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Policy Brief

MENAdrought: Toward drought management in Jordan

Key messages

- Jordan is becoming more vulnerable to the impacts of drought due to climate change increasing its frequency and severity, groundwater depletion, and reductions in surface water inflows.
- The impacts of drought on rainfed agricultural systems and springs are particularly severe.
- Jordan's Ministry of Water and Irrigation (MWI) has taken on a primary technical and operational coordination function related to drought policy. MWI's Drought Management Unit leads the inter-agency Drought Technical Committee (DTC).
- Key outputs of the MENAdrought project included the development of an operational Drought Early Warning System (DEWS), assessments of drought impacts and vulnerability, and support for the DTC to develop a Drought Action Plan (DAP) that links the DEWS with policy and governance processes for drought preparedness, mitigation, and response actions.
- The DAP is the 'policy vehicle' that takes the technical information from the DEWS and enables its application in policy decision-making.
- Information from the DEWS and an impact assessment commissioned by the DTC were used by governmental decision-makers in early 2022 to justify and target the provision of drought financial relief in the Tafilah Governorate.
- Now the Jordanian government and the DTC need support to capitalize on these developments and working relationships to implement the DAP preparedness, mitigation, and response actions and embed it in government practice.

Introduction

Droughts have become more pronounced in the MENA region due to changes in precipitation patterns and rising temperatures caused by climate change. Less water reaches wadis, aquifers, springs, and crops. This contributes to increased frequency of droughts, as well as their length and severity. The impacts of droughts in MENA affect nearly every segment of society and sector in the economy and can have

profound effects on livelihoods and households in the long term.

Between 1998–2001, Jordan experienced its most severe dry period in the past 500 years. According to the last Jordanian climate change national communications report, Jordan will face decreases in rainfall, increases in temperature and shifts in the rainy season by 2050. Climate-related hazards such as extreme temperatures, droughts, floods and landslides are expected to increase in frequency and intensity in this period. Jordan is an upper middle-income country with a population of more than 11 million people. It is one of the most water-scarce countries in the world. Renewable water supplies meet only

About MENAdrought

Launched in 2018, the MENAdrought project empowers the governments of Jordan, Lebanon and Morocco (countries in the Middle East and North Africa [MENA] region) with the tools to anticipate, prepare for, and mitigate the worst impacts of drought. The project is helping build self-reliance so the three countries can effectively manage the impacts that droughts have on water and food security, and in turn limit the social and economic damage resulting from drought.

Led by the International Water Management Institute (IWMI) with support from the United States Agency for International Development (USAID), MENAdrought pools the resources and expertise of global leaders in the field of drought monitoring, forecasting and management.

MENAdrought uses an approach based on three pillars to improve drought risk management. The pillars are: developing drought monitoring and early warning systems; conducting impact and vulnerability assessments; and drought mitigation, preparedness and response planning.

two-thirds of the country's needs. Consequently, Jordanians are particularly vulnerable to the effects of drought on their livelihoods, especially for the 102,000 farming households, most of whom are smallholders.

Droughts can exacerbate already complex social and economic challenges and instabilities, including in relation to migration. Jordan has a significant number of refugees worldwide and currently hosts approximately 1.3 million Syrians. Such large-scale migration poses major challenges for Jordanian institutions and infrastructure, which increases vulnerability to drought impacts.

Assessing Jordan's needs

The MENAdrought project developed novel technical and policy tools for drought monitoring and management. As a first step, MENAdrought assessed the needs of Jordanian stakeholders for drought monitoring and management. The assessment identified key knowledge and institutional gaps related to drought definitions, information sharing, inter-sectoral engagement (especially between farmers and government agencies), technical capacity of government agencies and existing policies, and sources of vulnerability to drought and its impacts in various sectors.

Addressing the needs

Government officials subsequently decided on several discrete priority impacts to address through development of a Drought Early Warning System (DEWS) and a Drought Action Plan (DAP) that includes preparedness, mitigation, and response components (available online at <https://bit.ly/3pNP5K>).

To meet identified needs related to drought definitions and declaration procedures, the DAP relies on information from the DEWS to support drought response decision-making.

Development of a Drought Early Warning System (DEWS)

The DEWS includes both monitoring and forecasting components.

The map-based monitoring component uses an enhanced Composite Drought Indicator (eCDI) produced using remote sensing (satellite) and environmental modeling data to identify anomalies for each month, relative to average conditions in that month since 2000. These anomalies include factors like precipitation, vegetation condition, soil moisture and a proxy for evapotranspiration.

Data generated for these factors is used to produce an eCDI value for each 5x5 km area in the country. This allows policymakers to categorize different regions of Jordan into one of four drought levels simply, effectively, and quickly: no drought, moderate drought, severe drought or extreme drought.

Furthermore, eCDI results were analyzed statistically to produce potential 'trigger' thresholds for drought management actions. In Jordan, triggers reflect the relationships between annual rainfed staple crop production and yields, and historical drought severity, longevity, and extent.

The eCDI outputs are provided to drought monitoring and management committees through a straightforward web interface. This enables visualization of drought conditions at various administrative levels and over time, and it eases comparison of drought events across the country and in relation to past events (Figure 1).

Information from the drought monitoring system was used by governmental decision-makers in early 2022 to justify

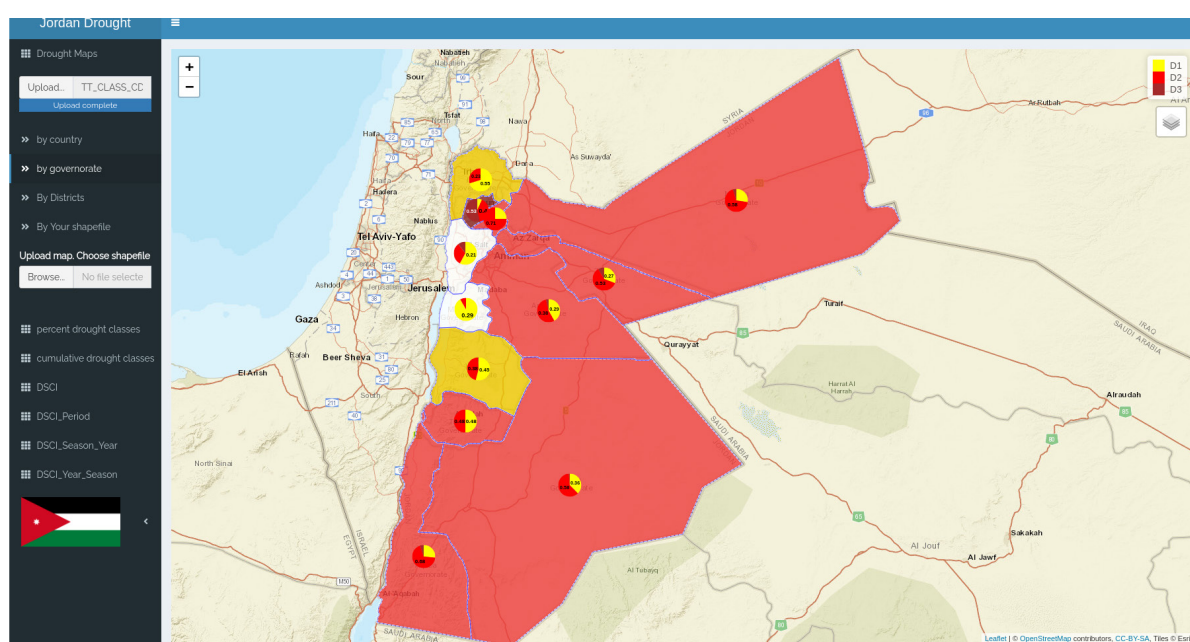


Figure 1. Web interface for the Jordanian drought monitoring system showing district-level drought conditions.

and target provision of drought financial relief in the Tafilah Governorate (see Box 1).

With this system, Jordan has a powerful tool for early detection of the impacts of drought, and Jordanian officials are eager to explore other options for triggers in the future to expand its usefulness.

Seasonal forecasting

The seasonal forecasting tools developed through MENAdrought use convolutional neural network (CNN) models, an artificial intelligence technique, to provide information on predicted precipitation up to three months in advance. The CNN models use precipitation forecast data produced by global centers to predict precipitation in Jordan according to five climate regions.

The CNN-based system implemented by MENAdrought has been shown to accurately predict rainfall with a two-month lead time in sub-humid and semi-arid areas of Jordan. In arid areas, the predictive accuracy was significantly lower, in part due to rare precipitation events.

This approach has enabled high accuracy, high precision forecasts that will support the DTC in its efforts to prepare for, and mitigate, drought impacts by providing advanced warning of drought occurrence.

With these monitoring and forecasting tools on the table, MENAdrought provides: early detection of the impact of drought on different agricultural systems in Jordan and a

tool for seasonal precipitation forecasting. This forecast precipitation data could be used in hydrological models to predict streamflow or agricultural models to predict crop yield and production.

Figure 2 shows the predicted monthly rainfall anomaly for all of February 2022. The figure was produced in early January. Thus, it forecasts with ‘two months lead time’. It shows the percent of rainfall above and below normal. Dark blue areas are predicted to have 60% rainfall above average for the month of February compared to all Februaries in 2000 to the present year, and dark brown areas are expected to have 60% less rainfall than average for the month of February.

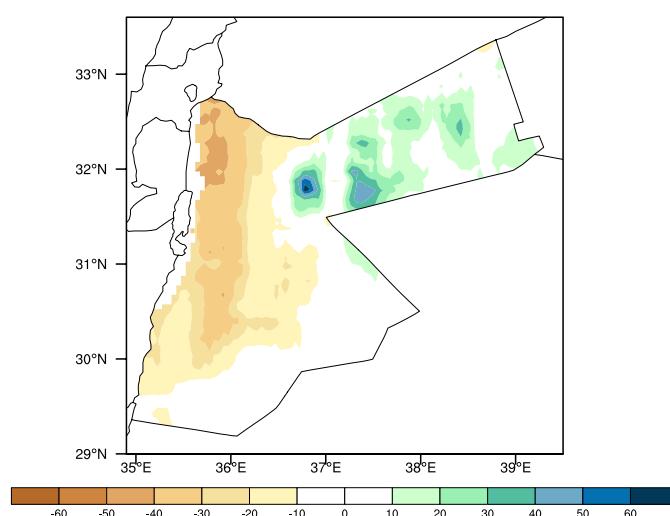


Figure 2. February 2022 rainfall anomaly (% of precipitation above or below the normal from the year 2000 onwards) as predicted with a lead time of two months.

BOX 1. Tafilah Governorate Case Study

During the winter and spring of 2020–2021, the eCDI showed that parts of the Tafilah Governorate were experiencing ‘severe’ drought conditions. Jordan’s DAP dictates that two months of severe drought in late spring meet its criteria for an ‘emergency’ drought response to address likely impacts on people living in poverty and critical socioeconomic sectors.

At the direction of HE the Minister of Agriculture, the DTC requested MENAdrought to undertake an impact assessment with local reporters in Tafilah as well as develop a general method for local drought impact reporting that could be implemented quickly and easily anywhere in Jordan.

The MENAdrought project team conducted a rapid assessment of the following:

- Context and stakeholders: current and ongoing social and economic impacts of drought on various stakeholders in the Tafilah Governorate.
- Drought vulnerabilities: underlying vulnerabilities that have contributed to these impacts on various stakeholder groups; and
- Resilience and response: local needs and response recommendations to strengthen stakeholder resilience to drought impacts.

The DTC shared findings with and advised HE the Minister of Agriculture, who decided to provide financial relief to the most vulnerable farmers. Also, the DTC now has a standard three-page drought impact reporting form and assessment method, which local officials and stakeholders can use in future drought years.

Mapping drought impacts and vulnerabilities across Jordan

MENAdrought assessed which communities, ecosystems, economic sectors and stakeholders are at the highest risk from drought, and what are the reasons for that risk.

A key output of MENAdrought was the creation of a drought hazard map showing which parts of Jordan face the highest risk of drought (Figure 3). The map is based on eCDI results from the past two decades. It identifies various areas of high drought hazard, including the Rift Valley mountain chain (from south to north on the western border), Karak and Balqa' governorates, and parts of Zarqa, Jerash and Ma'an. Low hazard areas identified include the northern highlands in Irbid, Ajloun, and Jarash as well as parts of the Amman, Zarqa, Mafraq and Tafilah governorates.

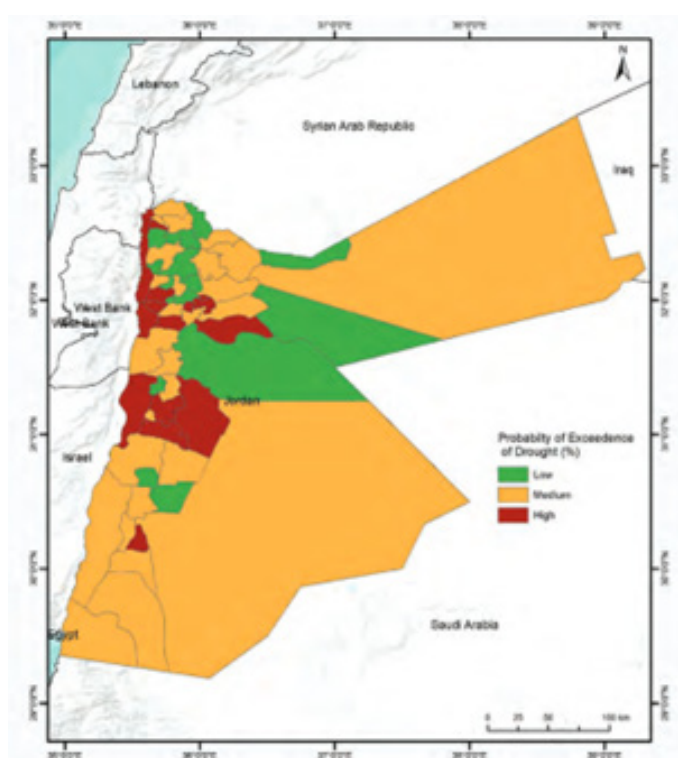


Figure 3. Drought hazard map for Jordan. Red indicates high drought risk relative to the national average, yellow indicates moderate drought risk and green indicates low drought risk.

Agriculture sector vulnerability to drought and the impacts of drought on smallholder farmers, herders and rural communities

MENAdrought's early work identified agriculture and water supply as the two most vulnerable sectors, and subsequent work focused on agriculture given the focus of the DEWS on agricultural drought impacts.

MENAdrought led various efforts in Jordan, including:

- surveying different government stakeholders on priority impacts and root sources of vulnerability to those impacts;
- a case study on the relationships between fragility, migration, and drought in the Zarqa Governorate, and

- a drought impact and vulnerability analysis in Tafilah Governorate during the severe 2021 drought.

MENAdrought's studies focused on systemic sources of the agriculture sector's vulnerability to drought: environmental, socioeconomic, governance, financial, and market. Environmental drivers (like water quality issues or depleting groundwater) interact with these systems, for example, through the price of energy and market structure challenges that result in impacts on communities. Figure 4 highlights the issues influencing smallholders' vulnerability to drought.

Droughts, water scarcity, and associated climatic and environmental changes have a great impact on agricultural production, and thus on the livelihoods of rural agrarian communities. However, the precise effects of drought are obscured and/or mediated – even to those who are experiencing them – by a variety of intermediate factors such as water management, resource costs and socioeconomic circumstances within households and communities.

In many parts of Jordan, and in particular Al Zarqa where MENAdrought conducted a case study, the increasing costs of water and agriculture, as well as declining revenues in the face of centralized water and agricultural regulation and management, dictate how social and economic decisions are made in water-scarce conditions. The decisions primarily result in shifts away from agricultural investments, which can impact migration decisions for the younger generation.

Findings of MENAdrought suggest that the economic impacts of droughts – including reduced agricultural productivity and income as well as increased resource costs – contribute to the fragility of farming communities and their economic and mobility decisions. Resource management and socioeconomic

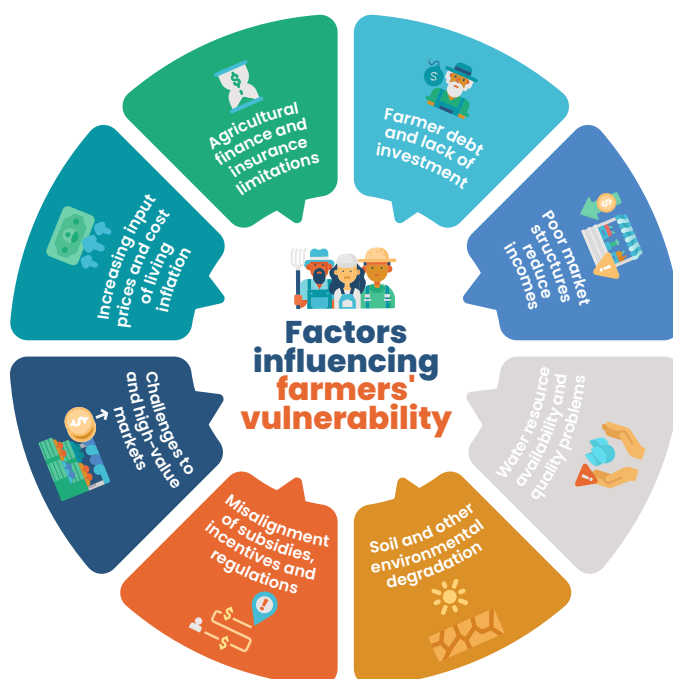


Figure 4. Factors influencing farmers' vulnerability.

conditions increase the sensitivity to drought impacts, and communities adopt coping strategies that can affect their social cohesion, livelihoods, or food security, and some in the community choose to migrate in search of better opportunities.

Gender issues need to be addressed

Across Jordan, women-led households are 62% more likely to be food insecure or vulnerable to food insecurity, when compared to families led by men. Households headed by women are more likely to experience poor food consumption and lower dietary diversity, and thus experience the impacts of drought more palpably on their health and wellbeing.

Further, women are particularly exposed to drought's financial impacts because of their reduced ability to access formal assistance or credit and loan facilities. This is due to their lower rates of asset and land ownership, lower earnings, lower rates of account holding, and cultural reasons including requirements for male guarantors.

The major disparity between men and women in employment in the agriculture sector is primarily because women have a far greater role in subsistence farming activities (as part of unpaid household labor) and far greater proportional employment on commercial farms as casual and seasonal labor. Women are consequently under more strain than men when completing agricultural labor and duties, and yet their typical wages are only 50% that of their male counterparts for unskilled and manual seasonal tasks. Drought increases employment casualization (shift to informal, non-contractual employment) and deteriorates wages. The availability of cheaper labor from refugee communities also limits women's ability to organize, communicate and negotiate around employment issues, particularly those stemming from drought impacts.

Financial risk management and remediation products

To address some of the identified needs and sources of vulnerability, MENAdrought worked extensively on financial risk management and remediation products.

First, it reviewed disaster-focused financial risk management mechanisms and their respective strengths and weaknesses in the MENA region. Second, based on that review, it undertook a focused market systems assessment of agricultural producers and agricultural finance sector actors in Jordan to determine systemic constraints and blockages of relevance for drought financial risk management.

Finally, it elaborated three potential financial risk management products suitable for the Jordanian market based on extensive engagement with financial actors and agricultural producers. These are ready to be piloted in the identified communities given additional support.

1. Individual livestock Takaful index-based insurance

This index-based Islamic insurance product is designed to protect individual sheep and goat herders and livestock-cereals integrators from drought-related mortality and productivity losses. Each holder subscribes to the insurance to cover its registered flock (number and weight) at a percent coverage. Premium pricing is based on drought hazard, and strike levels are determined through drought severity and coverage as assessed using eCDI scores as a proxy for pasture availability.

2. Group mutual insurance

This index insurance product is aimed at community-based organizations (CBOs) that group growers of staple crops in critical rainfed highlands governorates, Irbid, Ajloun, Jerash, Balqa and Madaba. CBOs would be covered by a group insurance plan that compensates the group for crop failure using local land cover and eCDI information. Delivery of this product through CBOs requires seed funding to develop a product that could then be implemented by an insurance company or broker that undertakes the risk transfer.

3. Smallholders-focused inter-seasonal agricultural loan

This product is for farmers registered with the Agricultural Credit Corporation (ACC) and Ministry of Agriculture to access inter-seasonal loans to maintain and grow investments. Registered farmers will be eligible to access seasonal and zero percent interest loans (approved by the ACC) for their income gap due to drought based on eCDI information. Losses would be defined in Jordanian Dinar per dunam (about 1000 square meters), and loans would support farmers to relaunch their cropping activities for the season following a drought. A donor or development agency will cover the payment of services and interest rates for the initial seven years of loan implementation. Rollout of the product would be targeted over 'hotspots' (areas with higher drought hazard and vulnerability) and could be scaled to the primary production basins of Jordan.

Institutional development

Drought management falls within the strategic and operational policy remit of several ministries and national centers. In recent years, the Ministry of Water and Irrigation (MWI) has taken a primary technical and operational coordination function with MENAdrought support. This includes MWI's issuance in 2018 of the Water Sector Policy for Drought Management and establishment of formal agreements with the Jordanian Meteorological Department to operate the DEWS.

Furthermore, to enhance drought preparedness, mitigation, and response planning, the International Water Management Institute (IWMI) worked closely with multi-ministerial, interdisciplinary teams with various functions across the Government of Jordan. This has occurred through the inter-agency Drought Technical Committee (DTC), which is chaired by the head of MWI's Drought Management Unit.

A Drought Action Plan is now on the table

The DTC iteratively developed the DAP, which helped government agencies consider what drought impacts are most important for them to address first, from their point of view, and how to do so with the available resources, policy context, and the constraints they face.

The DAP includes measures for various agencies to proactively *prepare* for and *mitigate* drought risks before drought occurs, as well as coordinate approaches to *respond* to drought once it begins. Response measures are intended to reduce impacts on and conflicts between different users of water, e.g., domestic consumers, industry, agriculture and tourism.

To develop the DAP, government stakeholders prioritized impacts they wished to address in the first iteration. The DTC identified eight priority drought impacts to target in the first iteration of the DAP (Table 1).

The DAP is intended to be an operational and responsive policy document that will be updated regularly by the DTC. The current iteration (Version 1.24) has been endorsed by the DTC and is now ready for approval by relevant executive leadership.

As such, the Jordan DAP is in a 'ready to go' state, and parts are already being implemented, as evidenced by the assessments and actions related to the Tafilah drought described in Box 1.

Recommendations for future work

MENAdrought's recommendations address all aspects of the drought effect chain through suggested future work on policies and governance, development of technical tools, and generation, sharing, and application of usable information from those tools (Table 2).

Table 1. Priority impacts addressed by Jordan's DAP.

Priority impact	How DAP addresses the impact
Drought can contribute to water resource degradation by increasing demand for available resources, for example for irrigation, at a time when less water is available.	The DAP includes drought mitigation and response actions targeting chronic water stress and insecurity, shortfalls in governance capacity, and increasing water stress during drought periods.
Drinking water services often deteriorate during drought conditions. Tangible impacts to consumers include supply becoming less reliable, more expensive and less equitable. Utilities and service providers also face impacts from declining customer satisfaction and declining revenues.	The DAP includes drought mitigation and response actions targeting impacts on customer service and loss of universal and equitable service delivery during drought periods.
The productivity of irrigated agriculture is, generally, less vulnerable to drought conditions than rainfed agriculture. During emergency conditions, irrigation permits may be revoked or restricted and water-intensive crops are highly vulnerable to irrigation shortages.	The DAP includes drought mitigation and response actions to rationalize water allocations during drought periods, and to share costs and benefits between irrigators and other members of society.
The productivity of rainfed agriculture and productivity of livestock are highly vulnerable to drought impacts. Small farmers, pastoralists and those living in rural poverty are disproportionately affected by drought, which directly impacts their livelihoods and principal sources of income.	The DAP includes drought mitigation and response actions targeting drought impacts on yield losses and poverty of rainfed farmers and pastoralists during drought periods.
Drought degrades rangelands and forests , with higher temperatures and less water reducing vegetation growth and making them vulnerable to overgrazing and, in the case of forests, fire. Underlying vulnerabilities include long-term ecosystem degradation from land-use change, over-exploitation, and weaknesses in enforcement of regulations.	The DAP includes drought mitigation and response actions targeting drought impacts on the degradation of forests and rangelands and forest fires during drought periods.
Diarrhoeal disease often increases during drought periods, particularly along the Jordan Valley and in agricultural communities using treated wastewater in irrigation. Underlying vulnerabilities include shortfalls in monitoring water and food quality, access to sanitation and personal hygiene, and capacity of local health centers to respond to outbreaks.	The DAP includes drought mitigation and response actions targeting higher levels of pathogens in water and food and health impacts on children during drought periods.

Conclusion

Jordan suffers from increasingly severe and recurrent droughts, which are particularly hard on vulnerable farmers and poor populations who struggle with water and food insecurity. The root causes of vulnerability for Jordanian farmers and the water sector stem from a wide range of interacting environmental, social, economic and governance factors.

The MENAdrought project helped the Jordanian government establish a Drought Early Warning System with monitoring and forecasting components that is linked to a national Drought Action Plan that aims to address these underlying aspects of vulnerability. This plan includes preparedness and mitigation actions for agencies to take before drought hits, as well as response actions to reduce impacts once drought arrives.

The monitoring system provides robust, regular, and easily understandable information on drought. When drought first appears, responses focus on communication to and preparation with various stakeholders about how to respond if the situation deteriorates. If the drought worsens, the plan guides decision-making and specific interventions. Agencies have already considered how best to spend their limited financial and human resources, so that it eases their decisions about interventions once drought has occurred.

Now the Jordanian government and particularly the Drought Technical Committee need support to capitalize on these systems, plans, and working relationships to implement the Drought Action Plan and preparedness, mitigation and response actions, and embed the Plan in government practice.

Table 2. Recommendations to meet drought monitoring and management needs.

Need type	Specific need	MENAdrought work to address need	Recommendations for future work
Drought-specific policy, governance, and institutional arrangements	Embed DAP components and inter-agency cooperation Improve public – private engagement on drought monitoring and management issues	Working with the DTC to develop the DAP Supporting the DTC to undertake the drought impact assessment in Tafilah	Unlock capacity through institutional analysis and engagement with key stakeholders (ministries, agencies, and others) to understand drought management's position within their strategic objectives and resourcing and governance processes Support implementation of DAP including through sector- and entity-specific planning processes Creation of a Drought Impact Reporting network
Technical information tools	Ongoing improvement of the DEWS	Development of the eCDI and seasonal precipitation forecasting systems as well as tools to support their use (e.g., web interface)	Continue research and development on seasonal precipitation and temperature forecasting using CNN techniques Support the activities of a Drought Impact Reporting network Support the DTC (and/or constituent agencies) to undertake drought impact monitoring using DEWS tools
	Develop hydrological drought monitoring and forecasting capabilities using DEWS inputs	Not a focus for MENAdrought	Support development of hydrological modeling capabilities to improve MWI's ability to monitor and forecast hydrological drought Support development of other tools based on satellite imagery analysis for hydrological drought monitoring
	Improve regulatory enforcement	The DAP specifies the regulations that should be targeted	Support the relevant ministry with development and deployment of information and tools to facilitate regulatory enforcement, especially in relation to groundwater abstraction
Information translation and sharing	Identify regions at highest risk of drought impacts to target interventions	Developed a drought hazard (climatological risk) map that shows where drought is most frequent and severe. Other components produced relevant information on exposure, sensitivity, and adaptive capacity in various communities and economic sub-sectors	Undertake spatial vulnerability mapping focused on the water supply sector and/or specific agricultural sub-sectors (e.g., annual and perennial crops such as fruit orchards) including co-development of methods and application software, and train local staff in their use
	Engage with intended audiences to create usable information products and stable information sharing networks	DTC worked with government officials and other stakeholders for validation of the eCDI The DTC produces drought progression bulletins targeted at drought management decision-makers	Support the activities of a Drought Impact Reporting network Engage with governmental, farming, agribusiness, agri-finance, and applied research organizations to develop targeted information and/or advisory products based on the DEWS. Examples include technical (for extension services and water authorities) and non-technical (for user associations and farming communities) guidance materials
Drought-related financial risk management	Need for drought-relevant financial risk management products	Conducted a market systems assessment and developed potential pilot products tailored for the Jordanian agriculture/finance sector	Drought Financing for Jordan: develop a pilot product (or products) to test with the intended targets determined through MENAdrought's market systems development work
Drought-related agricultural practice improvements	Understand the drought-crop connection: offer irrigation and planting guidance	Development of the drought mitigation compendium	Support governmental and private sector agricultural extension services actors to increase uptake of efficient water and nutrient conservation technologies and practices building on past market system development work in Jordan

Further reading

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Partners

Primary partners: International Water Management Institute (IWMI); National Drought Mitigation Center, University of Nebraska-Lincoln; Daugherty Water for Food Global Institute, University of Nebraska; Goddard Space Flight Center, National Aeronautics and Space Administration (NASA); and Johns Hopkins University.

National leader: Ministry of Water and Irrigation.

National partners: Department of Statistics; Jordan Meteorological Department; Ministry of Agriculture; Ministry of Health; Ministry of Environment; National Agricultural Research Center; National Center for Security and Crisis Management; and the University of Jordan.

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IWMI is a CGIAR Research Center

The International Water Management Institute (IWMI) is an international, research-for-development organization that works with governments, civil society and the private sector to solve water problems in developing countries and scale up solutions. Through partnership, IWMI combines research on the sustainable use of water and land resources, knowledge services and products with capacity strengthening, dialogue and policy analysis to support implementation of water management solutions for agriculture, ecosystems, climate change and inclusive economic growth. Headquartered in Colombo, Sri Lanka, IWMI is a CGIAR Research Center with offices in 14 countries and a global network of scientists operating in more than 30 countries.

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