently in production. Despite improved reporting on climate change, regional disaster management capacities, such as drought and flood warning mechanisms in the region are extremely low (UNDP, 2018), while the region needs capacity development in the government sector and effective governance systems to build resilience to climate change (UNDP, 2018; Arab Water Council, 2021b).

National reports on SDG and climate change progress often lack true integration of environmental, social, and economic indicators in measuring climate change impact. Climate change, water security, energy, food security, and social vulnerability should be addressed in an integrated manner in the region through applying nexus thinking. This also requires a more pronounced collaboration between researchers and policy-makers (Arab Water Council, 2021b). Often, the ministries tracking sustainable development progress are not the same ministries working on climate change, and other ministries again are concerned with social issues and social protection. A regional policy dialogue on climate security organized and hosted by the Arab Water Council in 2020 confirmed that Arab policy approaches lack nexus thinking and integrated decision-making tools that will help address the multi-sectoral aspects of compound risk fueled by climate change (Arab Water Council, 2021a). The Arab Water Council and UN Women (2022), in turn, show that there is a lack of concerted policy approaches addressing the climate, migration, and gender nexus. Climate change impacts and their links with ecosystem, social, and economic factors are not yet fully understood, specifically in all of their implications on the ground across the region. This project works towards building a better multi-sectoral understanding of the impacts of climate change in the region by developing innovative methodologies for assessing climate change impact in its interrelationship with social vulnerability.

Morocco, Algeria, and Jordan.

10

INTEGRATED CLIMATE CHANGE INDICATORS: THE CASE STUDY OF JORDAN

10 INTEGRATED CLIMATE CHANGE INDICATORS: THE CASE STUDY OF JORDAN

10.1 Overview

The present study focuses on drought risk and social vulnerability in Jordan. The study's focus on drought is an important and timely one, given the climate change-related drought risk the Arab region is facing. Across the region, changes in precipitation patterns are being observed that have been linked to climate change (Arab Water Council, 2021a). Jordan is among the region's and the world's most water scarce countries. Water scarcity is defined as having less than 1,000 mł of water available per person per year. Jordan now only has around 100 mł of water available per person per year, and is thus situated well below the absolute water scarcity threshold of 500 mł per person per year. The Hashemite Kingdom is the fifth most water-scarce country in the world, with steadily declining water resources (Hagood, 2020). A total of 75% of Jordan's territory is classified as desert, receiving less than 200 mm of rainfall per year (ranging from 600 mm in the northern uplands to 50 mm in the southern and eastern desert areas) (UNDP, 2021). Water harvesting and rainfed agriculture play an important role in Jordan. These are threatened by lowered precipitation levels and reduced run-off (Abu-Allaban et al., 2015; USAID, 2017), which is escalating water scarcity in the country and is negatively affecting farming livelihoods. Jordan's aquifers, some of which are non-renewable, are also suffering from a large degree of over-extraction (Hagood, 2020).

While Jordan is witnessing dwindling water resources, more and more water is needed for a growing population. In 2019, Jordan's total population was about 10.1 million, 90% of which lived in urban areas. Jordan's population increased from 6.1 to 10.2 million between 2007 and 2020 (World Bank, 2020b), largely due to the country hosting large numbers of refugees from Syria. Jordan has a total area land of 89,320 km˛, only 8.9 percent of which is agricultural land (World Bank, 2020b). A total of 90% of the population lives on only 10% of the country's surface area. With limited agricultural activity possible due to the dry climate and the limited water resources, Jordan has also been facing issues of food security. As WFP food security updates show, a total of 16% of households in Jordan showed a poor or borderline Food Consumption Score (2020) in 2018, and 15% in 2020 (WFP, 2020). Jordan's economy is largely dependent on trade and service-related activities. However, manufacturing, agriculture, mining, and construction activities have contributed significantly to the country's economy in recent years. In 2019, the country's GDP per capita was estimated at US$ 2,925. The country is still suffering from a decline of GDP growth, which was 18.6 percent in 1992 and declined to 2 percent in 2019 (UNICEF, 2020).

UNICEF (2020) refers to a poverty rate of 15.7% in 2019 and an unemployment rate of 18.7% in 2018. Poverty in Jordan is more pronounced in rural areas than in urban areas, and about 10% of Jordanians live in rural areas. According to the World Bank (2020), approximately 19% of the rural population is classified as poor. However, urban areas are also increasingly struggling with poverty, particularly neighborhoods hosting large numbers of refugees. Poverty issues are also present in Jordan's refugee camps. Because of the arid conditions and lack of water for irrigation, many of the rural poor cannot grow enough crops to feed themselves and their families. People who find other ways to supplement their incomes generally earn very little. Regular drought exacerbates the situation. For example, during the 1999/2000 drought, wheat production dropped from 70,000 to 9,000 tons, an amount that fell disastrously short of the country's demand for about 650,000 tons of wheat annually (World Bank, 2020b). This is significant, as around a quarter of the Jordanian population depend on the agri-food sector for their livelihoods, while the sector remains an important source of income and employment, particularly in rural Jordan (WFP, 2020).

According to the Arab Water Council (2017), many of Jordan's rural poor live under extremely difficult conditions. For one, this is due to inadequate access to alternative sources of income. Second, they find limited opportunities to diversify their farming enterprises because of low rainfall, poor soil quality, and the topography of the land they cultivate. An additional challenge is the lack of collaterals for loans and difficulty in obtaining loans needed for investment in farm activities that could lead to higher incomes. As much of the agricultural land in the country is not owned by the land users, but rented, there is often an unwillingness to make long-term investments on the land cultivated by tenant farmers. The most vulnerable groups identified by the Arab Water Council (2017) include large rural households (with eight family members) headed by illiterate or poorly educated people, households headed by women, households with sick or elderly people, and households that do not own any or very little land. Families headed by women often struggle disproportionately with poverty and own fewer economic assets than households headed by men. Drought and soil degradation are often additional challenges that further complicate these rural livelihoods.

10.2 Climate Change Impact in Jordan

Climate change is expected to have serious implications on the country's efforts to eradicate poverty and realize sustainable development for current and future generations—ultimately making climate change an issue of inter-generational equity. Climate change scenarios indicate that Jordan and the Middle East could suffer from reduced agricultural productivity and water availability among other negative impacts. At the same time, a substantial potential for cost-effective reduction of GHG emissions exists in Jordan (UNDP, 2013).

Spatial and temporal drought analyses, based on extreme climate change scenarios, suggest that agricultural and hydrological drought in the northern basins of Jordan may double by the end of the century, seen from the baseline year 1980 (Rajsekhar and Gorelick, 2017). According to the Jordanian Government's National Communication on Climate Change, which is focused on the lower Zarqa River Basin in the Governorates of Balqa, Jerash, and Ajloun as study area (The Hashemite Kingdom of Jordan 2014, 114):

> **"Climate change is limiting water resources, and supplementary irrigation is currently required. Houses are seeing the need to have cooling systems installed. Traditions and social aspects of the population are changing as a result of the new conditions. Communities are exposed to several stresses due to the new climate conditions and as a result their climate change vulnerability is increasing."**

The report also presents different scenarios of climate change projections for Jordan and their impact on the country considering temperature, precipitation, evapotranspiration, and wind speed. The study focuses on the water sector and agriculture sectors given these sectors' high vulnerability to climate change in Jordan (The Hashemite Kingdom of Jordan, 2014). For rainfed agriculture, the impacts of climate change scenarios look particularly dire:

"According to Al-Bakri et al. (2010), a 1°C increase in temperature and 10% decrease in precipitation will decrease yield by 7% for wheat and 18% for barley. While a 2°C increase in temperature and 20% decrease in precipitation will decrease yield by 21% for wheat and 35% for barley due to shorter duration of crop growth and lower water availability" (The Hashemite Kingdom of Jordan, 2014, 152).

The National Communications' maps on climate change impact on ecosystems as well as the adaptive capacity of ecosystems have been included in this study. The Jordanian Government, in partnership with the country's climate change experts, is currently working on an updated national communication.

Over the past years, several studies on drought impact in Jordan have been carried out. In 2019, UNDP conducted a drought vulnerability and impact assessment for several groundwater basins in Jordan (Amman-Zarqa, Yarmouk, Azraq, and Mujib) (Al-Bakri and Al-Qinna, 2019b) as part of the project "Strengthening the national water governance capacities in drought management." For the water sector only, and when taking into account stakeholder knowledge, Azraq shows high drought vulnerability, Yarmouk and Amman-Zarqa medium vulnerability, and Mujib low vulnerability. When considering all exposure, sensitivity, and adaptive capacity factors, the results change considerably. In this case, Yarmouk exhibits extreme drought vulnerability, Mujib high vulnerability, Amman-Zarqa low vulnerability and Azraq no vulnerability (Al-Bakri and Al-Qinna, 2019b). In Al-Bakri and Al-Qinna's (2019b) study, experts highlight the following drought concerns for Jordanian groundwater basins:

Table 3: Drought impacts on selected groundwater basins in Jordan (Al-Bakri and Al-Qinna, 2019b, 22, UNDP report, visually modified by AWC).

	Amman Zarqa Basin	Yarmouk Basin	Mujib Basin	Azraq Basin
Low water availability for drinking purposes			(houses already have rainwater harvesting)	
Low water quality for drinking purposes				
Decline in groundwater level				
Increased water demand for crop production				
Deterioration of the environmental ecosystems (cover, wildlife, etc.)				
Compatibility of the crops to the quality of treated wastewater, and lack of safety aspects from consumers perspective.				

Another study conducted by GoAL WaSH and UNDP (2019) validated Jordan's composite drought index and drought vulnerability maps based on exposure, sensitivity, and adaptive capacity dimensions. The study finds the highest drought vulnerability in the northwest of the country, in the Governorates of Irbid, Jerash, and Ajloun. The report assigns these high rainfall areas of Jordan high sensitivity and simultaneously low adaptive capacity to drought. The assessment is based on the following indicators: drought occurrence (exposure), population, agriculture, livestock, forest and reserves (sensitivity), and poverty, municipal water, and irrigation water (adaptive capacity). The study concludes that Mafraq and Aqaba have zero drought vulnerability, while Zarqa, Maan, Tafiela, Madaba, and Balqa have low drought vulnerability. The Badia El Shamaliya District, which is the case study area for our project, receives a no-drought vulnerability score, but also a low adaptive capacity score for drought.

10.3 Integrated Research and Policy-Making

Given that drought and water scarcity are among Jordan's most prominent national challenges, it is crucial that research, policy-making and policy implementation address water management in an integrated manner. Alqadi et al. (2021) identify a persisting lack of communication between researchers and policy-makers in implementing Jordan's national water strategy. In order to ensure that Jordan's policy actions rely on research results and scientific evidence, the authors suggest including government actors in both research design and literature collection, as grey literature about water management is often not readily available without the involvement of government actors. In creating new, integrated research and policy-making tools that enable researchers and policy-makers to make important links between the different spheres of climate change impact – including social vulnerability, this study takes a look at climate change impacts and social vulnerability in Jordan. Based on climatic and socio-economic data collected for the national level in Jordan, a multi-disciplinary approach is used to measure and assess climate change impact, with a particular focus being placed on social vulnerability.

11

ANALYTICAL METHODOLOGY

11 ANALYTICAL METHODOLOGY

11.1 Conceptual Overview

Climate risk is determined by the climate and weather events (hazards), and exposure and vulnerability to these hazards (Cardona et al., 2012). The climate change **hazard** assessed in this study is drought. Around the world, places and people are starting to be exposed to climate change impacts such as drought. **Exposure** refers to the "physical presence of people, livelihoods, infrastructure or other assets in places that could be adversely affected by hazards" (Gerlak and Greene, 2019, 108). Climate change hazard can affect environmental functions, services, resources, but also economic, social and cultural assets (IPCC, 2019). **Sensitivity**, in turn, refers to the extent the human environment system is susceptible to climate change (Cardona et al., 2012). The extent to which people are affected by climate hazards is closely linked to types of livelihoods. Some livelihoods, due to their physical exposure, as well as their dependence on natural resources, are more sensitive to climate change than others, in other words more susceptible to its damage. Very climate-sensitive livelihoods are those directly dependent on access to ecosystems and resources, such as agriculture, agro-pastoralism, fisheries or forestry (Gerlak and Greene, 2019). **Adaptive capacity** determines the potential or ability to adapt and recover from the impact of climate change (de Sherbinin et al., 2019). In this context, household demographic and socio-economic characteristics, proximity to infrastructure and services, household asset ownership, but also social protection systems, become important variables (Jagarnath, 2020).

Vulnerability as a concept includes exposure, sensitivity, and adaptive capacity of systems to climate change hazards – such systems can be ecosystems, communities, or economic systems. Importantly, vulnerability is also shaped by existing circumstances that are often independent of the hazard (de Sherbinin et al., 2019), for example pre-existing and systemic inequality. Social vulnerability, as defined in previous sections, focuses on people, communities, and societies and the ways in which they are affected by, and cope with, climate change impact. Vulnerable livelihoods, state fragility, and a lack of capacity and social protection can increase the propensity of a person or group to be adversely affected by hazards, and limit his or her ability to cope. However, social systems cannot be viewed in isolation, and are inherently intertwined with physical, economic, and environmental aspects. Hence, the range of indicators used to measure social vulnerability to climate change should represent all these spheres. As previously outlined, this study makes a conscious effort to highlight the **social** elements of vulnerability in the context of climate change impact, which are often under-represented and under-counted. Often, indicators used to measure social vulnerability, such as poverty or unemployment, do not reflect the full complexity of social vulnerability, including for example ethnicity, migration status, gender, or health.

Placing a conscious focus on human agency, adaptive capacity is included in the social vulnerability assessment of this study. The concept of adaptive capacity is very close to, and often used as synonymous with the concept of **resilience** (Maygarden, 2021, see Figure 13). Based on Cutter et al. (2008), Madajewicz (2020, 2031) defines resilience as "…the ability to cope with the damage incurred as a result of a hazard and to recover, including learning to build greater future resilience into the recovery". Resilience includes the notion of returning to a pre-hazard state, "[t]he ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (Weichselgartner and Kellman, 2015, 259 based on UN-ISDR, 2009, 24).

Using the above-defined concepts as a backbone, the present study proposes an integrated analysis of drought impact and social vulnerability by developing a complex and multi-sectoral indicator index. Satellite data and national statistics are used to map social vulnerability and drought impact at the national scale in Jordan using GIS technology, thus identifying and visualizing hotspots of social vulnerability to drought impact. The study is informed by recent conceptual approaches used to assess vulnerability. In part, the methodology used here borrows from the IPCC's 2014 paradigm, which sees vulnerability and adaptive capacity as intrinsic parts of the system, not as something that only becomes important in the aftermath of an event (Figure 12). Secondly, the conceptual approach to measuring vulnerability and risk methodology is informed by an approach outlined by Penn State University in 2021 (Maygarden, 2021) (Figure 13). Here, vulnerability is a function of exposure, sensitivity, and adaptive capacity, which is then multiplied by the hazard – in this case, drought. Our addition here is one of emphasis – consciously expanding the range of **social vulnerability indicators** in the assessment. For this reason, more indicators measuring social vulnerability were included than in previous studies conducted in the Arab region, covering more aspects of pre-existing vulnerabilities and structural inequalities. The final mapped outcomes of this study are a map of vulnerability (with an emphasis on social vulnerability) and a map of drought risk.

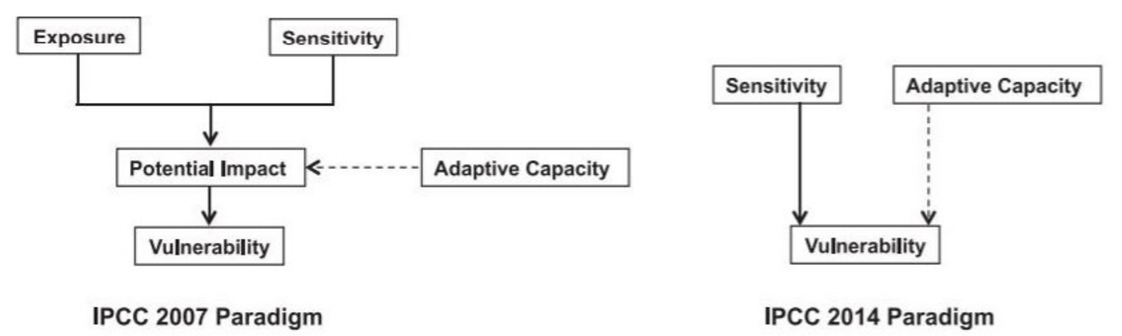


Figure 1. The concept of vulnerability as presented in the IPCC 2007 and 2014 reports. Solid and dashed arrows respectively show a positive and negative functional relationship of a component with vulnerability.

Figure 12:
Approaches to climate risk assessments taken by IPCC (Source: Sharma and Ravindranath, 2019, 051004).

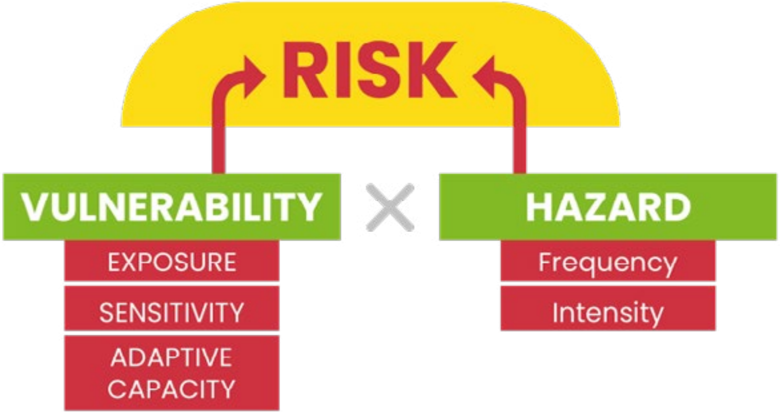


Figure 13:
Model for climate change risk assessment – blue circle was added to emphasize this study's focus on vulnerability, particularly social vulnerability (Adapted from Maygarden, 2021).

11.2 Social Vulnerability Indicators

As outlined above, the targeted assessment of the complex social elements of social vulnerability remains a research gap. Studies that consider environmental and socio-economic

and political drivers of vulnerability in their interplay require more complex and multi-sectoral indicators than conventional approaches. This includes tools and approaches that can measure and articulate complex drivers and processes of vulnerability (Gerlak and Greene, 2019), such as surveys and case studies. Here, social science methodologies can be of great relevance to the understanding of climate vulnerability. As Gerlak and Greene (2019, 109) suggest: "coupled framings of vulnerability begin with the systematic identification of vulnerable populations through the integration of social, economic, and climate data— including vulnerability assessments, vulnerability mapping, and the use of both quantitative and qualitative data."

Recent studies on social vulnerability and climate change / environmental hazard suggest a variety of indicators and proxies to measure social vulnerability. Various studies employ complex SV Indices (Cutter et al., 2003) that consider multi-sectoral indicator sets, including the so-called Social Vulnerability Index, "a multidimensional, scale dependent, spatially reliant algorithm for quantifying the relative socio-economic and demographic quality of a place as a means of understanding vulnerability" (Cutter et al., 2009, 22). In measuring climate-related heat stress in urban South Africa, Jagarnath et al. (2020) use both demographic and socio-economic census data for a social vulnerability index they include in their assessment. While age, race, income, or education can commonly be found as proxies for social vulnerability, more complex parameters such as malnutrition, body mass index, or morbidity are more seldomly used (de Sherbinin et al., 2019). Madajewicz (2020, 2030) suggests that features of communities, institutions, infrastructure, and the environment, as well as access to information, the capacities of community groups, as well as features of geography and infrastructure are important indicators of social vulnerability and resilience. For their study on climate change and livelihood vulnerability in the Himalayas, Adhikari et al. (2020) create a composite Livelihood Vulnerability Index comprised of the following indicators: socio-demographic profile, livelihood strategies, social networks, health, food, water, natural disasters, and climate variability. Gender is another indicator that plays an important role in determining the social vulnerability (but also the resilience and adaptive capacity) of communities. As UNDRR (2021, xiii) points out in relation to droughts, whose frequency and intensity can be affected by climate change: "Droughts may affect men and women differently, and their impacts often amplify existing structural inequalities across social groups, ages or other demographic categories." Table 4 presents examples of indicators used by Cutter et al. (2009) to measure social vulnerability.

Table 4: Selected population characteristics influencing social vulnerability (Source: Cutter et al., 2009, 21)

Concept of Characteristics	Proxy Variable	Effect on Social Vulnerability
Socioeconomic status	% poverty per capita income	Increases High decreases; low increases)
Gender	% female headed households	Increases
Race and/or ethnicity	% African Americans % Hispanic	Increases Increases
Age	% elderly % under 18	Increases Increases
Housing tenure (ownership)	% renters % homeowners	Increases Decreases
Employment	% unemployed	Increases
Occupation	% agricultural workers % low skilled service jobs	Increases Increases
Family Structure	% single parent households Large families	Increases Increases
Education	% Less than High School	Increases
Population Growth	Rapid growth	Increases
Access to medical services	Higher density of medical establishments and services	Decreases
Special needs populations	Homesless, transients, nursing home residents	Increase
Social dependence	% social security recipients	Increase

An important component in measuring the social vulnerability of communities is geography. Setting indicators for social vulnerability depends on the vulnerability drivers per country or region, the availability of data, the country context, and the policies of sharing information per country (UNDP, 2017). The indicators that identify social vulnerability in the Arab Region differ from those set for the EU, although the two regions share some geographical characteristics. The Arab Water Council has classified vulnerability indicators as socio-economic indicators and political indicators according to Table 5 (Arab Water Council, 2017).

Table 5: Social vulnerability indicators according to the Arab Water Council's Social Vulnerability Assessment (Source: Arab Water Council, 2017, 21-23)

Socioeconomic Indicators	**Sub-indicator**	**Political Indicators**	**Sub-indicators**
Uneven Economic Development	• Gini Coefficient • Income share of highest 10% • Income share of lowest 10% • Rural and urban distribution of services • Improved service access • Slum population	State Legitimacy	• Corruption • Government effectiveness • Political participation • Electoral process • Level of democracy • Illicit economy • Drug trade • Protests and demonstrations • Power of resilience.
Poverty Economic Decline	• Economic deficit • Government • Debt • Unemployment • Youth employment • Purchasing power • GDP per capita • GDP growth • Inflation	Human Rights and Rule of Law	• Press freedom • Civil liberties • Political freedom • Human trafficking • Political prisoners • Incarceration • Religious persecution • Torture • Executions
Demographic Pressures	• Natural disasters • Disease • Environmental • Pollution • Food scarcity • Malnutrition • Water • Scarcity • Population growth • Youth bulge • Mortality	Human Fight and Brain Drain	• Migration per capita • Human capital • Emigration of educated citizens
Public Services	• Policing • Criminality • Education provision • Literacy • Water and sanitation • Infrastructure • Quality healthcare • Telephony • Internet access • Energy reliability • Roads	Security Apparatus	• Internal conflict • Small arms proliferation • Riots and protests • Fatalities from conflict • Military coups • Rebel activity • Militancy • Bombings • Political prisoners.
Group Grievance	• Discrimination • Powerlessness • Ethnic violence • Communal violence • Sectarian .....word missing • Religious violence	Fractionalized Elites	• Power struggles • Defectors • Flawed elections • Political competition
Refugees and Internally Displaced Persons (IDPs)	• Displacement • Refugee camps • IDP camps • Disease related to displacement • Refugees per capita • IDPs per capita • Capacity to absorb	External Intervention	• Foreign assistance • Presence of peacekeepers • Presence of UN Missions • Foreign military intervention • Sanctions • Credit rating

Studies on **adaptation to climate change** and climate change resilience also include the existence and state of important institutions, as well as the challenges and assets for adaptation in the following list of indicators: "(1) primary livelihoods, (2) main environmental changes observed and whether attributed locally to climate change, (3) non-climate drivers of change; (4) greatest impacts on livelihoods and social/cultural conditions; (5) important institutions and the role they play; (6) most important challenges and assets for adaptation; and (7) other important observations regarding adaptation" (Berman et al., 2020, 6). In their study on sensitivity and adaptive capacity, Inostroza et al. (2016, 10) consider the percentage of children and the elderly, the percentage of the disabled, family structures, education, unemployment rates, water supply, communication channels, the existence of medical services, the existence of infrastructure, among others. Madajewicz (2020, 2032) includes economic structure, household structure, age, education, health, ethnicity, geography and infrastructure, information, and community organization. Making an argument for the fundamentally local nature of adaptive capacity, and focusing on the concept of environmental subjectivities, Ford and Norgaard (2020, 43) argue that current climate change research and discourse neglect how "differences in social location and culture shape people's knowledge of and responses to climate change." The authors propose an approach based on situated knowledges that considers indigenous cultures, class, race, as well as power structures in people's adaptation to climate change. This approach of localized understanding and situated knowledges is reflected in the case study approach taken by the current study.

For its measurement of hazard and exposure, sensitivity and adaptive capacity to drought, the present study used the above-presented lists of indicators as a basis to produce a list of multi-sectoral and complex indicators. The choice of indicators here reflects the focus of the analysis on drought impact on the agricultural / agro-pastoral sector, with an emphasis on social indicators. Table 6 presents the full list of indicators used in this study.

Table 6: Full list of indicators used in this study

HAZARD	SOURCE	REFERENCE DATE	RESOLUTION
Standardized Precipitation Index	CHIRPS	1982 - 2021	5 Km
Temperature Anomaly Trends as Number of Hot Seasons	ECWMF	1981-2021	11 Km
Frequency of Poor NDVI Seasons on LTA	MODIS	2003 - 2021	1 Km
EXPOSURE			
Climate Change Impact on Ecosystems	TNC	2014	1 Km
Irrigation Type Prevalence of Rainfed and Irrigated Agriculture	MOA	2019	Admin 2
Heads of Livestock	DOS	2019	Admin 1
Population Density	WorldPop	2020	1 Km
Land Cover/Land Use	FAO	2017	10 m
Rangelands	CHIRPS	1982 - 2021	5 km
Access to Water for Farming (Composite Indicator)	MWI, CHIRPS, UNIJOR	2022	
SENSITIVITY			
Land Degradation	MODIS	2001-2018	250m
Groundwater Deficit	MWI	2020	Basin
Unemployment	DOS	2021	Admin 1
Household Income	DOS	2017	Admin 1
Household Expenditure (Composite Indicator)	DOS	2017	Admin 1
Female-Headed Households	DOS	2019	Admin 1
Prevalence of Illness and Disability	DOS	2010	Admin 1
Households Receiving Government Aid	DOS	2010	Admin 1
Prevalence of Household Members with Health Difficulties	DOS	2015	Admin 3
Household Water Shortage in Public Network	DOS	2010	Admin 1
Households with Below Average Living Standard Index	DOS	2010	Admin 1
Percentage of Poor People	DOS	2010	Admin 2
Number of Refugees	UNHCR	2021	Admin 1
ADAPTIVE CAPACITY			
Ecosystem Adaptive Capacity (Composite Indicator)	TNC , MoE, Taifour	2014, 2021	
Education Level	DOS	2015	Admin 3
Food Security	WFP	2014	Admin 2
Health Insurance for Jordanians and Migrants	DOS	2015	Admin 3
Access to Water for Household (Composite Indicator)	DOS	2017 (sources of Water) 2019 (population and water supply)	Admin 1
Household Asset Ownership	DOS	2010	Admin 1
Population Variation	WorldPop	2020, 2010	1 Km
New Groundwater Wells	MWI	2014, 2015	GPS

11.3 Data Sources

This study presented here is based on multiple data sources, and the most recent data available was used for all assessments. Long-term data on drought, rainfall, temperature and other hazard and exposure indicators were derived from global databases such as CHIRPS, WorldPop, WorldClim, among others. Data from FAO was used for land cover / land use, while the Jordanian Ministry of Water and Irrigation provided data on water bodies in Jordan. The Royal Botanical Gardens provided data on a recent ecosystem assessment. Some climate impact data was derived from Jordan's 2014 National Communication on Climate Change. While an updated Communication is scheduled to be released later in 2022, this data was not yet available for our assessment. All social data was formally requested from the Department of Statistics in Jordan (DOS) through the project's research partner, the World Food Program office in Amman, Jordan. DOS was very forthcoming and provided most of the indicators that are derived from the National Census for 2015, as well data as recent as 2021. National Census data is by default available at the neighborhood level. Other statistical data is available online at the Governorate level, including data from a statistical analysis on Quality of Life conducted with UNDP in 2010. Some recent social data was either not available or classified. For this reason, the most recent available data on poverty at the sub-national level in Jordan is from 2010, as the Jordanian Government is not releasing more recent data on the subject. Data on food security was provided by the World Food Programme.

11.4 Using GIS to Identify Drought and Social Vulnerability Hotspots

11.4.1 Layer Processing in GIS

Geographic information systems analysis was used to feed the data with a spatial dimension. This spatial dimension was used throughout the analysis in order to converge data and information coming from different sources into the same portion of the territory and create a bond between exposure, sensitivity, and adaptive capacity. In order to do this, the territory was divided using a fixed compound grid, which was then used as a reference for all other layers: all datasheets taken into consideration have been merged to this country-wide net, regardless of their initial spatial, spectral, or temporal resolution. For this purpose, the population density layer from World Pop 2020 (https://www.worldpop.org/) was chosen as reference layer to create the country-wide fishnet layer.

Each individual information layer was processed to match the country grid. The below images show the steps during processing of the layer for data sources originally acquired as raster dataset (Figure 14) or as simple tables, initially acquired without geographical reference (Figure 15).

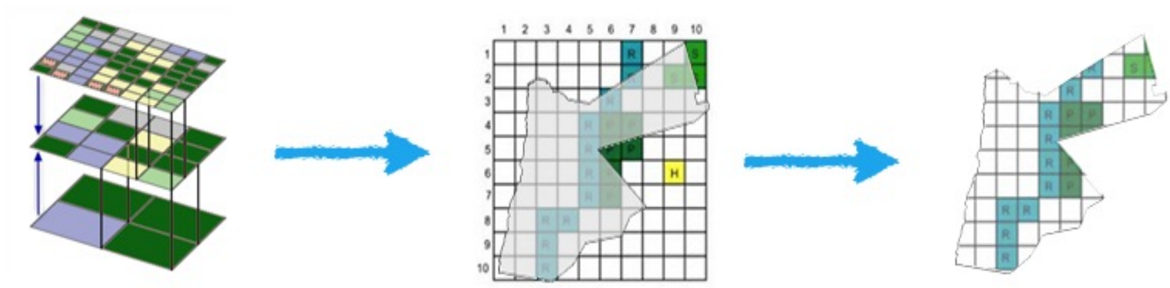


Figure 14: Processing raster layers (Source: WFP, 2022).

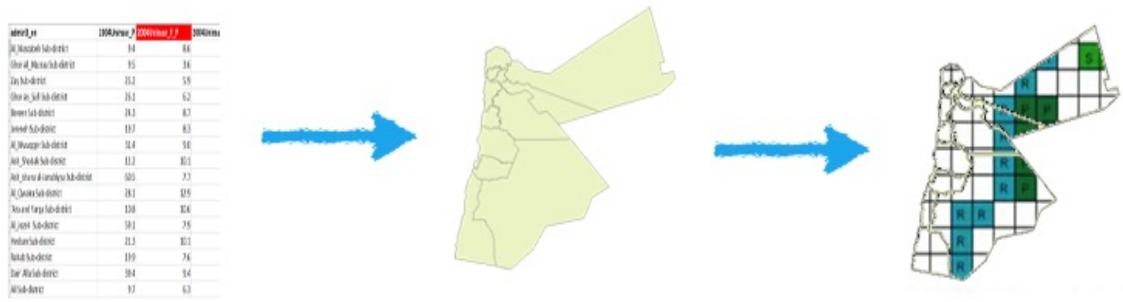


Figure 15: Processing tabular information (Source: WFP, 2022).

Tabular data was processed using the most typical GIS procedure, which makes use of coding convention to match the smallest available geometry to the distinctive information contained in the table. In addition to that, the information was transferred spatially to the analysis reference grid, together with the thematic information contained in the records. For raster layers, it was of relevance whether the initial resolution of the raster was higher or lower compared to the reference grid. Information was re-sampled to match the grid size and structure (Figure 14). Further information on this procedure can be found below in the description of Figure 16:

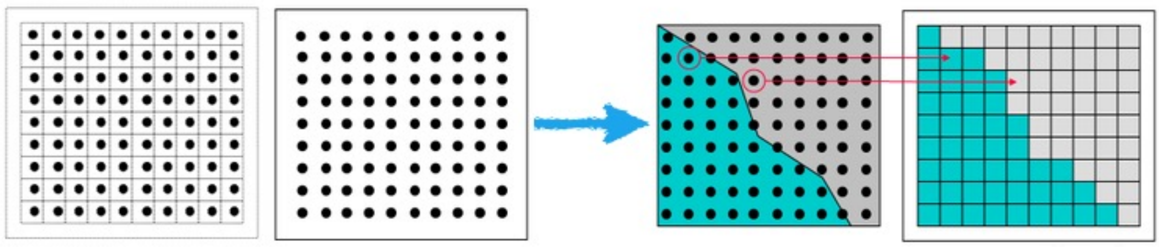


Figure 16: After re-sampling (as shown in Figure 14), raster cell content has been transferred to the master fishnet grid layer by associating properties for each cell to a grid of centroids, then bridged from the points into the final layer (Source: WFP, 2022).

11.4.2 Rationale for the Methodology

This methodology allows to federate and link to the same spatial resolution all the different layers procured for the analysis and to generate a single, unified table containing information coming from all sources. Reasons behind this choice are rooted in i) the identified need to combine and converge datasets that are originated from different providers (some of which not available or unknown at the time the project started) and ii) to overcome the typical association of information to administrative boundaries only, which provides a clear and well-heeled picture of the results, however, limits results to the administrative area and therefore provides less precise information in terms of territorial coverage.

11.4.3 Relation between the Administrative Areas and Unit of Measure

The country-wide grid maintains a strong relationship to the administrative areas, and findings from the analysis can also be framed and located within administrative areas of reference. As an example, we can look at the Ain Albasha District (second level administrative area) and compare it to the analysis grid.

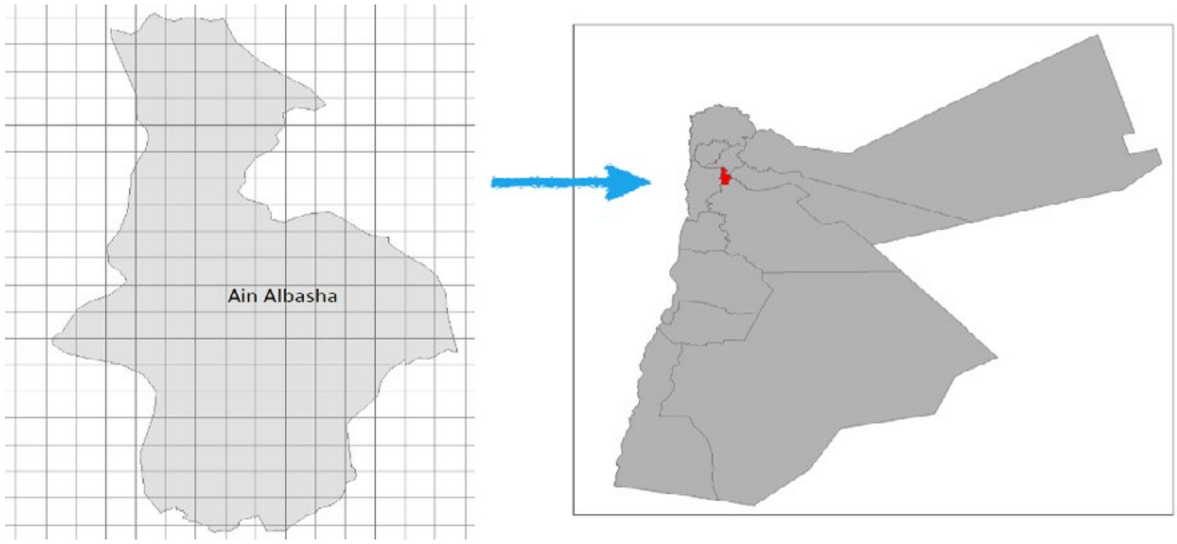


Figure 17:
Ain Albasha in relation to the analysis grid (left) and to the locator map (right).

As shown in Figure 17, Ain Albasha district is composed of 175 grid elements, of which 96 are completely contained within the administrative area. Once generated and identified, results of the analysis can easily be associated with the administrative area(s) they belong to. Results can be measured using hectares, kilometers, or by counting the number of cells that have the same characteristics. Each cell can be classified according to specific indicators and cells belonging to the same class. Further, each cell can be summed to calculate and map the portion of territory that belongs to specific results.

In order to make this possible, the single grid-element as unit of measure was used, where 1 analysis unit (AU) is equivalent to 0.7486 km^2 when using PSE 1923 Palestine Belt Coordinate System and WGS84 Datum, or 0.738 km^2 when using UTM37N and WGS84 datum. For visualization purposes, most of the maps in this report are using an un-projected latitude longitude geographic system based on WGS84.

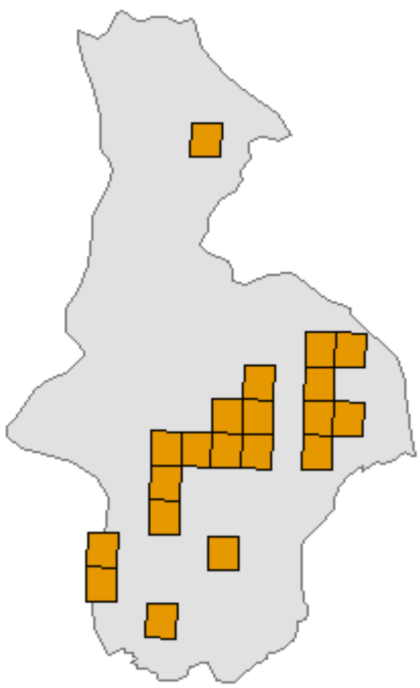


Figure 18: Count of cells with a particular attribute, here cropland as an example.

As an example, we can represent and count the AU within the Albasha district whose land cover (Proba-V 2019) is classified as "cropland" (Figure 18). In this case, 20 AU have been selected. Final values can thus be transposed into other units by using the conversion values.

This resolution has been chosen in order to conciliate the needs to investigate information at country scale, with (i) the need to keep the final consolidated output table easily manageable through the available resources (software and hardware), (ii) the possibility of replicating the analysis for other countries and (iii) the availability of wide-spread usage of WorldPop population density by researchers and institutions.

11.5 Classification and Layer Weights

For classification of the datasets, each statistical dataset was divided into three categories – low, medium, and high (hazard / exposure / sensitivity / adaptive capacity). For example, if a dataset on sensitivity provided statistical data about unemployment in Jordan per district, the bracket showing the highest unemployment numbers was assigned a "high sensitivity" label, the bracket showing medium unemployment numbers a "medium sensitivity" label, and the bracket with the lowest unemployment numbers a "low sensitivity" label. The classification was performed following both a statistical methodology (dividing the dataset into three equal portions), but also factoring international and national standards of income, poverty, water scarcity, for example, with the help of Jordanian experts. Each section of this report includes a table that outlines the classification process for each dataset. This exercise was carried out for all of the data layers shown under the exposure, sensitivity, and adaptive capacity layers shown in (Figure 19).

EXPOSURE	SENSITIVITY	ADAPTIVE CAPACITY
Climate Change Impact on Ecosystems	Land Degradation	Ecosystem Adaptive Capacity (Composite Indicator)
Irrigation Type Prevalence of Rainfed and Irrigated Agriculture	Groundwater Deficit	Education Level
Heads of Livestock	Unemployment	Food Security
Population Density	Household Income	Health Insurance for Jordanians and Migrants
Land Cover/Land Use	Household Expenditure (Composite Indicator)	Access to Water for Household (Composite Indicator)
Rangelands	Female-Headed Households	Household Asset Ownership
Access to Water for Farming (Composite Indicator)	Prevalence of Illness and Disability	Population Variation
	Households Receiving Government Aid	New Groundwater Wells
	Prevalence of Household Members with Health Difficulties	
	Household Water Shortage in Public Network	
	Households with Below Average Living Standard Index	
	Percentage of Poor People	
	Number of Refugees	
High / medium / low x layer weight (1,2,3)	High / medium / low x layer weight (1,2,3)	High / medium / low (higher adaptive capacity is assigned lower numbers) x layer weight (1,2,3)

Figure 19: Classification and weight calculations for data layers.

The layers were then mapped to show which pixels on the map of Jordan were considered as having high, medium, and low exposure / sensitivity / adaptive capacity in the context of that particular dataset (in the maps, the colors green, yellow, and red represent low, medium, and high hazard / exposure / sensitivity – in the case of adaptive capacity the values were flipped, meaning that here green means high adaptive capacity). "High" was given the numerical value 3, medium the numerical value 2, and "low" the numerical value 1 (with exception for adaptive capacity, where 1 and 3 were flipped). For each dataset, each pixel obtained a number – either 1, 2, or 3. This number was then multiplied by a weight assigned to the layer itself, representing the comparative importance of each indicator to the analysis (again weights between 1 and 3 were assigned, which, as averages based on the inputs from different experts, became values with one decimal point, e.g. 2.1, 3.4 or 1.6) (Figure 19). To arrive at a final vulnerability score for each location on the map, the values of all indicators (classification value multiplied by assigned weight) were added together as shown in Figure 20 (e.g. in example A, low vulnerability 1 x weight 1, plus medium vulnerability 2 x weight 2, plus medium vulnerability 2 x weight 3, becomes 1+4+6, which adds up to 11). This was done for all indicators included in the study, so that each point on the map received a final score. The final values were then classified again using natural breaks (14 classes, ranging from low (green) to high (red)).

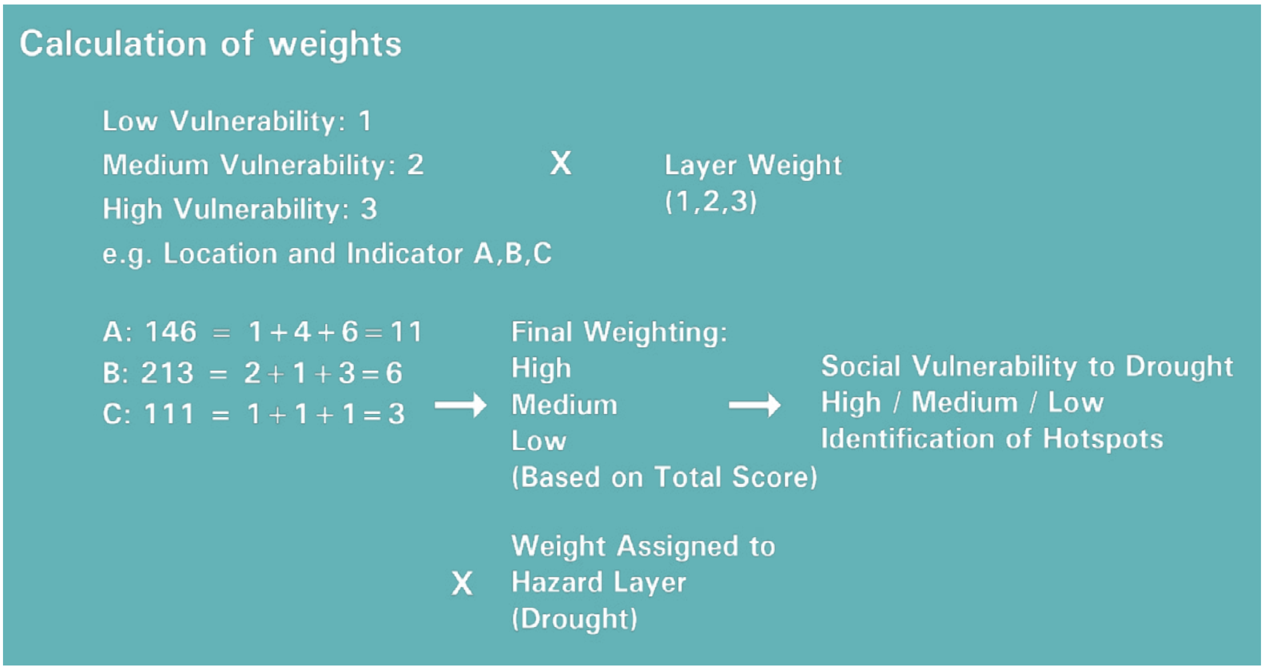


Figure 20: Assigning weights to the data layers to arrive at a final indicator index.

11.6 Participatory Weighting of Layers

The methodology and classification were discussed in three stakeholder dialogues carried out in Amman in November and December of 2021, and in January of 2022. The meetings were attended by drought and socio-economic experts from UNDP, the Ministry of Water and Irrigation of Jordan, from the National Agricultural Research Center, the Department of Statistics, the Department of Environment, as well as professors from different Jordanian Universities. The selected experts consulted and engaged in this study had been involved in previous integrated climate change assessments in the past, including Jordan's national communications on climate change and various UNDP-led studies on drought and vulnerability. Thus, the experts were familiar with the integrated approach of this study. Following the stakeholder meetings, slight adjustments to the classification process were made to accommodate the experts' feedback, as well as new recommended data sources added to the analysis. Table 7 lists the names of the Jordanian experts who were involved at various stages of this study.

Table 7: Jordanian experts who contributed to the study

NAME	ROLE	INSTITUTION
EXPERT CONTRIBUTIONS AND PARTICIPATION IN WEIGHTING EXERCISE		
Dr Mohammed Al-Qinna	Department of Land Management and Environment	Hashemite University
Dr Jawad Al-Bakri	Department of Land, Water and Environment	University of Jordan
Dr Emad Al-Karablieh	Dept. of Agricultural Economics and Agribusiness Management	University of Jordan
Ehab Eid	Expert on Terrestrial and Marine Biodiversity Conservation	Independent Expert
Dr Maram Jameel Abbady	Climate Change Specialist and Drought Monitoring Researcher	National Agricultural Research Center (NARC)
Dr Sudki Hamdan	Head of Environmental Statistics	Department of Statistics
Dr Wafa Shehadeh	Head of Climate Change Unit	Ministry of Water and Irrigation
Dr Sami Tarabieh	Projects Coordination Specialist	UNDP Jordan
Dr Dawoud Isied	Hydrogeological and Environmental Consultant	Independent Expert
EXPERT CONTRIBUTIONS		
Dr Amani Al-Assaf	Economist of Environment and Natural Resources	University of Jordan
Dr Alaa Wahbeh	Head of Climate Change and Drought monitoring Division	National Agricultural Research Center (NARC)
Dr Ali Ghanem	Head of Drought Unit	Ministry of Water and Irrigation
Jihad Zuwaidah	Field Officer	NGO WADI
Mira Haddad	Research Associate	ICARDA

During three participatory expert stakeholder workshops held in January 2022, each data layer was assigned a weight in terms of its overall impact on drought and social vulnerability. For this assessment, an online ranking tool using the Mentimeter platform was used to give the experts the opportunity to assign a particular weight to each data layer. For example, an expert may have felt that unemployment weighed heavier in the overall vulnerability calculation than health, or access to water heavier than the educational level. For this purpose, experts were asked to assign each layer the weight of either 1, 2, or 3. The average weight assigned to each layer was used as a multiplication factor for the classification score each pixel had received in the classification step (Figure 19). The final step entailed adding up all scores across all layers, giving each pixel on the map a final score (Figure 20). In this way, overall hazard, exposure, sensitivity, and adaptive capacity maps were produced, as well as final vulnerability and risk maps. Table 8 presents the weights assigned to each indicator by the group of Jordanian experts.

Table 8: Weights assigned to indicators by Jordanian experts

CATEGORY	WEIGHT ASSIGNED BY EXPERTS (AVERAGE)
HAZARD	
Standardized Precipitation Index	2.5
Temperature Anomaly Trends as Number of Hot Seasons	2.1
Frequency of Poor NDVI Seasons on LTA	2.5
EXPOSURE	
Climate Change Impact on Ecosystems	2.4
Irrigation Type Prevalence of Rainfed and Irrigated Agriculture	3
Heads of Livestock	2.4
Population Density	2.9
Land Cover/Land Use	2.4
Rangelands	2.1
Access to Water for Farming (Composite Indicator)	2.9
SENSITIVITY	
Land Degradation	2.8
Groundwater Deficit	2.6
Unemployment	2.2
Household Income	2.2
Household Expenditure (Composite Indicator)	1.8
Female-Headed Households	2.4
Prevalence of Illness and Disability	2.1
Households Receiving Government Aid	2.2
Prevalence of Household Members with Health Difficulties	2.3
Household Water Shortage in Public Network	2.4
Households with Below Average Living Standard Index	1.9
Percentage of Poor People	2.5
Number of Refugees	2.1
ADAPTIVE CAPACITY	
Ecosystem Adaptive Capacity (Composite Indicator)	1.9
Education Level	2.3
Food Security	2.8
Health Insurance for Jordanians and Migrants	2.3
Access to Water for Household (Composite Indicator)	2.9
Household Asset Ownership	2
Population Variation	2.3
New Groundwater Wells	2.5

11.7 Case Study Research

In addition to the GIS mapping of drought and social vulnerability indicators at the national level, a case study was carried out to investigate the impacts of drought on a community that is already experiencing social vulnerability issues. Understanding the local contextuality of drought impact on the ground is a way of ground-truthing data collected at the national level, increasing our understanding of how drought risks intersect with other risks in localities. Research conducted at the community level provides an in-depth understanding of the processes that define the intersection of drought and social vulnerability, taking into account a people's perspective on drought. Moreover, local case study research can help understand what adaptation strategies local communities are taking to cope with drought impact. In this way, locally collected data can enhance our understanding of the processes that explain the types and extent of vulnerabilities mapped at the national level.

The case study method is used among a cross-section of disciplines, including the social sciences, health, education, and business education. It involves the in-depth investigation and descriptive and exploratory analysis of a particular case, individual, group, event or community in a real-life setting, creating an understanding of complex processes, relationships, experiences, and underlying principles on the ground (PressAdacemia, 2018; Tardi, 2019). A case study can help shed light on the question of why certain things are happening, or why people are acting in certain ways. While the mapping of national level identified where the hotspots for both drought impact and social vulnerability are in Jordan, this data cannot explain how people on the ground are experiencing this linked impact, and how they are reacting and adapting to it. The additional case study thus provides depth and context in building an understanding of how social vulnerability and drought impact intersect in people's lives.
As this study considers precarious livelihoods in socially vulnerable communities under climate change-induced drought, the focus of this study was placed on agricultural and pastoralist livelihoods. As outlined in the introduction, farmers, livestock producers, and pastoralists directly depend on ecosystem services, which makes their livelihoods more immediately vulnerable to drought. The community of Deir El Kahf in the Northern Badia district of Mafraq Governorate was selected as the case study location after a literature review, focused web searches, and discussions with several Jordanian experts on drought, livelihoods, socio-economic matters, agriculture, climate change, and water management. The selection criteria for the case study location were:

- pre-existing social vulnerability and poverty issues
- presence of both irrigated and rainfed agriculture
- existence of both agricultural and agri-pastoral livelihoods in the community
- presence of refugees

Due to delays in obtaining the data for the mapping process on the national level, the national mapping results were not yet ready by the time the case study research was carried out. For this reason, the selection of case study had to rely on the recommendations of Jordanian experts. The experts consulted in this matter were: Sami Tarabieh (UNDP), Dr Mohammed Al-Qinna (Hashemite University), Dr Jawad Al-Bakri (University of Jordan), Mira Haddad (ICARDA), Dr Aman Al-Assaf (University of Jordan), Dr Amer Jabarin (Economic Agribusiness Expert), Jihad Zawaidah (NGO WADI), and Dr Dawoud Isied (Hydrologist, Straight Lights Consultants). The case study location of Deir El Kahf was selected after weighing all suggestions against the above-mentioned selection criteria. How the selected location scored after the national mapping was concluded can be seen in section 12. The fieldwork was formally supported by the Ministry of Environment of Jordan.

This case study, as many others (Tardi, 2019), employed a mixed method approach that combined the collection of both qualitative and quantitative data. The research depended mainly on semi-structured, face-to-face key informant interviews. The research team interviewed 50 community members who have farms or livestock, who rent land or work on farms, or whose livelihoods depend on farming or livestock raising. The sample, selected through a participatory stakeholder mapping exercise as well as recommendations from a local NGO, included a range of individuals representing different geographical areas of the village of Deir El Kahf, different ethnicities and age groups, as well as different genders. The interview questionnaire was developed by the Arab Water Council. A geo-referenced data collection application was developed by the World Food Programme to be used in parallel with interviewing to collect quantitative data and GPS locations of the interviews. Both qualitative questionnaire and quantitative tool are included, along with more detailed information on the interview technique, in Annex 5 (15.5). Further, the research team made observations, took picture and video material, collected local statistics and data, and explored secondary data about the study area. The researchers also performed a thorough literature review and web search about the case study area Badia El Shamaliya and the village of Deir El Kahf. The case study research in Deir El Kahf was carried out with a local partner, a development NGO headed by a female resident who is working very hard to support the development of Deir El Kahf. Two stakeholder meetings were carried out at the office of this local NGO. More information on the case study methodology and procedure can be found in section 12 of this report.

12

STUDY RESULTS: MAPPING COMPONENT AT NATIONAL LEVEL

12 STUDY RESULTS: MAPPING COMPONENT AT NATIONAL LEVEL

12.1 Overview of the Mapping Process

The World Food Programme's VAM conducted the spatial analysis for this project, processing large statistical datasets into GIS-based maps. In a first step, separate maps for each indicator set were produced after a classification of indicators into low, medium, and high hazard / exposure / sensitivity and adaptive capacity. The study uses a total of 31 indicators based on over individual 40 datasets (some indicators are composites, as shown in Table 6). Datasets that were used as proxies for all indicators were collected, re-classified and grouped following examples from existing literature, best practices, input of international and Jordanian experts, and criteria identified in previous studies on similar themes.

Thematic maps were built using the most recent and most refined available sources of data at the time of the analysis. However, as this study combines datasets from different sectors (environmental, social, population, economic, agriculture, water management), it was impossible to gather datasets that cover exactly the same timespans. In the case of global environmental data, long-term datasets are now available that reach back to the 1960s in some cases. This is not the case for the social data. As social conditions such as poverty or unemployment can change rapidly, the most recent datasets were used here to reflect the current social vulnerability conditions across Jordan.

The GIS team made use of the most detailed geodata sources in order to establish the best correlation between tabular information and the "where" component of the information. This information, when not provided inherently in the data source, was added during the computation and processing phase of the data management.

In a second step, all classified maps were combined and multiplied by the weight assigned to each indicator by Jordanian experts. Lastly, the final mapping of overall climate change-related drought and social vulnerability hotspots was performed. All individual maps are presented in this section, starting with drought hazard maps, followed by exposure, sensitivity and adaptive capacity.

The final vulnerability map is based on the sections of exposure, sensitivity, and adaptive capacity. The last section, the overall drought risk, was calculated by multiplying the final vulnerability map by the hazard.

As all categories of the analysis – hazard, exposure, sensitivity, and adaptive capacity – were mapped separately at first, there are final, classified maps for each of these categories. All of these maps are valuable outputs in their own right – in addition to their input into the final analysis. The following sections will close with maps that present both the unweighted and weighted results of the analysis. The weighted results are based on the weight assigned to each indicator by Jordanian experts. Both the unweighted and weighted results are presented to enable the reader to compare the results, and to assess how the weighting of indicators affects the result.

12.2 Data Sources and Reference Maps

Before looking at the thematic maps generated from a number of different sources, including data from several government authorities and open-source data available on the Internet, maps of the administrative divisions, including first, second and third administrative level were produced. Presented below, these maps can be used as reference to read information on a specific area from the thematic maps. Table 9 provides an overview of the range of data sources used in the analysis, and the acronyms of the institutions that will be used in the text.

Table 9: List of data sources used for the maps and their acronyms used in the text

ACRONYM FOR DATA SOURCES	ORGANIZATION
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station
DOS	Jordanian Department of Statistics
ECWMF	European Centre for Medium-Range Weather Forecasts
FAO	Food and Agriculture Organization of the United Nations
MOA	Jordanian Ministry of Agriculture
MODIS	Moderate Resolution Imaging Spectroradiometer
MOE	Jordanian Ministry of Environment
MWI	Jordanian Ministry of Water and Irrigation
NDVI	Normalized Difference Vegetation Index
RBG	Jordanian Royal Botanic Garden
RSCN	Jordanian Royal Society for the Conservation of Nature
TNC	Third National Communication on Climate Change
UNEP	United Nations Environmental Programme
UNHCR	United Nations High Commissioner for Refugees
SDI	Spatial Data Infrastructure
WFP	World Food Programme
WorldPop	WorldPop Population Data

Data was made available based on administrative boundaries of the Jordanian Government - Governorates, Districts, Sub-Districts – as well as on the level of basins and ecosystems. Figures 21, 22, and 23 present these administrative boundaries of the Jordanian government, while Tables 10 and 11 provide an overview of all the Governorates, Districts and Sub-Districts for the reader's reference and for a better understanding of the maps and study results.

Figure 21 presents the first administrative level, the 12 governorates of Jordan. The second level administrative division in Jordan is composed of 51 Districts (Liwa) which are represented in Figure 22. Table 10 provides an overview of these numbered administrative divisions. Figure 23 is a reference map for third level administrative areas: 89 subdistricts (Qda) which have been numbered from 0 to 88 in the below reference map and list. These are detailed in Table 11.

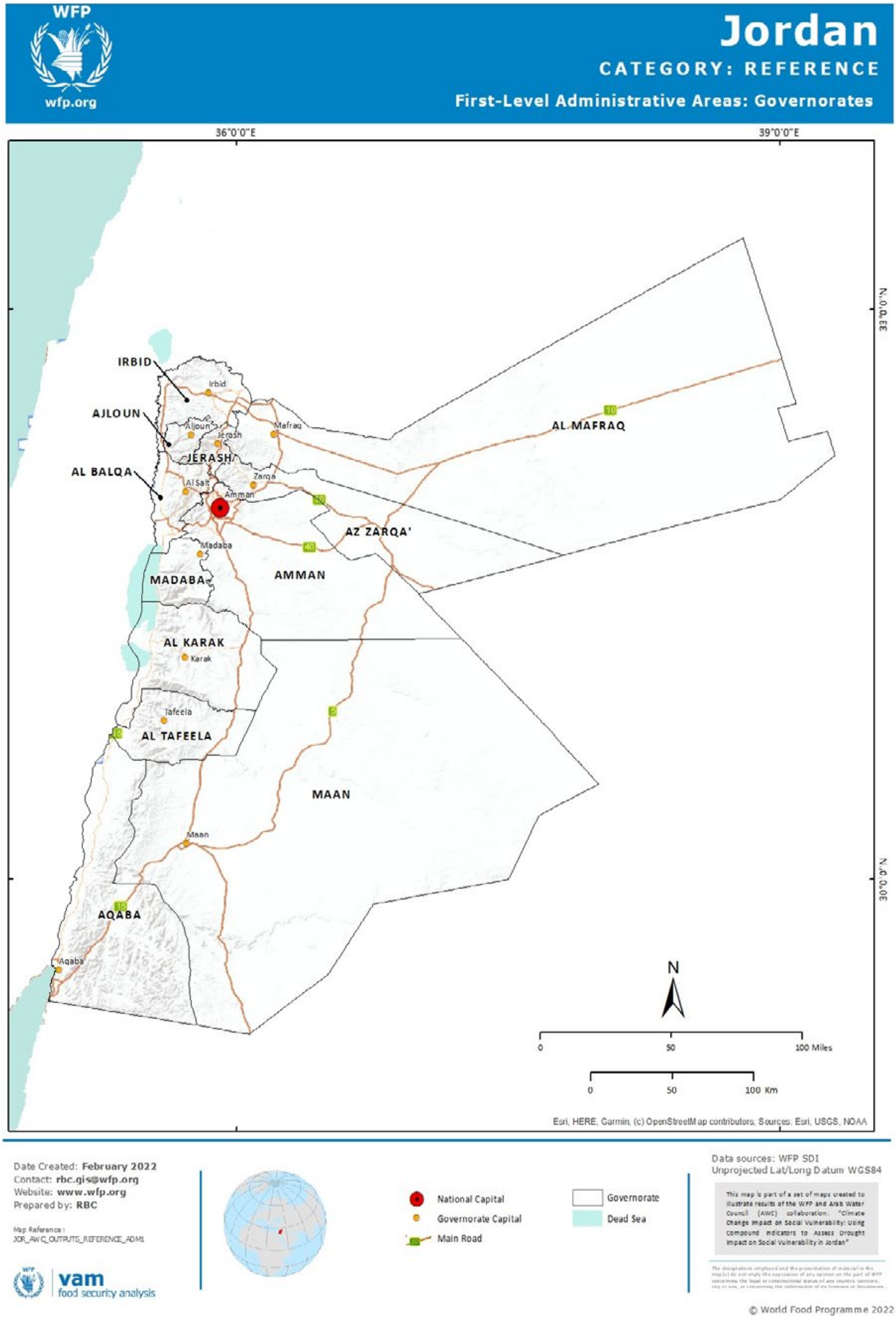


Figure 21: Map of first-level administrative areas in Jordan, including country capital and governorate chief towns.

Figure 22: Map of second-level administrative areas in Jordan, numbered (see Table 10 for explanation).

Figure 24 shows a map of all groundwater water basins in Jordan – a unit that is relevant in the context of environmental indicators. Figure 25 presents the Jordanian ecosystems. These reference maps set the scene for the mapped study results presented in the coming section.

Table 10: Second-level administrative areas in Jordan, organized by the numbers presented in Figure 22

MAP LABEL	DISTRICT	GOVERNORATE
0	Qasabet Al-Balqa'a	Al Balqa
1	At-Taybeh	Irbid
2	Al-Koorah	Irbid
3	Bsaira	Al Tafeela
4	Ma'an	Maan
5	Sahab	Amman
6	Al-Jami'ah'	Amman
7	Al-Faqo'e	Al Karak
8	Qasabet Jarash	Jerash
9	Al-Quairah	'Aqaba
10	Al-Jizah	Amman
11	Na'oor	Amman
12	Al-Hasa	Al Tafeela
13	Al-Qatraneh	Al Karak
14	Al-Muaqqar	Amman
15	Al-Wastiyyah	Irbid
16	Shobak	Maan
17	Ayy	Al Karak
18	Qasabet Al-Aqaba	Aqaba
19	Bani Kenanah	Irbid
20	Ash-Shoonah Al-Janoobiah	Al Balqa
21	Qasabet Al-Mafraq	Al Mafraq
22	Dair Alla	Al Balqa
23	Qasabet Madaba	Madaba
24	Kufranjah	Ajloun
25	Ar-Rwaished	Al Mafraq
26	Qasabet Ajlun	Ajloun
27	Al-Aghwar Al-Janoobiyah	Al Karak
28	Al-Mazar Ash-Shamali	Irbid
29	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq
30	Bani Obeid	Irbid
31	Al-Quaismah	Amman
32	Ar-Ramtha	Irbid
33	Qasabet Al-Zarqa	Az Zarqa'
34	Marka	Amman
35	Qasabet Al-Karak	Al Karak
36	Al-Russeifa	Az Zarqa'

37	Al-Qasr	Al Karak
38	Qasabet Amman	Amman
39	Al-Hashemiyah	Az Zarqa'
MAP LABEL	**DISTRICT**	**GOVERNORATE**
40	Qasabet Irbid	Irbid
41	Badia El Shamaliya	Al Mafraq
42	Mahes & Al-Fuhais	Al Balqa
43	Al-Petra	Maan
44	Wadi Essier	Amman
45	Qasabet At-Tafiela	Al Tafeela
46	Al-Aghwar Ash-Shamaliyah	Irbid
47	Dieban	Madaba
48	Al-Mazar Al-Janoobee	Al Karak
49	Ain Albasha	Al Balqa
50	Al-Huseiniya	Maan

Figure 23: Map of third-level administrative areas in Jordan, numbered (see Table 11 for explanation).

Table 11: List of third-level administrative areas in Jordan by numbers (see Map 23)

MAP LABEL	SUB DISTRICT	DISTRICT	GOVERNORATE
0	Umm Ar Rasas	Al-Jizah	Amman
1	Dair Alla	Dair Alla	Al Balqa
2	Mahes and Fahes	Mahes & Al-Fuhais	Al Balqa
3	Rwashed	Ar-Rwaished	Al Mafraq
4	Ad Deseh	Al-Quairah	'Aqaba
5	Qaser	Al-Qasr	Al Karak
6	Bani Kinana	Bani Kenanah	Irbid
7	Qasabet As Salt	Qasabet Al-Balqa'a	Al Balqa
8	Ma'an	Ma'an	Maan
9	Bani Obaid	Bani Obeid	Irbid
10	Ash Shuna Ashamalya	Al-Aghwar Ash-Shamaliyah	Irbid
11	Fisalieh	Qasabet Madaba	Madaba
12	Umm Al Jemal	Badia El Shamaliya	Al Mafraq
13	Ayy	Ayy	Al Karak
14	Sakhera	Qasabet Ajlun	Ajloun
15	Qwaismeh	Al-Quaismah	Amman
16	Ayn Al Basheh	Ain Albasha	Al Balqa
17	Badiah Ash Shamaliyya Al Gharbeh	Badiah Ash-Shamalieh AlGharbeh	Al Mafraq
18	Mujeb	Al-Qasr	Al Karak
19	Ghor Al Mazraa	Al-Aghwar Al-Janoobiyah	Al Karak
20	Alazraq	Qasabet Al-Zarqa	Az Zarqa'
21	Qasabet Ajloun	Qasabet Ajlun	Ajloun
22	Ma'en	Qasabet Madaba	Madaba
23	Petra	Al-Petra	Maan
24	Mwaqqer	Al-Muaqqar	Amman
25	Qasabet Irbid	Qasabet Irbid	Irbid
26	Kofranja	Kufranjah	Ajloun
27	Zay	Qasabet Al-Balqa'a	Al Balqa
28	Jezeh	Al-Jizah	Amman
29	Qasabet A Mafraq	Qasabet Al-Mafraq	Al Mafraq
30	Mastabeh	Qasabet Jarash	Jerash
31	Qasabet Madaba	Qasabet Madaba	Madaba
32	Kora	Al-Koorah	Irbid
33	Qasabet A Tafilah	Qasabet At-Tafiela	Al Tafeela
34	Hesban	Na'oor	Amman
35	Adruh	Ma'an	Maan
36	Husah	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq
37	Wadi As Sir	Wadi Essier	Amman

MAP LABEL	SUB DISTRICT	DISTRICT	GOVERNORATE
38	Hashemieh	Al-Hashemiyah	Az Zarqa'
39	Manesheih	Qasabet Al-Mafraq	Al Mafraq
40	Jereneh	Qasabet Madaba	Madaba
41	Balama	Qasabet Al-Mafraq	Al Mafraq
42	Jafr	Ma'an	Maan
43	Faqua	Al-Faqo'e	Al Karak
44	Ara and Yarqa	Qasabet Al-Balqa'a	Al Balqa
45	Arjan	Qasabet Ajlun	Ajloun
46	Ail	Ma'an	Maan
47	Aredah	Qasabet Al-Balqa'a	Al Balqa
48	Deeban	Dieban	Madaba
49	Rahab	Qasabet Al-Mafraq	Al Mafraq
50	Wastiyya	Al-Wastiyyah	Irbid
51	Qasabet Al Karak	Qasabet Al-Karak	Al Karak
52	Berma	Qasabet Jarash	Jerash
53	Naur	Na'oor	Amman
54	Ash Shobak	Ar-Ramtha	Maan
55	Deir El Kahf	Badia El Shamaliya	Al Mafraq
56	Delail	Qasabet Al-Zarqa	Az Zarqa'
57	Umm Al Basateyn	Na'oor	Amman
58	Muraygha	Ma'an	Maan
59	Areed	Dieban	Madaba
60	Melieh	Dieban	Madaba
61	Wadi Araba	Qasabet Al-Aqaba	Aqaba
62	Sabeha	Badia El Shamaliya	Al Mafraq
63	Marka	Marka	Amman
64	Qasabet Az Zarqa	Qasabet Al-Zarqa	Az Zarqa'
65	Hasa	Al-Hasa	Al Tafeela
66	Umm Al Qutain	Badia El Shamaliya	Al Mafraq
67	As Saleheyyeh	Badia El Shamaliya	Al Mafraq
68	Qwaira	Al-Quairah	'Aqaba
69	Ramtha	Ar-Ramtha	Irbid
70	Qatraneh	Al-Qatraneh	Al Karak
71	Sama As Sarhan	Badiah Ash-Shamalieh Al Gharbeh	Al Mafraq
72	Bereen	Qasabet Al-Zarqa	Az Zarqa'
73	Qasabet Amman	Qasabet Amman	Amman
74	Jameh	Al-Jami'ah'	Amman
75	Mazar Ash Shamali	Al-Mazar Ash-Shamali	Irbid
76	Qasabet Al Aqaba	Qasabet Al-Aqaba	Aqaba
77	Sahab	Sahab	Amman
78	Qasabet Jerash	Qasabet Jarash	Jerash

MAP LABEL	SUB DISTRICT	DISTRICT	GOVERNORATE
79	Muab	Al-Mazar Al-Janoobee	Al Karak
80	Khalediah	Badiah Ash-Shamalieh Al Gharbeh	Al Mafraq
81	Besareh	Bsaira	Al Tafeela
82	Taibeh	At-Taybeh	Irbid
83	Husayniyya	Al-Huseiniya	Maan
84	Rujm Ash Shami	Al-Muaqqar	Amman
85	Rusayfa	Al-Russeifa	Az Zarqa'
86	Ghor As Safi	Al-Aghwar Al-Janoobiyah	Al Karak
87	Mazar Janubi	Al-Mazar Al-Janoobee	Al Karak
88	Ash Shuna Janubiyya	Ash-Shoonah Al-Janoobiah	Al Balqa

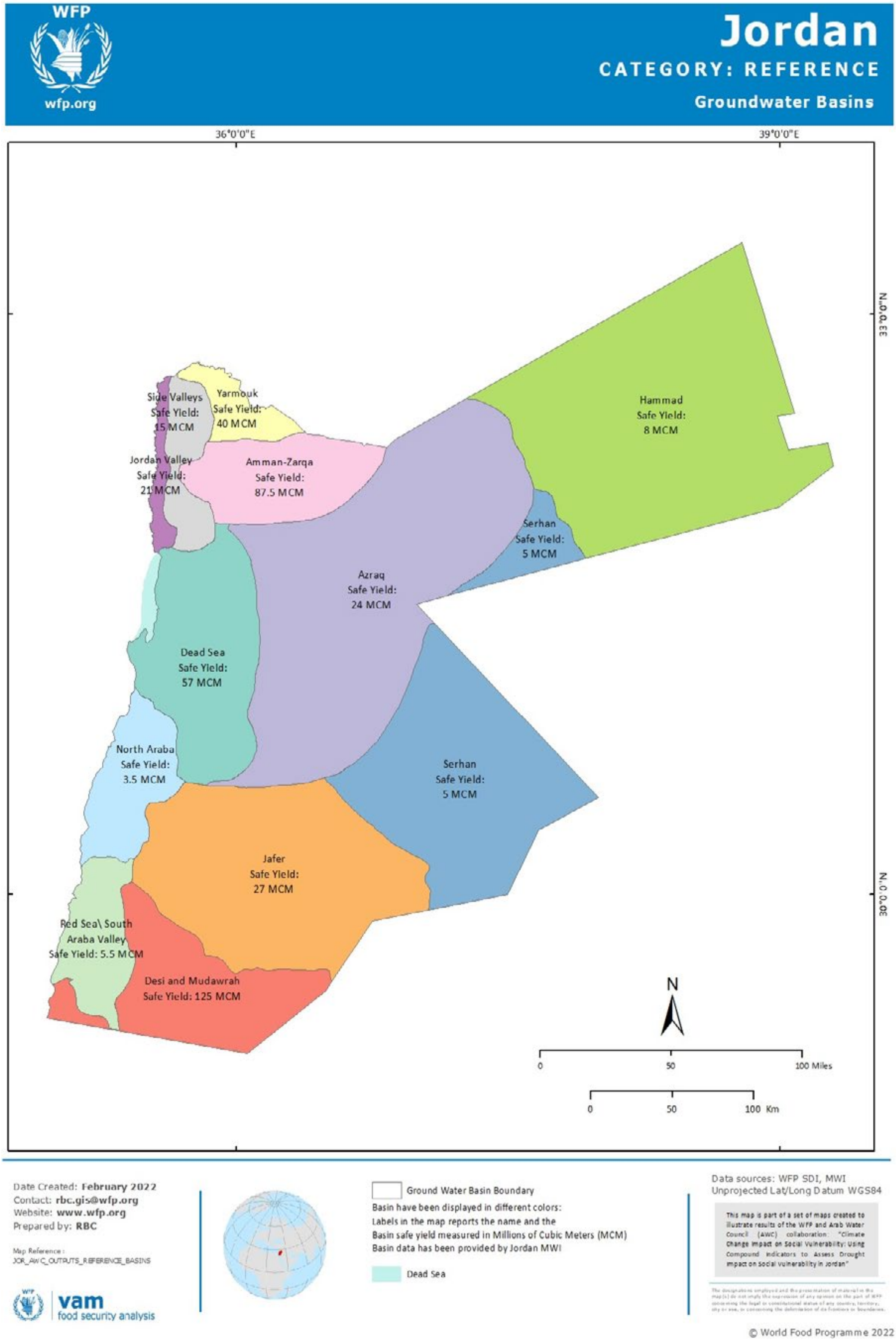


Figure 24: Map of groundwater basins including safe yield.

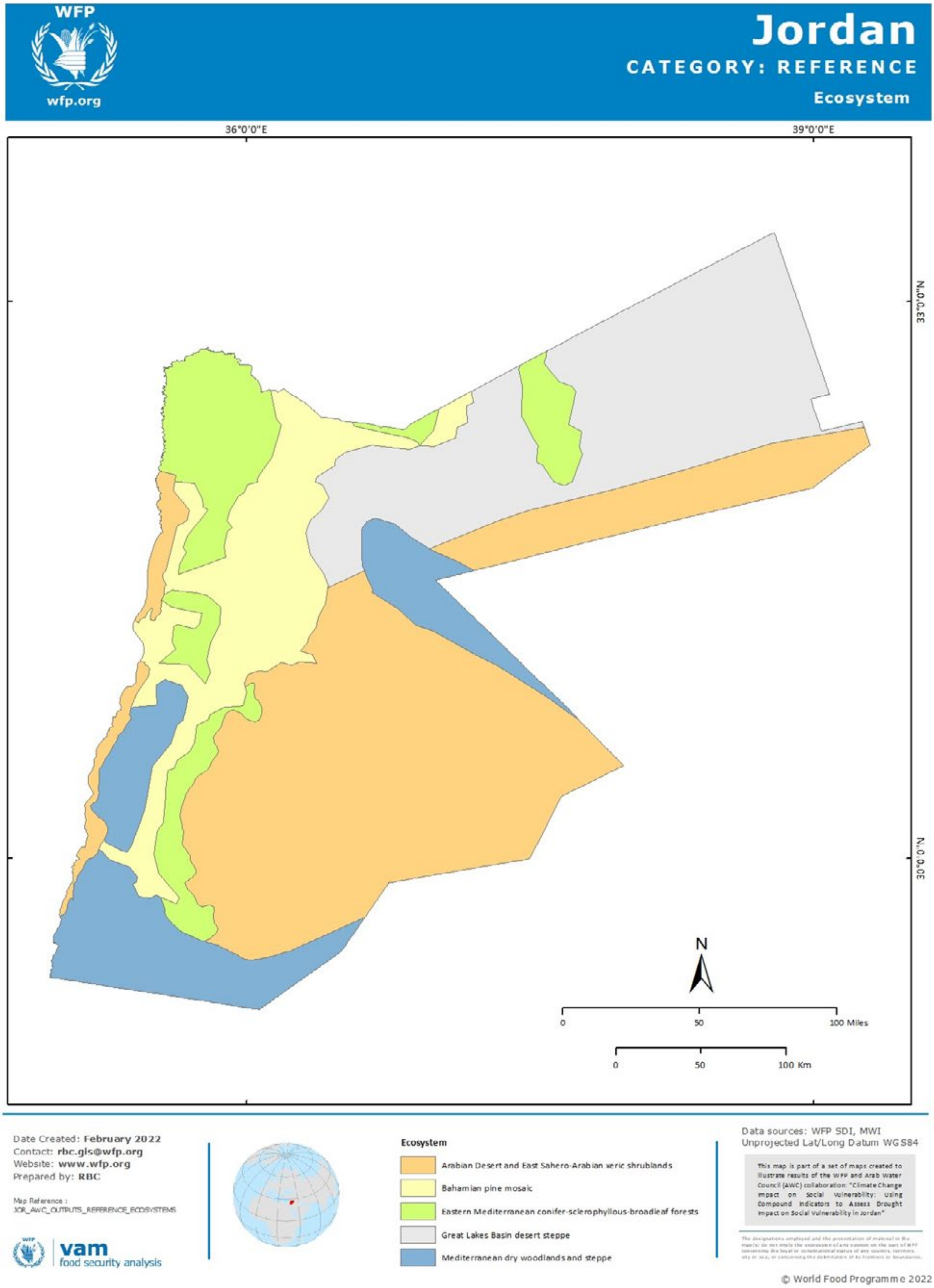


Figure 25: Map of ecosystem classification for Jordan.

12.3 Hazard Maps

The set of maps and data in this section refers to the hazard-based data layers of this analysis. These are all climate and weather-related data sets with strong focus on drought. A drought is defined as a period of time with abnormal precipitation deficit, in relation to the long-term average conditions for a given area of interest and period of interest. Unfortunately, recent drought maps based on a CDI (Combined Drought Indicator) created by the Jordanian National Drought Committee were not made available for the purpose of this study.

For this reason, the research team constructed its own Combined Drought Indicator for its hazard maps. The set of hazard maps used here include the Standard Precipitation Index (SPI), the analysis of Air Temperature, and the Normalized Difference Vegetation Index (NDVI). The SPI indicator presents the anomalies as deviations from the mean of observed total precipitation values. The Normalized Difference Vegetation Index (NDVI) quantifies vegetation by measuring the difference between near-infrared and red light (first used by Rouse et al. in 1973). While the near-infrared component is strongly reflected by the vegetation, the red band is entirely absorbed by it. More information about the NDVI can be obtained from the link: https://gisgeography.com › ndvi-normalized-difference-vegetation-index

Data sources used for the hazard analysis include CHIRPS for the SPI, ECMWF for the temperature analysis, and MODIS for the NDVI analysis. The results have been overlaid by an Aridity Index layer, which adds an important scope to the results, as Jordan is an overall arid country with aridity peaks in specific areas. This section further presents some additional maps that provide more nuanced context, such as precipitation maps. These additional maps were not included in the overall risk analysis, but are presented as an additional source of information on drought processes in Jordan.

12.3.1 Standardized Precipitation Index

For the present study, SPI 12 was selected to grade and classify the precipitation data. The SPI is a commonly used indicator to detect and grade droughts:

https://public.wmo.int/en/resources/library/standardized-precipitation-index-user-guide

Information presented here is based on the full CHIRPS archive to date https://www.chc.ucsb.edu/data/chirps

The full set of data from CHIRPS available to date (1981 – 2021) was used to calculate the number of times that the derived SPI values are below -1. This analysis was repeated throughout the time series. Areas with SPI < -1 have been cumulated along the time series to generate a final raster image.

With the goal to capture the rainy season within each single iteration, the CHIRPS data has been set to start on 01 August and end on 31 July. The relevant CHIRPS data can be found here:

https://data.chc.ucsb.edu/products/CHIRPS-2.0/

More granular data and information regarding precipitation based on CHIRPS data and NDVI based on MODIS can be found in the link: https://dataviz.vam.wfp.org/seasonal_explorer/
Figure 26 graphically shows the processing and classification of a long-term average SPI using GIS programming.
For Jordan, a study on drought has to consider the general and country-wide distribution of

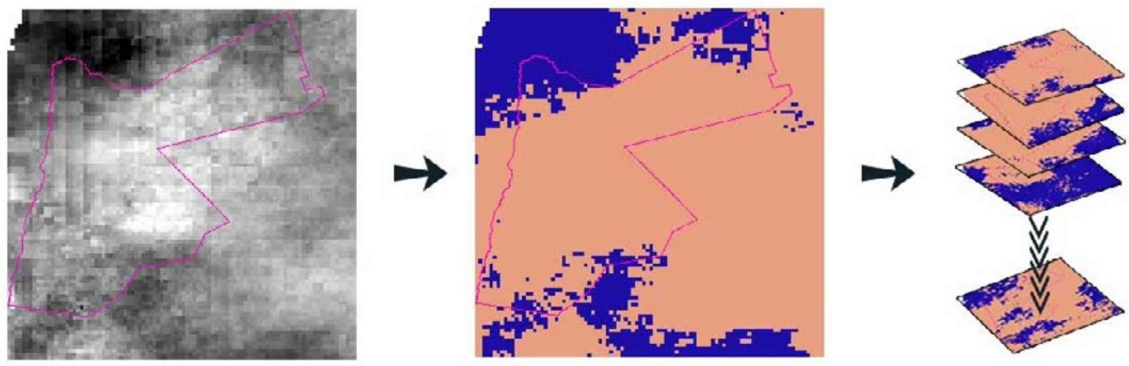


Figure 26:
Processing and classification of composite long-term average SPI data (Source: WFP).

aridity. For the current study, the aridity index presented in Table 12 was used. This index can help characterize the general soil conditions. The dataset published by the European Commission's Joint Research Centre in its World Atlas of Desertification can be found in the following link:

https://wad.jrc.ec.europa.eu/patternsaridity

This data was derived from the Global Precipitation Climatology Centre and potential evapotranspiration data from the Climate Research Unit of the University of East Anglia (CRUTSv3.20), WAD3-JRC, modified by Spinoni et al. (2015).

Aridity is in fact a permanent condition of climate, while drought is a temporary phenomenon that can be described as temporary aberration in the water supply. Aridity is frequently used to describe areas with low rainfall, and it is almost exclusively restricted to that. Drought, in turn, can potentially impact other climatic regimes. Table 12 shows Middleton and Thomas's (1997) Aridity Index.

Table 12: Aridity levels and index values (Source: Middleton and Thomas, 1997, WAD2)

Aridity Level	Aridity Index
Hyper arid	AI < 0.05
Arid	0.05 <= AI < 0.2
Semi-arid	0.2 <= AI < 0.5
Dry subhumid	0.5 <= AI < 0.65

The following maps show the results of climate-related variables for drought hazard together with an overlay of the aridity index for Jordan. The striped parts of the maps always indicate the hyper arid areas of the country. This distinction is relevant, as drought conditions in hyper arid ecosystems have to be evaluated very differently from those occurring in farming areas, for example. Desert ecosystems are ecosystems that are inherently hyper arid.

Figure 27 is based on 40 years of SPI data and shows the number of occurrences when the SPI was lower than -1 between 1982 and 2021 in Jordan, indicating the occurrence of drought. The number of occurrences for different parts of the country is presented in the map legend.
In addition to the 40-year analysis, it is possible to look at results of the SPI in a more recent time frame, over the past 10 years. Figure 28 shows the areas that have reported below

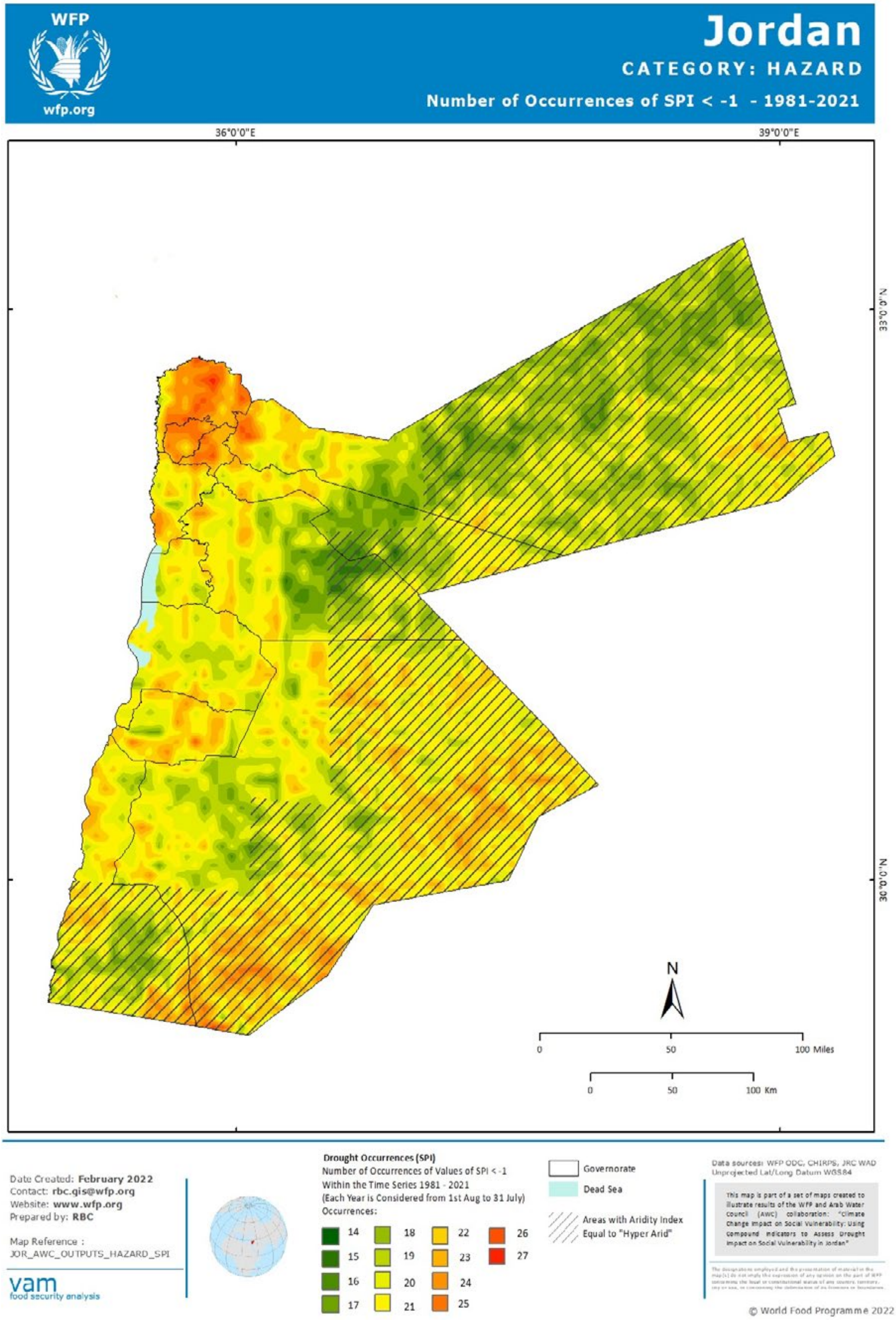


Figure 27: Number of occurrences of negative SPI values (1982-2021), hyper arid areas shown as stripes.

threshold values of SPI-12 over the span of the past 11 years (2011-2021). The map shows clearly intensified drought results for parts of Jordan.
The 40-year time series was used for the overall vulnerability and risk analyses. The goal of this time series is to show the number of occurrences of SPI-12 < -1 calculated on the full set of

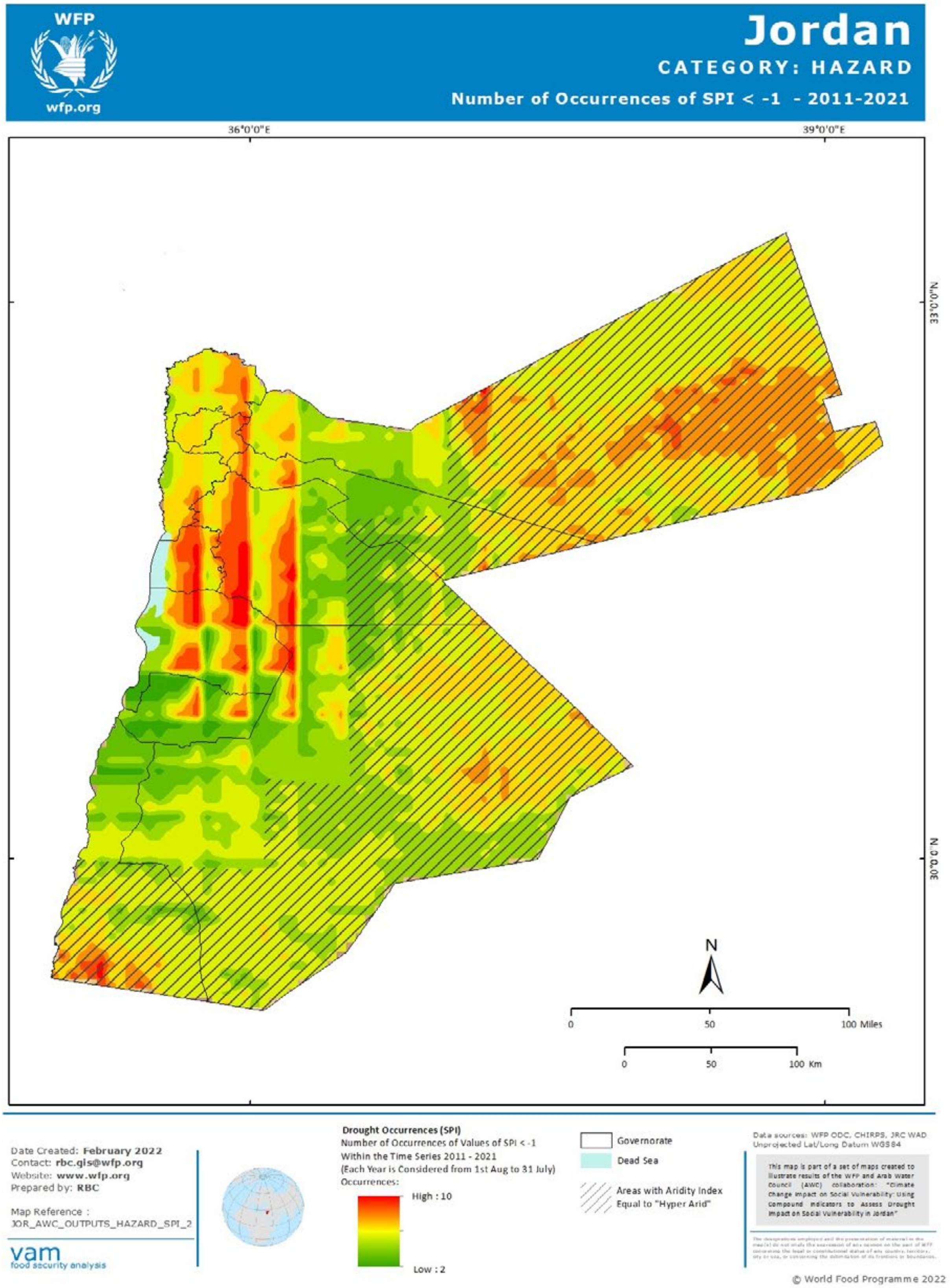


Figure 28: Drought occurrences in Jordan based on SPI, 2011-2021.

data (1982-2021). Results of the frequency analysis show that the minimum number of events is 14, while the maximum number is 27.

In order to select the threshold values for the classification of the number of occurrences over time into a hazard classification range, the frequency of events was considered: the minimum number of occurrences is 14, corresponding to a frequency of 2.8 years, while the maximum number of occurrences is 27, which translates into a frequency of 1.4 years. These numbers indicate that most of the areas in Jordan are subject to very frequent droughts.

The lower hazard class was set to a drought occurrence of 16, meaning a frequency of 40%. The higher class represents a drought occurrence above 20, which refers to a frequency of 50%. This means that the red areas in Figure 29 reported a drought event at least every other year over the timespan of the past 40 years.

While the temporal resolution is 40 years, the spatial resolution that is made available in the public section of CHIRPS website is about 5 km: https://www.chc.ucsb.edu/data/chirps
For the above-mentioned reasons, results obtained from the analysis of the 1982-2021 time series were classified as follows:

Table 13: Classification of SPI

CLASSIFICATION	RANGES
Low hazard	Number of occurrences of SPI-12 <-1 are < 16
Medium hazard	Number of occurrences of SPI-12 <-1 are >= 18 and <= 20
High hazard	Number of occurrences of SPI-12 <-1 are > 20

The mapped results are shown in Figure 29.

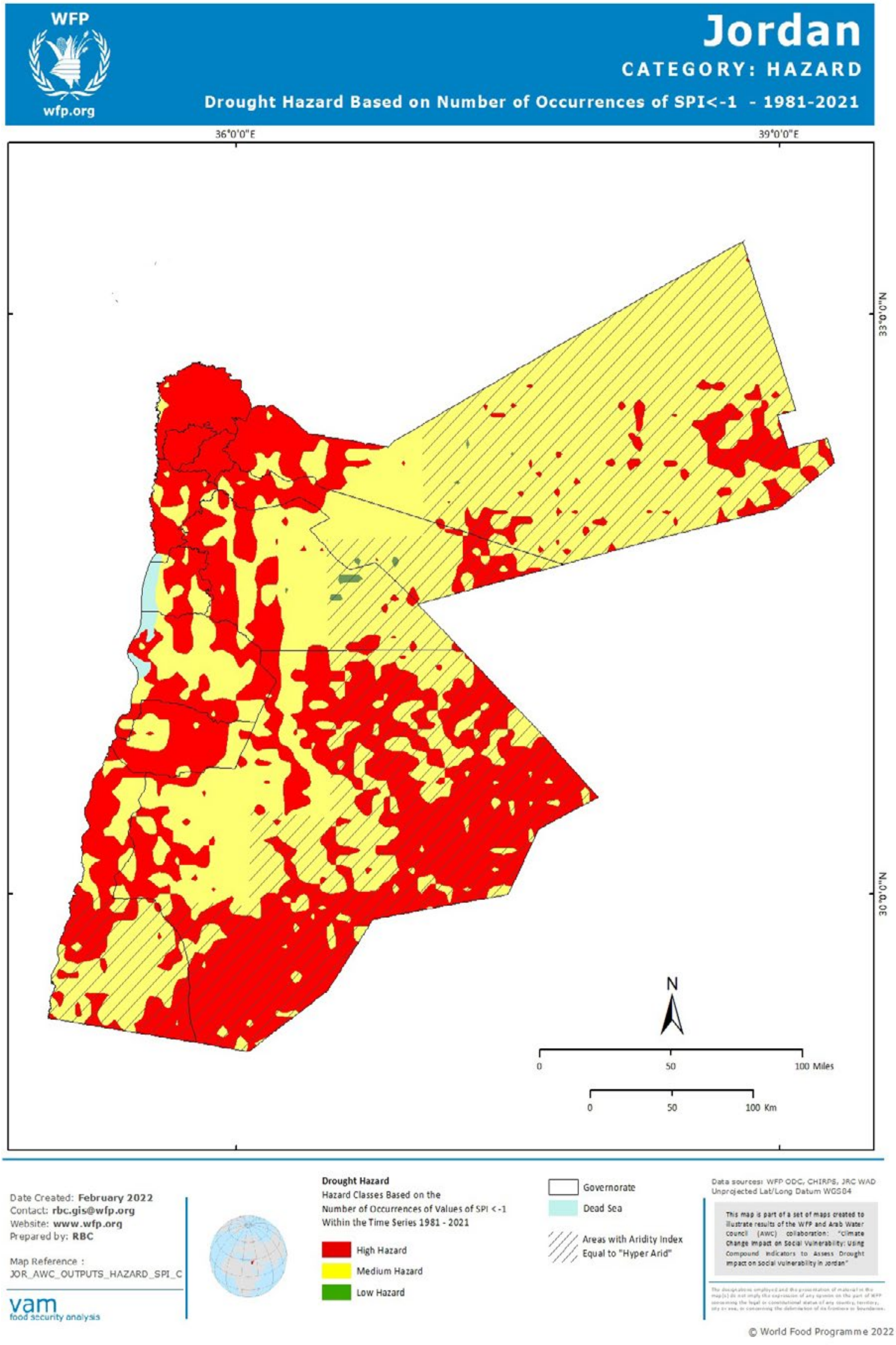


Figure 29: Drought hazard based on the SPI.

12.3.2 Frequency of Extreme Temperature Events

The temperature layers used here capture the number of occurrences of "hot" seasons for the period 1981 to 2021 against the long-term average (LTA) (1986-2015). A "hot" condition exists when the annual average maximum temperature value is above 0.5 C of the LTA. The data was acquired from the European Centre for Medium-Range Weather Forecasts (ECMWF). The following maps show the number of occurrences for hot seasons compared to the respective long-term average, for the August to July period (12-month analysis) and for the agricultural growth season, which in Jordan starts in January and continues through to April (4-month analysis). While the temporal resolution is 40 years, the spatial resolution that is made available in the public section of ECMWF website is some 11 km and can be found by following this link: https://www.ecmwf.int/en/forecasts/datasets

The ranges for classifying the data into low, medium, and high hazard are shown in Table 14 below. Figure 30 displays the absolute number of hot seasons in the measured time period, while Figure 31 illustrates the classified result.

Table 14: Classification of extreme heat

CLASSIFICATION	RANGES
Low hazard	Number of occurrences of hot seasons is < 9
Medium hazard	Number of occurrences of hot seasons is >= 9 and < 11
High hazard	Number of occurrences of hot seasons Is >= 11

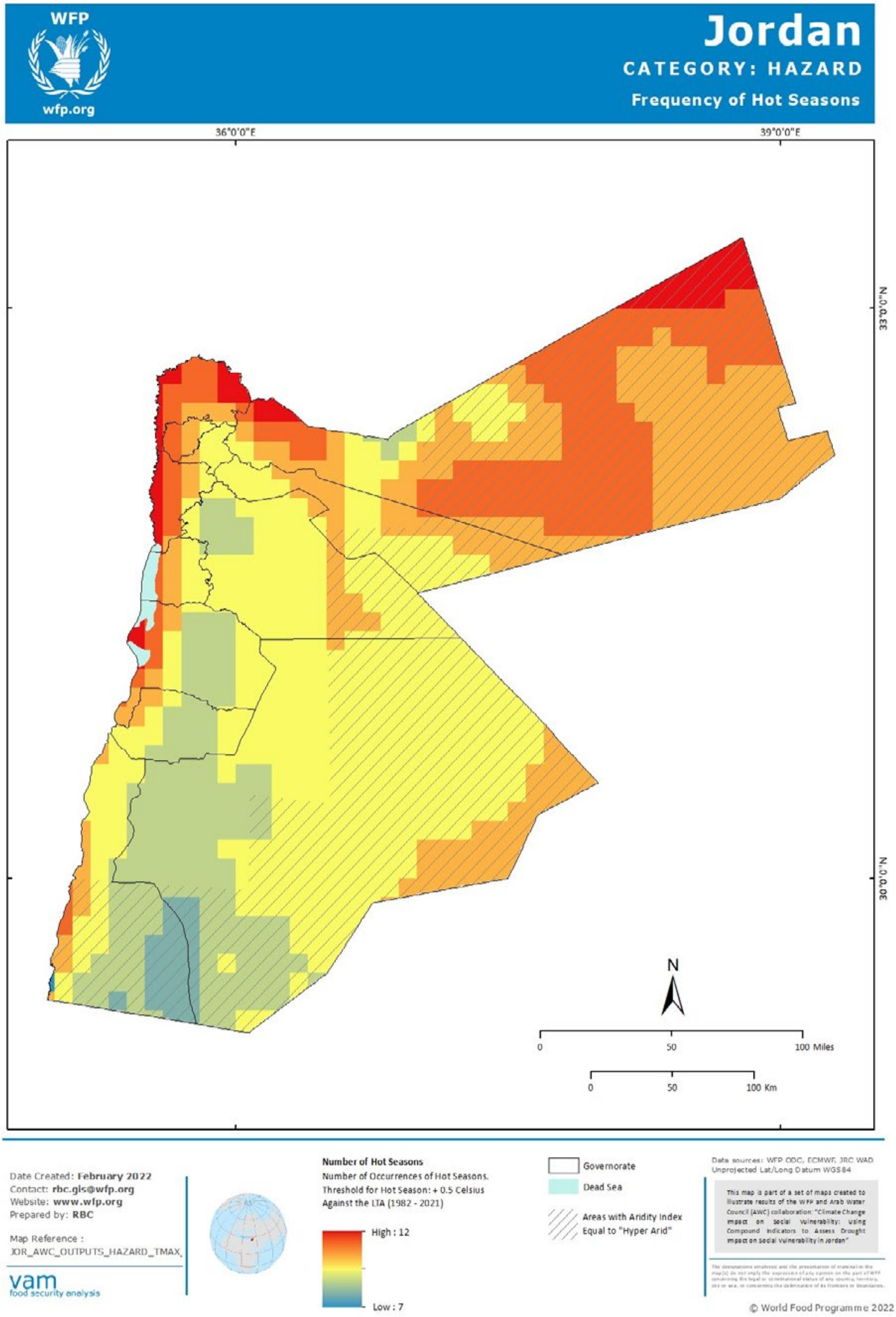


Figure 30: Frequency of hot seasons for the period 1981 to 2021 against the long-term average (LTA) (1986-2015).

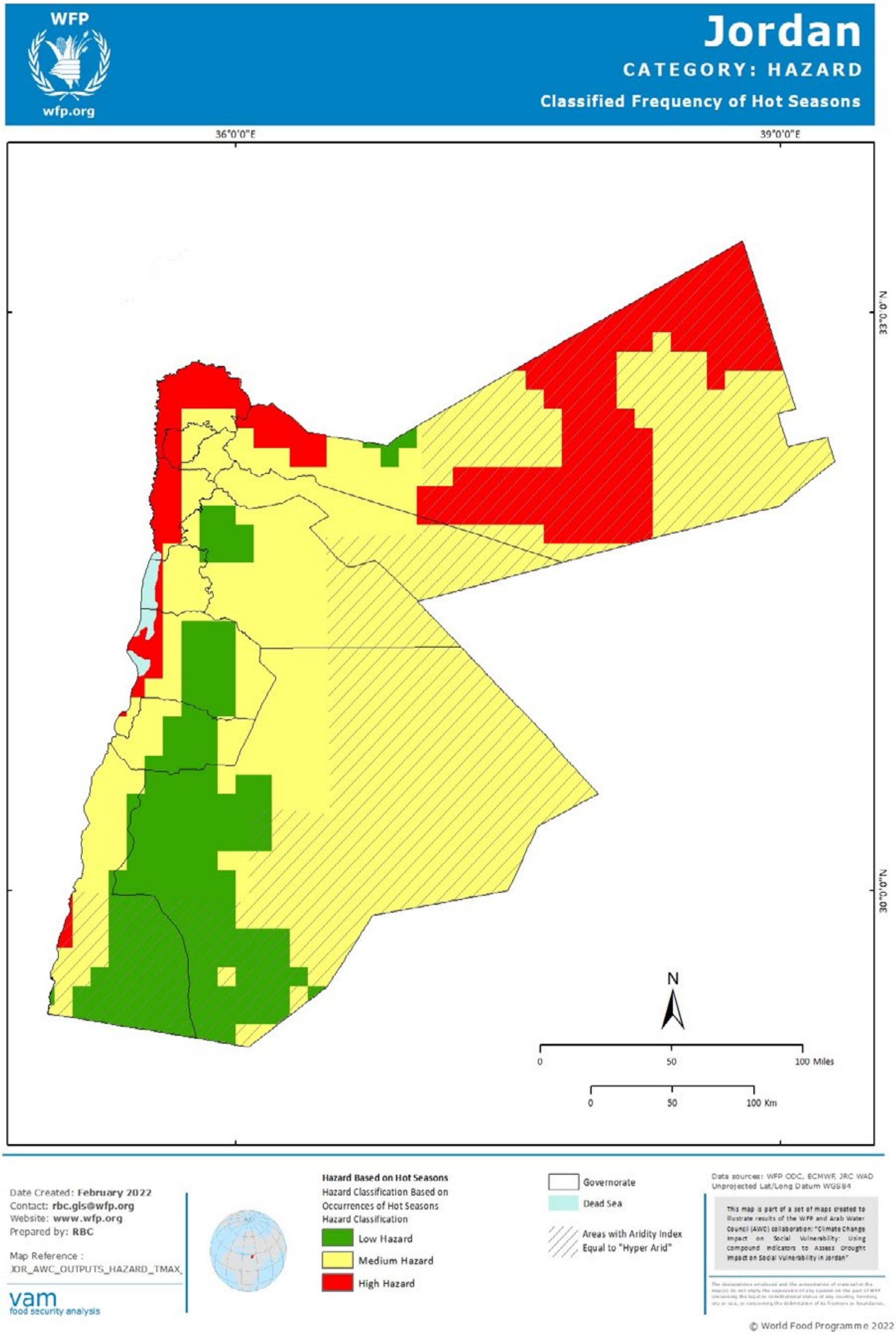


Figure 31: Hazard based on the indicator "frequency of hot seasons".

12.3.3 2020 Temperature Anomaly

In addition to the trend analysis used to grade the hazard component of the final spatial analysis, results of temperature anomalies for the year 2020 are presented below. The analysis is based on data obtained from TerraClimate and processed via Earth Engine: these maps show areas experiencing minimum and maximum temperature anomalies comparing 2020 average values against TerraClimate long-term average (1990-2020) (Figure 32). These maps are not used for the final analysis, but are presented here to enhance the understanding of temperature impact in Jordan.

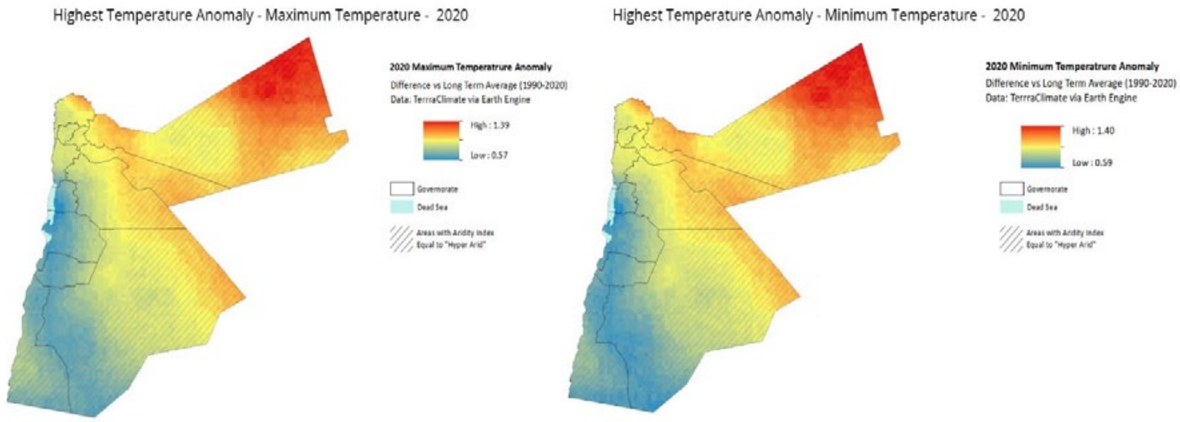


Figure 32: Maximum temperature anomaly distribution for 2020 (left) and minimum temperature anomaly distribution for 2020 (Sources: WFP SDI, TerraClimate, JRC WAD, 2020).

12.3.4 Rainfall Anomaly

In order to better understand the precipitation patterns in Jordan and in addition to the SPI, the frequency of poor rainfall seasons was analyzed. The following maps (Figure 33) show the frequency of poor rainfall seasons, where "poor" means that the overall precipitation has been less than 80% of the expected values from the long-term average. The following maps have not been included in the overall hazard analysis, as rainfall data is already included in the SPI. However, they are used here to depict the precipitation conditions over the 2011-2020 decade and with regards to the full time series 1982-2020 in order to enhance the overall understanding of drought in Jordan. The data used in this section is from CHIRPS.

More granular data and information regarding precipitation and vegetation performance can be found through the following link: https://dataviz.vam.wfp.org/seasonal_explorer/

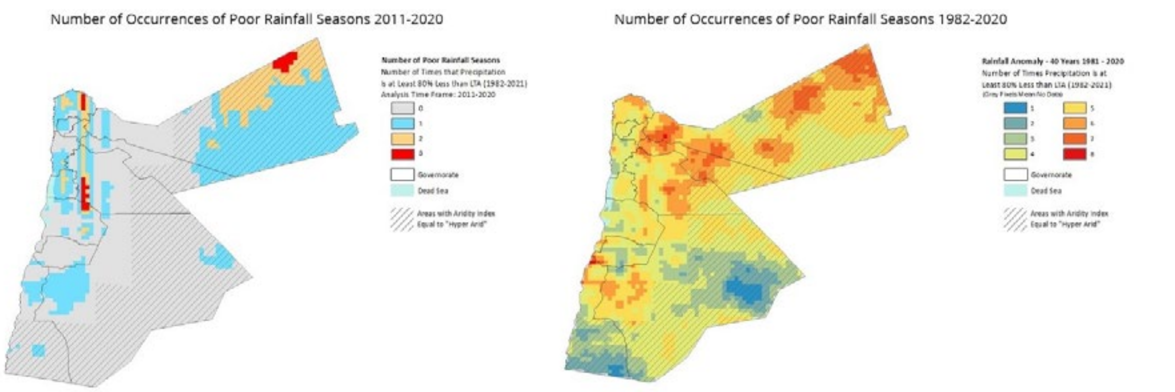


Figure 33: Number of occurrences of poor rainfall seasons (2011-2020) and (1982-2020) (Sources: WFP SDI, CHIRPS, JRC WAD, 2020).

12.3.5 Normalized Deviation Vegetation Index (NDVI)

As part of the definition of hazard, we have analyzed the Normalized Deviation Vegetation Index (NDVI), which was built on the MODIS time series 2003-2021. The NDVI was calculated on the basis of 12 months (NDVI-12).
This analysis shows the frequency of below average values of NDVI compared to the Long-Term Average (LTA). A vegetation season is considered "poor" when the annual maximum NDVI value is below or equal to the 85% of the LTA.
The results show a minimum of 2 events and a maximum of 14 in 18 years, starting in 2003. A high frequency pattern is clustered in the western part of the country, ranging from North to South, in an area where hills and peaks are present, and aridity does not reach extreme values.

The NDVI frequency was classified based on the criteria shown in Table 15. Figure 34 shows the absolute numbers of NDVI anomaly occurrences between 2003 and 2021, while Figure 35 displays the classified map.

Table 15: Classification of NDVI

CLASSIFICATION	RANGES
Low hazard	Number of occurrences of NDVI anomaly is < 4
Medium hazard	Number of occurrences of NDVI anomaly is >= 4 and < 9
High hazard	Number of occurrences of NDVI anomaly is >= 9

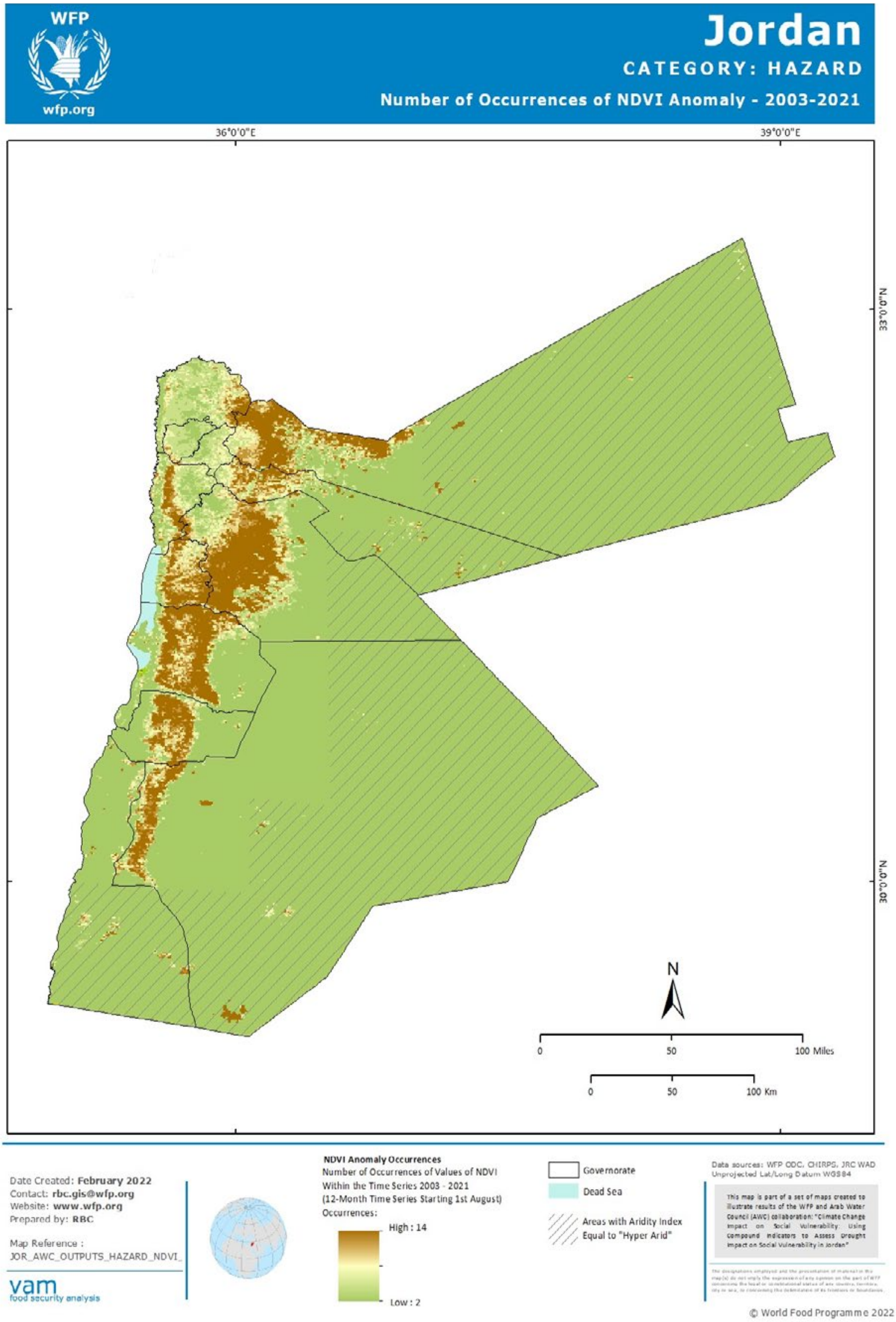


Figure 34: Number of occurrences of NDVI anomaly.

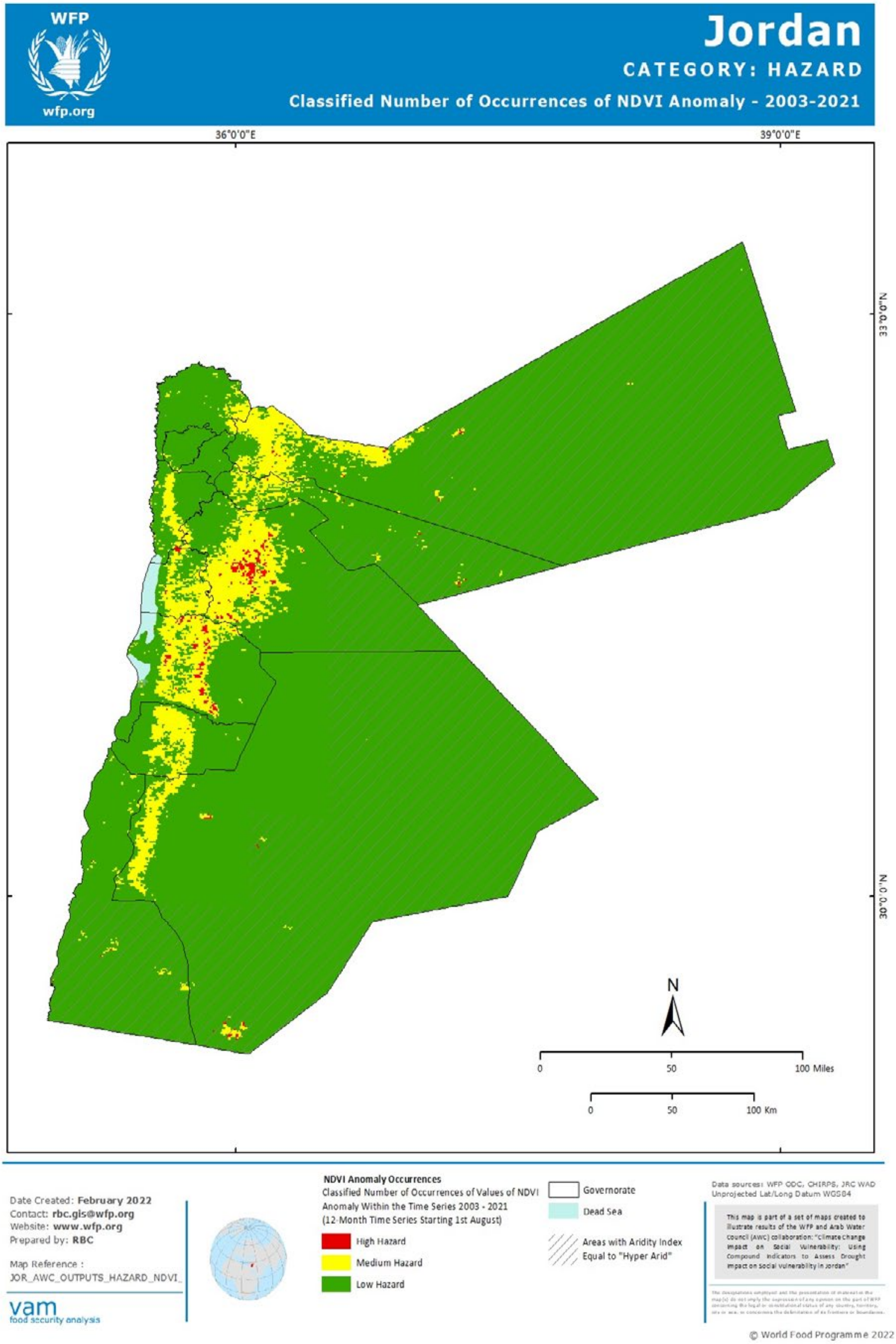


Figure 35: Hazard based on the indicator "occurrences of NDVI anomaly".

12.3.6 Hazard Analysis: Overall Results

Results of the hazard analysis are obtained by combining all indicators and their hazard scores into one layer. The three layers that contribute to the final result are displayed in Figure 36. Figure 37 shows the unweighted overall hazard results, while Figure 38 presents the same results while factoring the weighting of indicators as provided by Jordanian experts.

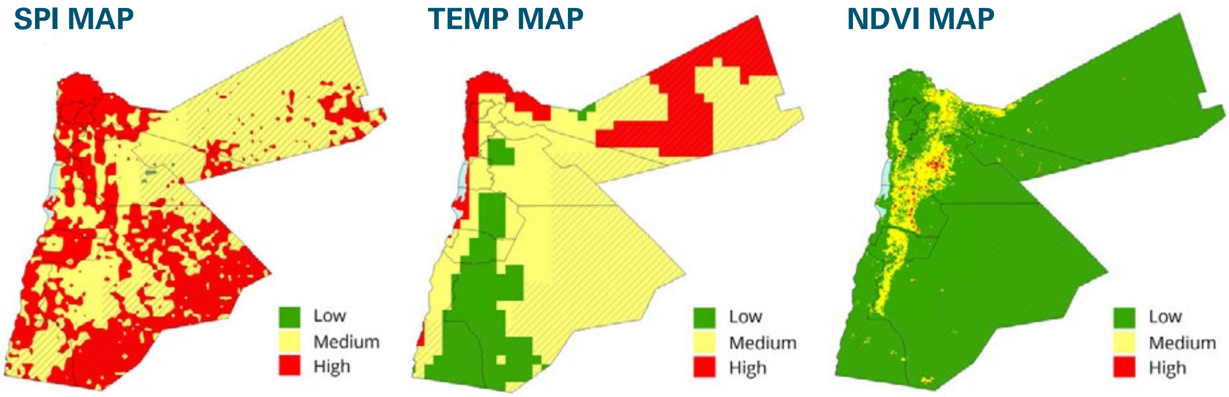


Figure 36: Layers on which the overall drought hazard calculation is based.

Figures 37 and 38 show the unweighted and weighted hazard result, respectively. The unweighted result presented in Figure 37 is based on a calculation in which all indicators are assigned equal weight. The weighted result presented in Figure 38 is based on the weight assigned to each indicator by the group of Jordanian experts who supported the study. Only the weighted map was included in the final analysis of this study. Figure 39 places the two maps next to each other for easier comparison. What can be seen is that the weighted map sees the desert areas in the governorate of Mafraq as being lower hazard than the unweighted map, and also assign an even stronger low hazard status to the darker green areas in Mafraq, Zarqa, and Amman Governorates.

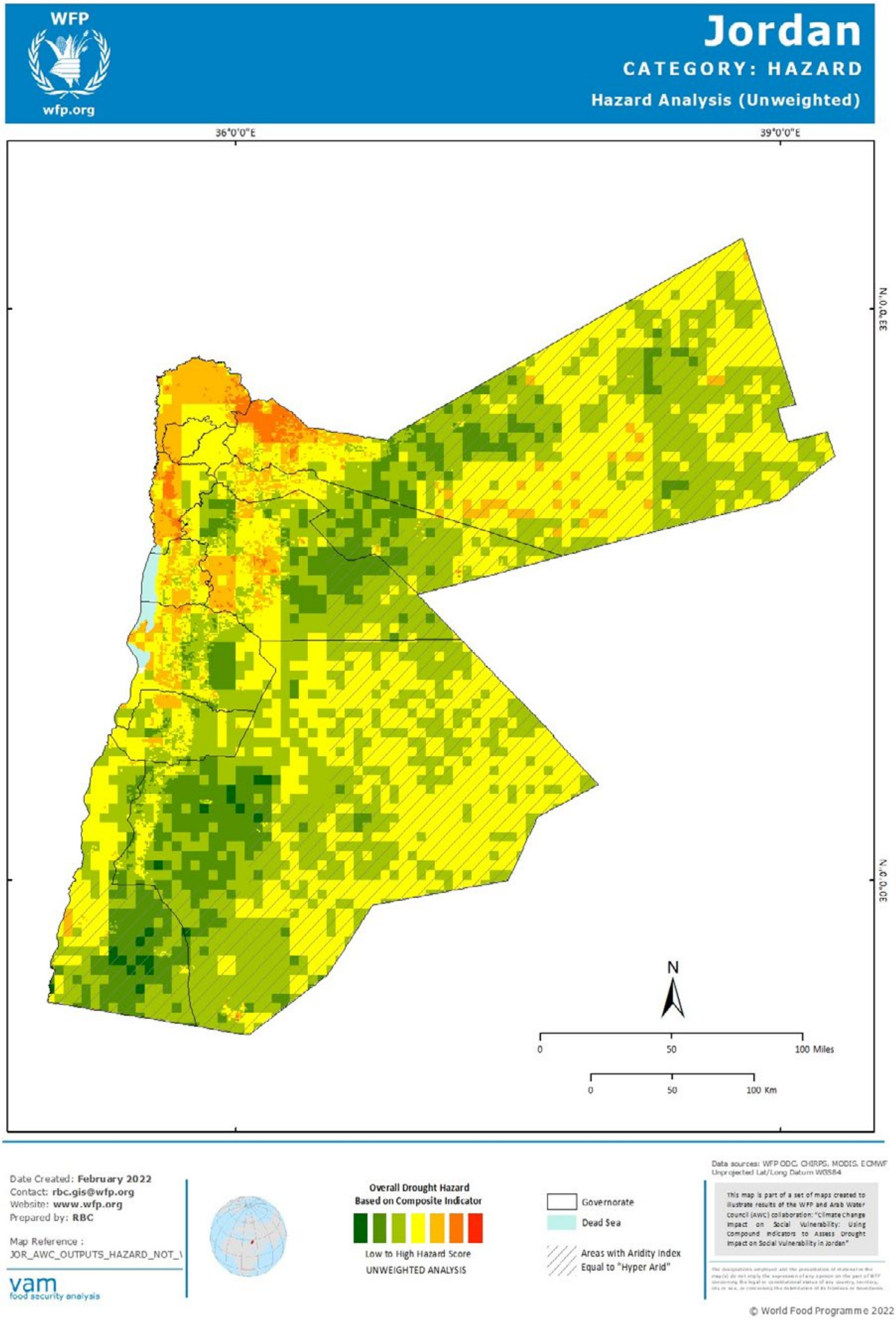


Figure 37: Overall drought hazard based on all hazard indicators, unweighted.

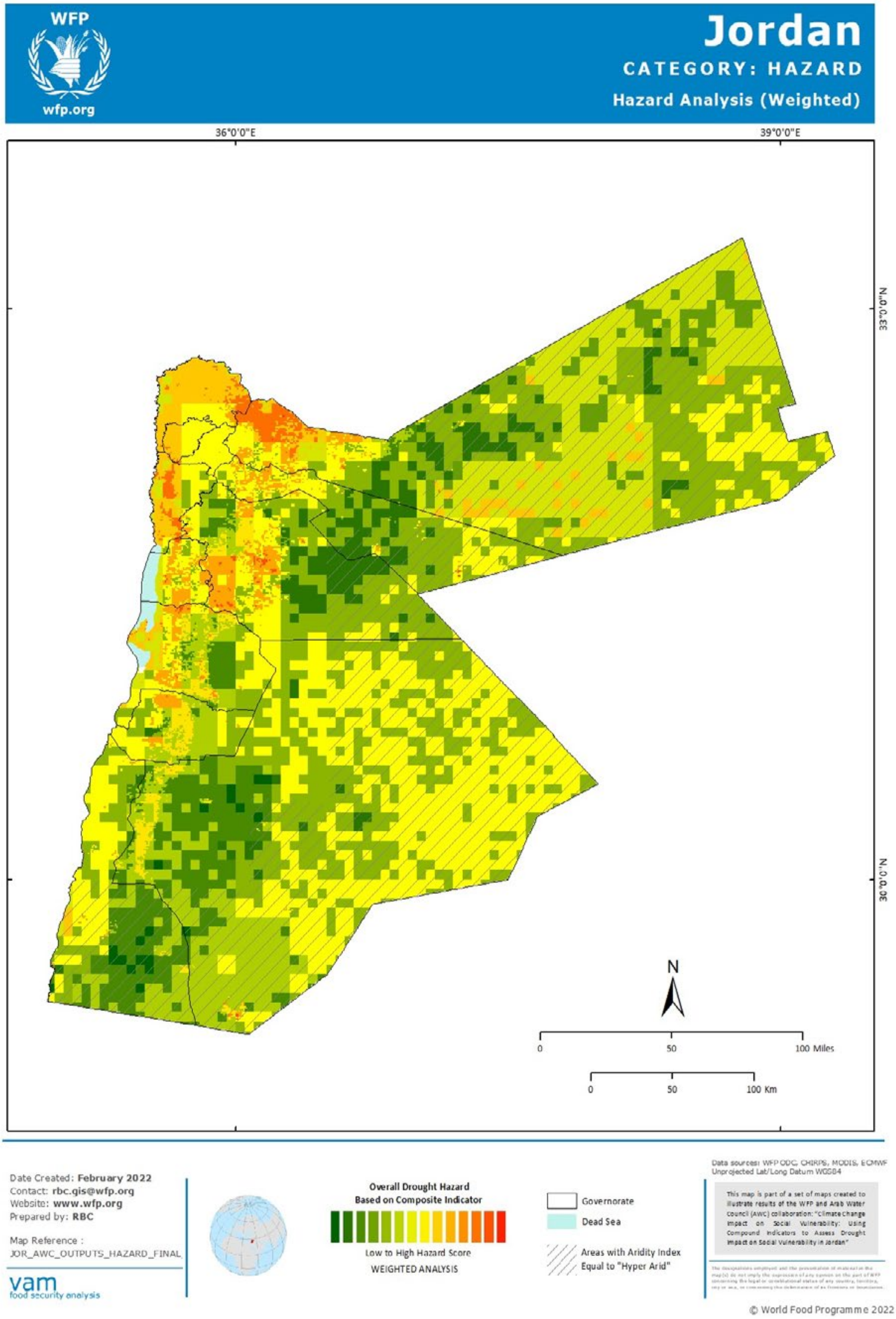


Figure 38: Overall drought hazard based on all hazard indicators, weighted.

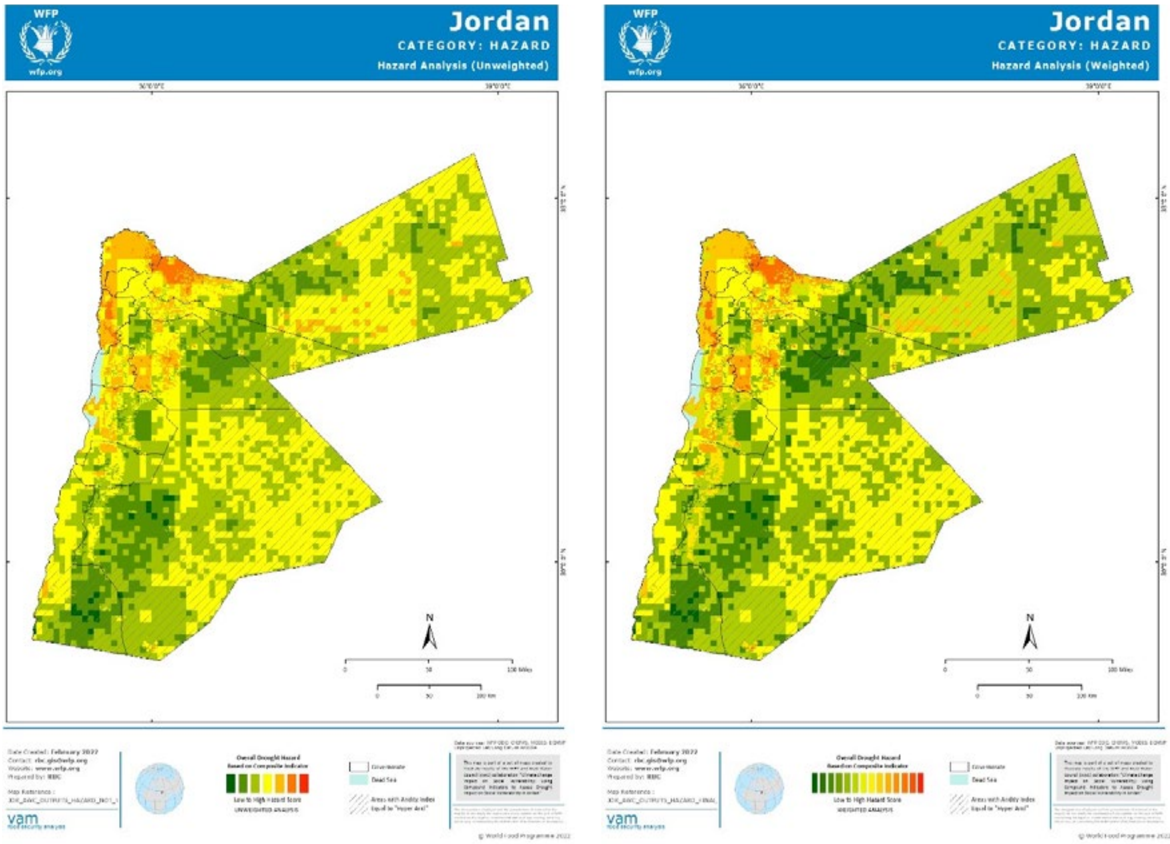


Figure 39: Comparison of unweighted (left) and weighted (right) hazard results.

12.4 Exposure Maps

Exposure is one component of the climate change vulnerability, which depicts the propensity of the territory and the communities living in the territory of being adversely affected when exposed to a hazard. In the context of this study, factors were selected that potentially expose territories to drought impacts. As this study has a particular focus on drought impact on agriculture and agri-pastoralism, the relevant indicators included here are expected climate change impacts on ecosystems (The Hashemite Kingdom of Jordan, 2014), agricultural systems (rainfed / irrigated land), the presence of livestock, population density, land cover, the presence of rangelands (areas with less than 200 mm of rainfall per year), as well as a composite indicator of water access to farming.

12.4.1 Climate Change Impact on Natural Environments

Maps on expected climate change impact on natural areas were obtained from Jordan's National Communication on Climate Change (TNC) (The Hashemite Kingdom of Jordan, 2014). An updated communication is expected to be published later this year, on the basis of which the presented layers could be updated. The maps published in the 2014 TNC relate to two forecast scenarios based on Representative Concentration Pathways (RCPs). The RCP 4.5 and RCP 8.5 scenarios forecast for the 2040 to 2070 period were mapped here. The maps published in the 2014 TNC were reclassified for low, medium, and high exposure and produced for the minimum climate impact scenario and the maximum climate impact scenario.

The exposure score used to classify the 2014 TNC map for RCP 4.5 is based on the following criteria shown in Table 16:

Table 16: Exposure classification for 2014 TNC map for RCP 4.5

CLASSIFICATION	RANGES
Low exposure	Climate change impact is <= 4
Medium exposure	Climate change impact is > 4 and < 6
High exposure	Climate change impact is >= 6

The exposure score used to classify the 2014 TNC map for RCP 8.5 is based on the following criteria as shown in Table 17:

Table 17: Exposure classification used for TNC map for RCP 8.5

CLASSIFICATION	RANGES
Low exposure	Climate change impact is <= 6
Medium exposure	Climate change impact is > 6 and < 7.25
High exposure	Climate change impact is >= 7.25

Figure 40 presents the classified exposure map based on expected climate change impact on ecosystems for minimum values, while Figure 41 shows the same for maximum values.

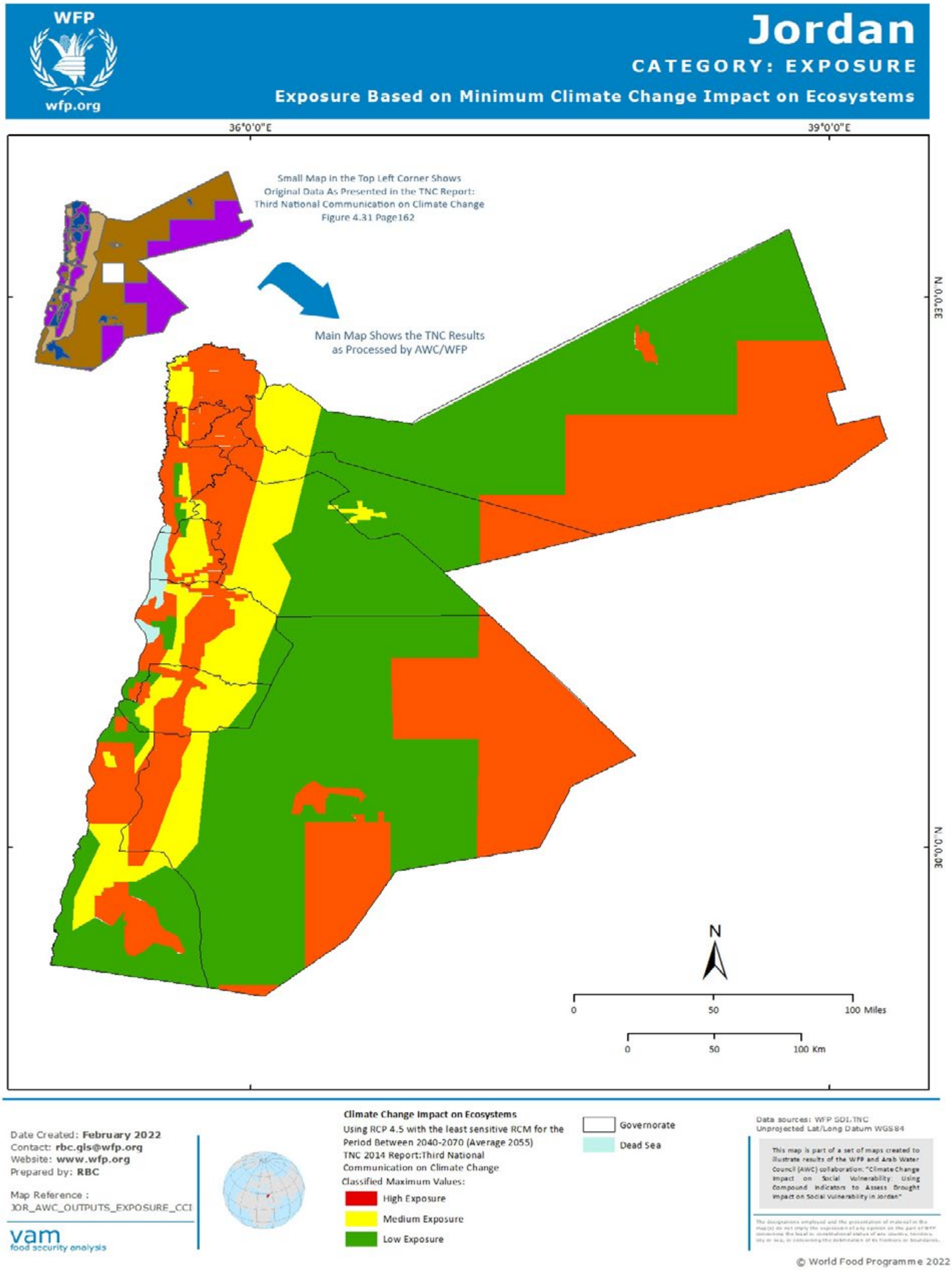


Figure 40: Classified exposure map for minimum climate change impact on ecosystems, based on the latest published TNC (The Hashemite Kingdom of Jordan, 2014). The original map is shown in the inlet (top left).

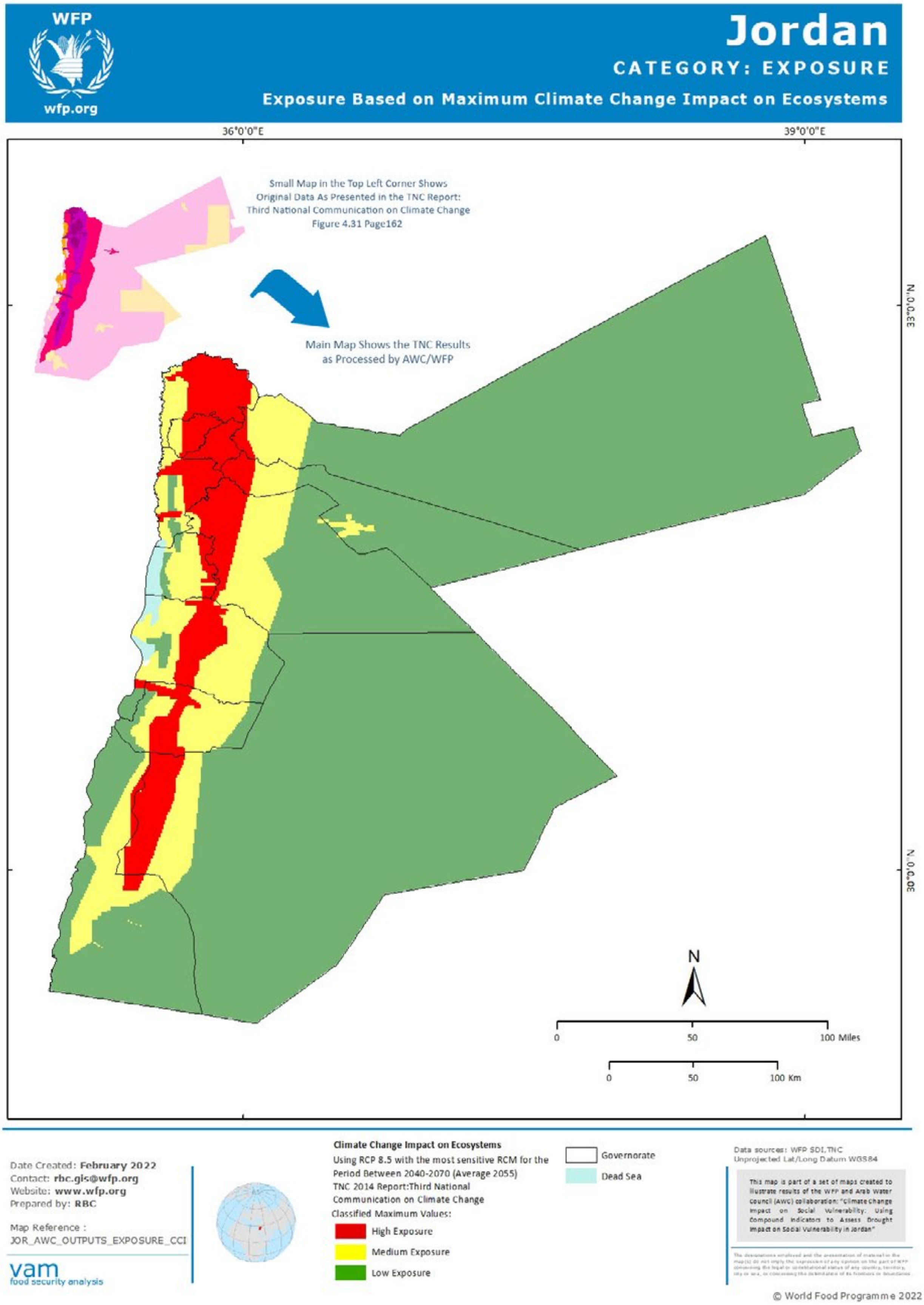


Figure 41: Exposure based on indicator "maximum climate change impact on ecosystems" from latest published TNC (The Hashemite Kingdom of Jordan, 2014). The original map is shown in the inlet (top left).

12.4.2 Irrigation Type: Rainfed and Irrigated Agriculture

This study places particular emphasis on drought in the context of agriculture. Agricultural systems in Jordan depend on irrigation or precipitation for the growth of various crops cultivated and harvested during the agricultural season. The distribution of these agricultural systems varies geographically across Jordan, and there are some areas in the country where agricultural systems are exclusively irrigated or rainfed. In fact, over the course of time the Jordanian government supported the conversion of some arid areas into suitable cultivated areas through irrigation investment, in order to diminish the competition for arable land and augment the internal production.

This section makes use of data made available by the Ministry of Agriculture (MoA) at second administrative level using information from 2019. The dataset describes the distribution of agricultural land as divided by the two systems – irrigated and rainfed. This information was converted into percentages for rainfed land and irrigated land with respect to the total arable land within each district. The mapped results are shown in Figures 42 (prevalence of irrigated agriculture by District) and 43 (prevalence of rainfed agriculture by District).

Figure 44 shows the classified exposure map. The underlying assumption was that, in an agricultural context, areas with more irrigated agriculture are less immediately exposed to drought, as in those areas, farmers have access to two water sources: rainfall as well as an irrigation source (groundwater or a surface water body).

The exposure score was assigned according to the following criteria summarized in Table 18:

Table 18: Exposure score for irrigated land

CLASSIFICATION	RANGES
Low exposure	Prevalence of irrigated land is > 75% of total agricultural land
Medium exposure	Prevalence of irrigated land is >= 25% and <= 75% of total agricultural land
High exposure	Prevalence of irrigated land is < 25% of total agricultural land

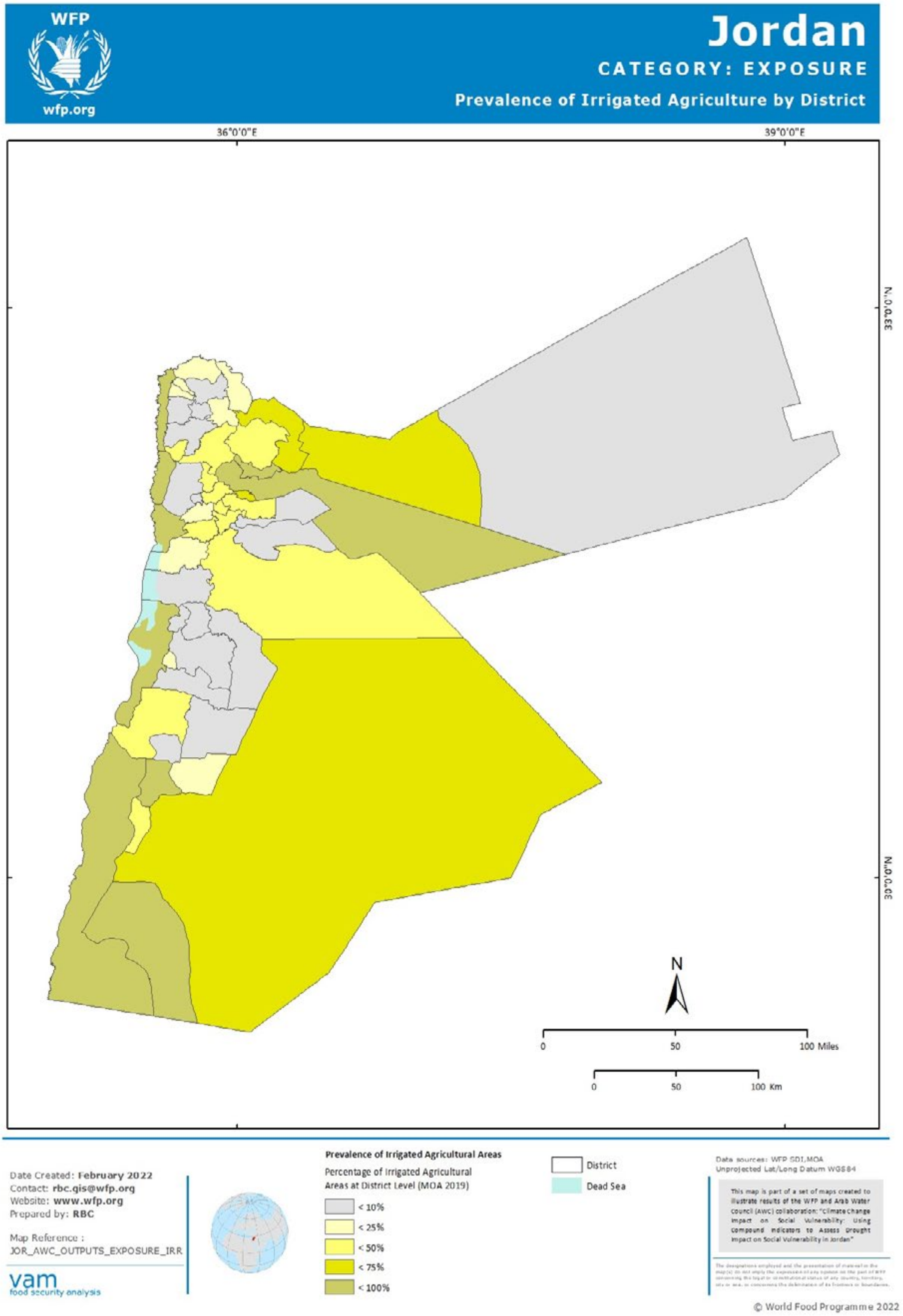


Figure 42: Prevalence of irrigated agriculture by district.

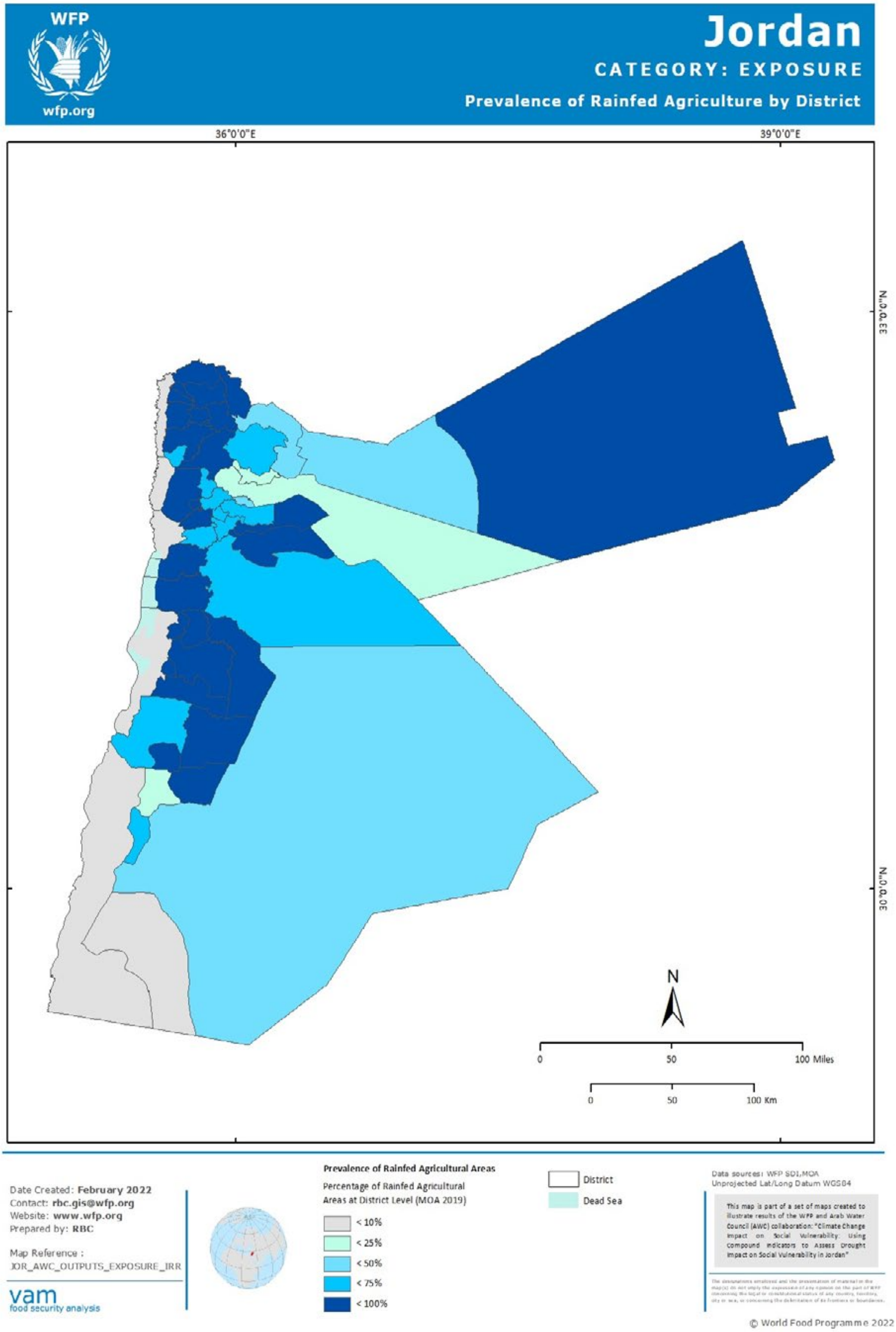


Figure 43: Prevalence of rainfed agriculture by district.

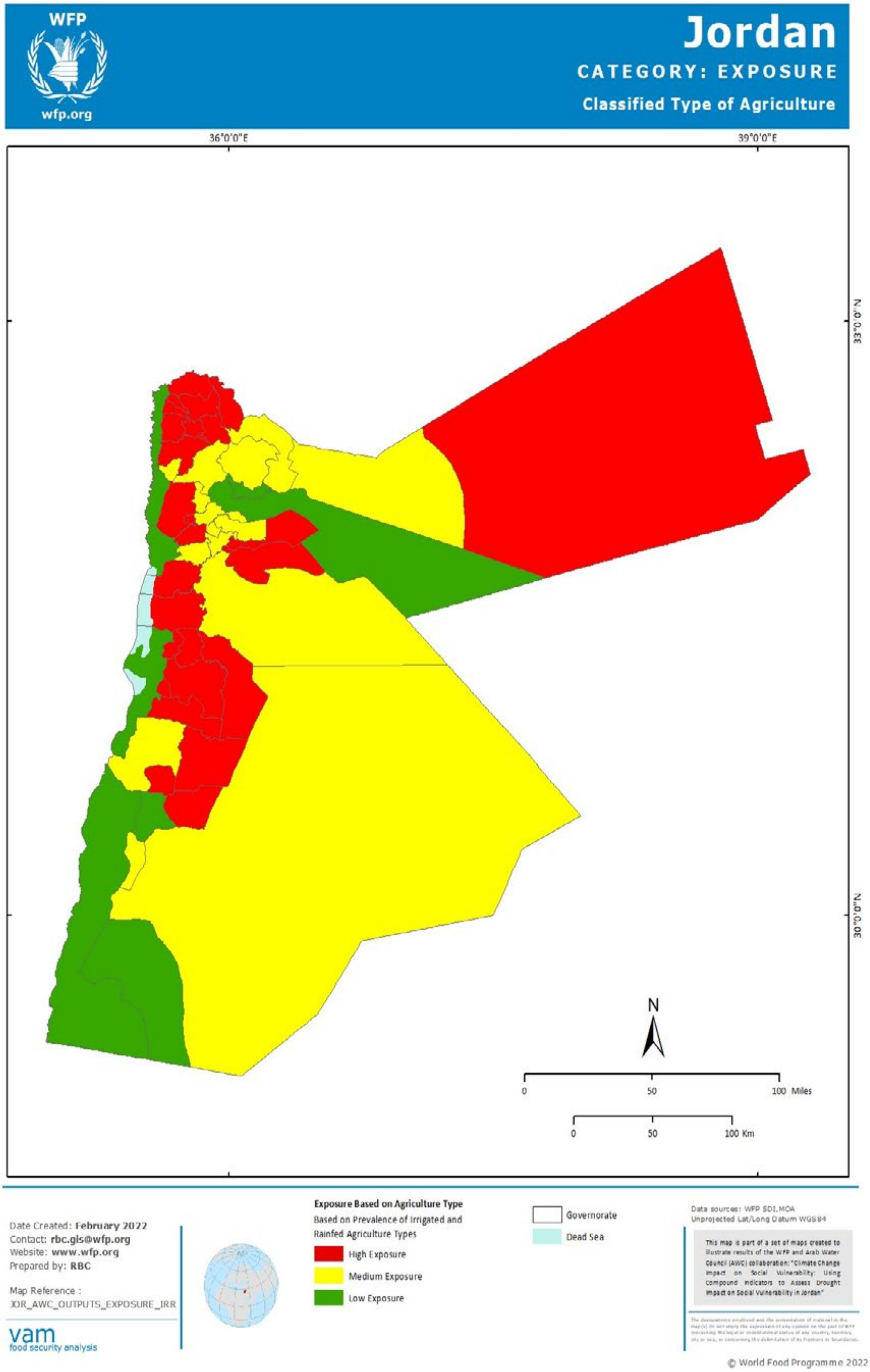


Figure 44: Exposure based on the indicator "type of agriculture".

12.4.3 Presence of Livestock

Livestock rearing plays an important role in Jordan's agricultural systems, also in the context of pastoralism and grazing. Data on the presence of livestock at Governorate level was received from DOS with reference to the year 2019. Information on the number of cows, goats and sheep was then aggregated to define the overall presence of these three animals. Sheep are by far the most relevant population, with up to some 850,000 heads in Mafraq only (28% of the entire sheep population in the country). Aqaba and Maan have the largest portion of goats in the country, while Zarqa has the largest cow population with some 33,000 heads. The maximum cumulative livestock presence is found in Mafraq (24%) and Amman (18%), both in reference to the total in-country livestock population. Figure 45 shows the populations of cows, goats, and sheep in the different Governorates of Jordan.

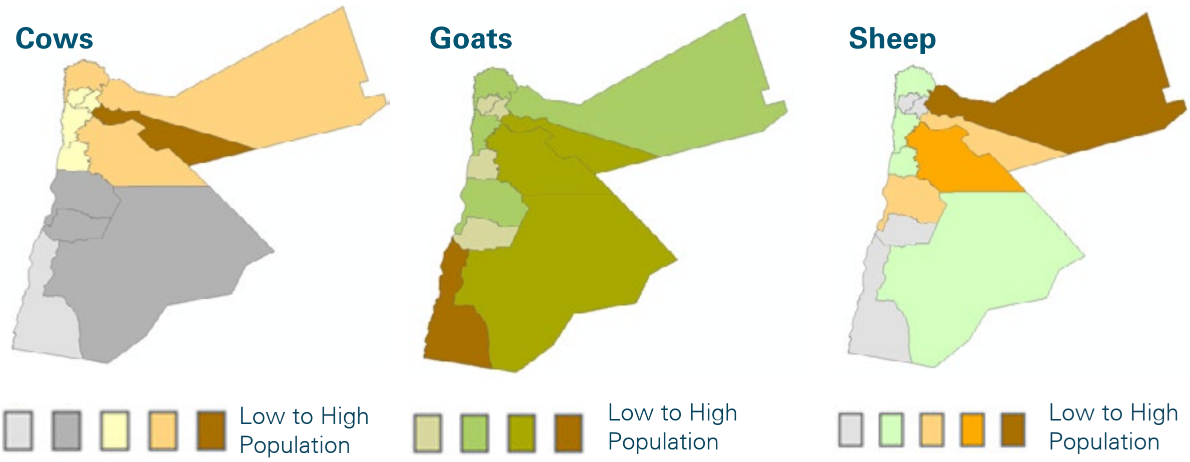


Figure 45: Populations of cows, goats, and sheep by Governorate (Sources: DOS, 2019 and WFP, 2022).

According to Jordanian experts on agriculture and economics, as discussed during our focus groups, the presence of livestock plays an important role in exposure to drought in the agricultural sector. The rationale here is that farmers with livestock are more exposed to drought, as livestock is in constant need of feed and water, and thus livestock-based livelihoods are particularly exposed to drought impact. Based on the presence of livestock, exposure was calculated according to the criteria shown in Table 19:

Table 19: Exposure to drought based on the presence of livestock

CLASSIFICATION	RANGES
Low exposure	Total number of heads of livestock is < 150,000
Medium exposure	Total number of heads of livestock is >= 150,000 and < 400,000
High exposure	Total number of heads of livestock is >= 400,000

Figure 46 shows the resulting exposure map based on this classification.

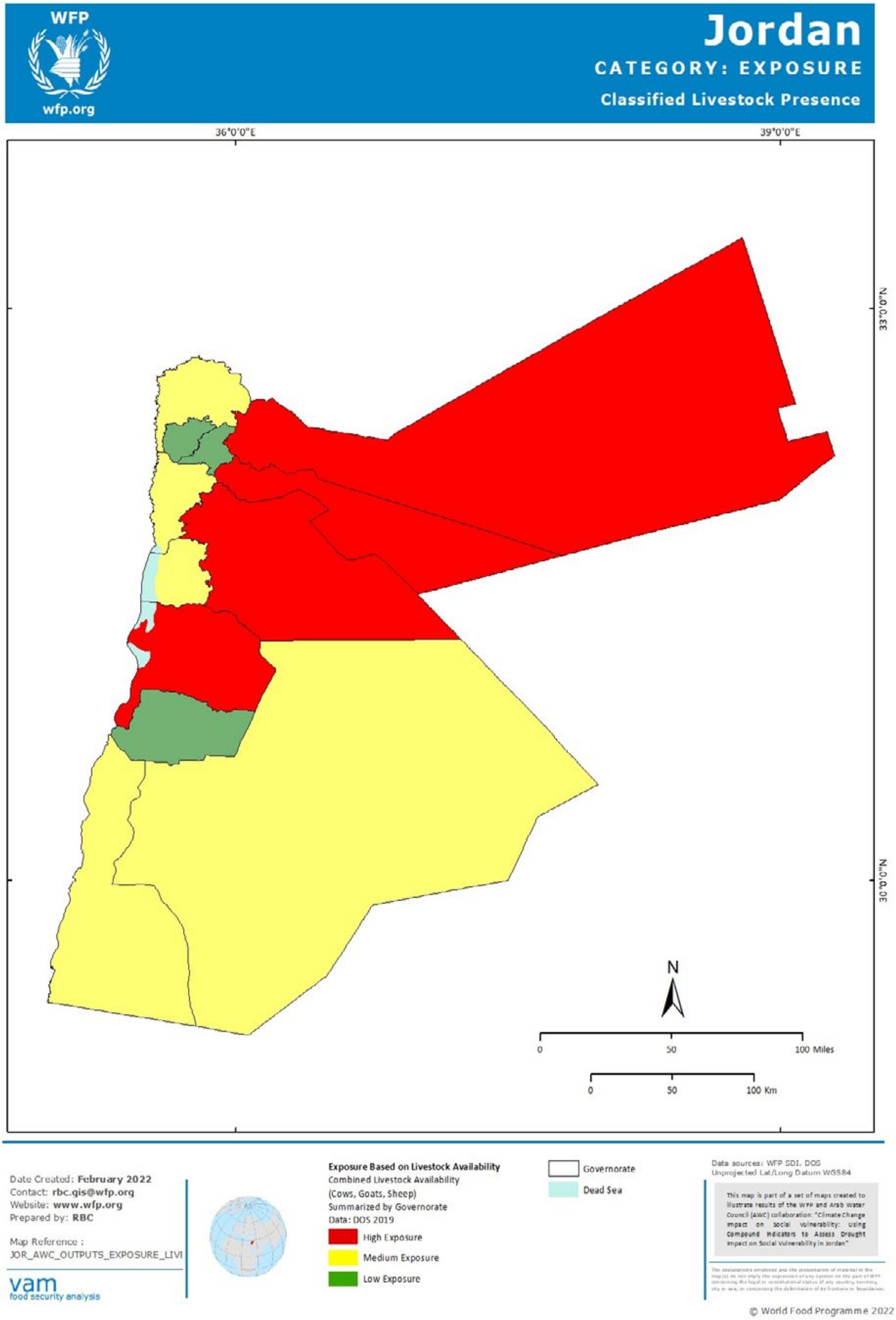


Figure 46: Exposure based on the indicator "presence of livestock".

12.4.4 Rangelands

Rangelands are of particular interest in Jordan and have been used in this study to identify areas used for pastoral activities such as grazing native and domestic animals on native vegetation. Rangelands are defined as areas receiving less than 200 mm per year cumulative precipitation values. The results are based on CHIRPS LTA (1982-2021). https://www.eolss.net/Sample-Chapters/C10/E5-35-01.pdf

The classification of the rangeland layer only includes two classes – medium and high exposure, given that rainfall in Jordan is generally comparatively low. The classification can be seen in Table 20:

Table 20: Classification of rangelands

CLASSIFICATION	RANGES
Medium exposure	Total number of heads of livestock is >= 150,000 and < 400,000
High exposure	Total number of heads of livestock is >= 400,000

Figure 47 is a map of rangelands in Jordan. The classified exposure map for rangelands is shown in Figure 48.

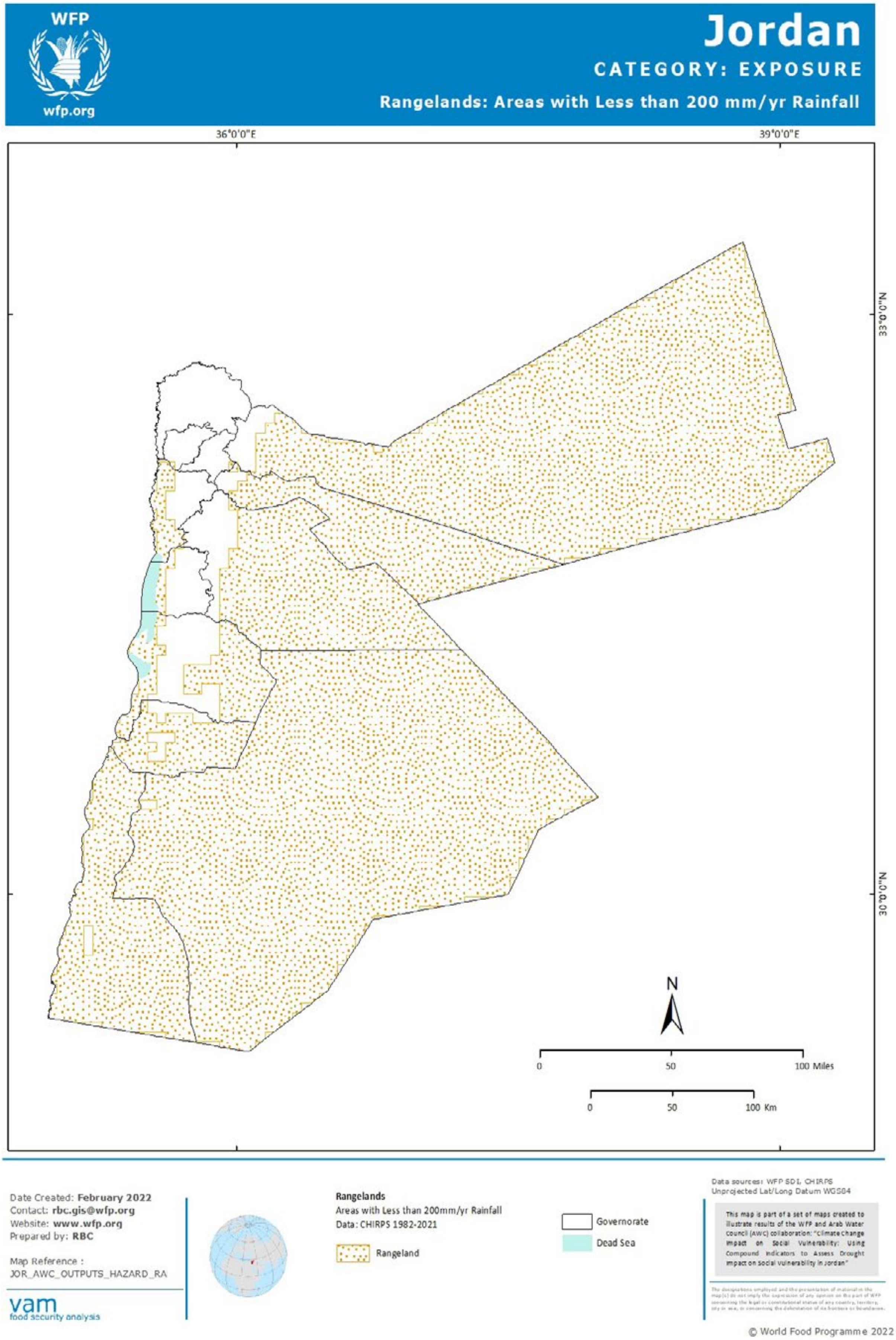


Figure 47: Rangelands in Jordan.

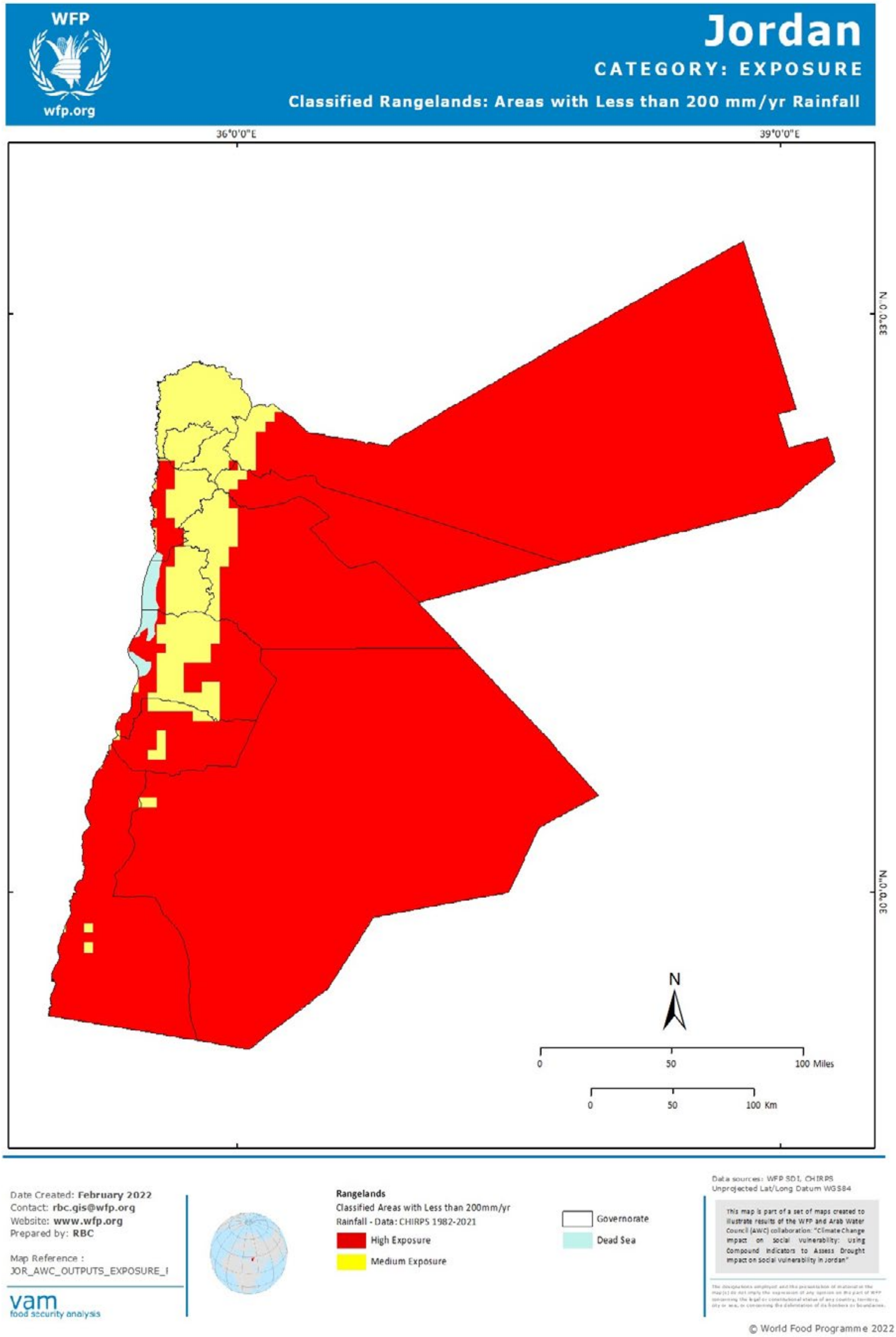


Figure 48: Exposure based on the indicator "presence of rangelands".

12.4.5 Population Density

Human presence on the territory and general population density can be used to understand the actual human exposure to risks and threats. In this study, the pixel-based population information available from WorldPop 2020 was used as a reference grid for the other layers (see the GIS methodology section and the population comparison in the reference maps section) https://www.worldpop.org/geodata/summary?id=24777

For the present study, population figures from WorldPop 2020 were used, as this data comes with the relevant pixel-based, granular information needed for this analysis. During the research phase of this project, it was discovered that there are significant discrepancies between population numbers for Jordan published by different sources (Table 21). These differences are important for studies such as this one, and may in part be explained by population growth caused by the rapid influx of refugees. The 2019 DOS data could not be used for the current study, as this data is based on the first administrative level, not on pixels.

Table 21: Comparison of population figures for Jordan from various sources (Sources: Wikipedia, WorldPop, DOS)

GOVERNORATE	GOVERNORATE CAPITAL	GOVERNORATE POPULATION WIKIPEDIA 2022	GOVERNORATE POPULATION WORLDPOP 2020	GOVERNORATE POPULATION DOS 2019	GOVERNORATE POPULATION WP 2020 VS WIKIPEDIA	PERCENTAGE DIFFERENCE WP 2020 VS DOS
Amman	Amman	2,473,400	2,691,740	4,536,500	8.83	-40.66
Irbid	Irbid	1,137,100	1,286,380	2,003,800	13.13	-35.80
Mafraq	Mafraq	300,300	403,095	622,500	34.23	-35.25
Jerash	Jerash	191,700	222,403	268,300	16.02	-17.11
Ajloun	Ajloun	146,900	175,223	199,400	19.28	-12.12
Zarqa	Zarqa	951,800	1,065,789	1,545,100	11.98	-31.02
Balqa	Al-Salt	428,000	477,378	556,600	11.54	-14.23
Madaba	Madaba	159,700	171,895	214,100	7.64	-19.71
Karak	Al Karak	249,100	274,610	358,400	10.24	-23.38
Aqaba	Aqaba	139,200	144,924	213,000	4.11	-31.96
Maan	Maan	121,400	124,480	179,300	2.54	-30.57
Tafiela	Tafiela	89,400	98,360	109,000	10.02	-9.76
Kingdom		6,388,000	7,136,277	10,806,000	11.71	-33.96

Figures 49 and 50 illustrate the population density and classified exposure based on population density, derived from the criteria shown in Table 22:

Table 22: Exposure classification based on population density

CLASSIFICATION	RANGES
Low exposure	Number of inhabitants per km^2 is > 49
Medium exposure	Number of inhabitants per km^2 is >= 50 and < 499
High exposure	Number of inhabitants per km^2 is >= 500

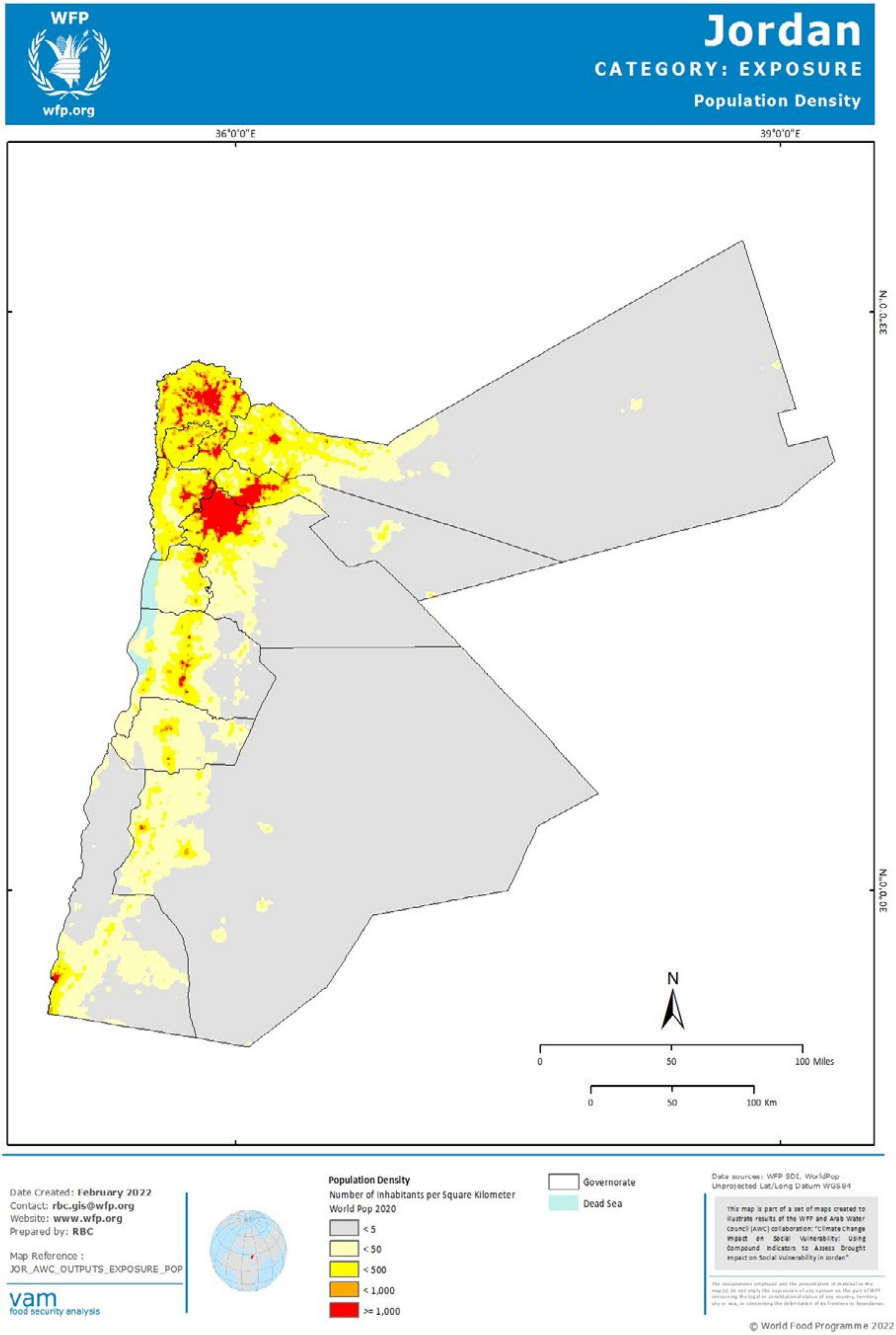


Figure 49: Population density in Jordan.

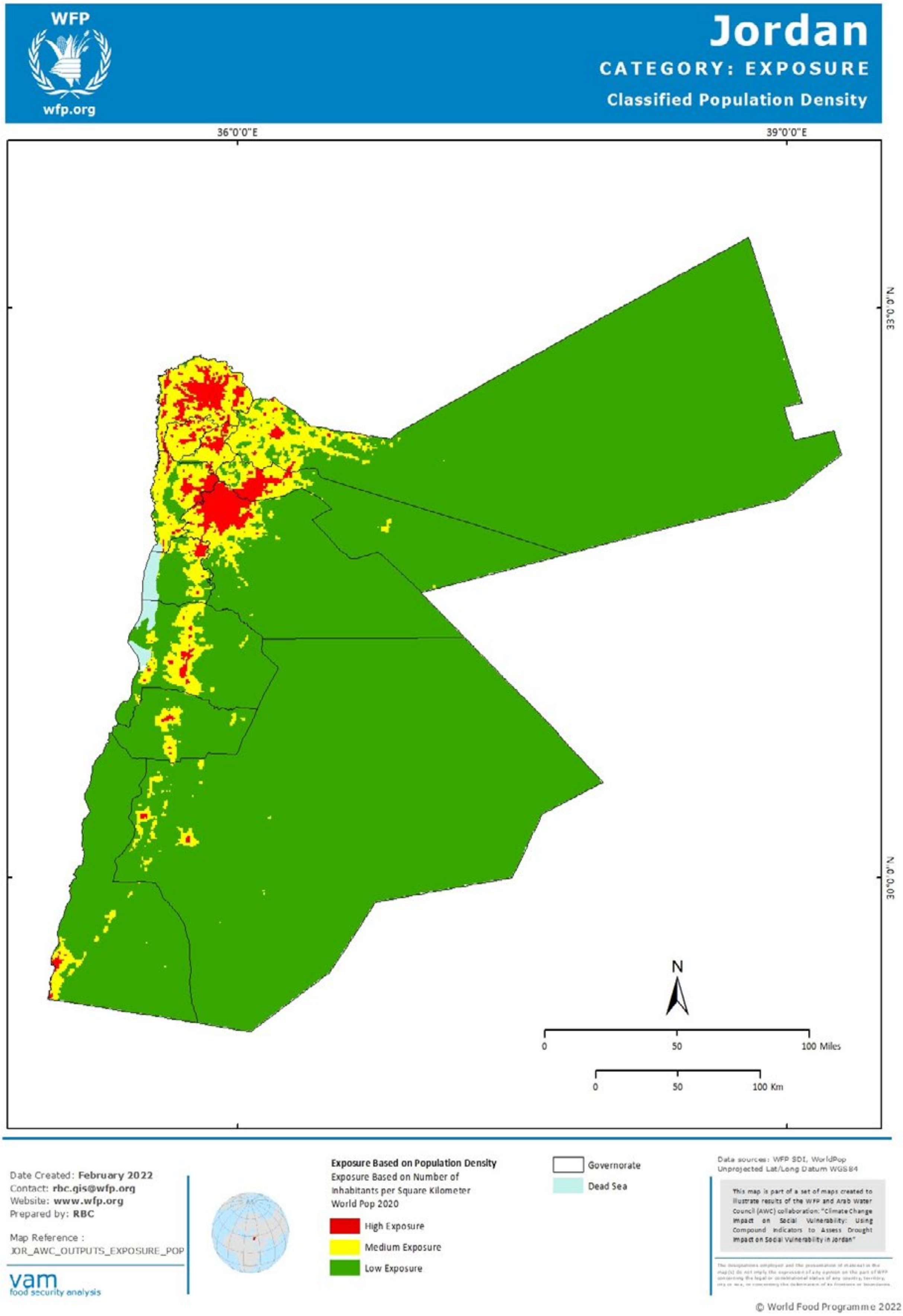


Figure 50: Exposure based on the indicator "population density".

12.4.6 Land Cover

For this analysis, two land cover layers were acquired and compared. The first one is from ESA Proba-V archive, which was updated in 2019 and is composed of 18 classes. The set is well-known and widely used in environmental studies, as it has global coverage and interesting spatial resolution. It is often used by UN research groups and in the academic context. Data from ESA Proba-V was extracted for Jordan and displayed in Figure 51.

However, for Jordan, a higher resolution land cover map was made available, which also incorporates useful land use features. This layer was produced by FAO in 2017 and is composed of 23 classes. This dataset was chosen over the ESA layer because of the higher spatial resolution and level of detail. The dataset can be found at this location:
https://data.apps.fao.org/map/catalog/srv/eng/catalog.search#/metadata/6dfcc76d-e0aa-439e-a10d-6366be3f23bc

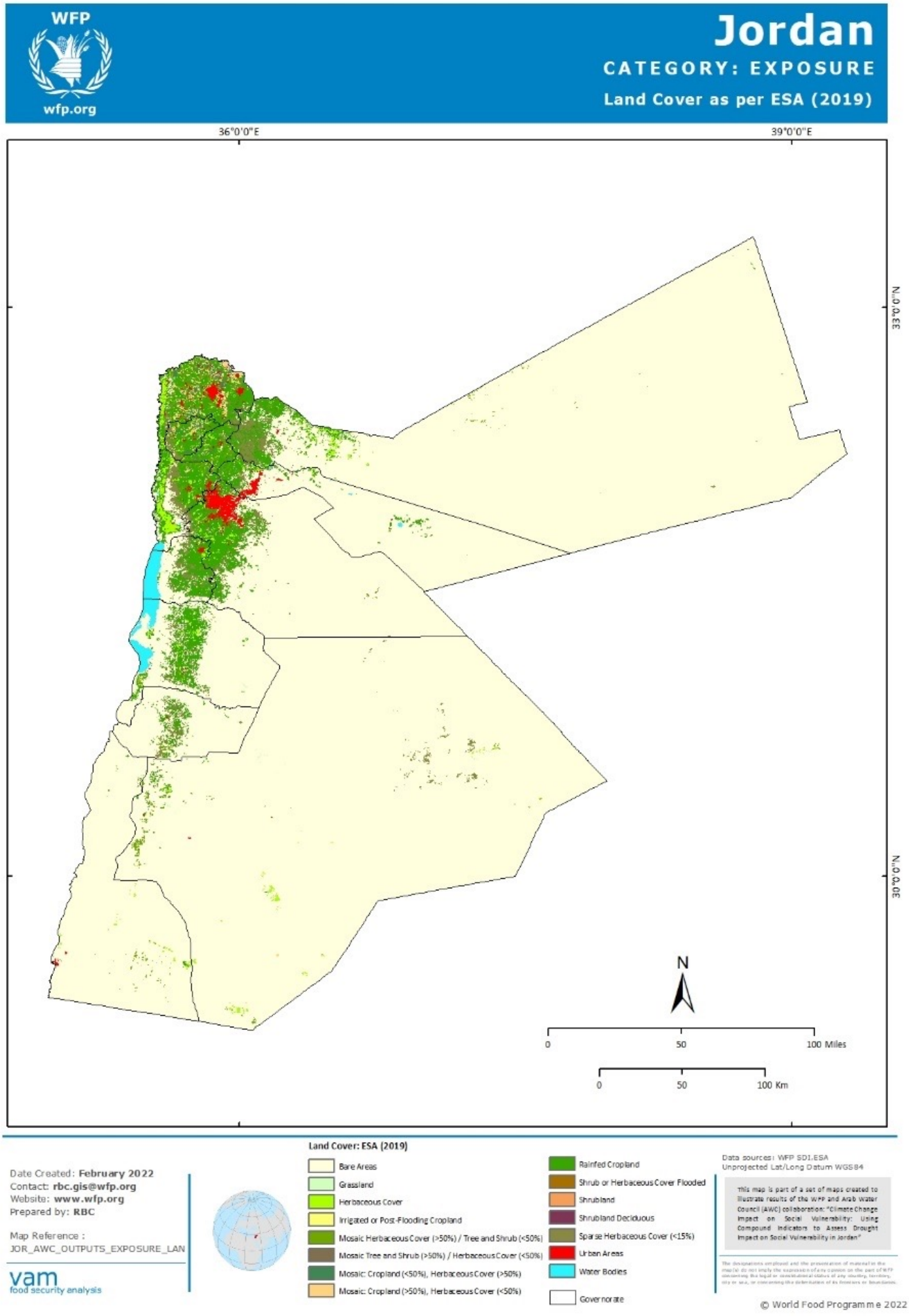


Figure 51: Land cover as per ESA (2019), reproduced by WFP (2022).

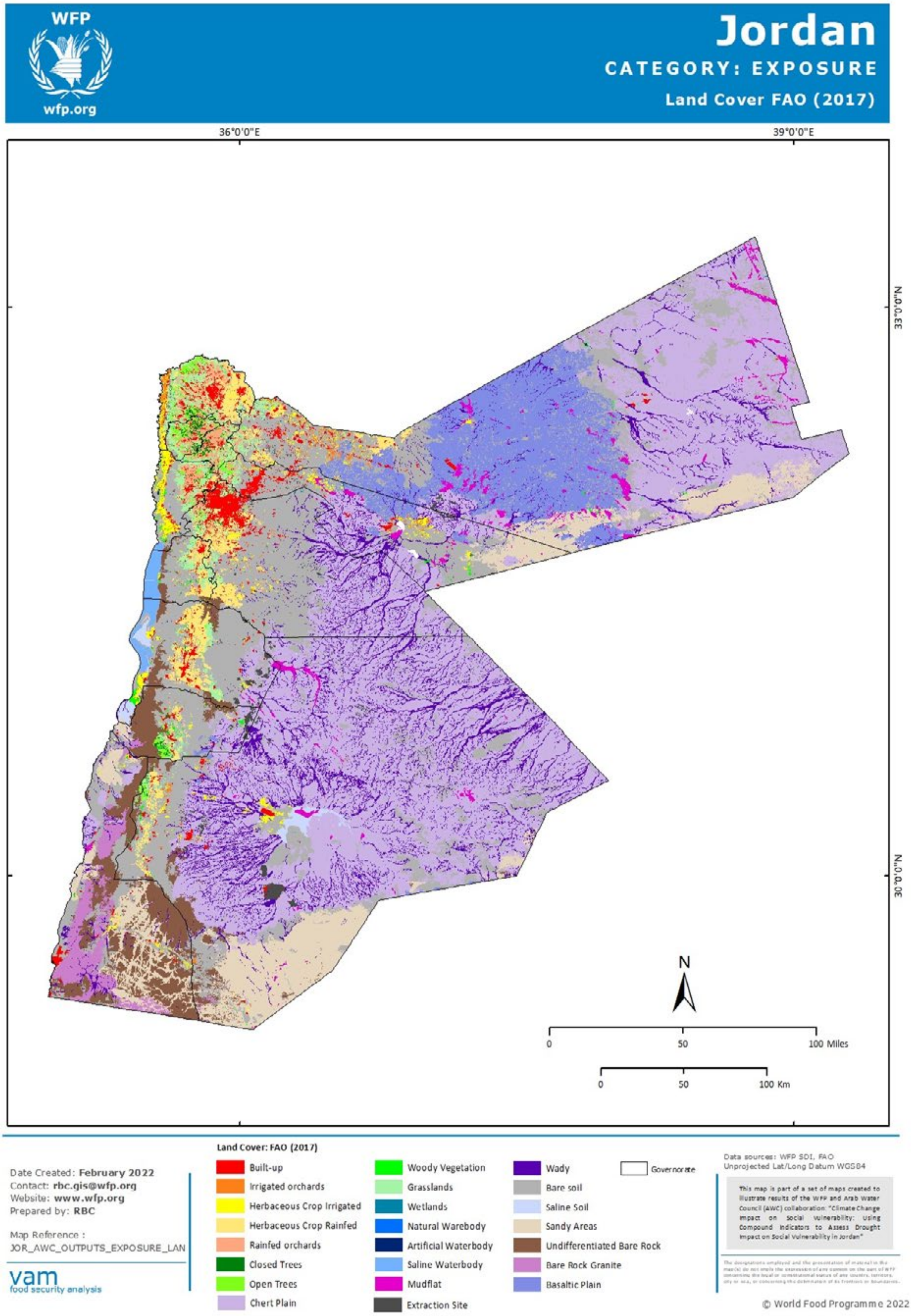


Figure 52: Land cover and land use map by FAO (2017), reproduced by WFP (2022).

The FAO Land cover dataset originates from Sentinel-2 data collected from April to November 2016. The initial resolution is 10 meters. Figure 52 shows the FAO dataset used in this study. Based on this FAO map, an exposure classification was performed by assessing the exposure of each land cover type to drought. In this classification, both the ecosystem characteristics, as well as the land use value, specifically for agricultural and pastoral livelihoods, were considered. The classification was performed and reviewed by AGIR (Bassem Katlan) with input from several Jordanian and international experts (Ehab Eid, Muhammad Al-Qinna, and Mike Bourke). Table 23 presents the final classification, which combines the various expert inputs:

Table 23: Drought exposure classification for land cover and land use

FAO 2017 LAND COVER	EXPOSURE	CLASSIFICATION BY EXPERTS
Bare soil	Low exposure	
Basaltic plain	Medium exposure	
Sandy areas	Medium exposure	
Closed trees	High exposure	
Extraction site	Low exposure	
Herbaceous crop irrigated	Medium exposure	
Irrigated orchards	Medium exposure	
Mudflat	Medium exposure	
Open trees	High exposure	
Saline soil	Medium exposure	
Wadi	High exposure	
Wetlands	High exposure	
Woody vegetation	High exposure	
Grasslands	High exposure	
Herbaceous crop rainfed	High exposure	
Rainfed orchards	High exposure	
Artificial waterbody	High exposure	
Bare Rock granite	Low exposure	
Built-up	Low exposure	
Chert plain	Low exposure	
Natural waterbody and fresh water	High exposure	
Saline waterbody	Medium exposure	
Undifferentiated bare rock	Low exposure	

Figure 53 shows the map that resulted from the above classification.

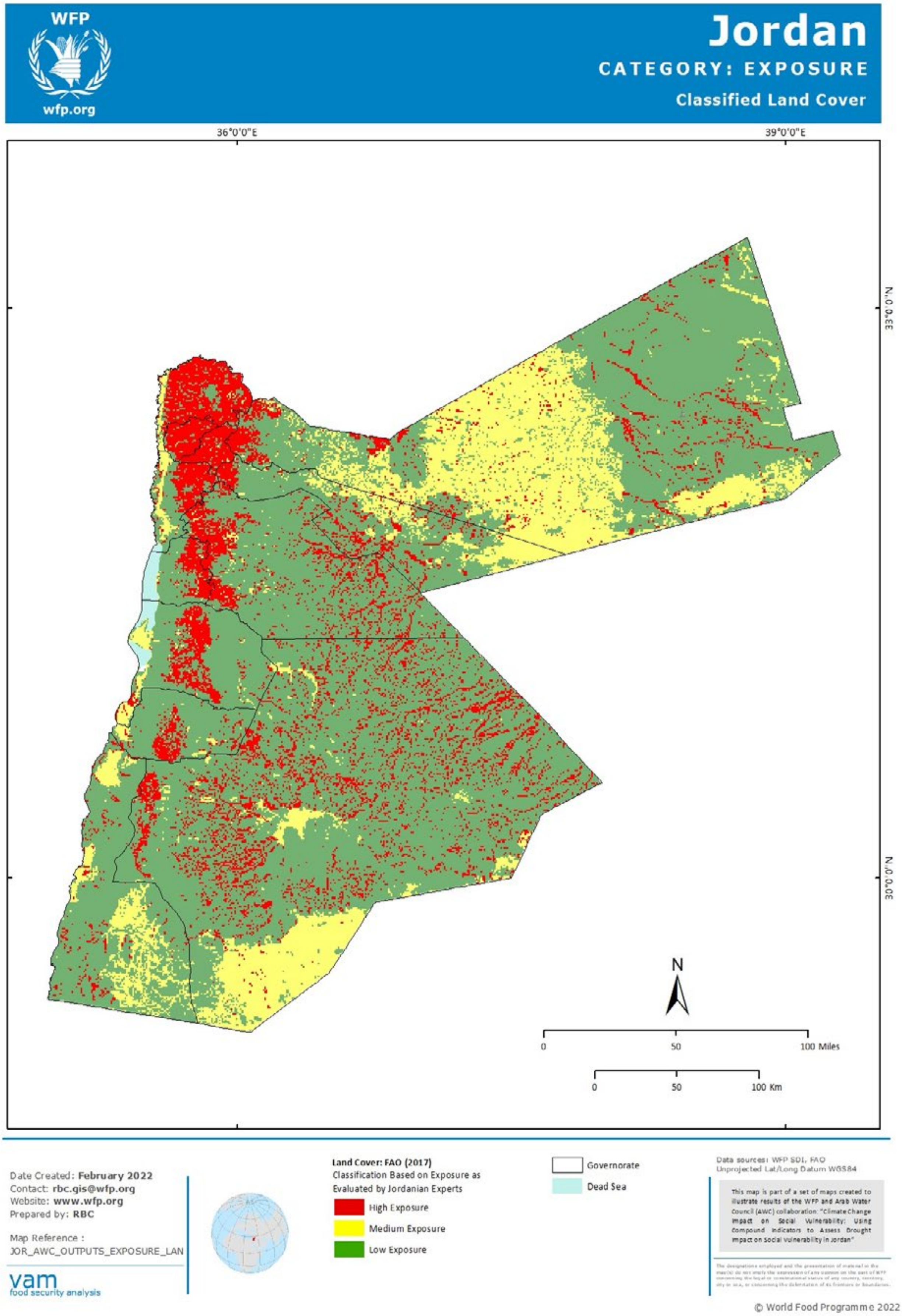


Figure 53: Exposure based on the indicator "land cover".

12.4.7 Composite Indicator: Water Access for Farming

The agricultural sector is particularly dependent on, and therefore vulnerable to, drought impacts. In the present study, water access for farming has been included as a variable of exposure. Firstly, farmers who have access to a source of fresh surface water are assumed to be less exposed to drought impact than farmers who only rely on rainfall for farming. Secondly, surface freshwater sources are directly and immediately impacted by drought. This includes natural water sources such as rivers, wadis, and springs, but also man-made features to capture surface water such as dams. Although groundwater aquifers are less immediately affected by drought, they are also partly replenished by precipitation. Groundwater in Jordan is increasingly subject to over-exploitation and excessive pumping. While the existence of groundwater may decrease the overall vulnerability of farmers to drought, and digging wells is often a drought response, there is an increasing deficit in Jordan's groundwater aquifers. For this reason, groundwater deficit was included in this composite indicator for exposure. Wastewater treatment plants offer an additional opportunity to re-use surface and groundwater used by municipalities. Such non-conventional water resources are becoming increasingly important as alternative irrigation options in the region.

To measure exposure based on access to fresh surface water, a composite indicator was developed based on the following datasets:

- Proximity to water courses such as rivers, canals, or wadis
- Proximity to natural and artificial lakes and waterbodies
- Proximity to other sources of water such as springs, dams or wastewater treatment plants
- Groundwater deficit

In order to calculate a buffer zone of impact around these water bodies in the context of farming, a logistic regression (LR) model was used to analyze the relation between irrigated cropland / rainfed agriculture and grassland to water resources in Jordan. The regression was performed on the national level. The LR is a methodology applied in geo-statistics to understand the probability and correlation of certain phenomena, based on a set of environmental variables. This method has been adopted in the past to analyze the forest fire probability (Modugno et al., 2016) or to study landslide hazards (Modugno et al., 2022).
In this exercise, the variable studied (the dependent variable) is related to a specific land cover class: in this case the irrigated cropland areas extracted from FAO land cover map (FAO, 2017, see above). The probability to have an irrigated cropland surface was analyzed considering a set of independent variables such as: distance from 'dams and lakes', distance from 'springs', distance from 'wells', distance from wastewater treatment plants ('WWTP'), distance from 'rivers and canals', and distance from 'desert dams' (data on these water resources is published by the Jordanian Ministry of Water and Irrigation). In the case of distance from 'wadis', the probability of a surface area of rainfed irrigation or grassland was calculated, as wadis are dry river beds in the desert that only hold water for part of the year after seasonal rainfalls. For this reason, they play a larger role in pastoral livelihoods and grazing than in irrigated agriculture. The altitude was considered as an additional variable using the NASA digital elevation model at 30m of spatial resolution (Farr et al., 2007) to introduce to the LR model the gravity force and morphology dimension.

The hypothesis was that the irrigated cropland / rainfed agriculture and grassland presence probability would be inverse to the distance from water resources and inverse to the altitude values. Lower water resources distance and lower altitude values should remark the highest probability to have irrigated cropland areas (or, in the case of wadis, rainfed irrigation / grassland). The LR confirms our hypothesis for all the variables considered. However, thanks to the Receiver Operating Characteristic Curve (ROC), the LR goodness indicator, it was possible to understand which independent variables are the most important, and to extract their spatial behavior across the space. Finally, the probability value, inverse to the distance from each independent variable, was implemented to define the vulnerability value (low, medium, high).

Following the ROC value for each independent variable – a value between 0 and 1, where 0.5 was considered as the threshold of goodness – an area of influence for each type of water body was calculated, as presented in Table 24.

Table 24: Independent variables, statistical correlation value (ROC), and areas of influence (Sources: FAO, 2017, MWI, 2020 and WFP, 2022).

INDEPENDENT VARIABLES	ROC	AREA OF INFLUENCE
Dams / Dam Lakes	0.75	55 km
WWTPs	0.82	15 km
Desert Dams	0.71	25 km
Springs	0.82	30 km
Wells	0.88	6 km
Wadis*	0.57	1.3 km
Altitude	0.64	660 m

*Wadi has been set in relation to 'rainfed cropland' and 'grassland' areas.

The calculation of the area of influence is also presented in Figure 54.

The areas of influence were classified as shown in Table 25. Closer proximity to the water source was assigned lower exposure to drought, while greater distances translated into higher levels of exposure.

Table 25: Exposure classification of areas of influence

	WATER SOURCES AND DISTANCES FROM WATER SOURCES IN KM / ALTITUDE IN M						
EXPOSURE	WELL	DAMS / DAM LAKES	WWTPS	SPRINGS	DESERT DAMS	WADIS	ALTITUDE
Low (1)	<3km	<29km	<15km	<15km	<12Km	<650m	330m
Medium (2)	>=3 and <=6km	>=29 and <= 55km	>=15 and <=30km	>=15 and 30km	>=12 and <=25 km	>= 650 and <=1300m	>=330m and <=660 m
High (3)	>6km	>58km	>30km	>30km	>25km	>1300m	>660m

Figure 55 displays all the map layers that went into the composite indicator, clarifying how they were combined to produce a composite output.

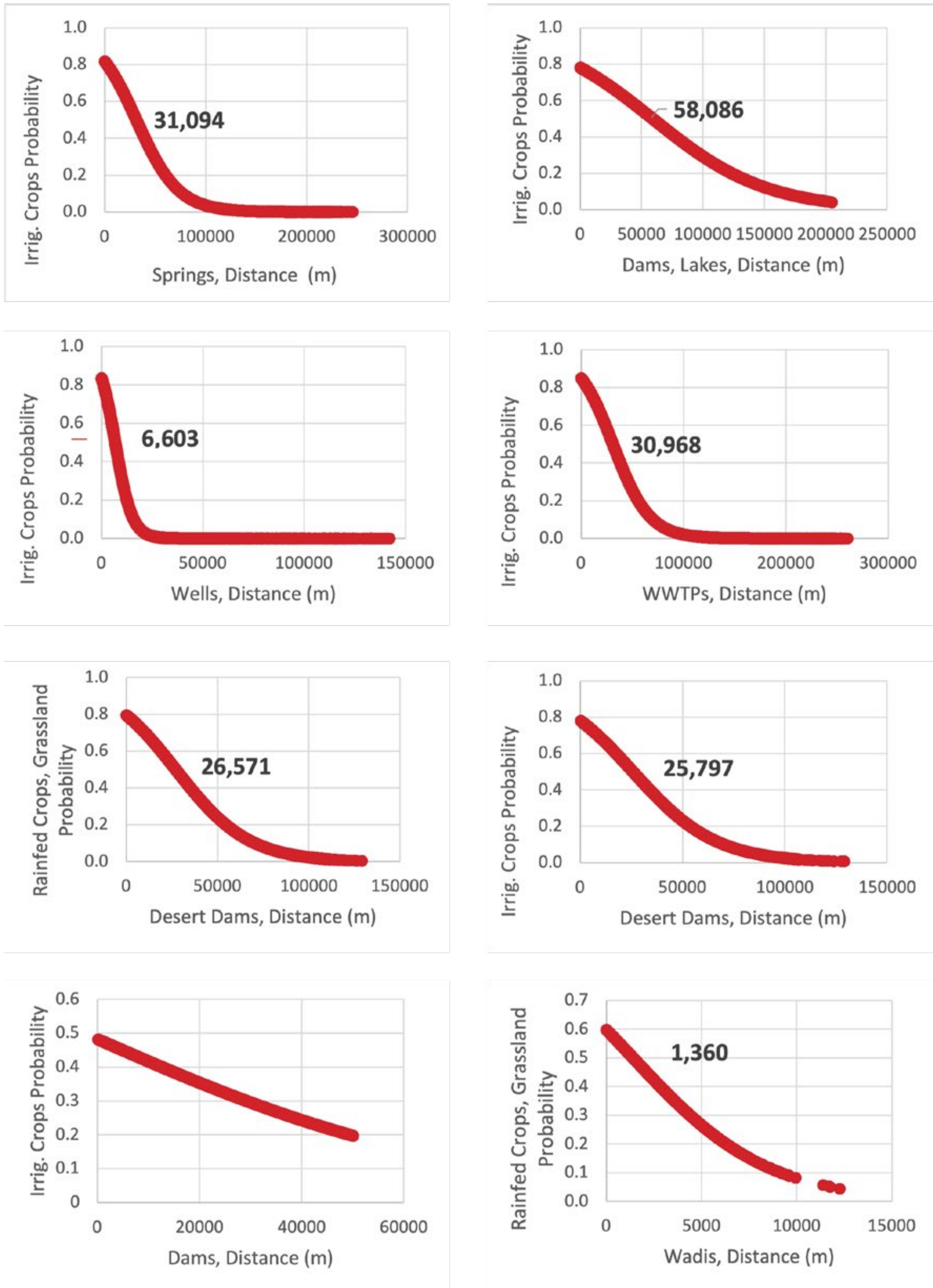


Figure 54: Calculation of distances using LR (Source: WFP, GIS Unit, HQ, Rome, 2022).

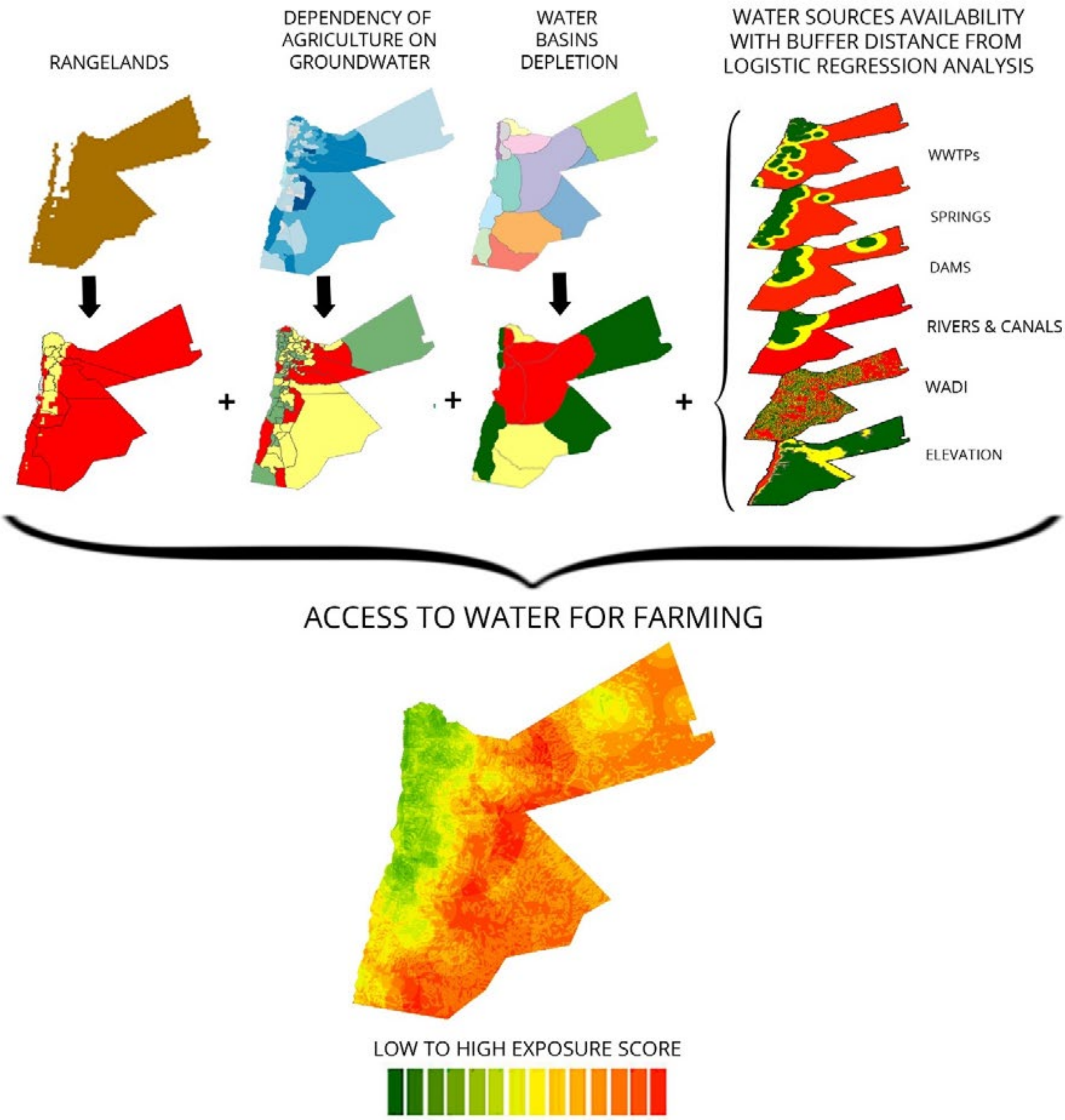


Figure 55: Different data layers contributing to the composite indicator water access for farming.

In Figure 56, a slightly different presentation of these results is shown, using administrative boundaries as a basis for presentation.

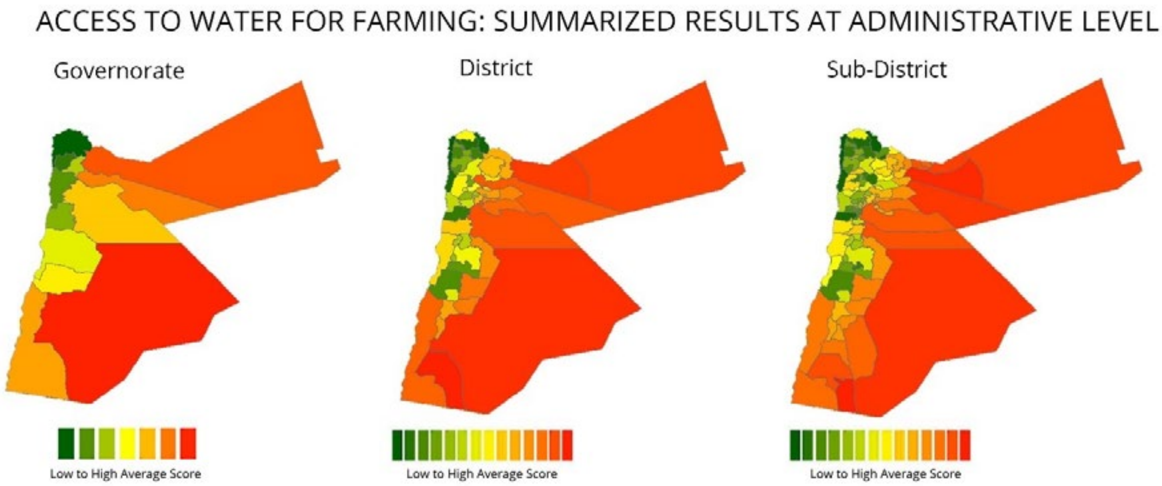


Figure 56: Results of water access for farming composite indicator at administrative levels.

Table 26 presents the classification criteria that were used to determine high, medium, and low exposure for the composite indicator. The mapped result is visible in Figure 57.

Table 26: Classification of access to water for farming

CLASSIFICATION	RANGES
High exposure	Numeric value resulting from combination of all indicators is <= 18
Medium exposure	Numeric value resulting from combination of all indicators is > 18 and < 25
Low exposure	Numeric value resulting from combination of all indicators is <= 25

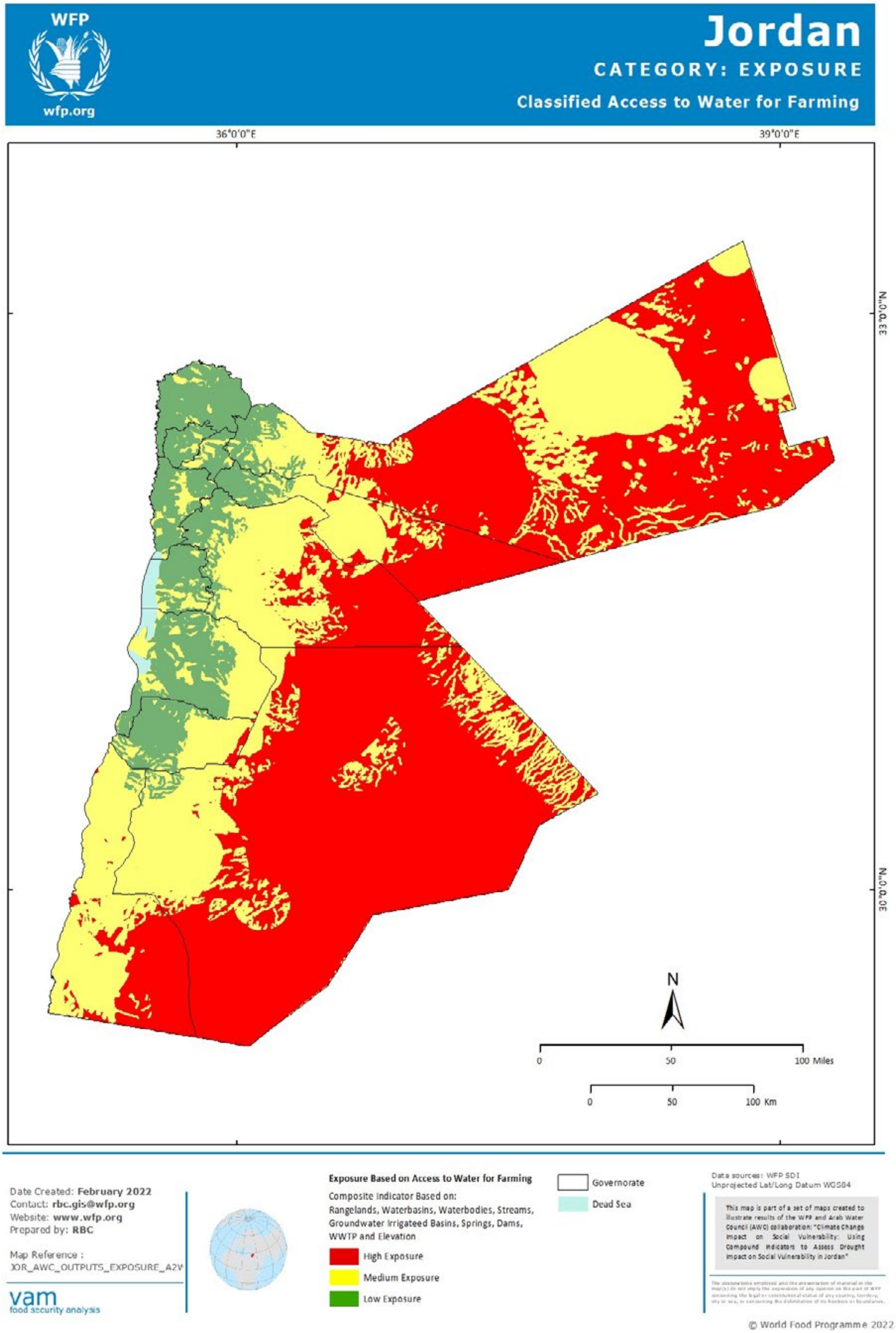


Figure 57: Exposure based on the indicator "access to water for farming".

12.4.8 Exposure Analysis: Overall Results

The overall exposure results based on all indicators presented above are shown in Figure 58 (unweighted) and Figure 59 (weighted). Only the weighted map was used in the final analysis of this study. Figure 60 directly compares the weighed and unweighted results. What becomes clear is that the drought exposure overall is lower than the hazard, particularly in the unweighted map. The colors come out much stronger in the weighted map, both the higher and lower exposure levels, meaning that the weights assigned by Jordanian experts make the high and low exposure much more pronounced. Areas of Mafraq Governorate, the Governorate of Irbid in the far north of Jordan, as well as Amman, parts of Balqa, and the mountainous areas of Karak and Tafiela receive the highest drought exposure scores based on this assessment.

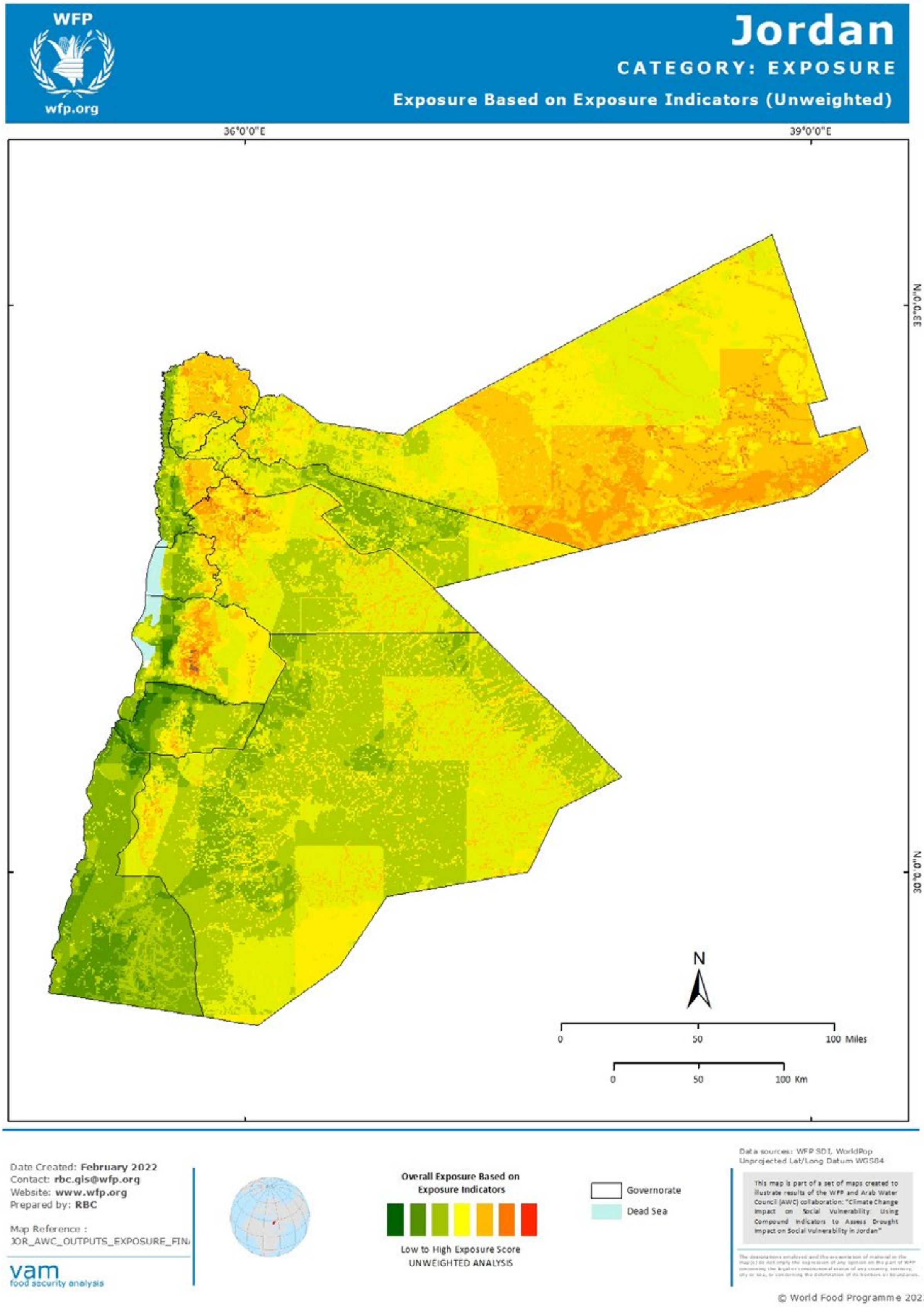


Figure 58: Overall exposure based on all exposure indicators, unweighted (WFP SDI and various sources, see above).

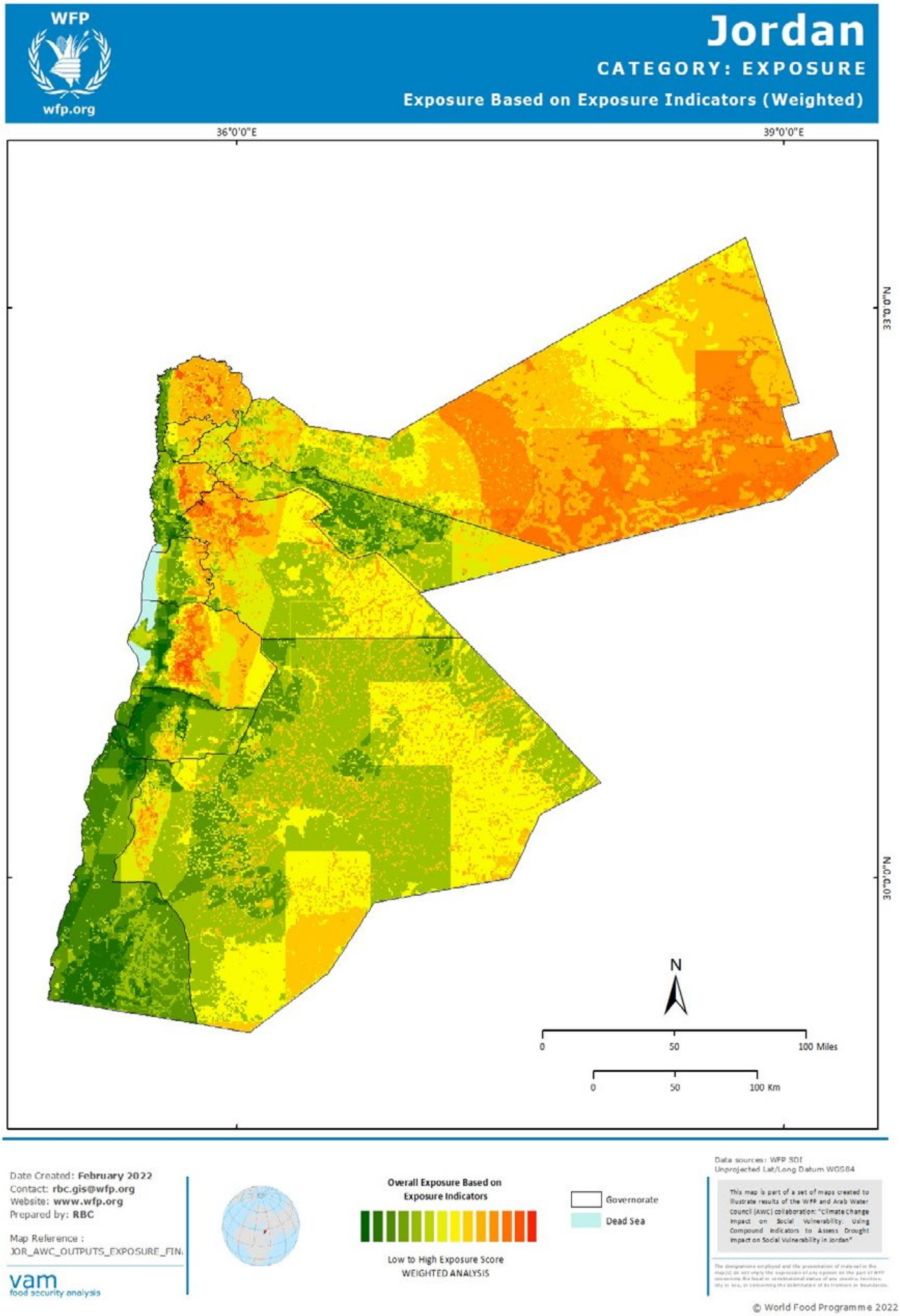


Figure 59: Overall exposure based on all exposure indicators, weighted (WFP SDI and various sources, see above).

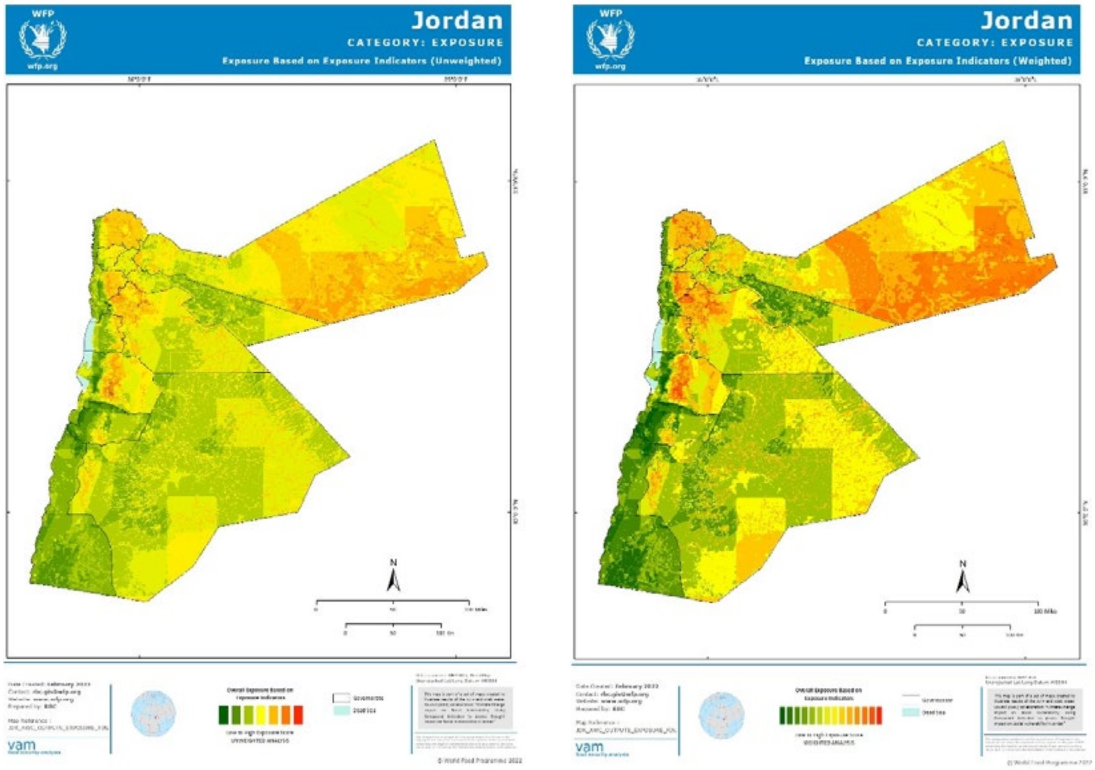


Figure 60: Comparison of unweighted (left) and weighted (right) exposure results. various sources, see above).

12.5 Sensitivity Maps

12.5.1 Land Degradation

Land degradation is considered an aggravating factor to shocks and risks. The land degradation indicator was generated based on an Ecological Value (EV) calculated by using MODIS Land Cover data from 2001 to 2019. The ecological value was then used to create a map of change over time. According to the WFP Integrated Context Analysis (ICA) methodology, the ecological value can be defined as vegetation presence for each land cover class and related ecosystem services (Costanza et al., 1997). Additional Information on the WFP ICA Programme can be found through the link https://geonode.wfp.org/imaps/ica/

The re-classification and allocation of ecological value is performed using the criteria shown in Table 27:

Table 27: Classification based on ecological value

CLASS	LAND COVER CLASS	NEW CLASS	NEW NAME	ECOLOGICAL VALUE
2	Evergreen broadleaf forest	1	Forest	6
1	Evergreen needleleaf forest	1	Forest	6
4	Deciduous broadleaf forest	1	Forest	6
3	Deciduous needleleaf forest	1	Forest	6
5	Mixed forest	1	Forest	6
11	Permanent wetlands	2	Wetland	6
6	Closed shrublands	3	Shrubland	5
7	Open shrublands	3	Shrubland	5
8	Woody savannas	3	Shrubland	5
10	Grasslands	4	Grassland	4
9	Savannas	4	Grassland	4
14	Cropland/Natural vegetation mosaic	5	Cropland	3
12	Croplands	5	Cropland	3
16	Barren or sparsely vegetated	6	Barren or sparsely vegetated	2
13	Urban and built-up	7	Urban and built-up	1
255	Fill value	No Data	Fill value	0
15	Snow and ice	9	Snow and ice	0
254	Unclassified	No Data	Unclassified	0
0	Water	11	Water	0

With the goal to reduce the MODIS classification error effect, and in order to create a more robust temporal comparison over time, data from different years was classified and aggregated in two series: "Time 1" (2001 – 2008) and "Time 2" (2012 – 2019). Based on this time series, the EV ranges from -48 (when highest negative ecological value is -6, multiplied by the number of years (8) in the time series) to 48 (when highest positive ecological value is 6 multiplied by the number of years (8) in the time series). In this study the minimum and maximum resulting EV are respectively: -29 and 25.

The change in ecological value over time is used here as a proxy to grade the land degradation: the final land degradation index is calculated by subtracting the cumulative value of the "Time 2" (current land cover status) group from the cumulative value of the "Time 1" group.
In order to define the sensitivity classes associated with the land degradation, the following methodology has been applied: positive and null ecological values were set to "Low Sensitivity," while negative ecological values were divided into three classes using the natural breaks division (Table 28).

Table 28: Classification of ecological value

CLASSIFICATION	RANGES
Low sensitivity	Positive and null ecological values or ecological values are >= -1 and < -5
Medium sensitivity	Ecological values are >= -5 and < -13
High sensitivity	Ecological values are >= -13 and <= -29

Figure 61 shows areas with negative land cover changes, while Figure 62 presents the classified sensitivity based on land degradation.

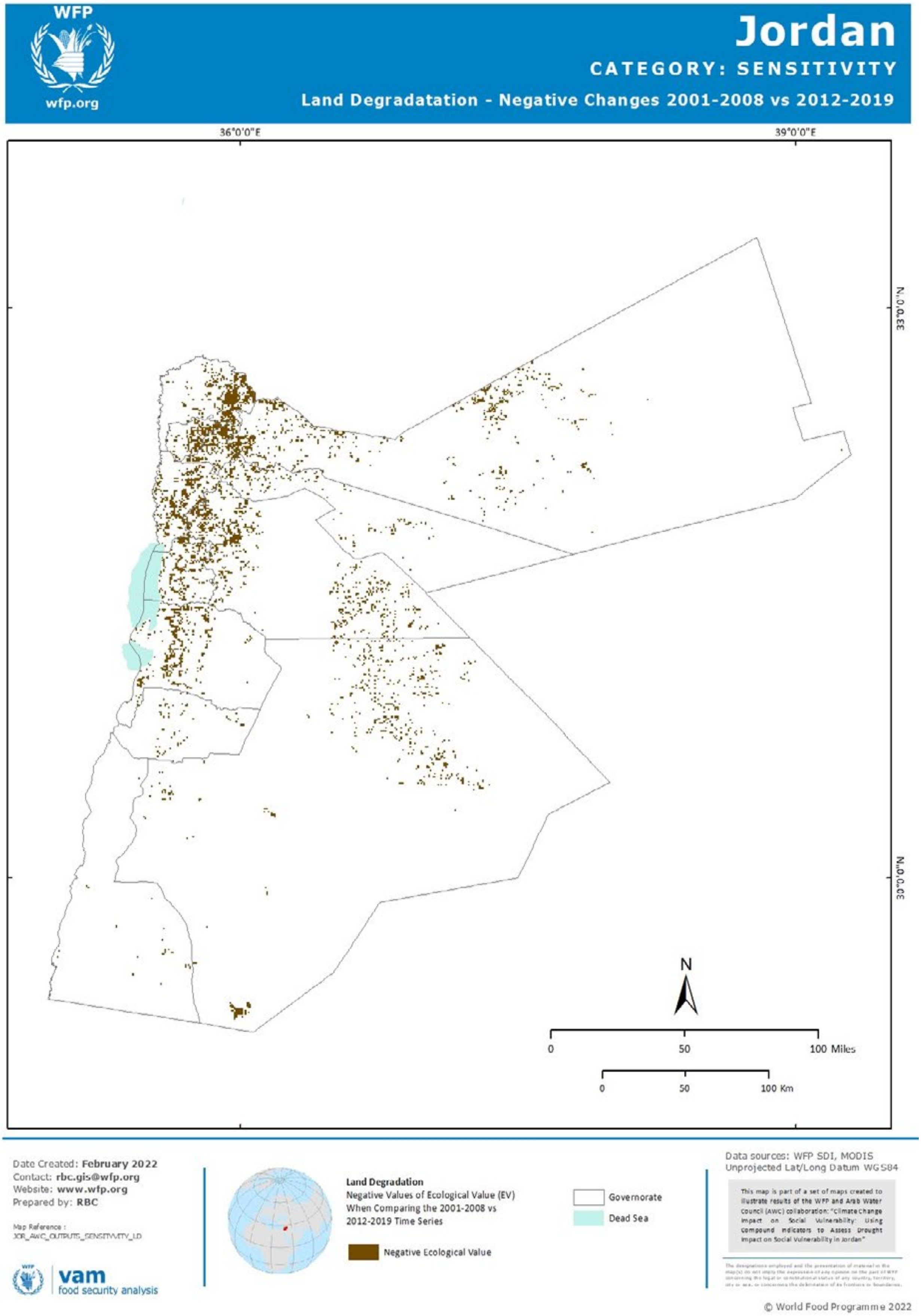


Figure 61: Areas with negative land cover changes.

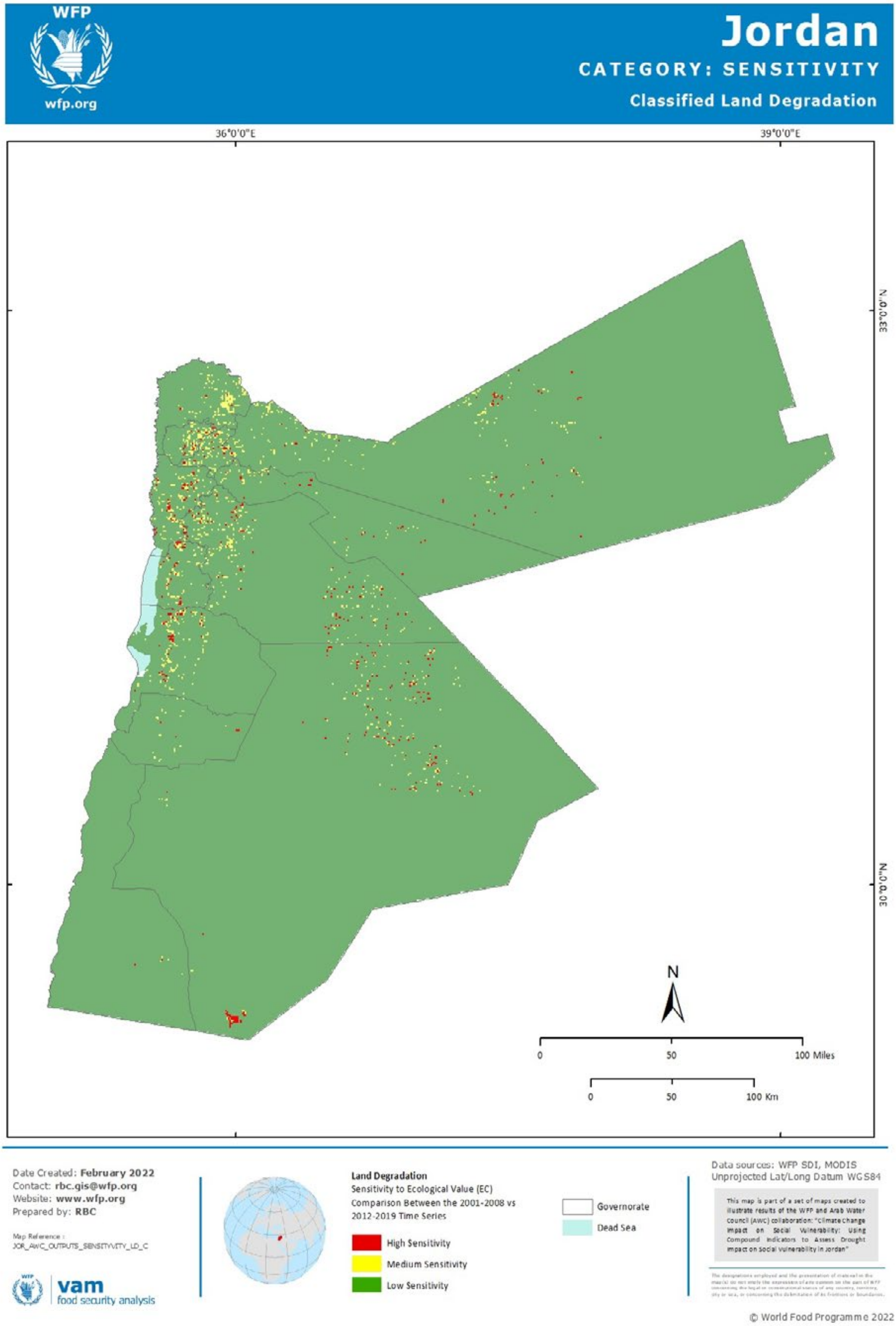


Figure 62: Sensitivity based on the indicator "land degradation".

12.5.2 Unemployment

Unemployment is an important social variable in an analysis of sensitivity to drought. People without employment have a more precarious livelihood to begin with, have no stable income, and struggle to absorb shocks caused by drought – for example an increase in prices. The dataset chosen to represent unemployment was provided by the Jordanian Department of Statistics (DOS). It is derived from a survey conducted in 2021 and summarized at first administrative level. Based on this data, the total unemployment rates for Jordanian Governorates lie between 20.3% and 29%, while female unemployment rates range from 22.1% to 43.4%. The highest prevalence of unemployment and female unemployment is found in Tafiela, with 29% for the total population and 43.4% for females. Such figures can be considered high in a middle-income country such as Jordan. For the overall sensitivity analysis, only the total unemployment was used, as in the Arab region many females work in the household economy, on family farms, or in the informal sector. For this reason, formal female employment is not a very representative indicator, particularly in the agricultural context. However, female unemployment was also mapped as an additional stand-alone product and to emphasize the gendered nature of unemployment in Jordan.

For the purpose of this analysis, we have utilized the following criteria to create sensitivity classes (Table 29):

Table 29: Sensitivity classes for unemployment

CLASSIFICATION	RANGES
Low sensitivity	Prevalence of unemployment is < 21 %
Medium sensitivity	Prevalence of unemployment is >= 21% and <=24%
High sensitivity	Prevalence of unemployment is > 24 %

The female unemployment data was classified as shown in Table 30. Again, this classification was not used in the final analysis, but is included in order to enable a better understanding of Figure 64.

Table 30: Classification of female unemployment (not included in final analysis)

CLASSIFICATION	RANGES
Low sensitivity	Prevalence of unemployment is < 25 %
Medium sensitivity	Prevalence of unemployment is >= 25% and <=35%
High sensitivity	Prevalence of unemployment is > 35 %

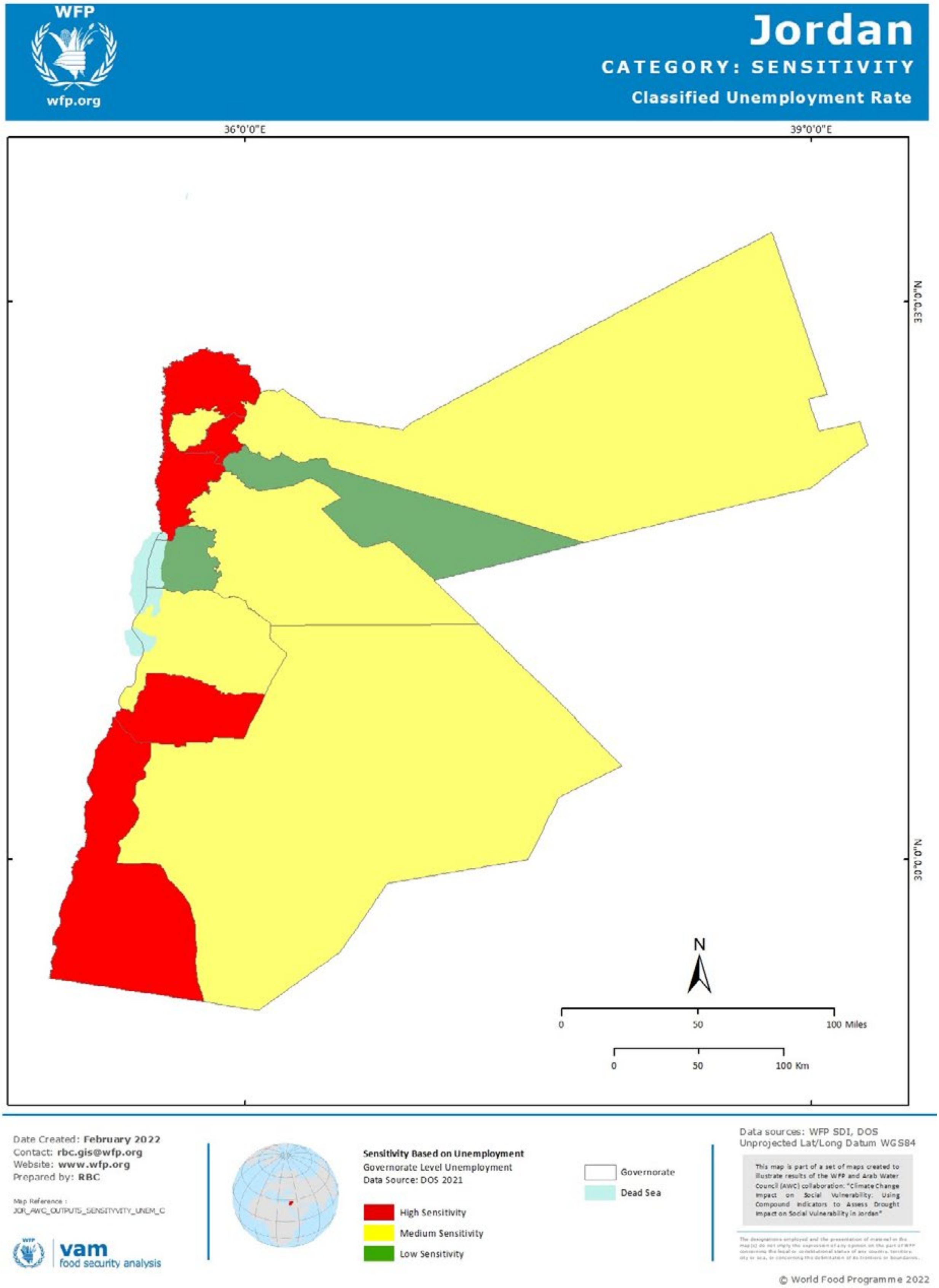


Figure 63: Sensitivity based on the indicator "unemployment" (used for overall analysis).

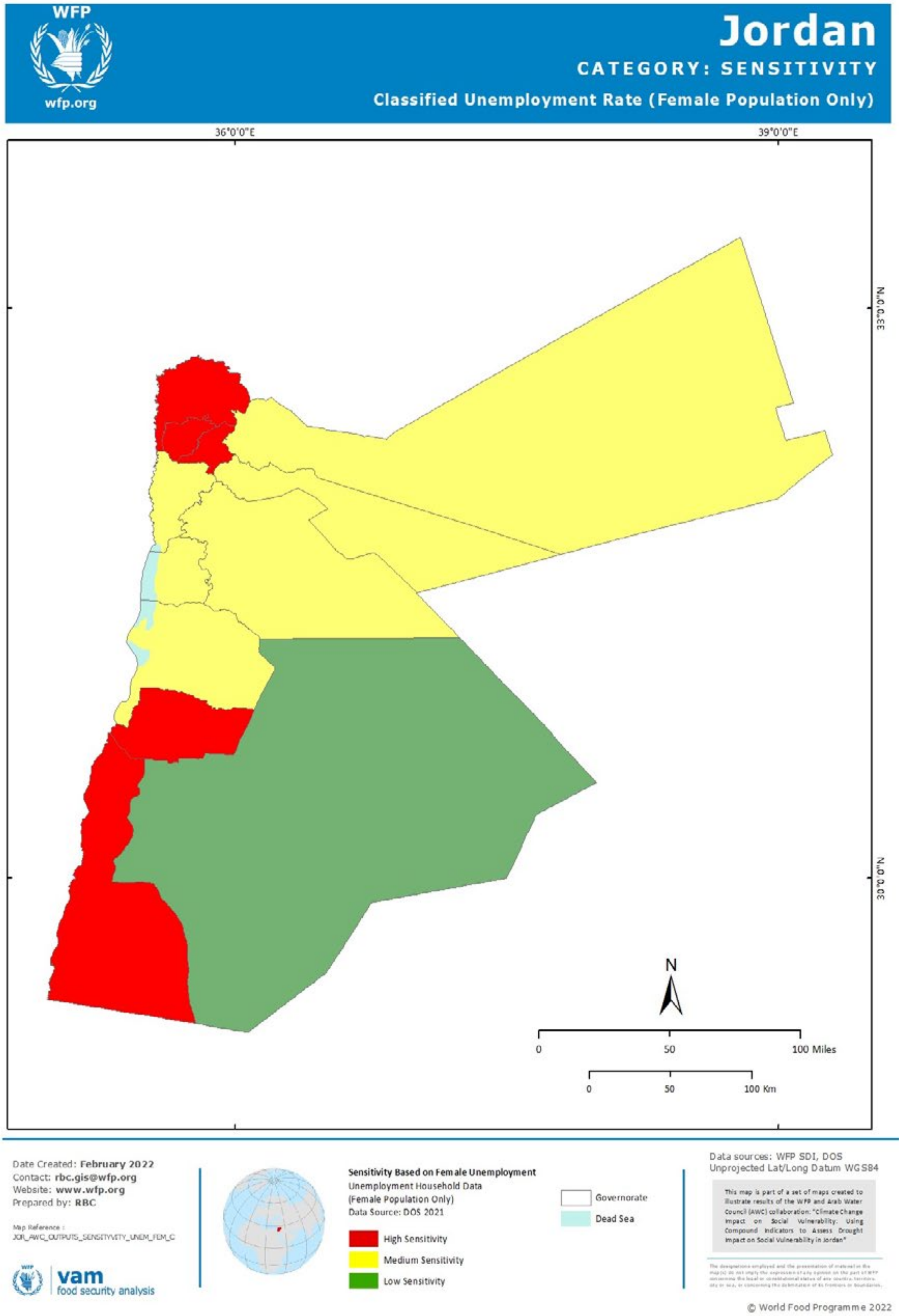


Figure 64: Sensitivity based on the indicator "female unemployment" (not used for overall analysis).

12.5.3 Household Income

Annual household income data from 2017, presented at Governorate level, was provided by DOS. The data as received from DOS contained household income data organized in 12 groups: from less than 2,500 Jordanian Dinar (JOD) (one JOD was worth 1.41 USD at the time of the research in November 2021) per year to more than 25,000 JOD per year. For our analysis, based on the suggestions from Jordanian experts, the first three income classes were grouped as: i) less than 2,500 JOD/yr, (ii) more than 2,500 JOD/yr and less than 5,000 JOD/yr, and (iii) more than 5,000 JOD/yr and less than 7,500 JOD /yr together as the low-income bracket. These three groups combined are defined as "Low Income" in the sensitivity analysis. Resulting values of Low Income have been subsequently classified using the criteria outlined in Table 31:

Table 31: Classification of low income

CLASSIFICATION	RANGES
Low sensitivity	Prevalence of households with low income is < 38%
Medium sensitivity	Prevalence of households with low income is >= 38% and <=43%
High sensitivity	Prevalence of households with low income is > 43%

The classified sensitivity map for low income is presented in Figure 65. As can be seen in this map, the Governorates with the lowest household income are Mafraq, Zarqa, Jerash, and Maan. The highest household incomes can be found in Amman, Karak, and Balqa.

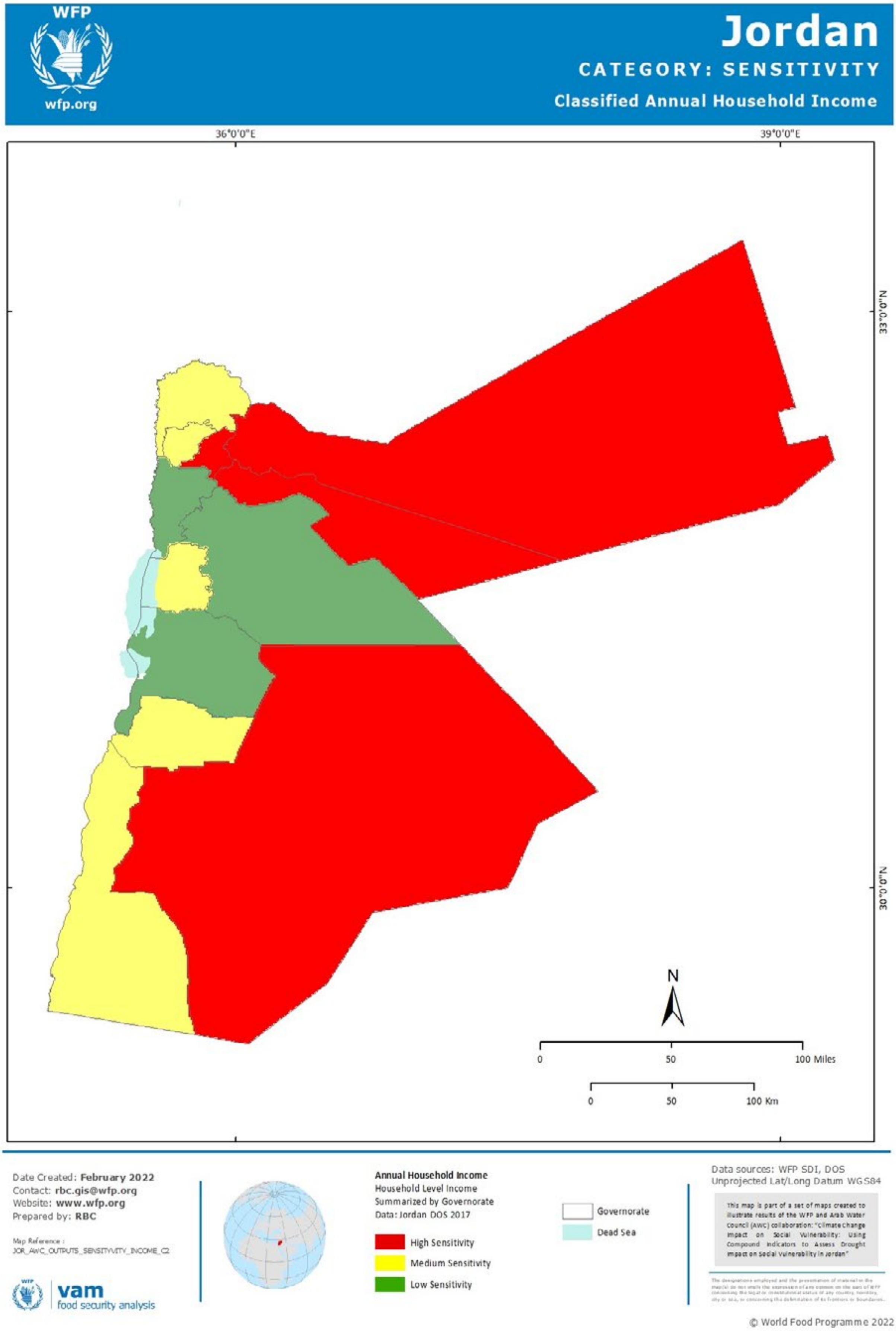


Figure 65: Sensitivity based on the indicator "annual household income".

12.5.4 Household Expenditure: Composite Indicator

Household expenditures can be a proxy for poverty and social vulnerability when calculating how much money households are spending on basic living expenses (as a proportion of all expenses), as well as on food items as compared to non-food items. Households spending most of their income on basic living and food each month have less money left over for saving, to invest in household assets, and to spend on adaptation measures in response to climate change. As a consequence, they may be less eligible for financial loans.

Data at Governorate level was provided by the Department of Statistics (DOS) and extracted from the Household Expenditures & Income Survey 2017. DOS records household expenditure data in two main categories: food related and non-food related expenses. For the present analysis, 5 different classes were established: i) expenses related to food items, ii) education expenses, iii) health-related expenses, iv) transportation expenses, and v) energy-related expenses.

To classify sensitivity based on household expenditure, a composite indicator was created. For this composite indicator, the following two indicators were used: A) the component of "Essential Living Expenses" when compared to the overall household expenses and B) the component "Food Expenses" expenditure ratio between food items[1] and non-food[2] items. Sensitivity was calculated as a composite indicator based on the percentage of household expenditure on basic living as well as food as compared to all household expenditures.

The "Essential Living Expenses" were calculated by putting together the full list of food items (with the exclusion of "Tobacco and Cigarettes" and "Restaurants and Cafes") with expenses for education, health, transportation, and housing (water, electricity and gas). The sum of these expenses was then compared to the overall household expenditure, thus calculating how much of their total expenditure households need to dedicate to covering their basic living expenses. Essential living expenses as a percentage of all expenses are highest in the Governorate Madaba (85.9%), while the lowest rate is found in Irbid (76.8%). It should be noted, however, that all numbers are above 75%, meaning that Jordanians spend at least three quarters of their income on covering essential living expenses.

In addition to this, a "Food vs Non-Food Items" score was calculated, measuring the amount of money households spend on food items as compared to non-food related expenses. This dataset shows considerably more data variation than the combined essential living expenses. The production of the composite and the calculation of sensitivity scores are represented in the Table 32:

1 The food items categories as provided by the data source are: Cereals, Cereal Products and Bread, Meats and Poultry, Fish and Sea Foods, Dairy, Cheese and Eggs, Oils and Fats, Fruits and Nuts, Vegetables and Legumes, Sugar and its Products, Spices and Food Additives, Tea, Coffee and Cacao, Water and Soft drinks, Alcohols, Tobacco and Cigarettes, Restaurants and Cafes.

2 The non-food items categories as provided by the data source are: Clothing and Footwear, Housing, Water, Electricity and Gas, Furniture, Carpets and Placemats, Household Appliances, Housewares, Cleaning Materials, Domestic Services, Health, Transport, Communication, Recreation and Culture, Education, Miscellaneous Goods and Services. Tobacco and restaurant visits were removed from the category food.

Table 32: Calculation of the composite indicator "Essential Living Expenses" and "Food Expenses"

GOVERNORATE	PREVALENCE OF ESSENTIAL LIVING EXPENSES OUT OF ALL EXPENSES	SENSITIVITY SCORE 1	PERCENTAGE OF EXPENSES ON FOOD VS. NON-FOOD ITEMS	SENSITIVITY SCORE 2	COMPOSITE SENSITIVITY SCORE[3]
Amman	81.6	Medium	31.6	Low	Medium
Balqa	77	Low	36.9	Low	Low
Irbid	76.8	Low	46.8	Medium	Medium
Jarash	83.5	High	56.8	High	High
Madaba	85.9	High	47.7	Medium	High
Mafraq	78.7	Medium	47	Medium	Medium
Zarqa	78.3	Medium	46.9	Medium	Medium
Ajlun	80.4	Medium	47.6	Medium	Medium
Aqaba	85	High	38.5	Low	Medium
Karak	80.1	Medium	57	High	High
Maan	78	Medium	47.3	Medium	Medium
Tafiela	82.4	High	70.6	High	High

The final sensitivity map based on this composite indicator is presented below in Figure 66. As can be seen, there is only a single Governorate, Balqa, that receives an overall low sensitivity score based on this indicator. Jerash, Madaba, Karak, and Tafiela are particularly sensitive according to the composite indicator on household expenditure.

3 In the case of two different values, the higher value was adopted in the production of all composite indicators in this study. For example, in the case of one low and one medium, medium was assigned.

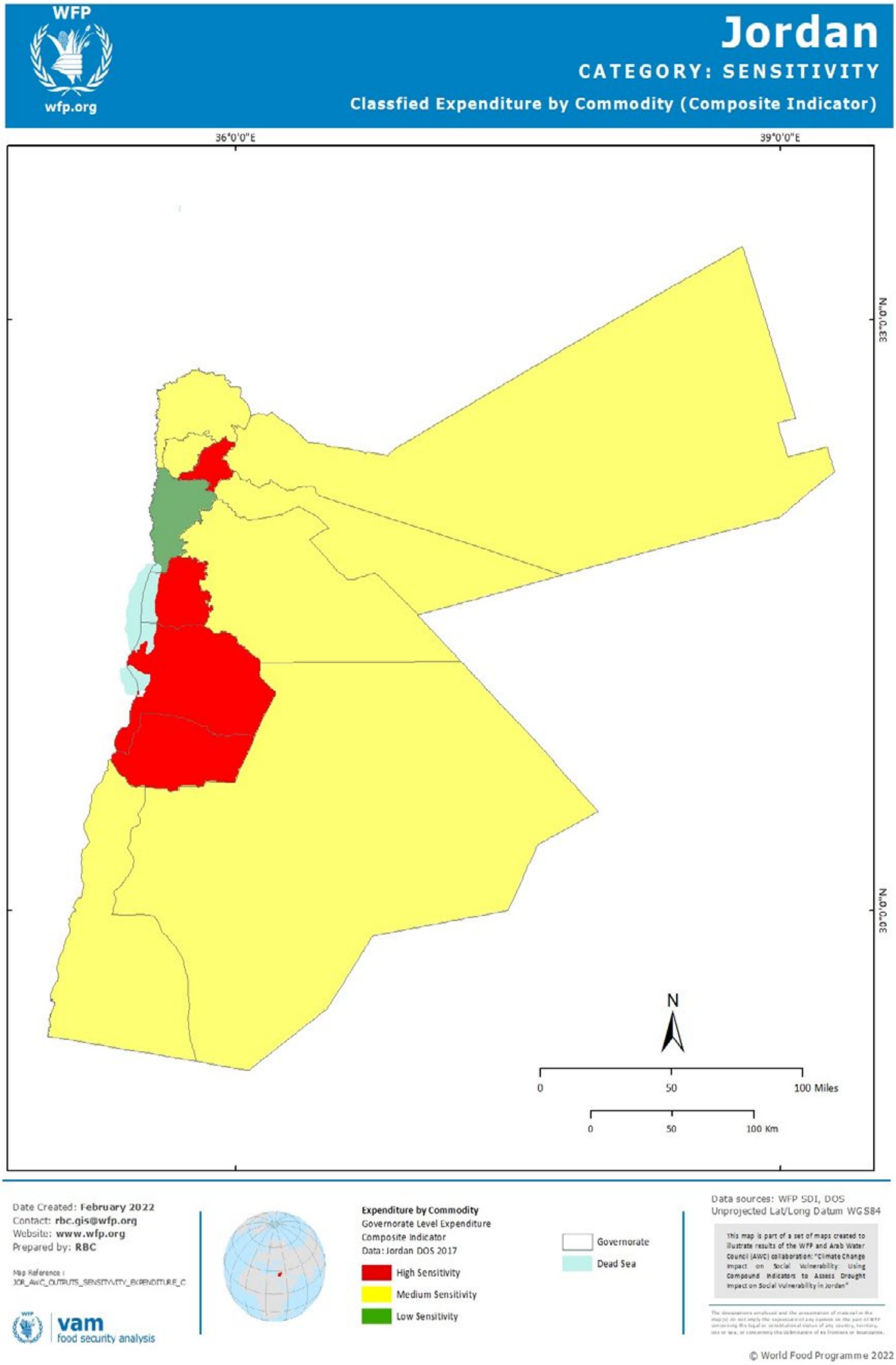


Figure 66: Sensitivity based on the composite food security indicator built from "essential living expenses" and "food expenses".

12.5.5 Female-Headed Households

Female-headed households can be more socially vulnerable than male-headed households, particularly in the Arab region, as women are facing an intersectionality of risk as well as the double burden of generating income for the household and running the household itself. Households headed by females struggle more often with employment and income generation, and also have fewer economic assets than households headed by men. For example, only 44% of households headed by women own agricultural land and 30% own livestock (World Bank, 2020). In turn, 68% of households headed by men own land and 36% of them own livestock. Similarly, only 21% of women who are heads of households receive loans for agricultural development and 9% for income-generating activities, compared to 43 and 14% of men who are heads of households (Arab Water Council, 2017). The statistics for the Arab region are particularly dire in regards to gender inequality, as outlined above.

The incidence of female-headed households can thus be one proxy for social vulnerability and is included in the sensitivity segment of this study. To calculate the percentage of female-headed households, DOS data generated at the Governorate level for the year 2019 was used. While the variation in the number of female-headed households across Jordanian Governorates is only 7.6% (10.2-17.8%), Aqaba is the Governorate with the lowest number of female-headed households (10.2%), while the highest incidence of female-headed households can be found in Tafiela (at 17.8%).

The classification is based on the criteria outlined in Table 33.

Table 33: Classification of female-headed households

CLASSIFICATION	RANGES
Low sensitivity	Prevalence of female-headed households is > 13%
Medium sensitivity	Prevalence of female-headed households is >= 13% and <= 15%
High sensitivity	Prevalence of female-headed households is > 15%

The map based on this classification is presented in Figure 67.

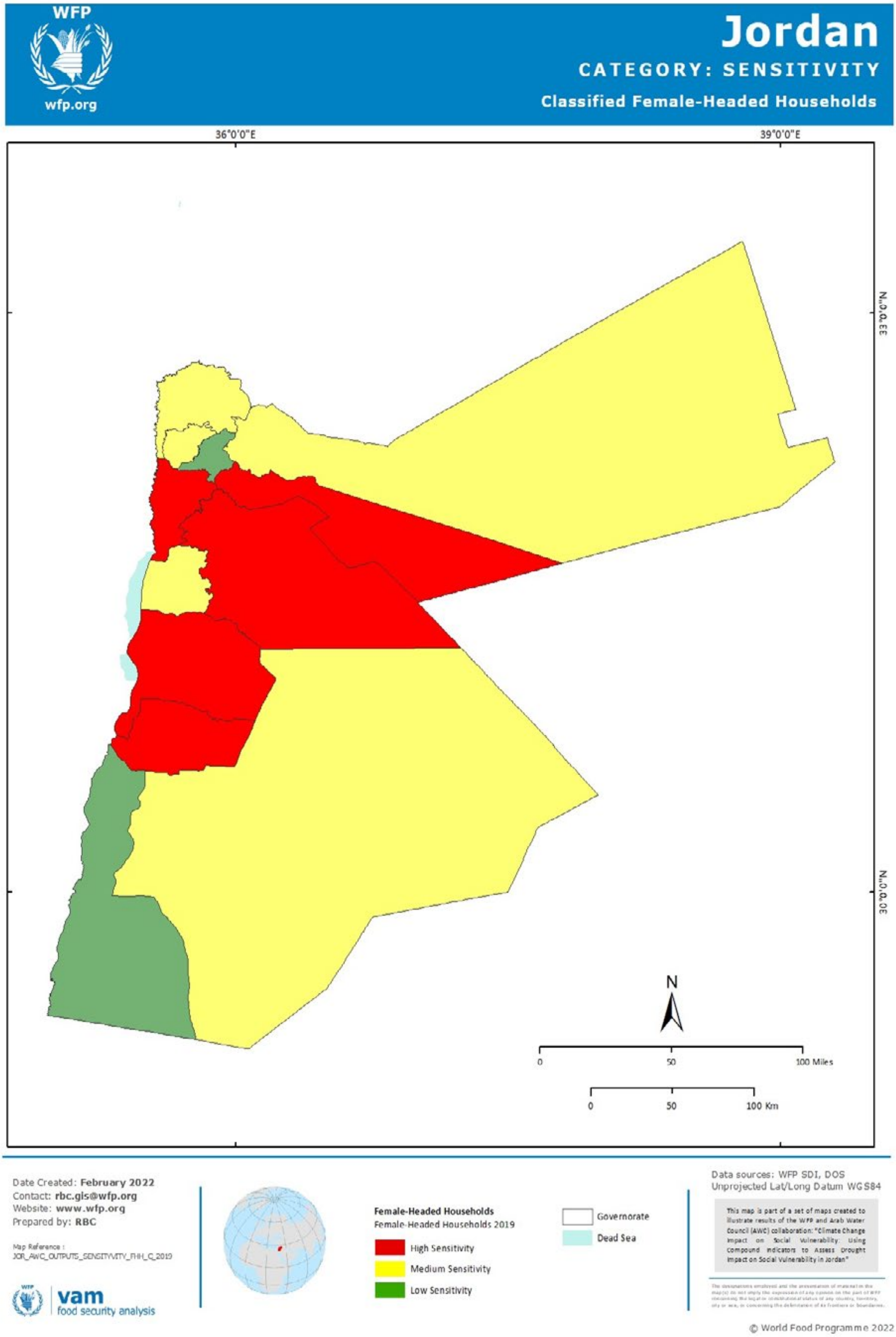


Figure 67: Sensitivity based on the indicator “female-headed households”.

While the most recent data from 2019 used for the analysis (Figure 67), more refined but slightly older DOS data at the third administrative level from the General Census in 2015 was used to show the difference in the number of female-headed households between Jordanians and non-Jordanians living in Jordan (Figure 68). The figures were compared to DOS data from 2004 to calculate the change in the incidence of female-headed households over time. Again, this data was not included in the final analysis because more recent data was available. However, the data is shown here for clarification purposes and to present this important, gender-based indicator at a more refined spatial scale. As seen in Figure 68, sensitivity based on the number of female-headed households is generally higher among non-Jordanians than Jordanians. Moreover, the sensitivity based on the number of female-headed households has increased between 2004 and 2015 for both Jordanian and non-Jordanian households in large parts of Jordan (the classification can be found in Annex 1).

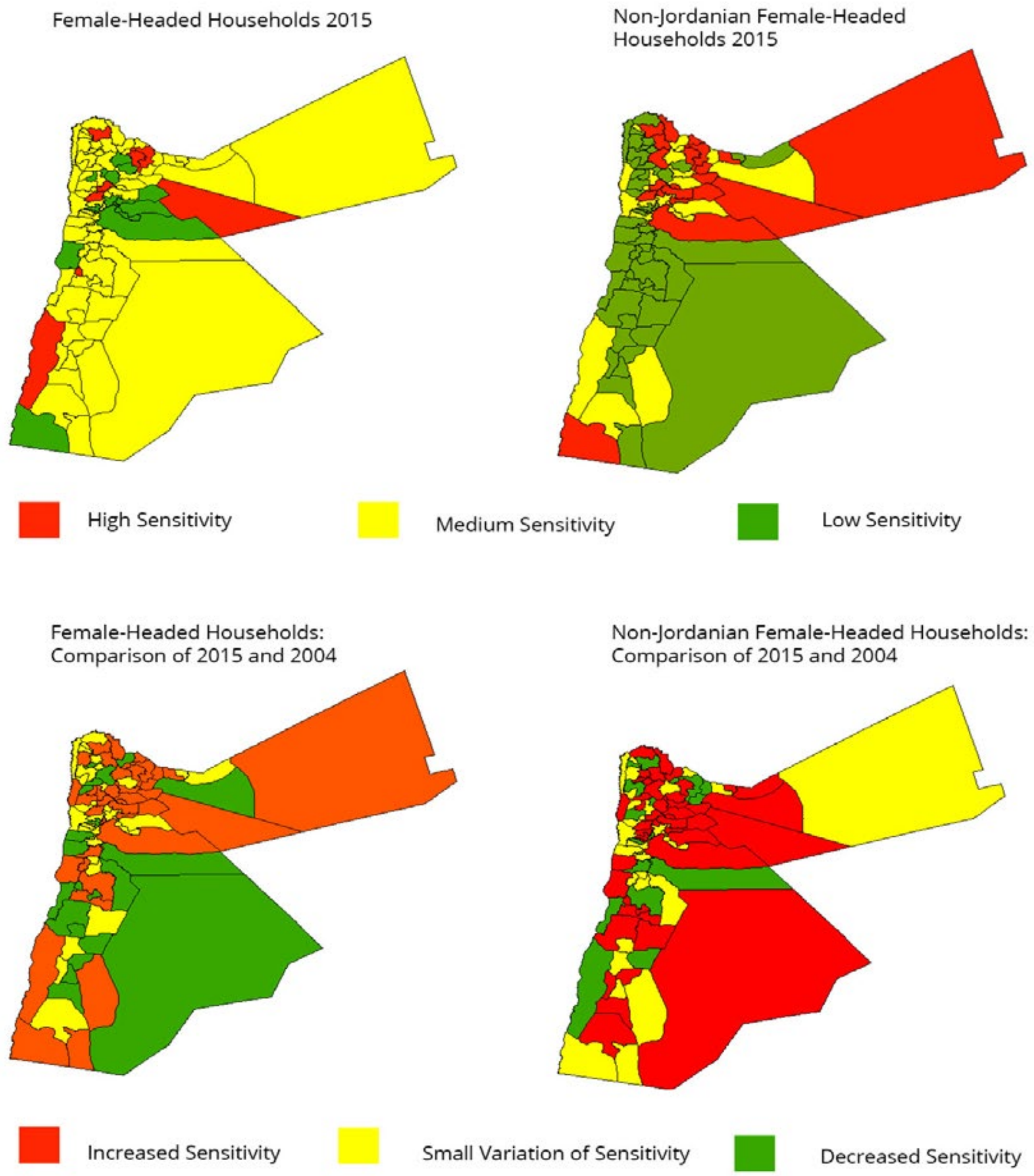


Figure 68: a) Sensitivity based on female-headed Jordanian households in 2015; b) Sensitivity based on female-headed non-Jordanian households in 2015; c) Comparison of sensitivity based on female-headed households between 2015 and 2004; d) Comparison of sensitivity among non-Jordanian female-headed households between 2015 and 2004 (Sources: DOS, 2004 and 2015, WFP SDI, 2022).

12.5.6 Household Members with Health Difficulties

Health issues among household members can increase the sensitivity of a household to the adverse impacts of climate change. People with pre-existing health conditions are more vulnerable to heat waves and temperature extremes, for example. Moreover, health problems cause additional expenditures for households that can have a heavy impact on their overall financial situation, especially where household members are not covered by medical insurance. In addition to this, differently abled household members and household members with permanent problems of speech and movement can be impaired when it comes to developing adaptation strategies to climate change. This includes both physical adaptation strategies as well as issues such as education, information, and planning. There is also a gender dimension to the sensitivity here, as it is mostly women who look after household members with health problems. Climate change intensifying health problems thus means an increased burden for women.

Data collected in 2015 for households with members experiencing heath difficulties was provided at third administrative level by DOS. The survey includes a wide range of diseases and impairments, including eye and ear problems, movement, memory, communication, self-care and others. The data on health difficulties came pre-classified by different grades of severity. For this analysis, the information was grouped and summarized at sub-district level with the following criteria (Table 34):

Table 34: Classification of household members with health difficulties

CLASSIFICATION	RANGES
Low sensitivity	Prevalence of households with health difficulties is < 2.4%
Medium sensitivity	Prevalence of households with health difficulties is >= 2.4% and < 3.5%
High sensitivity	Prevalence of households with health difficulties Is >= 3.5%

At 4.5%, the sub-district of Ayy (item No. 13 in the third administrative level map and table found in the maps and table reference section of this document) is the one with the highest prevalence of household members with health difficulties. At 2.2%, Wadi Araba is the sub-district with the lowest prevalence of household members with health difficulties. Figure 69 contains the classified map.

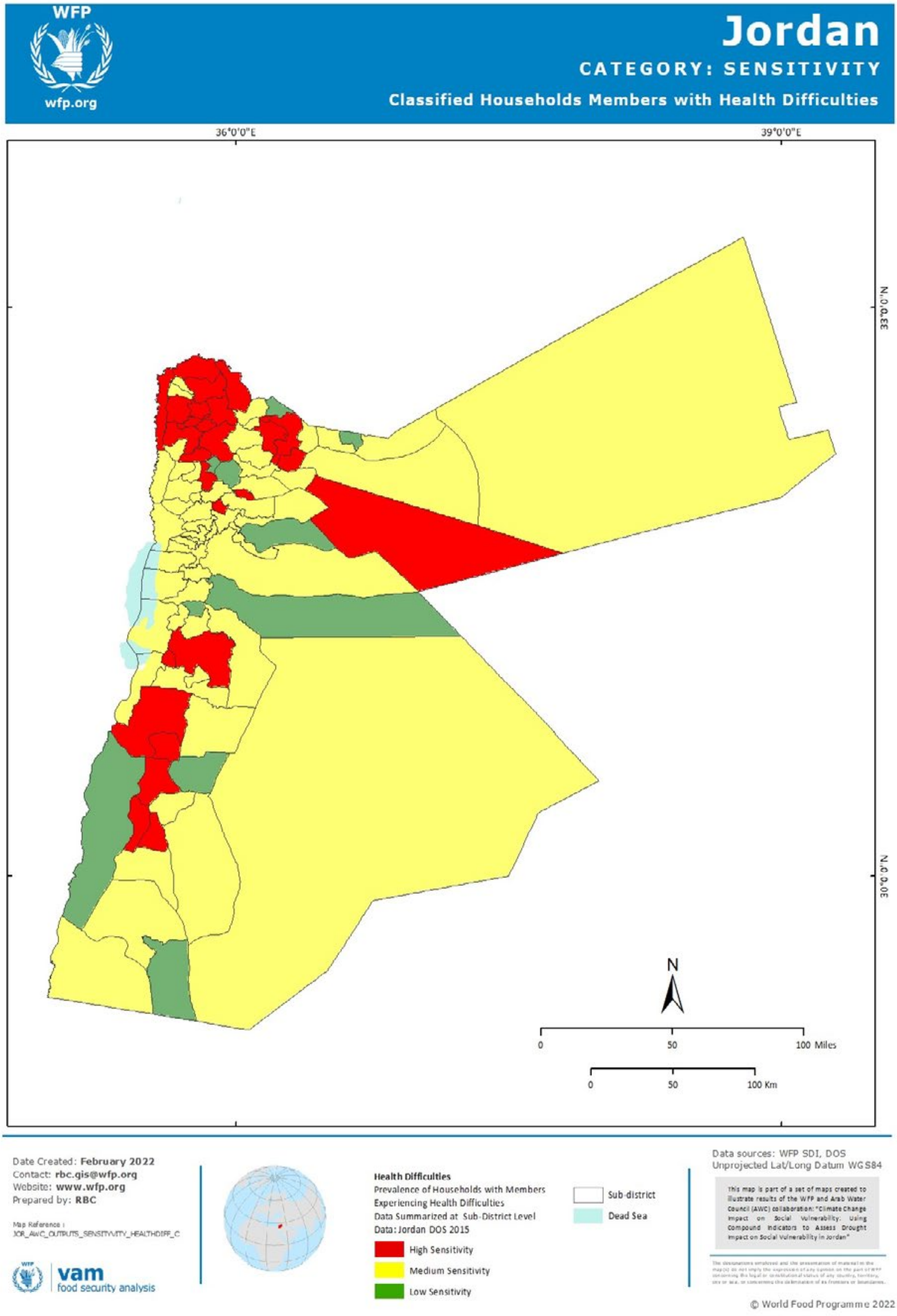


Figure 69: Sensitivity based on the indicator "household members experiencing health difficulties".

12.5.7 Households Receiving Aid and Support

The reception of government aid can be seen as a sensitivity indicator (showing that an administrative unit has a higher prevalence of poverty), as well as an adaptive capacity indicator (enhancing a household's capacity to respond to climate change impacts). In this context, the number of households receiving government aid is being interpreted as a proxy for systemic social inequality and poverty, and thus sensitivity. Data regarding the distribution of Government aid was found at Governorate level in the DOS Quality-of-Life Survey from 2010. This data can be found through the following link:
https://jorinfo.dos.gov.jo/Databank/pxweb/en/Poverty/

Data was extracted from Table 2.9 in the category "Quality of Life Index": "Percentage of Households by Source of Aid and Governorate and Urban \ Rural (%)". The table summarizes at Governorate level the prevalence of households receiving support from one or more of the following sources of aid: Government-related organizations such as Zakat Fund, Royal Court, MOH, or NAF, and non-governmental organizations such as UNRWA, HCR, WFP and various religious associations.

Data for households not receiving any support from Government institutions was calculated and ranked in percentages, then classified as presented in Table 35.

Table 35: Classification for households receiving aid and support

CLASSIFICATION	RANGES
Low sensitivity	Prevalence of households receiving aid is < 45%
Medium sensitivity	Prevalence of households receiving aid is >= 45% and <= 55%
High sensitivity	Prevalence of households receiving aid is > 55%

According to this classification, Mafraq represents the most sensitive Governorate with only 41.8% of the population not receiving any kind of aid or support – meaning that almost 60% of the population is receiving some form of aid. Tafiela is the Governorate that receives the lowest share of support – here a total of 72.6% do not receive any kind of aid. These numbers, of course, do not exclude the possibility that there are households in these Governorates that need aid and support, but are not currently receiving any. The full results of this classification are presented in Figure 70.

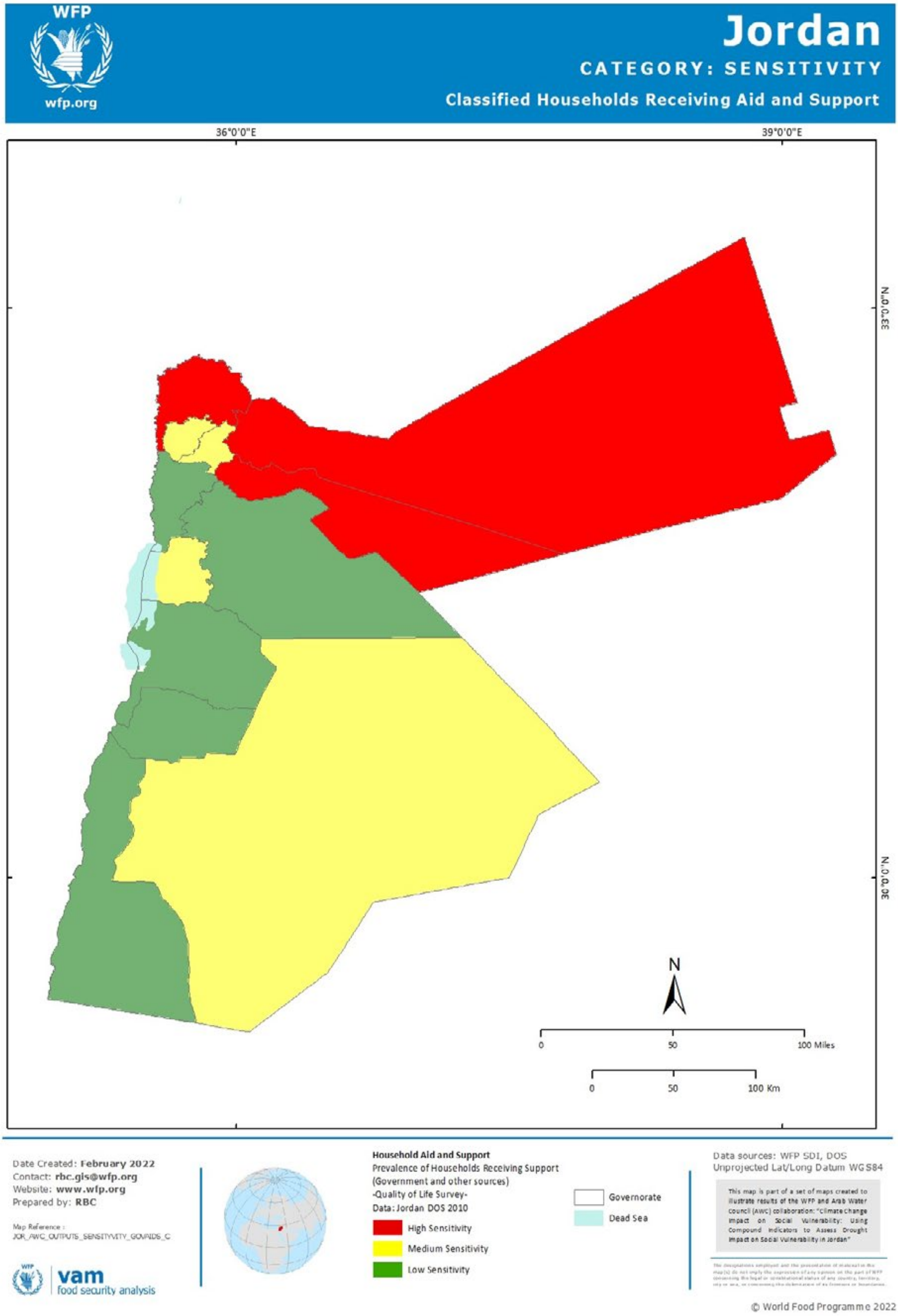


Figure 70: Sensitivity based on the indicator "households receiving aid and support".

12.5.8 Household Water Shortage in Public Network

Most households in Jordan receive water from public networks only once a week. This is even the case in the capital city Amman. Water is then stored in tanks on household roofs to make water available in households throughout the week. In the Quality-of-Life Survey conducted by UNDP and DOS in 2002 and 2010, some surveyed households complained about water shortages in the public network. Water shortages in the public network increase the sensitivity of households to drought, even in the context of agriculture and growing food, as often gardens, trees, and olive groves around the house are irrigated with household water. Households that complain about water shortages in the public network are thus considered more sensitive to drought.

The indicator used here can also be found in the Quality-of-Life DOS Survey from 2010, which generated data at Governorate level. For the current study the "Below Mid-Level" category was selected, which includes the percentage of population that was classified with a below-average quality of life. Within this category, the percentage of people with shortages of water in public network was used for the analysis.

Governorates from the "Below Mid-Level" category with highest and lowest percentage of water shortages in public network are: Aqaba with 4.6%, and Balqa with 64.2%.
The classification performed here is presented in Table 36.

Table 36: Classification for water shortages in public network

CLASSIFICATION	RANGES
Low sensitivity	Distribution of households with below-average water shortage in public network is < 15%
Medium sensitivity	Distribution of households with below-average water shortage in public network is >= 15% and < 40%
High sensitivity	Distribution of households with below-average water shortage in public network Is >= 40%

The resulting classified sensitivity map can be seen in Figure 71.

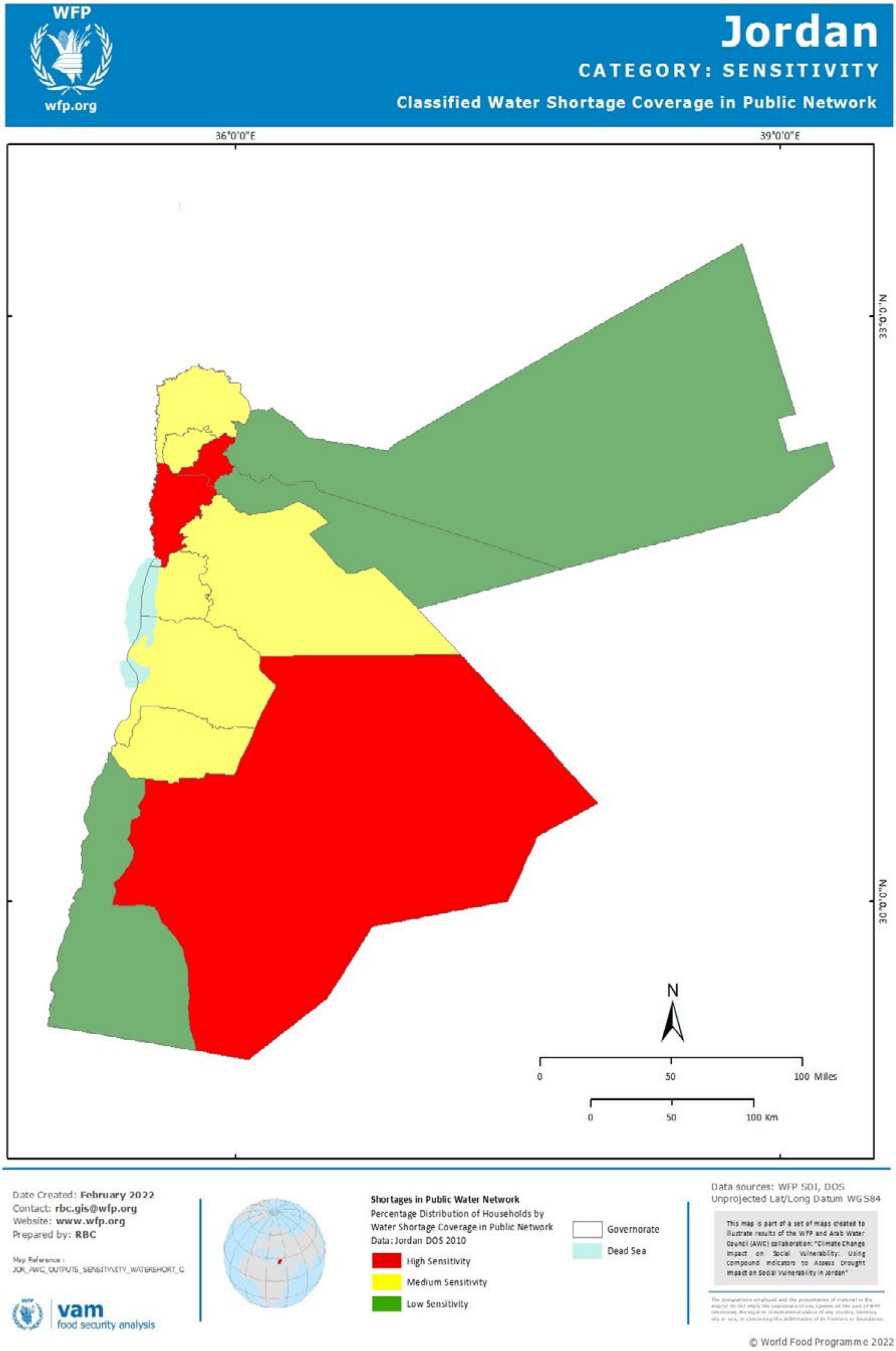


Figure 71: Sensitivity based on the indicator "water shortages in public network".

12.5.9 Living Standard Index

This indicator is found in the Quality-of-Life Survey, conducted by DOS in cooperation with UNDP generating data at Governorate level for 2002 and 2010, which is available through the following link:
https://jorinfo.dos.gov.jo/Databank/pxweb/en/Poverty/Poverty__Evolution-of-Quality-Life-Index__Living-Standard-Index/General_01.px/

The dataset, which is already a composite indicator, was published by DOS with a breakdown into three groups: percentage of "Below Middle Level", percentage of "Middle Level", and percentage of "Above Middle Level" Quality of Life (QoL). For the present analysis, the "Below Middle Level" category for 2010 was selected and the percentage of people within this bracket who have a Low Living Standard according to the Index established by UNDP and DOS was used. The data was reclassified based on the criteria shown in Table 37.

Table 37: Classification of living standard

CLASSIFICATION	RANGES
Low sensitivity	Percentage of low living standard in "Below Middle Level" QoL is < 20%
Medium sensitivity	Percentage of low living standard in "Below Middle Level" QoL is >= 20% and < 35%
High sensitivity	Percentage of low living standard in "Below Middle Level" QoL is >= 35%

According to this classification, the highest percentage of people with a lowest living standard within the "Below Mid-Level" QoL bracket can be found in Ajlun with 39.9%, followed by Mafraq with 37.9%. The highest living standard is found in Amman (19%). The mapped result is presented in Figure 72.

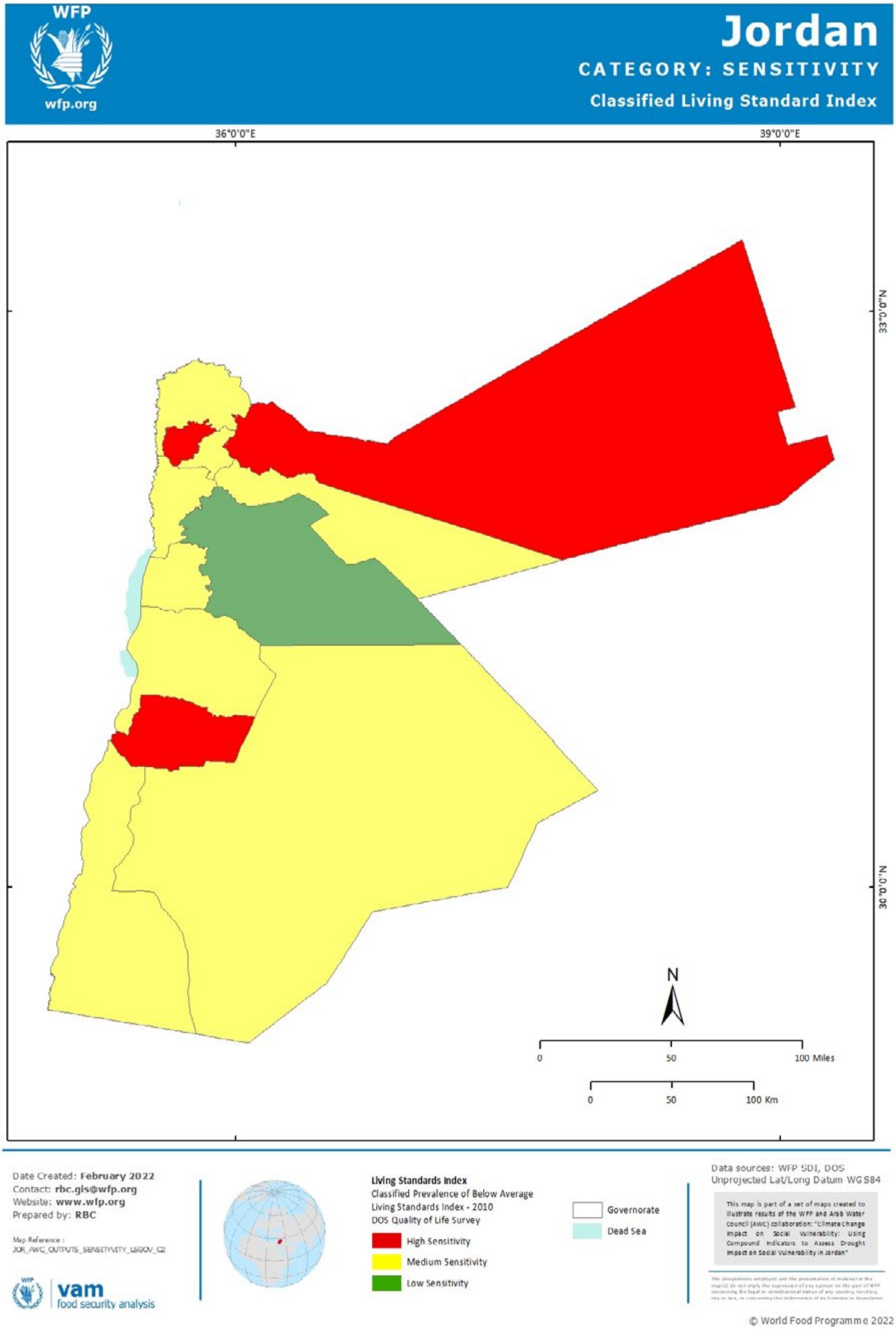


Figure 72: Sensitivity based on the indicator "living standard".

12.5.10 Percentage of Poor by District

Unfortunately, the Jordanian Government is not publicly releasing poverty data at sub-national level that is more recent than 2010. For this reason, the analysis had to be based on statistical information from 2010 published by DOS at the second administrative level, the District level. With high numbers of unemployment, large portions of households receiving a form of aid or support, and high numbers of refugees hosted by the country, it can be assumed that the 2010 figures at District level understate the current poverty situation in Jordan's Districts. The 2019 national poverty rate released by the Government of Jordan was 15.7% (World Bank, 2020c).

Based on the 2010 data, the districts with the highest poverty rate are Ar-Rwaished (in Mafraq Governorate) at 69.6%, Al Husayniyya (in Maan Governorate) at 52.5%, and Al-Aghwar Al-Janoobiyah (in Karak Governorate) at 45.4%. The Governorate with the lowest poverty rate in 2010 is Amman at 1.7%. These numbers show the significant differences in poverty rates between Governorates.

The classification performed is presented in Table 38.

Table 38: Classification of percentage of poor by District

CLASSIFICATION	RANGES
Low sensitivity	Percentage of poor by district is < 5%
Medium sensitivity	Percentage of poor by district is >= 5% and <= 20%
High sensitivity	Percentage of poor by district is > 20%

The resulting sensitivity map at District level is shown in Figure 73.

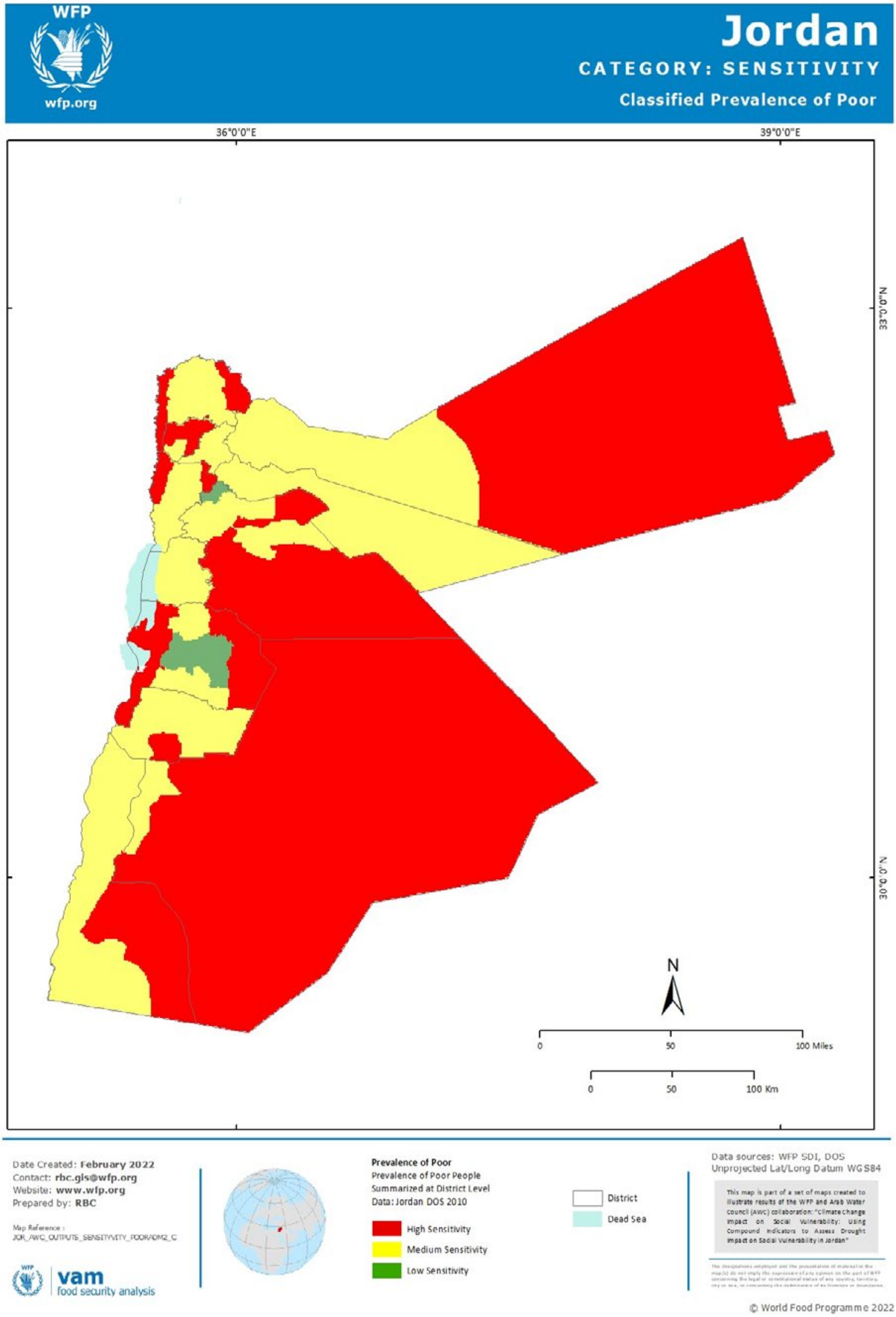


Figure 73: Sensitivity based on the indicator "percentage of poor by District".

12.5.11 Water Deficit (Based on Groundwater Depletion)

Farmers in Jordan are heavily dependent on groundwater wells. However, Jordan's aquifers are over-exploited, while a growing number of wells can create a draw-down effect. The water deficit in groundwater basins, calculated as a function of water availability, abstraction rate, and safe yield, is used to quantify groundwater depletion. Yield, abstraction, and depletion are measured in millions of cubic meters (MCM). The data presented here has been derived from the Ministry of Water and Irrigation (MWI) at basin level in 2017 (Table 39).

Table 39: Status of Groundwater Basins

GROUNDWATER BASIN NAME	SAFE YIELD	ABSTRACTION	DEPLETION STATUS AS PER MWI	BALANCE (CALCULATED AS DEPLETION PROXY)
Amman - Zarqa	87.5	165	-77.5	-77.5
Araba North	3.5	6.6	-3.1	-3.1
Araba South	5.5	10.9	-5.4	-5.4
Azraq	24	69.7	-45.7	-45.7
Dead Sea	57	83.8	-26.8	-26.8
Disi	125	141.56	-16.6	-16.56
Hammad	8	1.6	None	6.4
Jafr	27	35.5	-8.5	-8.5
Jordan Side Valley	15	45.6	-30.6	-30.6
Jordan Valley	21	27	-6	-6
Sirhan	5	4	None	1
Yarmouk	40	54.5	-14.5	-14.5

The column Balance was created by subtracting Abstraction from Safe Yield. The Balance column was used as Depletion proxy for the classification (as the value "none" could not be used for classification). The highest groundwater depletion volumes can be found in Zarqa Basin at -77.5 MCM and Azraq Basin at -45.7 MCM, while Hammad and Sirhan Basins show no depletion.

The data was used to classify groundwater basins by determining basins with high, medium and low sensitivity. The basins with higher depletion volumes were classified as more sensitive. The classification was performed according to the criteria presented in Table 40.

Table 40: Classification of groundwater depletion in basins

CLASSIFICATION	RANGES
Low sensitivity	Groundwater depletion is > -8
Medium sensitivity	Groundwater depletion is >= -8 MCM and < -25 MCM
High sensitivity	Groundwater depletion is >= 25 MCM

The mapped results are presented in Figure 74.

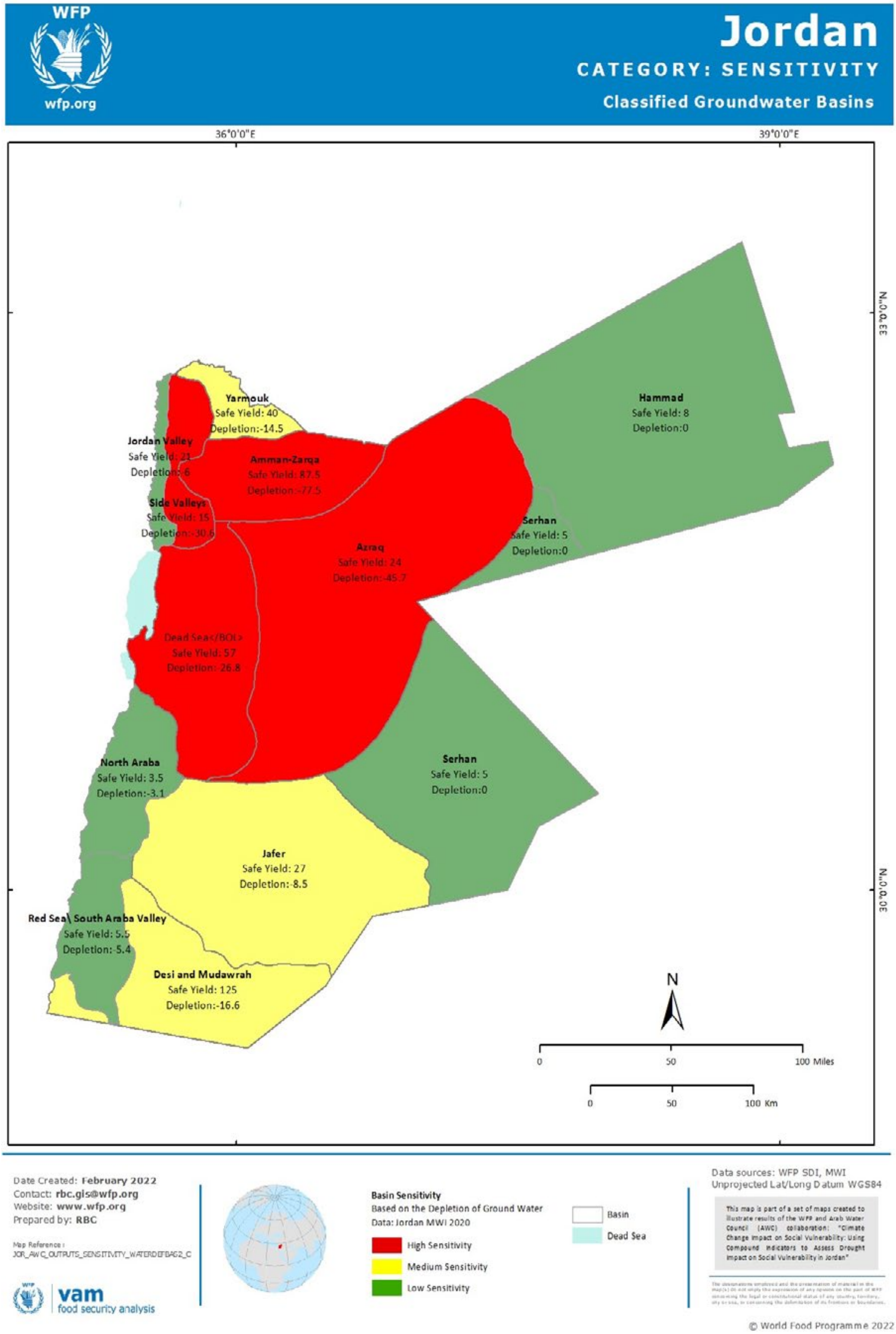


Figure 74: Sensitivity of groundwater basins based on the indicator "groundwater depletion".

12.5.12 Number of Refugees

Jordan is hosting millions of refugees, 760,000 of whom are registered by UNHCR, with Syria being the most significant country of origin (UNHCR, 2022a). While a lot has been done recently to generate job and income opportunities for refugees in Jordan (UNHCR, 2022a), refugees often find themselves in situations of poverty and are thus sensitive to outside shocks. UNHCR numbers from March 2022 (UNHCR, 2022b) show that as many as 64% of refugees in Jordan live on only 3 Dinar per day. As these refugees are applying negative coping strategies, such as lowering their calorie intake, in the face of shocks such as the COVID-19 impact, climate impacts such as droughts are also likely to affect the income strategies and resilience of refugees, particularly in their roles as daily laborers in agriculture.
For the present analysis, recent refugee numbers released by UNHCR in 2021 was used. This data can be found by using the following link: https://data2.unhcr.org/en/documents/details/88982

In this data, there is a link between the Governorates that host the largest number of refugees, Mafraq, Zarqa, Amman, and Irbid, and the location of large refugee camps in Jordan, the largest camps being Zaatari in Mafraq Governorate and Azraq Camp in Zarqa Governorate. It should be noted, however, that the majority of refugees in Jordan are hosted in communities, not in campus, thus potentially enhancing pressure on natural resources and public services, and thus increasing the drought sensitivity of the host community as well. Moreover, the Governorates located close to the Syrian border receive more traffic across the border than others, as well as higher numbers of non-registered refugees. Notably, not all refugees in Jordan are registered by UNHCR at Governorate level.

The classification of data was performed according to the ranges shown in Table 41.

Table 41: Classification for number of refugees

CLASSIFICATION	RANGES
Low sensitivity	Number of registered refugees is <= 9,000
Medium sensitivity	Number of registered refugees is > 9,000 and < 50,000
High sensitivity	Number of registered refugees is >= 50,000

The mapped result is presented in Figure 75.

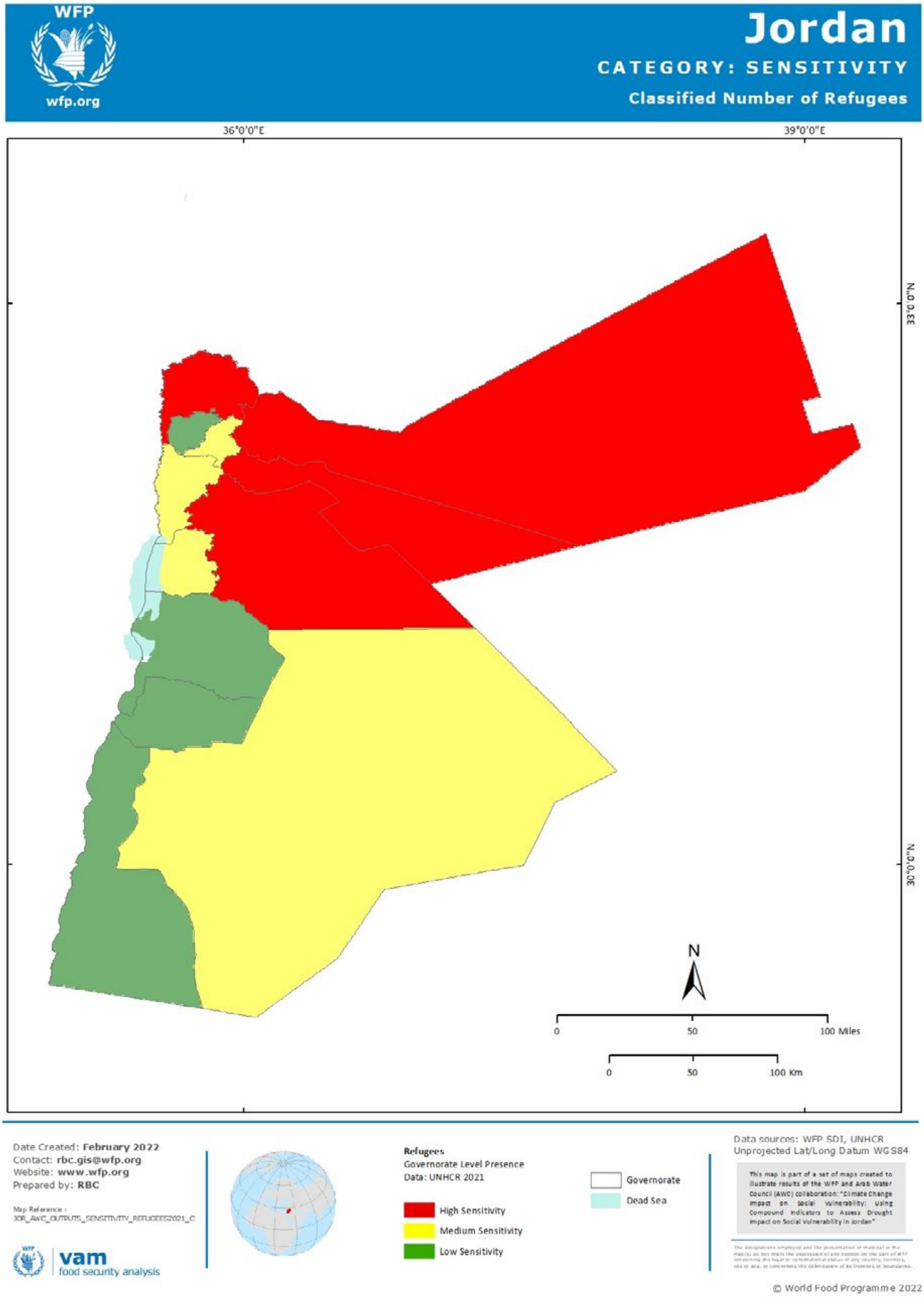


Figure 75: Sensitivity based on the indicator "number of refugees hosted".

12.5.13 Sensitivity Analysis: Overall Results

The overall results of the sensitivity component of this analysis are displayed in Figures 76 and 77. The results are generated by adding all the individual sensitivity scores of the relevant indicators presented in this section and then multiplying them by the weight assigned to the various sensitivity indicators by the Jordanian experts. The overall sensitivity score for each map unit was then produced as a cumulative GIS map output.

For the purpose of comparison, both the unweighted overall result (Figure 76) and the weighted overall result (Figure 77) are presented. For the overall vulnerability and risk assessments, only the weighted result was used. Figure 78 shows a comparison of the weighed and unweighted results. Interesting in this comparison is that, in this case, the weighting process reduced the overall level of sensitivity. It can be seen that the colors shown in Figure 77 (Figure 78 right) have less orange and more green hues than the colors in Figure 76 (Figure 78 left). Jordan's most sensitive areas, according to this assessment are parts of Mafraq, Irbid, Jarash, Tafiela, and Maan. Amman, which shows some hazard and exposure levels, is assigned very low sensitivity to drought in this assessment.

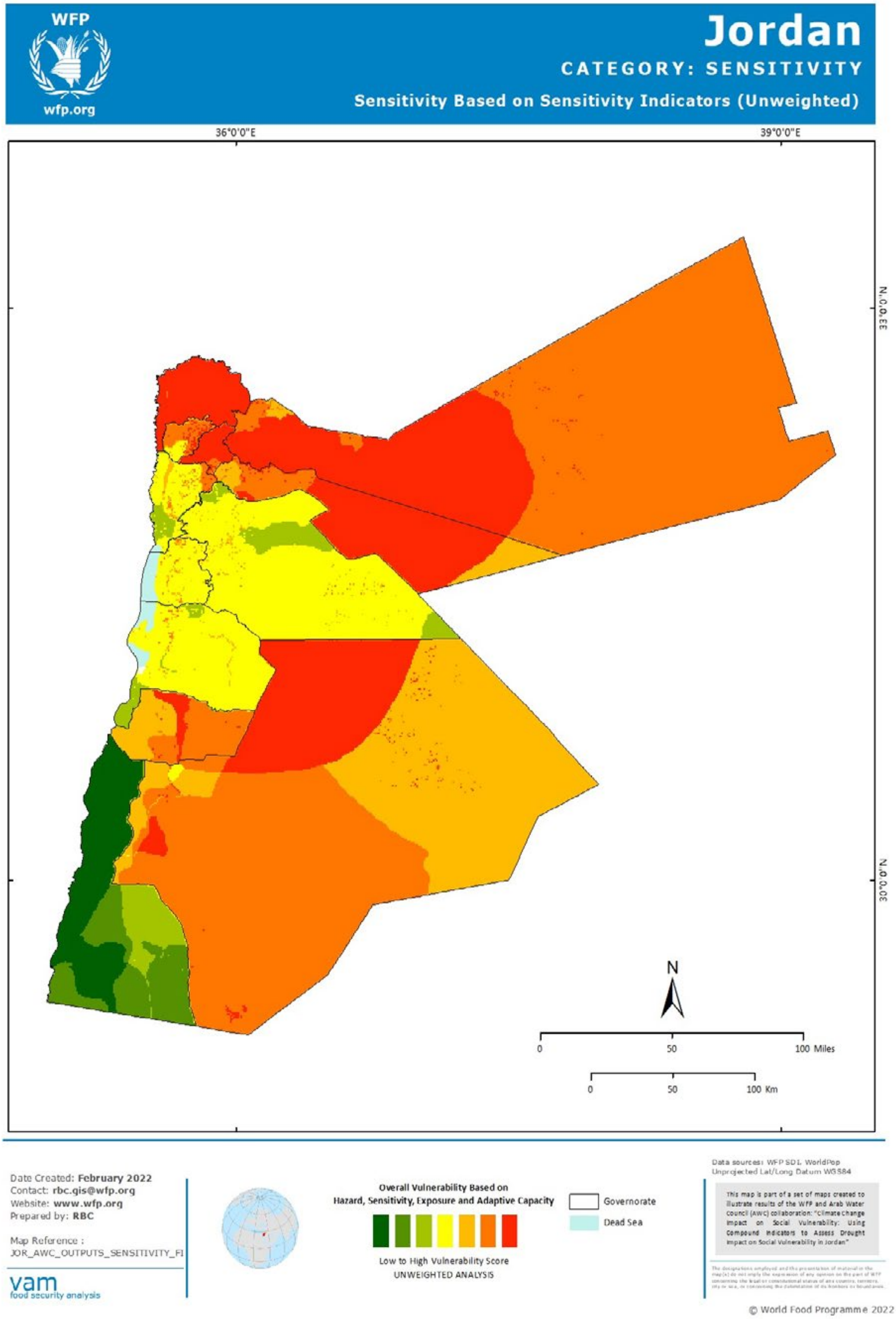


Figure 76: Overall sensitivity based on all sensitivity indicators, unweighted.

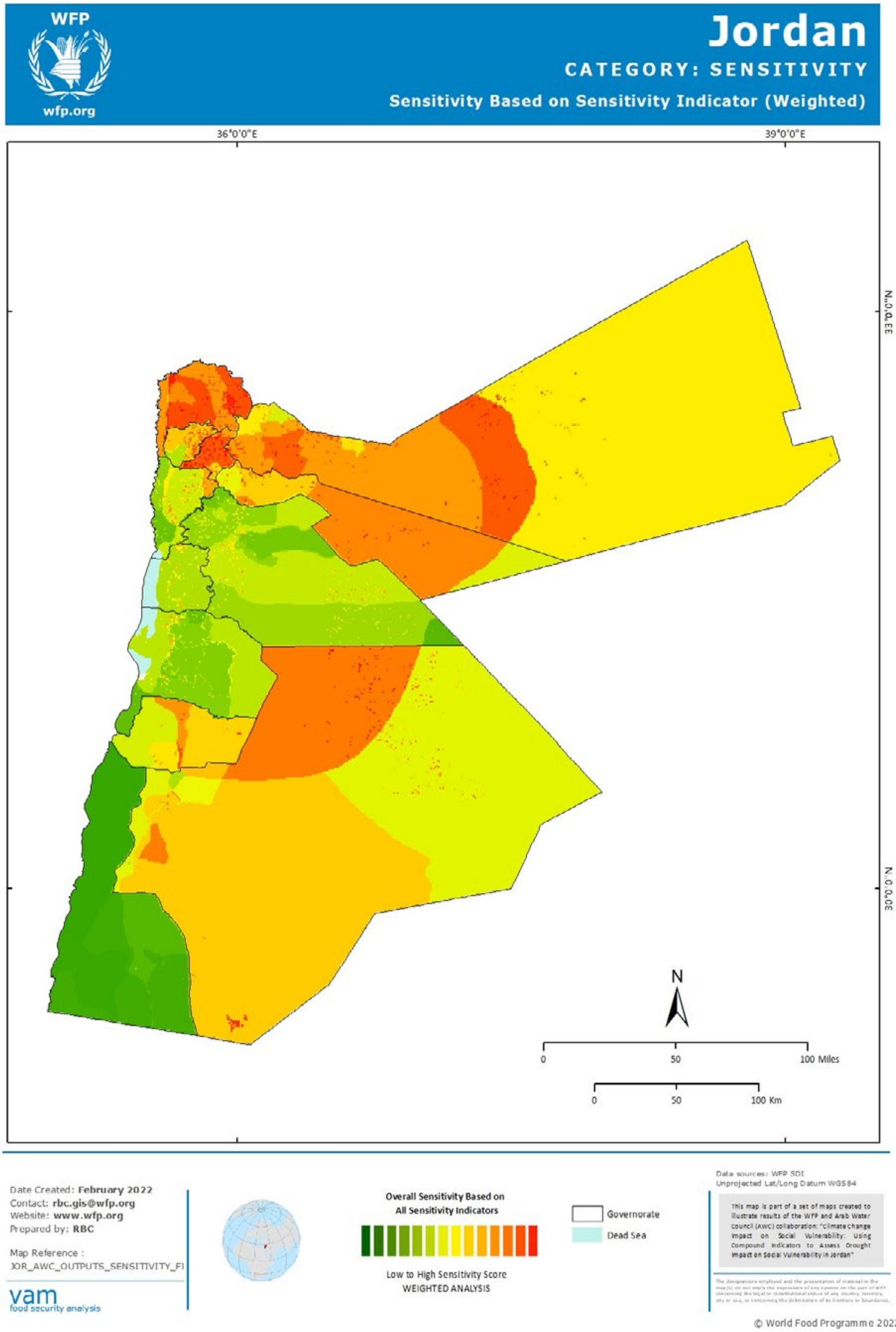


Figure 77: Overall sensitivity based on all sensitivity indicators, weighted.

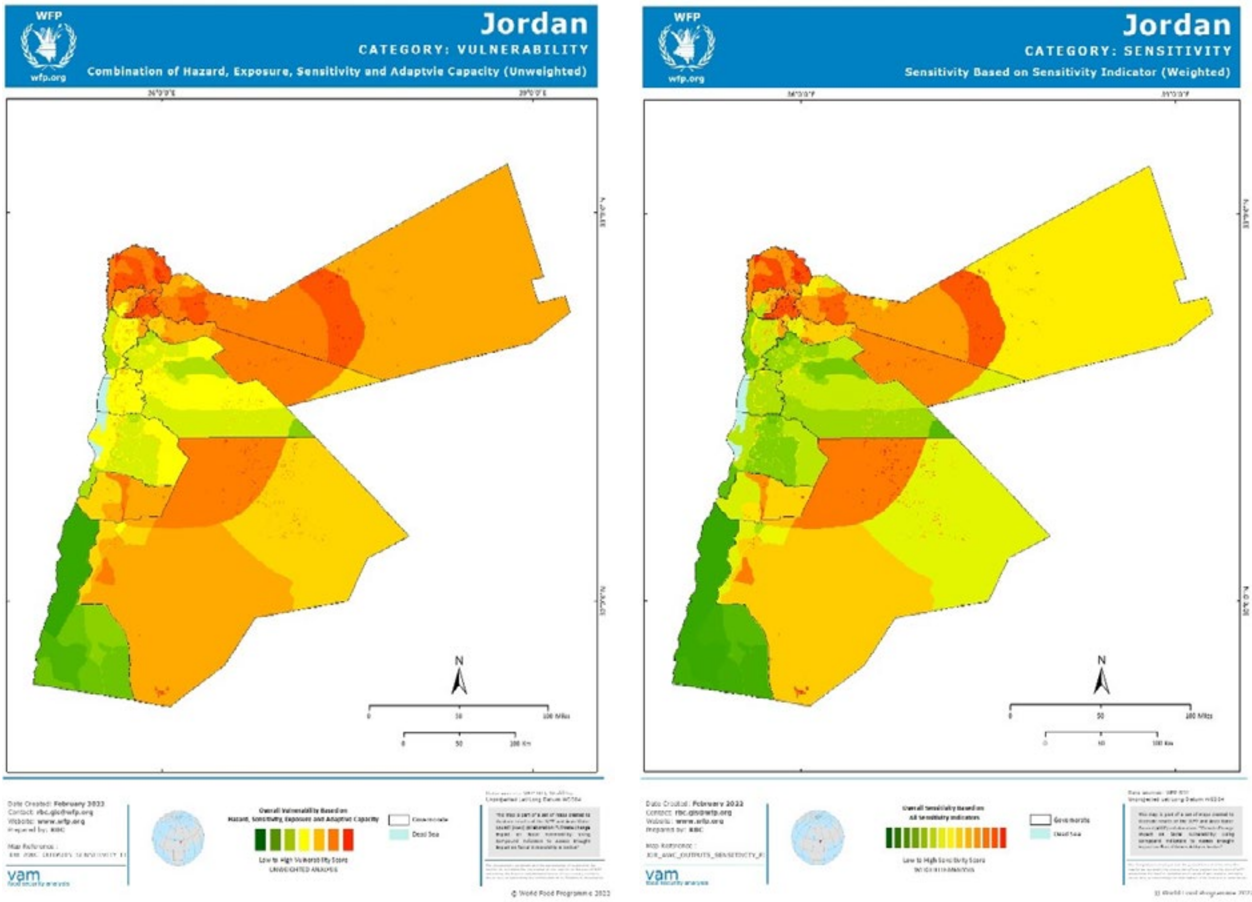


Figure 78: Comparison between the unweighted (left) and weighted (right) sensitivity results.

12.6 Adaptive Capacity Maps

12.6.1 Ecosystem Adaptive Capacity

An important element in overall drought risk is the adaptive capacity of an ecosystem to drought. To calculate the adaptive capacity of the ecosystems to drought, a composite indicator was produced based on three data sources:

- **Layer 1:** A novel calculation of areas of high biodiversity and interest for conservation was used (Taifour, 2021 partly based on Hijmans et al., 2005). Data for the climate were taken from WorldClim v.2.1, with a resolution of 2.5 km (± 5 km) (Hijmans et al., 2005). This layer is a vulnerability calculation (higher values mean higher vulnerability and lower adaptive capacity) based on the three following premises: i) inclusion of areas for conservation are not yet degraded to the point of no reversal, ii) inclusion of locations in which climatic variables are predicted to remain stable and can support the persistence / adaptive capacity of vegetation throughout changes to climate (Ashcroft, 2010, Keppel et al., 2012), and iii) exclusion of habitats with a mix of vegetation types so that an optimal representation of a single type could be ensured. The layer was already received as a classified version.

Layer 1 was classified in the following way (Table 42):

Table 42: Classification of ecosystem vulnerability, based on layer 1

CLASSIFICATION	RANGES
Low vulnerability	Ecosystem vulnerability is >= 4
Medium vulnerability	Ecosystem vulnerability is >= 2.75 and < 4
High vulnerability	Ecosystem vulnerability is < 2.75

- **Layer 2:** Existing national parks and protected areas (Ministry of Environment). The existence of national park or protected area received the value "0" for lower vulnerability and the non-existence of a national park or protected area, received the value "1" for higher vulnerability (therefore lower adaptive capacity).

- **Layer 3:** Map on ecosystem adaptive capacity included in Jordan's Third National Communication on Climate Change (2014, page 164). This layer is an ecosystem adaptive capacity layer and its classified values needed to be "flipped" in order to make them compatible with Layer 1, which is a vulnerability layer (higher vulnerability values mean lower adaptive capacity and vice versa).

Layer 2 was classified in the following way (Table 43):

Table 43: Classification of ecosystem adaptive capacity (flipped for the purpose of building the composite indicator), based on TNC 2014

CLASSIFICATION	RANGES
High adaptive capacity	TNC Ecosystem Adaptive Capacity based on Vegetation: areas with values equal to 3.25, 3.5, 4
Medium adaptive capacity	TNC Ecosystem Adaptive Capacity Based on Vegetation: areas with values equal to 2.75, 3
Low adaptive capacity	TNC Ecosystem Adaptive Capacity Based on Vegetation: areas with values equal to 1.25, 2, 2.25

As the inputs were partly vulnerability and partly adaptive capacity layers, it was agreed to perform a vulnerability calculation based on all layers and then to "flip" the result (high vulnerability = low adaptive capacity)

Moreover, the first two layers used do not cover the entirety of the country of Jordan. The first layer (Taifour, 2021) excludes areas that are not relevant for conservation efforts. The second layer (Ministry of Environment) only includes established and proposed protected areas, proposed important plant areas, important bird areas, and Jordan's Special Conservation Areas. In order to create a composite indicator and map that include values for the entirety of the country, the following rationale was used:

- Wherever there was information in Layer 1, but also in Layer 2, the value from Layer 2 was used – assuming a lower vulnerability (and higher adaptive capacity) in areas with rich biodiversity and healthier ecosystems.
- Wherever there was information in Layer 1, but no information in Layer 2 (no established and proposed protected areas, proposed important plant areas, important bird areas, or Jordan's SCA) the value from Layer 1 was used.
- Wherever Layer 1 had no values at all, the values from Layer 3 were used.

This methodology prioritizes the newer data and methodologies, resorting to the older data from 2014 only in places where there was no available data from the other layers.

In the final ecosystem adaptive capacity map (Figure 79), we used lower vulnerability values for higher adaptive capacity (essentially "flipping" the result) in order to enable the calculation of an overall vulnerability score for exposure, sensitivity, and adaptive capacity. A lower vulnerability score represents higher adaptive capacity.

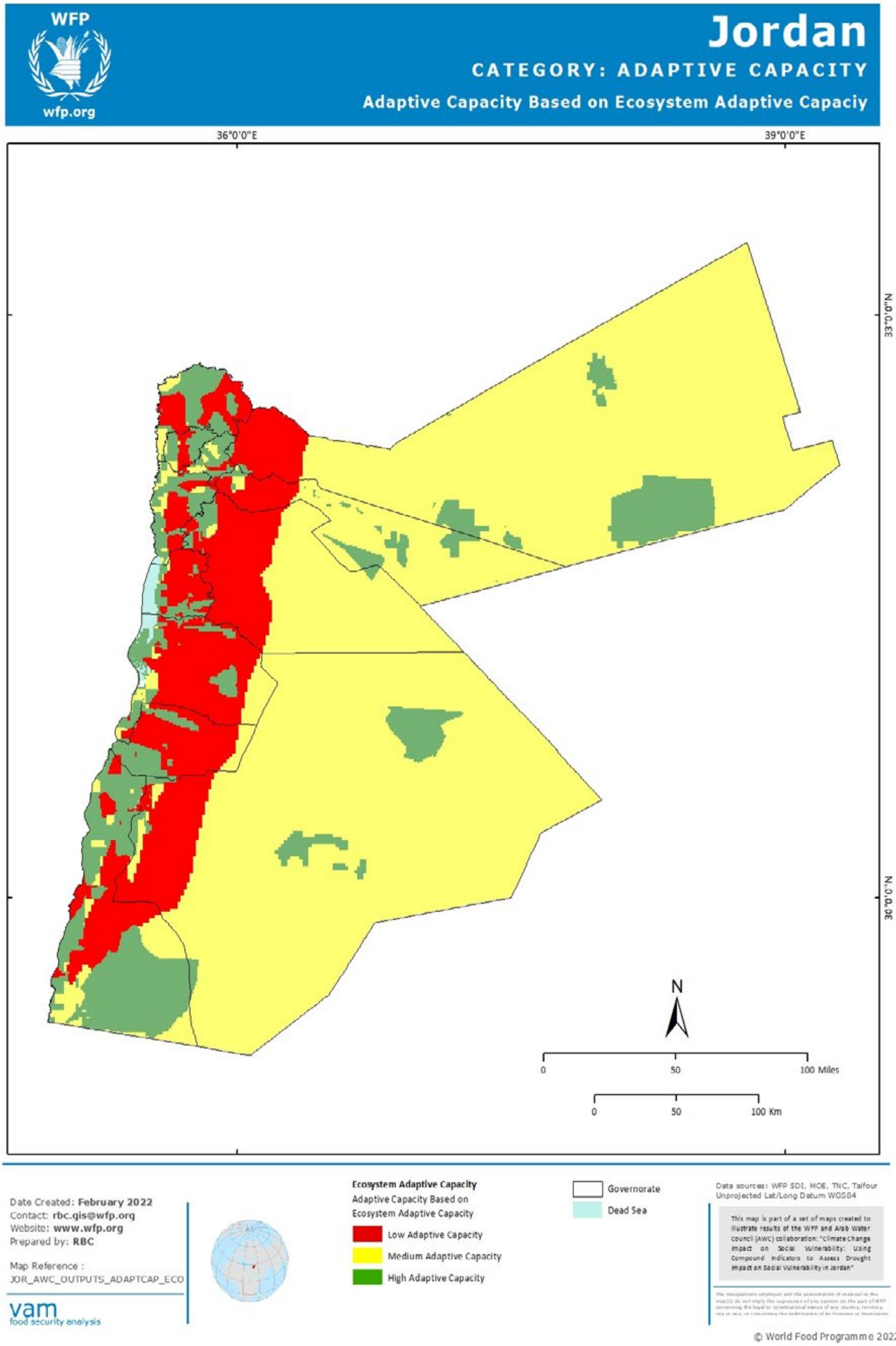


Figure 79: Adaptive capacity of ecosystems to drought.

12.6.2 Level of Education, Composite Indicator

Access to education and information plays an important role in the capacity of local communities to adapt to challenges of climate change and socio-economic vulnerability. This includes the ability to access, understand, and process information, to plan strategically, and the ability actively to seek out support schemes. Households with lower access to quality education and schooling may have a lower adaptive capacity to climate change. This applies particularly to households with a number of illiterate household members. A composite indicator of adaptive capacity based on access to education and schooling was built based on district level data from the General Census conducted in 2015 provided by the Department of Statistics. The development of the composite indicator is based on the following steps:

The datasets provided by DOS provide a head count of people with different education levels by Governorate using the following group classes: Illiterate, Read and Write, Elementary, Primary, Vocational Education, Secondary, Intermediate Diploma, Bachelor, Higher Diploma, Master and PhD.

For the present analysis, the 11 classes were divided into three main groups. The first group includes Illiterate and Read and Write, the second group includes Elementary to High School Diploma, and the third group includes Higher Education Degrees, from Bachelor to PhD. Group percentages were calculated for each Governorate and the three groups were labeled "Poor Education", "Medium Level Education" and "Higher Education." With the goal to translate the prevalence of different levels of education into higher and lower adaptive capacity for each group class, threshold levels were established using the criteria presented in Tables 44, 45, and 46.

Table 44: Classification of adaptive capacity based on poor education

CLASSIFICATION	RANGES
High adaptive capacity	Prevalence of poor education is < 10%
Medium adaptive capacity	Prevalence of poor education is >= 10% and <= 20%
Low adaptive capacity	Prevalence of poor education is > 20%

Table 45: Classification of adaptive capacity based on medium education

CLASSIFICATION	RANGES
High adaptive capacity	Prevalence of medium level education is > 50%
Medium adaptive capacity	Prevalence of medium level education is => 35% and <= 50%
Low adaptive capacity	Prevalence of medium level education is < 35%

Table 46: Classification of adaptive capacity based on higher education

CLASSIFICATION	RANGES
High adaptive capacity	Prevalence of higher education is > 50%
Medium adaptive capacity	Prevalence of higher education is >= 35% and <= 50%
Low adaptive capacity	Prevalence of higher education is < 35%

The composite of the three groups has been created as shown in the Annex 2. The resulting map can be seen in Figure 80.

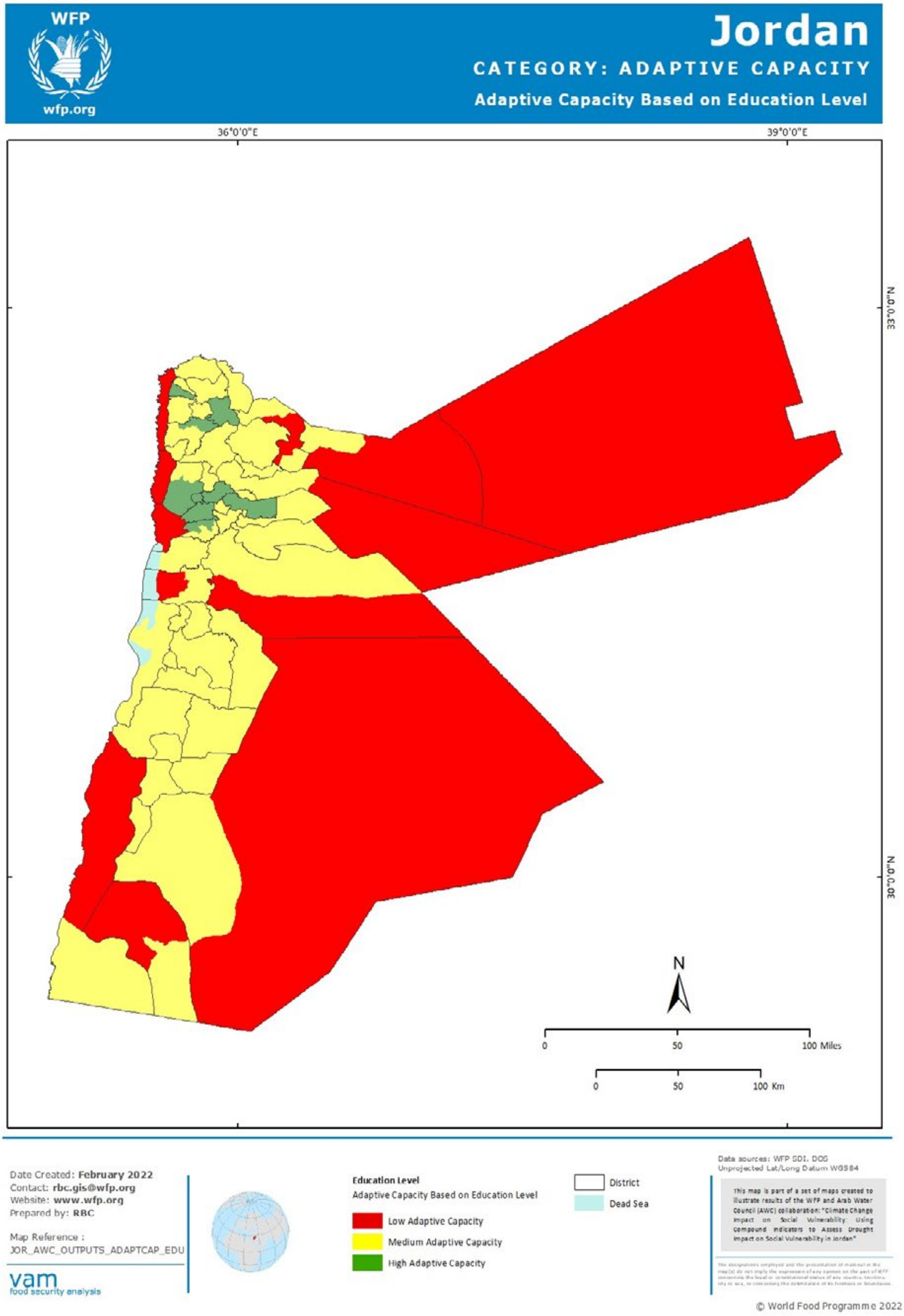


Figure 80: Adaptive capacity based on the indicator "education level".

12.6.3 Population Variation (2020 – 2010)

Population variation is an important indicator for adaptive capacity to climate change impact, as it can reflect migration movements in and out of territories. As people are adapting to climate change, they may migrate from a rural area to an urban area. While climate-induced migration is largely seen as a negative climate change impact, migration can also be a successful adaptation strategy.

However, out-migration can also mean that people were unable to adapt to climate change impacts in the place they lived, leaving them only with the last option to migrate. This is the way the indicator population variation was used in the present analysis. For this analysis, negative population variation signifies places that people have left, while positive population variation signifies places that people have migrated to.

Of course, there are many migration drivers and drivers of population variation other than climate change. Moreover, population variation can also be due to internal growth. However, the population variation can show some general trends of movement across a country, especially as territories lose significant parts of their population. Here, a notable negative population trend was interpreted as a lack of adaptive capacity in place.
The criteria for the classification of this layer are shown in Table 47:

Table 47: Classification of population variation

CLASSIFICATION	RANGES
High adaptive capacity	Population variation is >= 40 inhabitants per km¸
Medium adaptive capacity	Population variation is >= -40 and < 40 inhabitants per km¸
Low adaptive capacity	Population variation is > -40 inhabitants per km¸

Figure 81 is a general map of changes in population density in different parts of Jordan based on WorldPop (2010 and 2020). The map captures all population variation. The dark orange areas are those that have experienced a rise in population, the light orange ones those where population numbers have reduced. The map reveals interesting dynamics, for example an increase of population numbers along main roads. The classified map (starting to capture variation at a number of 40 inhabitants per km¸) showing different levels of adaptive capacity is shown in Figure 82.

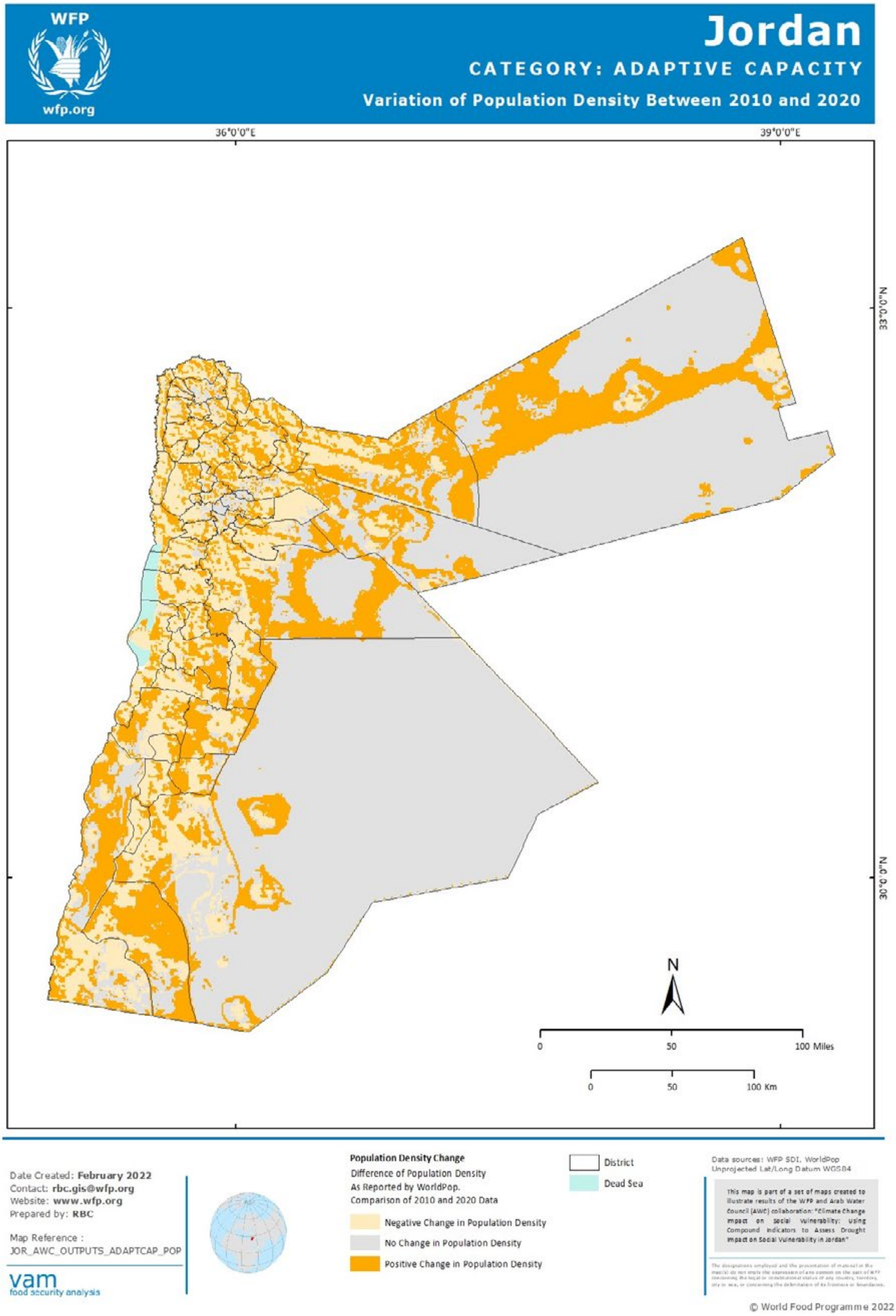


Figure 81: Change in population density between 2010 and 2020.

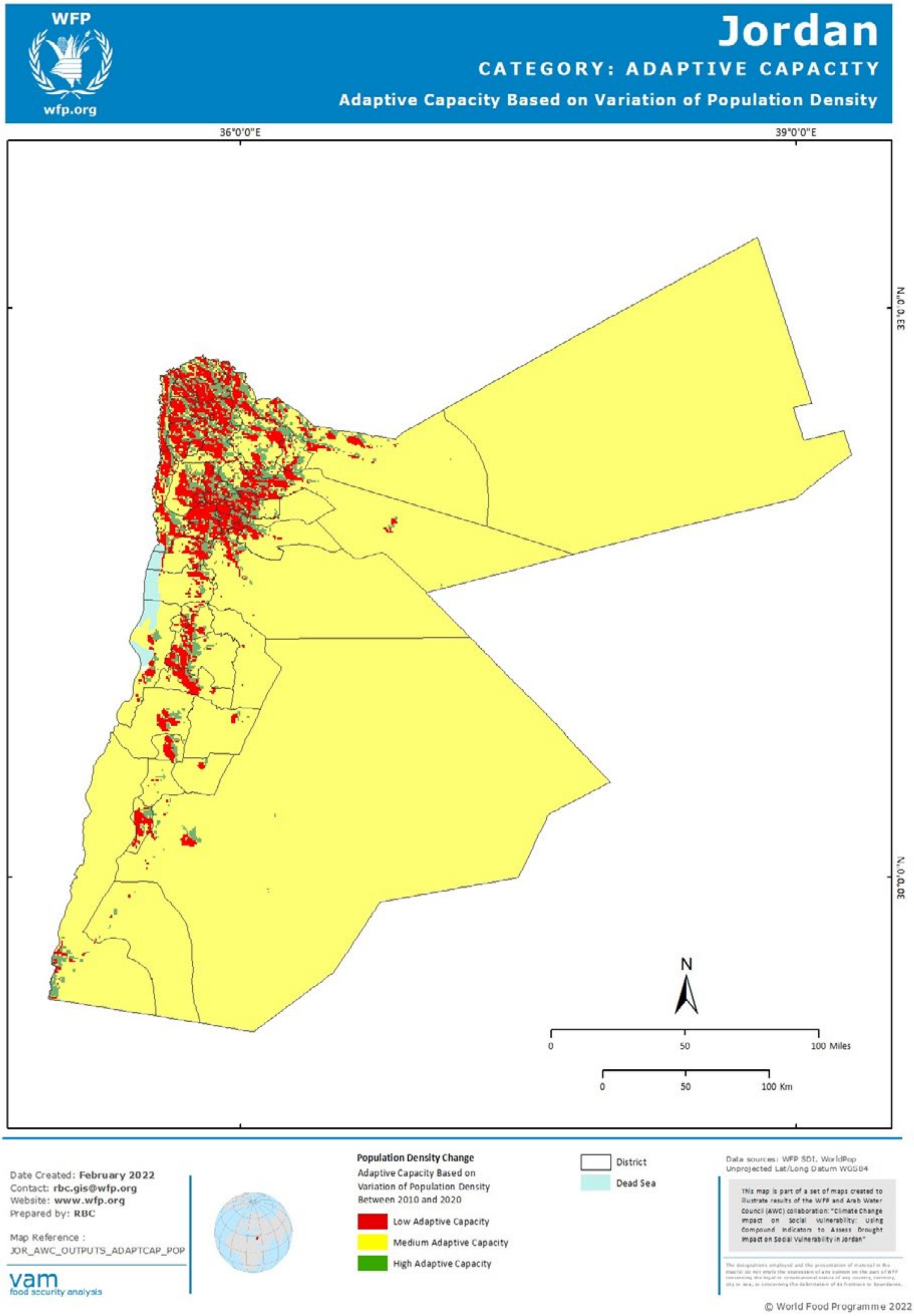


Figure 82: Adaptive capacity based on the indicator "variation in population density".

12.6.4 Household Access to Water

Access to household water is an important adaptive capacity indicator in the context of drought. Based on various indicators, the Arab Water Council and WFP, with the help of the Department of Statistics in Jordan, produced a composite indicator on household access to drinking water, including water source, water supply, population and number of households. Levels of adaptive capacity were determined based on the level of access. The indicator is based on data provided by the Department of Statistics from the years 2017, 2019, and 2020. The composite indicator is based on the following elements:

1. Water source: The dataset shared by DOS displays the distribution of housing units by main source of drinking water, at governorate level, with the categories being: Tank, Rainwater, Mineral Water, Filtered Water, Public Water Network and "Other". For the present analysis the categories were divided into two groups, the first one includes Mineral, Filtered and Public Network, the second one Tank, Rainwater and "Other". The category with the lowest adaptive capacity was assumed to be Tank, Rainwater and "Other," as this includes people who have no access to public tap water.
2. Water supply: The total water supply by governorate was provided by DOS in million cubic meters (MCM).
3. Population number: The total population number was also supplied by DOS to calculate the per person water supply by dividing water supply by population.

Based on 2 and 3, water supply per capita was calculated.
The data sources can be accessed through the following links:
http://dosweb.dos.gov.jo/DataBank/Population_Estimares/PopulationEstimatesbyLocality.pdf
http://dosweb.dos.gov.jo/DataBank/Population_Estimares/Municipalities2019.pdf

The classification for adaptive capacity based on this composite indicator was performed as follows (Table 48):

Table 48: Classification of indicator 'water source'

CLASSIFICATION	RANGES
High adaptive capacity	Percentage of people relying on rainwater, tank or "other" is < 2%
Medium adaptive capacity	Percentage of people relying on rainwater, tank or "other" is >= 2 and < 10%
Low adaptive capacity	Percentage of people relying on rainwater, tank or "other" is >= 10%

The classification criteria based on per capita water supply in mł of water are shown in Table 49:

Table 49: Classification of indicator 'per capita water supply'

CLASSIFICATION	RANGES
High adaptive capacity	Number of mł per capita is > 60
Medium adaptive capacity	Number of mł per capita is >= 40 and < 60
Low adaptive capacity	Number of mł per capita is < 40

The two Indicators were combined as shown in Annex 3. The resulting adaptive capacity based on household water access is presented in Figure 83. Only Tafiela has a high adaptive capacity based on household water access, while the far northwest of the country has the lowest adaptive capacity based on this indicator.

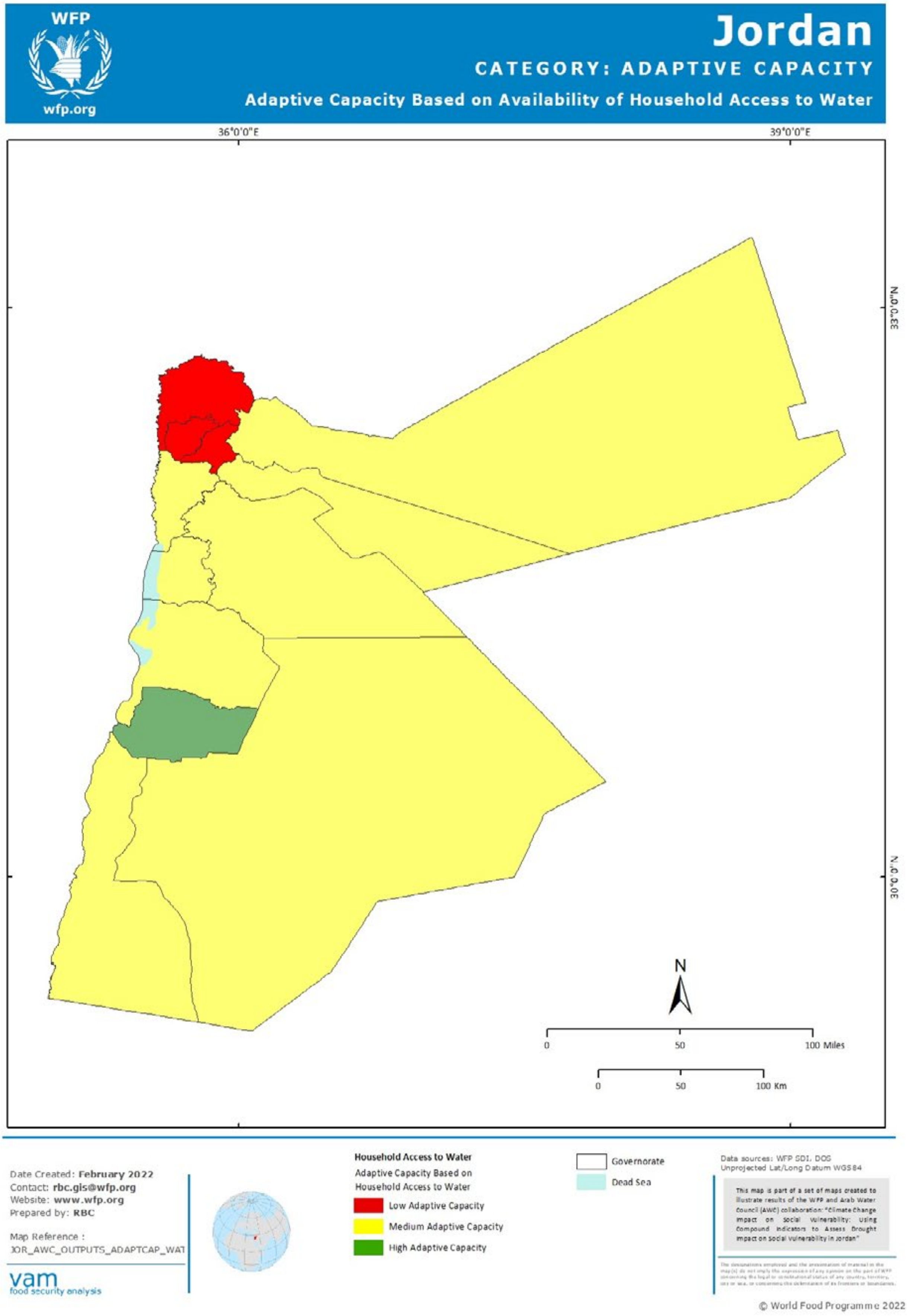


Figure 83: Adaptive capacity based on composite indicator "household access to water".

12.6.5 Food Security

The ability to feed one's family, for example in the context of an agricultural livelihood, can enhance a household's adaptive capacity to drought. Food Security data used for this study is the Inadequate Diet Score extracted from the Food Consumption Score, which was used as a proxy for lack of food security. The Inadequate Diet Score is generated by calculating the percentage of population that reported "Poor" and "Borderline" status against the three categories for Food Consumption Score: "Poor", "Borderline" and "Acceptable". The Data was collected and analyzed by DOS in 2014, in partnership with WFP.

The classification for inadequate diet score was performed as follows (Table 50):

Table 50: Classification of inadequate diet

CLASSIFICATION	RANGES
High adaptive capacity	Prevalence of inadequate diet is < 5%
Medium adaptive capacity	Prevalence of inadequate diet is >= 5% and <= 10%
Low adaptive capacity	Prevalence of inadequate diet is > 10%

Lower scores of Inadequate Diet translate into better food security and thus higher adaptive capacity. The adaptive capacity map for food security is shown in Figure 84.
It should be noted that one food security aspect, the affordability of food, is also represented in the sensitivity indicator household expenses, which includes household expenses for food items versus non-food items.

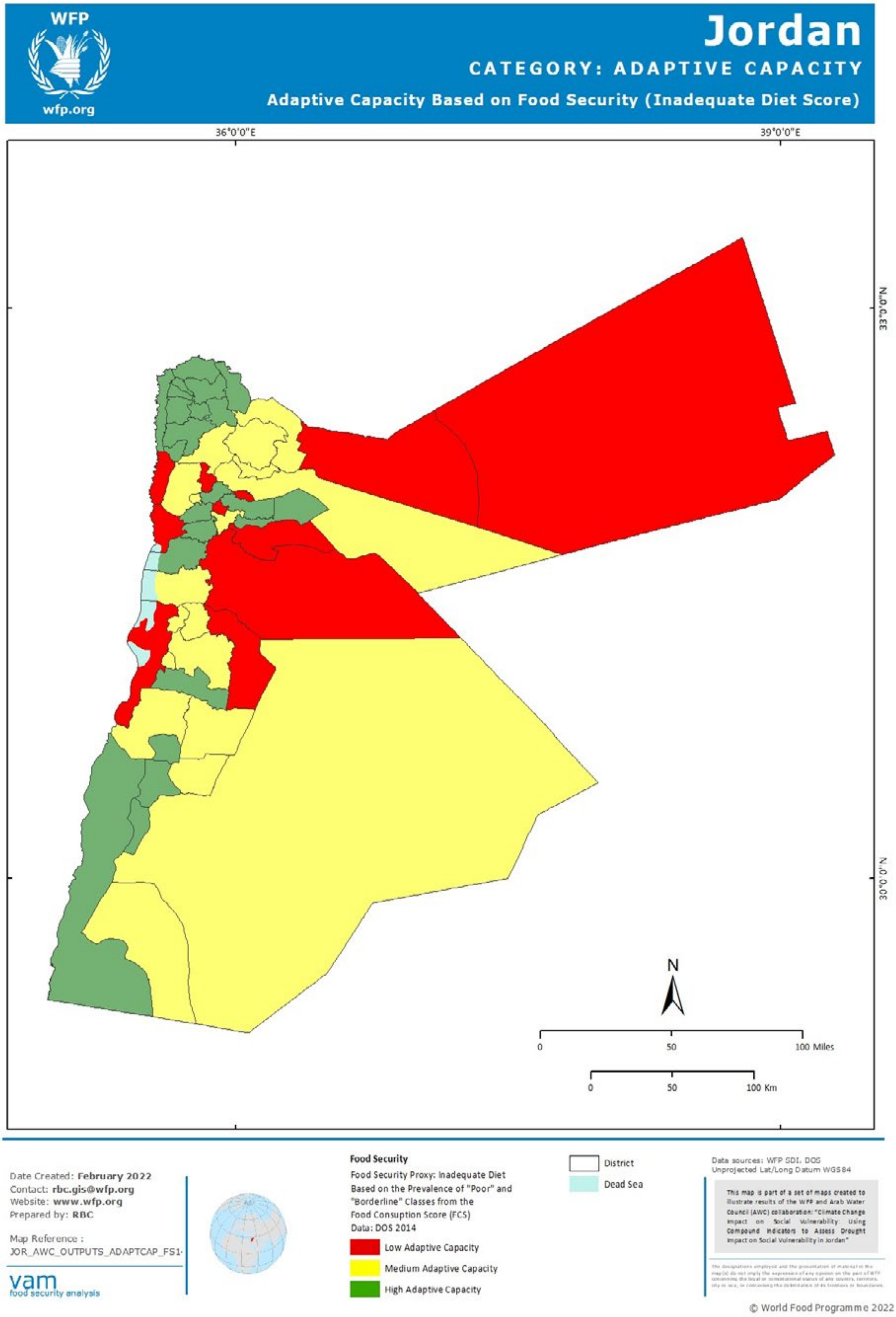


Figure 84: Adaptive capacity based on the indicator “food security”.

12.6.6 Household Asset Ownership

Households that own more assets can be more adaptive to drought, as they have more room to financially maneuver the negative impacts of drought. For example, selling off a car, a piece of land, or furniture in times of hardship can be an adaptation strategy. Where households are living on the bare minimum of assets, there is significantly less room to maneuver, making those households less adaptive. More assets also give households securities or collaterals to access loans. The adaptive capacity of households based on asset ownership was calculated using data provided by the Department of Statistics (DOS) based on data at Governorate level collected in 2002 and 2010, which were compared (Figure 82). For the overall analysis, only the more recent data was used and classified. Higher household asset ownership is translated into higher adaptive capacity. The classification is shown in Table 51:

Table 51: Classification of household asset ownership

CLASSIFICATION	RANGES
High adaptive capacity	Percentage of people in the "Below Average" group is < 10%
Medium adaptive capacity	Percentage of people in the "Below Average" group is >= 10% and < 15%
Low adaptive capacity	Percentage of people in the "Below Average" group is >= 15%

Figure 85 shows a comparison of households with below-average asset ownership by Governorate in 2002 and 2010. What becomes visible is that during this time span the percentage of households with below-average asset ownership has increased in some Governorates – notably Mafraq and Balqa. Figure 86 shows the classified adaptive capacity map based on household asset ownership 2010.

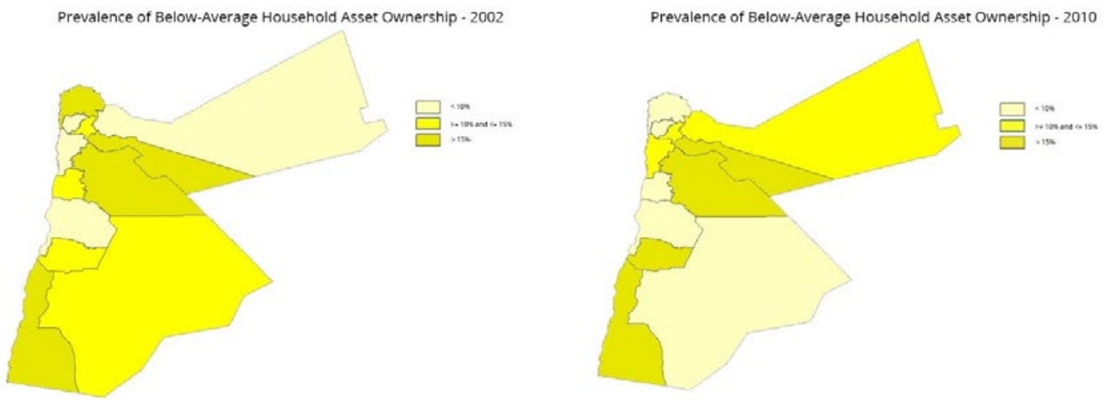


Figure 85: Comparison of household asset ownership in 2002 and 2010 by Governorate (Sources DOS, 2002 and 2010; WFP SDI, 2022).

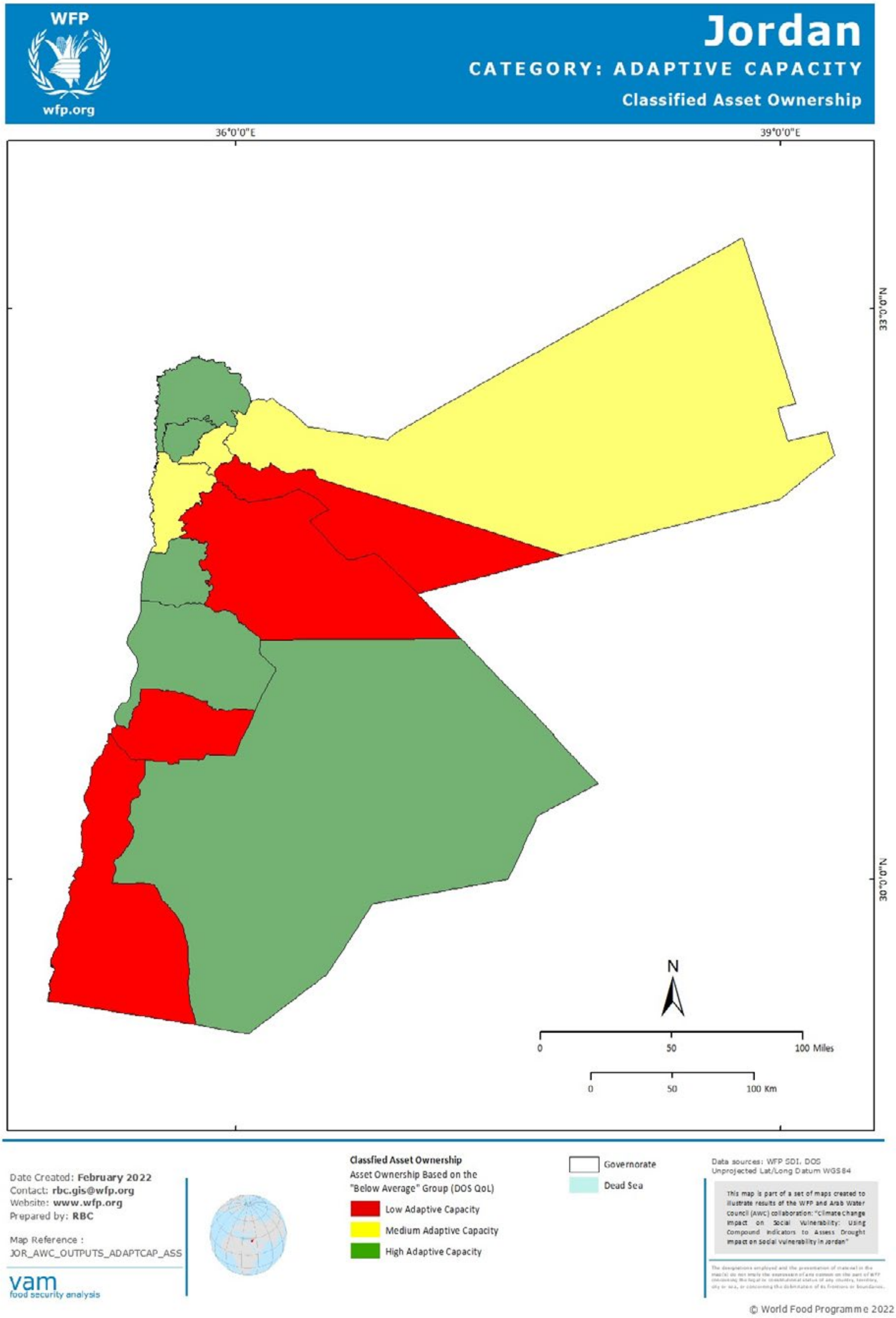


Figure 86: Adaptive capacity based on the indicator "household asset ownership".

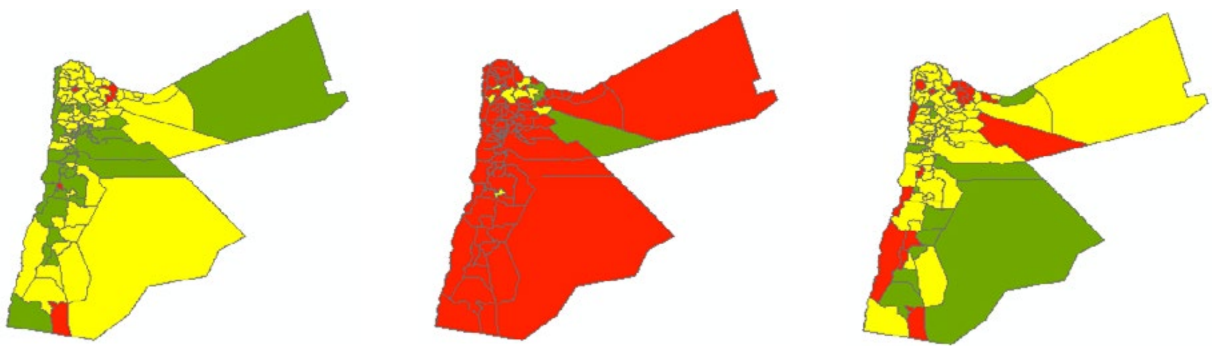
12.6.7 Health Insurance for Jordanian and Migrants

The availability of health insurance can increase the adaptive capacity of households in the face of a climate crisis, reducing the general household expenditures on health, and providing a safety net for expenditures on health difficulties caused by climate extremes. Data for the availability of health insurance programs was made available from DOS from the 2004 and 2015 national surveys. The data was summarized at third administrative level. Based on this data, maps on gender and migrant insurance, results for the female population and for non-Jordanian population, as well as a comparison between the 2004 and 2015 records were produced (Figures 87-89). These small maps were not included in the overall analysis. The selected indicator for the analysis is the prevalence of uninsured population in 2015 (Figure 90).

The classification of uninsured population in 2015 was performed as follows (Table 52):

Table 52: Classification health insurance

CLASSIFICATION	RANGES
High adaptive capacity	Prevalence of 2015 uninsured population is < 20%
Medium adaptive capacity	Prevalence of 2015 uninsured population is >= 20% and < 40%
Low adaptive capacity	Prevalence of 2015 uninsured population is >= 40%

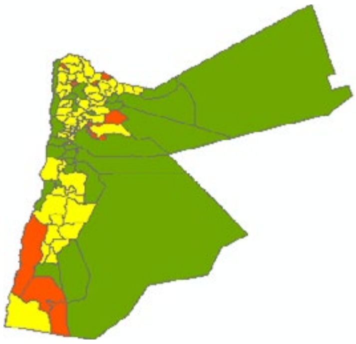


Distribution of Health Insurance
Uninsured Female 2015 (on Total Population)

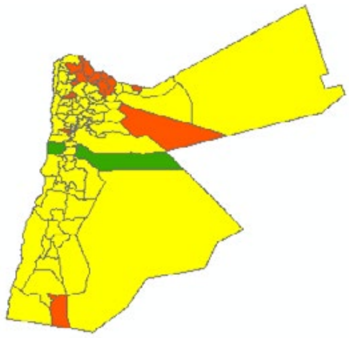
Distribution of Health Insurance
Uninsured non-Jordanians 2015 (on non-Jordanian Population)

Distribution of Health Insurance
Uninsured non-Jordanians 2015 (on Total Population)

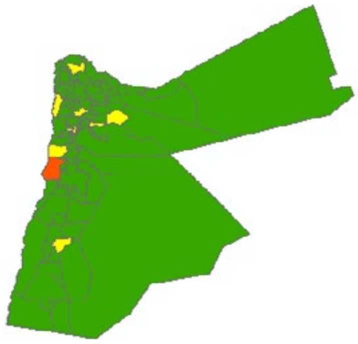
Figure 87: Distribution of health insurance of females and non-Jordanians in 2015 (Sources: DOS, 2015; WFP SDI, 2022).



Distribution of Health Insurance 2004 vs. 2015 Uninsured (on Total Population)



Distribution of Health Insurance 2004 vs. 2015 Uninsured Female (on Total Population)



Distribution of Health Insurance 2004 vs. 2015 Uninsured non-Jordanians (on Total Population)

Figure 88: Distribution of health insurance in 2004 vs. 2015 (Sources: DOS, 2004 and 2015; WFP SDI, 2022).

Distribution of Health Insurance 2004 vs. 2015 Uninsured non-Jordanians (on Total Uninsured)

Figure 89: Distribution of health insurance 2004 vs. 2015 (Sources: DOS, 2004 and 2015; WFP SDI, 2022).

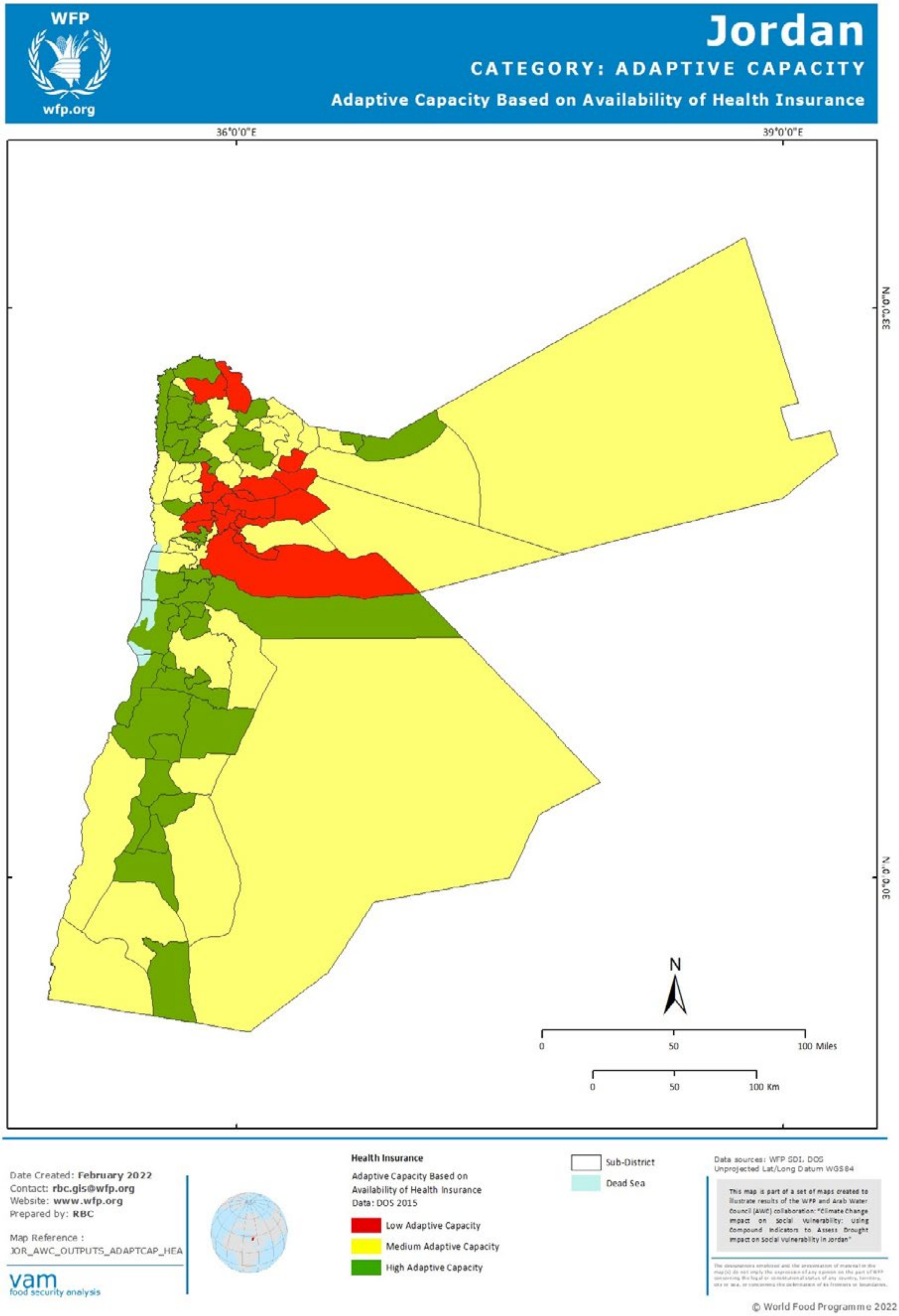


Figure 90: Adaptive capacity based on indicator "availability of health insurance".

12.6.8 New Groundwater Wells

Access to drilling groundwater wells can enhance the adaptive capacity of communities in the face of drought and water scarcity. Figure 91 displays the number of new water wells drilled between 2014 and 2015, by basin. The map is based on data provided by the Ministry of Agriculture in Jordan (2015). While new groundwater wells may have a positive immediate effect in the context of the adaptive capacity of agricultural communities, they can have a detrimental effect on groundwater aquifers, especially as aquifers in Jordan already suffer from over-extraction. For this reason, in many parts of Jordan the drilling of new wells is forbidden. Figure 92 shows the classified version for adaptive capacity based on the number of new groundwater wells. The classification was performed as shown in Table 53:

Table 53: Classification of the indicator "number of new groundwater wells" (2014-2015)

CLASSIFICATION	RANGES
High adaptive capacity	Number of new wells is > 30
Medium adaptive capacity	Number of new wells is >= -10 and < 30
Low adaptive capacity	Number of new wells is <= -10

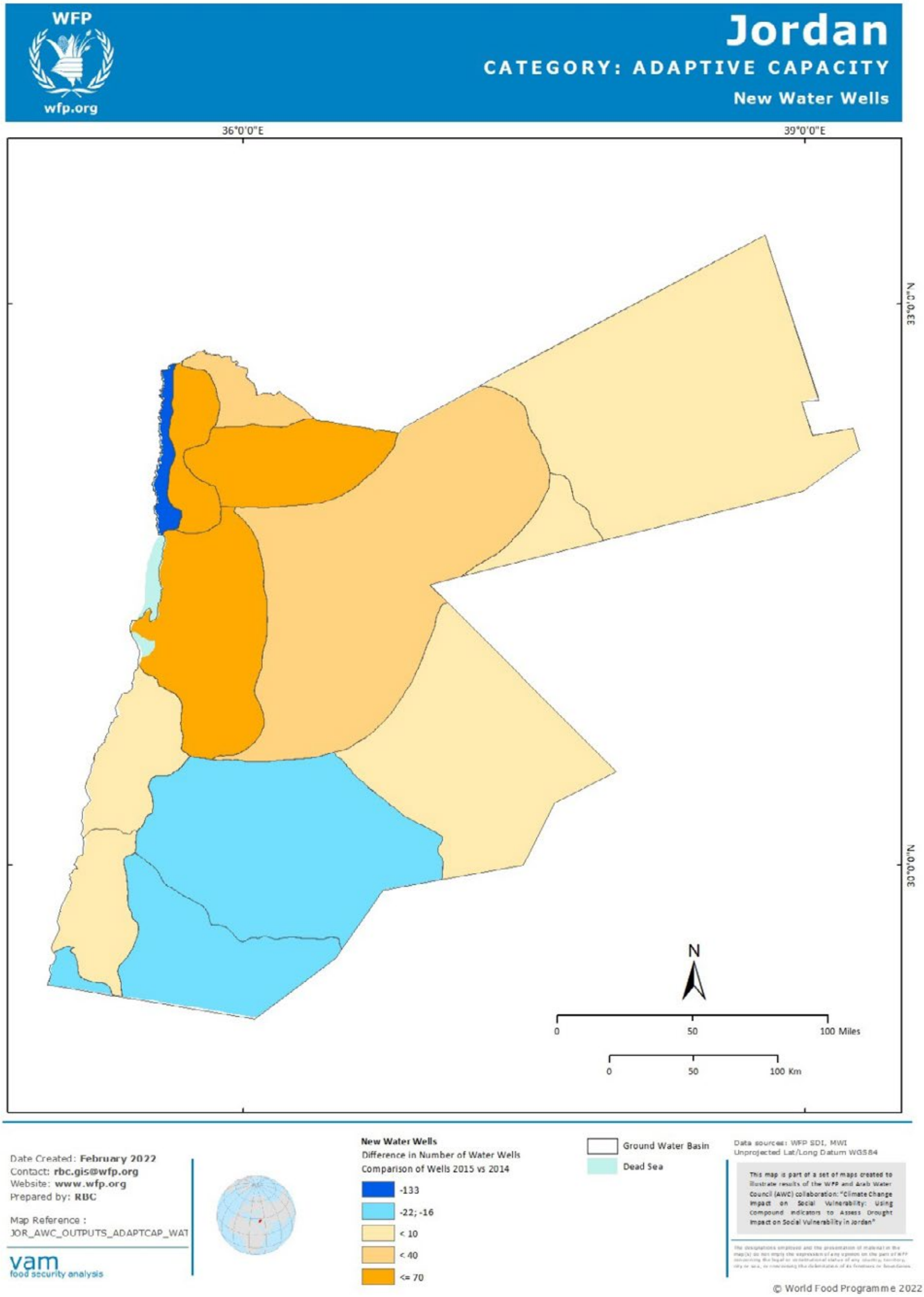


Figure 91: Number of new groundwater wells in 2015, as compared to 2014.

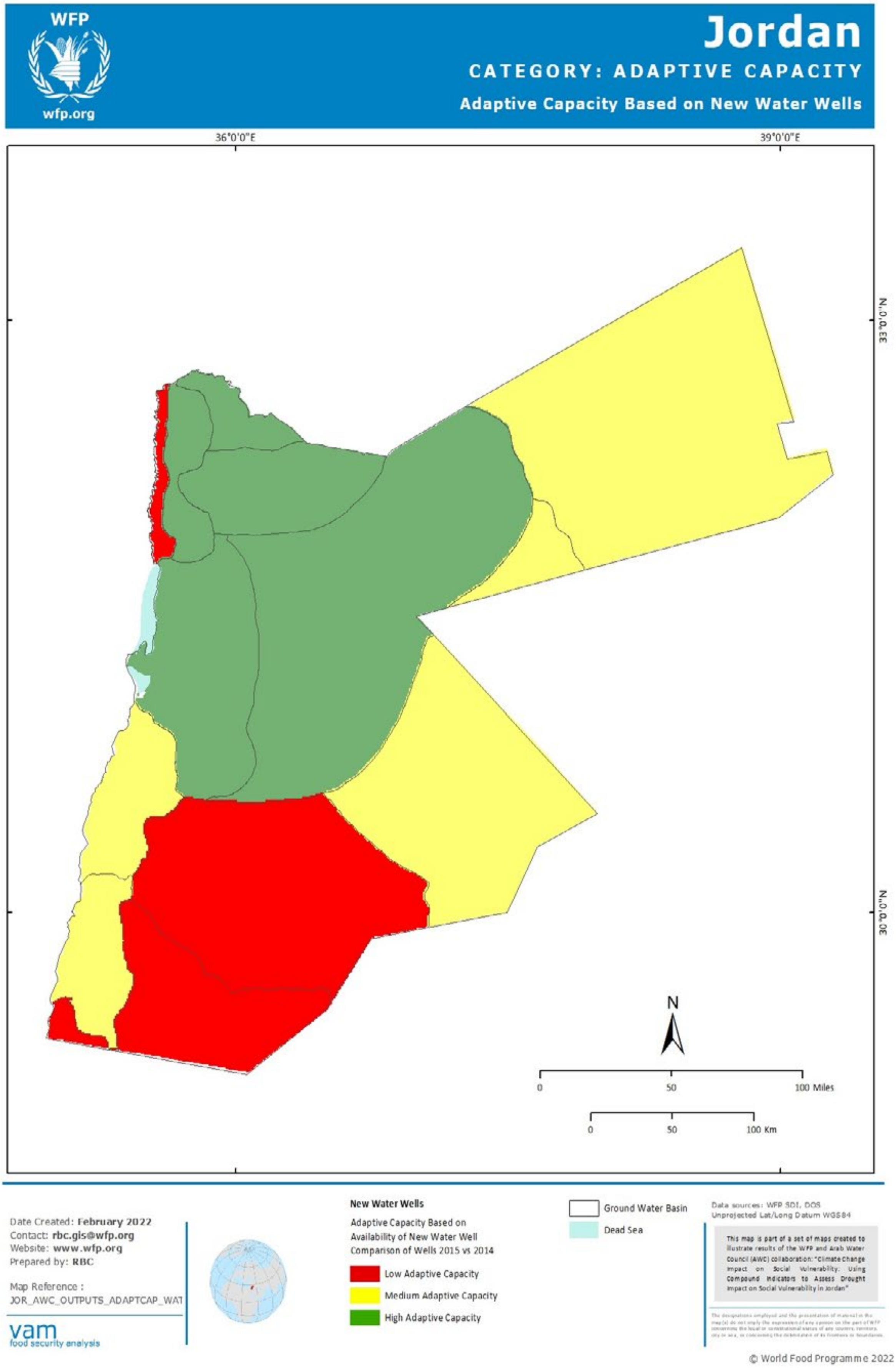


Figure 92: Adaptive capacity based on indicator "number of new groundwater wells".

12.6.9 Adaptive Capacity Analysis: Overall Results

Figure 93 shows the unweighted overall adaptive capacity results based on all adaptive capacity indicators. Figure 94 presents the overall adaptive capacity based on the weighting assigned to the various indicators by Jordanian experts. Only the weighted map was included in the overall risk calculation. Figure 95 shows the comparison between the unweighted and the weighted results. What can be seen here is that the weighting intensified the colors in the map, meaning that the experts' weighting increased both the low and high adaptive capacity scores. According to the weighted map, parts of Mafraq, Zarqa, Amman, Balqa, and Aqaba have the lowest adaptive capacity in the country. It is interesting that Irbid, which received significantly high or at least higher scores for hazard, exposure, and sensitivity, has comparatively high adaptive capacity to drought impact, according to the indicators measured (as seen in the green color). In terms of adaptive capacity, the areas of the county with higher rainfall and more vegetation have the better cards when it comes to adaptive capacity.

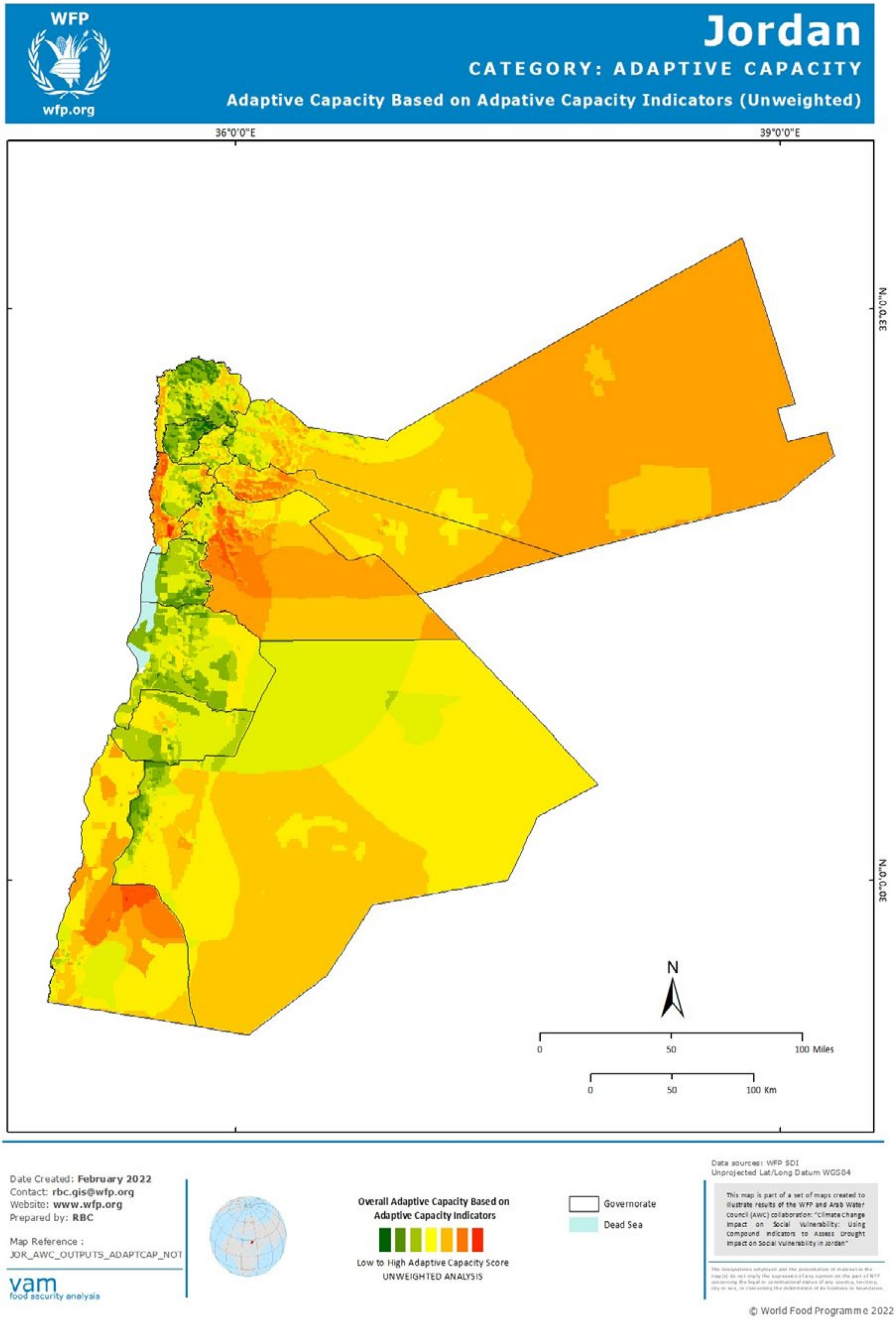


Figure 93: Overall adaptive capacity based on all adaptive capacity indicators, unweighted.

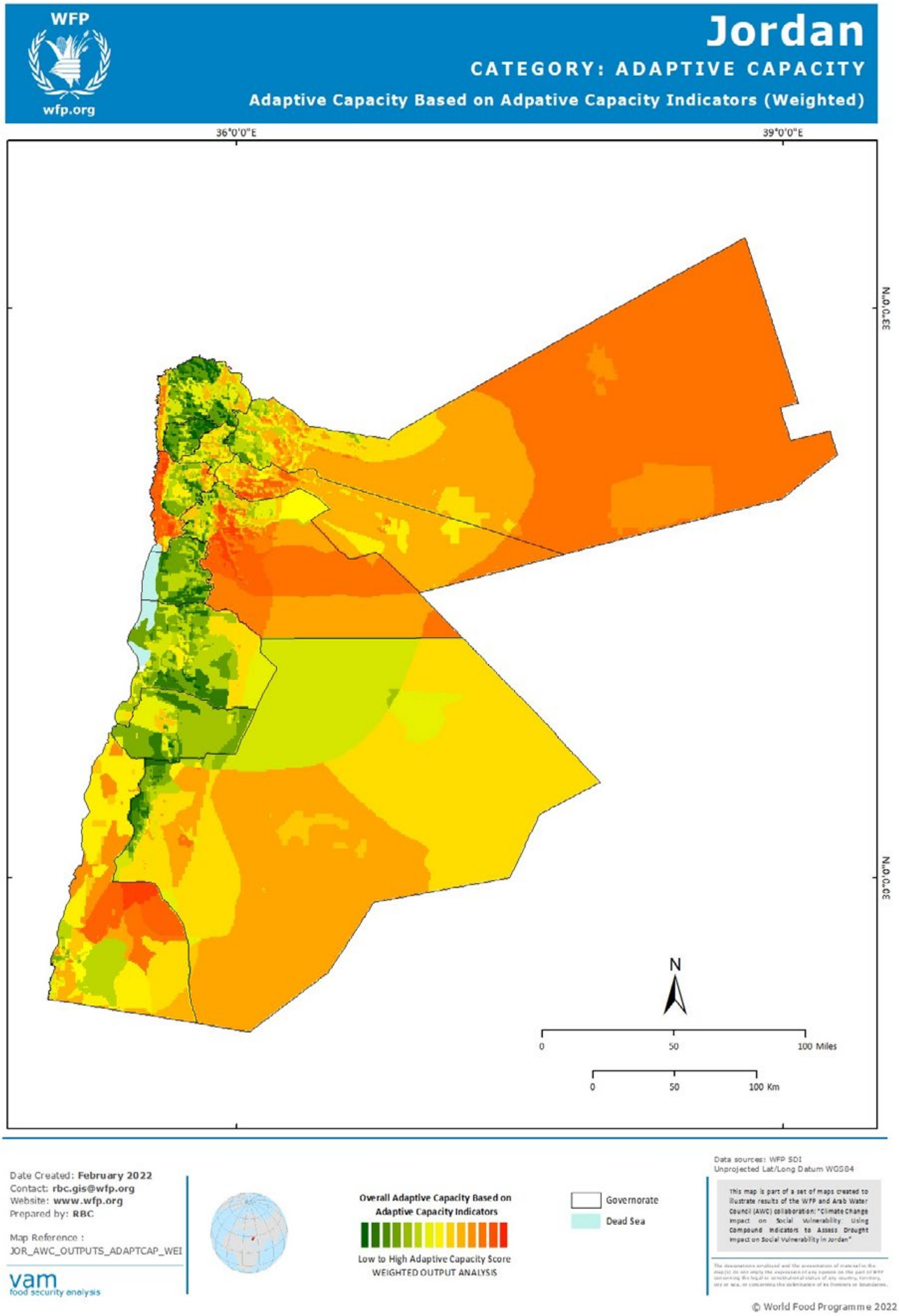


Figure 94: Overall adaptive capacity based on all adaptive capacity indicators, weighted.

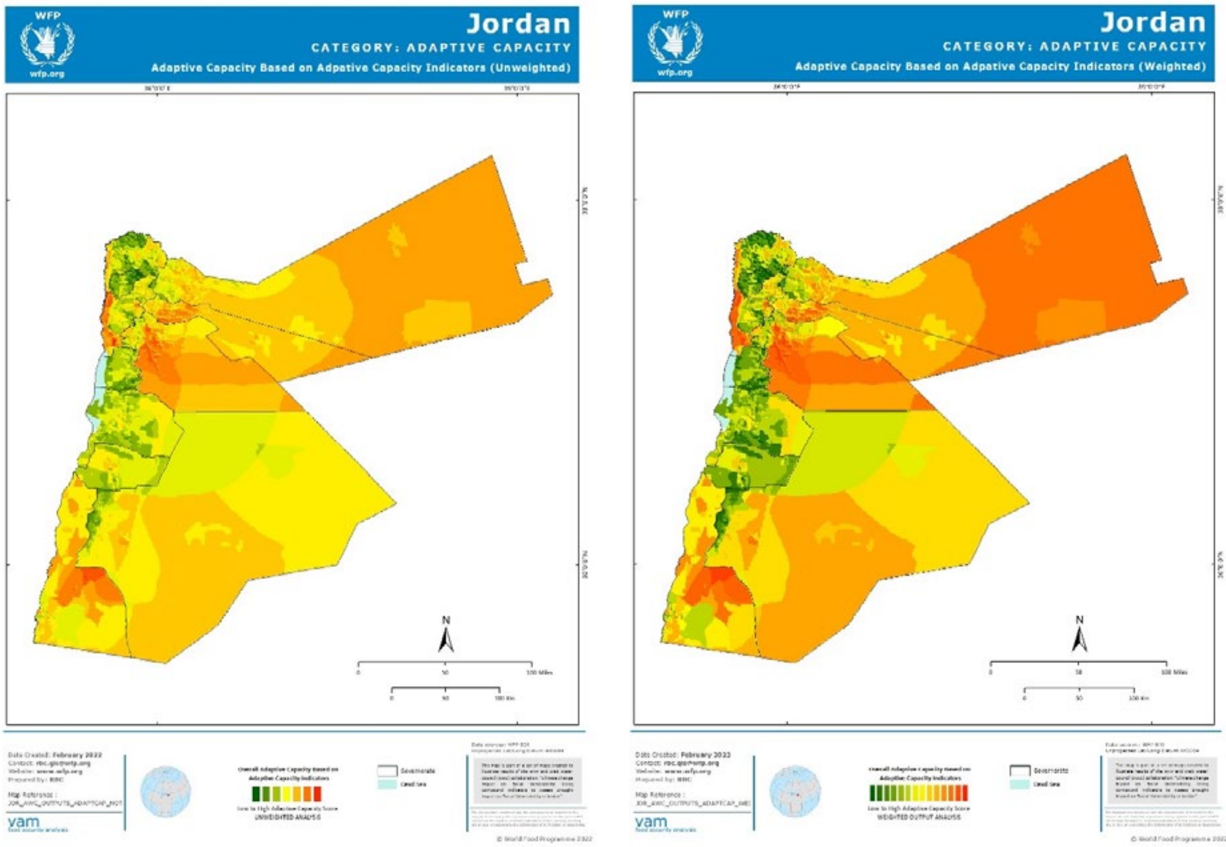


Figure 95: Comparison of unweighted (left) and weighted (right) adaptive capacity results.

When compared to the map of rangelands (Figure 96), which was already shown as Figure 47 in the section exposure, it becomes clear that the indicators ecosystem adaptive capacity and water access have a relevant impact on the final result here. Areas of Jordan that receive more than 200 mm of rainfall per year also receive the highest adaptive capacity scores.

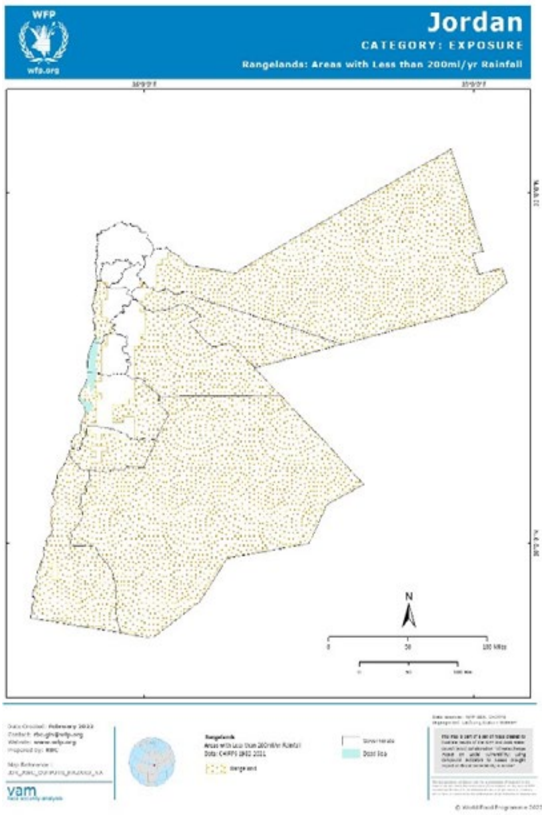


Figure 96: Rangelands (reposting of Figure 47).

12.7 Overall Vulnerability and Risk Analysis

The overall vulnerability and risk analyses are based on the individual layers and maps presented in the previous sections. The overall vulnerability assessment is a cumulative result based on the categories Exposure, Sensitivity, and Adaptive Capacity. The unweighted vulnerability map is presented in Figure 97, while Figure 98 shows the vulnerability map based on the weighting of Jordanian experts. Only the weighted map was used in the final analysis. Figure 99 shows a comparison of the unweighted and weighted vulnerability results. A comparison of the two maps in Figure 99 shows that, again, the weighting led to an intensification of colors on the map, meaning that both the low and the high vulnerability scores are stronger on the weighted map. Taking all exposure, sensitivity, and adaptive capacity indicators into account, the most vulnerable parts of the country are particularly the majority of Mafraq, as well as Irbid, Zarya, Amman, and Maan Governorates. The least overall vulnerability score is found in Aqaba Governorate.

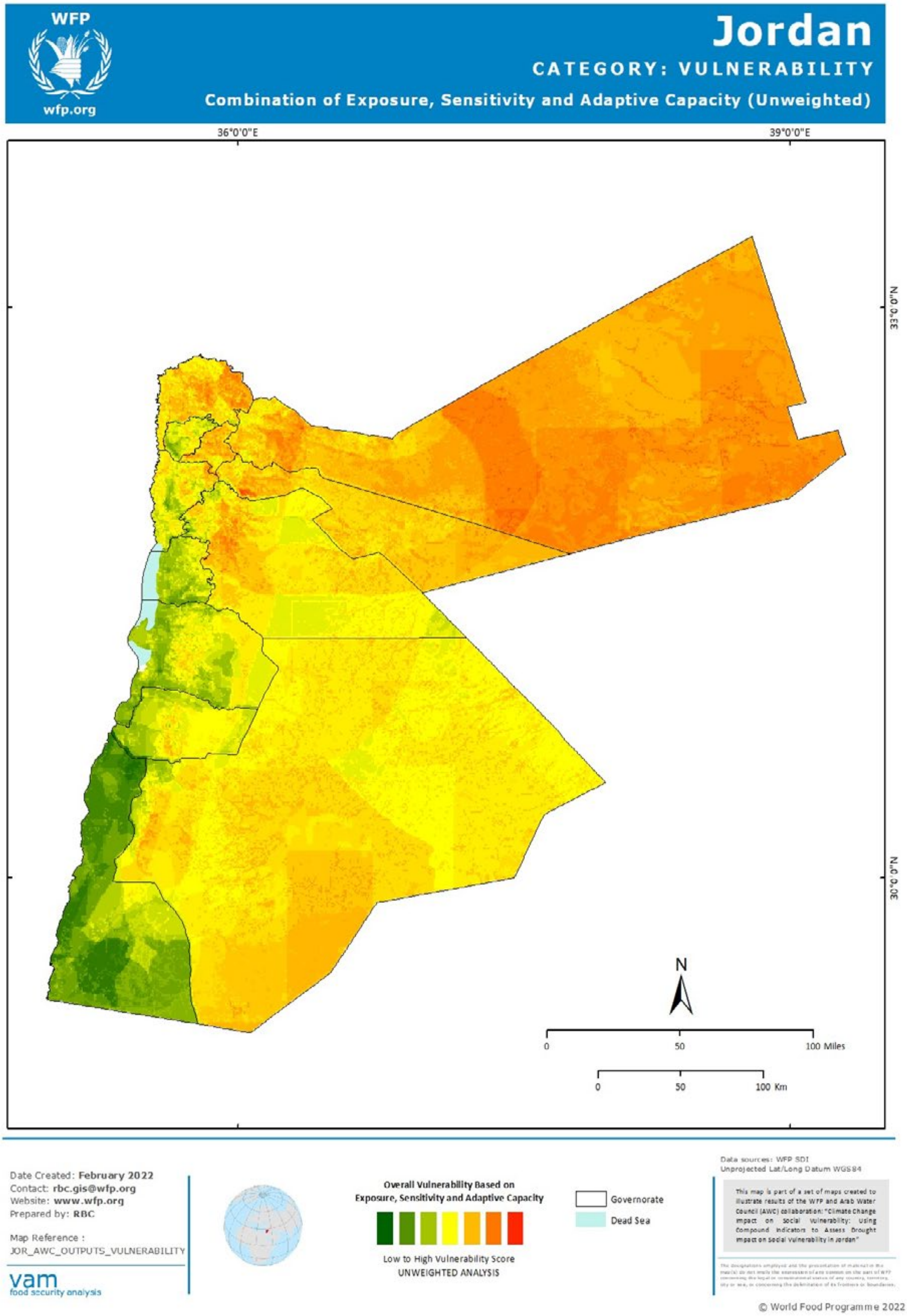


Figure 97: Overall vulnerability (based on exposure, sensitivity, and adaptive capacity), unweighted.

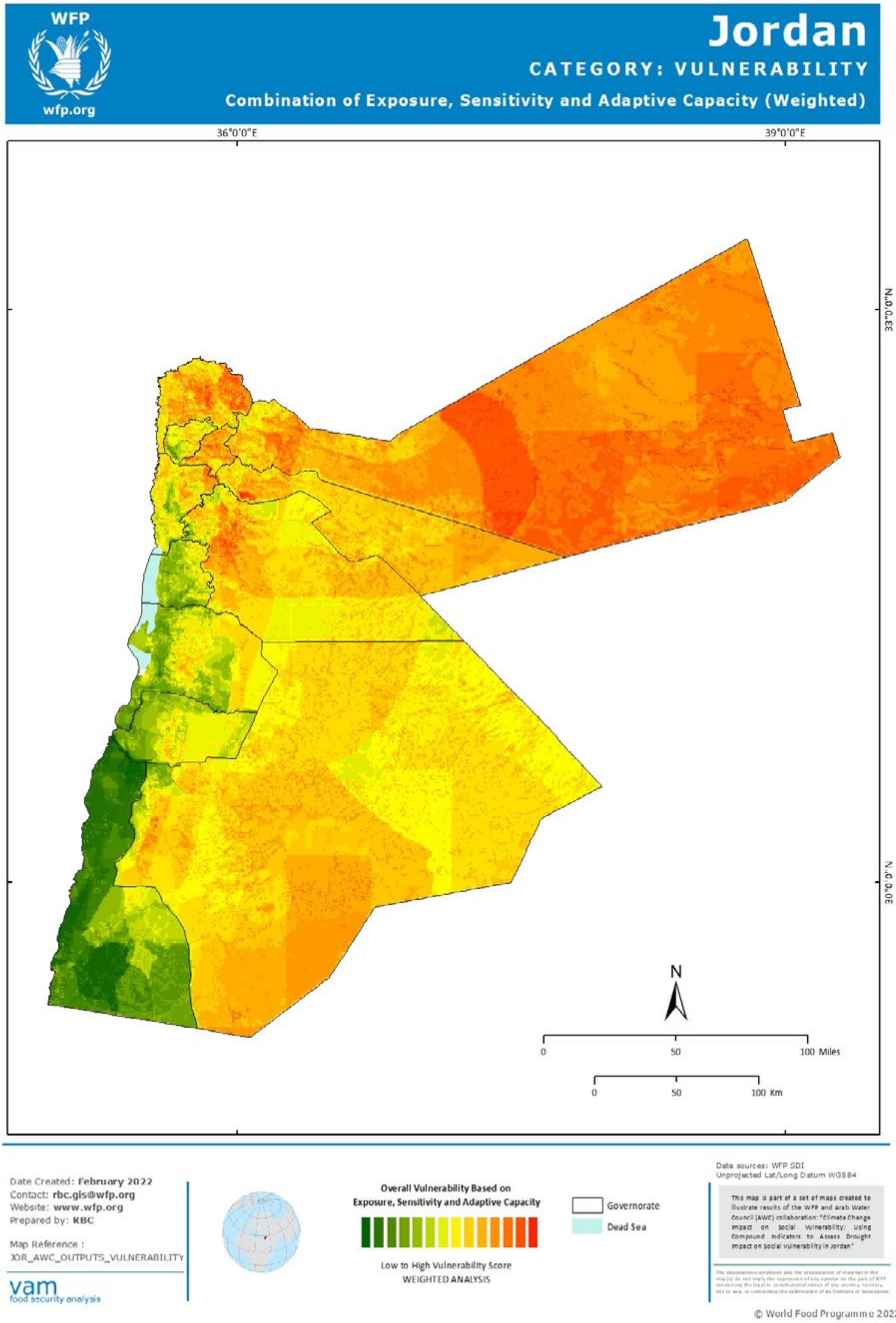


Figure 98: Overall vulnerability (based on exposure, sensitivity, and adaptive capacity), weighted.

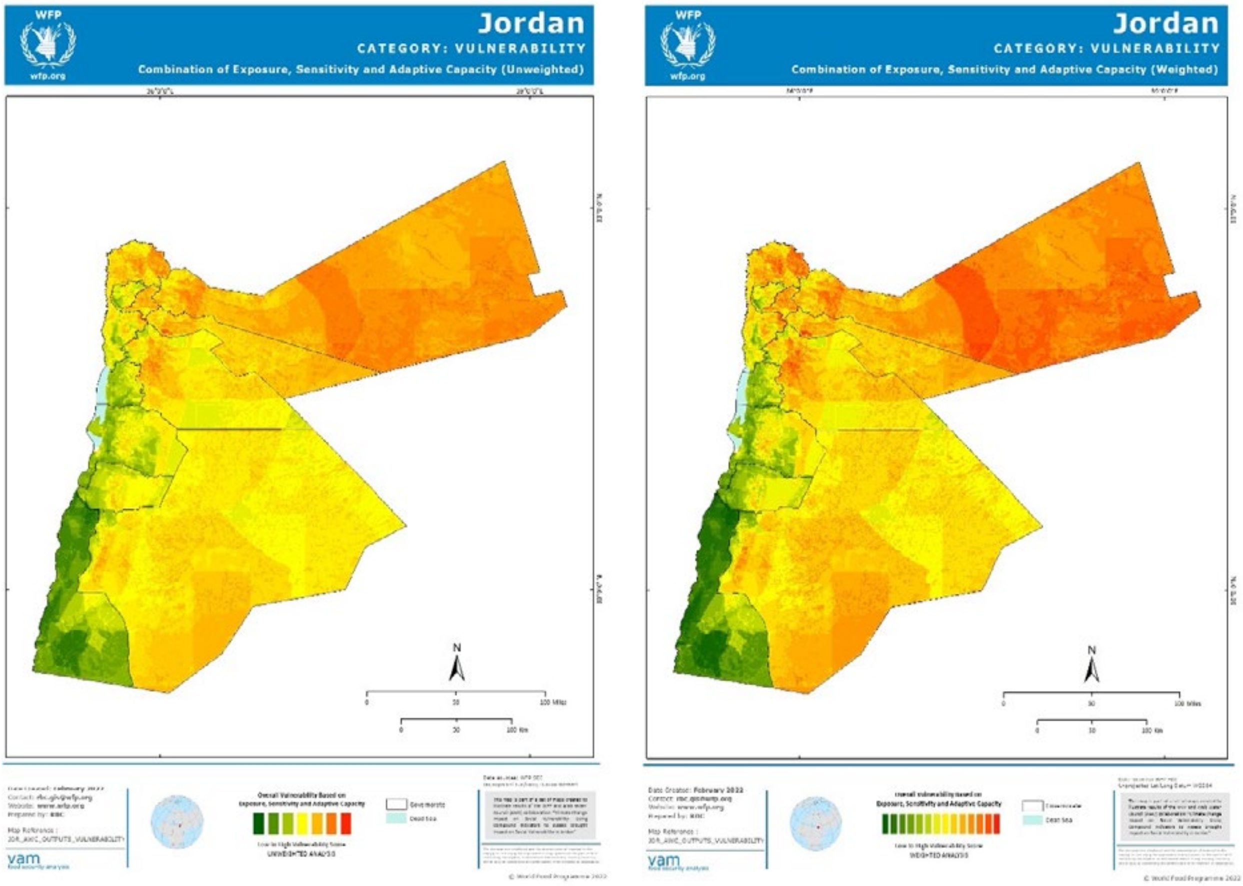


Figure 99: Comparison of the unweighted (left) and weighted (right) vulnerability results.

Based on all the afore-presented indicators and assessments, a final risk map was derived by multiplying the Vulnerability result by the Hazard – in this case, drought, as was summarized in the methodology as the following formula:

Risk =
Vulnerability (as a function of Exposure, Sensitivity, and Adaptive Capacity) x Hazard

The final unweighted risk map is presented in Figure 100, while the weighted risk map based on all indicators can be seen in Figure 101. Figure 102 shows a direct comparison between the unweighted and weighted risk maps.

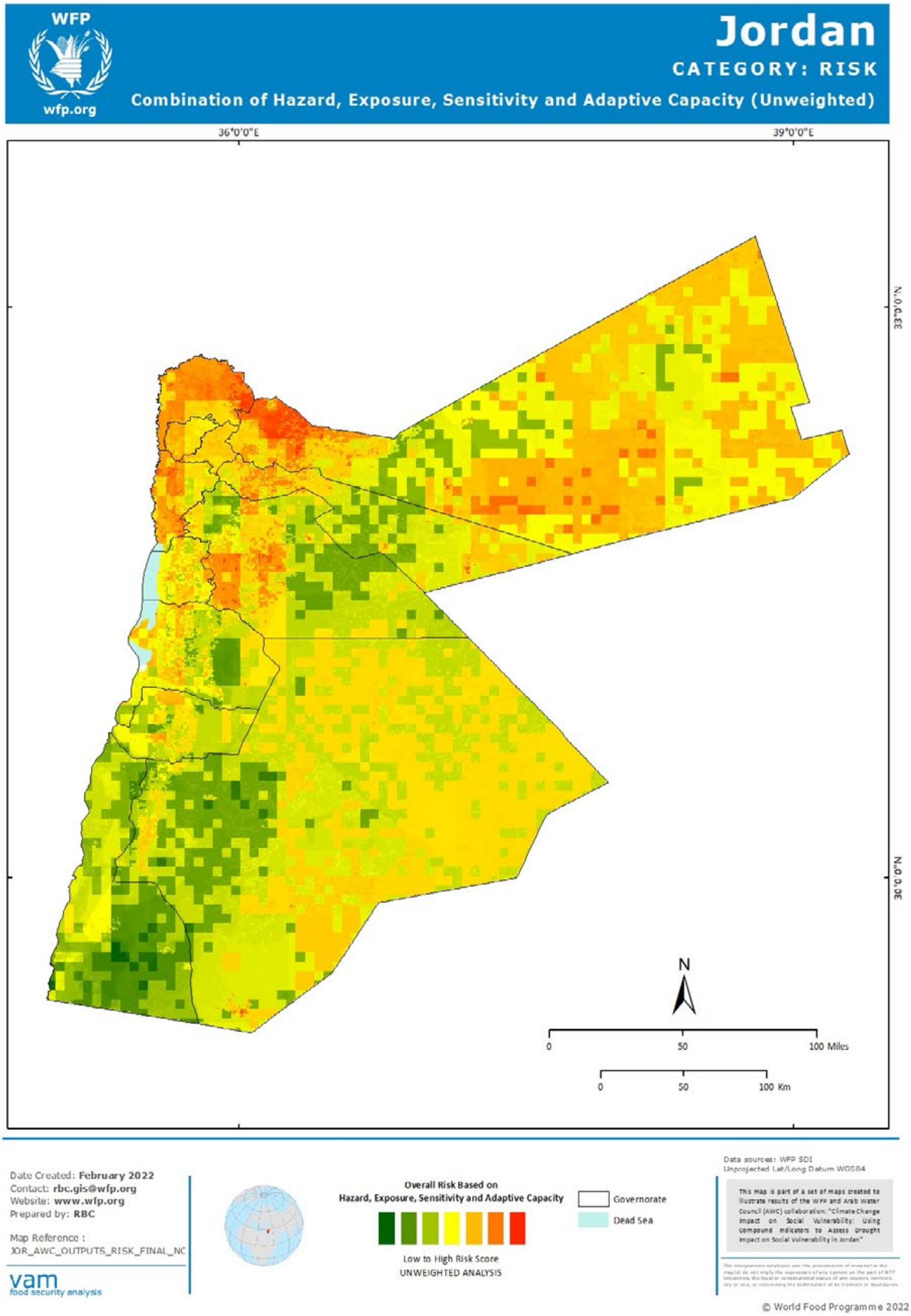


Figure 100: Overall risk based on hazard multiplied by vulnerability (as a function of sensitivity, exposure, and adaptive capacity), unweighted.

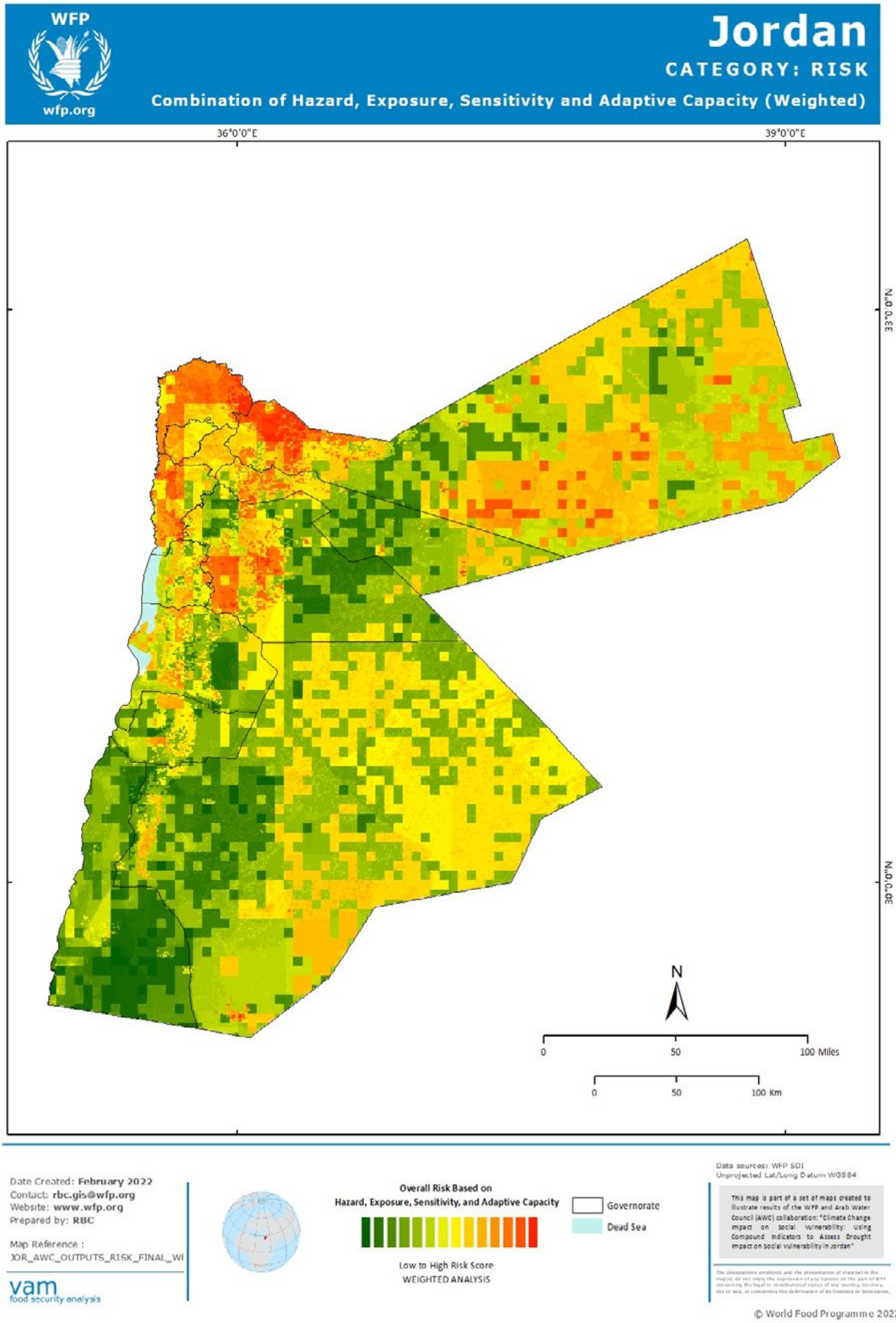


Figure 101: Overall risk based on hazard multiplied by vulnerability (as a function of exposure, sensitivity and adaptive capacity), weighted.

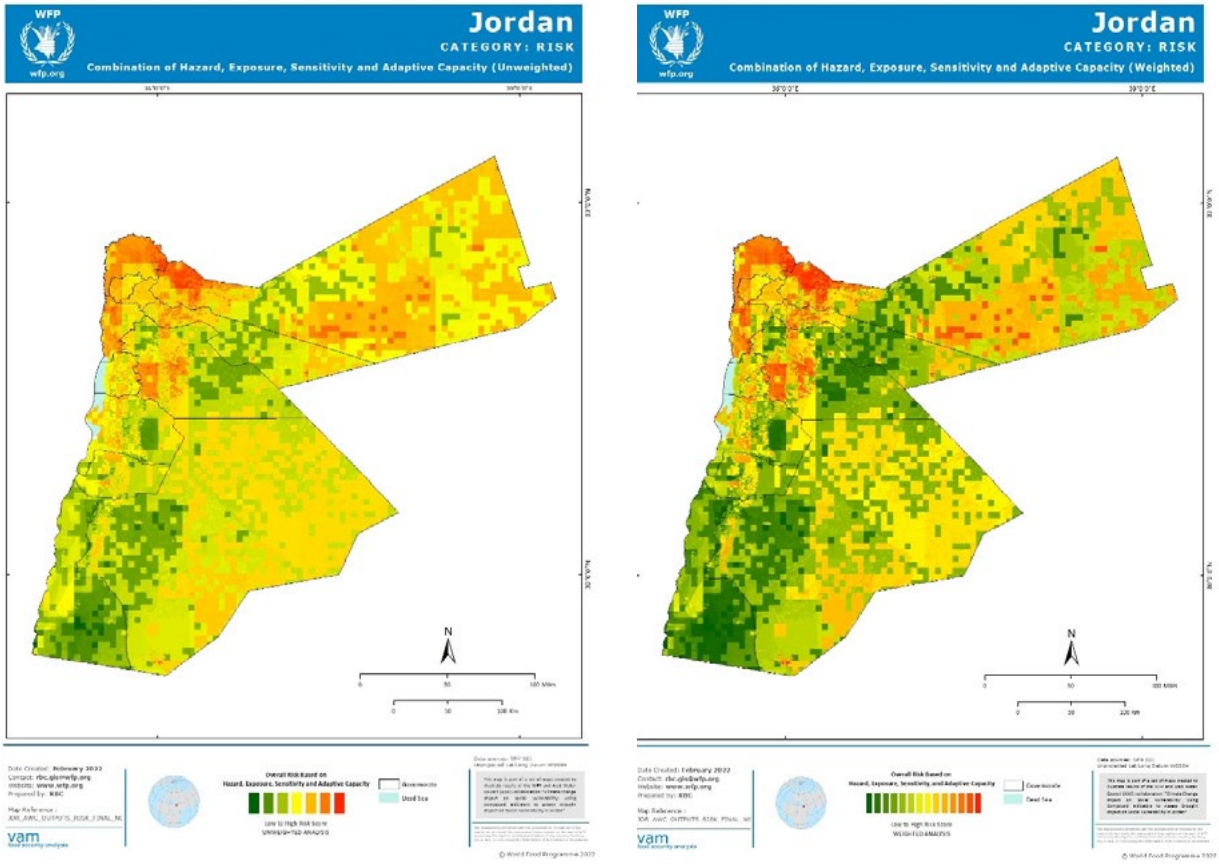


Figure 102: Comparison of unweighted (left) and weighted (right) risk results.

Again, as can be seen in the two maps presented in Figure 102, the weighting of indicators intensified the colors in the map on the right, meaning that low and high risk received higher / lower scores than in the unweighted map. Looking at overall risk, the highest risk can be found in the northern parts of the country, especially Irbid and the northwestern part of Mafraq, as well as in the northwestern parts of Zarqa and Amman. A band of low vulnerability goes across the country which very much reflects the hazard results, which has a strong weight in this analysis due to the multiplication with the hazard factor.

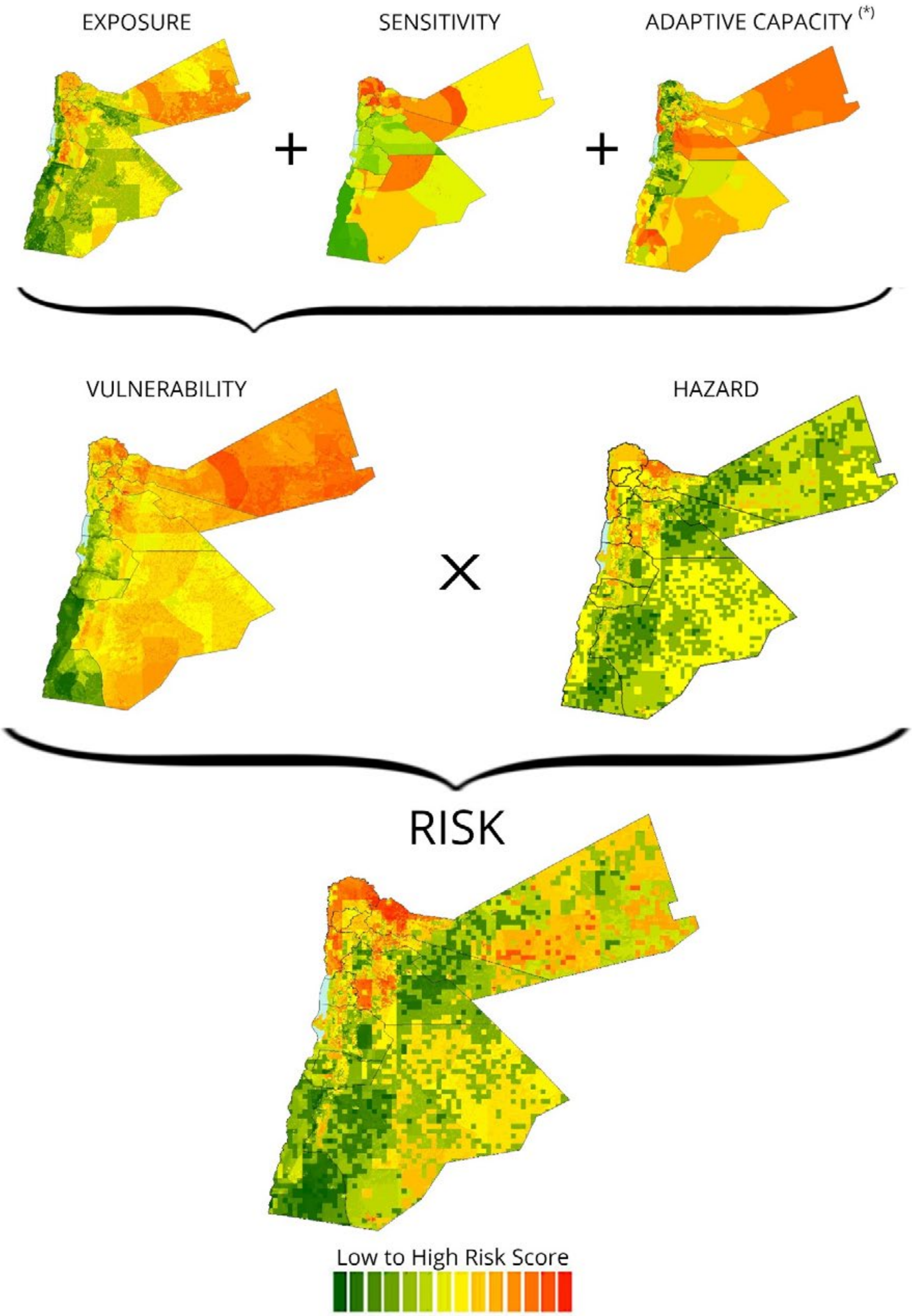


Figure 103: Overall output presented as a reflection of the methodology used. (*) Note: results for adaptive capacity were "flipped" as explained in the text.

Figure 103 presents all weighted study results at a glance, for the purpose of easier comparison. The overview of maps presented in Figure 103 sheds light on how the different elements contribute to the overall result. It is to be noted that the results for adaptive capacity were "flipped" – meaning that high adaptive capacity was assigned low numbers, making it appear green on the map, thus conforming to the green areas of low hazard, exposure, and sensitivity in the other maps ((*) in Figure 96). Thus, in the context of adaptive capacity, the color green refers to high adaptive capacity, while green also means low hazard, exposure, and sensitivity. This "flipping" made it possible to add adaptive capacity to the other layers for an overall analysis (rather than subtracting it). It should also be noted that the hazard layer has a large impact on the overall result in this methodology, as the vulnerability layer is multiplied by the hazard layer.

The highest overall drought risk is found in the northwestern part of Jordan. This result is consistent with the drought analyses recently performed by UNDP Jordan (GoAL WaSH and UNDP, 2019; UNDP, 2019). Other high drought risk areas can be found in the Governorates of Mafraq, Zarqa, and Amman.

What can be observed is that the overall risk map, which is heavily impacted by the hazard layer it is multiplied by, obscures some of the high sensitivity and low adaptive capacity issues that are particularly important in the parts of the country with medium and high exposure to drought.

What the present analysis adds is a more detailed understanding of the exposure, sensitivity, and adaptive capacity of different parts of Jordan. First, it should be noted that large parts of Jordan suffer from medium to high sensitivity and low adaptive capacity to drought impact. In the sensitivity map, for example, it can be seen that, besides the northwestern Governorates of the country, the Governorates of Mafraq, Zarqa and parts of Maan show high sensitivity to drought impact – including parts of the country that currently show lower overall drought risk. Regarding adaptive capacity to drought, only about a third of the country's landmass is classified as having high adaptive capacity. However, many of the densely inhabited parts of Jordan, with the exception of parts of Amman Governorate, show high adaptive capacity. Moreover, large parts of Mafraq and Zarqa, Amman, parts of Balqa and parts of Aqaba exhibit low adaptive capacity to drought impacts. Some of the areas that show considerable drought hazard and exposure are marked by low adaptive capacity to drought.

From a policy perspective, these maps generate an important insight into where there is need for additional policy intervention with a view to lowering sensitivity and boosting adaptive capacity. A nuanced analysis of social vulnerability based on a large number of sensitivity and adaptive capacity indicators is of paramount importance for climate change planning. Parts of the country with high vulnerability to drought may have to be addressed with socio-economic policy packages that reduce sensitivity and increase adaptive capacity. This is particularly the case as the geographical distribution of drought hazard can shift over time, meaning that areas with currently lower hazard values may face higher values in the future. For this reason, Jordan should invest in drought resilience in the identified vulnerability hotspots.

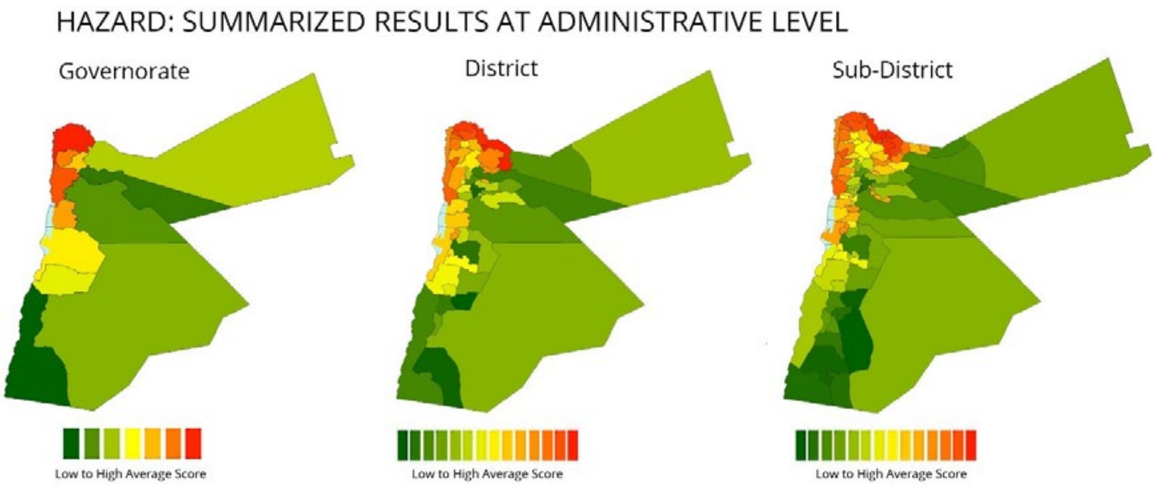


Figure 104: Summary of hazard results at different administrative levels.

In order to facilitate an easier use of the maps for policy-makers, the final results were also mapped at the different administrative levels – the first (Governorate), second (District), and third (Sub-District) level, based on the average overall score of these administrative units, as shown in Annex 4. Figure 104 depicts the overall hazard analysis, analyzed by Governorate (by creating an average score per Governorate, District, and Sub-District, based on all hazard layers). Regarding drought hazard at administrative levels (Figure 104), the Governorates located in the far northwestern part of the country – Irbid, Ajlun, Balqa, and to a lesser extent Jerash and Madaba received the highest overall score, meaning the highest average overall drought hazard. This picture becomes more refined when zooming into the District level. Here it becomes evident that Ar-Ramtha (both District and Sub-District) in Irbid Governorate and Al-Badiah Ash-Shamalieh Al-Gharbieh in Mafraq are faced with a high drought hazard, as well as the Districts (and Sub-Districts) Bani Kinana, Al Wastiyya, At Taibeh, Qasabet Irbid and Al Kora. In the Governoate of Ajloun, Kufranjah has a high average score, as well as Al Aredah, Dair Alla, Ash Shuna al-

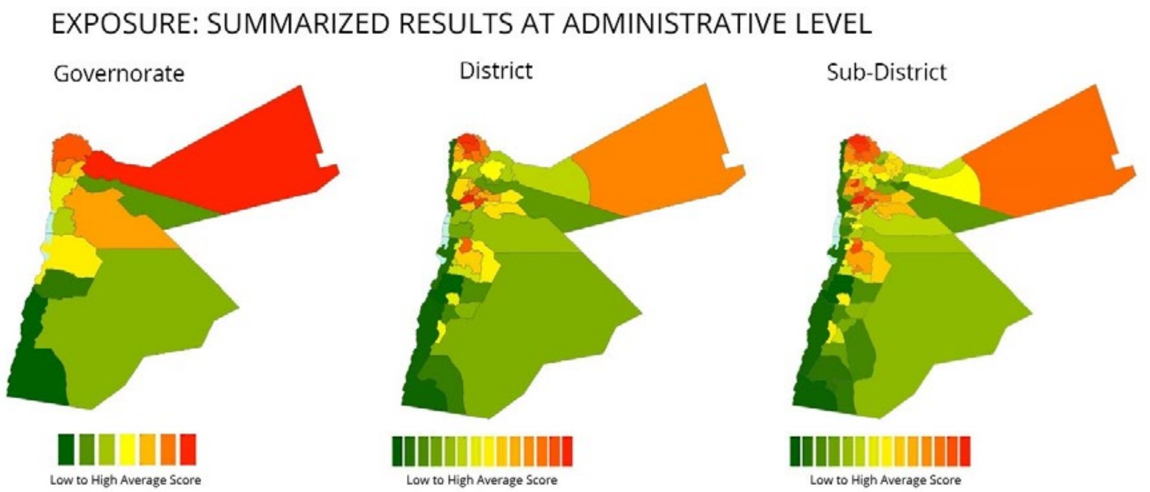


Figure 105: Exposure results presented at different administrative levels (Sources: WFP SDI, several other sources, see above).

Janubiyya in Balqa Governorate. In the map at Sub-District level, the view becomes even more refined. In addition to the Sub-Districts already named, Husah, Sama As Sarhan, and Al-Badiah Ash-Shamalieh Al-Gharbieh (Al-Badiah Ash-Shamalieh Al-Gharbieh) have a high average hazard score. Figure 105 shows the drought exposure results presented for different administrative levels in Jordan.

At Governorate level, Mafraq receives the highest average exposure score, followed by Irbid and Ajloun. In the more refined picture at District level, it becomes clear that the eastern parts of Mafraq are more exposed to drought than the western parts of the Governorate. The highest exposure rates here can be found in parts of Amman (Wadi As Sir, Al Jameh, Al Qwaismeh). In Irbid Governorate, all Districts show high exposure score, except for Ash Shuna Ashamalya Sub-District in Al-Aghwar Ash-Shamaliyah District. Other Sub-Districts with high exposure scores are Zay Sub-District in Qasabet Al-Balqa District in Balqa Governorate, Al Qaser (Sub-District and District) in Karak, and Al Rawashed (also District) in Mafraq.

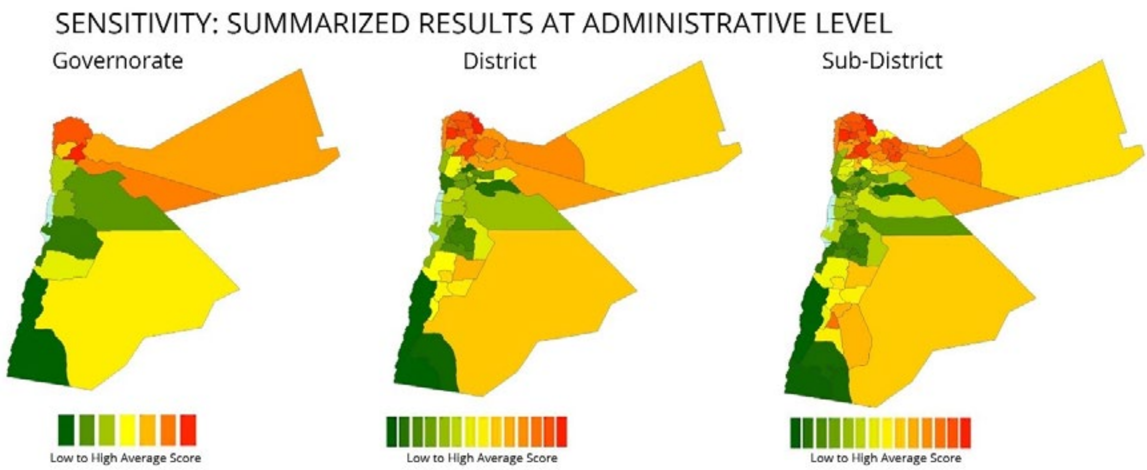


Figure 106: Sensitivity results presented at different administrative levels.

Figure 106 presents the sensitivity results for different administrative levels of government.
In terms of sensitivity, the Governorates with the highest sensitivity are Ajloun, followed by Irbid, Zarqa, and Mafraq. On the District and Sub-District levels, Ar-Ramtha is showing a very high average sensitivity score, as well as Berma and Qesabet Jerash in Jerash Governorate, as well as Kora and and Mazar El Shamali (both Districts and Sub-Districts) in Irbid. A slightly lower, but still very high overall average score is found in Bani Kinana, Bani Obaid, and Qasabet Irbid (all Districts and Sub-Districts) in Irbid Governorate. In Mafraq, El Badiah Ash Shamaliyya Al Gharbeh and Qasabet Al Mafraq (both Districts and Sub-Districts), as well as Khalediah in Badiah Ash-Shamalieh Al Gharbeh, Mafraq, have high scores. A relatively high score that sticks out in comparison to its surrounding areas is the Sub-District of Ail in Maan District, Maan Governorate.

Figure 107 shows the adaptive capacity results by different administrative levels.

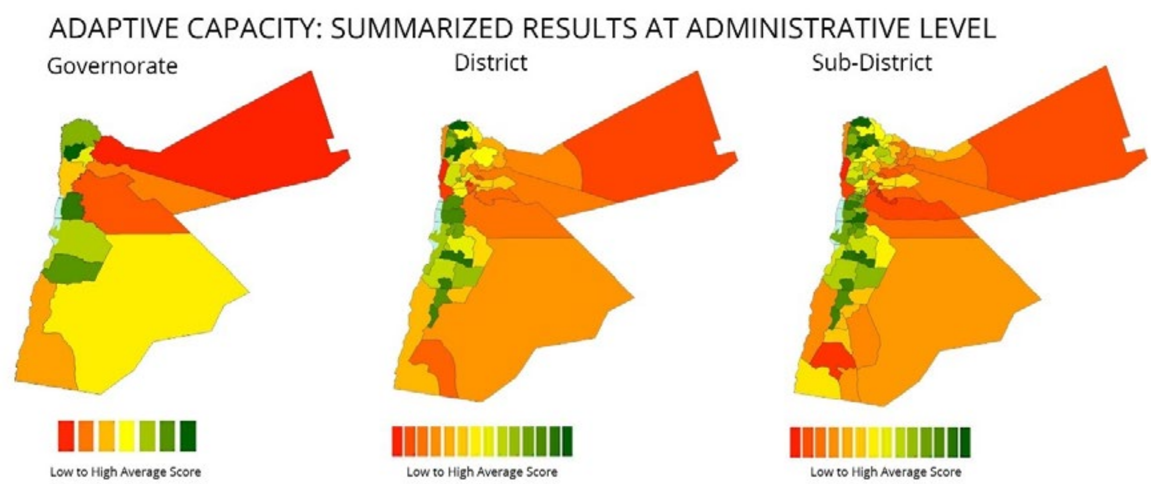


Figure 107: Adaptive capacity results presented at different administrative levels.

Regarding adaptive capacity results, Maan Governorate receives the lowest overall scores, translating to a low adaptive capacity (given that numbers were flipped), followed by Amman Governorate, and then Zarqa and Aqaba. At the District and Sub-District level, Dair Alla and Ash Shuna Janubiyya in Balqa stick out (both have the same name at District and Sub-District level). Further, Qwaira (District and Sub-District) in Aqaba Governorate, Qwaismeh (District and Sub-District) in Amman, Rujm Ash Shami in Al-Muaqqar District in Amman, and Qasabet Amman (District and Sub-District) in Amman Governorate receive low adaptive capacity scores. Rusayfa (District and Sub-District) in Zarqa Governorate exhibits a very low average adaptive capacity score. In Mafraq, Rwashed (District and Sub-District) show the lowest adaptive capacity score. As can be seen in the map, numerous other Districts and Sub-Districts are orange, meaning that there is considerable work to be done to enhance the adaptive capacity of communities in Jordan.

Figures 108, 109, and 110 show the overall vulnerability at different administrative levels in Jordan. At Governorate level, the highest overall vulnerability can be seen in Mafraq Governorate, followed by Jerash, Irbid, Zarqa and Maan. At District and Sub-District levels, the highest vulnerability can be found in again in Rwashed (District and Sub-District), Qasabet A Mafraq (District and Sub-District), and Badiah Ash Shamaliyya Al Gharbeh (District and Sub-District), as well as As Saleheyyeh Sub-District in Badia El Shamaliya District in Maan Governorate, Ramtha (District and Sub-District) and Qasabet Irbid (District and Sub-District) in Irbid Governorate, and Rusayfa (District and Sub-District) in Zarqa. Again, Ail in Maan District, Maan Governorate, also shows a higher overall vulnerability score than its surrounding Districts. When comparing the Sensitivity, Adaptive Capacity, and Vulnerability scores, a trend can be seen that will help policy-makers identify the hotspots of social vulnerability in Jordan. It is on such sensitive, vulnerable communities with low adaptive capacity that social protection policies and resilience-building strategies can be focused.

Figures 111, 112, and 113 present the overall drought risk at different administrative levels in Jordan. In terms of overall risk (after multiplication with the hazard layer), Irbid, followed by Balqa, Ajloun and Jerash have the highest overall average risk scores. At the District and Sub-District level, Qasabet A Mafraq (District and Sub-District), Manesheih Sub-District in Qasabet A Mafraq District, Badiah Ash Shamaliyya Al Gharbeh (District and Sub-District), Khalediah Sub-District, Husah Sub-District, and Sama As Sarhan all in Badiah Ash Shamaliyya Al Gharbeh District, as well as Umm Al Jemal Sub-District in Badia Al Shamaliyya District have very high overall scores. Further high overall average risk scores are found in Ramtha (District and Sub-District), Bani Kinana (District and Sub-District), Qasabet Irbid (District and Sub-District), Wastiyya (District and Sub-District), Taibeh (District and Sub-District), and Kora (District and Sub-District) in Irbid Governorate. As can be seen on the map, there are numerous other Districts with considerable risk scores that have not been listed here.
Figure 114 adds another element of analysis to the map by combining the overall vulnerability layers in different ways in order to show the impact of specific layers on the overall result.

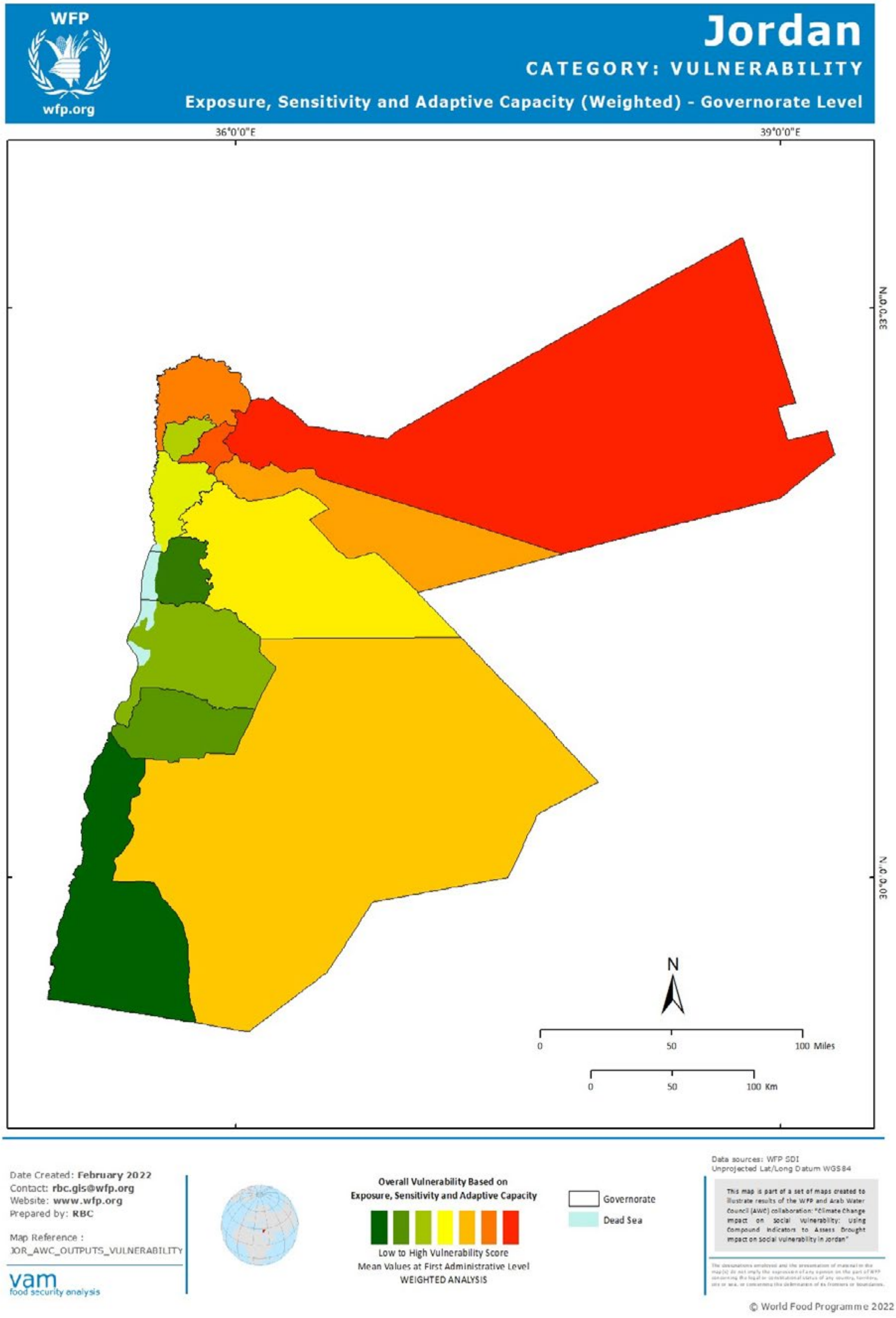


Figure 108: Mean overall vulnerability score at first administrative level (Governorates).

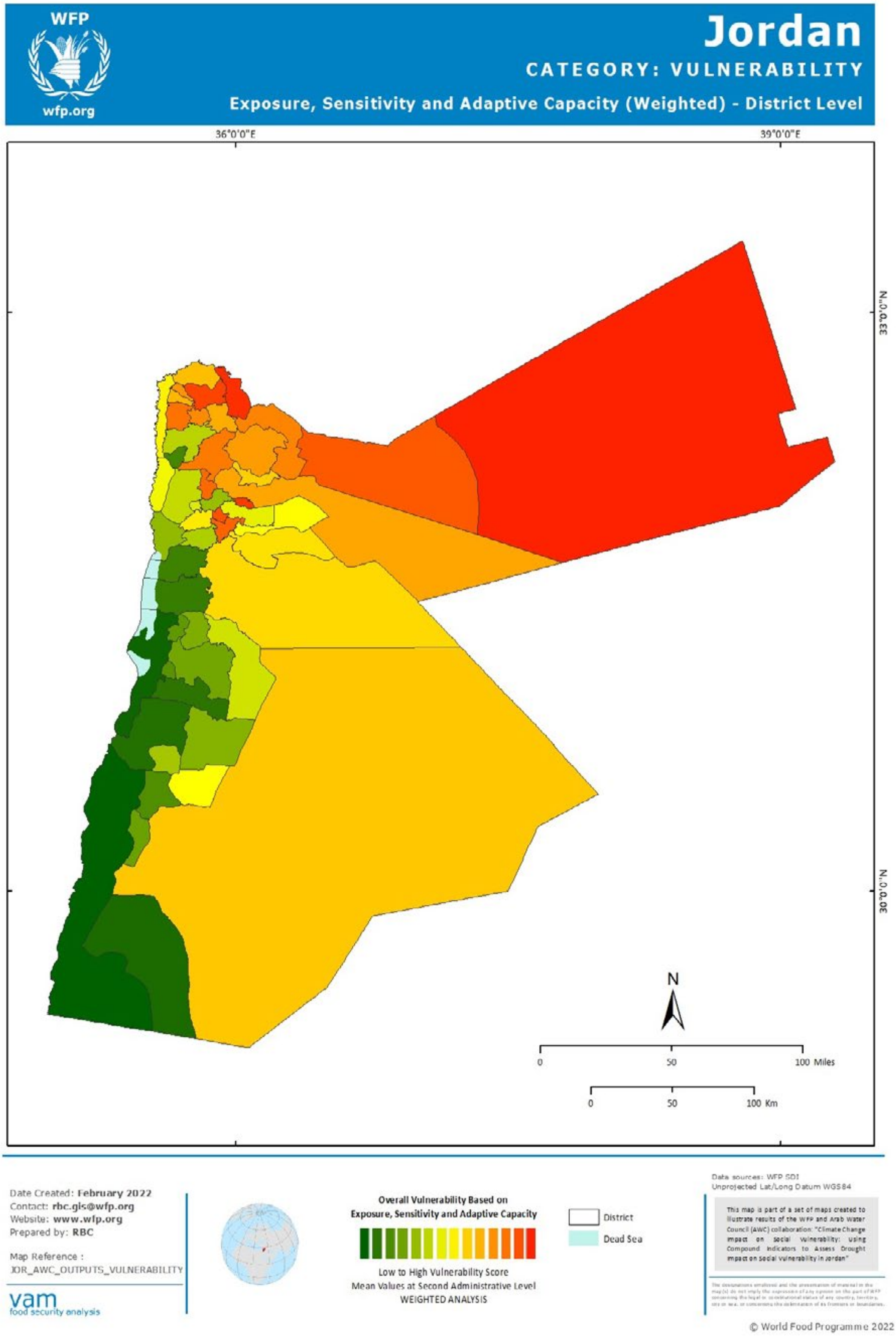


Figure 109: Mean overall vulnerability score at second administrative level (Districts).

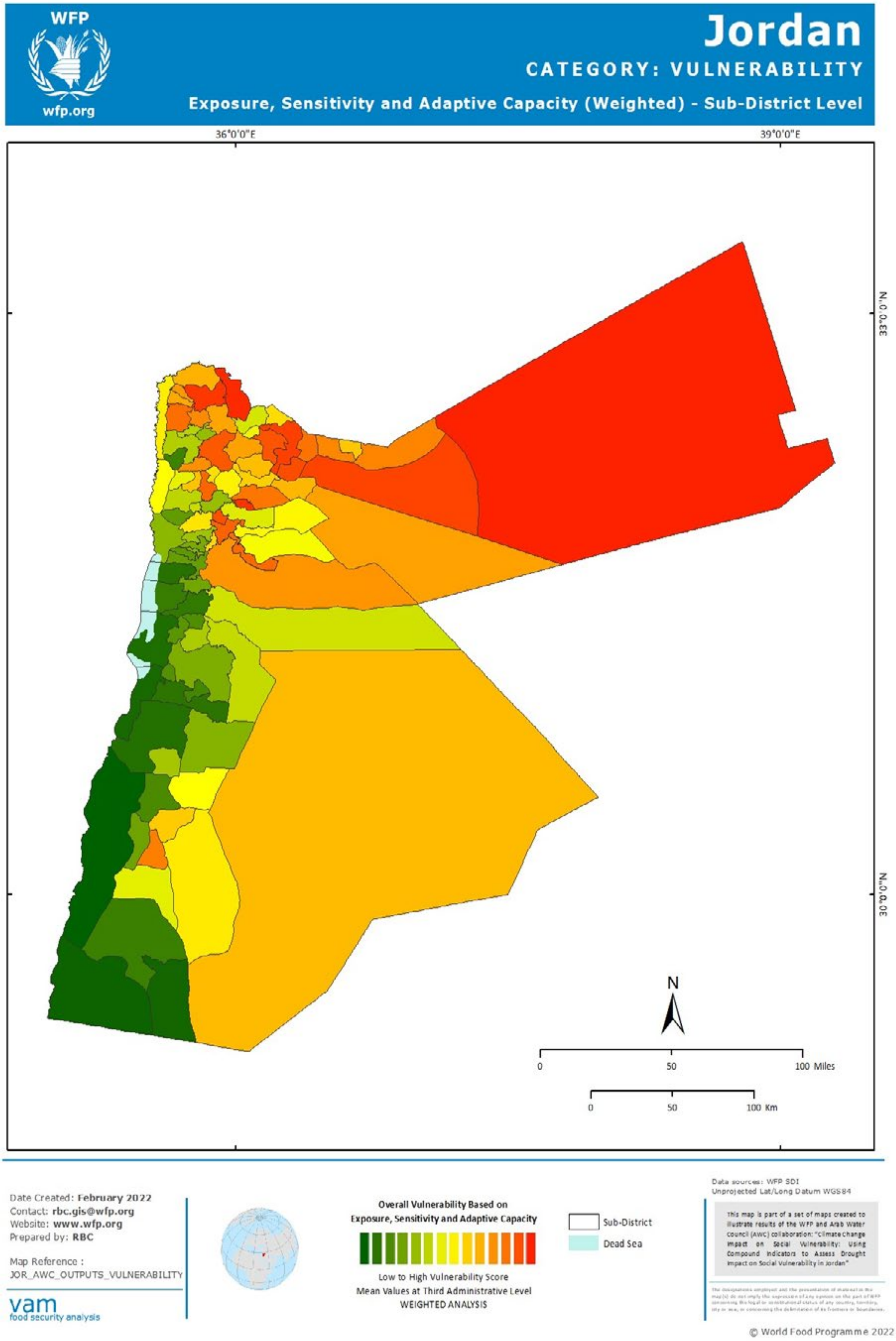


Figure 110: Mean overall vulnerability score at third administrative level (Sub-Districts).

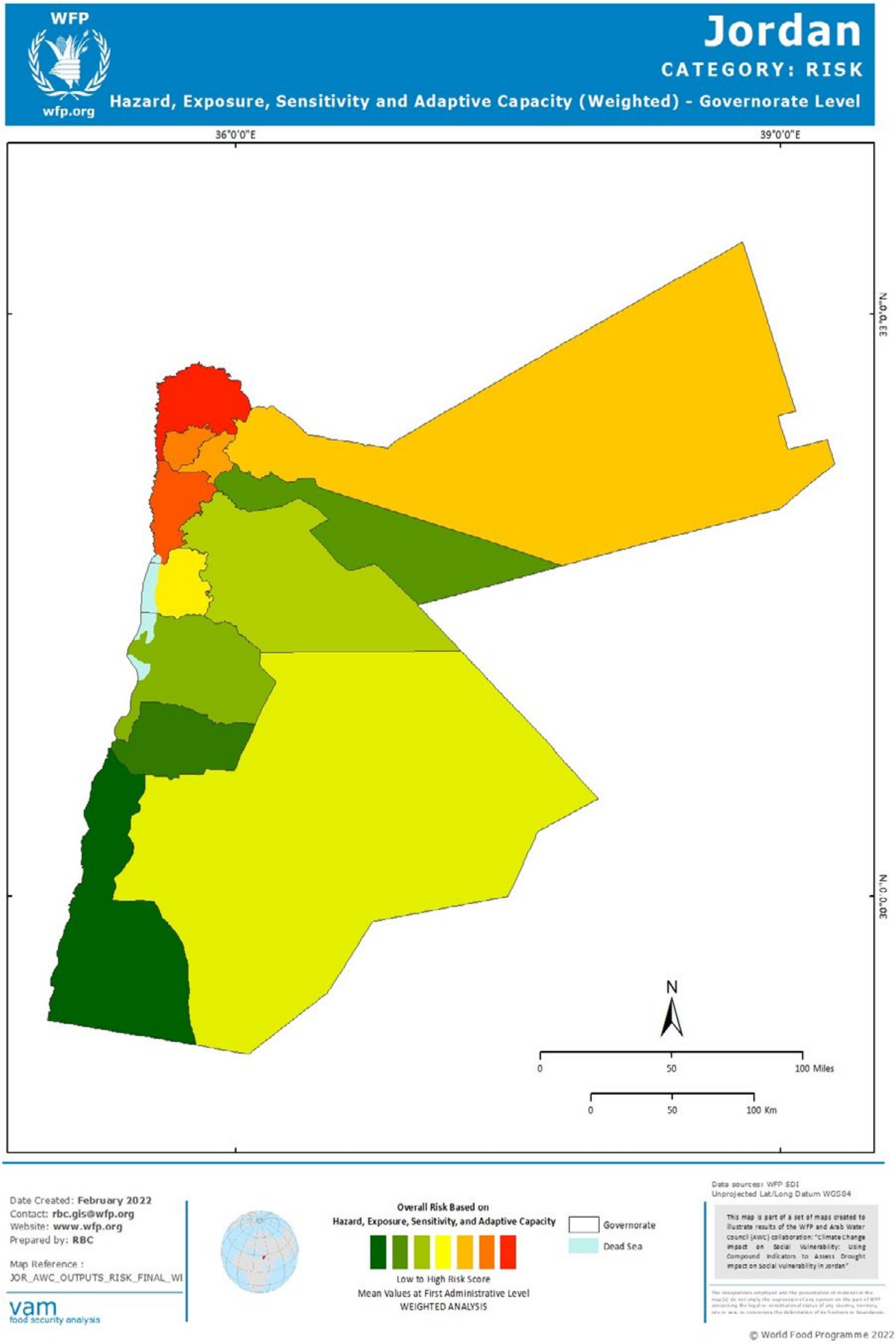


Figure 111: Mean overall risk score at first administrative level (Governorates).

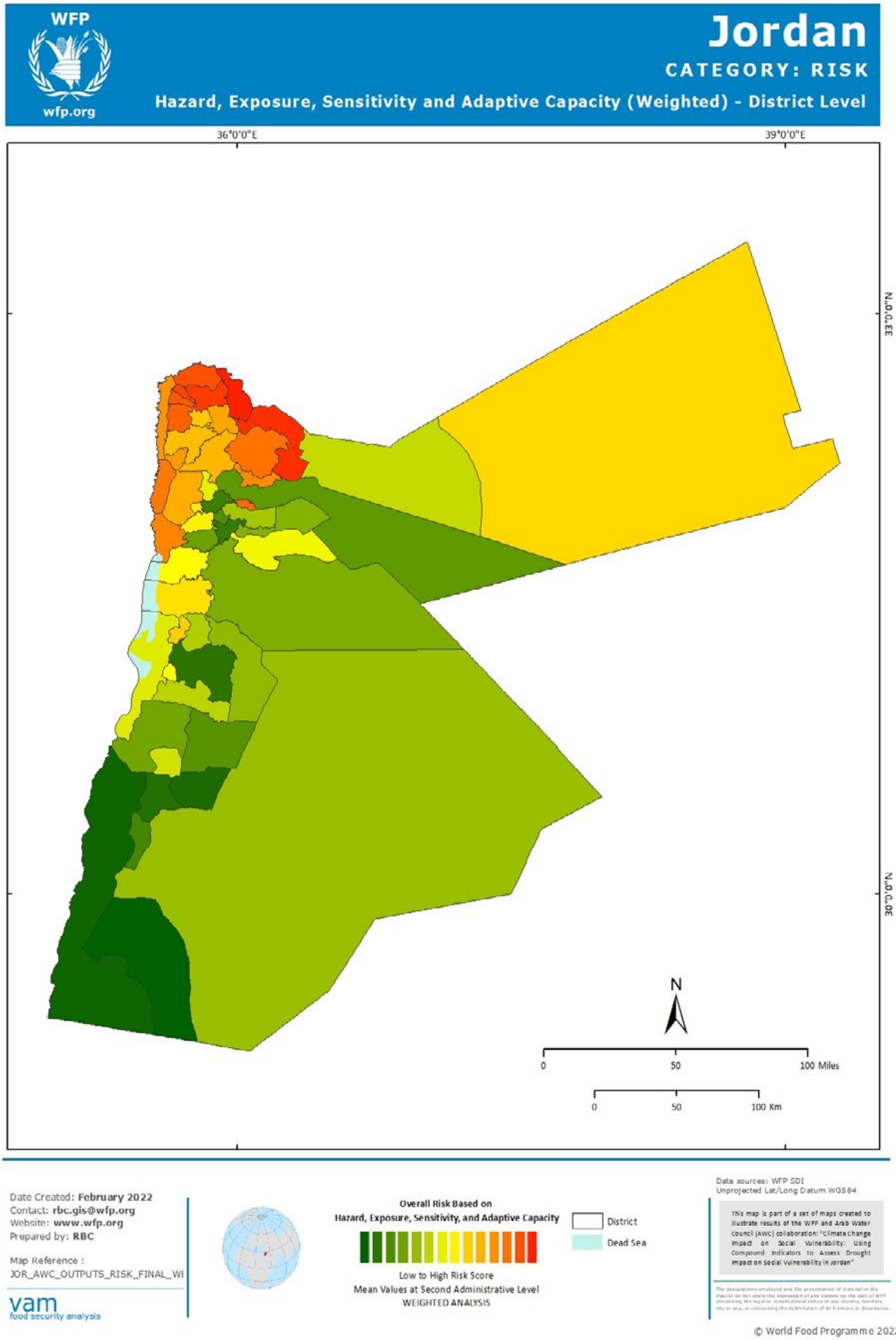


Figure 112: Mean overall risk score at second administrative level (Districts).

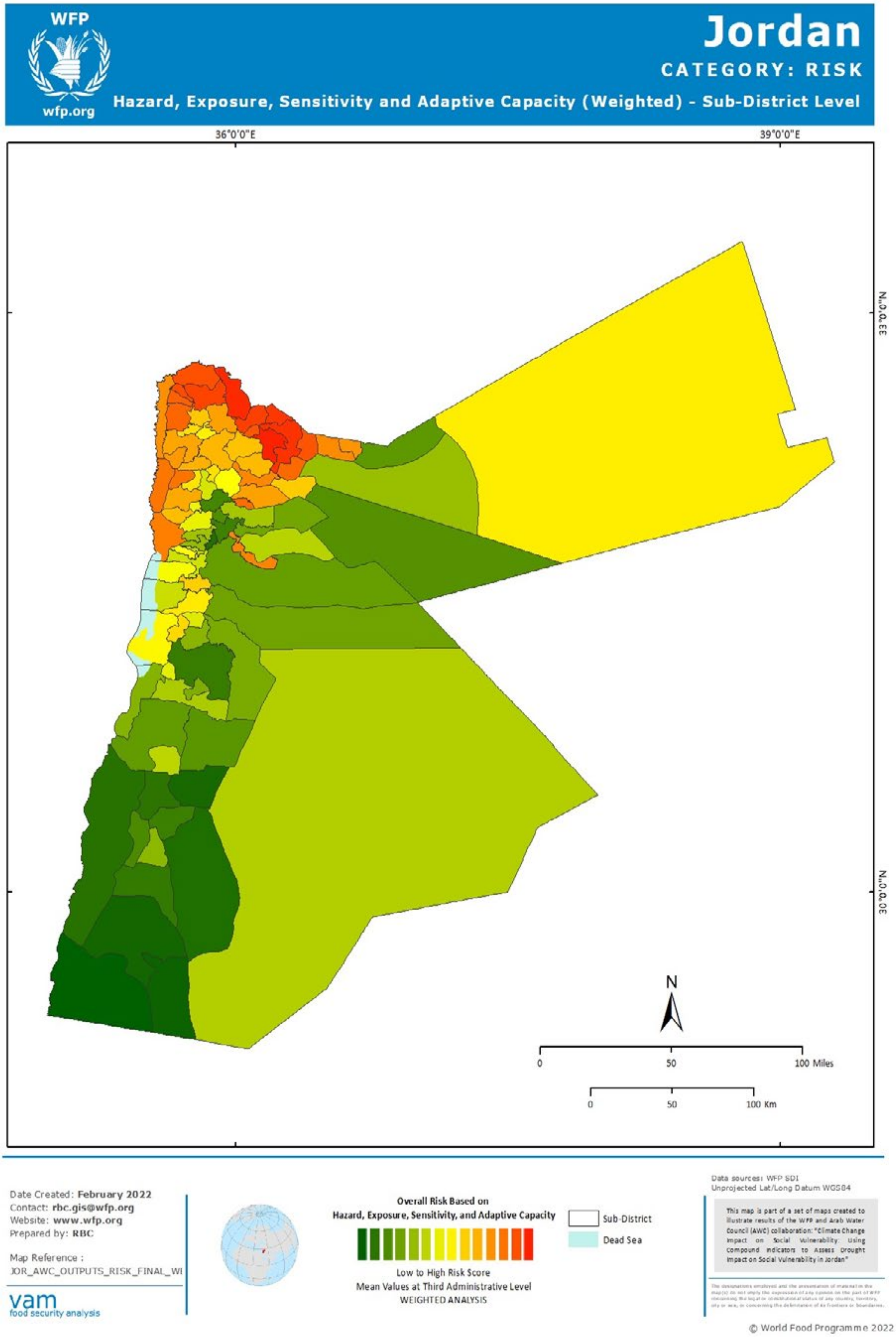


Figure 113: Mean overall risk score at third administrative level (Sub-Districts).

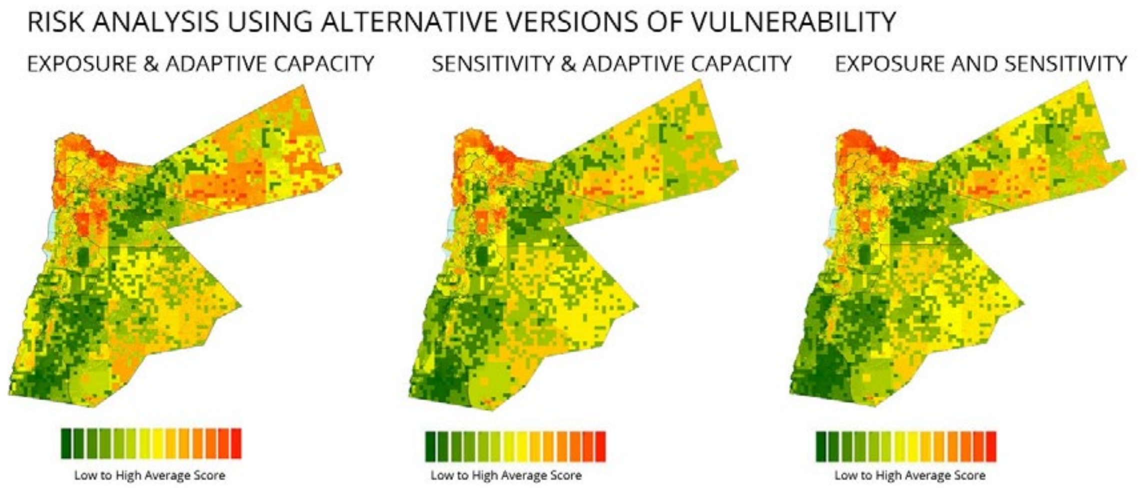


Figure 114: Alternative versions of vulnerability (alternative combinations of the layers).

All maps were multiplied by the hazard layer, meaning that hazard is present in all three map versions. What is left out is always one layer only, so that the impact of the respective map layer can be determined. The map on the left shows a combination of exposure and adaptive capacity only, leaving out the sensitivity layer. The map in the middle shows a combination of sensitivity and adaptive capacity only, leaving out the exposure layer. The map on the right shows a combination of exposure and sensitivity only, leaving out the adaptive capacity layer. These maps can be useful in determining priority areas for policy action. For example, the map in the middle shows which parts of the country have high sensitivity and low and adaptive capacity in the face of drought hazard – helping policy-makers to identify hotspots that may require the most immediate attention in terms of policy action on social protection. The map on the left shows which parts of the country show low adaptive capacity in the face of drought exposure, and where work on boosting community adaptive capacity might be needed.

12.8 Conclusion: Mapping at National Level

As this analysis shows, expanding the number of social indicators in the climate risk analysis significantly broadened the scope of the analysis and of the results. The more complex sensitivity and adaptive capacity layers add an element of information that is not only important to climate scientists, but also to policy-makers. As can be seen in the results, the hazard and exposure maps alone cannot capture the vulnerability of communities to climate change impact. The vulnerability categories of sensitivity and adaptive capacity significantly change the final score and map color in multiple places across the country. It is thus critical that indicators used to measure sensitivity and adaptive capacity reflect the full complexity of social vulnerability to climate change. Studies using only a limited number of social indicators cannot capture the full complexity of social vulnerability. Given that these layers in particular represent a large range of indicators, they deliver more nuanced and comprehensive results that help understand climate change impact on communities in more holistic ways. This includes taking into account pre-existing social vulnerabilities and more complex social indicators in the context of adaptive capacity.

13

CASE STUDY RESULTS: THE VILLAGE OF DEIR EL KAHF

13 CASE STUDY RESULTS: THE VILLAGE OF DEIR EL KAHF

13.1 Case Study Inception

The Sub-District of Deir El Kahf, where the case study research was carried out, is located in the Badia El Shamaliya District in Mafraq Governorate, as can be seen in Figure 115. Figures 116 and 117, based on the Humanitarian Topographic Atlas of Jordan, show the location of the area very close to Jordan's border with Syria. The red dots on both maps show where interviews were carried out for the present research, reflecting that researchers took care to interview residents of all villages that are colloquially grouped as "Deir El Kahf".

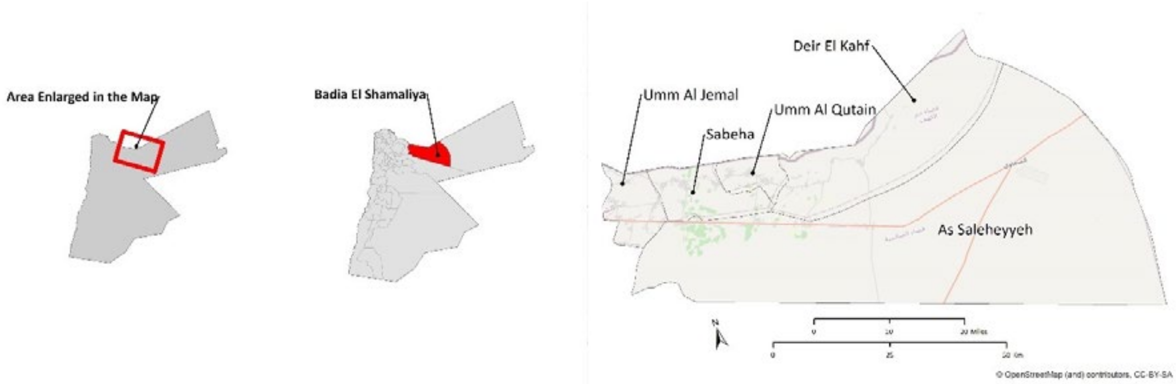


Figure 115: Location of Deir El Kahf (Source: WFP, 2022).

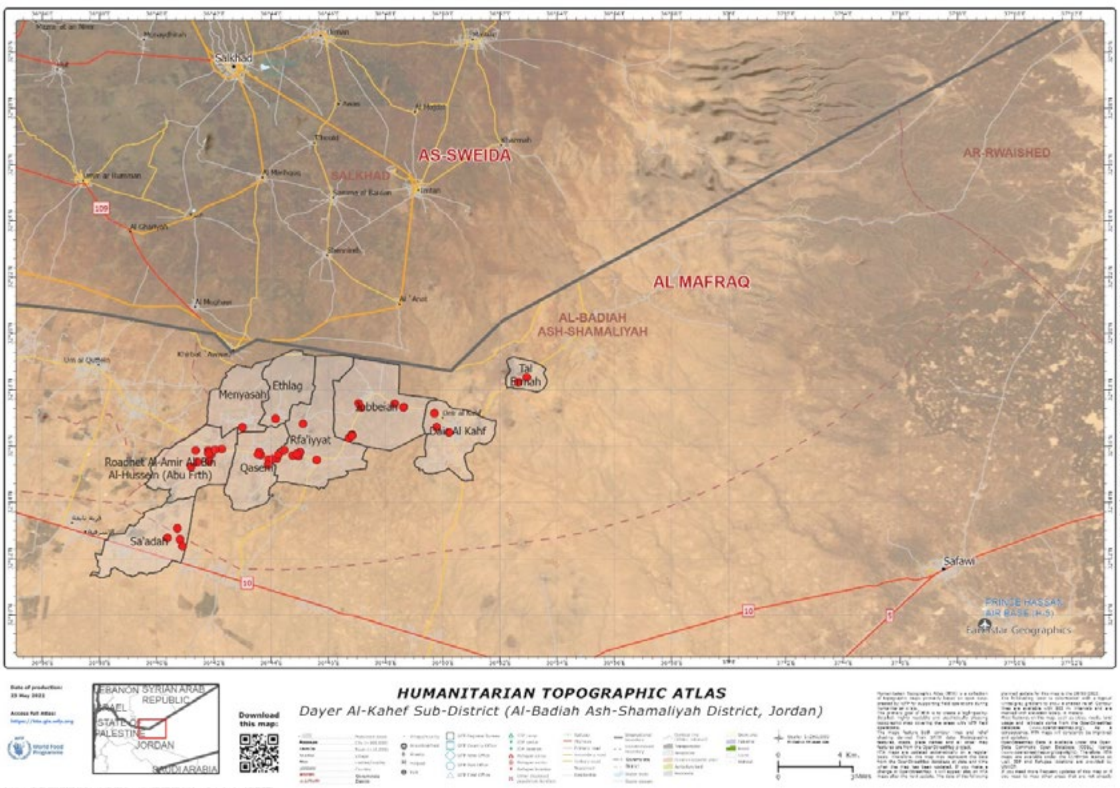


Figure 116: Location of Deir El Kahf Sub-District on the map of Jordan. Red dots represent locations of interviews carried out (Sources: Humanitarian Topographic Atlas, WFP, 2022).

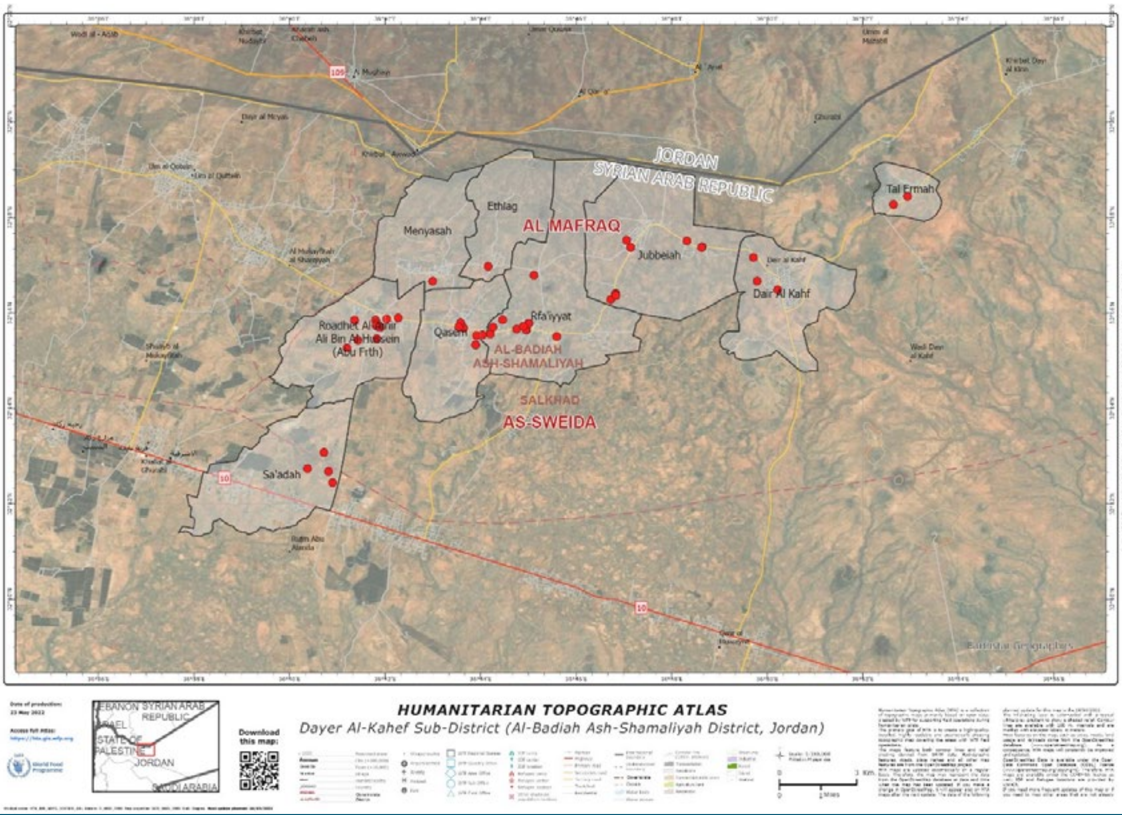


Figure 117: Location of Deir El Kahf Sub-District on the map of Jordan, zoomed in. Red dots represent locations of interviews carried out (Sources: Humanitarian Topographic Atlas, WFP, 2022).

The case study started with an introductory community stakeholder meeting held in November 2021 at the beginning of the fieldwork to introduce the study to the community members, identify the most relevant stakeholders, and identify the most important issues related to social vulnerability and drought. The meeting was attended by 13 residents of Deir El Kahf (9 men and 4 women) of different ages, representing different parts of the village and different professions (Figure 118). The direct and indirect stakeholders related to drought impact on social vulnerability in Deir El Kahf were as follows:

STAKEHOLDERS

Direct

1. Youth of both genders
2. Farmers of both genders
3. Livestock breeders of both genders

Indirect

1. Female dairy makers
2. Representatives from the commercial sector of both genders

Following the production of this simple stakeholder list, the local partner suggested community members that represented the identified stakeholder groups. The interviews were carried out by a local consultant and his female assistant, and were facilitated by the female head of the local NGO, who is very well connected and respected in the village. The interviews were conducted in Arabic language and took between 30 mins and one hour. While most interviews were carried out at participants' homes, some took place at agricultural fields or inside the tents of field workers, at the NGO's office, or at houses of interviewees' neighbors (Figure

119). Among the 50 interviewees were 7 refugees who were interviewed in tents on the farm they worked on as seasonal laborers. Some of the other respondents also had a migration background (some were born in Syria), but had lived in Deir El Kahf for so many years that they had taken on Jordanian citizenship and identified as Jordanian. All participants showed interest in the study and were forthcoming in participating in the interviews. However, one interviewee was not comfortable with his data being recorded, which means that all results are shown for a total of 49 interviewees. A total of 49 out of the 50 interviews were voice recorded with the participants' prior recorded consent based on the form attached in Annex 7.

Figure 118: Initial stakeholder focus group held in Deir El Kahf in November 2021 (Photos: Dawoud Isied and Martina Jaskolski).

Figure 119: Key informant interviews carried out in Deir El Kahf in November and December 2021 (Photos: Martina Jaskolski).

After the 50 interviews had been completed in December 2021, data analysis began. The quantitative data was evaluated through statistical analysis and presented in graphs and tables. The georeferenced data was used for producing maps of locally relevant processes, such as loss of farmland or inequalities in water access. The qualitative data was analyzed using a key word / key theme approach in Arabic, and important key word-based summaries were then translated to English. Important quotes from interviews were transcribed verbatim and translated into English.

The study was completed with a final stakeholder meeting to present the study results to community members from Deir El Kahf. The meeting was held at the NGO's office and attended by 8 men and 2 women, all of whom had attended the first stakeholder meeting and were participants of the study (Figure 120). Following a presentation of results by the local consultant, a participatory and interactive assessment of the study results gave the participants the chance to question and comment on the study results, and to suggest solutions and next steps.

Figure 120: Second stakeholder focus group held in Deir El Kahf in January 2022 (Photos: Martina Jaskolski).

13.2 Introduction to the Case Study Location Deir El Kahf in the Northern Badia

The village of Deir El Kahf is located in the Province of Northern Badia (Badia El Shamaliya) in Mafraq Goveronate, around 80 km to the east of the city of Mafraq. The term Badia refers to "a desert or arid region where Bedouins or Badu dwell" (Al-Khaza'leh et al., 2020, 1074). Around 80% of Jordan is considered Badia, and the Northern Badia constitutes 36% of that space, occupying a total area of 71,474 km^2 (Al-Homoud, 2011; Al-Khaza'leh et al., 2020, 1074). The sub-district of Deir El Kahf occupies an area of 646 km^2. The village of Deir El Kahf itself consists of various scattered hamlets that are connected by asphalt roads and that span across an area of 665 km^2 when measured on the Palestine 1923 Belt (Projected Coordinate System).

Deir El Kahf is located only a few kilometers to the south of the Jordanian-Syrian border, south of Jebel Druze in Syria. The village can be reached by following the Mafraq-Safawi road, and is located just to the north of this main road. Before the late 1960s, there was little permanent settlement in the area of present-day Deir el Kahf and mainly pastoral nomads could be found roaming the area. Then, based on tribal land claims, permanently settled villages were established. The village of Deir El Kahf consists of decentralized hamlets that provide space for gardens and small agricultural areas around most houses. Most residents are permanently settled and practice a mix of cultivation and grazing / livestock rearing, and pastoral nomadism has been replaced by transhumance. Agriculture is mainly rainfed and focuses on fodder production for livestock rearing (Millington et al., 1999). Figures 121 and 122 show impressions of the village of Deir El Kahf.

Figure 121: Village of Deir El Kahf in November 2021 (left) and January 2022 (right) (Photos: Martina Jaskolski).

Figure 122: Road leading towards Deir El Kahf (left) and village of Deir El Kahf (right) (Photos: Martina Jaskolski).

13.2.1 History

Historically, the area was referred to as Hauran, having been included in French Syria and partly in British Transjordan during colonial times (Kennedy, 1995). The border between Transjordan and Syria was formally enacted in 1920 as a result of secret treaties between the Imperial Powers during World War I (evolving over a period of 17 years starting in 1915), followed by the creation of the Hashemite Emirate of Transjordan in 1921 (Amadouny, 1995). The area is known for its rich archaeological history, including Roman ruins and evidence of water harvesting techniques such as water reservoirs and cisterns constructed as early as the Bronze Age (Kennedy, 1995). Hunters and pastoralists have been present in the area since Neolithic times, and have learned to make the most of an arid and scarce landscape (Betts, 2017). Aerial photography of the Badia spanning over a hundred years has revealed traces of Bronze age settlements, terraced gardens, water pools, remnants of early Islamic towns, cairns, and markers of the Cairo-Baghdad air route can still be seen in the Badia sands (Bewley and Repper, 2017). Structures that early explorers had described as so-called desert kites were later identified as game drives that had helped local hunters to trap gazelles (Betts, 2017). Deir El Kahf is home to one of the best-preserved forts of the Roman empire that houses an ancient roofed cistern (Figure 123). Early archaeological expeditions found an abundance of evidence of early agricultural activity around the fort, such as ancient walls that divided agricultural fields or traces of ancient furrows (Kennedy, 1995).

Figure 123: Ruins of a Roman fort in Deir El Kahf (Photos: Dawoud Isied).

13.2.2 Environment, Climate, Soils and Water

Deir El Kahf is located in Azraq Basin, which covers a total area of around 12,000 km^2 (numbers vary between 11,742 km^2 and 12,710 km^2 (Al-Bakri et al., 2016; Khoury, 2018). Around 90% of the Azraq Basin is located in Jordan, the rest in Syria and Saudi-Arabia. The highest elevation of around 1,500 m is located in the north towards the border with Syria near Jebel Druze, which is 1,550 m high (Abdulla et al., 2000; Khoury, 2018). Water in the basin drains from all directions towards the center of the basin, the Azraq depression, a circular mud flat and salt pan with an elevation of 500 m above sea level. To the south, east and west, the elevation increases again to around 900 m (Abdulla et al., 2000; Al-Bakri et al., 2016).

Figure 124: Basalt rocks dotting the landscape in and around Deir El Kahf. Local residents use the rocks to build walls marking the edges of their land (Photos: Martina Jaskolski).

The landscape of Northeastern Jordan can be divided into the so-called harra, a basalt desert, and a limestone desert (hamad) (Meister et al., 2019, 364). Deir el Kahf is located in the part of the desert that is dominated by basalt (Figure 124). The area south of Jabal Druz, where Deir el Kahf is located, is geologically part of the Harrat ash Shaam basalt field, a type of rock that originates from ancient volcanic activity of six different phases and covers an area of about 45,000 km^2 in Jordan, Syria, and Saudi-Arabia (Ibrahim and El-Naqa, 2018; Salameh et al., 2018). Farmers in the Northern Badia traditionally use the basalt rocks cleared for agricultural cultivation to demarcate their fields (Millington et al., 1999) – a practice that creates clearly visible structures in satellite imagery of the area.

The majority of soils in the Azraq Basin are Aridisols that host a sparse natural vegetation of desert shrubs and short grasses (Khresat and Quda, 2006). Typical for arid climates, "[a]ridisols are soils with one or more distinctive pedogenic horizons which have been either enriched or depleted of substances by moving water…The genesis of these soils accounts for the accumulation of calcium carbonate, soluble salts, and gypsum in the subsoil" (Khresat and Quda, 2006, 116 and 117) with a clay content that was observed to increase with depth. The natural vegetation in the area is part of the Saharo-Arabian plant region and consists mainly of grasses, herbs, and shrubs that grow on the poorly developed soils. Vegetation growth occurs mainly in the wadis and mud pans that receive flooding during regional rainfalls and overgrazing has led to a reduction in vegetation cover in recent years (Meister et al., 2019, quoting Al-Eisawě, 1996; Tansey, 1999; and Roe, 2000).

Climatically, the Northern Badia is located in a transition zone between semi-arid regions towards the Mediterranean and the fully arid zone of the Syrian Desert (Meister et al., 2019; Ziadat et al., 2006). It forms part of the rangelands, which are defined as receiving between 100 and 200 mm of rain per year (Ziadat et al., 2006). The Azraq Basin experiences two well-defined seasons, a hot and dry summer and a cold and relatively wet winter. Average temperatures are 26.6°C in summer and 11.6°C in winter, the hottest months being July and August (Ibrahim and El-Naqa, 2018). Mean annual temperatures vary between a maximum of 35°C-38°C in summer and a minimum of 2°C to 9°C in winter. The mean annual temperature in Safawi is about 18.9°C (Meister et al., 2019, 367, quoting Allison et al., 2000 and Meister et al., 2017). Precipitation that usually falls in the Azraq Basin between the months of October and May is subject to variability and ranges from below 50 to 150 mm/year (Dottridge and Jaber, 1999), while the northern part of the basin is more humid than the south and east [one author even quotes rainfall volumes of up to 500 mm/year in the north (Alkhatib et al., 2019)]. The Northern Badia is reported to receive 116 mm of rainfall per year, thus classifying it as arid climate that is also affected by what Al-Khaza'leh et al. (2020, 1074) refer to as "frequent drought cycles". However, the rainy season's combination of rainfalls with low evaporation rates during the fall, winter, and spring has made rainfed irrigation in the area possible (Millington et al., 1999).

Water infiltration is low, which is why even moderate storms can cause considerable run-off (Figure 125). This is why water harvesting is an ancient practice in the desert of Northeastern Jordan and has historically played an important role in the area. Using the waters of seasonal streams or wadis through storage in small earth ponds for irrigation already provided the water supply for the 6,000-year-old city of Jawa (Alkhaddar, 2003). The area used to receive winter run-off from Jabal al Druze in Syria through wadis expanding southward towards northern Jordan and the north-eastern Badia (Dottridge and Jaber, 1999). The major wadis discharge into the center of the Azraq Basin at Qa' El Azraq, which is a sabkha consisting of mudflats, salt pans, and wetlands (Ibrahim and El-Naqa, 2018). In 1989 (WAJ, 1989), these winter surface flows provided additional quantities of water of an estimated average of 27 × 106 mł yr21 (WAJ, 1989). Local farmers and herders use these winter surface flows to irrigate grain and fodder crops on areas affected by occasional flooding, the so-called marebs. However, a large percentage of rainfall evaporates or runs off and then evaporates (Dottridge and Jaber, 1999). Moreover, recent years have shown a change in the seasonality and quantity of rainfalls in the area, seriously affecting rainfed agriculture and livestock production (Isied, 2021, pers.comm.).

Figure 125: Wadis around Deir El Kahf that capture and channel run-off (Photo: Dawoud Isied).

The Azraq Basin used to have the most substantial resources of surface and groundwater compared to other Badia areas (Dottridge and Jaber, 1999). There are three aquifer systems in the area: The Upper Aquifer (depth of a few meters to over 350 m), the Middle Aquifer System (depths of 300-1,000 m) and a Deep Aquifer System (depths of 1,300-3,400 m) (Abdulla et al., 2000; Alkhatib et al., 2019; Dottridge and Jaber, 1999). In arid and semi-arid environments, the climatic conditions severely limit the natural recharge of groundwater resources (Alkhatib et al., 2019, Rödiger et al., 2020), and changes in precipitation drive changes in groundwater recharge (Rödinger et al., 2020). Research shows a high variability of groundwater recharge with most recharge to the upper aquifer complex occuring from the north, northeast, and northwest, with some additional minor recharge from the west (Ibrahim and El-Naga, 2018; Alkhatib, 2019). Permeable rocks enable groundwater flows from Jebel Arab towards the center of the Azraq Basin, where the major well fields are located. Ibrahim and El-Naqa (2018, 237) calculate a recharge rate of 35.5 MCM infiltration and 20 MCM natural recharge. Limited recharge conditions contribute to water scarcity in the area, especially as abstraction from the aquifer systems is increasing.

The unconfined Upper Aquifer is the most heavily used (Dottridge and Jaber, 1999). Pressure on the Azraq aquifer, which naturally discharged water in the form of natural springs around Aqzraq in the 1960s (UNDP, 1966), increased in the 1980s. Wells were drilled for irrigated agriculture and for drinking water, which is transported off towards Amman for domestic water use (Al-Bakri et al., 2016; Dottridge and Jaber, 1999; Zanchetta et al., 2016). The state of equilibrium that existed before the 1960s was disturbed in the 1980s, when the abstraction started to exceed recharge levels (Dottridge and Jaber, 1999). As a consequence, Azraq's natural springs dried up in the 1990s (Alkhatib et al., 2019). In the year 2000, there were over 500 wells operating in the Azraq Basin, both public and private (Abdulla et al., 2000). Alkhatib et al.'s (2019, 1143) study on the Azraq Basin shows that "[a]t present, the safe yield of the groundwater resource equals 30% of the overall actual pumping rate, indicating that the aquifer is highly exploited." Increasing water demand in the capital Amman, as well as in Zarqa and Irbid, as well as an increase of water abstraction for irrigated agriculture meant that abstraction rates continuously increased to 40×106 mł/year in 2013 (Alkhatib et al., 2019). Al-Bakri et al (2016) quote a safe yield[1] of 24 MCM for the Azraq Basin and a groundwater abstraction for irrigation of 31.6 MCM based on Ministry of Water and Irrigation records, and 67 MCM based on remote sensing data (a significant difference), showing an over-abstraction of 367%. According to Zanchetta et al. (2016, S225) "[t]he situation at Azraq Oasis is a good example of how human behavior can pose a huge threat to the existence of an oasis, adding to the naturally imposed hazard of desertification." The cessation of spring flow in the Azraq Basin's aquifer systems has also had negative impacts on the famous wetland in Azraq (Dottridge and Jaber, 1999).

1 "The concept of safe yield of an aquifer has been used since the 1920s, when it was defined 'as the water that can be abstracted permanently without producing undesirable results'" (Meinzer, 1923, quoted in Dottridge and Jaber, 1999, 319).

Figure 126: A drinking water well drilled in the Azraq mudflat to supply water to Amman (Photo: Martina Jaskolski).

Recent studies assess how and where managed aquifer recharge in arid areas, including the Azraq Basin, may be possible (Alkhatib et al., 2021). There has been a stop to permissions of drilling new wells. The wells in operation are those whose licenses had been obtained before 1995, as no new licenses were being granted due to fears of over-abstraction and damages to the RAMSAR wetland site in Azraq (Millington et al., 1999). Figure 126 shows a drinking water well near the road between Azraq and Safawi.

The decrease in groundwater quality is another reason for concern in the Azraq Basin. In the 1990s, the water quality of the Aquifer system around Azraq was considered good, with generally low salinity levels (Dottridge and Jaber, 1999). This situation changed over the years with continued over-extraction of groundwater for both agricultural and domestic purposes. The wells adjacent to the main well fields in the center of the Azraq Basin (Qa' El-Azraq) are showing continuously increasing levels of salinity (Ibrahim and El-Naqa, 2018). A 2003 study carried out in the Northern Badia region around Deir El Kahf suggests that groundwater wells experience moderate risk of decreasing water quality due to increasing salinity levels as well as rising agrochemical residues in the water (Al-Adamat et al., 2003).

12.2.3 Settlement and Social Composition

The Jordanian Badia is generally sparsely populated. The population of the entire area of Deir El Kahf was around 16,000 in 2020 according to WorldPop. Making up 80% of the Jordanian landmass, it houses only 5% of the country's population (Hood and Al-Oun, 2014). Deir El Kahf and the Northern Badia are regarded as marginal areas that are struggling with poverty problems. In 2009, Deir El Kahf was named as one of the poverty pockets of Jordan. The region is predominantly inhabited by local Bedouin communities, with the main social groups being Chechen, Druze and Bedouins. In recent years there has been a considerable number of Syrian refugees living either in host communities in the area or in nearby refugee campus, such as Al-Zaatari camp (Al-Homoud, 2011; Al-Khaza'leh et al., 2020; Al Naber and Molle, 2016). Given the closeness of Deir El Kahf and its neighboring communities to the Syrian border, which is basically an open desert border, there is considerable movement of people back and forth. Some respondents jokingly said: "People come to Jordan in the morning and go back to Syria at night." Others reported having heard or witnessed gunfire on the nearby border during the Syrian conflict. Millington et al., (1999, 365) describe the changes of population and livelihoods in the area over the past few decades as follows:

"Since the 1960s, northern Jordan has seen a dramatic expansion in the cultivated area, which continues to move eastwards into increasingly drier landscapes. Population growth has been high as villages have been established and in-migration (both temporary and permanent) has occurred because of population relocation. During the period of settlement there has been a switch from farming systems dominated by nomadic pastoralism to those comprising cultivation and stock rearing. The last two decades have witnessed a marked decline in stock rearing and a concomitant increase in rain-fed and irrigated cultivation. This transition has occurred in parallel with migration, settlement and village expansion" (Millington et al., 1999, 365).

As people started to settle permanently in the villages between Mafraq and Safawi, the population of the area started to grow (Millington et al., 1999). This brought with it not only a major change in lifestyle for many previously nomadic people, but also meant that claims over land access and ownership needed to be settled. Land ownership is a complex process that is in part going back to the times of Ottoman Empire and colonial occupation in Jordan. The freedom of the Bedouin's nomadic lifestyle was partly curtailed by the military activity during the Ottoman empire and then again during the legal establishment of the Syria-Transjordan border, land reforms, as well as the construction of the Hejaz Railway in the area (Amadouny, 1995). Different land ownership arrangements include the acquisition of state land, informal land ownership claims as part of Bedouin agricultural expansion into the desert, as well as large-scale irrigation investment projects (Al Naber and Molle, 2016). This classification shows an overlap of formal, state-based systems and informal clan-based systems. Claims over land access and ownership have traditionally been a source of conflict between different population and interest groups. While the relationships between Chechen, Druze and Bedouins are generally good, there have been some reports of land ownership-related conflicts (Al Naber and Molle, 2016).

Despite the fact that most residents now lead a permanently settled life, the nomadic heritage of many of the Badia's residents continues to shape the region's Bedouin culture. As many residents did not permanently settle until the mid-1980s, older people would still remember the nomadic lifestyles they grew up leading. Despite the drastic changes to their lifestyle, many Bedouins retain their cultural identity through accents, poetry, songs and wedding traditions. Of course, some of these traditions have changed over time, examples being the reduced length of weddings over time from a week to a day or two, or women not performing certain dances anymore due to cultural change. Gender-based spatial segregation remains a traditional practice in Bedouin culture, for example in Bedouin tents (Hood and Al-Oun, 2014). As Hood and Al-Oun (2014, 79) note: "Although many Bedouin women work outside the home, the public/private opposition is still applicable in the Bedouin community today and the binary is evident in the processes that work to maintain and transform traditions important in Bedouin life."

13.2.4 Local Livelihoods

Most of the community members of Deir El Kahf are now sedentary farmers or livestock producers. While there are smallholder farmers who practice rainfed agriculture to grow olive trees, vegetables and grains for household consumption, selling only production surplus, there are also larger-scale investors in irrigated agriculture in the area. Livestock plays an important role, not only as a food source, but also as financial insurance. The North-Eastern Badia of Jordan is one of the few remaining areas of the Middle East where pastoral nomadism is still practiced (Meister et al., 2019). Farmers in the region use either transhumant or sedentary (agro-pastoral) livestock production systems. Transhumant lifestyles are pastoral with herders practicing different movements of seasonal mobility – one eastward during the winter and early spring ("al tashreeg") and one back westward ("al tahreeb") after that (Al-Khaza'leh et al., 2020). Meister et al. (2019) show how these traditional, seasonal movements reach far eastward into the eastern part of Mafraq from just west of Safawi (where Deir El Kahf is located) to just east of Ruwayshid. Ancient circular livestock enclosures, windbreaks, and huts, often made from basalt rock, visible through aerial photography and satellite imagery, show that this practice has been going on for millennia (Meister et al., 2019). To this day, boreholes and rain harvesting ponds play an important role as water sources used for livestock rearing (Al-Khaza'leh et al., 2020).

Sheep and goats are the most commonly raised type of livestock in the Northern Badia (Al-Khaza'leh et al., 2020). Raising small ruminants is the primary source of livelihood for Jordanians living in rural and marginal parts of Jordan. Small ruminant animals actually represent the "largest proportion of biomass in the country" (Al-Khaza'leh et al., 2020, 1073). While these animals enhance food security and also provide farmers with monetary security, they are often limited by factors such as water shortage, reduced grazing lands, or diseases (Al-Khaza'leh et al., 2020). According to a study conducted in the Northern Badia in 2020, transhumant livestock breeders travel an average of 21.3 km from their holes to the boreholes during the dry season and 18.9 km during the wet season. In comparison, sedentary livestock breeders traveled only between 9 and 10 km (Al-Khaza'leh et al., 2020). The same study recorded 366,940 heads of sheep, 61,210 heads of goats, 3,020 heads of cattle, and 1,130 heads of camels in the Northern Badia in 2017, while "the total population of sheep and goat keepers was 3,150" (Al-Khaza'leh et al., 2020, 1075). In the past decades, agriculture and livestock production in the area have been suffering from inadequate rainfall, poor land management, uncontrolled grazing, all of which together have been accelerating land degradation (Ziadat et al., 2006) – a process that has severe implications for local livelihoods.

12.2.5 Development Concerns

The Northern Badia is referred to as one of the poorest regions in Jordan (Al-Homoud, 2011). For this reason, it has been the focus of a number of development programs, including government programs, programs led by UN Institutions, but also efforts by MerciCorps. The Badia Research and Development Program (BRDP), perhaps the most well-known initiative in the area, started in 1992. The BRDP was an action research project that unveiled many of the socio-economic problems of the northern Badia. These included residents being frustrated with inadequate public services, limited educational standards and literacy (56% of adults showed only limited literacy, 22% of boys and 34% of girls were not going to school) (Dutton and Shahbaz, 1999, citing Dutton, 1998). The depletion of groundwater in the Azraq basin and abstraction of water from the aquifer beyond its safe yield were among the issues identified as most pressing for the program (Dottridge and Jaber, 1999). A study conducted in 2009 revealed mild to moderate levels of malnutrition, growth stunting, and iron deficiencies and anemia in Bedouin children living in the North Badia of Jordan (Khatib and Elmadfa, 2009). A study on community satisfaction, carried out in the village of As-Salhiyyah, which neighbors Deir el Kahf, found that local residents valued the strong community interaction and mutual support, safety, the low-density settlement of the area and the lack of pollution, but expressed frustration with the housing situation, a lack of job opportunities and public services, their income, and the poor up-keep of public services (Al-Homoud, 2011). In terms of infrastructure, the main road was paved before 1972, while the smaller roads connecting the various villages along the main axis with each other were paved in the 1980s and 90s (Millington et al., 1999). Over the last few decades, a lot has been done to increase the density of primary and secondary schools in the area, as well as improving access to medical services (Isied, pers. comm., 2021). Since the Syrian crisis, the increased influx of refugees to the area has increased the pressure on natural resources and income opportunities again.

13.2.6 Water Scarcity and Agriculture in the Northern Badia

The Northern Badia is "particularly affected by water shortages and poor water quality" (Al-Khaza'leh et al., 2020, 1074). There are no perennial types of irrigation such as springs, streams, or natural water pools (Kennedy, 1995). Since the 1960s, the government promoted a switch from livestock rearing to rainfed and irrigated agriculture in the area, enhanced, for example by the withdrawal of a sheep-feed subsidy (Millington et al., 1999). Most of the larger-scale irrigated agricultural expansion into the Northern Badia occurred between the early 1970s and early 1990s, moving the frontier of irrigated agriculture eastwards. Interviews carried out with farmers in the Northern Badia in the 1990s showed that farmers were already experiencing patchy grain harvests in the 1990s, with satisfactory harvests reported between once every year and once every six years. Some farmers would also alternate between rainfed cultivation in the winter and irrigated cultivation in the summer months (Millington et al., 1999). Intensifying water scarcity in the area, based on insufficient quantities of rain, or rain falling in unfavorable areas, as well as rising population numbers, have increased the hardships of agriculture and livestock production in the area. As Al-Khaza'leh et al. (2020, 1073) note, "[w]ater is the most important nutrient for the production of healthy livestock. Water scarcity bottlenecks livestock production in arid and semi-arid regions, particularly during the dry season." A lack of rainfall also impacts transhumant production systems, where water scarcity means that pastoralists have to travel longer distances and pay more money to access water.

To make use of every drop of water, water harvesting has historically been practiced in the Northern Badia, and is continued to this day. Expanding such water harvesting efforts and providing the necessary technical support for the design, management, and rehabilitation of water harvesting systems could be a way towards improving water accessibility in the Northern Badia (Al-Khaza'leh et al., 2020; Ziadat et al., 2006). In the 1960s, the Jordanian Government established a number of concrete ponds in the area and also embarked on the restauration of existing Roman ponds, establishing water reservoirs that were able to hold up to 10,000 mł, mostly in small villages. In the 1990s, the concrete pond design was replaced by earth ponds, 15 of which were constructed as part of the Badia Research and Development Programme (Alkhaddar, 2003). Micro-catchment water harvesting techniques and dryland rehabilitation efforts have shown promising results in other parts of Jordan (Tatsumi et al., 2021) and are also being implemented in the Northern Badia region (Isied, 2021, pers.comm.; Zueidah, 2021, pers. comm.).

13.2.7 Climate Change

The already water-scarce Northen Badia region is particularly vulnerable to climate change, particularly changes in rainfall amounts and patterns as a result of climate change. Al Qatarneh et al. (2018) model the impact of climate change in the Azraq Basin, projecting overall warmer weather for the region. The authors' projection for an increase in mean maximum temperature over the period between 2015 and 2030 is 0.3 °C or 2% with a confidence of 95%. The authors did not detect a significant trend for the mean minimum temperature for the same period. The results translate into an increase of mean annual temperature of 0.15 °C between 2015 and 2030 or 1%, again with a confidence of 95%. The authors expect an increase of days on which the maximum temperature exceeds 38 °C by 6 days and the minimum temperature 20 °C by 5 days over the same study period. The projections do not indicate a significant change for either rainfall or streamflow, but indicate that more research was needed to monitor the streamflow of local wadis (Al Qatarneh et al., 2018). Both focus groups and interviews in Deir El Kahf revealed that local residents have noticed significant changes in the weather in recent years.

In our drought assessment for Jordan, the area around Deir El Kahf shows mixed results for overall drought risk, with most of the study area showing above average and higher drought risk scores. Some parts of the study area even fall within the high drought risk category. In Figure 127, the results from the national assessment were overlain with the geographical locations of field visits and interviews in Deir El Kahf (the blue dots).

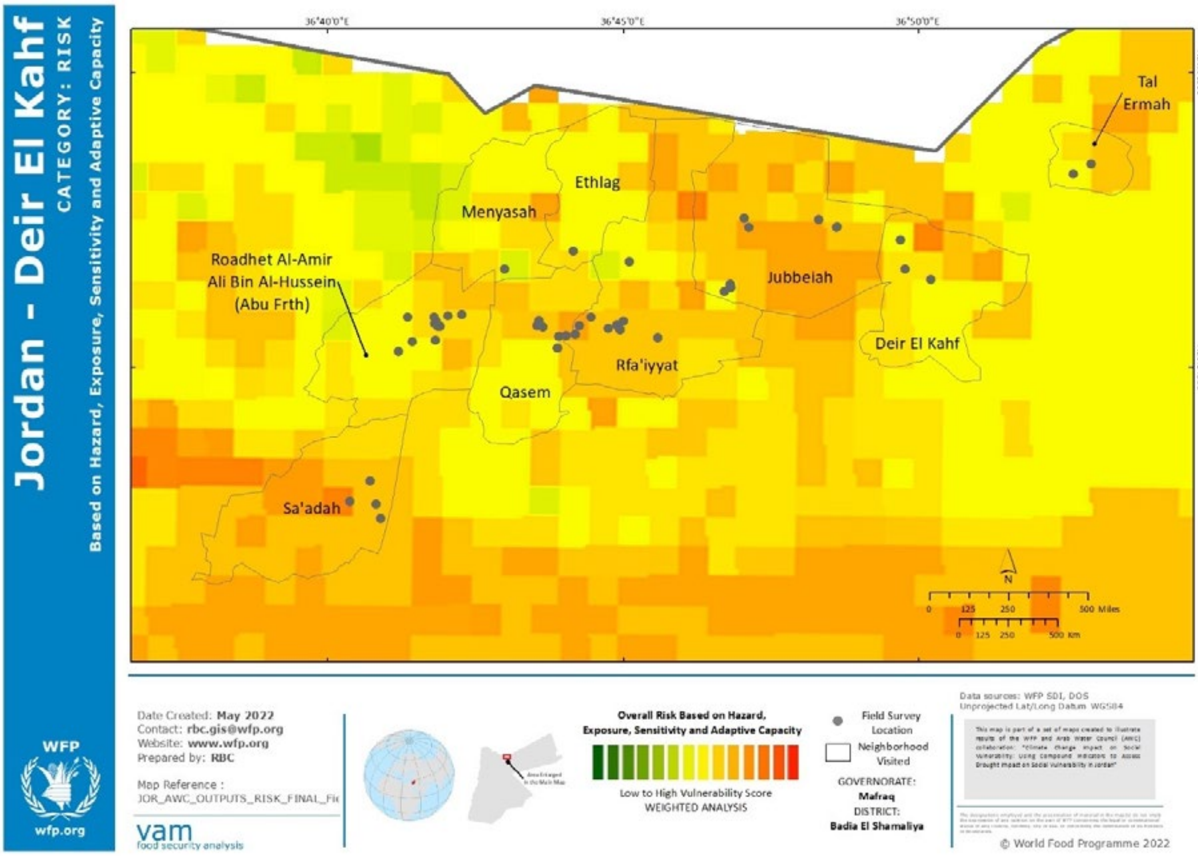


Figure 127: Overall drought risk for the study area in Deir El Kahf (grey dots represent the places where interviews were carried out) (Source: WFP, 2022).

Figures 128 through 133 are showing the specific results on hazard, exposure, sensitivity, adaptive capacity, vulnerability, and overall drought risk for the case study area around Deir El Kahf, where the interviews for the case study were carried out. The maps show that, while the drought hazard in the area is low (Figure 128), exposure levels for at least part of the study area are a little higher (Figure 129). The lower drought hazard may in part be explained by the study area's location in the desert, and just on the border to the hyper-arid part of the country.

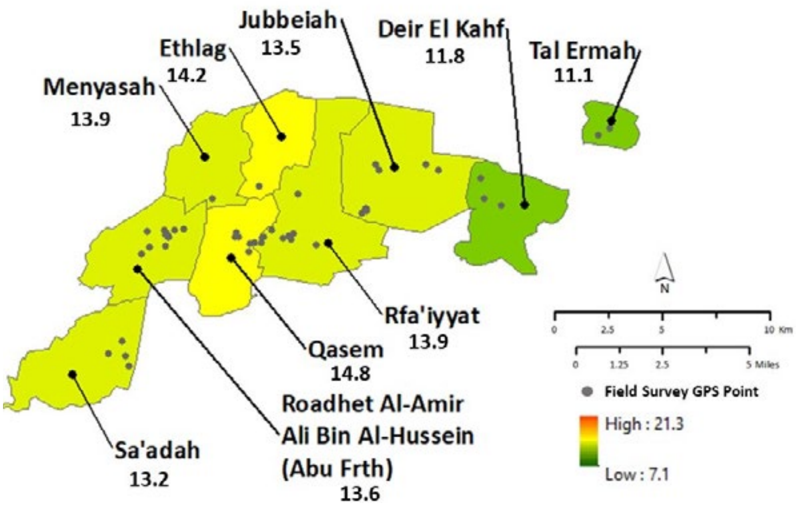


Figure 128: Overall hazard by fourth-level administrative area in Deir El Kahf region (excerpt from full map presented above).

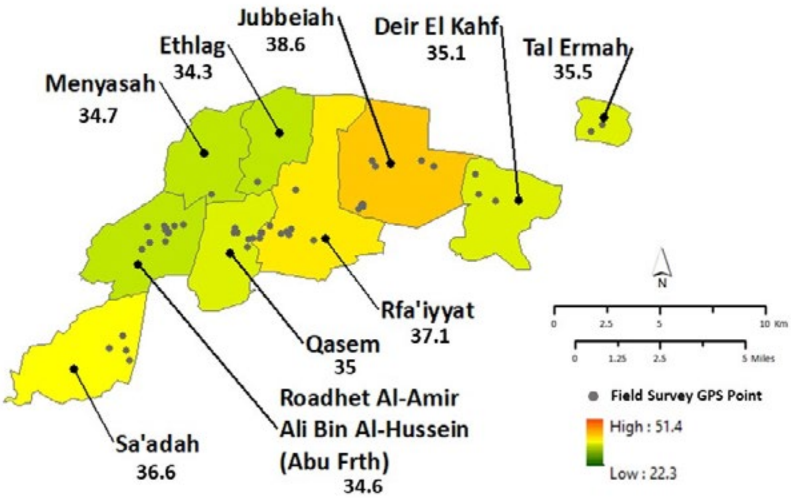


Figure 129: Overall exposure by fourth-level administrative area in Deir El Kahf region (excerpt from full map presented above).

When looking particularly at the sensitivity and vulnerability indicators, Figures 130 and 131 show that the numbers for the study area are definitely higher. This is particularly due to the social indicators included in these two categories.

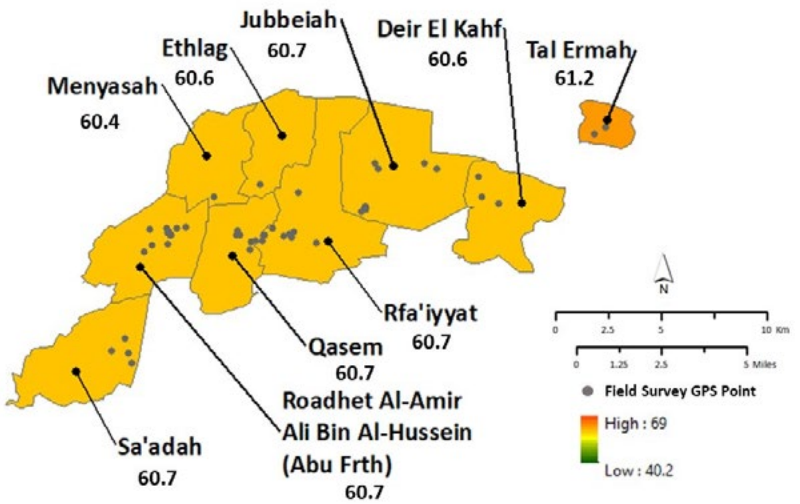


Figure 130: Overall sensitivity by fourth-level administrative area in Deir El Kahf region (excerpt from full map presented above).

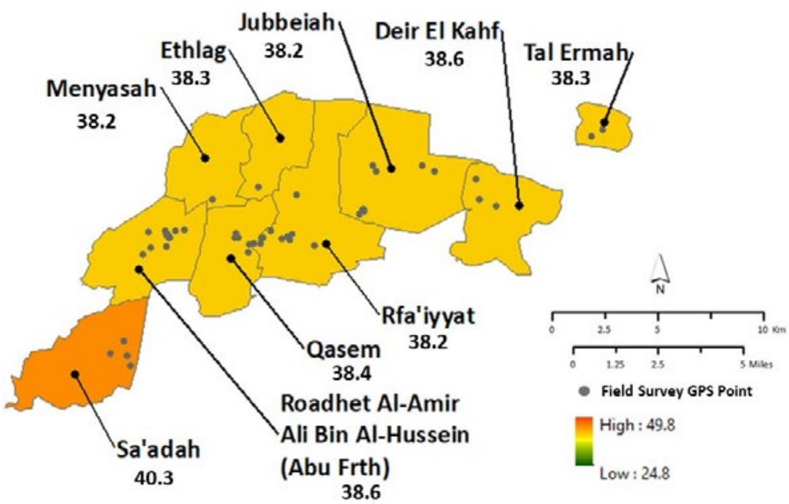
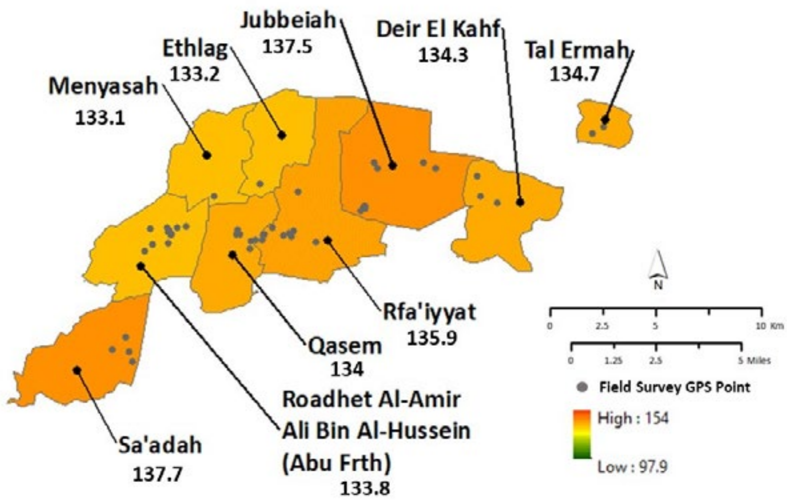


Figure 131: Overall adaptive capacity by fourth-level administrative area in Deir El Kahf region (excerpt from full map presented above).

The combination of exposure, sensitivity, and adaptive capacity results in an overall vulnerability score for the study area that is relatively high (Figure 132). The overall drought risk (sensitivity multiplied by the hazard) is lower again, given that the hazard scores are relatively low (Figure 133). Figure 134 shows an overview of the study results on social vulnerability and risk based on the national mapping effort.

Figure 132: Overall vulnerability by fourth-level administrative area in Deir El Kahf region (excerpt from full map presented above).



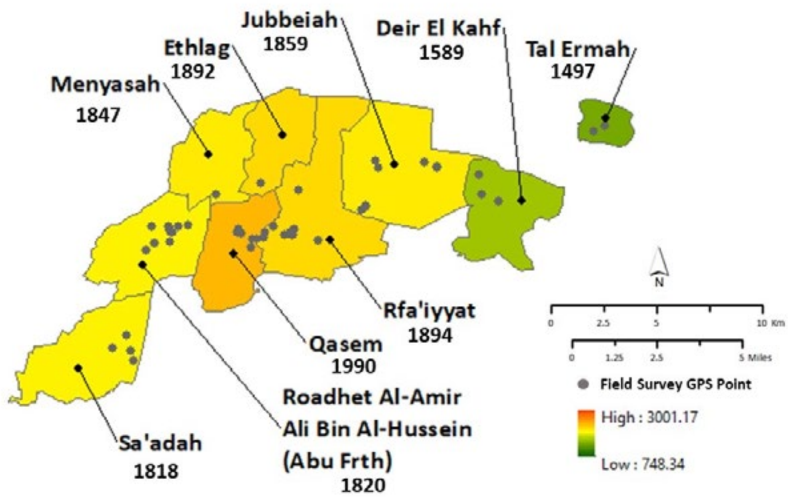


Figure 133: Overall drought risk by fourth-level administrative area in the Deir El Kahf region (excerpt from full map presented above).

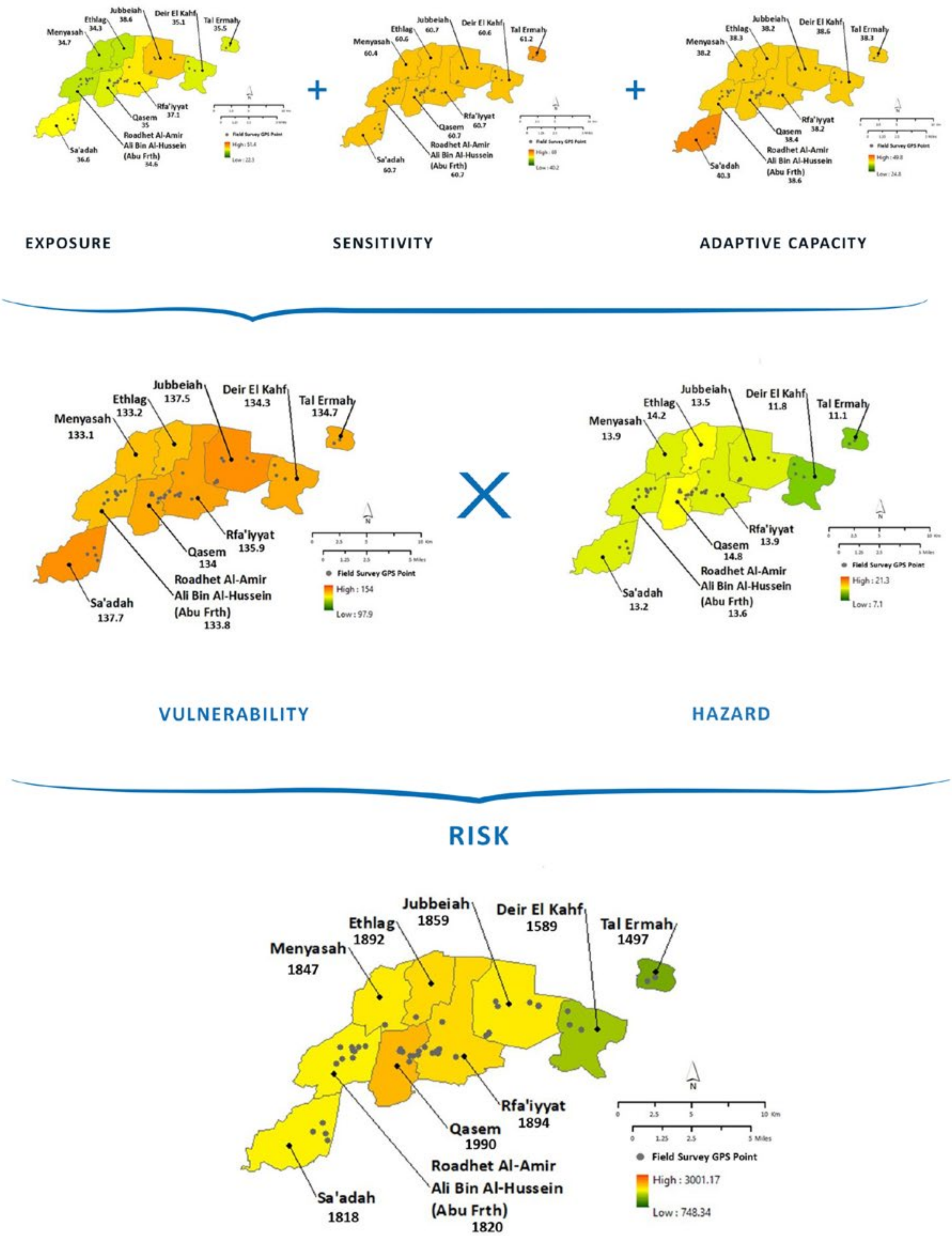


Figure 134: Overview of local study results for Deir El Kahf (excerpt from full map presented above)., based on national mapping.

13.3 Fieldwork in Deir El Kahf

13.3.1 Location of Interviews

The fieldwork in Deir El Kahf was carried out in different sections of the village. Figure 135, which displays the locations of the homes of respondents, also shows the close proximity of Deir El Kahf to the Syrian border, as well as its location on the lower slopes of Jabal Druze. Figure 136 shows a satellite image of the built-up area of a small section of Deir El Kahf, such as the structures of the main roads and buildings. As can be seen, the area is not densely populated and most houses have large yards, gardens, or olive groves around them. The picture, taken in March 2021, also illustrates how sparse greenery is and that trees and plants around houses often depend on irrigation with household water. The majority of houses are sturdy brick and cement or concrete constructions with multiple rooms.

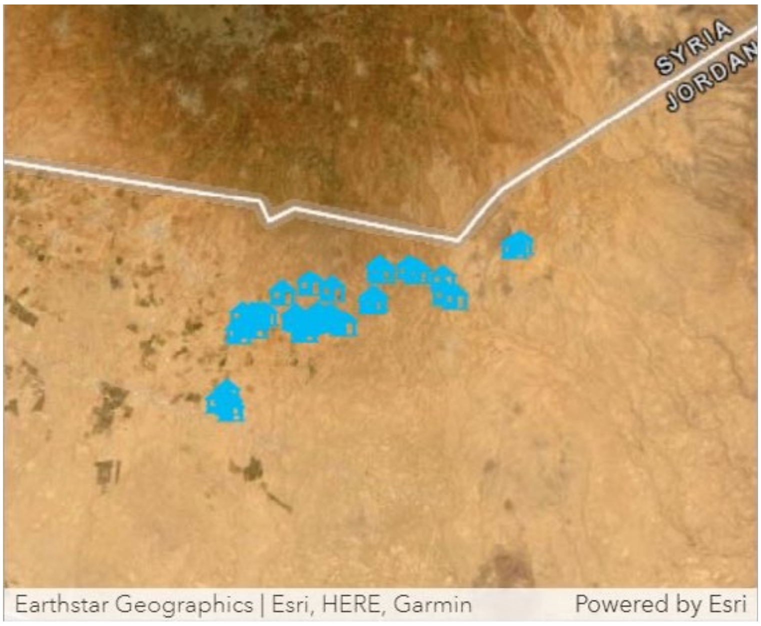


Figure 135: Map of the homes of interviewees in Deir El Kahf (Source: WFP, 2022).

Figure 136: Satellite image of Deir El Kahf (Source: MAXAR / PNG, 2021).

13.3.2 The Interview Sample

Interviews in Deir El Kahf were conducted with 37 men (76% of respondents) and 12 women (24% of respondents). The age groups of the respondents are presented in Figure 137. While all age groups over 18 years are represented in the sample, most respondents were between 41 and 60 years of age.

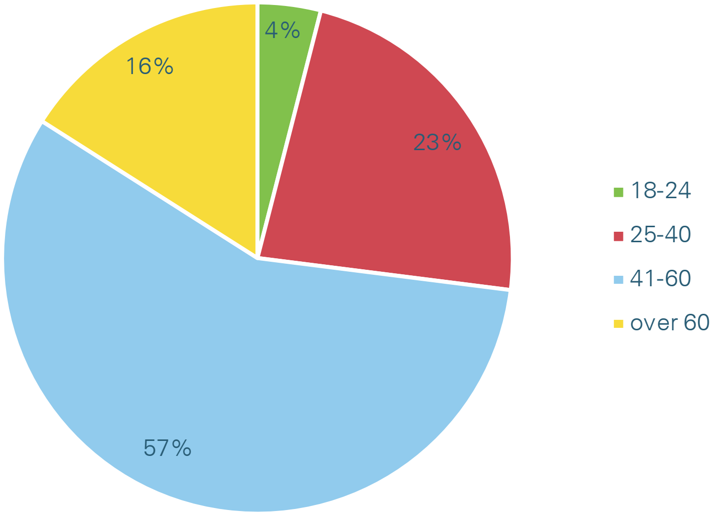


Figure 137: Age groups of respondents (%) in Deir El Kahf.

Most of the respondents had completed primary school only (51%), while 37% had a secondary degree and 12% a tertiary degree (Figure 138).

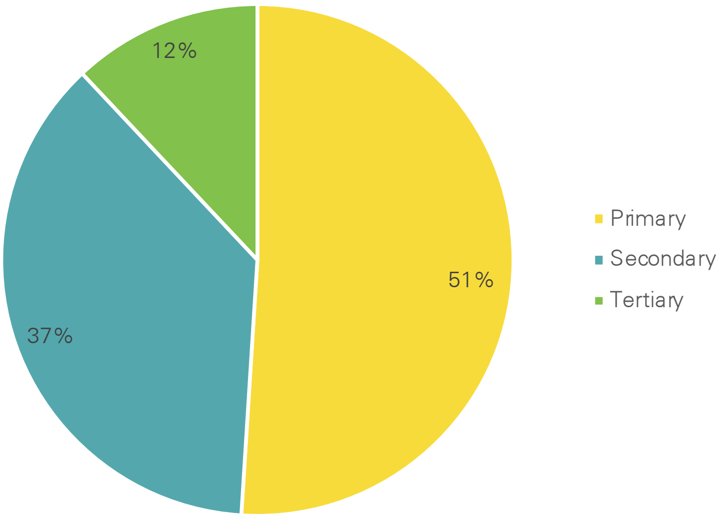


Figure 138: Educational level of respondents (%).

13.3.3 Families and Household Structures

Families in Deir El Kahf are quite large with most respondents claiming that they had between 5 and 9 household members. The village is also characterized by a rather young demographic structure (Figure 139). A total of 72% of the households had members under the age of 15. 12 respondents even reported having 5-9 members under the age of 15 in one household. In turn, 70% of households do not to have household members above the age of 60 years.

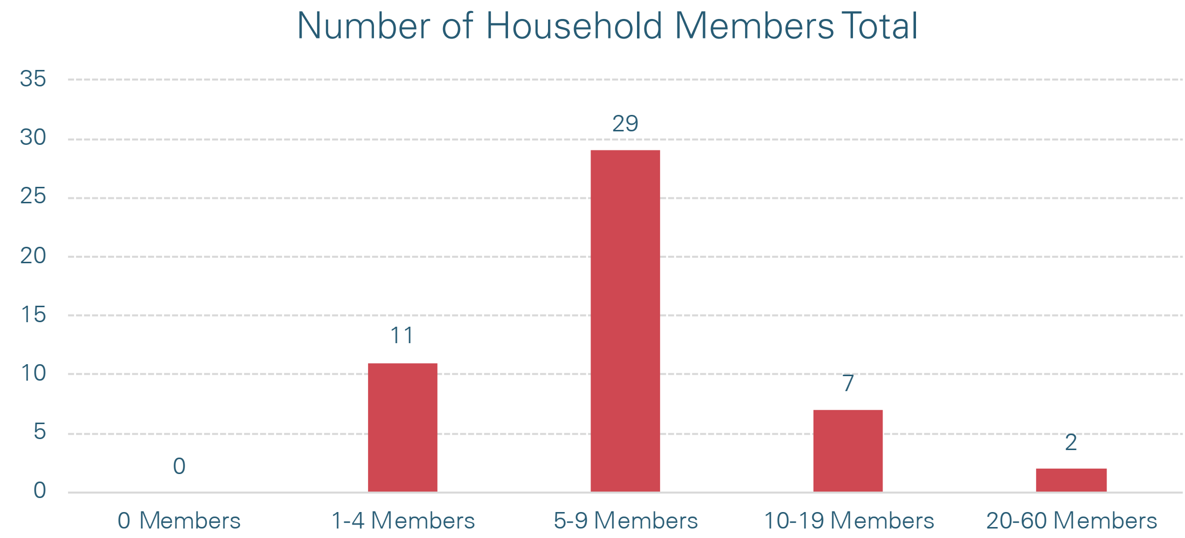


Figure 139: Household sizes of those interviewed in Deir El Kahf.

The overwhelming majority of 85.7% of the respondents own their house, with only 14.2% renting. Houses in Deir El Kahf are simple structures made mainly of bricks, cement, and concrete, but they are not necessarily small (Figure 140). A total of 86% of the respondents live in houses with more than 3 bedrooms. Houses are not well insulated. Most community members of Deir El Kahf get through the cold winters by burning wood or using plug-in heaters (83.7%), 16.3% stated they had gas heaters.

Figure 140: Families in front of their homes in Deir El Kahf (Photos: Martina Jaskolski).

13.3.4 Livelihoods

Farming and livestock production are a major pillar of livelihood generation in Deir El Kahf. However, most residents make a living from more than one source of income. People may have a government job, cultivate a piece of land, and raise livestock. Figure 130 shows that a total of 11 respondents were government employees, a profession that guarantees a minimum of livelihood security. A significant number of the older respondents were retirees, many of them former military officers, who receive a regular monthly pension. While the interview sample included people who used to farm, presently farm, work on a farm, or are part of a farming family, it was interesting to note that many respondents do not consider farming their main profession or source of income anymore. When asked about their main profession, only one respondent mentioned farming as the main source of income, while two mentioned livestock breeding. Less common professions include entrepreneurs and doctors, while most interviewed women worked in the household economy (Figure 141). The vast majority of 96% of the respondents stated that agriculture was not their main source of income at the present time. This does not mean that these respondents do not farm, but that they do not consider farming their main profession. As the interviews revealed, farming is not seen as a safe, sole source of income in Deir El Kahf anymore, which is why most community members seek at least one other form of employment or income to diversify their livelihoods.

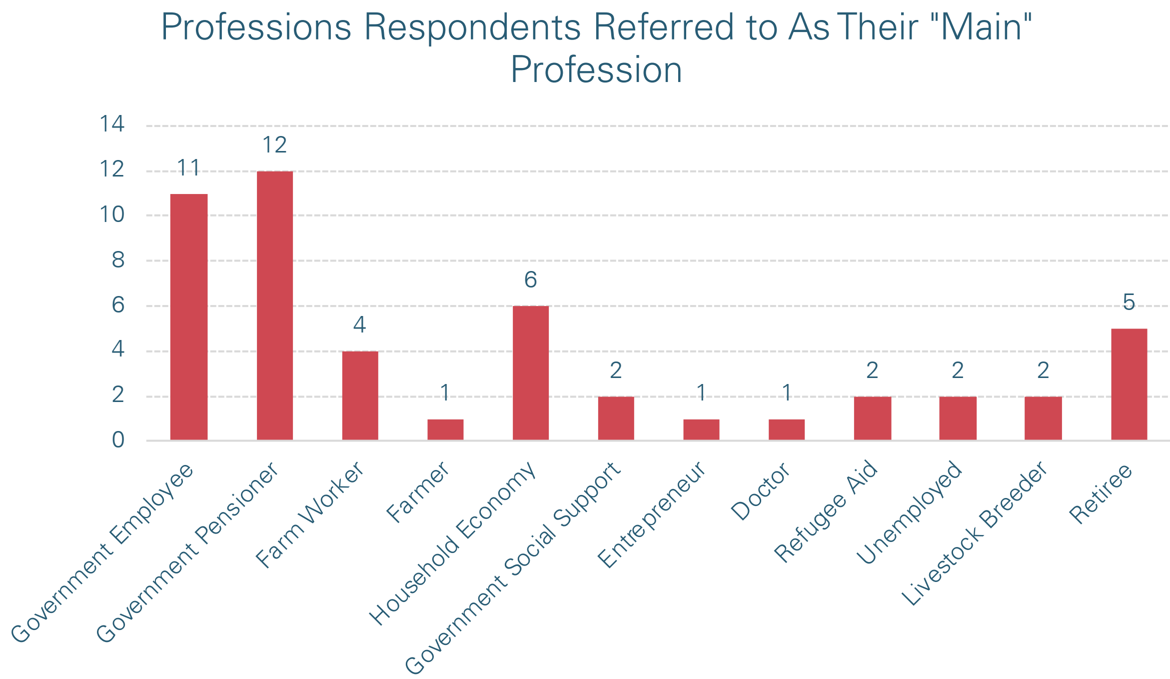


Figure 141: Main professions as stated by respondents in the interviews.

“Having to make life work” under often adverse conditions is something the residents of Deir El Kahf referred to again and again in interviews. Figures 142 and 143 illustrate the simplicity and often make-shift reality of life in Deir El Kahf, showing a local shop, a farm, farming equipment, and livestock pens in the area.

However, while not considered the main source of income, agriculture and livestock raising still play important roles in Deir El Kahf. A total of 49 out of 50 respondents owned or had access to a farm, came from a family that was involved in farming, or were working on a farm. Half of those farms were best described as mainly pursuing agriculture (35%) or horticulture (14%), while 33% were a mix of agriculture and livestock production, and 18% mainly geared towards livestock production (Figure 144). Of those interviewed, 59% were farm owners, 8% were renting land, and the rest had other types of access to farms, for example as farmworkers or through relatives.

Figure 142: Making a living in a water-scarce landscape: water tanks and sheep pens (Photos: Dawoud Isied).

Figure 143: Impressions of life in Deir El Kahf: A local shop and a farm (Photos: Dawoud Isied).

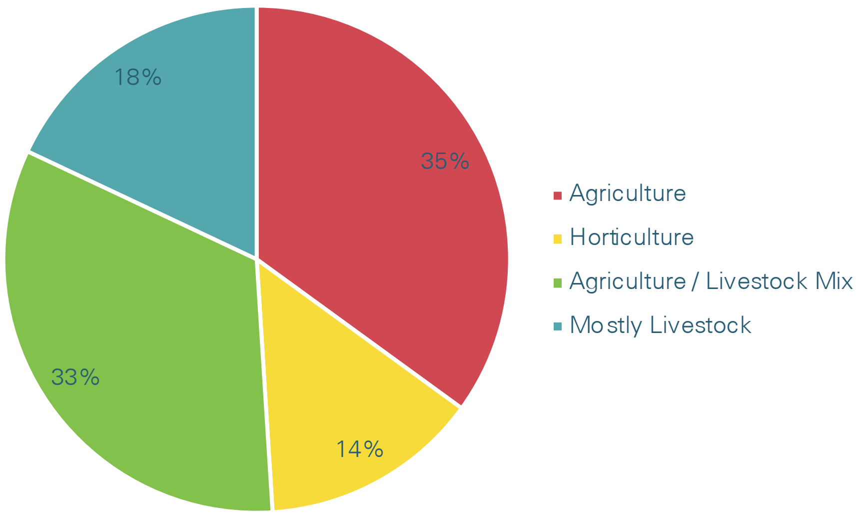


Figure 144: Types of farms (%) interviewees own or work at.

There was a large variation in the sizes of farms, ranging from under 20 donum (1 donum is equivalent to 2.48 acres of land) to over 1,000 donum. Almost 30% of the farms in Deir El Kahf are between 20 and 29 donum in size (Figure 145).

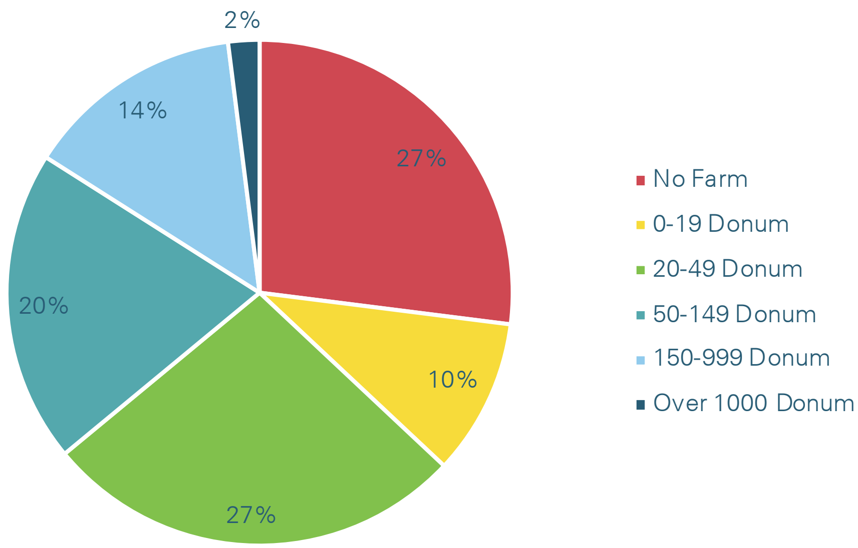


Figure 145: Sizes of farms (%) interviewees own or work at.

In terms of irrigation, 59.2% of the farms owned or operated by those interviewed in Deir El Kahf rely on rainfed cultivation, 18.4% were irrigated and 4% were pursuing a mix of rainfed and irrigated agriculture, depending on the season. As one farmer explained during the interview: "During winter, we depend on rain, during summer we irrigate." Farms that have access to wells for irrigation pump from around 350 meters of depth from the local aquifer. Pumps are usually operated with electricity pumps rather than with Diesel generators. Farmers grow a mix of crops including grains (over 50%), fruit trees, olives and vegetables (Figure 146). Many families own olive groves and vegetable gardens near their houses, many of which have to be irrigated by the scarce amount of domestic water available in the village when there is not enough rain. Having to use domestic water for irrigation around the house often means having to purchase additional tanks of drinking water from trucks at high cost. Figure 147 shows different types of irrigation in Deir El Kahf – drip irrigation on commercial farms with access to wells, and olive trees near households irrigated with household water using water hoses.
Figure 148 maps the types of irrigation practiced by respondents in Deir El Kahf. Through the

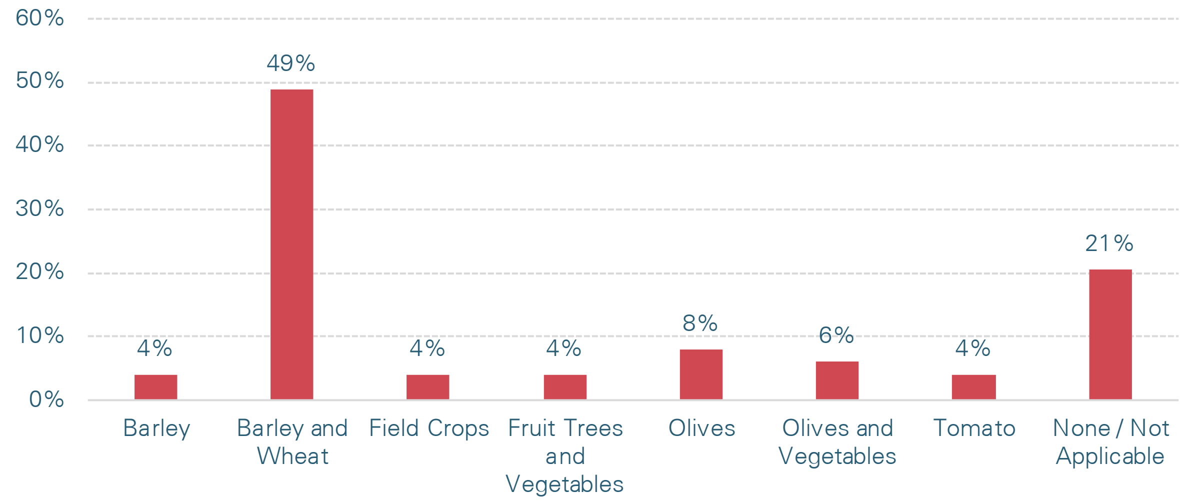


Figure 146: Types of crops grown by the research participants in Deir El Kahf.

Figure 147: Fruit trees and vegetable farms irrigated by well water (both pictures at the top top and picture bottom left) and olive groves near homes irrigated by rain and household water (bottom right) (Photos: Martina Jaskolski).

geo-referenced data collected during the interviews in Deir El Kahf, it was possible to map which farmers practice rainfed agriculture (green dots), irrigated agriculture (blue dots), and a mix of rainfed and irrigated agriculture (red dot). The yellow dots show respondents who are not engaged in farming. The map shows that rainfed agriculture is the most prominent growing form in Deir el Kahf, creating an immediate dependence of farmers on local rainfalls.

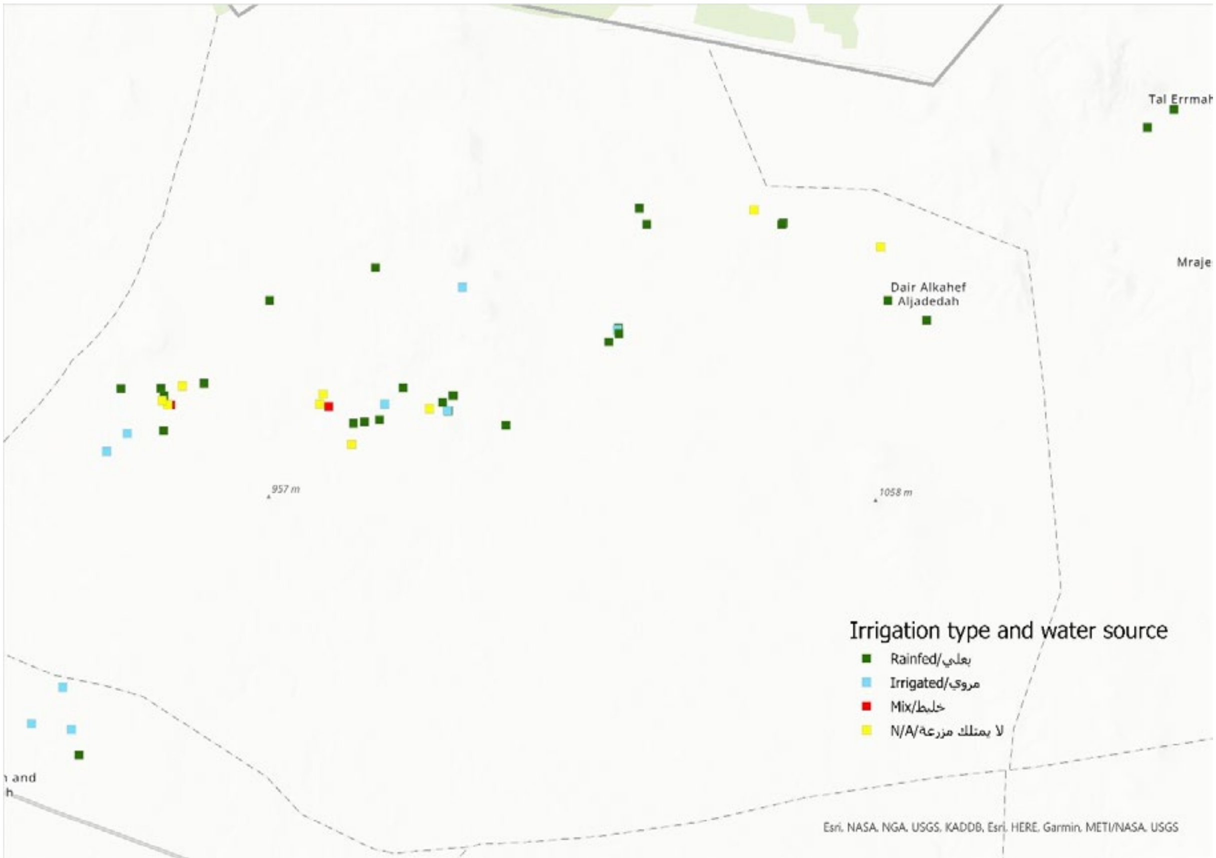


Figure 148: Farms of respondents / farms respondents work on by irrigation type (Source: WFP).

The vast majority of crop production (69.4%) among our research respondents is geared towards producing feed for livestock, 2% for the local market, and 2% for export[2]. The farms in Deir El Kahf are mostly managed and operated using family labor. A total of 78% of respondents stated that they did not employ and farm laborers. Most families have between 1 and 4 family members working on their family farm (1-2 workers: 30.6%; 3-4 workers: 28.6%). A total of 10.2% of respondents stated that 5-6 family members were working on their farm [3]. Some of the farm owners do employ additional agricultural laborers, some of whom are Syrian refugees. A total of 18% of respondents employ between 1 and 4 workers, and only 4% hire more than 4 agricultural workers. The farms employing a higher number of laborers were the larger, irrigated farms operated by investors. Often such employment is seasonal, for example during harvest times. Figure 149 shows the tomato harvest on a farm rented by an investor from Mafraq.

2 The remaining percentage reflects those who selected "other" because they do not have a farm.

3 A further 30.6% said they had no family members working on their family farms. This, however, includes respondents who do not farm.

Figure 149: Tomato harvest on a commercial farm that depends on well irrigation (Photo: Martina Jaskolski).

Farming has become an expensive operation. Renting farmland cost around 300 Jordanian Dinar (JOD) (one JOD was worth 1.41 USD at the time of the research in November 2021) per Dunum (one Dunum equals 1,000 m^2, which is a quarter of an acre) per year in Deir El Kahf in November 2021 for a piece of land not connected to water or electricity. In comparison, a Dunum of land connected to water and electricity cost 5,000 JOD per year in the village. Drilling a well in the area cost around 185,000 JOD with a permit at the time of the research – however, residents emphasized that it had become impossible to obtain drilling permits since 1997, after drilling had become illegal. "Some large investors still obtain permits somehow," one resident stated, "sometimes connections seem to transcend the law". Farmers complained about the high cost of Diesel and water. The water price in Deir El Kahf, according to local respondents, is 1.5 JOD per m^3 (prices in Amman reach between 1.6 and 1.75 JOD per m^3). "If you grow watermelon, you pay more for water than you get from selling the watermelon", one farmer explained during the focus group session. An investor from Mafraq who owns a 350 donum farm growing trees and vegetables pays between 9,000 and 10,000 JOD per year for electricity to operate his irrigation pump. Adding costs for fertilizers and pesticides, combined with low sales prices for agricultural products, often pushes local farms below a profit margin. For local tomatoes that sell for 60 Piasters per kg in the shop, local farmers receive 6 Piasters per kg from traders. In order to obtain better prices for their products, some local farmers drive to Saudi Arabia and the Gulf countries to sell.

Rearing livestock is a common practice in Deir El Kahf. Almost 70% of the respondents in Deir El Kahf reported owning livestock. Of the livestock owners, most own between 2 and 60 heads, while only 10% operate larger livestock farms with over 200 heads (Figure 150). Small ruminants are the most common type of livestock owned in Deir El Kahf – 22.4% own goats, 20.4% sheep and 24.5% both sheep and goats. Figure 151 shows livestock seen around Deir El Kahf.

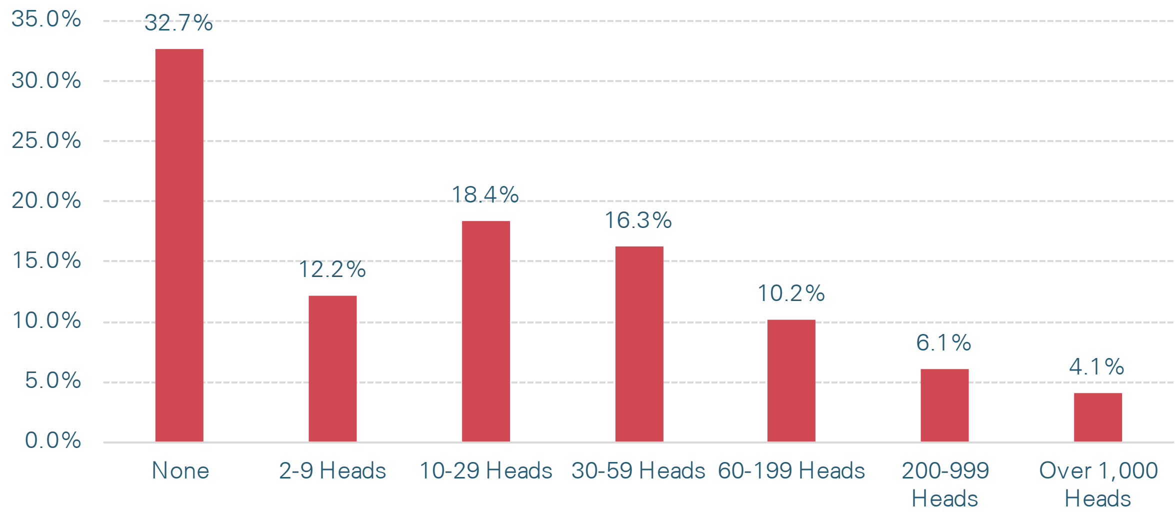


Figure 150: Heads of livestock owned by respondents(%).

Figure 151: Sheep and goats are the most common type of livestock raised in Deir El Kahf (Photos: Martina Jaskolski (left) and Dawoud Isied (right)).

A government agricultural engineer working in the area of Deir El Kahf stated that there were 19 thousand heads of livestock in the area. The livestock is fed by fodder crops that farmers either produce themselves or purchase. The government provides some agricultural services, such as free vaccinations and collection books to control the number of livestock and distribution of fodder. Medical treatment for livestock is not always locally available. The most dangerous diseases currently affecting livestock production in the area, according to the agricultural engineer, are smallpox and foot and mouth disease, for which vaccinations are available.

The research participants, most of whom live fully sedentary lives in Deir El Kahf, do not travel large distances to access pastures for their livestock. The majority of respondents reported traveling between 1 and 5 km to graze their livestock, with 5 km being the furthest distance quoted (Figure 152 – the figure only refers to the respondents who said they accessed pastures for livestock grazing, a total of 28). None of the respondents were engaged in long-distance seasonal pastoral migration movements, although, according to participants, some residents still follow the long-established pastoral migration patterns.

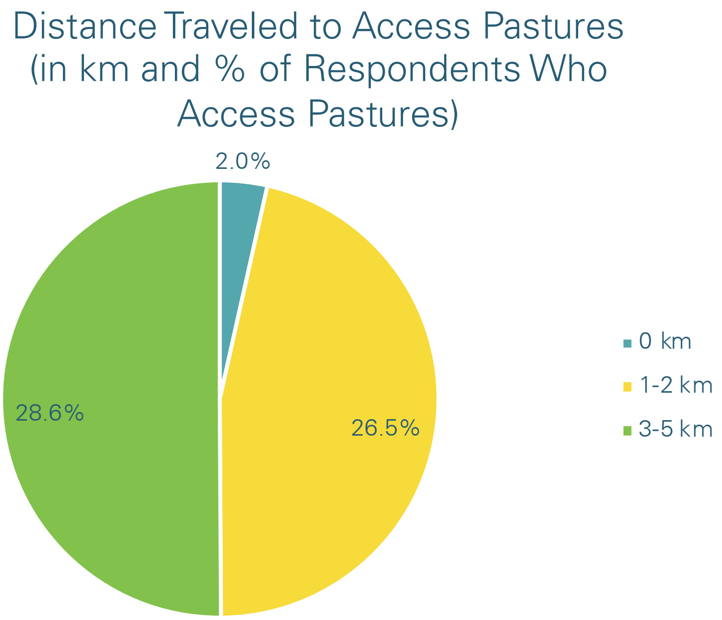


Figure 152: Distance traveled by interviewees to access pastures for grazing.

Most of those interviewed in Deir El Kahf run smaller farming businesses that combine crop and livestock production with gardening. Some of the interviewees described their livelihood as follows:

"We raise goats. We have a property that depends on rainfall. No irrigation is available for planting. We plant about 100 Dunum of wheat and barley."

"We carry out home gardening and grow olive trees. We produce for household use only, the whole family works in the garden. We plant irrigated plants but the olive trees depend on rain."

"We rent 20 Dunum in order to feed 20 heads of livestock. The family works on the farm. After planting and harvesting tomatoes, the livestock eat what is left behind. They are also fed with fodder."

"My father has livestock and we plant according to rain. We have 30-40 Dunum of land that we cultivate in size in Al-Rafa'iya. We bring in Jordanian and non-Jordanian workers, only men. Women help by taking care of livestock only. I have 30-40 sheep."

Some of the interviewees run larger farm operations that are geared towards exporting crops:

"We have 300 Dunum of our own property. We plant several times, rainfed field crops. Part of the land is pastures and part is for agriculture. We are used to working on the farm, sometimes we rent workers. We depend on rain."

"Our land is 4,000 Dunum in size, we have no water on it. We are 7 brothers, working on the land. We depend on rain. My brothers have some sheep and goats."

"I plant trees on 90% of the land. I will stop planting vegetables next year due to the lack of rain and the high cost. I rent 350 dunums and employ 70-80 workers from June until October. The family works on the land especially during the school holiday period. The ones who work are males only. Of the workers, 3/4 are female and the rest are males. They are Jordanians. We export 80% of our products abroad."

13.3.5 Climate Change and Drought Impact

Drought, water scarcity, and changes in amounts and patterns of rainfall are significantly impacting the agricultural livelihoods of Deir El Kahf. During the initial focus group carried out with a range of stakeholders form the village in November 2022, the attendees were asked to summarize the direct and indirect damages drought was having on their livelihoods. Below are the points raised by the focus group as most significant drought impacts:
Drought and Livelihood Damages

Direct Damages

1. Low livestock and agricultural production
2. Difficulty to maintain the Livestock and Agriculture
3. Low pastures and rise of fodder prices
4. Damage on underground water

Indirect Damages

1. Damages on health
2. Rise of fodder prices
3. Consumption of water stock
4. Fall in the prices of animal products

The interviews carried out in Deir El Kahf further confirmed that drought has had a noticeable impact on the lives of people living in the village. Almost 100% of the 50 community members interviewed in Deir El Kahf have noted a change in weather patterns over the past two years, noticing particularly an increase in heat waves, droughts and frost / cold (Figure 153).
Almost 50% of farmers stated that weather changes had considerably impacted their livelihoods.

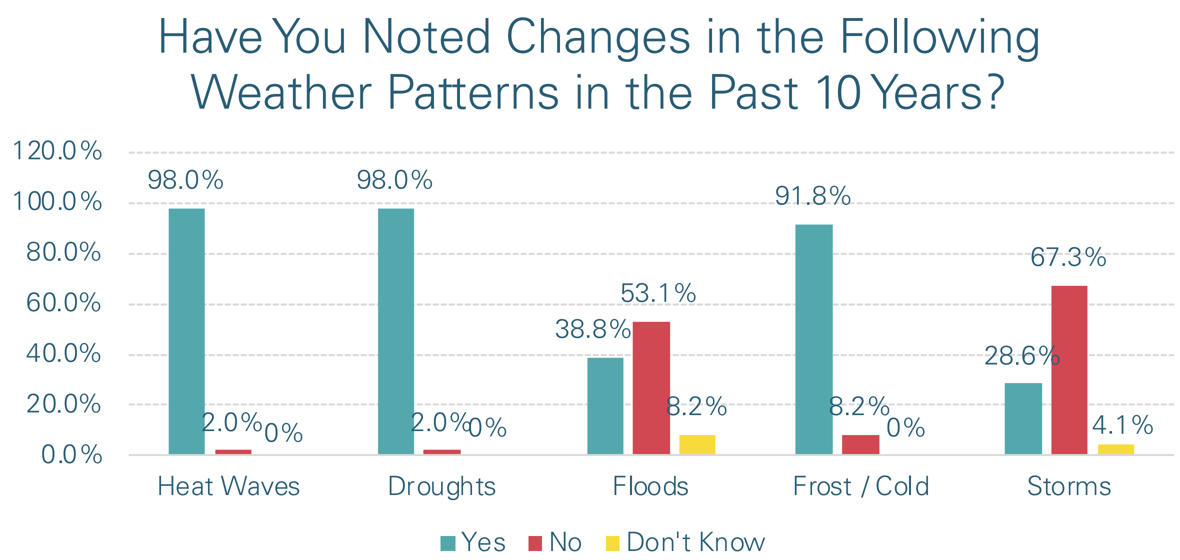


Figure 153: Local experiences of changes in weather patterns in the past 10 years.

A further 18.4% noted some extent of impact. Almost a quarter of the respondents did not feel that weather changes had impacted their livelihoods, while a further 8.2% were unsure (Figure 154).

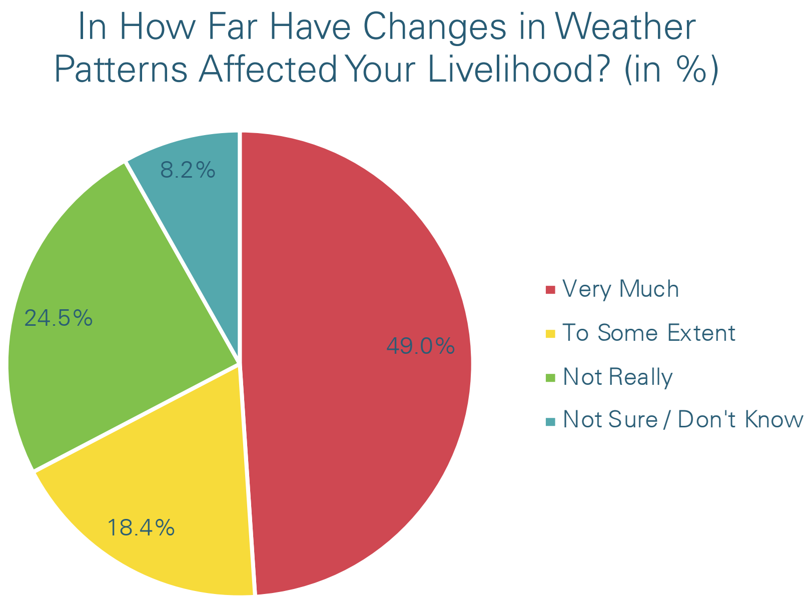


Figure 154: Participants' felt impact of weather changes on local livelihoods.

Farmers' voices from Deir El Kahf reflected that local livelihoods are intrinsically connected with the weather. Farmers have noticed a change in weather patterns, such as changes in temperature and precipitation patterns and strength.

"The weather has become very hot and dry and very cold. 20 years ago, it was not like that. Floods have harmed people. The government does nothing, it does not help or compensate people."

"The weather has become very hot and dry and very cold. 20 years ago, it was not like that. Floods have harmed people. The government does nothing, it does not help or compensate people."

"Rain has been decreasing starting 10 years ago. Water has become less, there is more winter frost and more summer heat."

"A lot of snow used to come to this area. Now the snow is very rare and the rain is very light."

"It has become very hot and very cold."

"5 years ago, rain used to fall in January, February, and March. Now everything changes, the rain is late. Winter and summer changed their timing."

Changes in temperatures, agricultural seasons and amounts of rainfall are having an immediate and profound impact on agricultural livelihoods in Deir El Kahf, especially as rainfed agriculture depends on the right amount of rainfall during certain times of the year that correspond to the planting cycle. Some of the local farmers described the situation as follows:

"It did not rain this year and the rain and cold were delayed, which affected the crops and harmed them, so their diseases increased. We treated them with pesticides."

"I planted a ton of wheat that did not sprout."

"Farming has been bad for more than 4 years and its cost is high."

"Drought is a global problem that also affects Jordan. It is caused by the lack of rain. Agriculture has declined a lot because of the poor financial return. Its cost is higher than its gains. Rainfed agriculture is not strong now due to the lack of rain - even the harvesting of the crop is expensive. As a pastoral society, the economic impact of drought is 70%. We need greens to graze sheep, they are gone. In other areas such as Irbid, many have also stopped raising sheep."

"We planted wheat and barley, but it did not sprout. The rainy season was late. I planted two sacks of wheat in 30 Dunums, but it did not sprout."

"The incidence of drought is increasing, the rain has become less. We used to have 100 olive trees, now we only have 15 due to drought."

Farmers engaged in grazing and livestock production recounted similar experiences:

"I have 25 heads of livestock (sheep and goat) and 20 Dunum of land. The family works. We depend on rain. The situation is so difficult with the drought, that's why I looked for employment."

"The land is dry, there is no grazing land available."

"We grow wheat and barley on about 200 Dunum. We depend on rain for irrigation. We have 300 sheep and goats. They eat fodder. For two years now, and this year as well, nothing has been growing. For the past 10 years, the planting has been bad. Expensive fodder and the drought have increased the problem. We borrow from the merchants until we feed the cattle and pay at the end of the season."

"Drought is going from bad to worse. There are no green pastures for livestock anymore."

"Grazing is so difficult, the land is 10 km away. The land used to be green and the rain was enough, but not anymore. We depend on fodder."

"The water is not enough. It evaporates quickly during the summer. My father plants vegetables, almonds and olives. He has 50 heads of cattle and feeds them barley, bran, alfalfa, straw, bread. Our pastures dried up because of artesian wells running dry. The pastures are far away. We grow wheat and barley, but the product depends on rain, and in the last two years the crop has been bad due to drought."

"The grazing has been bad for about a year. During the last 10 years some years were good others were bad and no grazing or vegetable growing were possible. The weather is frosty in winter and very hot in summer. There are no floods. In drought years we feed the animals fodder. Grazing as a livelihood is in danger."

As it is becoming impossible for farmers to rely on grazing, the production and purchasing of fodder crops for livestock increases. "We buy fodder at high prices", one farmer said. A farmer who had taken up employment outside agriculture said "I buy the livestock feed from my salary". The drought impact, coupled with a lack of fodder and high fodder prices, have become so bad that many farmers in Deir El Kahf have sold either all or a part of their livestock over the past few years. Many have given up farming altogether, quoting that farming had seized to be a secure type of livelihood and an "unsafe source of income". "Livestock and agriculture have become useless - the cost is more than the benefit, due to drought," one farmer concluded.
Farmers have reacted to change in weather patterns in various ways. Reducing the farmed area (42.9%) and selling off all their livestock (32.7%) or reducing the heads of livestock (26.5%) were among the most common reactions, while 55.1% of farmers had taken out a loan, and 22.4% had taken on additional jobs. A combination of different adaptation strategies, including a diversification of livelihoods, were often recounted by the interviewees. One farmer explained: "Drought has damaged livestock, vegetables and irrigated crops. We changed the type of work, we reduced the number of livestock and adjusted the type of agriculture." Digging additional wells, changing grazing grounds, and changing farming patterns were reactions that were less frequently mentioned (Figure 155). One respondent mentioned that the illegal drilling of wells had become a problem and stated that 20 illegal wells had been dug in the area as a response to drought.

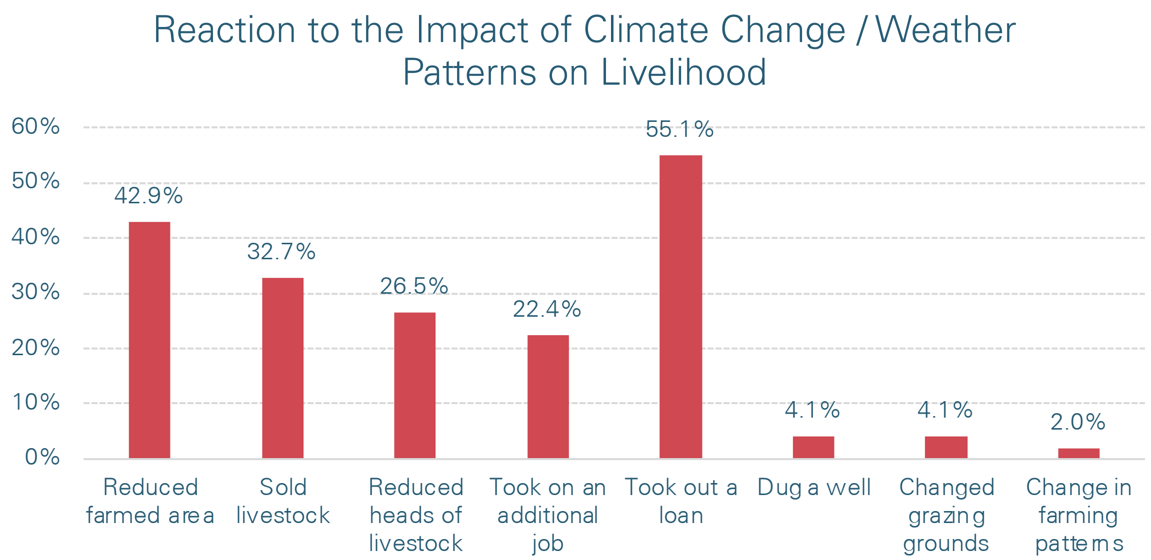


Figure 155: Reactions to the impact on climate change and changed weather patterns on livelihoods.

The following quotes summarize the extent of the livelihood impacts in Deir El Kahf:

- "Since the forties, my father was planting wheat and barley for livestock and for bread. When the grazing land decreased we started selling one after one to feed the rest of the sheep, so the livestock ate itself. Now agriculture is so bad due to lack of rain.
- 2003, 2012 and 2020 were good, other years were too bad. We have been reducing the number of heads of livestock so that we can afford to buy its food. Now we only have around 100 sheep."
- "We had 200 sheep, but nothing is left due to drought. We used to cultivate, but due to drought we don't anymore. We had 100 Dunum of land."

- "20 years ago, we used to plant and do agriculture, but not anymore. We used to have 120 heads of livestock, we reduced them due to drought. We used to plant barley, but not anymore due to drought."
- "We used to grow vegetables and trees, but now we don't grow vegetables because they need irrigation. As for the trees, they may live with rain. The climate has changed. We used to farm, but not anymore. We had livestock and we sold them because they are useless without rain. There are no ponds, projects, basins, the state does not help and does not find solutions. Unemployment is high due to drought, there is neither agriculture nor livestock. 95% of people here have stopped working in agriculture and grazing."
- "I had 300 heads of livestock, now I have 30."
- "Our land is 100 Dunum in size. We sold part of it. We gave up farming and raising livestock because of drought and lack of rain."
- "People are selling their livestock to make ends meet. I regret selling mine."
- "I am an employee at the municipality, we used to have 150 heads of livestock, now we only have 10. due to drought we had to buy fodder which is expensive (not less than 10 JOD). We used to plant 200 Dunum. We depend on rain. Now we do not plant anymore."
- "I had 1,000 heads of livestock, I sold them one after the other due to lack of grazing land and mainly due to drought."
- "A long time ago we had 150 sheep and goats and we used to plant 100 Dunum of wheat and barley. The family did all the job. The land was green and full of trees, now it is dry due to lack of rain. "
- "I had 50 sheep and goats. We used to make flour and bread out of wheat and use the barley for animals, produced milk, yoghurt, labneh and cheese. Grazing land was close. Now I don't have livestock. There is no grazing, there is no rain. Grazing and farming are more difficult. There is no rain. When the rain is good, the income of livestock is good, but now it is not good. The rain is delayed. People no longer plant because of drought."
- "I do not graze sheep at the moment because the fodder is expensive and the drought is creating a lack of pastures. I used to raise livestock before I took up another employment. We used to have 1,000 heads of livestock and 500 Dunum of land. We depended on rain. The family did all the work. We produced milk and cheese. We sold 80%. Now we do not plant nor do we have livestock. The drought has become worse and the heat has increased."

The change in agricultural livelihoods in Deir El Kahf can be visually presented by mapping data generated through the georeferenced field tool used for the collection of quantitative data during the interviews in Deir El Kahf on an interactive mapping platform. Figure 156 presents the number of those respondents who have ever had a farm as green dots on the map. Among the green dots, there are farms who had to abandon their farming operations entirely (red diamond), and farms who had to reduce their farm size due to drought impact and other challenges (orange diamond). The green dots with a blue diamond are those who managed to continue farming without making any changes to their farming arrangements. The map shows that almost half of the respondents who were engaged in farming either had to reduce their farm sizes or gave up farming altogether. Almost one third (8 out of 30) of the respondents closed their farming businesses entirely in the last few years.
The situation looks even more dramatic for livestock owners. Of the 32 respondents who have

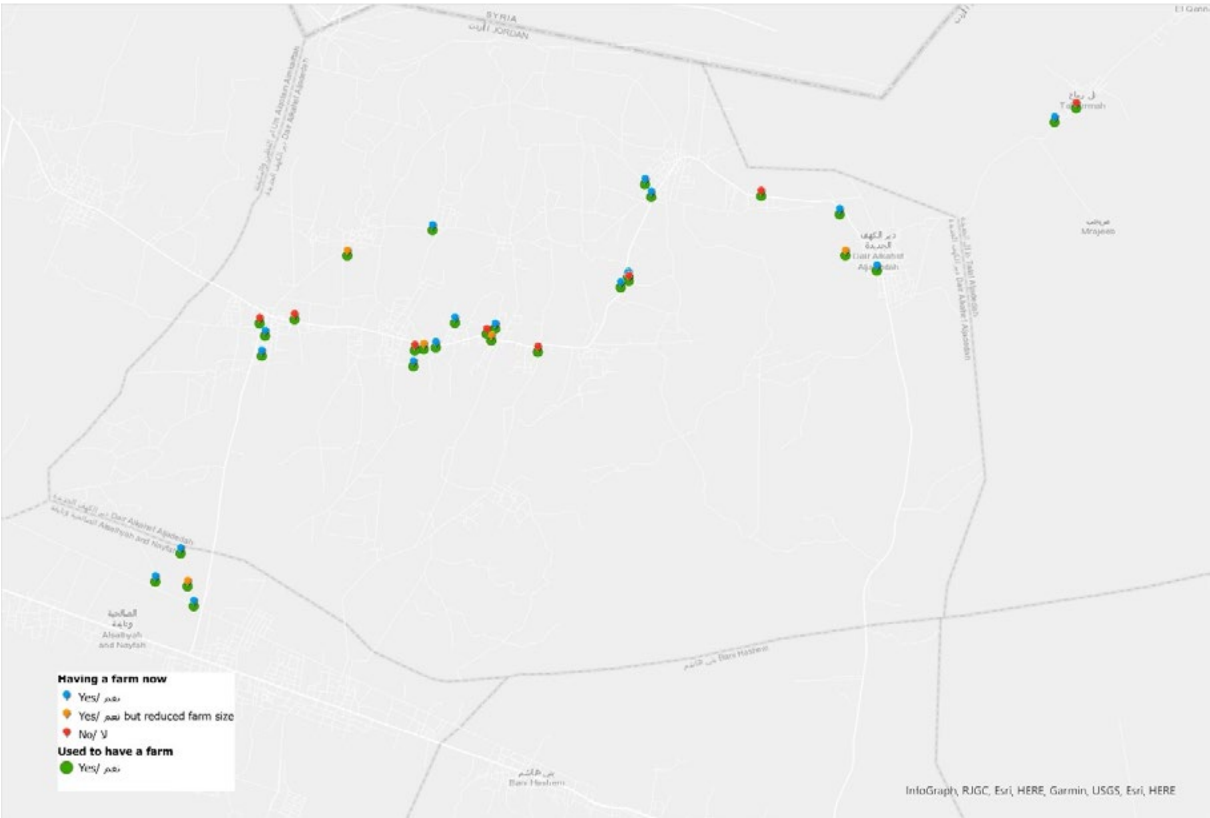


Figure 156: A visual presentation of agricultural livelihood changes among research participants in Deir El Kahf.

ever owned livestock, only 5 have been able to retain the same number of heads of livestock in recent years. A total of 17 respondents had to reduce the number of animals in recent years, while 10 had to sell all of their livestock (Figure 157).
The below satellite images taken in March 2021 (Maxar / PNG, 2021) show that a large number

Figure 157: Livestock owned by respondents in the past as compared to the present situation (Source: WFP, 2022).

of agricultural fields around Deir El Kahf are not cultivated (Figure 158). The large white structure shown in the first picture is a chicken farm located on the main road near the entrance to the village. Larger and more intensive farming ventures, such as the green areas seen in the pictures, often depend on irrigation.

Figure 158: Satellite images of Deir El Kahf showing agricultural change in the area, taken in March 2021 and available on the Digital Globe Archive (Maxar / PNG, 2021).

Figure 159: The Google Earth Images presented above reflect the changes in agricultural activity around the villages surrounding Deir El Kahf over the past decades (Google Earth).

Figure 159, in turn, shows that agricultural investment and expansion have led to an overall increase in agricultural area around Deir El Kahf between 2007 and 2019 (image at top). However, a zooming into the fields around the villages where the study was carried out uncovers that some farmers have given up their plots or are planting only a part of their agricultural area. Also, when looking at images from different years, a shifting and switching of planted and unplanted areas can be observed. The two images in the middle and below show changes in agricultural areas between 2017 and 2019 and 2012 and 2019, respectively. In the images from

2019, entire agricultural plots have disappeared from the map. Larger agricultural farm with access to groundwater wells have a competitive advantage in terms of water access, and may thus show more resilience to drought impact in the face of time.

13.3.6 Loss of Livelihoods and Poverty

The destruction of rural livelihoods by drought has increased poverty in Deir El Kahf, as seen by local residents. When asked whether they thought poverty was a problem in Deir El Kahf, the overwhelming majority of respondents, 96%, answered yes (Figure 160). Poverty was the single most mentioned issue respondents mentioned when asked about social problems in the village. One respondent said: "Deir El Kahf is not listed among the pockets of poverty. It was listed for 4 years, but poverty exists and is increasing".

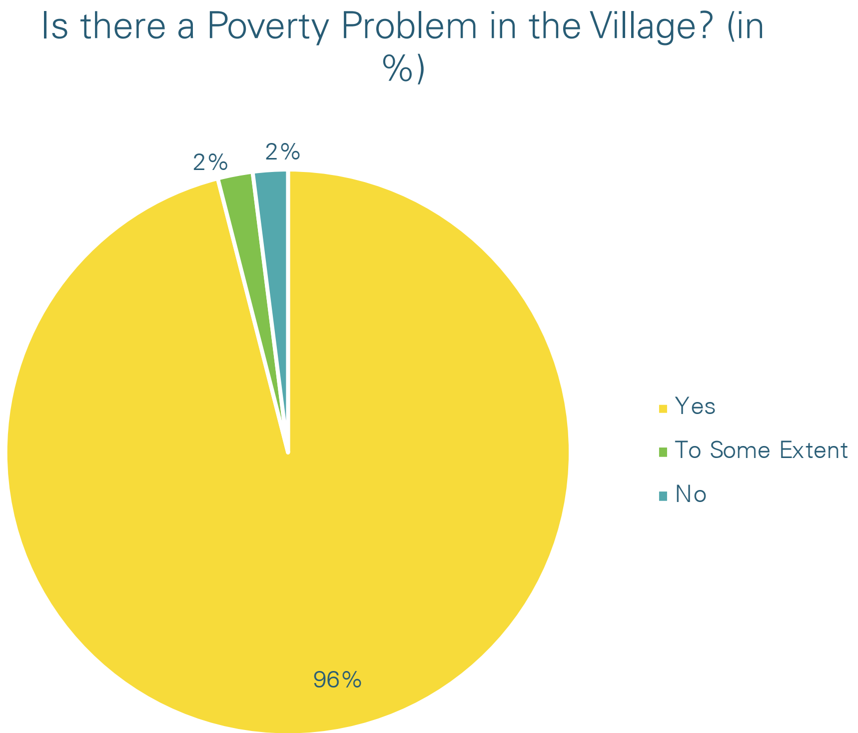


Figure 160: Perceived poverty problems by respondents in Deir El Kahf.

According to the villagers, drought has acted as a threat multiplier, exacerbating an already dire poverty problem. The respondents also felt that an increase in poverty exacerbated inequality in the village. While poverty and dwindling livelihoods are having an impact on most residents in Deir El Kahf, the vast majority of respondents (73.5%) felt that some people are hit harder than others (Figure 161). In the interviews, people expressed that they thought livestock owners, people depending on grazing, those with limited income and daily laborers were particularly hard hit by poverty.

"Half of the village is poor and poverty is increasing due to the high cost of living, drought, lack of pastures, and lack of agriculture. Livestock owners are the ones who are most affected by poverty."

"Drought is one of the causes of poverty, in addition to the absence of factories or projects."

"The low-income group is most affected - the daily laborers, those with minimum salary."

"There is no work, and those who work in agriculture have certainly been affected."

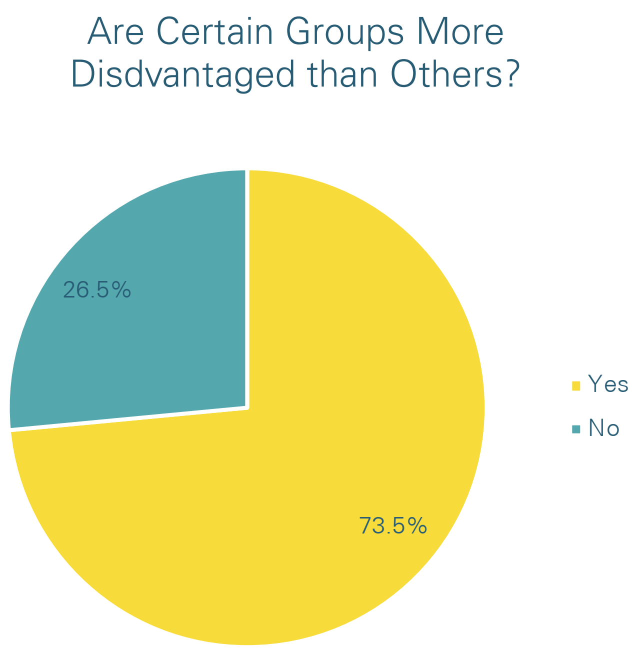


Figure 161: Respondents' perception of inequality.

As people are losing the livelihoods they have practiced for generations, they are struggling to find alternative incomes. This is not an easy task, given the relative under-development of the area of Deir El Kahf and a general lack of employment options. As one farmer explained: "2015 was a good year. Since then all became worse. We left agriculture and looked for employment." Government employment is a much-sought solution, given that it provides a stable income as well as better social security and a secure pension. One respondent said: "Poverty is the most important problem of society and it is increasing. Most people escape poverty by joining the military service. Most university graduates do not find work. The state does nothing." Alternative employment options outside the agricultural sector in Deir El Kahf remain scarce. The respondents made strong links between poverty and unemployment, especially youth unemployment, stating that many well-educated youths would not find a job. Because of frustration, theft and the use of drugs had increased in the village, some of the respondents had noticed. One respondent stated: "The girls go to Ad-Dulayl and Azraq to work in the factories for a low salary, and the transportation is paid by them. All this is because of the poverty that occurred due to drought and the lack of agriculture and grazing."

The respondents were asked about any sources of income they had other than farming. Salaries and daily labor, pensions, the reliance on the income or pension of a family members, as well as a combination of different sources of income were the most common responses (Figure 162). However, almost 30% stated that they had no other income in addition to farming, in many cases making their livelihoods even more precarious.

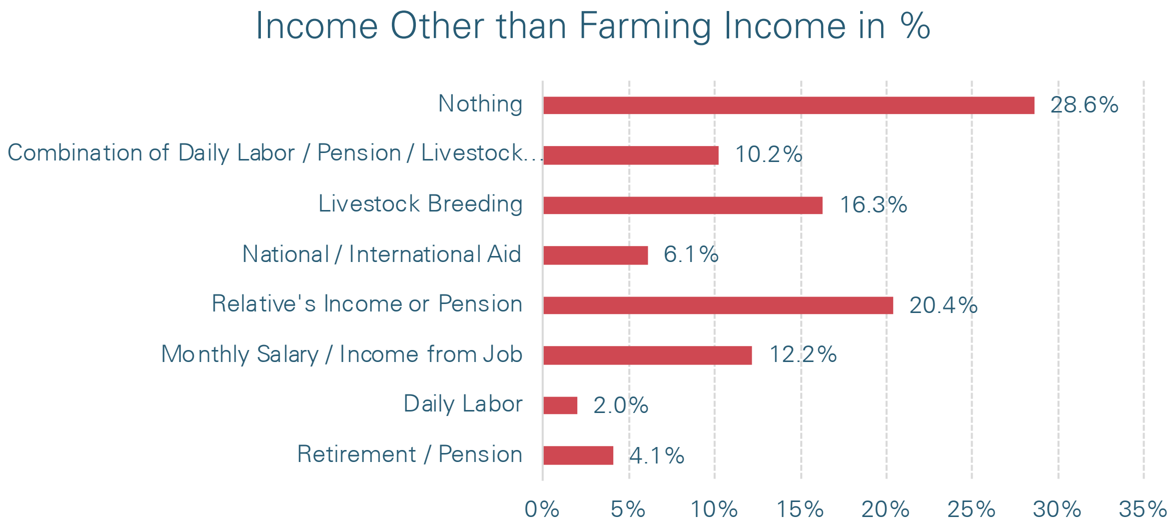


Figure 162: Sources of income respondents have outside the agricultural sector.

13.3.7 Migration and Refugees

Being located so close to the Syrian border, Deir El Kahf is an easily accessible location for Syrian refugees. The local respondents stated that there were 10 to 15 Syrian families that permanently lived in Deir El Kahf. In addition to this, seasonal farm workers arrive and temporarily reside on farms to work throughout the season. When respondents were asked how they perceived the number of migrants Deir El Kahf was hosting, the majority of the respondents (57.1%) felt they were many, 30.6% thought there were some, while around 10% said there were no migrants in Deir El Kahf (Figure 163). Importantly, the responses shown in Figure 163 represent perceived numbers of migrants, not official statistics. The question was asked to evaluate how residents viewed the presence of migrants in the village – whether there was a sense that there was a strong or weak overall presence. Obtaining an actual, official number of all migrants at any given time is almost impossible, as the seasonal workers are not formally registered in the village.

The influx of refugees has made the employment situation in Deir El Kahf even more difficult, as many residents feel they are competing with refugees for jobs, particularly on the agricultural labor market. Many refugees leave refugee camps in the area (for example Zaatari camp) for the duration of the agricultural season and work as laborers on farms, living in tents at a fair distance from the village (Figure 164). Because they receive support from the UN and from the government, they are able to work for lower wages, thus putting further stress on an already difficult job market. Refugees working seasonally on farms have their own social and labor organization system with usually one spokesperson who would negotiate the terms of employment and residence with the farm owner. As larger families often work together, Syrians are able to accept lower salaries.

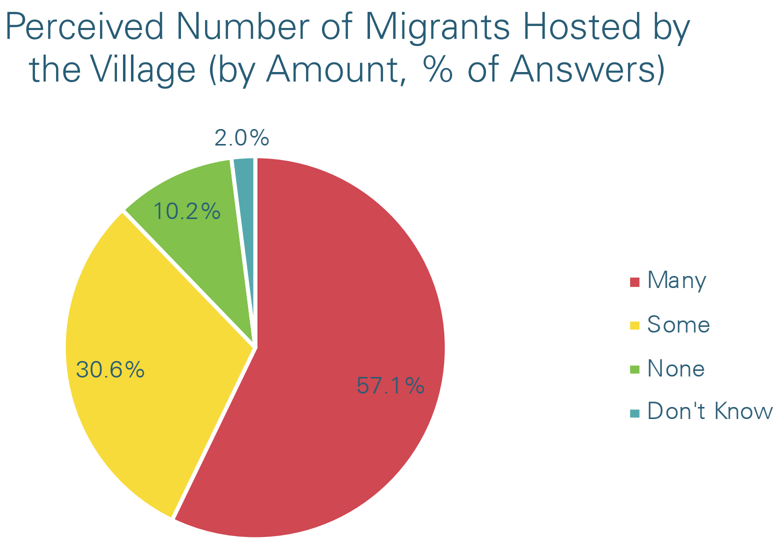


Figure 163: Presence of migrants in Deir El Kahf, as perceived by respondents.

With their own livelihoods under threat, many of the respondents looked at an increased competition from Syrian refugees on the local job market with fear:

> **"There are plenty of refugees. The situation has become more difficult. Syrians work everything at cheap prices, which has closed the door for Jordanians. Even house rents have become more expensive. It used to be 20 JOD, now it is 100 JOD."**

> **"There are much fewer job opportunities for Jordanians. Before the Syrian asylum, there were job opportunities on farms, but now no – the workers are all Syrians."**

> **"There are many refugees, which has left no job opportunities for Jordanians. The Syrians work at a lower price. Unemployment has increased and the poverty has increased."**

Besides the influx of refugees into Jordan, migration as an adaptation strategy to climate change impact was also mentioned several times during the interviews. Out of the 50 respondents, 34.7% stated that many people had migrated away from Deir El Kahf due to climate change and drought, while 46.9% felt that some people had migrated for this reason (Figure 165).

Figure 164: Seasonal workers from Syria temporarily residing in tents pitched on agricultural fields (Photos: Dawoud Isied).

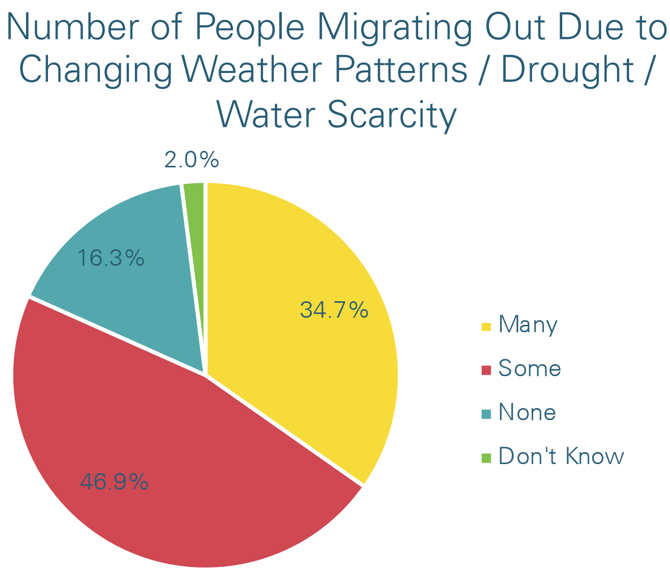


Figure 165: Climate/weather change-induced out-migration as perceived by the interviewees.

The loss of agricultural livelihoods, reduced incomes and lack of jobs were mentioned as primary drivers of out-migration. However, some pastoralists have also migrated in search for better pastures. During the interviews, the respondents gave the following reasons for the perceived out-migration from Deir El Kahf:

"Agriculture is in decline. We produce for household consumption. The seasons are going from bad to worse. The rains are late and things get worse. Our source of income has decreased, so some people have left."

"We are taking up loans, reducing the number of livestock and the extent of farming. Some people migrated to the city."

"Migration to the cities and outside the country has increased."

"The income was affected and became less. I took many loans. People work outside agriculture to make a living and migrate."

"Climate change has made people leave agriculture and move to cities looking for employment"

"Migration of people began with seasonal migration, they return after the end of the season. Some have migrated to the area of the Deir for grazing."

13.3.8 Water Scarcity, Climate Change, and Food Security

Living in rural areas with access to farmland and animals can diminish social vulnerability in the context of food security. Families in farming areas who struggle financially are often able to derive basic food such as grains, vegetables, meat, and milk products from their farms. Self-sufficiency in food production thus enhances local resilience in terms of food supply and access. Many families in Deir El Kahf used to produce grains, vegetables, fruit, olives and milk products for their household consumption. However, people increasingly abandoning farming and livestock production also means that community members rely increasingly on purchasing food, which acts as another burden on limited incomes and financial wellbeing. As the production of agricultural crops for home consumption is becoming increasingly unreliable, people are relying more and more on their incomes from jobs outside agriculture. The interview respondents described the situation as follows:

"The house has an area of land of 1 Dunum. We cultivate 80 Dunum of wheat and barley, depending on rain. The family members work without pay. We have goats and sheep and we produce milk and cheese for the house and for sale. I sell to other families on demand. We feed our animals for 150 JOD monthly, which is my whole salary. The cultivated lands are smaller in size than before."

"We buy fodder at high prices. Agricultural production is light due to lack of rain. We grow wheat and barley for our livestock."

"We make makdous, labneh and other products for home consumption."

"Wheat and barley are grown for the household and livestock. We do not sell fodder or wheat - we need them for our livestock. Our sheep's products are milk that the cheese-maker takes as well as cheese and butter. We feed the sheep with barley subsidized by the government."

"We produce milk for home consumption and we sell the extra cheese."

"We work outside agriculture to get our daily food."

"We live in a rented house. We do not produce any food, we buy all of our food."

"Most of the products are supplies for home consumption. The livestock survives on fodder crops because the pastures are far away. Our land is getting less productive year after year. It is unsafe because agriculture is difficult and creates suffering due to the cold and heat in the desert, it is causing fatigue."

13.3.9 Public Services and Living Expenses

In addition to drought impacting agricultural livelihoods, people are increasingly feeling an impact of water scarcity on their domestic lives as well. While all of Deir El Kahf's residents have access to safe and improved drinking water (98% stated they had access), most households have tap water access supplied by the government one day per week only, and for a limited number of hours. Only few households stated access to water on more than one day a week (Figure 166). Figure 167 shows the spatial representation of households and their access to water – between once and seven days per week. Both figures confirm that the most common situation is only one day of water access per week. The households who have tap water more than one day per week may be those situated at the beginning of the main public water pipes, local respondents proposed as an explanation during the second focus group. Among some of the participants, the presentation of this result triggered surprise. "There are people in Deir El Kahf who have access to water seven days a week?", one participant shouted, and added jokingly, "let's go find them!". Access to household water was a big topic during the two focus groups, as residents are increasingly using household water to irrigate their gardens. Most respondents (89.9%) use the tap water for both cooking and drinking, while 10% use it for cooking only. At times of water shortage, households rely on purchasing additional water tanks from trucks (67.3%), some buy bottled water or use well water (Figure 168). In either case, water shortage presents an additional expenditure to already stretched household budgets.

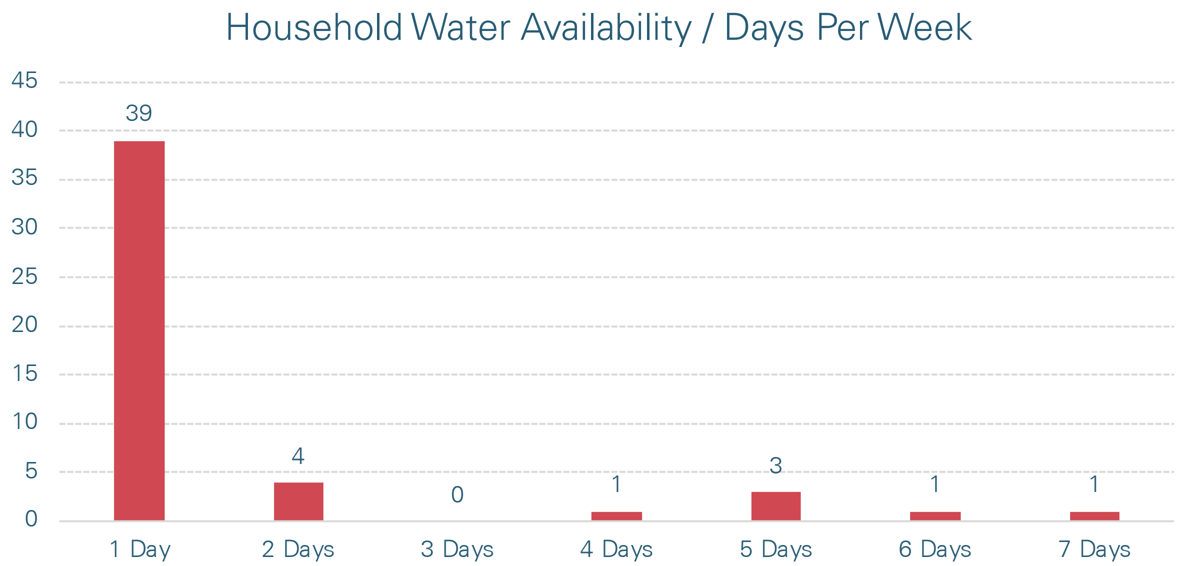


Figure 166: Frequency of tap water availability per household per week, as stated by interviewees.

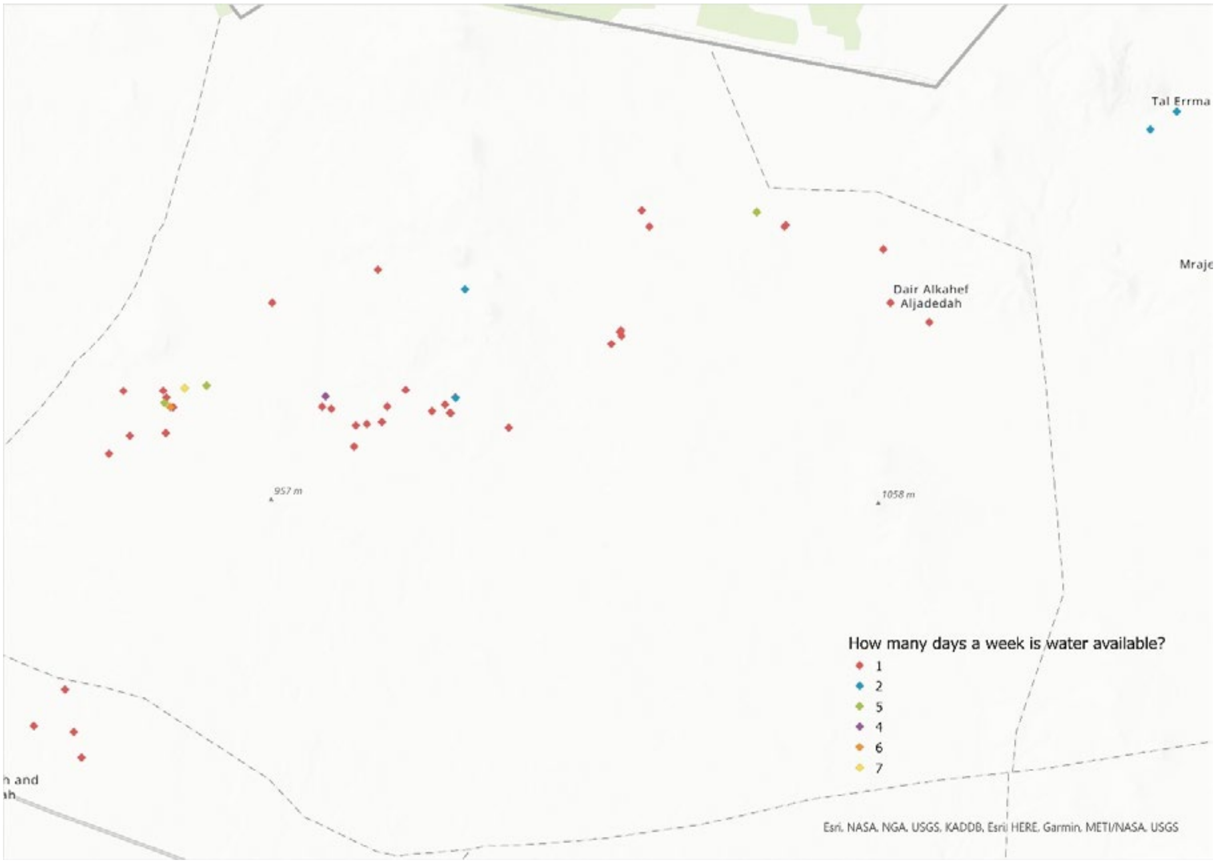


Figure 167: Spatial representation of water availability per interviewee household in Deir El Kahf (Source: WFP, 2022).

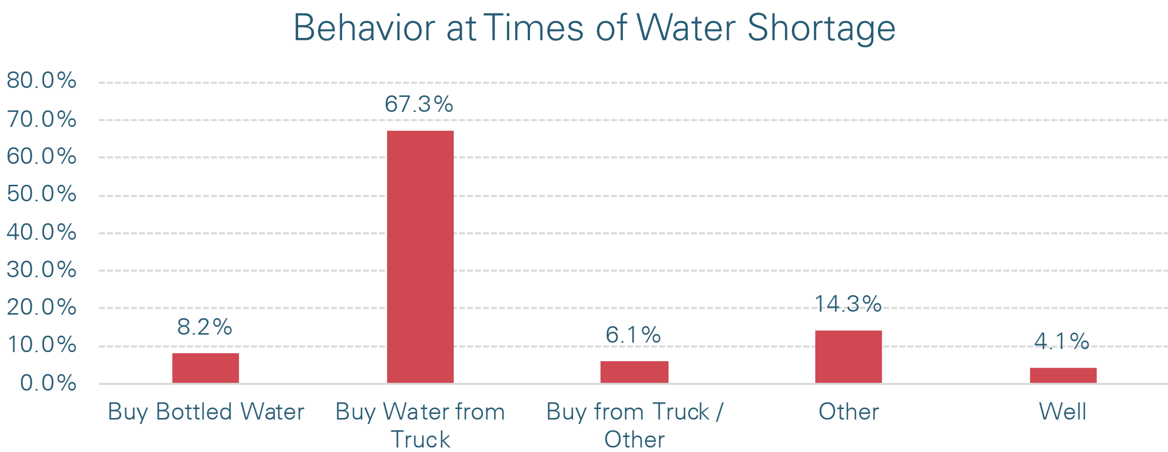


Figure 168: Respondents' behavior at times of water shortage.

Most respondents are quite satisfied with the quality of drinking water. A total of 65% rated the water quality as either excellent or good, a further 18.4% as sufficient (Figure 169). While 53% had noticed no change in household water quantity or quality over the past 10 years, 51% of those who did notice a change reported a decrease in water quantity (8.2% stated an increase in quantity), while only 4.1% noticed a decrease in quality.

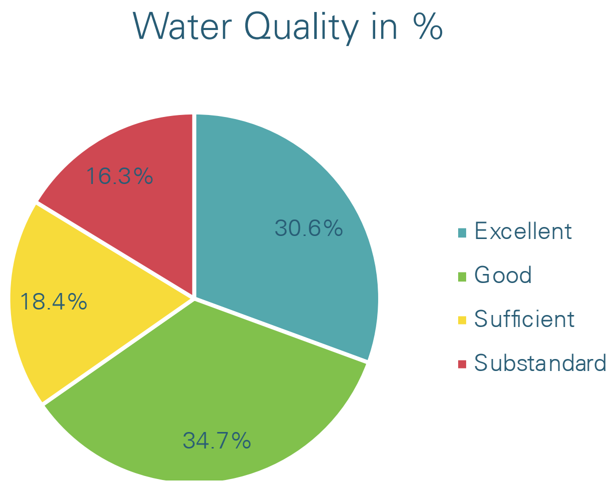


Figure 169: Water quality in Deir El Kahf as perceived by interviewees.

The residents of Deir El Kahf were happy with the quality of electricity, stating that electricity coverage was generally available 24/7 with no major or frequent electricity cuts worth mentioning. However, households in Deir El Kahf struggle with the rising cost of living in the village, especially given the simultaneous pressure on local farming livelihoods. Interview respondents stated that 50-90% of their living expenses were dedicated to purchasing food, and 20-30% on water and electricity. This is a noticeable rise in expenses compared to the findings of a participatory study conducted on the acceptance of greywater recycling in the north-eastern Badia of Jordan in 2009. This study found that people at the time spent about 5% of their income on water, while domestic water was available 24 hours per week at the time (Dalahmeh et al., 2009, 159-169). Figure 170 provides impressions of people making a living in Deir El Kahf.

Figure 170: Making ends meet in Deir El Kahf: A mother with her child and a Syrian refugee living in a tent (Photos: Dawoud Isied).

Most residents listed expenses of around 20% for education (depending on the number of children at school or university), but also stated that transportation for higher education was a considerable monthly expense. Health expenses were quoted at between 0 and 30%, depending on whether there were family members with a serious illness. Transportation to more specialized clinics were also mentioned as significant sources of expenditure. While a local clinic for basic medical services exists, hospitals that provide more special care are located 20-50 km away. Overall, around 50% of the respondents rated the costs of education and healthcare as affordable, 20-37% as reasonably expensive, and between 6 and 12% as expensive (Figure 171). High costs of living are placing considerable burdens on the households in Deir El Kahf that are already struggling to maintain their livelihoods:

"We need to buy 7 water tanks, but in villages they can't deliver it to me. The electricity is not cut off if we pay, but the bills are expensive. We can't pay. They cut it off from us, and the salary is above half a debt to the shop, and the rest is water and electricity. Then we start a new debt."

"We spend our entire salary, at the end of the month there is nothing left. Prices are high."

"The water bill 15 JOD, the electricity bill above 35 JOD. Food costs are high, more than half of the salary."

"Water costs are 25 JOD every 3 months and water tanks 20 JOD per month. Electricity and water take up 20% of our household expenses."

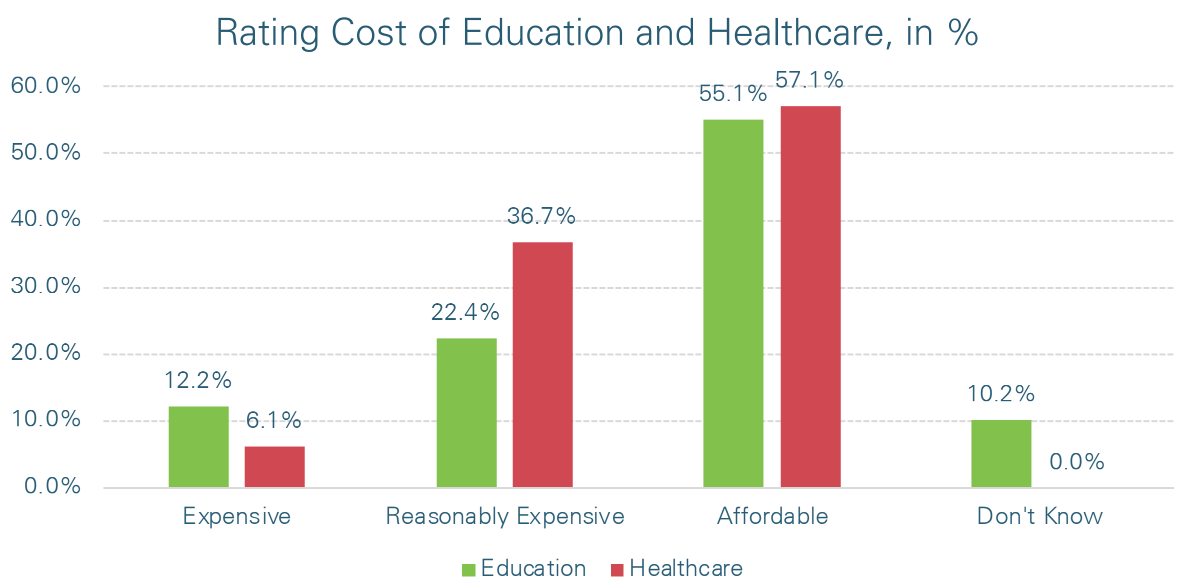


Figure 171: Cost of local healthcare and education, as seen by the respondents.

The respondents from Deir El Kahf found education and healthcare mostly affordable or reasonably affordable (Figure 171). They were more critical about the quality than the availability of healthcare and education. Between the two, healthcare services were seen as more insufficient than educational services (Figure 172). During the focus group meetings, several residents recounted that the local medical center often lacked the presence of a doctor as well as the required medical equipment, or that needed medical treatment or drugs were not available. This meant that residents with healthcare issues often had to travel to the regional hospital at their own expense.

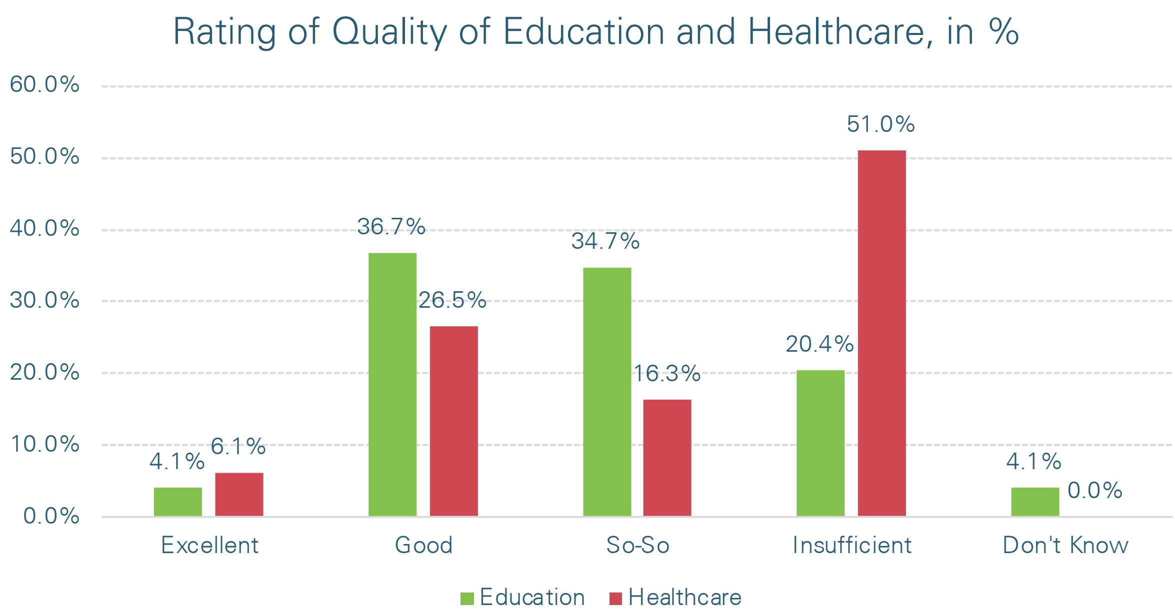


Figure 172: Quality of local education and healthcare services, rated by interviewees.

All respondents have primary and secondary education as well as basic healthcare available within a distance of 1-5 km (Figure 173). Local respondents emphasized that many educational and medical facilities had been established in Deir El Kahf within the last couple of decades.

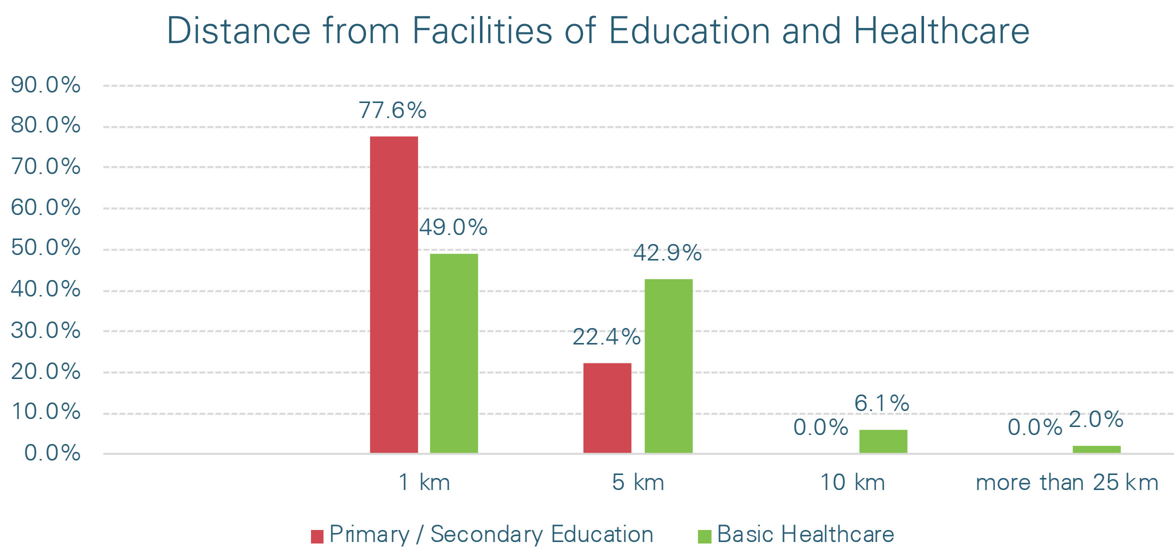


Figure 173: Distance from education and healthcare facilities, as stated by respondents.

The changing weather conditions have also had an impact on the comfort of living in the village of Deir El Kahf, as well as on household expenses. The majority of respondents felt that hot and cold weather affected the comfort of living in their home, while rain, storms, and snow were seen as having less of an impact (Figure 174). Colder and hotter weather means that residents have higher expenses for heating and cooling. As one respondent said: "In summer we need a fan, in winter a wood heater".

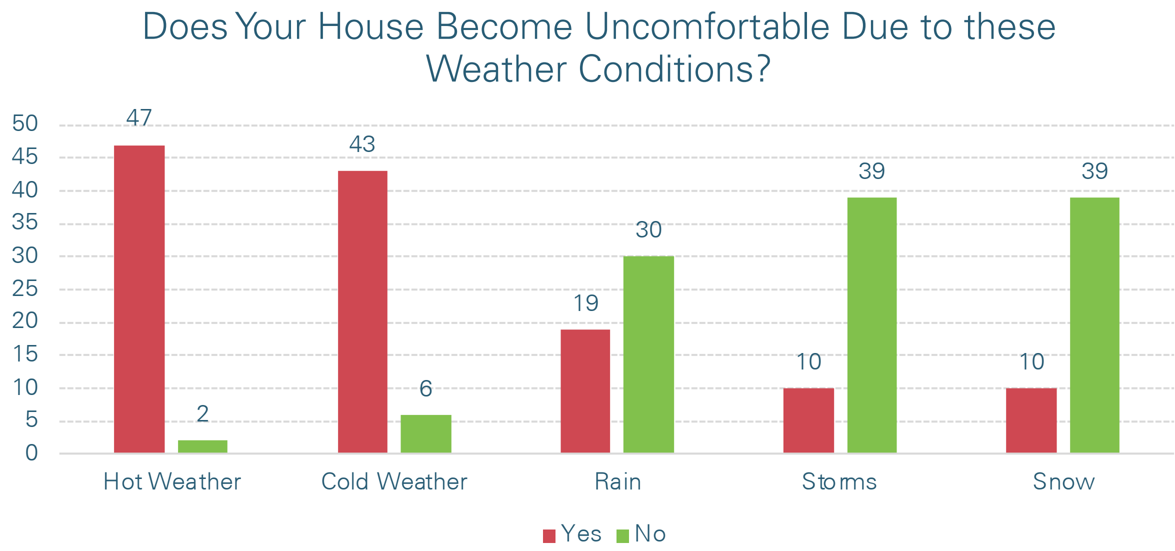


Figure 174: Extreme weather and perceptions of living conditions in Deir El Kahf.

13.3.10 Drought, Social Cohesion, and Social Support

As the residents of Deir El Kahf struggle to maintain a viable livelihood, strong community support and social capital can become important resilience strategies. Social cohesion and mutual support among community members are among the strongholds of Bedouin culture. As stated above, the strong bonds between community members were among those things local residents treasured in the Northern Badia, as previous research in the area found. Especially in times of hardship, such as increasing drought and water scarcity in the area placing pressure local livelihoods, community support and the help of neighbors and family can be of utmost importance in coping with livelihood challenges. When asked about the existence of social cohesion in the village of Deir El Kahf, a majority of 57.1% of the 50 respondents in this study affirmed the full existence of social cohesion. Another 34.7% felt that social cohesion existed to some extent, while a minority of 8.2% referred to there being no community cohesion whatsoever (Figure 175). None of those who claimed there was no community cohesion had a refugee or migrant status. As Figure 176 shows, those people who observed lesser degrees or even cohesion are spread out fairly evenly across the map of the village.
The vast majority of interviewed residents of Deir El Kahf stated that they felt welcome in the

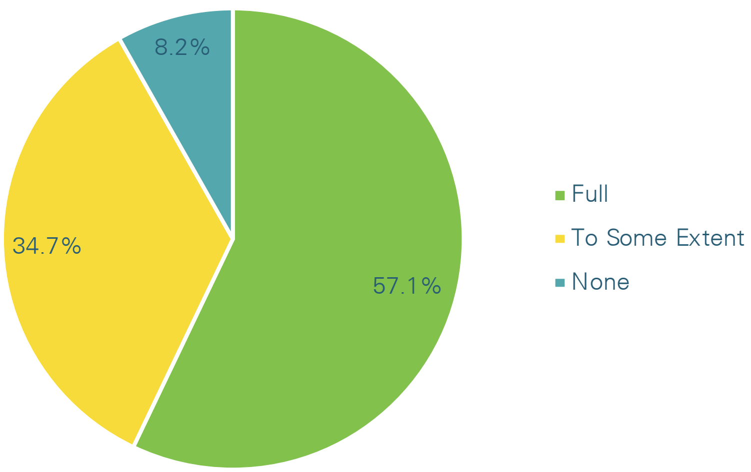


Figure 175: Existence of social cohesion in Deir El Kahf (%), as seen by local residents.

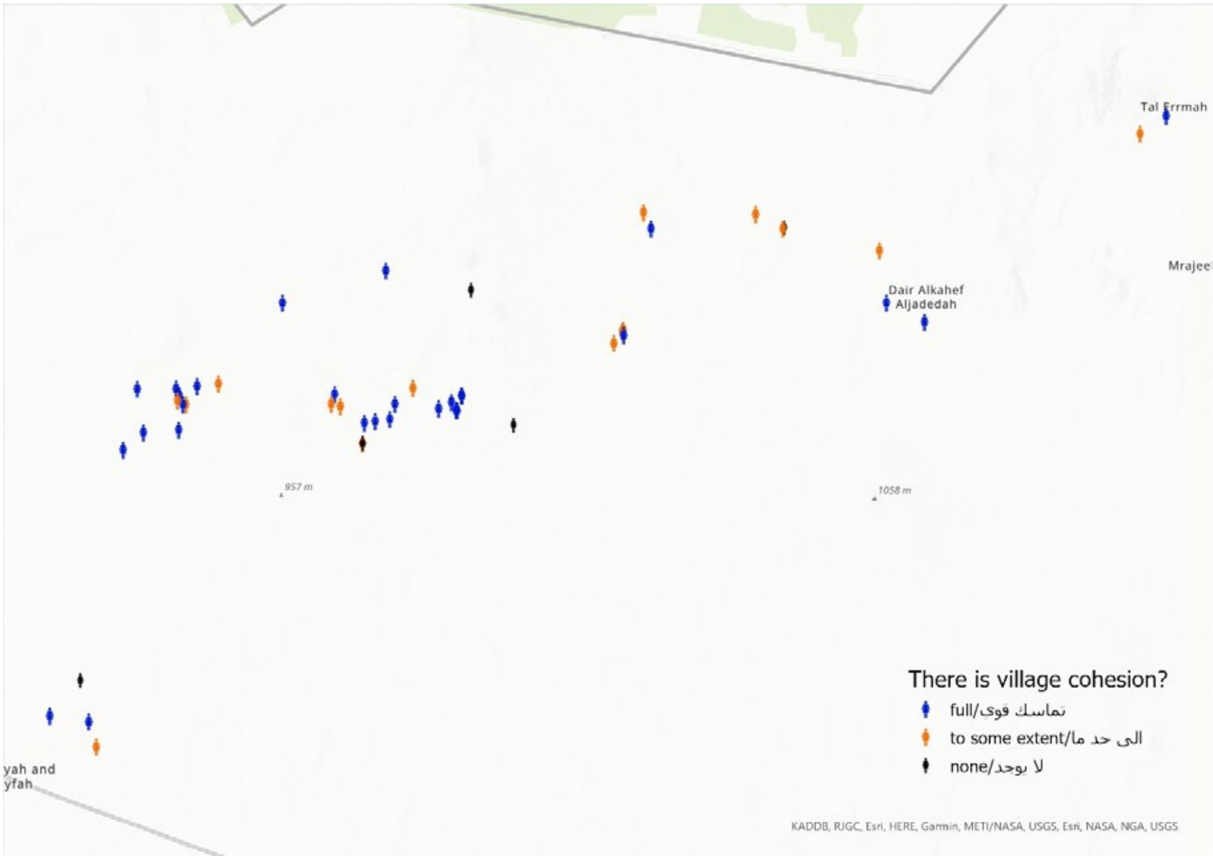


Figure 176: Spatial visualization of community cohesion (Source: WFP, 2022).

community (73.5%), while 22.4% felt welcome to some extent and 4.1% did not feel welcome at all (Figure 177). Only 30.6% of the respondents are members of a club or community association or community group. In times of hardship, a large majority of 73.5% of respondents feel supported by their neighbors and community, 18.4% feel supported at times, while a small minority of 4.1% do not feel any community support (Figure 178).

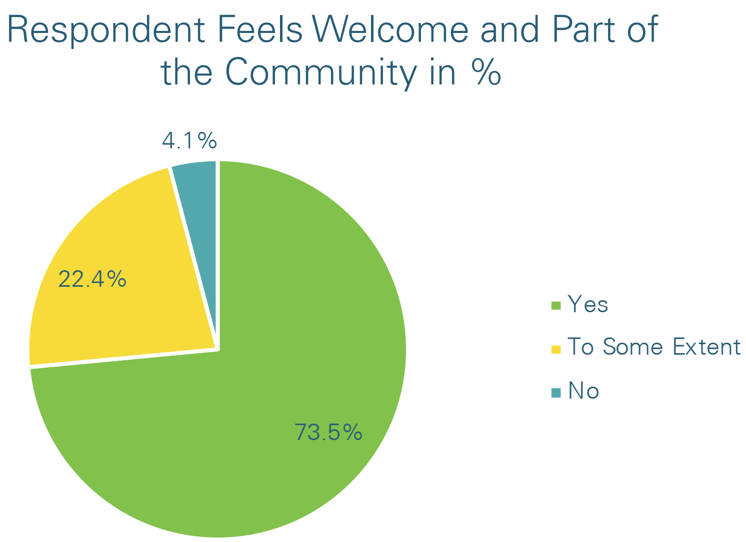


Figure 177: Feelings of belonging and inclusion among interviewees.

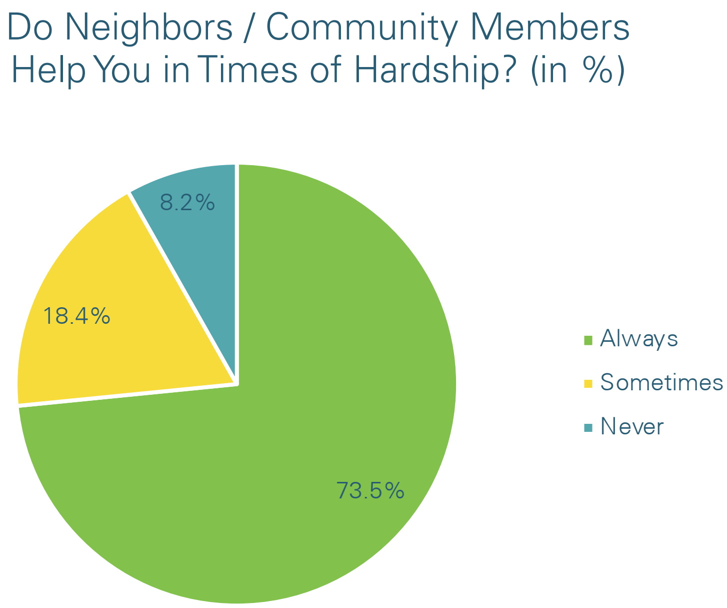


Figure 178: Perceived social cohesion and community support at times of hardship.

In the interviews, many respondents linked the strong perceived community cohesion in Deir El Kahf with Bedouin and desert culture, but also with the social proximity of the residents of Deir El Kahf – many residents of the village are either related or have known each other for generations. Figure 179 shows local residents and Syrian refugees in Deir El Kahf. The social ties of extended families strengthen community cohesion and social capital. Moral support, breeders using each other's land for grazing in times of drought, or sharing bread were some of the things the respondents mentioned as examples of mutual support in the village. Some respondents stated that emotional support was stronger than financial support. Local community associations were also quoted as sources of help and support. The following are quotes of respondents describing community cohesion in Deir El Kahf:

"Cohesion exists. We meet in joys and sorrows. We help each other morally, but financially, the possibilities are limited."

"Neighbors sometimes support each other financially and sometimes morally."

"The community is cohesive and connected. We visit and take care of each other."

"People in the desert are still clinging to tribalism. If someone needs help, people help that person."

"People here are interconnected and maintain the customs of the Bedouins, for example mutual respect."

The community is cohesive, especially relatives, and most of the village are relatives. They help at weddings and comfort each other, they are not joint officially or as part of an association, but people are close to each other at times of disaster."

Figure 179: Sharing a home in Deir El Kahf - Syrian refugees (left) and local residents (right) (Photos: Dawoud Isied).

Some commentators felt that it was specifically the absence of government support that made people stick together more closely. "The government does not know a thing about us," one person said. Another respondent stated: "Cohesion exists, morally at least. The government does nothing." Building resilience in the face of hardship was something that will rely to a large extent on retaining community bonds and cohesion.

However, some respondents felt that social cohesion in Deir El Kahf was not as strong as it used to be, due to cultural change and poverty. As people were all struggling financially, it was getting harder to provide financial support for each other in times of hardship, several interviewees said. Some felt that mutual support these days was restricted to extended families and did not happen as often anymore among neighbors. Below are the voices of those who saw a breakdown or general lack of social cohesion in the village:

"Years ago, people were more supportive. Due to poverty and unemployment, cohesion has become less."

"The social cohesion used to be better. Today, everyone is a stranger. There is no coherence."

"Social cohesion is weak and the government does not help."

"Cohesion is less. Each person is responsible for him- or herself. Some have migrated."

"People are not connected. There are no associations to support people, the loans are bad."

"People fight for water and grazing land."

"People fight for water and grazing land."

"There have been some troubles over green lands due to drought."

"Due to lack of grazing land, there are some troubles between livestock keepers and land owners."

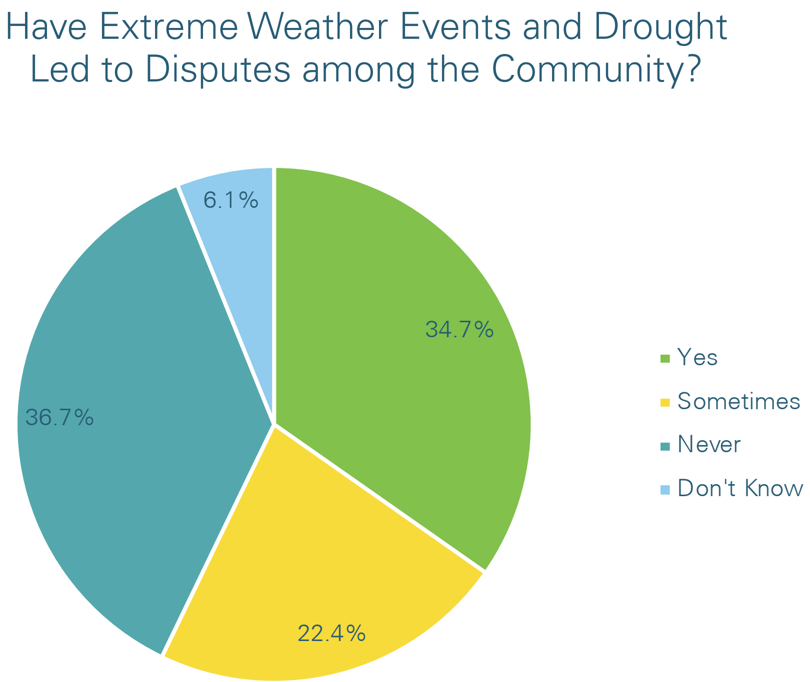


Figure 180: Impact of drought and extreme weather on community cohesion, as felt by respondents.

12.3.11 Refugees and Social Cohesion

The influx of refugees into Jordan and Deir El Kahf presents interesting questions about the social integration of refugees into the community. When asked whether Syrians were generally more connected to each other than to the rest of the community of Deir El Kahf, 77.6% of respondents thought that was the case (Figure 181). Especially with regards to the Syrians working on farms, it was felt that they were less integrated into the local community and more connected to each other than to Jordanians. Those who have permanently settled in Deir El Kahf, and particularly those who arrived in Jordan many years ago, were seen as more integrated into the community. For the present research, several of Syrian refugees living in tents and working on farms were interviewed, as well as Syrians permanently living in the village of Deir El Kahf. Their views and opinions are represented in all the data presented here.

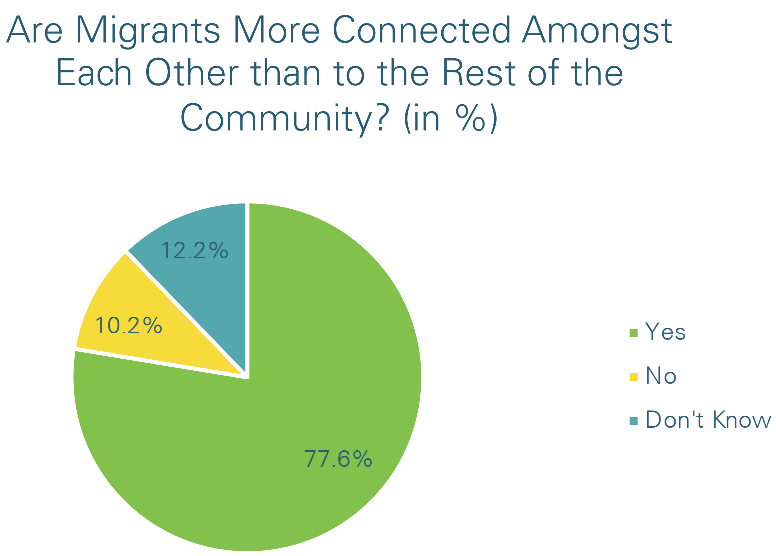


Figure 181: Respondents' views on the connectedness of migrants to the rest of the community.

When asked to quantify the impact migrants had had on Deir El Kahf, specifically on resources and public services, most respondents (almost 80%) thought there had been a significant impact (Figure 182).

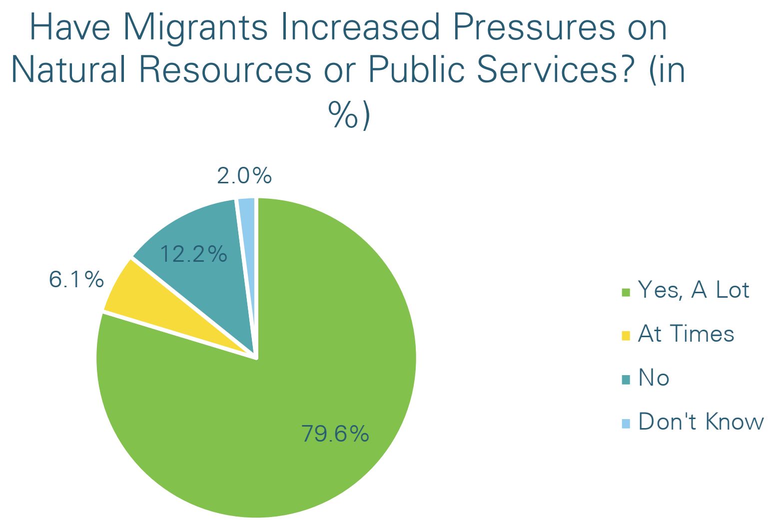


Figure 182: Perceived impact of migrants on life in Deir El Kahf.

While several respondents emphasized that Syrians were guests in Deir El Kahf and were welcome in the village, there was also a strong sentiment among the majority of interviewees that Syrians were increasing hardships due to the competition they were creating on the local labor market. One farmer we interviewed adamantly refused to hire Syrian labor, stating that he was only employing Jordanians, as he wanted "nothing to do with refugees". However, there were also positive comments about the presence of Syrian refugees in the community. The respondents described their sentiments as follows:

"The Syrian refugees are our brothers, but we have divided our food with them, but unemployment among Jordanians has increased due to refugees."

"Yes, there are many refugees in Deir el Kahf. There is a positive impact on education, so they stimulated Jordanian students. The influence of Syrian refugees is light in our region."

"There are not many refugees. The laborers come from the camps to Al-Manara, Prince Ali and Al-Rifa'at to work on the farms. They are more cohesive and interconnected with each other. They put pressure on health, schools, and services."

13.3.12 Formalized Support Systems and Government Support

Generally, the respondents showed disappointment in the formal social support systems in the village. Just over 60% thought there was no type of social support system for them in times of hardship, while 28.6% thought there was some support and 10.2% felt that they had formal support (Figure 183).

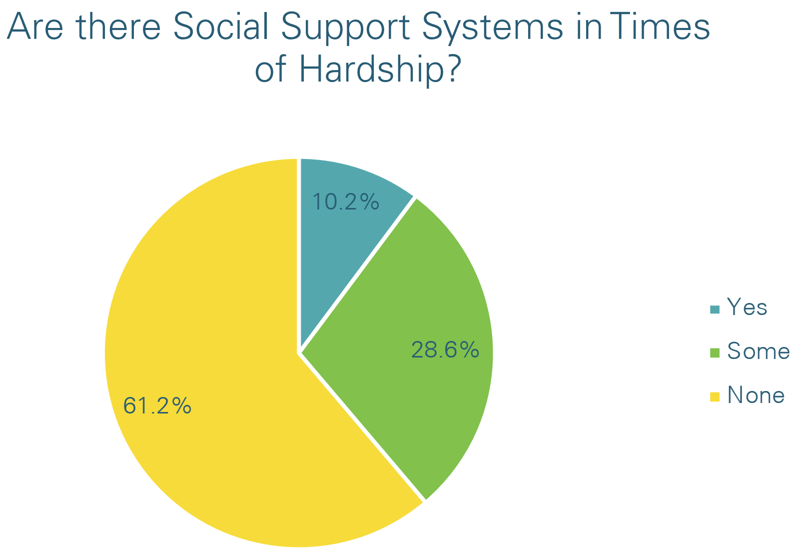


Figure 183: Perceived existence of formalized social support systems in the village.

Farmers were complaining about a lack of government support in coping with the impacts of drought and climate change, as well as with poverty and unemployment. There are, however, a number of NGOs that are trying to facilitate development initiatives as well as social support for local residents. One particularly active NGO is led by a local woman (Figure 184). The NGO that hosted this research project in Deir El Kahf was handing out food supply boxes to needy families at the time the focus group was held at the NGO building. The NGO has already worked with a number of international organizations on development projects in the area, including USAID and Mercicorps, UNDP, the Goethe Institute, and the US Forest Service.

Figure 184: Strong women in Deir El Kahf - female director of a local NGO that facilitates social support and local development (left) and a women's handicrafts group run by the local development association (right) (Photos: Martina Jaskolski and Dawoud Isied).

The interview respondents voiced their concerns with a lack of social protection and formalized social support systems as follows:

"The government does not compensate anyone for his losses due to floods or disasters, which have a direct impact on agriculture and livestock. It has become a very bad situation. Most of the people left the land and sold their sheep. They took a loan from the agricultural loan. Even livestock medicines are very expensive."

"Poverty is increasing. There are government systems for assistance: social development, the royal court, associations, good people. There are lots of loans, but they are bad in the long run."

"There is no state support, there are loans for livestock owners, but they are not enough and you have to pay them back."

"Sometimes I have support, but this is not available for everyone. I mean, every 3 months, about 6 people receive something. It is not enough, life is difficult, and the problems of poverty increase."

"The State does not support citizens. Agriculture and livestock breeding are the primary sources of livelihood for the people in the desert. Sometimes you are in debt and buy from the shop with debt and you cannot pay. For two years I have not paid electricity or water."

"Some people have stopped farming and grazing. I took a loan from agriculture to buy fodder. We need help, we no longer grow food."

"Poverty is on the rise due to high prices and drought, and it has repercussions on everything: food supplies are on the rise, government support does not exist, we hear about national aid but we have not touched it. They distribute it according to favoritism and knowledge."

"Poverty has increased, there is no employment and no help from government, but some funds for specific people suffering from hard conditions. Loans are not the solution. The government does not support or compensate us."

13.3.13 Advantages and Disadvantages of Living in Deir El Kahf

During the focus group discussions and interviews, the participants were asked what they thought were the positive and negative aspects of living in the village of Deir El Kahf. Table 53 summarizes their responses.

Table 54: Perceived advantages and disadvantages of living in Deir El Kahf

Advantages	Disadvantages
The social life and the social bonds	The lack of water
Presence of family	High prices for everything
Ownership of property	Extreme weather: Heat, frost, and drought
Calm and quiet lifestyle, peace of mind	Unemployment
Traditions	Absence of development projects
Living is cheaper than in the city	Lack of infrastructure and transportation
Clean environment and lack of pollution	Presence of thieves
No population pressure	Long distance from the city
Sense of belonging, having been born here	Lack of quality medical services Problems with local government officials

There were also several respondents who said they liked nothing about Deir El Kahf, some said they simply got used to it or were born there, so could not help living in Deir El Kahf. Others said they simply loved Deir El Kahf exactly the way it was. Figure 185 shows some additional impressions of Deir El Kahf.

Figure 185: A place that offers a quiet life, marked by daily struggles of accessing resources. The road towards Deir El Kahf (left) and a family in front of their house, with our local consultant Dawoud Isied (right) (Photos: Martina Jaskolski, Dawoud Isied).

During the introductory focus group conducted in the village at the beginning of the study in November 2021, the farmers also identified a list of general problems that were affecting life in Deir El Kahf. These problems are listed here:

1. **Health problems**
   - Two medical centers are available with no proper equipment.
   - Four primary medical centers are available with no equipment
   - Al- Badia Hospital has no equipment nor staff

2. **Education**
   - Education depends on additional teachers who lack experience
   - On-line teaching is a problem itself
   - Poor education start-up for students
   - Migrating experienced people to other areas

3. **Water**
   - Lack of water supply, as the water comes for less than 4 hours a week in some areas
   - Poor water networks and high losses of water
   - Low economic level and much poverty due to drought
   - Unfair distribution
   - High energy bill for well owners and subsidence of groundwater

4. **Development projects**
   - Low economical level and much poverty due to drought
   - Weak tourism capabilities and services and not being promoted as a tourist area

5. **Public services**
   - Weakness of the municipality's capabilities
   - Expansion of the geographical area
   - Distance from the center
   - Weakness of infrastructure

6. **Refugees**
    - Pressure on water sources
    - Pressure on infrastructure
    - Pressure on public services
    - Local community experiences competition for job opportunities

7. **Labor**
    - No operational projects
    - Drought
    - Weakness in quality of teaching
    - Weakness of infrastructure for investment
    - Distance of the area from the center

8. **Social problems**
    - Weakness of social bonds and cohesion
    - Drug use spreads (consuming and trading), because it is close to Syrian borders, the war in Syria, weakness of religious faith and social control

9. **High cost of living**
    - Rise in prices generally
    - Rise in fuel prices
    - Rise in transportation fees
    - Lots of taxes

10. **Low production**
    - Low animal production due to drought which caused the dryness of the pastures.

When addressing intersecting vulnerabilities in Deir El Kahf and ensuring that pre-existing social vulnerabilities do not make climate change impacts even more unbearable than they already are, holistic policies have to be implemented that address the above-mentioned problems in a concerted effort. The previous sections have shown how interrelated drought impact in the village is with water availability, unemployment, poverty and gender, the general cost of living but also, when considering people's adaptive capacity to climate change, with education, asset ownership, and livelihood alternatives, as well as health insurances and services.

13.3.14 The Impact of Covid-19

The global Coronavirus pandemic has added an additional strain on people's livelihoods. The interviewed residents of Deir El Kahf reported that the Covid-19 pandemic had increased the level of unemployment in the area, also intensifying poverty. For many residents, especially daily laborers, work had at least temporary stopped due to Covid-19, as farmers were struggling to sell their products. Several respondents also commented on the disruptions Covid-19 has caused in the educational sector as well as the implementation of projects in the area.

Two farmers were recounting their experiences of the impact of Covid-19 on life in Deir El Kahf as follows:

"We have sheep and goats. We use their milk for making cheese. The cheese-maker is complaining - there are no buyers, especially during the times of Corona, so he won't pay us! Wool is very cheap or thrown away. Life is going from bad to worse."

"Covid has had a negative impact on everyone and has created a lack of movement, it has stopped our work and the milk was thrown away because no one could be reached to buy milk."

"Covid has impacted us morally, mentally, financially, and we fear the future."

People also reported on the cultural impact of increased social distance, affecting social events and cultural traditions, for example wedding traditions, in the village of Deir El Kahf. People were scared for their health and visiting each other less often. The rules of social distanced had also made movement harder, according to the respondents, limiting for example movements between houses and farms. Some respondents also reported an increase in prices due to Covid-19.

The global Covid-19 pandemic had just acted as a risk multiplier in the village, affecting several socio-economic aspects of village life and making local livelihoods even more precarious. As one respondent put it: "We were suffering prior to Corona, now we are suffering more."

13.3.15 Possible Solutions

During the interviews, the respondents were asked about possible solutions to the drought impact on rural livelihoods in Deir El Kahf. Several respondents suggested water harvesting techniques, such as setting up new or refurbishing existing water pools, basins, and dams. While some participants suggested that drilling new wells could be a solution, others pointed to the prohibition of the drilling of illegal wells, and the problem of tapping the already scarce groundwater resources. More support for farmers and livestock breeders was a commonly named theme, through agricultural development projects, lowering fodder prices, and drought social protection programs. The respondents also referred to the creation of new job opportunities in the area through establishing factories and industries. Setting up training programs could help people transition from agricultural livelihoods to other types of livelihoods. Raising salaries and controlling the competition between Jordanian and migrant workers on the labor market were other points raised in the interviews, while some also suggested a decrease in loan fees.

Many respondents mentioned the government as a source of solutions and were expressing their need for more government support in finding solutions. Here are the opinions of respondents about possible support systems.

"The Government should support farmers and livestock breeders. Reducing the price of fodder, creating ponds to collect water, water harvesting, and setting up factories to employ people are possible solutions."

"The solutions are in the hands of the decision-makers. We need to support the livestock breeders with feed, provided that they pay at the end of the season and we need to establish dams or watersheds.''

The respondents were generally very negative about loans, sharing experiences how loans had dragged them into financial disaster and had created a financial dependency that was not making their life situation easier. Many respondents had taken out loans to buy fodder, build a house, or simply save their livelihoods in the face of hardship. Some described loans as "bad" and "useless":

"95% of all people here depend on loans."

"90% are mortgaged to banks for loans."

"I took a loan, but I did not solve the problem."

"I took a loan, but I did not benefit from it."

Possible solutions to the identified problems in Deir El Kahf were also discussed at the stakeholder meeting in Deir El Kahf in January 2022. Keeping in line with a participatory methodology, the stakeholder debriefing presented the community members with an opportunity to see the study results, to comment on the findings, and to add any issues or information to the conclusion. The meeting was carried out on January 19th 2022 at the offices of the local partner NGO and was attended by a total of two community members, 8 men and 2 women. The participants showed interest in the results and agreed with the study findings, adding a list of recommendations to the proposed study conclusions. The comments made by the stakeholder group included:

- Water harvesting initiatives in order to make better use of available water resources. A concrete suggestion was to find a grant to enable the refurbishment of ancient water harvesting technologies present in the area.
- Grants providing funding that actually reaches the livelihoods of people. Meeting participants recounted several experiences of projects where corruption or unprofessional implementation had led to either "no" or "no meaningful" implementation.
- An improvement in public services – improving the quality of local health services was a cause that was raised repeatedly during the interviews and the stakeholder meetings.
- Building viable and resilient livelihood alternatives. The residents of Deir El Kahf repeatedly mentioned the need to create additional job opportunities in the area in various sectors, such as industry, factories, service provision, as well as training and capacity development needs that would help people switch to those alternative livelihoods.

13.3.16 Case Study Conclusion

The case study on the village of Deir El Kahf has provided valuable insights into how already socially vulnerable communities whose livelihoods directly depend on rain and other ecosystem services experience the impact of increased drought. The interviews conducted in Deir El Kahf have confirmed that people are indeed experiencing a change in climate in the village, especially regarding heat, cold, and changed rainfall patterns. The case of Deir El Kahf also shows that farmers are seeing climate change as having a considerable impact on their livelihoods already, especially as the villagers depend on farming and livestock raising for their livelihood. The majority of agriculture in Deir El Kahf is rainfed, meaning that farmers directly depend on seasonal rains and are feeling the impact of changing weather patterns. The impact of drought has led farmers to abandon their farms and to either reduce the heads of livestock owned, or to sell their livestock altogether. Among the selected sample of 50 respondents in Deir El Kahf, half of the respondents who were engaged in farming either had to reduce their farm sizes or gave up farming altogether. Almost one third of the respondents closed their farming businesses entirely in the last few years, while of the 32 respondents who have ever owned livestock, only 5 have been able to retain the same number of heads of livestock in recent years. A total of 17 respondents had to reduce the number of animals in recent years, while 10 had to sell all of

their livestock. Residents are describing agriculture and livestock raising as livelihoods that are not safe and profitable under current conditions. Thus, drought has pushed many residents out of their livelihood, exacerbating their social vulnerability.
Even before the impact of climate change started to become noticeable in the village, Deir El Kahf was known as a socially vulnerable village suffering from a range of socio-economic issues. Registered as a poverty pocket of Jordan for several years, Deir El Kahf already struggled with poverty, unemployment, and a lack of access to affordable and quality public services. As the collected data shows, drought is acting as a threat multiplier in the village, amplifying the already existing socio-economic insecurities by further disrupting local livelihoods. As the respondents confirmed, drought, water scarcity, poverty and unemployment are seen as the most pressing problems in the village, as villagers are scrambling for alternatives to their previous livelihoods. The lack of alternative employment options in the area, for example in the shape of industry, factories, shops, or development projects leaves many without hope of building viable livelihood alternatives. Youth, female-headed households, daily laborers, migrants, and refugees are among those seen as the most vulnerable groups in the village.

As the villagers of Deir El Kahf are struggling to build resilience to climate change impact, most villagers are emphasizing the social cohesion and mutual support that community members experience. The perceived absence of formal assistance seems to strengthen a sense of self-help and community support in some cases. Moral support, emotional support, financial help, or help in the form of sharing food or water are all strategies residents of Deir El Kahf are already employing to make it through the rough periods of struggle presented by a combination of social vulnerability, drought, and even Covid-19. Local NGOs are one organized social entity that is trying to channel social and economic support towards the community members most in need. Building on existing structures of social cohesion and social support is a possibility to strengthen local adaptation strategies to climate change impact. On the flipside, policies should work against those processes in the village that threaten to erode social cohesion, such as unemployment, the frustration of youth, and perceived inequalities between local residents and refugees, and the lack of integration of some groups of refugees.
Policy-makers have to address the situation in Deir El Kahf in an integrated manner – recognizing that social vulnerability and drought impact are intertwined. The respondents were complaining about a lack of meaningful formal support. Understanding what groups in the community are most vulnerable and how their livelihoods are impacted by drought will help design policies that address both social vulnerability and drought in a concerted effort. Integrated policies designed to address compound risk should be developed, based on local data and evidence such as that collected in the present study.

One important question to consider is to what extent the indicators used to assess climate change and social vulnerability in the context of drought at the national level are relevant to the local level assessment in Deir El Kahf. Do all of these indicators play a role in Deir El Kahf? Are there locally relevant indicators in Deir El Kahf that were not considered in the national level study? In order to answer this question, it makes sense to take a second look at the indicators presented earlier in the study (Table 6).

Table 55: Taking another look: Indicators used in the national level study on climate change and social vulnerability (same indicators as shown in Table 6)

HAZARD
Standardized Precipitation Index
Temperature Anomaly Trends as Number of Hot Seasons
Frequency of Poor NDVI Seasons on LTA
EXPOSURE
Climate Change Impact on Ecosystems
Irrigation Type Prevalence of Rainfed and Irrigated Agriculture
Heads of Livestock
Population Density
Land Cover/Land Use
Rangelands
Access to Water for Farming (Composite Indicator)
SENSITIVITY
Land Degradation
Groundwater Deficit
Unemployment
Household Income
Household Expenditure (Composite Indicator)
Female-Headed Households
Prevalence of Illness and Disability
Households Receiving Government Aid
Prevalence of Household Members with Health Difficulties
Household Water Shortage in Public Network
Households with Below Average Living Standard Index
Percentage of Poor People
Number of Refugees
ADAPTIVE CAPACITY
Ecosystem Adaptive Capacity (Composite Indicator)
Education Level
Food Security
Health Insurance for Jordanians and Migrants
Access to Water for Household (Composite Indicator)
Household Asset Ownership
Population Variation
New Groundwater Wells

A second look through this list of indicators reveals that the indicators selected for the national level assessment have high relevance to the case of Deir El Kahf. The prevalence of drought (lack of rainfall, temperature anomalies) was confirmed locally, which, combined with a lack of groundwater resources is having a heavy toll on livelihoods in the village. In terms of exposure, the indicators type of irrigation (rainfed), existence of livestock, water access for farming and location in the so-called rangeland zone have particularly high relevance for the situation in Deir El Kahf. The themes of poverty, employment and the availability of jobs, access to government support and funding, social protection and insurance, the presence of migrants and their impact on the local job market, as well as limited access to public water supply feature heavily in the interviews conducted with local residents. Residents also complained about the quality of healthcare, which is not a sensitivity indicator in the present study. In terms of adaptive capacity, education, access to food and rising food prices, and the ability to dig groundwater wells were mentioned by residents of Deir El Kahf. An important aspect of the adaptive capacity of Deir El Kahf residents is the ability to diversify their livelihoods. The existence of secondary and tertiary sector jobs, local investment levels, and the presence of vocational training opportunities play important roles here. It may be challenging to find existing datasets as proxies for these types of indicators. However, a better understanding of what matters locally, can help inform government entities and researchers to start collecting the right information and data, and to start storing, analyzing and making it available. Vocational training data, for example, could be collected and published as part of national educational data. The presence of industrial and service sector businesses is an indicator that should be available on a national scale as well. Adding the availability of healthcare, or of the type of healthcare / distance from healthcare services to the list of indicators would also be important, and national level data on this would have to be made available in a spatial or geo-referenced format. Refining the indicators is an important step towards making climate risk assessments more accurate and relevant.

14

CONCLUSION

14 CONCLUSION

This report is a comprehensive analysis of drought risk with special focus on social vulnerability in Jordan. The research project has provided a series of maps on drought hazard, exposure, sensitivity, adaptive capacity and overall drought risk in Jordan. With a thematic focus on social vulnerability, a particularly wide range of social vulnerability indicators was selected, which are found primarily in the sensitivity and adaptive capacity sections of this research. Taking a multi-sectoral, cross-disciplinary and participatory approach to assessing drought risk in Jordan, the report works towards building a more comprehensive and holistic understanding of drought risk that places particular stress on the social indicators of vulnerability and adaptive capacity. The research team worked with a comprehensive list of 31 indicators that represent over 40 individual datasets retrieved from a variety of global and national sources. Many of these indicators are proxies for pre-existing social vulnerability and capture many aspects of vulnerability that may not directly be linked to drought, but that play an important role in overall drought vulnerability and risk.

As the maps show, widening the scope of social vulnerability analysis in climate risk research helps identify hotspots of climate change risk that also integrate the various facets of social vulnerability. In this way, it addresses a research gap, namely the inclusion of pre-existing and systemic vulnerabilities in climate risk assessments and responses in order to foster a better understanding of how climate change intersects with social processes. Knowing where hotspots of both climatic impact and social vulnerability are, is a fundamental pre-requisite for an integrated climate response. Further, these detailed maps show that climate change responses will have to take different shapes and require concerted responses from multiple policy sectors – a tailored social protection mechanism or a targeted economic and job creation initiative, in coordination with other climate approaches, can help increase climate resilience.

One of the goals of this piece of work is to

encourage climate researchers and policy-makers across the Arab region to place more focus on social indicators of vulnerability, and to routinely include social indicators into climate vulnerability and climate risk assessments – thus producing multi-sectoral and integrated climate analyses that transcend the current silos of analysis. The inclusion of a wider range of social indicators in the vulnerability assessments makes a visible difference to the map results at the national level. As the detailed map results show, climate indicators alone understate the sensitivity of local communities to climate risk, while a limited number of sensitivity and adaptive capacity indicators reduces the richness of mapping results. The complexity of indicators used here, including indicators on health, migration, female-headed households, education, household asset ownership, government aid and support, and access to insurance has helped produce more nuanced sensitivity, adaptive capacity, and vulnerability outputs. Based on these refined maps, presented here at both pixel and administrative level, policy-makers can identify hotspots of social vulnerability to drought that may need particular attention in the implementation of social protection and resilience policies. In this way, a more comprehensive and indicated methodology on studying climate change impact becomes an important policy-making tool.

This report shows the merits of addressing climate change at multiple scales of analysis. The report combines results at regional, national, and local levels and thus ensures that both the larger-scale climatic changes, but also the real, on-the-ground impacts on communities are considered in the collection of evidence for climate action. The local level analysis adds another layer of evidence that generates a better understanding of the locally diverse impacts of climate change. The case study of Deir El Kahf is an important contribution to the analysis at national level – adding both nuance and substance and creating situated knowledge and evidence of climate change impact on the ground. A more comprehensive understanding of how local communities experience and adapt to climate change can help inform policy approaches. The case study area here is located in a District

that in the national mapping exercise shows minimum hazard and exposure, but medium to high vulnerability. While Deir El Kahf is only a medium level hotspot of overall climate risk in Jordan on the final map, it scores much higher on vulnerability, and drought has already pushed many residents' livelihoods beyond the brink of unsustainability. It seems that in Deir El Kahf, drought impacts are felt more strongly on the ground than the national maps may suggest. For this reason, it is important to expand local level research across localities in Jordan – perhaps starting with some of the drought risk or vulnerability hotspots identified in this report. Giving local communities a stage to voice their experiences and needs adds to our depth of understanding of what our statistical and mapping results may really say about livelihoods and lived experiences on the ground. The case study on Deir El Kahf is enlightening and generates an understanding of how drought-affected communities modify and diversify their livelihoods, and what expectations they have for State support in reducing vulnerability.
The report also makes a case for participatory approaches to climate research. Given the complexities of data and indicators utilized here, experts from various backgrounds were needed to contribute to the analysis. The weighting of data in a national context further requires the expert knowledge of local scientists and policy-makers who are involved in the subject matter on a daily basis and who can make informed and sensible decisions on assigning weights to different indicators. Further, the daily, lived experiences of farmers from Deir El Kahf adds a level of local knowledge and expertise to the study that increases its depth and relevance. By including the interviews and conversations with international scholars, Jordanian experts, and with local communities, this report combines and integrates climate change expertise at multiple levels and scopes.

The results of this study will form the basis for the development of a policy-making tool on climate change analysis and policy-making for the Arab region. The policy-making tool will be based on the multi-sectoral, integrated methodology used in this report. The tool aims to offer solutions for policy-makers for routinely integrating social vulnerability indicators into climate risk analyses and policies. The report will also be used as a starting point for assessing how social protection policies may start incorporating climate change as emerging risk. This includes considering how social and economic policy-making can help communities brace for climate change impacts and build stronger resilience. The participatory approach taken in this research will be reflected in the policy-making tool, suggesting ways in which policy-makers can engage both experts and representatives of local communities in the design of climate change policies. Such a participatory methodology can help policy-users voice their needs and contribute their local experience and adaptation skills to climate policies. In fact, multi-criteria decision tools on groundwater modeling developed in Jordan have proven stronger when more focus was placed on social and economic aspects, as well as farmers' opinions (Alkhatib et al., 2019).

This report takes a step towards expanding the scope of climate risk analyses in the region. Climate change has to be understood as compound risk, and as a multiplier of a variety of existing risks and vulnerabilities. Many of the risk factors related to climate change are newly emerging and fast evolving. Others have been present as systemic risks and vulnerabilities for decades. Climate change can intensify these risks. When looked at from a different perspective, pre-existing risks and vulnerabilities may hinder communities in their ability to adapt to climate change. Our research methodologies have to be flexible, multi-sectoral, integrated, and nexus based in order to capture the complexity of compound risk, at the multiple and complex levels where such risks have started to occur. Only by using integrated, multi-sectoral, and multi-scalar research tools can climate research in the Arab region generate the nuanced evidence needed to develop climate change policies that successfully address compound risk. Innovative and multi-sectoral methodologies will not only help policy-makers, funding bodies, and financing institutions, but also have a bearing on the achievement of the Sustainable Development Goals and the Paris Agreement in the region.

15

RECOMMENDATIONS

15 RECOMMENDATIONS

Based on the current study, the authors and partnering entities who have worked together on this research project would like to make some recommendations to researchers, policy-makers, and implementing agencies across the region. In order to advance the region's multi-sectoral, integrated, and coordinated response to climate change, policy-makers, researchers and implementing agencies are recommended to:

- Expand the range of indicators used for climate change risk assessments and include various sectors in the analysis. One such important sector is social matters, including social well-being and social vulnerability.
- Develop capacity to generate more georeferenced data and GIS-based maps on climate change and social vulnerability.
- Build on existing climate risk indicator lists, databases, and mapping projects to help improve the climate and social vulnerability evidence from places across the region.
- Ensure that existing research on climate change and social vulnerability translates into the identification of vulnerable groups and communities by the responsible government entities. Knowing where and how people are most vulnerable to climate change is a prerequisite for designing policies that benefit the right people.
- Carry out more case studies in localities across the region. Besides theoretical models and indicator analyses at various scales, thers is a need to learn how real people on the ground are experiencing climate change, and what their needs and responses are.
- Ensure that local research helps spark local action. Participatory, community-based approaches to climate change are not only important for building place-based evidence to inform policies and programs, but also to leverage local funding and climate change action and to empower local entities and leaders. Climate change mitigation, adaptation, anticipatory action, and disaster response are often most effective and immediate at the local level. Local associations, NGOs, and civil society organizations are often closest to the people and can help spread awareness, advocate for, and kick-start climate change programs in communities. Supporting the initiative of women and youth is particularly important, and the women's association of Deir El Kahf is an example of local women acting as leaders in climate action.
- Foster better collaboration between research and government agencies in sharing relevant data from multiple research and government sectors. Obtaining data both on and from different sectors can be difficult and tedious, and not all agencies are willing to make relevant data publicly available. There is a need for better national and regional databases on climate change indicators for different sectors, similar to the globally available datasets on temperature, rainfall, or population. Free data access and sharing will make it easier to identify climate change and social vulnerability hotspots, and to carry out anticipatory action as well as climate change response work in these areas.
- Broaden the focus of community resilience approaches and create new links among different sectors and solutions. While for some communities, infrastructural measures might help in coping with climate change impact, other communities may benefit more from employment programs, social protection schemes, financial support programs, loan products, or gender empowerment measures. This study has shown that social vulnerability indicators that are relevant to climate change responses may not always, at first glance, seem related to climate change. A better understanding of the links and connections between these sectors and of local needs and specificities will help design more multi-faceted climate change responses.

- Enable better cross-sectoral collaboration between government entities in facing climate change. Multi-ministry approaches, the engagement of stakeholders from different sectors, cross-disciplinary research and data collection, integrated methodologies, and cross-cutting solutions can help to tackle climate change in its varieties of impact. This might mean that existing social protection mechanisms, insurance schemes, agricultural support systems and other existing social support policies will have to be adjusted to include climate change as a new type of risk. At the same time, new and targeted products will have to be designed that can help protect people from the multiplicity and complex nature of climate change impacts. It is important that these products be based on local evidence and needs – in Deir El Kahf, for example, residents did not see loans as a helpful way to cope with the impact drought is having on their livelihoods.
- Leverage funding from various donors for more cross-cutting and cross-sectoral climate change research that brings together research teams from different disciplines and backgrounds. Funding is also needed to test community-based solutions for climate resilience, such as the water harvesting infrastructure proposed by the people of Deir El Kahf. Moreover, successful approaches to reduce social vulnerability to climate change will need to be tested and upscaled, which will also require funding and financial support.
- Fostering regional cooperation in sharing data, success stories, lessons learned, program design and approaches, decision-support tools, and capacity in designing and implementing innovative policies and programs. The Arab Water Council's Regional Climate Security Network is one such platform that strives to bring together regional experiences of, and approaches to, climate change.

The present study has taken around two years to complete and has required significant manpower, travel time, and finances. While a larger number of indicators, such as the ones used in this study, generates a more nuanced and complete understanding of the climate change and social vulnerability, not all researchers have the luxury of time and funding to carry out such major research projects. The selection of indicators depends on the type of climate risk that is being investigated. In this case, the focus was placed on drought and the agricultural sector. Beyond the common indicators of poverty and employment, sensitivity indicators should include household income and living standard, gender-based indicators, health, illness and disability indicators, as well as ethnicity, migration or refugee status. Besides ecosystem adaptive capacity, adaptive capacity indicators should include education and thus access to information, household assets, existence of insurances, aid, or social security, as well as out-migration numbers. This is besides indicators that are tailored to the relevant climate hazard. In the case of drought, these included several indicators on water availability and access, as well as on indicators related to agricultural livelihoods.

As this study shows, selecting and applying multi-sectoral indicators to capture the complexity of climate change as compound risk requires a close collaboration between different academic fields and Ministries. For researchers who wish to carry out similar research, a free methodology guide based on this study has been put together including downloadable PDF documents and instructional video material. These products are available trough the following link: https://gis.jor.wfp.org/ccsv/storymap.html

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17

ANNEXES

17 ANNEXES

17.1 Annex 1: Classification for Female-Headed Households 2004 and 2015

Classification female-headed households Jordanian, 2004:

CLASSIFICATION	RANGES
Low Sensitivity	Percentage of Female-Headed Households - 2004 Is < 10%
Medium Sensitivity	Percentage of Female-Headed Households - 2004 Is >=10% and <= 15%
High Sensitivity	Percentage of Female-Headed Households - 2004 Is > 15%

Classification female-headed households Jordanian, 2015:

CLASSIFICATION	RANGES
Low Sensitivity	Percentage of Female-Headed Households - 2015 Is < 10%
Medium Sensitivity	Percentage of Female-Headed Households - 2015 Is >=10% and <= 15%
High Sensitivity	Percentage of Female-Headed Households - 2015 Is > 15%

Classification non-Jordanian female-headed households, 2004:

CLASSIFICATION	RANGES
Low Sensitivity	Percentage of non-Jordanian Female-Headed Households - 2004 Is < 15%
Medium Sensitivity	Percentage of non-Jordanian Female-Headed Households - 2004 Is >=15% and <= 25%
High Sensitivity	Percentage of non-Jordanian Female-Headed Households - 2004 Is > 25%

Classification of difference (2015 vs 2004) for Jordanian households:

CLASSIFICATION	RANGES
Low Sensitivity	Difference of Percentage of Female-Headed Households - 2015 vs 2004 Is < 0%
Medium Sensitivity	Difference of Percentage of Female-Headed Households - 2015 vs 2004 Is >=0% and <= 2%
High Sensitivity	Difference of Percentage of Female-Headed Households - 2015 vs 2004 Is > 2%

Classification for non-Jordanian households:

CLASSIFICATION	RANGES
Low Sensitivity	Difference of Percentage of non-Jordanian Female-Headed Households - 2015 vs 2004 Is < 0%
Medium Sensitivity	Difference of Percentage of non-Jordanian Female-Headed Households - 2015 vs 2004 Is >=0% and <= 10%
High Sensitivity	Difference of Percentage of non-Jordanian Female-Headed Households - 2015 vs 2004 Is > 10%

17.2 Annex 2: Classification Table for Education

ADM3_EN	Illiterate_P	wIlliterate	Primary_P	wPrimary	AbovePrim_P	wAbvePrmry	wIPP
'Ara and Yarqa Sub-district	9.8	L	22.9	H	67.4	L	L
Mahes and Fahes Sub-district	9.1	L	23.9	H	67	L	L
Al_Jameh Sub-district	8.5	L	24.1	H	67.4	L	L
Qasabet As_Salt Sub-district	8.2	L	25.2	H	66.6	L	L
Al_Areed Sub-district	24.9	H	26.4	H	48.7	M	H
Umm ar-rasas Sub-district	20.2	H	27.3	H	52.5	L	H
Wadi As_Sir Sub-district	9	L	27.5	H	63.6	L	L
Deeban Sub-district	15.8	M	27.9	H	56.3	L	M
Al_Qaser Sub-district	16.5	M	28	H	55.5	L	M
Jereneh Sub-district	12	M	28.6	H	59.4	L	M
Qasabet Al_karak Sub-district	11.5	M	28.9	H	59.6	L	M
Al_Fisalieh Sub-district	13.1	M	29.5	H	57.3	L	M
Muab Sub-district	13	M	30	H	56.9	L	M
Al_'Aredah Sub-district	14.3	M	30.6	H	55	L	M
Melieh Sub-district	16.7	M	31	H	52.3	L	M
Qasabet At_Tafilah Sub-district	10.1	M	31.4	H	58.5	L	M
Ad_Deseh Sub-district	17.8	M	31.5	H	50.7	L	M
Al_Mazar Al_Janubi Sub-district	12.9	M	31.5	H	55.6	L	M
Umm Al_Qutain Sub-district	17.2	M	33.1	H	49.7	M	M
Dayer Al_Kahef Sub-district	25.1	H	34	H	40.9	M	H
Qasabet Al_Aqaba Sub-district	11.7	M	34.4	H	53.9	L	M
Arjan Sub-district	9.1	L	34.5	H	56.4	L	L
Zay Sub-district	12.3	M	34.7	H	53.1	L	M
Kofranja Sub-district	11.6	M	34.8	H	53.6	L	M
Al_Mastabeh Sub-district	10.2	M	34.9	H	54.8	L	M
Qasabet Ajloun Sub-district	10.2	M	35.2	M	54.7	L	M
Sabeha Sub-district	22.7	H	35.4	M	41.9	M	M
Naur Sub-district	8.6	L	35.5	M	56	L	L
As_Saleheyyeh Sub-district	40.2	H	35.8	M	24	H	H
Sakhera Sub-district	9.4	L	36.1	M	54.5	L	L
Qasabet Madaba Sub-district	11.4	M	36.3	M	52.3	L	M
Al_Faqua Sub-district	13.2	M	37.3	M	49.5	M	M
Besareh Sub-district	12.5	M	37.4	M	50.2	L	M
Rahab Sub-district	13.4	M	38	M	48.6	M	M
Bani Obaid Sub-district	9.8	L	38	M	52.2	L	L
Al_Jezeh Sub-district	22.9	H	38.2	M	38.9	M	M
Al_Petra Sub-district	19.9	M	38.3	M	41.8	M	M
Bani kinana Sub-district	10.3	M	38.5	M	51.1	L	M
Al_Qatraneh Sub-district	20.9	H	39	M	40	M	M
Ash_Shobak Sub-district	11.9	M	39.2	M	48.8	M	M

ADM3_EN	Illiterate_P	wIlliterate	Primary_P	wPrimary	AbovePrim_P	wAbvePrmry	wIPP
Hesban Sub-district	11.3	M	39.3	M	49.4	M	M
Al_Mujeb Sub-district	13.5	M	39.3	M	47.2	M	M
Al_Husayniyya Sub-district	25.4	H	39.4	M	35.2	M	M
'Ayn Al_Basheh Sub-district	11.7	M	39.4	M	48.9	M	M
Qasabet Amman Sub-district	10.3	M	39.6	M	50.1	L	M
Umm Al_Jemal Sub-district	24.8	H	40	M	35.3	M	M
Adruh Sub-district	17.9	M	40.5	M	41.6	M	M
Ma'en Sub-district	17.5	M	41.2	M	41.3	M	M
'Ayy Sub-district	15.6	M	41.3	M	43.1	M	M
Al_Mwaqqer Sub-district	13.9	M	41.4	M	44.6	M	M
Marka Sub-district	7.7	L	41.6	M	50.7	L	L
Umm Al_Basateyn Sub-district	12.8	M	41.6	M	45.6	M	M
Al_Hasa Sub-district	20.9	H	41.7	M	37.5	M	M
Ail Sub-district	17.3	M	41.7	M	40.9	M	M
Ghor As_Safi Sub-district	22.4	H	41.8	M	35.8	M	M
Qasabet Al-Mafraq Sub-district	16.8	M	42.7	M	40.5	M	M
Al_wastiyya Sub-district	7.9	L	42.8	M	49.3	M	M
Ghor Al_Mazraa Sub-district	19.9	M	42.8	M	37.3	M	M
Qasabet Az_Zarqa Sub-district	8.5	L	43.3	M	48.2	M	M
Al_Qwaira Sub-district	22.3	H	43.3	M	34.4	H	H
Al_Muraygha Sub-district	21.2	H	43.6	M	35.2	M	M
AL_Manesheih Sub-district	8.8	L	43.7	M	47.5	M	M
Al_Mazar Ash-shamali Sub-district	9	L	43.9	M	47.1	M	M
Al_Qwaismeh Sub-district	10	M	44.2	M	45.8	M	M
Dair 'Alla Sub-district	28.3	H	44.3	M	27.4	H	H
Wadi 'Araba Sub-district	30.1	H	44.3	M	25.6	H	H
Sahab Sub-district	14.5	M	44.4	M	41.1	M	M
Husah Sub-district	13	M	44.5	M	42.5	M	M
Qasabet Jerash Sub-district	10.2	M	44.6	M	45.1	M	M
Qasabet Irbid Sub-district	8.6	L	44.8	M	46.6	M	M
Bereen Sub-district	13.8	M	44.9	M	41.4	M	M
Sama As_Sarhan Sub-district	16.4	M	44.9	M	38.7	M	M
Ar_Rwashed Sub-district	37.7	H	45.7	M	16.6	H	H
Al_Kora Sub-district	9.5	L	45.8	M	44.7	M	M
Al_Hashemieh Sub-district	10.1	M	46.3	M	43.6	M	M
Al_Khalediah Sub-district	19.3	M	46.3	M	34.3	H	M
Ash_shuna al-Janubiyya Sub-district	27.2	H	46.6	M	26.2	H	H
Ma'an Sub-district	14.2	M	46.7	M	39.1	M	M
Rujm Ash-Shami Sub-district	13.2	M	47.5	M	39.2	M	M

ADM3_EN	Illiterate_P	wIlliterate	Primary_P	wPrimary	AbovePrim_P	wAbvePrmry	wIPP
Al_Jafr Sub-district	28.7	H	47.6	M	23.7	H	H
Ash_shuna Ashamalya Sub-district	21.4	H	48.1	M	30.5	H	H
Al_Rusayfa Sub-district	9.8	L	49.4	M	40.9	M	M
At_Taibeh Sub-district	8.1	L	50	L	42	M	L
Berma Sub-district	13.3	M	51.2	L	35.5	M	M
Balama Sub-district	10.9	M	53.5	L	35.5	M	M
Ar_Ramtha Sub-district	12	M	54.9	L	33.1	H	M
Al_Delail Sub-district	17.3	M	55.5	L	27.2	H	M
Al_Badiah Ash-Shamaliyya Al_Gharbeh Sub-district	23.7	H	61.9	L	14.4	H	H
Alazraq Sub-district	20.2	H	62.1	L	17.7	H	H
ADAPTIVE CAPACITY CLASSIFICATION							
L	< 10		< 35		< 35		
M							
H	> 20		> 50		> 50		

17.3 Annex 3: Building of Composite Indicator "Access to Household Water

ADM1	Per capita liter	Classficiation for supply per capita	Drinking water source (classification based on blue part of graph)	Composite of previous 2 columns	Supply m3	Population 2019	Adm1	Other	Tank	Rain Water	Mineral_Water	Filtered_Water	Public_Network	Tank, Rainwater, Other	Classification for drinking water source
Ajloun	90	H	H	H	6,389,138	194,700	Ajlun	2.3	0.4	18.7	54.9	13.6	10.1	21.4	H
Amman	122	M	L	M	197,753,632	4,430,700	Amman	0.5	0.5	0.6	52.7	31.5	14.2	1.6	L
Aqaba	175	M	L	M	13,292,811	208,000	Aqaba	0.6	0.2	0	10.8	6.5	81.8	0.8	L
Balqa	228	L	H	M	45,268,594	543,600	Balqa	4.5	4	1.8	47.9	23.3	18.6	10.3	H
Irbid	75	H	H	H	53,851,823	1,957,000	Irbid	0.8	0.5	21.6	55.1	11.2	10.8	22.9	H
Jarash	101	H	M	H	9,686,904	262,100	Jarash	2.1	1.3	3.3	73.8	8	11.5	6.7	M
Karak	176	L	M	M	22,514,996	350,000	Karak	3.1	0.1	0	71.3	11.1	14.4	3.2	M
Maan	266	L	M	M	16987962	175,200	Ma'an	2.6	1	0	57.4	10.5	28.6	3.6	M
Madaba	132	M	M	M	10092714	209,200	Madaba	0.8	0.4	0.7	71.8	12.8	13.6	1.9	M
Mafraq	132	M	M	M	29,236,153	608,000	Mafraq	2.2	6.1	0.5	49	13.3	29	8.8	M
Tafiela	211	L	L	L	8,214,554	106,500	Tafiela	0	0	0	40.5	3.4	56.1	0	L
Zarqa	111	H	L	M	60941988	1,509,000	Zarqa	0.4	0.4	0	43.2	43.4	12.6	0.8	L

Classification for supply per capita:
L > 40
H < 60

17.4 Annex 4: Tables for Overall National Analysis at Administrative Level

FID	OBJECTID	adm1_name	COUNT	AREA	MEAN	AREA (Km)
0	37	Maan	3273695	32736950000	12.6	32736950
1	38	Madaba	95183	951830000	14.7	951830
2	39	Amman	757022	7570220000	12.5	7570220
3	40	Al Mafraq	2648656	26486560000	12.9	26486560
4	148	Aqaba	687883	6878830000	11.7	6878830
5	149	Irbid	154044	1540440000	15.9	1540440
6	151	Ajloun	41985	419850000	15.2	419850
7	152	Al Balqa	111169	1111690000	15.4	1111690
8	153	Al Karak	358690	3586900000	13.2	3586900
9	154	Al Tafeela	220872	2208720000	13.1	2208720
10	155	Az Zarqa'	476579	4765790000	12.2	4765790
11	156	Jerash	40970	409700000	14.2	409700

Hazard Governorate Level:

FID	OBJECTID	adm2_name	adm1_name	COUNT	AREA	MEAN_SCORE	AREA (Km)
0	23	Qasabet Al-Balqa'a	Al Balqa	45477	454770000	15.22561465	454770
1	29	At-Taybeh	Irbid	6344	63440000	16.0056266	63440
2	40	Al-Koorah	Irbid	17856	178560000	15.69177804	178560
3	243	Bsaira	Al Tafeela	22701	227010000	13.49508873	227010
4	369	Ma'an	Maan	3158645	31586450000	12.63861945	31586450
5	387	Sahab	'Amman	48285	482850000	12.51299151	482850
6	448	Al-Jami'ah'	'Amman	12091	120910000	12.26010254	120910
7	457	Al-Faqo'e	Al Karak	10194	101940000	15.29148553	101940
8	471	Qasabet Jarash	Jerash	40970	409700000	14.23853288	409700
9	477	Al-Quairah	'Aqaba	255953	2559530000	10.79361045	2559530
10	530	Al-Jizah	'Amman	545844	5458440000	12.37400132	5458440
11	546	Na'oor	'Amman	18442	184420000	12.7862978	184420
12	613	Al-Hasa	Al Tafeela	95198	951980000	12.51544902	951980
13	628	Al-Qatraneh	Al Karak	106297	1062970000	12.64009992	1062970
14	672	Al-Muaqqar	'Amman	75124	751240000	13.42529959	751240
15	675	Al-Wastiyyah	Irbid	4585	45850000	16.27818899	45850
16	793	Shobak	Maan	38297	382970000	11.83327973	382970
17	873	Ayy	Al Karak	5737	57370000	14.34699303	57370
18	885	Qasabet Al-Aqaba	Aqaba	431930	4319300000	12.17173473	4319300
19	918	Bani Kenanah	Irbid	24573	245730000	16.29409845	245730
20	978	Ash-Shoonah Al-Janoobiah	Al Balqa	29541	295410000	16.19711181	295410
21	1106	Qasabet Al-Mafraq	Al Mafraq	60064	600640000	15.54863961	600640
22	1121	Dair Alla	Al Balqa	23360	233600000	15.84291448	233600
23	1230	Qasabet Madaba	Madaba	39837	398370000	14.48879187	398370
24	1237	Kufranjah	Ajloun	8657	86570000	16.23929698	86570
25	1388	Ar-Rwaished	Al Mafraq	2157794	21577940000	12.77684314	21577940
26	1430	Qasabet Ajlun	Ajloun	33328	333280000	14.98194272	333280
27	1486	Al-Aghwar Al-Janoobiyah	Al Karak	86287	862870000	14.55873951	862870
28	1525	Al-Mazar Ash-Shamali	Irbid	8620	86200000	14.22606709	86200
29	1537	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	66193	661930000	17.08626547	661930
30	1560	Bani Obeid	Irbid	18846	188460000	14.83435728	188460
31	1713	Al-Quaismah	'Amman	12002	120020000	11.21520619	120020
32	1766	Ar-Ramtha	Irbid	26534	265340000	17.08358266	265340
33	1847	Qasabet Al-Zarqa	Az Zarqa'	457887	4578870000	12.03567043	4578870
34	1881	Marka	'Amman	26248	262480000	12.98212453	262480
35	1891	Qasabet Al-Karak	Al Karak	76569	765690000	11.63698135	765690
36	2010	Al-Russeifa	Az Zarqa'	4446	44460000	14.99921297	44460
37	2096	Al-Qasr	Al Karak	24290	242900000	13.42261048	242900
38	2106	Qasabet Amman	'Amman	4539	45390000	11.34157342	45390
39	2128	Al-Hashemiyah	Az Zarqa'	14246	142460000	15.37436502	142460
40	2161	Qasabet Irbid	Irbid	23597	235970000	16.27729297	235970
41	2178	Badia El Shamaliya	Al Mafraq	364605	3646050000	12.37050176	3646050
42	2536	Mahes & Al-Fuhais	Al Balqa	2995	29950000	13.79572603	29950
43	2640	Al-Petra	Maan	23989	239890000	12.44686768	239890
44	2713	Wadi Essier	'Amman	14447	144470000	13.50040844	144470
45	2728	Qasabet At-Tafiela	Al Tafeela	102973	1029730000	13.55418612	1029730
46	2784	Al-Aghwar Ash-Shamaliyah	Irbid	23089	230890000	15.4054174	230890
47	2857	Dieban	Madaba	55346	553460000	14.80909917	553460
48	2886	Al-Mazar Al-Janoobee	Al Karak	49316	493160000	13.97898283	493160
49	2907	Ain Albasha	Al Balqa	9796	97960000	12.96352574	97960
50	3181	Al-Huseiniya	Maan	52764	527640000	10.63137022	527640

Hazard Sub-District Level:

OBJECTID	adm3_name	adm2_name	adm1_name	Adm3	COUNT	AREA	MEAN_SCORE	AREA (Km)
191	Umm Ar Rasas	Al-Jizah	'Amman	Umm Ar Rasas	283555	2835550000	12.61111485	2835550
276	Dair Alla	Dair Alla	Al Balqa	Dair Alla	23360	233600000	15.84291448	233600
614	Mahes and Fahes	Mahes & Al-Fuhais	Al Balqa	Mahes and Fahes	2995	29950000	13.79572603	29950
626	Rwashed	Ar-Rwaished	Al Mafraq	Rwashed	2157794	21577940000	12.77684314	21577940
699	Ad Deseh	Al-Quairah	'Aqaba	Ad Deseh	95342	953420000	11.02308778	953420
872	Qaser	Al-Qasr	Al Karak	Qaser	16620	166200000	12.98135417	166200
902	Bani Kinana	Bani Kenanah	Irbid	Bani Kinana	24573	245730000	16.29409845	245730
1046	Qasabet As Salt	Qasabet Al-Balqa'a	Al Balqa	Qasabet As Salt	19080	190800000	15.15567559	190800
1286	Ma'an	Ma'an	Maan	Ma'an	235677	2356770000	10.61107483	2356770
1695	Bani Obaid	Bani Obaid	Irbid	Bani Obaid	18846	188460000	14.83435728	188460
1948	Ash Shuna Ashamalya	Al-Aghwar Ash-Shamaliyah	Irbid	Ash Shuna Ashamalya	23089	230890000	15.4054174	230890
1959	Fisalieh	Qasabet Madaba	Madaba	Fisalieh	5130	51300000	14.4782652	51300
2024	Umm Al Jemal	Badia El Shamaliya	Al Mafraq	Umm Al Jemal	13800	138000000	15.81720938	138000
2046	Ayy	Ayy	Al Karak	Ayy	5737	57370000	14.34699303	57370
2056	Sakhera	Qasabet Ajlun	Ajloun	Sakhera	5741	57410000	14.19999981	57410
2264	Qwaismeh	Al-Quaismah	'Amman	Qwaismeh	12002	120020000	11.21520619	120020
2740	Ayn Al Basheh	Ain Albasha	Al Balqa	Ayn Al Basheh	9796	97960000	12.96352574	97960
2851	Badiah Ash Shamaliyya Al Gharbeh	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Badiah Ash Shamaliyya Al Gharbeh	28201	282010000	17.06173497	282010
3047	Mujeb	Al-Qasr	Al Karak	Mujeb	7670	76700000	14.3787617	76700
3224	Ghor Al Mazraa	Al-Aghwar Al-Janoobiyah	Al Karak	Ghor Al Mazraa	49144	491440000	15.06929984	491440
3245	Alazraq	Qasabet Al-Zarqa	Az Zarqa'	Alazraq	395248	3952480000	11.67961818	3952480
3371	Qasabet Ajloun	Qasabet Ajlun	Ajloun	Qasabet Ajloun	22594	225940000	15.27247453	225940
3405	Ma'en	Qasabet Madaba	Madaba	Ma'en	18965	189650000	14.84394935	189650
3488	Petra	Al-Petra	Maan	Petra	23989	239890000	12.44686768	239890
3523	Mwaqqer	Al-Muaqqar	'Amman	Mwaqqer	60895	608950000	13.04239591	608950
3564	Qasabet Irbid	Qasabet Irbid	Irbid	Qasabet Irbid	23597	235970000	16.27729297	235970
3647	Kofranja	Kufranjah	Ajloun	Kofranja	8657	86570000	16.23929698	86570
3834	Zay	Qasabet Al-Balqa'a	Al Balqa	Zay	6659	66590000	13.78097291	66590
3887	Jezeh	Al-Jizah	'Amman	Jezeh	262289	2622890000	12.11766297	2622890
3976	Qasabet A Mafraq	Qasabet Al-Mafraq	Al Mafraq	Qasabet A Mafraq	18673	186730000	17.46062721	186730
4112	Mastabeh	Qasabet Jarash	Jerash	Mastabeh	4599	45990000	13.95592501	45990
4161	Qasabet Madaba	Qasabet Madaba	Madaba	Qasabet Madaba	13686	136860000	14.11351761	136860
4218	Kora	Al-Koorah	Irbid	Kora	17856	178560000	15.69177804	178560
4527	Qasabet A Tafilah	Qasabet At-Tafiela	Al Tafeela	Qasabet A Tafilah	102973	1029730000	13.55418612	1029730
4577	Hesban	Na'oor	'Amman	Hesban	6351	63510000	13.24733126	63510
4626	Adruh	Ma'an	Maan	Adruh	29401	294010000	11.20912932	294010
4672	Husah	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Husah	15044	150440000	18.03332164	150440
4750	Wadi As Sir	Wadi Essier	'Amman	Wadi As Sir	14447	144470000	13.50040844	144470
5171	Hashemieh	Al-Hashemiyah	Az Zarqa'	Hashemieh	14246	142460000	15.37436502	142460
5207	Manesheih	Qasabet Al-Mafraq	Al Mafraq	Manesheih	4043	40430000	16.47506791	40430
5443	Jereneh	Qasabet Madaba	Madaba	Jereneh	2056	20560000	13.73706216	20560
5471	Balama	Qasabet Al-Mafraq	Al Mafraq	Balama	16971	169710000	14.59935783	169710
5662	Jafr	Ma'an	Maan	Jafr	2807845	28078450000	12.85799793	28078450
5871	Faqua	Al-Faqo'e	Al Karak	Faqua	10194	101940000	15.29148553	101940
5937	Ara and Yarqa	Qasabet Al-Balqa'a	Al Balqa	Ara and Yarqa	10488	104880000	15.57239641	104880
5946	Arjan	Qasabet Ajlun	Ajloun	Arjan	4993	49930000	14.56633258	49930
6173	Ail	Ma'an	Maan	Ail	20819	208190000	12.21780143	208190
6196	Aredah	Qasabet Al-Balqa'a	Al Balqa	Aredah	9250	92500000	16.01666973	92500
6255	Deeban	Dieban	Madaba	Deeban	20928	209280000	14.97200897	209280
6521	Rahab	Qasabet Al-Mafraq	Al Mafraq	Rahab	20377	203770000	14.40333692	203770
6677	Wastiyya	Al-Wastiyyah	Irbid	Wastiyya	4585	45850000	16.27818899	45850
6684	Qasabet Al Karak	Qasabet Al-Karak	Al Karak	Qasabet Al Karak	76569	765690000	11.63698135	765690
6706	Berma	Qasabet Jarash	Jerash	Berma	9585	95850000	14.44399559	95850
6714	Naur	Na'oor	'Amman	Naur	8782	87820000	13.17748827	87820
6956	Ash Shobak	Ar-Ramtha	Maan	Ash Shobak	38297	382970000	11.83327973	382970
6996	Deir Sl Kahf	Badia El Shamaliya	Al Mafraq	Deir Sl Kahf	66048	660480000	11.72774803	660480
7037	Delail	Qasabet Al-Zarqa	Az Zarqa'	Delail	20671	206710000	14.42205023	206710
7179	Umm Al Basateyn	Na'oor	'Amman	Umm Al Basateyn	3309	33090000	10.8632219	33090
7217	Muraygha	Ma'an	Maan	Muraygha	64903	649030000	11.29283119	649030
7294	Areed	Dieban	Madaba	Areed	23379	233790000	14.48474681	233790
7296	Melieh	Dieban	Madaba	Melieh	11039	110390000	15.18718209	110390
7345	Wadi Araba	Qasabet Al-Aqaba	Aqaba	Wadi Araba	231175	2311750000	13.21712668	2311750
7484	Sabeha	Badia El Shamaliya	Al Mafraq	Sabeha	17326	173260000	14.93034724	173260
7512	Marka	Marka	'Amman	Marka	26248	262480000	12.98212453	262480
7836	Qasabet Az Zarqa	Qasabet Al-Zarqa	Az Zarqa'	Qasabet Az Zarqa	25936	259360000	14.56638276	259360
7941	Hasa	Al-Hasa	Al Tafeela	Hasa	95198	951980000	12.51544902	951980
8078	Umm Al Qutain	Badia El Shamaliya	Al Mafraq	Umm Al Qutain	8586	85860000	15.07031246	85860
8115	As Saleheyyeh	Badia El Shamaliya	Al Mafraq	As Saleheyyeh	258845	2588450000	12.08985341	2588450
8741	Qwaira	Al-Quairah	'Aqaba	Qwaira	160611	1606110000	10.65738798	1606110
8805	Ramtha	Ar-Ramtha	Irbid	Ramtha	26534	265340000	17.08358266	265340
8858	Qatraneh	Al-Qatraneh	Al Karak	Qatraneh	106297	1062970000	12.64009992	1062970
9389	Sama As Sarhan	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Sama As Sarhan	9555	95550000	17.9077962	95550
9523	Bereen	Qasabet Al-Zarqa	Az Zarqa'	Bereen	16032	160320000	13.64267703	160320
9607	Qasabet Amman	Qasabet Amman	'Amman	Qasabet Amman	4539	45390000	11.34157342	45390
9626	Jameh	Al-Jami'ah'	'Amman	Jameh	12091	120910000	12.26010254	120910
9797	Mazar Ash Shamali	Al-Mazar Ash-Shamali	Irbid	Mazar Ash Shamali	8620	86200000	14.22606709	86200
9837	Qasabet Al Aqaba	Qasabet Al-Aqaba	Aqaba	Qasabet Al Aqaba	200755	2007550000	10.96793666	2007550
9975	Sahab	Sahab	'Amman	Sahab	48285	482850000	12.51299151	482850
9984	Qasabet Jerash	Qasabet Jarash	Jerash	Qasabet Jerash	26786	267860000	14.213533	267860
10119	Muab	Al-Mazar Al-Janoobee	Al Karak	Muab	8150	81500000	13.35460161	81500
10164	Khalediah	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Khalediah	13393	133930000	15.4880086	133930
10194	Besareh	Bsaira	Al Tafeela	Besareh	22701	227010000	13.49508873	227010
10200	Taibeh	At-Taybeh	Irbid	Taibeh	6344	63440000	16.0056266	63440
10368	Husayniyya	Al-Huseiniya	Maan	Husayniyya	52764	527640000	10.63137022	527640
10558	Rujm Ash Shami	Al-Muaqqar	'Amman	Rujm Ash Shami	14229	142290000	15.06398955	142290
10570	Rusayfa	Al-Russeifa	Az Zarqa'	Rusayfa	4446	44460000	14.99921297	44460
10621	Ghor As Safi	Al-Aghwar Al-Janoobiyah	Al Karak	Ghor As Safi	37143	371430000	13.88321581	371430
10741	Mazar Janubi	Al-Mazar Al-Janoobee	Al Karak	Mazar Janubi	41166	411660000	14.10259715	411660
11030	Ash Shuna Janubiyya	Ash-Shoonah Al-Janoobiah	Al Balqa	Ash Shuna Janubiyya	29541	295410000	16.19711181	295410

Exposure Governorate Level:

FID	OBJECTID	adm1_name	COUNT	AREA (m)	MEAN SCORE	AREA (Km)
6	151	Ajloun	41985	419850000	36.7	419850
7	152	Al Balqa	111169	1111690000	35.0	1111690
8	153	Al Karak	358690	3586900000	36.1	3586900
3	40	Al Mafraq	2648656	26486560000	39.3	26486560
9	154	Al Tafeela	220872	2208720000	31.7	2208720
2	39	Amman	757022	7570220000	36.5	7570220
4	148	Aqaba	687883	6878830000	30.3	6878830
10	155	Az Zarqa'	476579	4765790000	33.9	4765790
5	149	Irbid	154044	1540440000	38.8	1540440
11	156	Jerash	40970	409700000	36.3	409700
0	37	Maan	3273695	32736950000	34.7	32736950
1	38	Madaba	95183	951830000	34.9	951830

Exposure District Level:

FID	OBJECTID	adm2_name	adm1_name	COUNT	AREA (m)	MEAN SCORE	AREA (Km)
49	2907	Ain Albasha	Al Balqa	9796	97960000	38.8	97960
27	1486	Al-Aghwar Al-Janoobiyah	Al Karak	86287	862870000	30.8	862870
46	2784	Al-Aghwar Ash-Shamaliyah	Irbid	23089	230890000	30.7	230890
29	1537	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	66193	661930000	36.5	661930
7	457	Al-Faqo'e	Al Karak	10194	101940000	36.6	101940
12	613	Al-Hasa	Al Tafeela	95198	951980000	33.4	951980
39	2128	Al-Hashemiyah	Az Zarqa'	14246	142460000	34.0	142460
50	3181	Al-Huseiniya	Maan	52764	527640000	34.9	527640
6	448	Al-Jami'ah'	'Amman	12091	120910000	40.5	120910
10	530	Al-Jizah	'Amman	545844	5458440000	35.7	5458440
2	40	Al-Koorah	Irbid	17856	178560000	39.0	178560
48	2886	Al-Mazar Al-Janoobee	Al Karak	49316	493160000	36.6	493160
28	1525	Al-Mazar Ash-Shamali	Irbid	8620	86200000	40.6	86200
14	672	Al-Muaqqar	'Amman	75124	751240000	38.0	751240
43	2640	Al-Petra	Maan	23989	239890000	36.8	239890
37	2096	Al-Qasr	Al Karak	24290	242900000	40.5	242900
13	628	Al-Qatraneh	Al Karak	106297	1062970000	37.5	1062970
9	477	Al-Quairah	'Aqaba	255953	2559530000	31.1	2559530
31	1713	Al-Quaismah	'Amman	12002	120020000	40.9	120020
36	2010	Al-Russeifa	Az Zarqa'	4446	44460000	39.7	44460
15	675	Al-Wastiyyah	Irbid	4585	45850000	39.8	45850
32	1766	Ar-Ramtha	Irbid	26534	265340000	40.0	265340
25	1388	Ar-Rwaished	Al Mafraq	2157794	21577940000	39.9	21577940
20	978	Ash-Shoonah Al-Janoobiah	Al Balqa	29541	295410000	30.9	295410
1	29	At-Taybeh	Irbid	6344	63440000	38.9	63440
17	873	Ayy	Al Karak	5737	57370000	36.5	57370
41	2178	Badia El Shamaliya	Al Mafraq	364605	3646050000	36.5	3646050
19	918	Bani Kenanah	Irbid	24573	245730000	41.0	245730
30	1560	Bani Obeid	Irbid	18846	188460000	40.3	188460
3	243	Bsaira	Al Tafeela	22701	227010000	36.8	227010
22	1121	Dair Alla	Al Balqa	23360	233600000	32.1	233600
47	2857	Dieban	Madaba	55346	553460000	34.7	553460
24	1237	Kufranjah	Ajloun	8657	86570000	33.6	86570
4	369	Ma'an	Maan	3158645	31586450000	34.7	31586450
42	2536	Mahes & Al-Fuhais	Al Balqa	2995	29950000	40.9	29950
34	1881	Marka	'Amman	26248	262480000	38.9	262480
11	546	Na'oor	'Amman	18442	184420000	38.5	184420
26	1430	Qasabet Ajlun	Ajloun	33328	333280000	37.5	333280
18	885	Qasabet Al-Aqaba	Aqaba	431930	4319300000	29.9	4319300
0	23	Qasabet Al-Balqa'a	Al Balqa	45477	454770000	38.0	454770
35	1891	Qasabet Al-Karak	Al Karak	76569	765690000	38.5	765690
21	1106	Qasabet Al-Mafraq	Al Mafraq	60064	600640000	37.2	600640
33	1847	Qasabet Al-Zarqa	Az Zarqa'	457887	4578870000	33.8	4578870
38	2106	Qasabet Amman	'Amman	4539	45390000	39.4	45390
45	2728	Qasabet At-Tafiela	Al Tafeela	102973	1029730000	29.0	1029730
40	2161	Qasabet Irbid	Irbid	23597	235970000	41.0	235970
8	471	Qasabet Jarash	Jerash	40970	409700000	36.3	409700
23	1230	Qasabet Madaba	Madaba	39837	398370000	35.2	398370
5	387	Sahab	'Amman	48285	482850000	37.8	482850
16	793	Shobak	Maan	38297	382970000	33.2	382970
44	2713	Wadi Essier	'Amman	14447	144470000	41.2	144470

Exposure Sub-District Level:

FID	OBJECTID	adm3_name	adm2_name	adm1_name	COUNT	AREA(m)	MEAN SCORE	AREA(Km)
4	699	Ad Deseh	Al-Quairah	'Aqaba	95342	953420000	31.2	953420
35	4626	Adruh	Ma'an	Maan	29401	294010000	34.7	294010
46	6173	Ail	Ma'an	Maan	20819	208190000	36.0	208190
47	6196	Aredah	Qasabet Al-Balqa'a	Al Balqa	9250	92500000	39.3	92500
59	7294	Areed	Dieban	Madaba	23379	233790000	32.9	233790
17	2851	Badiah Ash Shamaliyya Al Gharbeh	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	28201	282010000	37.4	282010
56	7037	Delail	Qasabet Al-Zarqa	Az Zarqa'	20671	206710000	32.9	206710
43	5871	Faqua	Al-Faqo'e	Al Karak	10194	101940000	36.6	101940
11	1959	Fisalieh	Qasabet Madaba	Madaba	5130	51300000	34.9	51300
65	7941	Hasa	Al-Hasa	Al Tafeela	95198	951980000	33.4	951980
38	5171	Hashemieh	Al-Hashemiyah	Az Zarqa'	14246	142460000	34.0	142460
83	10368	Husayniyya	Al-Huseiniya	Maan	52764	527640000	34.9	527640
42	5662	Jafr	Ma'an	Maan	2807845	28078450000	34.9	28078450
74	9626	Jameh	Al-Jami'ah'	'Amman	12091	120910000	40.5	120910
28	3887	Jezeh	Al-Jizah	'Amman	262289	2622890000	35.9	2622890
80	10164	Khalediah	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	13393	133930000	35.3	133930
32	4218	Kora	Al-Koorah	Irbid	17856	178560000	39.0	178560
39	5207	Manesheih	Qasabet Al-Mafraq	Al Mafraq	4043	40430000	34.6	40430
30	4112	Mastabeh	Qasabet Jarash	Jerash	4599	45990000	35.5	45990
87	10741	Mazar Janubi	Al-Mazar Al-Janoobee	Al Karak	41166	411660000	36.0	411660
75	9797	Mazar Ash Shamali	Al-Mazar Ash-Shamali	Irbid	8620	86200000	40.6	86200
18	3047	Mujeb	Al-Qasr	Al Karak	7670	76700000	39.8	76700
58	7217	Muraygha	Ma'an	Maan	64903	649030000	34.1	649030
24	3523	Mwaqqer	Al-Muaqqar	'Amman	60895	608950000	38.0	608950
23	3488	Petra	Al-Petra	Maan	23989	239890000	36.8	239890
5	872	Qaser	Al-Qasr	Al Karak	16620	166200000	40.8	166200
70	8858	Qatraneh	Al-Qatraneh	Al Karak	106297	1062970000	37.5	1062970
68	8741	Qwaira	Al-Quairah	'Aqaba	160611	1606110000	31.0	1606110
15	2264	Qwaismeh	Al-Quaismah	'Amman	12002	120020000	40.9	120020
85	10570	Rusayfa	Al-Russeifa	Az Zarqa'	4446	44460000	39.7	44460
50	6677	Wastiyya	Al-Wastiyyah	Irbid	4585	45850000	39.8	45850
20	3245	Alazraq	Qasabet Al-Zarqa	Az Zarqa'	395248	3952480000	33.7	3952480
69	8805	Ramtha	Ar-Ramtha	Irbid	26534	265340000	40.0	265340
3	626	Rwashed	Ar-Rwaished	Al Mafraq	2157794	21577940000	39.9	21577940
44	5937	Ara and Yarqa	Qasabet Al-Balqa'a	Al Balqa	10488	104880000	34.4	104880
45	5946	Arjan	Qasabet Ajlun	Ajloun	4993	49930000	38.5	49930
67	8115	As Saleheyyeh	Badia El Shamaliya	Al Mafraq	258845	2588450000	36.7	2588450
54	6956	Ash Shobak	Ar-Ramtha	Maan	38297	382970000	33.2	382970
88	11030	Ash Shuna Janubiyya	Ash-Shoonah Al-Janoobiah	Al Balqa	29541	295410000	30.9	295410
10	1948	Ash Shuna Ashamalya	Al-Aghwar Ash-Shamaliyah	Irbid	23089	230890000	30.7	230890
82	10200	Taibeh	At-Taybeh	Irbid	6344	63440000	38.9	63440
16	2740	Ayn Al Basheh	Ain Albasha	Al Balqa	9796	97960000	38.8	97960
13	2046	Ayy	Ayy	Al Karak	5737	57370000	36.5	57370
41	5471	Balama	Qasabet Al-Mafraq	Al Mafraq	16971	169710000	36.8	169710
6	902	Bani Kinana	Bani Kenanah	Irbid	24573	245730000	41.0	245730
9	1695	Bani Obaid	Bani Obeid	Irbid	18846	188460000	40.3	188460
72	9523	Bereen	Qasabet Al-Zarqa	Az Zarqa'	16032	160320000	36.4	160320
52	6706	Berma	Qasabet Jarash	Jerash	9585	95850000	36.4	95850
81	10194	Besareh	Bsaira	Al Tafeela	22701	227010000	36.8	227010
1	276	Dair Alla	Dair Alla	Al Balqa	23360	233600000	32.1	233600
55	6996	Deir Sl Kahf	Badia El Shamaliya	Al Mafraq	66048	660480000	35.9	660480
48	6255	Deeban	Dieban	Madaba	20928	209280000	35.6	209280
19	3224	Ghor Al Mazraa	Al-Aghwar Al-Janoobiyah	Al Karak	49144	491440000	30.7	491440
86	10621	Ghor As Safi	Al-Aghwar Al-Janoobiyah	Al Karak	37143	371430000	31.0	371430
34	4577	Hesban	Na'oor	'Amman	6351	63510000	37.9	63510
36	4672	Husah	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	15044	150440000	35.5	150440
40	5443	Jereneh	Qasabet Madaba	Madaba	2056	20560000	38.8	20560
26	3647	Kofranja	Kufranjah	Ajloun	8657	86570000	33.6	86570
8	1286	Ma'an	Ma'an	Maan	235677	2356770000	32.9	2356770
22	3405	Ma'en	Qasabet Madaba	Madaba	18965	189650000	33.6	189650
2	614	Mahes and Fahes	Mahes & Al-Fuhais	Al Balqa	2995	29950000	40.9	29950
63	7512	Marka	Marka	'Amman	26248	262480000	38.9	262480
60	7296	Melieh	Dieban	Madaba	11039	110390000	36.7	110390
79	10119	Muab	Al-Mazar Al-Janoobee	Al Karak	8150	81500000	39.2	81500
53	6714	Naur	Na'oor	'Amman	8782	87820000	38.2	87820
21	3371	Qasabet Ajloun	Qasabet Ajlun	Ajloun	22594	225940000	37.1	225940
76	9837	Qasabet Al Aqaba	Qasabet Al-Aqaba	Aqaba	200755	2007550000	29.5	2007550
51	6684	Qasabet Al Karak	Qasabet Al-Karak	Al Karak	76569	765690000	38.5	765690
29	3976	Qasabet A Mafraq	Qasabet Al-Mafraq	Al Mafraq	18673	186730000	37.3	186730
73	9607	Qasabet Amman	Qasabet Amman	'Amman	4539	45390000	39.4	45390
7	1046	Qasabet As Salt	Qasabet Al-Balqa'a	Al Balqa	19080	190800000	38.3	190800
33	4527	Qasabet A Tafilah	Qasabet At-Tafiela	Al Tafeela	102973	1029730000	29.0	1029730
64	7836	Qasabet Az Zarqa	Qasabet Al-Zarqa	Az Zarqa'	25936	259360000	34.9	259360
25	3564	Qasabet Irbid	Qasabet Irbid	Irbid	23597	235970000	41.0	235970
78	9984	Qasabet Jerash	Qasabet Jarash	Jerash	26786	267860000	36.4	267860
31	4161	Qasabet Madaba	Qasabet Madaba	Madaba	13686	136860000	36.9	136860
49	6521	Rahab	Qasabet Al-Mafraq	Al Mafraq	20377	203770000	38.0	203770
84	10558	Rujm Ash Shami	Al-Muaqqar	'Amman	14229	142290000	37.8	142290
62	7484	Sabeha	Badia El Shamaliya	Al Mafraq	17326	173260000	35.7	173260
77	9975	Sahab	Sahab	'Amman	48285	482850000	37.8	482850
14	2056	Sakhera	Qasabet Ajlun	Ajloun	5741	57410000	38.1	57410
71	9389	Sama As Sarhan	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	9555	95550000	37.0	95550
57	7179	Umm Al Basateyn	Na'oor	'Amman	3309	33090000	40.4	33090
12	2024	Umm Al Jemal	Badia El Shamaliya	Al Mafraq	13800	138000000	35.7	138000
66	8078	Umm Al Qutain	Badia El Shamaliya	Al Mafraq	8586	85860000	35.9	85860
0	191	Umm Ar Rasas	Al-Jizah	'Amman	283555	2835550000	35.5	2835550
61	7345	Wadi Araba	Qasabet Al-Aqaba	Aqaba	231175	2311750000	30.2	2311750
37	4750	Wadi As Sir	Wadi Essier	'Amman	14447	144470000	41.2	144470
27	3834	Zay	Qasabet Al-Balqa'a	Al Balqa	6659	66590000	41.0	66590

Sensitivity Governorate Level:

FID	OBJECTID	adm1_name	COUNT	AREA (m)	MEAN SCORE	AREA (Km)
6	151	Ajloun	41985	419850000	36.7	419850
7	152	Al Balqa	111169	1111690000	35.0	1111690
8	153	Al Karak	358690	3586900000	36.1	3586900
3	40	Al Mafraq	2648656	26486560000	39.3	26486560
9	154	Al Tafeela	220872	2208720000	31.7	2208720
2	39	Amman	757022	7570220000	36.5	7570220
4	148	Aqaba	687883	6878830000	30.3	6878830
10	155	Az Zarqa'	476579	4765790000	33.9	4765790
5	149	Irbid	154044	1540440000	38.8	1540440
11	156	Jerash	40970	409700000	36.3	409700
0	37	Maan	3273695	32736950000	34.7	32736950
1	38	Madaba	95183	951830000	34.9	951830

Sensitivity District Level:

FID	OBJECTID	adm2_name	adm1_name	COUNT	AREA (m)	MEAN SCORE	AREA (Km)
49	2907	Ain Albasha	Al Balqa	9796	97960000	58.64234447	97960
27	1486	Al-Aghwar Al-Janoobiyah	Al Karak	86287	862870000	53.62537951	862870
46	2784	Al-Aghwar Ash-Shamaliyah	Irbid	23089	230890000	60.86475022	230890
29	1537	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	66193	661930000	60.56760591	661930
7	457	Al-Faqo'e	Al Karak	10194	101940000	53.58053686	101940
12	613	Al-Hasa	Al Tafeela	95198	951980000	58.71027717	951980
39	2128	Al-Hashemiyah	Az Zarqa'	14246	142460000	59.1359761	142460
50	3181	Al-Huseiniya	Maan	52764	527640000	57.41144347	527640
6	448	Al-Jami'ah'	'Amman	12091	120910000	51.34829965	120910
10	530	Al-Jizah	'Amman	545844	5458440000	54.16584188	5458440
2	40	Al-Koorah	Irbid	17856	178560000	63.23465077	178560
48	2886	Al-Mazar Al-Janoobee	Al Karak	49316	493160000	52.64958564	493160
28	1525	Al-Mazar Ash-Shamali	Irbid	8620	86200000	62.88677609	86200
14	672	Al-Muaqqar	'Amman	75124	751240000	51.50554263	751240
43	2640	Al-Petra	Maan	23989	239890000	55.9156612	239890
37	2096	Al-Qasr	Al Karak	24290	242900000	52.09573832	242900
13	628	Al-Qatraneh	Al Karak	106297	1062970000	54.76212799	1062970
9	477	Al-Quairah	'Aqaba	255953	2559530000	46.11900768	2559530
31	1713	Al-Quaismah	'Amman	12002	120020000	53.20907273	120020
36	2010	Al-Russeifa	Az Zarqa'	4446	44460000	58.07422395	44460
15	675	Al-Wastiyyah	Irbid	4585	45850000	61.21363001	45850
32	1766	Ar-Ramtha	Irbid	26534	265340000	63.54425181	265340
25	1388	Ar-Rwaished	Al Mafraq	2157794	21577940000	58.46451523	21577940
20	978	Ash-Shoonah Al-Janoobiah	Al Balqa	29541	295410000	51.92176386	295410
1	29	At-Taybeh	Irbid	6344	63440000	61.46399667	63440
17	873	Ayy	Al Karak	5737	57370000	52.48905201	57370
41	2178	Badia El Shamaliya	Al Mafraq	364605	3646050000	60.62804977	3646050
19	918	Bani Kenanah	Irbid	24573	245730000	61.67875699	245730
30	1560	Bani Obeid	Irbid	18846	188460000	61.59659311	188460
3	243	Bsaira	Al Tafeela	22701	227010000	58.13617074	227010
22	1121	Dair Alla	Al Balqa	23360	233600000	53.75746233	233600
47	2857	Dieban	Madaba	55346	553460000	54.25972676	553460
24	1237	Kufranjah	Ajloun	8657	86570000	54.52563367	86570
4	369	Ma'an	Maan	3158645	31586450000	58.61563552	31586450
42	2536	Mahes & Al-Fuhais	Al Balqa	2995	29950000	54.76106952	29950
34	1881	Marka	'Amman	26248	262480000	53.14882582	262480
11	546	Na'oor	'Amman	18442	184420000	53.24285806	184420
26	1430	Qasabet Ajlun	Ajloun	33328	333280000	59.68224079	333280
18	885	Qasabet Al-Aqaba	Aqaba	431930	4319300000	41.90414982	4319300
0	23	Qasabet Al-Balqa'a	Al Balqa	45477	454770000	55.84055588	454770
35	1891	Qasabet Al-Karak	Al Karak	76569	765690000	52.38197686	765690
21	1106	Qasabet Al-Mafraq	Al Mafraq	60064	600640000	61.01960015	600640
33	1847	Qasabet Al-Zarqa	Az Zarqa'	457887	4578870000	59.96748886	4578870
38	2106	Qasabet Amman	'Amman	4539	45390000	54.54137338	45390
45	2728	Qasabet At-Tafiela	Al Tafeela	102973	1029730000	56.13290388	1029730
40	2161	Qasabet Irbid	Irbid	23597	235970000	62.42693602	235970
8	471	Qasabet Jarash	Jerash	40970	409700000	62.5114174	409700
23	1230	Qasabet Madaba	Madaba	39837	398370000	54.57876158	398370
5	387	Sahab	'Amman	48285	482850000	55.06951362	482850
16	793	Shobak	Maan	38297	382970000	56.87881826	382970
44	2713	Wadi Essier	'Amman	14447	144470000	53.39430949	144470

Adaptive Capacity Governorate Level:

FID	OBJECTID	adm1_name	COUNT	AREA	MEAN_SCORE	AREA (Km)
6	151	Ajloun	41985	419850000	31.6	419850
7	152	Al Balqa	111169	1111690000	39.3	1111690
8	153	Al Karak	358690	3586900000	34.6	3586900
3	40	Al Mafraq	2648656	26486560000	42.0	26486560
9	154	Al Tafeela	220872	2208720000	33.9	2208720
2	39	Amman	757022	7570220000	40.9	7570220
4	148	Aqaba	687883	6878830000	39.5	6878830
10	155	Az Zarqa'	476579	4765790000	40.0	4765790
5	149	Irbid	154044	1540440000	34.3	1540440
11	156	Jerash	40970	409700000	36.6	409700
0	37	Maan	3273695	32736950000	38.6	32736950
1	38	Madaba	95183	951830000	32.5	951830

Adaptive Capacity District Level:

FID	OBJECTID	adm2_name	COUNT	AREA	MEAN_SCORE	AREA (Km2)
0	23	Qasabet Al-Balqa'a	45477	454770000	34.61780573	454770
1	29	At-Taybeh	6344	63440000	32.86190142	63440
2	40	Al-Koorah	17856	178560000	33.49828644	178560
3	243	Bsaira	22701	227010000	31.77711135	227010
4	369	Ma'an	3158645	31586450000	38.76147677	31586450
5	387	Sahab	48285	482850000	37.42911416	482850
6	448	Al-Jami'ah'	12091	120910000	34.70079282	120910
7	457	Al-Faqo'e	10194	101940000	33.09298466	101940
8	471	Qasabet Jarash	40970	409700000	36.62890178	409700
9	477	Al-Quairah	255953	2559530000	41.88949358	2559530
10	530	Al-Jizah	545844	5458440000	41.68535502	5458440
11	546	Na'oor	18442	184420000	35.29692438	184420
12	613	Al-Hasa	95198	951980000	33.75956677	951980
13	628	Al-Qatraneh	106297	1062970000	36.88464336	1062970
14	672	Al-Muaqqar	75124	751240000	41.69664794	751240
15	675	Al-Wastiyyah	4585	45850000	33.17011999	45850
16	793	Shobak	38297	382970000	32.77202342	382970
17	873	Ayy	5737	57370000	34.30456506	57370
18	885	Qasabet Al-Aqaba	431930	4319300000	38.04004105	4319300
19	918	Bani Kenanah	24573	245730000	30.1871081	245730
20	978	Ash-Shoonah Al-Janoobiah	29541	295410000	43.23605136	295410
21	1106	Qasabet Al-Mafraq	60064	600640000	35.72309469	600640
22	1121	Dair Alla	23360	233600000	44.43305134	233600
23	1230	Qasabet Madaba	39837	398370000	32.52521398	398370
24	1237	Kufranjah	8657	86570000	34.39346211	86570
25	1388	Ar-Rwaished	2157794	21577940000	42.64548751	21577940
26	1430	Qasabet Ajlun	33328	333280000	30.93695724	333280
27	1486	Al-Aghwar Al-Janoobiyah	86287	862870000	34.0393623	862870
28	1525	Al-Mazar Ash-Shamali	8620	86200000	31.11017438	86200
29	1537	Al-Badiah Ash-Shamalieh Al-Gharbieh	66193	661930000	38.3094885	661930
30	1560	Bani Obeid	18846	188460000	31.37370829	188460
31	1713	Al-Quaismah	12002	120020000	41.9964668	120020
32	1766	Ar-Ramtha	26534	265340000	36.49191163	265340
33	1847	Qasabet Al-Zarqa	457887	4578870000	40.06396665	4578870
34	1881	Marka	26248	262480000	37.24684401	262480
35	1891	Qasabet Al-Karak	76569	765690000	34.84298164	765690
36	2010	Al-Russeifa	4446	44460000	42.24471311	44460
37	2096	Al-Qasr	24290	242900000	33.07104838	242900
38	2106	Qasabet Amman	4539	45390000	43.57479565	45390
39	2128	Al-Hashemiyah	14246	142460000	38.59112714	142460
40	2161	Qasabet Irbid	23597	235970000	35.9736572	235970
41	2178	Badia El Shamaliya	364605	3646050000	39.66854077	3646050
42	2536	Mahes & Al-Fuhais	2995	29950000	33.3934879	29950
43	2640	Al-Petra	23989	239890000	32.16708888	239890
44	2713	Wadi Essier	14447	144470000	36.51128805	144470
45	2728	Qasabet At-Tafiela	102973	1029730000	34.55194643	1029730
46	2784	Al-Aghwar Ash-Shamaliyah	23089	230890000	39.39771333	230890
47	2857	Dieban	55346	553460000	32.49850836	553460
48	2886	Al-Mazar Al-Janoobee	49316	493160000	31.29887579	493160
49	2907	Ain Albasha	9796	97960000	38.52648947	97960
50	3181	Al-Huseiniya	52764	527640000	37.99945699	527640

Adaptive Capacity Sub-District Level:

adm2_name	adm1_name	Adm3	COUNT	AREA	MEAN_SCORE	AREA (Km2)
Al-Quairah	'Aqaba	Ad Deseh	95342	953420000	38.8	953420
Ma'an	Maan	Adruh	29401	294010000	38.0	294010
Ma'an	Maan	Ail	20819	208190000	38.1	208190
Qasabet Al-Zarqa	Az Zarqa'	Alazraq	395248	3952480000	40.0	3952480
Qasabet Al-Balqa'a	Al Balqa	Ara and Yarqa	10488	104880000	33.8	104880
Qasabet Al-Balqa'a	Al Balqa	Aredah	9250	92500000	35.0	92500
Dieban	Madaba	Areed	23379	233790000	33.2	233790
Qasabet Ajlun	Ajloun	Arjan	4993	49930000	30.8	49930
Badia El Shamaliya	Al Mafraq	As Saleheyyeh	258845	2588450000	40.2	2588450
Ar-Ramtha	Maan	Ash Shobak	38297	382970000	32.8	382970
Al-Aghwar Ash-Shamaliyah	Irbid	Ash Shuna Ashamalya	23089	230890000	39.4	230890
Ash-Shoonah Al-Janoobiah	Al Balqa	Ash Shuna Janubiyya	29541	295410000	43.2	295410
Ain Albasha	Al Balqa	Ayn Al Basheh	9796	97960000	38.5	97960
Ayy	Al Karak	Ayy	5737	57370000	34.3	57370
Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Badiah Ash Shamaliyya Al Gharbeh	28201	282010000	39.5	282010
Qasabet Al-Mafraq	Al Mafraq	Balama	16971	169710000	34.7	169710
Bani Kenanah	Irbid	Bani Kinana	24573	245730000	30.2	245730
Bani Obeid	Irbid	Bani Obaid	18846	188460000	31.4	188460
Qasabet Al-Zarqa	Az Zarqa'	Bereen	16032	160320000	38.1	160320
Qasabet Jarash	Jerash	Berma	9585	95850000	35.6	95850
Bsaira	Al Tafeela	Besareh	22701	227010000	31.8	227010
Dair Alla	Al Balqa	Dair Alla	23360	233600000	44.4	233600
Dieban	Madaba	Deeban	20928	209280000	30.9	209280
Badia El Shamaliya	Al Mafraq	Deir Sl Kahf	66048	660480000	38.3	660480
Qasabet Al-Zarqa	Az Zarqa'	Delail	20671	206710000	40.7	206710
Al-Faqo'e	Al Karak	Faqua	10194	101940000	33.1	101940
Qasabet Madaba	Madaba	Fisalieh	5130	51300000	33.2	51300
Al-Aghwar Al-Janoobiyah	Al Karak	Ghor Al Mazraa	49144	491440000	33.4	491440
Al-Aghwar Al-Janoobiyah	Al Karak	Ghor As Safi	37143	371430000	34.9	371430
Al-Hasa	Al Tafeela	Hasa	95198	951980000	33.8	951980
Al-Hashemiyah	Az Zarqa'	Hashemieh	14246	142460000	38.6	142460
Na'oor	'Amman	Hesban	6351	63510000	33.6	63510
Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Husah	15044	150440000	35.3	150440
Al-Huseiniya	Maan	Husayniyya	52764	527640000	38.0	527640
Ma'an	Maan	Jafr	2807845	28078450000	38.8	28078450
Al-Jami'ah'	'Amman	Jameh	12091	120910000	34.7	120910
Qasabet Madaba	Madaba	Jereneh	2056	20560000	32.5	20560
Al-Jizah	'Amman	Jezeh	262289	2622890000	43.0	2622890
Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Khalediah	13393	133930000	39.5	133930
Kufranjah	Ajloun	Kofranja	8657	86570000	34.4	86570
Al-Koorah	Irbid	Kora	17856	178560000	33.5	178560
Ma'an	Maan	Ma'an	235677	2356770000	38.9	2356770
Qasabet Madaba	Madaba	Ma'en	18965	189650000	31.7	189650
Mahes & Al-Fuhais	Al Balqa	Mahes and Fahes	2995	29950000	33.4	29950
Qasabet Al-Mafraq	Al Mafraq	Manesheih	4043	40430000	36.9	40430
Marka	'Amman	Marka	26248	262480000	37.2	262480
Qasabet Jarash	Jerash	Mastabeh	4599	45990000	36.2	45990
Al-Mazar Ash-Shamali	Irbid	Mazar Ash Shamali	8620	86200000	31.1	86200
Al-Mazar Al-Janoobee	Al Karak	Mazar Janubi	41166	411660000	31.4	411660
Dieban	Madaba	Melieh	11039	110390000	34.0	110390
Al-Mazar Al-Janoobee	Al Karak	Muab	8150	81500000	31.0	81500
Al-Qasr	Al Karak	Mujeb	7670	76700000	32.2	76700
Ma'an	Maan	Muraygha	64903	649030000	37.8	649030
Al-Muaqqar	'Amman	Mwaqqer	60895	608950000	41.1	608950
Na'oor	'Amman	Naur	8782	87820000	35.3	87820
Al-Petra	Maan	Petra	23989	239890000	32.2	239890
Qasabet Al-Mafraq	Al Mafraq	Qasabet A Mafraq	18673	186730000	37.8	186730
Qasabet At-Tafiela	Al Tafeela	Qasabet A Tafilah	102973	1029730000	34.6	1029730
Qasabet Ajlun	Ajloun	Qasabet Ajloun	22594	225940000	31.8	225940
Qasabet Al-Aqaba	Aqaba	Qasabet Al Aqaba	200755	2007550000	37.1	2007550
Qasabet Al-Karak	Al Karak	Qasabet Al Karak	76569	765690000	34.8	765690
Qasabet Amman	'Amman	Qasabet Amman	4539	45390000	43.6	45390
Qasabet Al-Balqa'a	Al Balqa	Qasabet As Salt	19080	190800000	34.9	190800
Qasabet Al-Zarqa	Az Zarqa'	Qasabet Az Zarqa	25936	259360000	41.9	259360
Qasabet Irbid	Irbid	Qasabet Irbid	23597	235970000	36.0	235970
Qasabet Jarash	Jerash	Qasabet Jerash	26786	267860000	37.1	267860
Qasabet Madaba	Madaba	Qasabet Madaba	13686	136860000	33.4	136860
Al-Qasr	Al Karak	Qaser	16620	166200000	33.5	166200
Al-Qatraneh	Al Karak	Qatraneh	106297	1062970000	36.9	1062970
Al-Quairah	'Aqaba	Qwaira	160611	1606110000	43.7	1606110
Al-Quaismah	'Amman	Qwaismeh	12002	120020000	42.0	120020
Qasabet Al-Mafraq	Al Mafraq	Rahab	20377	203770000	34.4	203770
Ar-Ramtha	Irbid	Ramtha	26534	265340000	36.5	265340
Al-Muaqqar	'Amman	Rujm Ash Shami	14229	142290000	44.1	142290
Al-Russeifa	Az Zarqa'	Rusayfa	4446	44460000	42.2	44460
Ar-Rwaished	Al Mafraq	Rwashed	2157794	21577940000	42.6	21577940
Badia El Shamaliya	Al Mafraq	Sabeha	17326	173260000	38.4	173260
Sahab	'Amman	Sahab	48285	482850000	37.4	482850
Qasabet Ajlun	Ajloun	Sakhera	5741	57410000	27.8	57410
Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Sama As Sarhan	9555	95550000	37.7	95550
At-Taybeh	Irbid	Taibeh	6344	63440000	32.9	63440
Na'oor	'Amman	Umm Al Basateyn	3309	33090000	38.5	33090
Badia El Shamaliya	Al Mafraq	Umm Al Jemal	13800	138000000	38.8	138000
Badia El Shamaliya	Al Mafraq	Umm Al Qutain	8586	85860000	37.3	85860
Al-Jizah	'Amman	Umm Ar Rasas	283555	2835550000	40.5	2835550
Qasabet Al-Aqaba	Aqaba	Wadi Araba	231175	2311750000	38.9	2311750
Wadi Essier	'Amman	Wadi As Sir	14447	144470000	36.5	144470
Al-Wastiyyah	Irbid	Wastiyya	4585	45850000	33.2	45850
Qasabet Al-Balqa'a	Al Balqa	Zay	6659	66590000	34.6	66590

Vulnerability Governorate Level:

FID	OBJECTID	adm1_name	COUNT	AREA	MEAN_SCORE	AREA (Km)
0	37	Maan	3274224	32742240000	131.9	32742240
1	38	Madaba	94912	949120000	121.8	949120
2	39	Amman	757220	7572200000	131.3	7572200
3	40	Al Mafraq	2649304	26493040000	140.1	26493040
4	148	Aqaba	687364	6873640000	113.3	6873640
5	149	Irbid	154007	1540070000	135.3	1540070
6	151	Ajloun	41952	419520000	127.0	419520
7	152	Al Balqa	110939	1109390000	128.9	1109390
8	153	Al Karak	358574	3585740000	124.1	3585740
9	154	Al Tafeela	220814	2208140000	123.1	2208140
10	155	Az Zarqa'	476570	4765700000	133.8	4765700
11	156	Jerash	40991	409910000	135.4	409910

Vulnerability District Level:

FID	OBJECTID	adm2_name	adm1_name	COUNT	AREA	MEAN	AREA (Km2)
49	2907	Ain Albasha	Al Balqa	9808	98080000	135.7970627	98080
27	1486	Al-Aghwar Al-Janoobiyah	Al Karak	86163	861630000	118.4765098	861630
46	2784	Al-Aghwar Ash-Shamaliyah	Irbid	22943	229430000	130.8867067	229430
29	1537	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	66258	662580000	135.3511543	662580
7	457	Al-Faqo'e	Al Karak	10187	101870000	123.2503648	101870
12	613	Al-Hasa	Al Tafeela	95214	952140000	125.8907492	952140
39	2128	Al-Hashemiyah	Az Zarqa'	14252	142520000	131.7587636	142520
50	3181	Al-Huseiniya	Maan	52761	527610000	130.2779714	527610
6	448	Al-Jami'ah'	'Amman	12074	120740000	126.5217575	120740
10	530	Al-Jizah	'Amman	546024	5460240000	131.537728	5460240
2	40	Al-Koorah	Irbid	17862	178620000	135.6746067	178620
48	2886	Al-Mazar Al-Janoobee	Al Karak	49293	492930000	120.4790166	492930
28	1525	Al-Mazar Ash-Shamali	Irbid	8625	86250000	134.7142717	86250
14	672	Al-Muaqqar	'Amman	75117	751170000	131.1791328	751170
43	2640	Al-Petra	Maan	23992	239920000	124.7067222	239920
37	2096	Al-Qasr	Al Karak	24299	242990000	125.6776087	242990
13	628	Al-Qatraneh	Al Karak	106305	1063050000	129.109194	1063050
9	477	Al-Quairah	'Aqaba	255895	2558950000	119.0749184	2558950
31	1713	Al-Quaismah	'Amman	12012	120120000	136.087827	120120
36	2010	Al-Russeifa	Az Zarqa'	4443	44430000	139.7215153	44430
15	675	Al-Wastiyyah	Irbid	4578	45780000	134.0005442	45780
32	1766	Ar-Ramtha	Irbid	26621	266210000	139.9675274	266210
25	1388	Ar-Rwaished	Al Mafraq	2158358	21583580000	140.9941787	21583580
20	978	Ash-Shoonah Al-Janoobiah	Al Balqa	29415	294150000	126.0772612	294150
1	29	At-Taybeh	Irbid	6348	63480000	133.166273	63480
17	873	Ayy	Al Karak	5738	57380000	123.149	57380
41	2178	Badia El Shamaliya	Al Mafraq	364640	3646400000	136.7527547	3646400
19	918	Bani Kenanah	Irbid	24616	246160000	132.887651	246160
30	1560	Bani Obeid	Irbid	18832	188320000	133.2689904	188320
3	243	Bsaira	Al Tafeela	22703	227030000	126.662072	227030
22	1121	Dair Alla	Al Balqa	23255	232550000	130.2595381	232550
47	2857	Dieban	Madaba	55175	551750000	121.3841486	551750
24	1237	Kufranjah	Ajloun	8639	86390000	122.5316142	86390
4	369	Ma'an	Maan	3159174	31591740000	132.1168934	31591740
42	2536	Mahes & Al-Fuhais	Al Balqa	2989	29890000	129.109971	29890
34	1881	Marka	'Amman	26249	262490000	129.3991252	262490
11	546	Na'oor	'Amman	18444	184440000	126.9827297	184440
26	1430	Qasabet Ajlun	Ajloun	33313	333130000	128.1146913	333130
18	885	Qasabet Al-Aqaba	Aqaba	431469	4314690000	109.845069	4314690
0	23	Qasabet Al-Balqa'a	Al Balqa	45472	454720000	128.4271054	454720
35	1891	Qasabet Al-Karak	Al Karak	76589	765890000	125.6731678	765890
21	1106	Qasabet Al-Mafraq	Al Mafraq	60048	600480000	133.9494999	600480
33	1847	Qasabet Al-Zarqa	Az Zarqa'	457875	4578750000	133.8488622	4578750
38	2106	Qasabet Amman	'Amman	4543	45430000	137.3543898	45430
45	2728	Qasabet At-Tafiela	Al Tafeela	102897	1028970000	119.6295422	1028970
40	2161	Qasabet Irbid	Irbid	23582	235820000	139.3122303	235820
8	471	Qasabet Jarash	Jerash	40991	409910000	135.4076588	409910
23	1230	Qasabet Madaba	Madaba	39737	397370000	122.2599284	397370
5	387	Sahab	'Amman	48298	482980000	130.3512029	482980
16	793	Shobak	Maan	38297	382970000	122.8665173	382970
44	2713	Wadi Essier	'Amman	14459	144590000	131.1464108	144590

Vulnerability Sub-District Level:

FID	OBJECTID	adm3_name	adm2_name	adm1_name	COUNT	AREA	MEAN_SCORE	AREA (Km2)
0	191	Umm ar-rasas Sub-district	Al-Jizah	'Amman	283756	2837560000	129.1331584	2837560
1	276	Dair 'Alla Sub-district	Dair Alla	Al Balqa	23255	232550000	130.2595381	232550
2	614	Mahes and Fahes Sub-district	Mahes & Al-Fuhais	Al Balqa	2989	29890000	129.109971	29890
3	626	Ar_Rwashed Sub-district	Ar-Rwaished	Al Mafraq	2158358	21583580000	140.9941787	21583580
4	699	Ad_Deseh Sub-district	Al-Quairah	'Aqaba	95281	952810000	115.3823413	952810
5	872	Al_Qaser Sub-district	Al-Qasr	Al Karak	16633	166330000	126.8876287	166330
6	902	Bani kinana Sub-district	Bani Kenanah	Irbid	24616	246160000	132.887651	246160
7	1046	Qasabet As_Salt Sub-district	Qasabet Al-Balqa'a	Al Balqa	19088	190880000	129.0313444	190880
8	1286	Ma'an Sub-district	Ma'an	Maan	235674	2356740000	130.9154955	2356740
9	1695	Bani Obaid Sub-district	Bani Obeid	Irbid	18832	188320000	133.2689904	188320
10	1948	Ash_shuna Ashamalya Sub-district	Al-Aghwar Ash-Shamaliyah	Irbid	22943	229430000	130.8867067	229430
11	1959	Al_Fisalieh Sub-district	Qasabet Madaba	Madaba	5128	51280000	123.2982829	51280
12	2024	Umm Al_Jemal Sub-district	Badia El Shamaliya	Al Mafraq	13842	138420000	135.5193399	138420
13	2046	'Ayy Sub-district	Ayy	Al Karak	5738	57380000	123.149	57380
14	2056	Sakhera Sub-district	Qasabet Ajlun	Ajloun	5734	57340000	126.2914731	57340
15	2264	Al_Qwaismeh Sub-district	Al-Quaismah	'Amman	12012	120120000	136.087827	120120
16	2740	'Ayn Al_Basheh Sub-district	Ain Albasha	Al Balqa	9808	98080000	135.7970627	98080
17	2851	Al_Badiah Ash-Shamaliyya Al_Gharbeh Sub-district	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	28239	282390000	138.9158621	282390
18	3047	Al_Mujeb Sub-district	Al-Qasr	Al Karak	7666	76660000	123.0522156	76660
19	3224	Ghor Al_Mazraa Sub-district	Al-Aghwar Al-Janoobiyah	Al Karak	49050	490500000	118.9868411	490500
20	3245	Alazraq Sub-district	Qasabet Al-Zarqa	Az Zarqa'	395233	3952330000	133.9493267	3952330
21	3371	Qasabet Ajloun Sub-district	Qasabet Ajlun	Ajloun	22591	225910000	128.3960426	225910
22	3405	Ma'en Sub-district	Qasabet Madaba	Madaba	18880	188800000	119.9045593	188800
23	3488	Al_Petra Sub-district	Al-Petra	Maan	23992	239920000	124.7067222	239920
24	3523	Al_Mwaqqer Sub-district	Al-Muaqqar	'Amman	60885	608850000	130.1034222	608850
25	3564	Qasabet Irbid Sub-district	Qasabet Irbid	Irbid	23582	235820000	139.3122303	235820
26	3647	Kofranja Sub-district	Kufranjah	Ajloun	8639	86390000	122.5316142	86390
27	3834	Zay Sub-district	Qasabet Al-Balqa'a	Al Balqa	6660	66600000	132.0239053	66600
28	3887	Al_Jezeh Sub-district	Al-Jizah	'Amman	262268	2622680000	134.1393076	2622680
29	3976	Qasabet Al-Mafraq Sub-district	Qasabet Al-Mafraq	Al Mafraq	18660	186600000	137.0313974	186600
30	4112	Al_Mastabeh Sub-district	Qasabet Jarash	Jerash	4604	46040000	131.4568845	46040
31	4161	Qasabet Madaba Sub-district	Qasabet Madaba	Madaba	13681	136810000	124.5514582	136810
32	4218	Al_Kora Sub-district	Al-Koorah	Irbid	17862	178620000	135.6746067	178620
33	4527	Qasabet At_Tafilah Sub-district	Qasabet At-Tafiela	Al Tafeela	102897	1028970000	119.6295422	1028970
34	4577	Hesban Sub-district	Na'oor	'Amman	6357	63570000	125.1123631	63570
35	4626	Adruh Sub-district	Ma'an	Maan	29391	293910000	131.8672414	293910
36	4672	Husah Sub-district	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	15049	150490000	129.2497553	150490
37	4750	Wadi As_Sir Sub-district	Wadi Essier	'Amman	14459	144590000	131.1464108	144590
38	5171	Al_Hashemieh Sub-district	Al-Hashemiyah	Az Zarqa'	14252	142520000	131.7587636	142520
39	5207	AL_Manesheih Sub-district	Qasabet Al-Mafraq	Al Mafraq	4040	40400000	130.0961402	40400
40	5443	Jereneh Sub-district	Qasabet Madaba	Madaba	2048	20480000	126.065723	20480
41	5471	Balama Sub-district	Qasabet Al-Mafraq	Al Mafraq	16975	169750000	132.1819773	169750
42	5662	Al_Jafr Sub-district	Ma'an	Maan	2808397	28083970000	132.2503473	28083970
43	5871	Al_Faqua Sub-district	Al-Faqo'e	Al Karak	10187	101870000	123.2503648	101870
44	5937	'Ara and Yarqa Sub-district	Qasabet Al-Balqa'a	Al Balqa	10487	104870000	123.6563759	104870
45	5946	Arjan Sub-district	Qasabet Ajlun	Ajloun	4988	49880000	128.9363285	49880
46	6173	Ail Sub-district	Ma'an	Maan	20829	208290000	135.0906703	208290
47	6196	Al_'Aredah Sub-district	Qasabet Al-Balqa'a	Al Balqa	9237	92370000	130.0014518	92370
48	6255	Deeban Sub-district	Dieban	Madaba	20944	209440000	120.502631	209440
49	6521	Rahab Sub-district	Qasabet Al-Mafraq	Al Mafraq	20373	203730000	133.3635806	203730
50	6677	Al_wastiyya Sub-district	Al-Wastiyyah	Irbid	4578	45780000	134.0005442	45780
51	6684	Qasabet Al_karak Sub-district	Qasabet Al-Karak	Al Karak	76589	765890000	125.6731678	765890
52	6706	Berma Sub-district	Qasabet Jarash	Jerash	9587	95870000	134.5396699	95870
53	6714	Naur Sub-district	Na'oor	'Amman	8772	87720000	126.5445373	87720
54	6956	Ash_Shobak Sub-district	Ar-Ramtha	Maan	38297	382970000	122.8665173	382970
55	6996	Dayer Al_Kahef Sub-district	Badia El Shamaliya	Al Mafraq	66012	660120000	134.8552872	660120
56	7037	Al_Delail Sub-district	Qasabet Al-Zarqa	Az Zarqa'	20683	206830000	132.4321276	206830
57	7179	Umm Al_Basateyn Sub-district	Na'oor	'Amman	3315	33150000	131.7289572	33150
58	7217	Al_Muraygha Sub-district	Ma'an	Maan	64883	648830000	129.8627352	648830
59	7294	Al_Areed Sub-district	Dieban	Madaba	23212	232120000	120.554257	232120
60	7296	Melieh Sub-district	Dieban	Madaba	11019	110190000	124.8078667	110190
61	7345	Wadi 'Araba Sub-district	Qasabet Al-Aqaba	Aqaba	230998	2309980000	109.4084827	2309980
62	7484	Sabeha Sub-district	Badia El Shamaliya	Al Mafraq	17342	173420000	134.8071324	173420
63	7512	Marka Sub-district	Marka	'Amman	26249	262490000	129.3991252	262490
64	7836	Qasabet Az_Zarqa Sub-district	Qasabet Al-Zarqa	Az Zarqa'	25930	259300000	135.2941277	259300
65	7941	Al_Hasa Sub-district	Al-Hasa	Al Tafeela	95214	952140000	125.8907492	952140
66	8078	Umm Al_Qutain Sub-district	Badia El Shamaliya	Al Mafraq	8599	85990000	131.9626224	85990
67	8115	As_Saleheyyeh Sub-district	Badia El Shamaliya	Al Mafraq	258845	2588450000	137.5920983	2588450
68	8741	Al_Qwaira Sub-district	Al-Quairah	'Aqaba	160614	1606140000	121.2654649	1606140
69	8805	Ar_Ramtha Sub-district	Ar-Ramtha	Irbid	26621	266210000	139.9675274	266210
70	8858	Al_Qatraneh Sub-district	Al-Qatraneh	Al Karak	106305	1063050000	129.109194	1063050
71	9389	Sama As_Sarhan Sub-district	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	9588	95880000	131.5174674	95880
72	9523	Bereen Sub-district	Qasabet Al-Zarqa	Az Zarqa'	16029	160290000	130.8617575	160290
73	9607	Qasabet Amman Sub-district	Qasabet Amman	'Amman	4543	45430000	137.3543898	45430
74	9626	Al_Jameh Sub-district	Al-Jami'ah'	'Amman	12074	120740000	126.5217575	120740
75	9797	Al_Mazar Ash-shamali Sub-district	Al-Mazar Ash-Shamali	Irbid	8625	86250000	134.7142717	86250
76	9837	Qasabet Al_Aqaba Sub-district	Qasabet Al-Aqaba	Aqaba	200471	2004710000	110.3481371	2004710
77	9975	Sahab Sub-district	Sahab	'Amman	48298	482980000	130.3512029	482980
78	9984	Qasabet Jerash Sub-district	Qasabet Jarash	Jerash	26800	268000000	136.3968668	268000
79	10119	Muab Sub-district	Al-Mazar Al-Janoobee	Al Karak	8140	81400000	122.632727	81400
80	10164	Al_Khalediah Sub-district	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	13382	133820000	137.4370575	133820
81	10194	Besareh Sub-district	Bsaira	Al Tafeela	22703	227030000	126.662072	227030
82	10200	At_Taibeh Sub-district	At-Taybeh	Irbid	6348	63480000	133.166273	63480
83	10368	Al_Husayniyya Sub-district	Al-Huseiniya	Maan	52761	527610000	130.2779714	527610
84	10558	Rujm Ash-Shami Sub-district	Al-Muaqqar	'Amman	14232	142320000	135.7810605	142320
85	10570	Al_Rusayfa Sub-district	Al-Russeifa	Az Zarqa'	4443	44430000	139.7215153	44430
86	10621	Ghor As_Safi Sub-district	Al-Aghwar Al-Janoobiyah	Al Karak	37113	371130000	117.8020358	371130
87	10741	Al_Mazar Al_Janubi Sub-district	Al-Mazar Al-Janoobee	Al Karak	41153	411530000	120.053016	411530
88	11030	Ash_shuna al-Janubiyya Sub-district	Ash-Shoonah Al-Janoobiah	Al Balqa	29415	294150000	126.0772612	294150

Risk Governorate Level:

FID	OBJECTID	adm1_name	adm1_id	COUNT	AREA	MEAN_SCORE	AREA (Km2)
0	37	Maan	901480	3274224	32742240000	1661.6	32742240
1	38	Madaba	901481	94912	949120000	1785.4	949120
2	39	Amman	901469	757220	7572200000	1643.7	7572200
3	40	Al Mafraq	901474	2649304	26493040000	1805.4	26493040
4	148	Aqaba	901476	687364	6873640000	1317.3	6873640
5	149	Irbid	901478	154007	1540070000	2155.5	1540070
6	151	Ajloun	901471	41952	419520000	1933.3	419520
7	152	Al Balqa	901472	110939	1109390000	1976.1	1109390
8	153	Al Karak	901473	358574	3585740000	1639.4	3585740
9	154	Al Tafeela	901475	220814	2208140000	1610.6	2208140
10	155	Az Zarqa'	901477	476570	4765700000	1628.4	4765700
11	156	Jerash	901479	40991	409910000	1927.9	409910

Risk District Level:

FID	OBJECTID	adm2_name	adm1_name	COUNT	AREA	MEAN_SCORE	AREA (Km2)
0	23	Qasabet Al-Balqa'a	Al Balqa	45472	454720000	1950.7	454720
1	29	At-Taybeh	Irbid	6348	63480000	2132.4	63480
2	40	Al-Koorah	Irbid	17862	178620000	2129.9	178620
3	243	Bsaira	Al Tafeela	22703	227030000	1708.5	227030
4	369	Ma'an	Maan	3159174	31591740000	1669.5	31591740
5	387	Sahab	'Amman	48298	482980000	1630.7	482980
6	448	Al-Jami'ah'	'Amman	12074	120740000	1552.6	120740
7	457	Al-Faqo'e	Al Karak	10187	101870000	1883.2	101870
8	471	Qasabet Jarash	Jerash	40991	409910000	1927.9	409910
9	477	Al-Quairah	'Aqaba	255895	2558950000	1284.3	2558950
10	530	Al-Jizah	'Amman	546024	5460240000	1629.3	5460240
11	546	Na'oor	'Amman	18444	184440000	1620.9	184440
12	613	Al-Hasa	Al Tafeela	95214	952140000	1575.8	952140
13	628	Al-Qatraneh	Al Karak	106305	1063050000	1631.1	1063050
14	672	Al-Muaqqar	'Amman	75117	751170000	1764.6	751170
15	675	Al-Wastiyyah	Irbid	4578	45780000	2180.6	45780
16	793	Shobak	Maan	38297	382970000	1454.7	382970
17	873	Ayy	Al Karak	5738	57380000	1770.1	57380
18	885	Qasabet Al-Aqaba	Aqaba	431469	4314690000	1336.9	4314690
19	918	Bani Kenanah	Irbid	24616	246160000	2165.1	246160
20	978	Ash-Shoonah Al-Janoobiah	Al Balqa	29415	294150000	2041.6	294150
21	1106	Qasabet Al-Mafraq	Al Mafraq	60048	600480000	2083.4	600480
22	1121	Dair Alla	Al Balqa	23255	232550000	2059.9	232550
23	1230	Qasabet Madaba	Madaba	39737	397370000	1770.8	397370
24	1237	Kufranjah	Ajloun	8639	86390000	1988.5	86390
25	1388	Ar-Rwaished	Al Mafraq	2158358	21583580000	1801.6	21583580
26	1430	Qasabet Ajlun	Ajloun	33313	333130000	1919.0	333130
27	1486	Al-Aghwar Al-Janoobiyah	Al Karak	86163	861630000	1725.3	861630
28	1525	Al-Mazar Ash-Shamali	Irbid	8625	86250000	1916.4	86250
29	1537	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	66258	662580000	2309.7	662580
30	1560	Bani Obeid	Irbid	18832	188320000	1975.8	188320
31	1713	Al-Quaismah	'Amman	12012	120120000	1519.3	120120
32	1766	Ar-Ramtha	Irbid	26621	266210000	2391.3	266210
33	1847	Qasabet Al-Zarqa	Az Zarqa'	457875	4578750000	1611.5	4578750
34	1881	Marka	'Amman	26249	262490000	1681.8	262490
35	1891	Qasabet Al-Karak	Al Karak	76589	765890000	1468.3	765890
36	2010	Al-Russeifa	Az Zarqa'	4443	44430000	2091.6	44430
37	2096	Al-Qasr	Al Karak	24299	242990000	1684.7	242990
38	2106	Qasabet Amman	'Amman	4543	45430000	1558.1	45430
39	2128	Al-Hashemiyah	Az Zarqa'	14252	142520000	2026.2	142520
40	2161	Qasabet Irbid	Irbid	23582	235820000	2267.3	235820
41	2178	Badia El Shamaliya	Al Mafraq	364640	3646400000	1690.6	3646400
42	2536	Mahes & Al-Fuhais	Al Balqa	2989	29890000	1775.0	29890
43	2640	Al-Petra	Maan	23992	239920000	1553.6	239920
44	2713	Wadi Essier	'Amman	14459	144590000	1771.4	144590
45	2728	Qasabet At-Tafiela	Al Tafeela	102897	1028970000	1621.2	1028970
46	2784	Al-Aghwar Ash-Shamaliyah	Irbid	22943	229430000	2015.2	229430
47	2857	Dieban	Madaba	55175	551750000	1795.9	551750
48	2886	Al-Mazar Al-Janoobee	Al Karak	49293	492930000	1684.8	492930
49	2907	Ain Albasha	Al Balqa	9808	98080000	1760.4	98080
50	3181	Al-Huseiniya	Maan	52761	527610000	1384.2	527610

Risk Sub-District Level:

FID	OBJECTID	iso3	adm3_name	adm2_name	adm1_name	Adm3	COUNT	AREA	MEAN_SCORE	AREA (Km2)
4	699	JOR	Ad Deseh	Al-Quairah	'Aqaba	Ad Deseh	95281	952810000	1271.3	952810
35	4626	JOR	Adruh	Ma'an	Maan	Adruh	29391	293910000	1480.9	293910
46	6173	JOR	Ail	Ma'an	Maan	Ail	20829	208290000	1654.8	208290
20	3245	JOR	Alazraq	Qasabet Al-Zarqa	Az Zarqa'	Alazraq	395233	3952330000	1565.5	3952330
44	5937	JOR	Ara and Yarqa	Qasabet Al-Balqa'a	Al Balqa	Ara and Yarqa	10487	104870000	1921.1	104870
47	6196	JOR	Aredah	Qasabet Al-Balqa'a	Al Balqa	Aredah	9237	92370000	2084.5	92370
59	7294	JOR	Areed	Dieban	Madaba	Areed	23212	232120000	1742.8	232120
45	5946	JOR	Arjan	Qasabet Ajlun	Ajloun	Arjan	4988	49880000	1879.6	49880
67	8115	JOR	As Saleheyyeh	Badia El Shamaliya	Al Mafraq	As Saleheyyeh	258845	2588450000	1662.3	2588450
54	6956	JOR	Ash Shobak	Ar-Ramtha	Maan	Ash Shobak	38297	382970000	1454.7	382970
10	1948	JOR	Ash Shuna Ashamalya	Al-Aghwar Ash-Shamaliyah	Irbid	Ash Shuna Ashamalya	22943	229430000	2015.2	229430
88	11030	JOR	Ash Shuna Janubiyya	Ash-Shoonah Al-Janoobiah	Al Balqa	Ash Shuna Janubiyya	29415	294150000	2041.6	294150
16	2740	JOR	Ayn Al Basheh	Ain Albasha	Al Balqa	Ayn Al Basheh	9808	98080000	1760.4	98080
13	2046	JOR	Ayy	Ayy	Al Karak	Ayy	5738	57380000	1770.1	57380
17	2851	JOR	Badiah Ash Shamaliyya Al Gharbeh	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Badiah Ash Shamaliyya Al Gharbeh	28239	282390000	2368.6	282390
41	5471	JOR	Balama	Qasabet Al-Mafraq	Al Mafraq	Balama	16975	169750000	1928.8	169750
6	902	JOR	Bani Kinana	Bani Kenanah	Irbid	Bani Kinana	24616	246160000	2165.1	246160
9	1695	JOR	Bani Obaid	Bani Obeid	Irbid	Bani Obaid	18832	188320000	1975.8	188320
72	9523	JOR	Bereen	Qasabet Al-Zarqa	Az Zarqa'	Bereen	16029	160290000	1782.3	160290
52	6706	JOR	Berma	Qasabet Jarash	Jerash	Berma	9587	95870000	1944.5	95870
81	10194	JOR	Besareh	Bsaira	Al Tafeela	Besareh	22703	227030000	1708.5	227030
1	276	JOR	Dair Alla	Dair Alla	Al Balqa	Dair Alla	23255	232550000	2059.9	232550
48	6255	JOR	Deeban	Dieban	Madaba	Deeban	20944	209440000	1803.1	209440
55	6996	JOR	Deir Sl Kahf	Badia El Shamaliya	Al Mafraq	Deir Sl Kahf	66012	660120000	1582.0	660120
56	7037	JOR	Delail	Qasabet Al-Zarqa	Az Zarqa'	Delail	20683	206830000	1911.2	206830
43	5871	JOR	Faqua	Al-Faqo'e	Al Karak	Faqua	10187	101870000	1883.2	101870
11	1959	JOR	Fisalieh	Qasabet Madaba	Madaba	Fisalieh	5128	51280000	1784.9	51280
19	3224	JOR	Ghor Al Mazraa	Al-Aghwar Al-Janoobiyah	Al Karak	Ghor Al Mazraa	49050	490500000	1793.0	490500
86	10621	JOR	Ghor As Safi	Al-Aghwar Al-Janoobiyah	Al Karak	Ghor As Safi	37113	371130000	1635.8	371130
65	7941	JOR	Hasa	Al-Hasa	Al Tafeela	Hasa	95214	952140000	1575.8	952140
38	5171	JOR	Hashemieh	Al-Hashemiyah	Az Zarqa'	Hashemieh	14252	142520000	2026.2	142520
34	4577	JOR	Hesban	Na'oor	'Amman	Hesban	6357	63570000	1658.1	63570
36	4672	JOR	Husah	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Husah	15049	150490000	2332.1	150490
83	10368	JOR	Husayniyya	Al-Huseiniya	Maan	Husayniyya	52761	527610000	1384.2	527610
42	5662	JOR	Jafr	Ma'an	Maan	Jafr	2808397	28083970000	1699.8	28083970
74	9626	JOR	Jameh	Al-Jami'ah'	'Amman	Jameh	12074	120740000	1552.6	120740
40	5443	JOR	Jereneh	Qasabet Madaba	Madaba	Jereneh	2048	20480000	1732.0	20480
28	3887	JOR	Jezeh	Al-Jizah	'Amman	Jezeh	262268	2622680000	1627.9	2622680
80	10164	JOR	Khalediah	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Khalediah	13382	133820000	2126.7	133820
26	3647	JOR	Kofranja	Kufranjah	Ajloun	Kofranja	8639	86390000	1988.5	86390
32	4218	JOR	Kora	Al-Koorah	Irbid	Kora	17862	178620000	2129.9	178620
8	1286	JOR	Ma'an	Ma'an	Maan	Ma'an	235674	2356740000	1389.3	2356740
22	3405	JOR	Ma'en	Qasabet Madaba	Madaba	Ma'en	18880	188800000	1779.7	188800
2	614	JOR	Mahes and Fahes	Mahes & Al-Fuhais	Al Balqa	Mahes and Fahes	2989	29890000	1775.0	29890
39	5207	JOR	Manesheih	Qasabet Al-Mafraq	Al Mafraq	Manesheih	4040	40400000	2133.9	40400
63	7512	JOR	Marka	Marka	'Amman	Marka	26249	262490000	1681.8	262490
30	4112	JOR	Mastabeh	Qasabet Jarash	Jerash	Mastabeh	4604	46040000	1830.9	46040
75	9797	JOR	Mazar Ash Shamali	Al-Mazar Ash-Shamali	Irbid	Mazar Ash Shamali	8625	86250000	1916.4	86250
87	10741	JOR	Mazar Janubi	Al-Mazar Al-Janoobee	Al Karak	Mazar Janubi	41153	411530000	1694.7	411530
60	7296	JOR	Melieh	Dieban	Madaba	Melieh	11019	110190000	1894.1	110190
79	10119	JOR	Muab	Al-Mazar Al-Janoobee	Al Karak	Muab	8140	81400000	1635.0	81400
18	3047	JOR	Mujeb	Al-Qasr	Al Karak	Mujeb	7666	76660000	1764.1	76660
58	7217	JOR	Muraygha	Ma'an	Maan	Muraygha	64883	648830000	1467.0	648830
24	3523	JOR	Mwaqqer	Al-Muaqqar	'Amman	Mwaqqer	60885	608850000	1700.5	608850
53	6714	JOR	Naur	Na'oor	'Amman	Naur	8772	87720000	1663.6	87720
23	3488	JOR	Petra	Al-Petra	Maan	Petra	23992	239920000	1553.6	239920
29	3976	JOR	Qasabet A Mafraq	Qasabet Al-Mafraq	Al Mafraq	Qasabet A Mafraq	18660	186600000	2391.7	186600
33	4527	JOR	Qasabet A Tafilah	Qasabet At-Tafiela	Al Tafeela	Qasabet A Tafilah	102897	1028970000	1621.2	1028970
21	3371	JOR	Qasabet Ajloun	Qasabet Ajlun	Ajloun	Qasabet Ajloun	22591	225910000	1959.5	225910
76	9837	JOR	Qasabet Al Aqaba	Qasabet Al-Aqaba	Aqaba	Qasabet Al Aqaba	200471	2004710000	1210.5	2004710
51	6684	JOR	Qasabet Al Karak	Qasabet Al-Karak	Al Karak	Qasabet Al Karak	76589	765890000	1468.3	765890
73	9607	JOR	Qasabet Amman	Qasabet Amman	'Amman	Qasabet Amman	4543	45430000	1558.1	45430
7	1046	JOR	Qasabet As Salt	Qasabet Al-Balqa'a	Al Balqa	Qasabet As Salt	19088	190880000	1947.9	190880
64	7836	JOR	Qasabet Az Zarqa	Qasabet Al-Zarqa	Az Zarqa'	Qasabet Az Zarqa	25930	259300000	1969.4	259300
25	3564	JOR	Qasabet Irbid	Qasabet Irbid	Irbid	Qasabet Irbid	23582	235820000	2267.3	235820
78	9984	JOR	Qasabet Jerash	Qasabet Jarash	Jerash	Qasabet Jerash	26800	268000000	1938.6	268000
31	4161	JOR	Qasabet Madaba	Qasabet Madaba	Madaba	Qasabet Madaba	13681	136810000	1759.1	136810
5	872	JOR	Qaser	Al-Qasr	Al Karak	Qaser	16633	166330000	1648.1	166330
70	8858	JOR	Qatraneh	Al-Qatraneh	Al Karak	Qatraneh	106305	1063050000	1631.1	1063050
68	8741	JOR	Qwaira	Al-Quairah	'Aqaba	Qwaira	160614	1606140000	1292.1	1606140
15	2264	JOR	Qwaismeh	Al-Quaismah	'Amman	Qwaismeh	12012	120120000	1519.3	120120
49	6521	JOR	Rahab	Qasabet Al-Mafraq	Al Mafraq	Rahab	20373	203730000	1919.8	203730
69	8805	JOR	Ramtha	Ar-Ramtha	Irbid	Ramtha	26621	266210000	2391.3	266210
84	10558	JOR	Rujm Ash Shami	Al-Muaqqar	'Amman	Rujm Ash Shami	14232	142320000	2038.7	142320
85	10570	JOR	Rusayfa	Al-Russeifa	Az Zarqa'	Rusayfa	4443	44430000	2091.6	44430
3	626	JOR	Rwashed	Ar-Rwaished	Al Mafraq	Rwashed	2158358	21583580000	1801.6	21583580
62	7484	JOR	Sabeha	Badia El Shamaliya	Al Mafraq	Sabeha	17342	173420000	2015.5	173420
77	9975	JOR	Sahab	Sahab	'Amman	Sahab	48298	482980000	1630.7	482980
14	2056	JOR	Sakhera	Qasabet Ajlun	Ajloun	Sakhera	5734	57340000	1793.3	57340
71	9389	JOR	Sama As Sarhan	Al-Badiah Ash-Shamalieh Al-Gharbieh	Al Mafraq	Sama As Sarhan	9588	95880000	2356.5	95880
82	10200	JOR	Taibeh	At-Taybeh	Irbid	Taibeh	6348	63480000	2132.4	63480
57	7179	JOR	Umm Al Basateyn	Na'oor	'Amman	Umm Al Basateyn	3315	33150000	1436.7	33150
12	2024	JOR	Umm Al Jemal	Badia El Shamaliya	Al Mafraq	Umm Al Jemal	13842	138420000	2144.5	138420
66	8078	JOR	Umm Al Qutain	Badia El Shamaliya	Al Mafraq	Umm Al Qutain	8599	85990000	1989.0	85990
0	191	JOR	Umm Ar Rasas	Al-Jizah	'Amman	Umm Ar Rasas	283756	2837560000	1630.5	2837560
61	7345	JOR	Wadi Araba	Qasabet Al-Aqaba	Aqaba	Wadi Araba	230998	2309980000	1446.6	2309980
37	4750	JOR	Wadi As Sir	Wadi Essier	'Amman	Wadi As Sir	14459	144590000	1771.4	144590
50	6677	JOR	Wastiyya	Al-Wastiyyah	Irbid	Wastiyya	4578	45780000	2180.6	45780
27	3834	JOR	Zay	Qasabet Al-Balqa'a	Al Balqa	Zay	6660	66600000	1819.4	66600

17.5 Annex 5: Interview Questionnaire and Quantitative Recording Tool

As the interviews were semi-structured, the interviewees followed the guiding questions presented in 15.5.1, but not necessarily in this order. Also, interviewees were given the space to veer off track and to tell their personal stories. The quantitative assessment tool (15.5.2) developed by WFP was operated on the mobile phone, which was developed by WFP and allowed for georeferencing. This additional tool was more structured. The interviewer's assistant navigated this tool in the background throughout the course of the interview, jumping between questions as the answers were given. The interviewer tried to weave these quantitative questions into the qualitative interviews in an informal way. The interviewer's assistant only intervened with direct questions when there was missing information.

17.5.1 Climate Change, Drought, and Social Vulnerability Interviews

1. Personal Information

- Could I ask you a little bit about yourself?
- Were you born in this community? Have you lived here for long?
- May I ask you how old you are? What is your livelihood / job / source of income? Do you have an educational background in this field, or did you learn from your parents and family members?

2. Livelihood

- Tell me a little more about your livelihood. Are you a farmer? What do you grow? Where is your farm? How big is your land?
- If you are not a farmer now, did you use to farm? Are you from a farming family?
- Is this your own land? How many people work this land? Only family members, or do you also hire agricultural workers at times? Who would you hire (male/female, ethnicity)? Do women in your household help with the farm work?
- Do you irrigate? Where does your water come from? Do you have animals? What do you do with your agricultural products? Do you sell them?
- Are you a herder? Do you have animals? How many and which animals? What do you do to feed them, where do you take them, have there been any changes to the grazing grounds?
- Has it become easier or harder to make an agricultural / pastoral living over the years? Why is that?
- Have you noticed changes over the years in the climate, temperature, amount of rainfall, the seasons?
- If yes, how have you reacted to such changes as a farmer?
- Overall, do you feel you have a secure livelihood?

3. Housing Information

We would like to know a little bit more about your household.

- Could you tell me a little more about the people who live in your household? Is it just your family, or extended family? How many children or older people?
- Would you say it is easy living in this village?
- Do you have good public services like access to tap water, electricity, clean drinking water?
- Are you connected to the national electricity and water grids? Do you have water every day? Do you ever suffer from electricity or water cuts / how often does this happen / how long does it cut? What do you do when such cuts happen? If there are water and electricity cuts, what do you do as contingency plan? Do you ever have to purchase water? Would you say that water and electricity shortages increase your monthly household bill?

- Do you feel that everyone in your community has equal access to public services such as water? Do you feel that all community members cope equally well with water and service bottlenecks?
- Are there any times of the year when you feel living in your house becomes uncomfortable, too hot or too cold? Has this changed at all over the years you have lived here? Have you noticed that water shortages at home coincide with very dry periods and a lack of rain?
- Do you produce all of your own food, or do you also buy food? How would you estimate your expenses for food (%), electricity (%) and water (%) in relation to your overall income?
- What about health in your family? Does any family have health or disability issues? Do you feel there are good health facilities nearby? Are they affordable? Do your family members have health insurance?

4. Village Life and Social Cohesion

We would like to understand a little better what it is like to live in this village.

- Could you tell us what is special about this village? What do you like the most / the least about living here?
- Would you say that this is a closely-knit community and that people would help each other out? Do you feel welcome and part of the community? Are there sections or groups in the community that are particularly close? Are any groups excluded from the community? Are you member of a social community group or associations? What associations are there?
- Has the village changed over the past few decades?
- Is your community hosting migrants? Has this changed life in any way?
- Are there problems with poverty in this village? Does this affect particular groups in the village?
- Do you feel that there are social support systems from the government for people in this village? E.g. insurances, access to loans or grants. Are those sufficient
- Do you think there are sufficient and affordable educational and health facilities that are equally accessible by everyone in the community? Can you estimate the rough percentage of your income spent on education and healthcare?
- Have your neighbors supported you in times of crisis, for example financially or by sharing food or labor?
- Do you feel the government is responsive to community needs? For example, in regards to extreme events like flash floods and droughts?

5. Climate Change Experiences

- Have you witnessed a change in local weather patterns such as heat waves, drought, floods, frost and cold, storms in the area in the past 10 years? Could you tell me a little bit about such an incident, what happened, and how it felt?
- Have such changes, particularly those related to drought, affected your work, business or livelihood, or quality of life? Have people in the village closed their farming businesses due to drought?
- How do you cope with such challenges? Have you changed the planted area, made irrigation system changes or planted different crops due to weather changes or water scarcity? Have you dug a well? What about other people in the village?
- Have you had to take up a loan because of drought impact in the past?
- Have people migrated away due to drought or floods?
- Have extreme weather events such as drought ever led to disputes or conflict in the community? Or does the community stick together even more?
- Do you think women are more vulnerable to these impacts than men? Are there any female-headed households in the village?
- What should be done, in your opinion, to prepare your community for the challenges of

climate change?
- In how far has COVID-19 impacted your livelihood?

17.5.2 Annex 6: Quantitative Interview Tool Developed by WFP

Introduction: Climate Change, Drought, and Social Vulnerability Interviews

Date and time of interview:*

8/16/2022 | 12:30 PM

Any initial notes about the location or interview?

Any special note you have?

255

GPS point for the interview location*

1. Personal Information

1.1 Gender:*

- a) male
- b) female

1.2 Age:*

Should be > 18 year

1.3 Marital status:*

- a) single
- b) married
- c) divorced
- d) widow/er

1.4 Education level:*

- a) primary
- b) secondary
- c) tertiary

1.5 Type of main work / profession:*

Multiple selection

- [ ] a) farmer on own farm
- [ ] b) farmer on rented farm
- [ ] c) farm worker
- [ ] d) pastoral nomad
- [ ] e) other (please specify)

1.6 Place of birth?*

1.7 Years of residence in the village?*

123

1.8 Migrant / refugee status?*

- a) migrant
- b) refugee
- c) none of the above

2. Livelihood

2.1 Type of livelihoods?*

- ☐ a) farmer
- ☐ b) pastoralist
- ☐ c) agricultuaral worker
- ☐ d) other: please specify
- ☐ e) NA

2.1 Type of farm?*

- ○ a) agriculture
- ○ b) horticulture
- ○ c) mostly livestock
- ○ d) mix of agriculture, horticulture, livestock

2.2 Location of farm?*

-

2.3 Size of farm? in achres?*

1₂³ →

2.4 Ownership of farm?*

- a) owned
- b) rented
- c) sharecropping
- d) other: please specify

2.5 Number of employed farm laborers?*

2.5.1 Number of househols members working in the farm?*

2.6 Types of crops grown?*

255

2.7 Irrigation type and water source?*

- a) irrigated
- b) rainfed
- c) mix of irrigated and rainfed
- e) NA

2.8 Water source?*

- a) well
- b) canal / river
- c) other
- e) NA

2.10 Number of animals owned?*

***Question 2.9 was not included in the final version of the tool.**

2.11 Type of animals owned?*

2.12 In case of pastoralism, km traveled to grazing areas?*

2.13 Is agriculture the main livelihoods income?*

- ◯ Yes
- ◯ No

2.14 I operate pumps in agriculture?*

- ◯ Yes
- ◯ No

2.15 Pumps are operated by?*

- ◯ a) diesel
- ◯ b) solar
- ◯ c) electricity
- ◯ d) other (please specify)

2.16 Other types of income?*

255

2.17 Crops produced for?*

- a) own consumption / livestock consumption
- b) local market
- c) export
- d) other (please specify)

3. Household Information

3.1 Number of people living in my household?*

123

3.2 Number of people below the age of 15:*

123

3.3 Number of people above the age of 60:*

123

3.4 I live in?*

- a) a house I own
- b) a house I rent
- c) an apartment I own
- d) an apartment I rent
- e) a rented room
- f) other (please specify)

3.7 The source of electricity is?*

Multiple selection

- a) national grid
- b) solar grid-tie
- c) solar off grid
- d) other

3.8 My household suffers electricity cuts?*

- Yes
- No

***Questions 3.8-3.11 were removed from the final version of the tool.**

3.12 Household has heating?*

- Yes
- No

3.14 Are there times of the year when staying in the house becomes uncomfortable due to:

a) hot weather?*

- Yes
- No

b) cold weather?*

- Yes
- No

c) rain?*

- Yes
- No

d) storms?*

- ◯ Yes
- ◯ No

e) snow?*

- ◯ Yes
- ◯ No

3.15 My household has access to safe, improved drinking water?*

- ◯ Yes
- ◯ No

3.16 Drinking water is?*

Multiple selection

- ☐ a) provided by government
- ☐ b) provided by private company
- ☐ c) provided by NGO
- ☐ d) purchased by tank
- ☐ e) have tap water but prefer to buy bottled water

3.17 Water availabilty is....*

Multiple selection

- ☐ a) available by tap at all times
- ☐ b) available by tap with interruptions
- ☐ c) delivered by truck at no cost
- ☐ d) delivered by truck at own cost
- ☐ f) other (please specify)

3.18 If water is not available at all times from the tap, how many days a week is water available?*

- ○ a) 1
- ○ b) 2
- ○ c) 3
- ○ d) 4
- ○ e) 5
- ○ f) 6
- ○ g) 7

3.19 At times of water shortage, I...*

Multiple selection

- [ ] a) buy bottled water
- [ ] b) access water from a well
- [ ] c) buy water from a truck
- [ ] d) other (please specify)

3.20 I use tap water for:*

- ○ a) drinking
- ○ b) cooking
- ○ a) both
- ○ d) none

3.21 The drinking water quality?*

○ a) excellent ○ b) good ○ c) sufficient ○ d) substandard

3.22 I have witnessed changes in the availability or quality of water over the past 10 years*

- ◯ Yes
- ◯ No

Please explain in qualitative content*

255

4. Village Life and Social Cohesion

4.1 There is village cohesion?*

- ◯ a) full cohesion
- ◯ b) to some extent
- ◯ c) none
- ◯ d) other (please specify)

4.2 Feels welcome and part of the communtiy?*

- ◯ a) yes
- ◯ b) to some extent
- ◯ c) no

4.3 Is there a poverty problem in the village?*

- a) yes
- b) to some extent
- c) no
- d) don't know

4.4 Are certain groups more disadvantages than others?*

- Yes
- No

4.5 Member in local associations, groups, clubs?*

- Yes
- No

4.6 Do neighbors / community members help in times of hardship?*

- a) always
- b) sometimes
- c) never
- d) don't know

4.7 Does the village host significant numbers of migrants?*

- a) yes, many
- b) some
- d) none
- d) don't know

4.8 Have migrants increased pressures on natural resources or public services?*

- a) yes, a lot
- b) at times
- c) no, not at all
- d) don't know

4.9 Are migrants more connected among each other than the rest of the community?*

- a) yes
- b) no
- c) don't know

4.10 Are there social support systems at times of hardship?*

- a) yes
- b) some
- c) none
- d) don't know

4.11 How do you rate government support and services at times of extreme weather (e.g. drought, storms)?*

- a) excellent
- b) good
- c) so-so
- d) insufficient
- e) don't know

4.12 How do you rate healthcare service costs?*

- a) affordable
- b) reasonably expensive
- c) too expensive
- d) don't know

4.13 How do you rate educational costs?*

- a) affordable
- b) reasonably expensive
- c) too expensive
- d) don't know

4.14 How do you rate healthcare quality*

a) excellent — b) good — c) so-so — d) insufficient — e) don't know

4.15 How do you rate the quality of educational services?*

a) excellent — b) good — c) so-so — d) insufficient — e) don't know

4.16 Basic healthcare services are within a radius of*

- a) 1 km
- b) 5 km
- c) 10 km
- d) 25 km
- e) more than 25 km
- f) don't know

4.17 Primary and secondary school are within a radius of*

- a) 1 km
- b) 5 km
- c) 10 km
- d) 25 km
- e) more than 25 km
- f) don't know

5. Climate Change Experiences

5.1 Have you noted changes in the following weather patterns in the past 10 years?

a) heat waves?*

- a) yes
- b) no
- c) don't know

b) droughts?*

- a) yes
- b) no
- c) don't know

c) floods?*

- a) yes
- b) no
- c) don't know

d) frost and cold?*

- a) yes
- b) no
- c) don't know

e) storms?*

- a) yes
- b) no
- c) don't know

5.2 In how far have they affected your livelihood?*

- a) very much
- b) to some extent
- c) not really
- d) not sure / don't know

5.3 How have you reacted to weather extremes affecting your livelihood? (tick all that applies)*

- ☐ a) dug additional well
- ☐ b) reduced farmed area
- ☐ c) sold livestock
- ☐ d) sold farm
- ☐ e) took up additional job
- ☐ f) migrated
- ☐ g) changed grazing grounds
- ☐ h) took up a loan
- ☐ i) other (please specify)

5.4 Have other people migrated out of the community due to changing weather / drought / water scarcity)?*

- ○ a) yes, many
- ○ b) yes, some
- ○ c) none
- ○ d) don't know

5.5 Have extreme weather events and drought led to disputes in the community?*

- a) yes
- b) sometimes
- c) never
- d) never, and crises make the community stick together more closely
- e) don't know

5.6 Do you think women are more vulnerable to climate change impacts / drought / water scarcity in the domain of agriculture?*

- a) yes
- b) no
- c) don't know

17.6 Annex 7: Consent Form

Project Title: Climate Change Impact on Social Vulnerability

Principal Investigators: Dr Tina Jaskolski, Dr Amel Azab

You are kindly asked to participate in a research study that assesses the impact of droughts on the vulnerability and resilience of communities in Jordan. Communities around the world are increasingly affected by drought and water scarcity. However, in policy responses to drought, the complex situations communities face in dealing with drought are often not adequately understood and considered. This research will help develop a better understanding of the complex interactions between drought and vulnerability and inform policy makers in designing climate change response policies that are tailored to people's needs.

The study, carried out in partnership by the Arab Water Council, the United Nations' World Food Programme and the United Nations Development Programme, is taking place on two different levels – a national level where complex indicators of drought and social vulnerability are mapped together using GIS programming, and a case study carried out at the local level in the village of Deir El Kahf in Jordan.

We would appreciate if you could tell us about your experiences with drought and water scarcity as a resident of Deir El Kahf. The information you provide for purposes of this research is confidential. The findings of the study may be published in a research report as well as in academic publications and in a policy brief, however, no names will appear in any of these publications.

The expected duration of your participation is estimated at between 30 minutes and 1 hour. Your participation will take place in the form of an interview with one of our researchers and, if you consent, we would like to audio record the conversation. Again, your name will not be released in relation to the audio recording. There will be no direct benefits to you from this research, but we are happy to share our research report and results with you once the research has been completed. You can choose to end your participation in the interview at any time.

The study has been endorsed by the Ministry of Environment of Jordan, as per attached research support letter. If you have questions about this study, please contact Dawoud Isied (Research Consultant), Nida Ibrahim (WFP) or Sami Tarabieh (UNDP) in Jordan, or Dr. Tina Jaskolski or Dr Amel Azab at the Arab Water Council in Cairo.

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I consent to take part in the study
Name and Signature:

We thank you for your participation!

الباحثين: د./ مارتينا جاسكولسكي ، د. / أمل عزب

نتشرف بالإحاطة بأن المجلس العربي للمياه، بالشراكة مع برنامج الأغذية العالمي (WFP) التابع للأمم المتحدة وبرنامج الأمم المتحدة الإنمائي (UNDP) ، بصدد إجراء دراسة بحثية بشأن تقييم تأثير الجفاف على مدى قابلية تأثر المجتمعات والمرونة في مجابهة هذه الظاهرة المناخية في الأردن. وقد تم التصديق على الدراسة من قبل وزارة البيئة الأردنية بموجب خطاب الدعم البحثي المرفق.

ورغم أن المجتمعات حول العالم تتأثر بشكل متزايد بظاهرة الجفاف وندرة المياه، إلا أنه أثناء استجابة السياسات لهذه الظاهرة، فإن المواقف المركبة التي تواجهها المجتمعات في التعامل مع الجفاف غالباً ما تكون غير مفهومة بوضوح وغير مأخوذة في الاعتبار بشكل كافٍ. ويهدف هذا البحث إلى المساعدة في تحقيق فهم أفضل للتفاعلات المركبة بين ظاهرة الجفاف وقابلية تأثر المجتمعات وإبلاغ صانعي السياسات لتصميم سياسات الاستجابة لتغير المناخ بحيث تكون مفصلة خصيصاً لسد الاحتياجات الفعلية للشعوب.

وتُجري الدراسة على مستويين مختلفين ــ المستوى الأول هو الصعيد الوطني حيث يتم تحديد المؤشرات المركبة للجفاف والهشاشة الاجتماعية معاً باستخدام برنامج نظم المعلومات الجغرافية، أما المستوى الثاني فهو دراسة حالة تنفذ على الصعيد المحلي في قرية دير الكهف بالأردن.

في هذا الإطار، نكون شاكرين مشاركتكم في هذه الدراسة البحثية من واقع تجاريكم الثمينة وخبراتكم المتراكمة عن ظواهر الجفاف وندرة المياه كمواطنين مقيمين في دير الكهف محل البحث. وننتهز الفرصة لنؤكد أن المعلومات المقدمة من سيادتكم لأغراض هذا البحث سوف تعامل في منتهى السرية، إلا أنه يمكن نشر نتائج الدراسة في التقارير البحثية أو في المنشورات الأكاديمية أو ملخصات السياسات ولكن دون ذكر أي أسماء في أي من هذه الإصدارات.

للمزيد من المعلومات أو الاستفسارات حول هذه الدراسة يُرجى الاتصال بالسيد/ داوود أسعيد (مستشار بحثي)، أو ندا إبراهيم (برنامج الأغذية العالمي) أو سامي طربية (برنامج الأمم المتحدة الإنمائي) بالأردن ، أو د./ مارتينا جاسكولسكي أو د./ أمل عزب بالمجلس العربي للمياه في القاهرة. مرفق البريد الإلكتروني لكل منهم:

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وسوف تكون المشاركة في شكل مقابلة مع أحد باحثينا لمدة 30 إلى 60 دقيقة، حيث يمكن في حالة موافقتكم تسجيل المحادثة صوتياً. ونؤكد مرة أخرى أنه لن يتم تحرير أي أسماء فيما يتعلق بالتسجيل الصوتي، ويمكنكم اختيار إنهاء مشاركتكم في المقابلة في أي وقت. ويسعدنا مشاركة تقريرنا البحثي ونتائجه معكم بمجرد الانتهاء من البحث.

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