Environmental & Social Impact Assessment (ESIA) for Drilling New Wells and Associated Infrastructure Works – Dubaydib Well Field / Disi

Climate Change Vulnerability Risk Assessment (CRVA)

July 2025

Contents

1. Introduction

The Disi Water Company (DIWACO) is contracted to Water and Irrigation (MWI)/Water Authority of Jordan (WAJ), and subcontracted the operation of the Dubaydib wellfield to Disi Amman Operation and Maintenance (DAOM). The principal objective of this project is to facilitate the resolution of the water supply problem experienced at Amman, the capital city of Jordan, and the surrounding area. Thus, increasing the supplied water to Amman and accordingly improving public health conditions.

The project is considered as part of the Government of Jordan's (GOJ’s) larger regional framework of water management and development of new resources. The project started operation in 2014 and it comprises of 55 production wells (46 operational and 9 standby). Recently the Disi project activated 4 of the standby wells to be 50 abstraction wells and 5 standby wells, and in 2023, the Al-Mudawara pumping capacity was expanded, resulting in an annual rise in the amount of water pumped from wells to 111 MCM and since 2024, production has been increased to 115 MCM. Water is collected from each of the wells via a ‘dendritic’ collector network and delivered to a collector tank north of the well field by a main spinal collector.

As per the existing project agreement terms, DIWACO is required to deliver up to 100 MCM of water per year to Abu Alanda and Dabuk in Amman from the Dubaydib well field. However, MWI asked DIWACO to raise the water delivery quantities to 120 MCM for the longer term (2025 onwards) due to the high demand, particularly in the summer. After conducting an infrastructure evaluation, DIWACO verified that the project could accommodate the addition of new wells to meet the quantity need of 120 MCM/year.

To reliably meet the increased water quantity requested by MWI/WAJ (up to a total of 120 MCM/yr), DIWACO is planning to conduct additional activities described in the following subsection. These additional activities are herein referred to as “The Proposed wells “which will be covered in the Environmental and Social Impact Assessment (ESIA).

The proposed project includes the following activities which will be covered in the ESIA:

- Drilling new groundwater wells (will involve drilling of the well shafts, installation of well casing, screens and pump head).
- Drilling activities are tentatively scheduled to commence in January 2026, and continue through July 2027 for the completion of the first four additional wells (Contingent upon financial security conditions, the approval of study results by all relevant parties, and the GoJ approval of the ESIA). Additional wells will be drilled as required to ensure the continuous availability of three redundant wells at all times, while pumping 120 MCM per year. Constructing the relevant infrastructure, including wellheads, compounds, pipelines and electricity networks to collect and transfer water to the existing collection tank.
- Constructing the relevant infrastructure including wellheads, compounds, pipelines and electricity networks to collect and transfer water to the existing collection tank.
- Extend the internal road network to connect the new wells with the existing parts of the project.

- Expansion of the overhead power line system to connect the new wells.

2. Climate Risk Vulnerability Assessment Objective

The purpose of this climate vulnerability assessment is to gain a comprehensive understanding of the potential climate change risks facing the proposed project, ensuring that these risks are thoroughly evaluated to determine the project's level of vulnerability in the context of changing environmental conditions. By identifying specific climate-related risks, this assessment aims to establish a clear picture of how climate stressors—such as temperature fluctuations, changing precipitation patterns, extreme weather events, and other climate-induced challenges—might impact the project's functionality and sustainability over time. Moreover, this assessment seeks to provide strategic recommendations for resilience-building measures that enhance the project's adaptability to climate impacts. These recommended actions are designed not only to mitigate potential disruptions but also to fortify the project against long-term climate uncertainties, thereby supporting its overall resilience and sustained performance in alignment with broader climate adaptation goals. To achieve these objectives, the assessment focuses on evaluating key climate-related vulnerabilities, including:

- Assessing the exposure of wells, access roads, power infrastructure, and water networks to climate hazards such as droughts, extreme temperatures, and flash floods.
- Ensuring the adaptive capacity of infrastructure design and operational practices to withstand and respond to these climate risks effectively.
- The assessment will include the project life cycle of construction and operation phases.
- This Climate Risk Vulnerability Assessment (CRVA) has been developed in alignment with the environmental and social requirements of the European Investment Bank (EIB) and the International Finance Corporation (IFC). It forms an integral part of the Environmental and Social Impact Assessment (ESIA) for the project, ensuring compliance with international best practices in climate risk management.

3. Jordan Climate Context

Jordan's social, economic, and ecological sectors are all vulnerable to climate change. The agricultural, water, urban, biodiversity, coastal, social and economic development, and health sectors are the seven sectors that the National Adaptation Plan (NAP) has identified in order to assess their vulnerability and available adaptation options.

A strategic target was suggested for every sector, in addition to strategic programs. For the water sector, for instance, the sectoral strategic target is enhancing sustainable water demand and supply through climate resilient measures. Several programs were identified:

- Integrating climate adaptation and resilience in policy and institutional reforms in the water sector.
- Improved water demand management and reducing gap between water demand and supply.
- Improving adaptive capacity of water utilities.
- Improved efficiency in water uses for sustainable development.

- Improving contribution of non-conventional water resources to the national water budget.
- Improving rainfall early warning systems and reducing flood risks.
- Supporting watershed and basin level management of water resources including transboundary water(NAP,2021).

4. Jordan Climate Sensitivity

According to Jordan's 4th National Communication Report[1], the projected climate change impacts for Jordan as the following:

Temperature Increase: Jordan is expected to experience more frequent heat waves and fewer frost days. A predicted rise in annual maximum temperature of up to 5.1°C and a rise in annual minimum temperature of 3.8°C by 2085, including an increase in the frequency of heat waves. In addition, Jordan's Fourth National Communication Report, future predicted heatwave events are more severe in terms of duration and magnitude, where the probability of occurrence increases to an average of 120 % by 2100. Thus, it is very likely that more severe threats are expected in terms of heatwave exposure intensity and duration.

Drought Increase: Jordan is expected to become increasingly drier, with a predicted 10-day increase in the number of consecutive dry days from 2040 to 2070. The most significant drought conditions are expected in the southern Aqaba region where some models also predict the greatest temperature increase.

Precipitation: Precipitation projections are highly variable but, overall, are expected to decrease between 15% to 60 % from 2011 to 2099. The future trends indicate the probability of occurrence of potential intense precipitation, which seems to decrease with time. On the other hand, the severity is variable by location and tends to become more intense during the mid-21st century and reduces by the end of the 21st century.

These changes present significant risks to Jordan's water resources, since they may diminish the amount of water obtained from surface and groundwater sources and deteriorate the quality of the water. According to the Jordan National Water Strategy 2023-2040[2], Jordan is one of the most water-poor countries in the world for renewable freshwater with around 61 cubic meters per capita in 2021 which is far less than the 500 cubic meters per capita annually that is internationally recognized as the absolute water scarcity line. Climate change and overuse of water resources have further reduced groundwater and surface water resources, whereas in 2040 the annual renewable water resources per capita is expected to reach only 35 m^3.

Furthermore, the likelihood of such increased incidence of droughts and an increasingly warmer drier future has critical implications on the quantity and quality of Jordan's freshwater

[1] Jordan's Fourth National Communication on Climate Change | United Nations Development Programme
[2] National Water Strategy 2023-2040, Jordan. https://www.mwi.gov.jo/EBV4.0/Root_Storage/AR/EB_Ticker/National_Water_Strategy_2023-2040_Summary-English_-ver2.pdf

resources and aggravates its current challenges3. In general, water-related impacts would include (MWI ,2016) [4]:

- Reduced total water availability with less rain, thereby reducing yields from surface water catchments.
- Less reliable seasonal patterns.
- More extreme events where surface catchments are eroded with a decrease in water quality.
- Groundwater is not recharged and rain fed agriculture suffers damages due to changes in runoff distribution.
- Increasing intensity of droughts during which reservoirs are not refilled.
- High rainfall events also increase erosion which causes losses of soil water storage and siltation of reservoirs.
- Higher temperatures resulting in higher evaporative demand and hence higher irrigation water demand.
- Higher temperatures affect the efficiency of wastewater treatment plants.
- Increased agricultural and drinking water demands during heat waves and droughts, thus exacerbating water storage depletion.
- Future intensification of energy price shocks on international energy markets and since the Jordanian water sector is very energy-intensive and dependent on fossil fuels; it becomes vulnerable to such price shocks.
- Increasing intensity of flood events during which water and other infrastructure experience overflows and damage.

5. Vulnerability Assessment Methodology

The standard procedure for assessing how climate change may affect a project is to ascertain the current climate parameters, determine these parameters future projection due to global climate changes, evaluate the potential impacts of these climate hazards on the project design or assets, and then decide how to modify the project specifications. This CRVA puts this strategy into practice by reviewing the literature on readily accessible Jordanian climate change documents, which include the following:

- Jordan's 4th national communication (NC4).
- Jordan's national adaptation plan (NAP, 2021).
- World Bank Climate Change Knowledge Portal (2021).
- National Water Strategy (MWI,2023).

A key component of this assessment involves analyzing the project climate projections using projections and maps from the NC4 to identify critical trends, such as:

- Temperature extremes, which can impact machinery performance, electricity grid due to heat-induced equipment failure, water network and the pipe corrosion due to temperature shifts and worker safety.

[3] Jordan's Third National Communication on Climate Change https://unfccc.int/sites/default/files/resource/jdrnc3.pdf

[4] Jordan's Ministry of Water and Irrigation, 2016. Climate Change Policy for a Resilient Water Sector https://www.unescwa.org/sites/default/files/event/materials/23-jordan_mwi-cc_policy_for_a_resilient_water_sector-2016-eng.pdf

- Precipitation variability, which affects water availability and road and water network stability.
- Drought frequency and heatwaves.

Climate Projections and Risk Assessment:

The CRVA incorporates climate projections from Jordan's NC4 and utilizes the spatial hazard maps provided in the NC4 to assess and quantify climate risks specific to the project area. This analysis identifies key climate hazards, including rising temperatures, decreasing precipitation, and an increased frequency of extreme weather events such as heatwaves and droughts, ensuring a comprehensive understanding of the potential climate impacts on the project. These projections inform the assessment of sensitivity and exposure, helping to evaluate risks related to water availability, infrastructure resilience, and ecosystem stability.

Integration into Project Planning

By incorporating these projections, the assessment identifies the most climate-sensitive aspects of the project and determines exposure levels based on geographic and sectoral vulnerabilities. These insights guide the selection of adaptation strategies, ensuring alignment with national climate adaptation priorities and enhancing long-term project resilience. Furthermore, this assessment will inform the project's design team to integrate climate-resilient features and support future operations and maintenance practices, ensuring the project's sustainability and adaptability to evolving climate conditions.

The Climate Risk Management Plan

aims to assess and prioritize risks by evaluating their likelihood and impact to enhance project resilience, the plan includes targeted mitigation measures.

To align with EIB and IFC requirements, CRVA findings will be documented and submitted in accordance with lenders's Environmental and Social Impact Assessment (ESIA) requirements.
This plan will be established to ensure long-term adaptability, incorporating annual reviews of groundwater levels and infrastructure performance to guide necessary adjustments and improvements. The most relevant key messages of the climate projections in the 4^{th} national communication relevant to the project area are described in **Table 1**.

Table 1: The Most Relevant Key Messages of the Climate Projections

Trend	Details
Intense precipitation and potential floods	There is no significant sign of heavy rain days (more than 20 mm), however future trends indicate the probability of occurrence of potential intense precipitation, that seems to decrease with time, especially at Representative Concentration Pathway (RCP) 8.5 as compared to RCP 4.5. On other hand, the severity is variable by location and tends to become more likely than not intense during the mid-21st century and reduces by the end of the 21st century. For the project area, projected annual precipitation under RCP 8.5 across the three future time horizons is estimated to range between 50–100 mm, with projected differences in annual precipitation falling between 20–30 mm. Furthermore, the ESIA recommends conducting a comprehensive hydrological study to support the effective design of flood mitigation measures.
More intense heatwaves	Future predicted heatwave events are more severe in terms of duration and magnitude, where the probability of occurrence increases to an average of 120% by 2100 (ranging from 54% to 398% based on spatial location) using RCP 4.5, and about a threefold increase (ranging from 1.5 to 9.0 times, based on spatial location) using RCP 8.5.

	The frequency of heatwaves in the project area is projected to increase by 100% to 150% by 2050, and will be between 150% to 200% until the year of 2040 to 2070.
Air Temperature	The minimum air temperature is projected to increase significantly, with an extremely likely rise of +1.2 °C [+0.6 °C to +2.9 °C] under RCP 4.5 and +2.7 °C [+2.1 °C to +4.5 °C] under RCP 8.5. Similarly, the maximum air temperature is extremely likely to increase by +1.1 °C [+0.7 °C to +1.7 °C] under RCP 4.5 and up to +3.1 °C [+2.6 °C to +3.7 °C] under RCP 8.5. For the Project area, the maximum average air temperature is expected to reach approximately 30–32 °C by 2050.
Insignificant wind changes	Wind speed forecasts didn't indicate significant changes; however, the Project area is about as likely as not to be subjected to wind bloom events exceeding 5.4 to 5.8 m/s in the Project area.

6. Sensitivity of the Project Components to Climate Conditions

For the purpose of this Project, the climate change hazards that may have implications on the proposed wells include higher temperatures, increased likelihood of droughts and infrequent but severe rainfall events, and concern of future intensification of energy price shocks on international energy markets. Therefore, the climate-change risks that have been identified of the proposed new wells as illustrated in **Table 2** below.

Table 2: Sensitivity of the Proposed Project Components to Climate/Weather Conditions

<table>
<tr><th>No.</th><th colspan="2">Defined Activity/ Interventions</th><th>Identified Risk</th></tr>
<tr><td>1</td><td colspan="2">Design of the proposed project components:
▪ New wells.
▪ Relevant infrastructure to collect and transfer water.
▪ Internal road network to connect the new wells with the existing parts of the project.
▪ Expansion of the overhead power line system to connect the new wells.</td><td>▪ Extreme weather conditions (High temperature and heavy rainfall) may impact the project components' design and specifications.</td></tr>
<tr><td>2</td><td colspan="2">Procurement, Construction, Installation, and Commissioning</td><td>▪ Extreme weather conditions (High temperature and heavy rainfall) may impact the transport, delivery, and installation of equipment. Thus, affecting the project timelines.
▪ Higher temperatures would increase the daily water demand for labor uses which would consequently increase the onsite water & wastewater storage.
▪ Heavy rainfall/floods can disrupt drilling operations and damage equipment. Accordingly, causes machinery malfunctions and increased maintenance costs.
▪ High temperatures could cause potential power outages and /or equipment overheating, delaying the construction operations.
▪ According to Jordan 4th National Communication on Climate Change Report[5], the precipitation in the Eastern and Southern Badia regions is likely to increase up to the year 2050, that could reach a maximum of 40%, so the extreme weather conditions (storm) might halt drilling activities and delay project timelines.
▪ Higher temperatures would create aversive odors within waste storage areas.
▪ Higher temperatures and droughts would cause fires for the chemicals and fuels stored within the construction sites.</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Operation of Well Field</td><td rowspan="3">General Operation Activities</td><td>▪ Extreme weather conditions might deteriorate the structural integrity of wellheads, pipelines, and associated infrastructure.</td></tr>
<tr><td>▪ Extreme weather conditions (heavy rain/floods) might cause soil erosion increasing the risk of damaging of the pipelines/infrastructure.</td></tr>
<tr><td>▪ Extreme temperatures can degrade road surfaces and building materials.</td></tr>
</table>

[5] https://www.undp.org/jordan/publications/jordans-fourth-national-communication-climate-change#:~:text=Jordan%27s%20Fourth%20National%20Communication%20Report%20investigates%20a%20set,the%20continued%20stress%20on%20the%20country%27s%20natural%20resources.

No.	Defined Activity/ Interventions		Identified Risk
		Energy Consumption	▪ Higher temperatures increase electricity loads leading to continuous blackouts that will affect wells operation.
			▪ The increased energy consumption raises energy expenses that will be used.
			▪ The increased energy consumption would increase the indirect generation of CO_2 emissions.
		Biodiversity	▪ Higher temperatures and scarcity of rain can exacerbate the degeneration of the area limiting the natural regeneration of plant species and leading to habitat disturbances.
			▪ Flash flood events might cause soil erosion increasing the risk of habitat disturbances and vegetation loss.
		Groundwater Temperature	▪ Rising groundwater temperatures can increase concentrations of harmful substances like arsenic or manganese, posing health risks when groundwater is used for drinking purposes. This is a significant concern for the drilling industry, which must adapt to these changing conditions[6]. However, The wells have a high depth with a total ranging from 394 to 600 m. ▪ Flooding and other extreme weather events may increase the risk of pollutants entering the groundwater system, deteriorating water quality.
		Groundwater Decline (Indirect Risks)	▪ Continued groundwater extraction will deepen the piezometric depression in the wellfield by an additional 20 to 25 meters, compared to the current groundwater table by 2038, and by over 50 meters in many parts of the field by 2065 [7] , extending beyond the wellfield and impacting surrounding areas, including agricultural zones in Disi and Al Mudawarra, which also rely on the aquifer for irrigation. thus, coupled with the extreme weather conditions, mainly higher temperatures, will exacerbate the groundwater extraction and the extent to which the agricultural zones will be affected.

[7] Simulations of abstraction scenarios for the Dubaydib wellfield, Final Report, BRGM/RC-73853-FR, 2024
[7] Simulations of abstraction scenarios for the Dubaydib wellfield, Final Report, BRGM/RC-73853-FR, 2024

CLIMATE CHANGE RISKS AND VULNERABILITY ASSESSMENT

Climate risk is the potential for negative consequences due to changing climatic conditions. The EIB approach for conducting a CRVA is based on the methodology developed by the European Financing Institutions Working Group on Adaptation to Climate Change [8]and is reviewed regularly to take account of new developments in this field. According to Joint Assistance in Supporting Projects in European Regions (JASPERS) Approach[9] which is a partnership between the Commission, the EIB and the European Bank for Reconstruction and Development (EBRD), the climate risk is evaluated based on the probability and the severity of the negative impact (high, medium, low).

The vulnerability of a project is determined by two key factors:

- The sensitivity of the project's components to climate hazards; and
- The likelihood of these hazards occurring at the project location, both now and in the future (exposure).

These aspects can be evaluated separately or together, depending on the stage of the project development cycle. In practice, they are often assessed in parallel. If the project location is known, specific climate hazards may already be identified or ruled out in terms of exposure. Similarly, if the technology has been selected, certain climate hazards may be deemed more or less relevant in the sensitivity analysis.

When considering a changing climate, the key changes are seen in the following climatic factors (these are also referred to as primary climate drivers):

- Temperature: changes in average temperatures and the frequency and magnitude of extreme temperatures;
- Precipitation (rain, snow, etc.) :changes in average precipitation and the frequency and magnitude of extreme precipitation events;
- Sea level : change in relative sea level;
- Wind speeds :changes in average wind speeds and maximum wind speeds;
- Humidity : changes in the amount of water vapor in the atmosphere;
- Solar radiation : changes in the energy from the sun.

This probability can cover 5 levels (Rare, Unlikely, Possible, Likely, Almost Certain) or otherwise. The scale used in the risk assessment of the Cost Benefit Analysis (CBA) Guide could be used for consistency with the wider risk assessment exercise[10]. The scale needs to be explained and each category needs to have a description about what that means (for example what is understood by "likely").

For some climate risks there can be considerable uncertainty about the likelihood of their occurrence. In such circumstances the assessment team should use their best judgement, based on currently available data, statistics and knowledge.

A general probability scale with five levels of probability is provided in **Table 3**.

[8] Microsoft Word - EUFIWACC Adaptation Note Version 1.0 ENGLISH FINAL 20160601 (econadapt.eu)

[9] The basics of climate change.pdf (eib.org)

[10] https://ec.europa.eu/regional_policy/sources/studies/cba_guide.pdf

Table 3: Scale for Assessing the Probability of Hazards Affecting the Project

	1	2	3	4	5
	Rare	Unlikely	Possible	Likely	Almost Certain
Meaning	Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times
OR					
Meaning	5% chance of occurring	20% chance of occurring	50% chance of occurring	80% chance of occurring	95% chance of occurring

Regarding the magnitude of the risk, the scale can cover 5 levels (insignificant, minor, moderate, major, catastrophic). The scale needs to be explained in relation to the project. Each category needs to have a description about what that means for the project (for example: what "Catastrophic" means). The consequences should be considered in terms of the physical assets and its operations, health and safety, environmental impacts, social impacts, financial implications, and reputational risk.

The severity scale with five levels of severity is provided in **Table 4**.

Table 4: Example Scale for Assessing the Severity of Consequence

	1	2	3	4	5
	Insignificant	Minor	Moderate	Major	Catastrophic
Meaning	Minimal impact that can be mitigated through normal activity.	An event which effects the normal project operation, resulting in impacts of a temporary nature.	A serious event requiring additional actions to manage, resulting in moderate impacts.	A critical event requiring extraordinary action, resulting insignificant, widespread or long term impacts.	Disaster with the potential to lead to shut down or collapse of the asset/network, causing significant harm and widespread long term impacts.

Having assessed the severity and probability of each hazard occurring, the significance level of each potential risk can be determined through a combination of the two factors. The risks can be plotted on a risk matrix to identify the most significant risks and those where future action is needed in terms of adaptation measures. **Table 5** presents an example of how such a risk matrix may look based on the example probably and severity scales.

Table 5: Monitoring and Evaluation Matrix for Climate Risks During Project Construction and Operation Phases, Based on Probability and Severity Ratings

	Probability	Rare	Unlikely	Probable	Likely	Almost Certain
Severity		1	2	3	4	5
Insignificant	1	1	2	3	4	5
Minor	2	2	4	6	8	10
Moderate	3	3	6	9	12	15
Major	4	4	8	12	16	20
Catastrophic	5	5	10	15	20	25

	Negligible Risk
	Low Risk
	Medium Risk
	High Risk
	Extreme Risk

Table 6 presents the evaluation and rationale for risk ratings for the proposed Project.

Table 6: Climate risk and vulnerability assessment for the new wells at Dubaydib wellfield

#	Defined Activity/ Interventions	Identified Risk	Severity of Impact Rating	Probability of Impact Rating	Significance of Impact Rating
1	**Design of the proposed project components:** ▪ New wells. ▪ Relevant infrastructure to collect and transfer water. ▪ Internal road network to connect the new wells with the existing parts of the project. ▪ Expansion of the overhead power line system to connect the new wells.	▪ Extreme weather conditions (High temperature and heavy rainfall) may impact the project components' design and specifications	Insignificant (1)*	Unlikely (2)	Low Risk (2)
2	**Procurement, Construction, Installation, and Commissioning**	▪ Extreme weather conditions (High temperature and heavy rainfall) may impact the transport, delivery, and installation of equipment. Thus, affecting the project timelines.	Minor (2)	Unlikely (2)	Low Risk (4)
		▪ Higher temperatures would increase the daily water demand for labor uses which would consequently increase the onsite water & wastewater storage.	Minor (2)	Unlikely (2)	Low Risk (4)
		▪ Heavy rainfall/floods can disrupt drilling operations and damage equipment. Accordingly, causes machinery malfunctions and increased maintenance costs.	Moderate (3)	Probable (3)	Medium Risk (9)
		▪ High temperatures could cause potential power outages and /or equipment overheating, delaying the construction operations.	Moderate (3)	Probable (3)	Medium Risk (9)
		▪ Extreme weather conditions (storms) might halt drilling activities and delay project timelines.	Minor (2)	Unlikely (2)	Low Risk (4)
		▪ Higher temperatures would create aversive odors within waste storage areas.	Minor (2)	Probable (3)	Low Risk (6)
		▪ Higher temperatures and droughts would cause fires for the chemicals and fuels stored within the construction sites.	Moderate (3)	Unlikely (2)	Low Risk (6)

#	Defined Activity/ Interventions		Identified Risk	Severity of Impact Rating	Probability of Impact Rating	Significance of Impact Rating
3	**Operation of Well Field**	**General Operation Activities**	▪ Extreme weather conditions might deteriorate the structural integrity of wellheads, pipelines, and associated infrastructure.	Major (4)	Unlikely (2)	Moderate Risk (8)
			▪ Extreme weather conditions (floods) might cause soil erosion increasing the risk of damaging of the pipelines/infrastructure.	Major (4)	Unlikely (2)	Moderate Risk (8)
			▪ Flooding and other extreme weather events may increase the risk of pollutants entering the groundwater system, deteriorating water quality.	Major (4)	Unlikely (2)	Medium Risk (8)
		Energy Consumption	▪ Extreme temperatures can degrade road surfaces and building materials.	Moderate (3)	Probable (3)	Medium Risk (9)
			▪ Higher temperatures increase electricity loads leading to continuous blackouts that will affect wells operation.	Moderate (3)	Probable (3)	Medium Risk (9)
			▪ The increased energy consumption raises energy expenses that will be used.	Moderate (3)	Probable(3)	Medium Risk (9)
			▪ The increased energy consumption would increase the indirect generation of CO_2 emissions.	Moderate (3)	Probable (3)	Medium Risk (9)
		Biodiversity	▪ Higher temperatures and scarcity of rain can exacerbate the degeneration of the area limiting the natural regeneration of plant species and leading to habitat disturbances.	Moderate (3)	Probable (3)	Medium Risk (9)
			▪ Flash flood events might cause soil erosion increasing the risk of habitat disturbances and vegetation loss.	Moderate (3)	Unlikely (2)	Low Risk (6)
		Groundwater Temperature	▪ Rising groundwater temperatures can increase concentrations of harmful substances like arsenic or manganese, posing health risks when groundwater is used for drinking purposes. This is a significant concern for the drilling industry, which must adapt to these changing conditions[11]. However, the wells have a total depth ranging from 394 to 600 m.	Major (4)	Rare (1)	Negligible Risk (4)

[12] Simulations of abstraction scenarios for the Dubaydib wellfield, Final Report, BRGM/RC-73853-FR, 2024

#	Defined Activity/ Interventions		Identified Risk	Severity of Impact Rating	Probability of Impact Rating	Significance of Impact Rating
			▪ Flooding and other extreme weather events may increase the risk of pollutants entering the groundwater system, deteriorating water quality.	Major (4)	Unlikely (2)	Medium Risk (8)
		Groundwater Decline (Indirect Risks), sustainable management of water resources is the responsibility of MWI	▪ Continued groundwater extraction will deepen the piezometric depression in the wellfield by an additional 20 to 25 meters, compared to the current groundwater table by 2038, and by over 50 meters in many parts of the field by 2065 [12] , extending beyond the wellfield and impacting surrounding areas, including agricultural zones in Disi and Al Mudawarra, which also rely on the aquifer for irrigation. thus, coupled with the extreme weather conditions, mainly higher temperatures, will exacerbate the groundwater extraction and the extent to which the agricultural zones will be affected.	Major (4)	likely (4)	High Risk (16)

*Assuming proper design

[12] Simulations of abstraction scenarios for the Dubaydib wellfield, Final Report, BRGM/RC-73853-FR, 2024

CLIMATE CHANGE RISK MANAGEMENT

Broad approaches to managing the identified climate risks are provided for the development of the proposed Project below and are detailed in **Table 7**.

Table 7: Summary of Adaptation and Mitigation Measures for Identified Climate Risks in the Project

#	Defined Activity/ Interventions	Climate Risk	Risk Rating	How climate Risks are addressed	Opportunities to Strengthen Climate Resilience or Climate Mitigation	Responsibility	KPI	Frequency
1	**Design of the proposed project components:** ▪ New wells. ▪ Relevant infrastructure to collect and transfer water. ▪ Internal road network to connect the new wells with the existing parts of the project.	▪ Extreme weather conditions (High temperature and heavy rainfall) may impact the project components' design and specifications.	Low Risk (2)	▪ Climate data has been considered during the process design of the Project, including climate future projections and will include a detailed hydrology study. ▪ Use of climate-resilient material in construction and proper insulation of buildings and equipment.	▪ Sharing of best practices in climate risk assessments, adaptation planning, and design. ▪ Use energy-efficient pumps and motors to reduce energy consumption in the groundwater abstraction process. This reduces carbon emissions associated with the use of non-renewable energy sources. ▪ Install smart controls and sensors for real-time monitoring and optimization of water extraction, ensuring	▪ Contractor	▪ Documentation of integration of climate projections in design reports ▪ % of pumps/motors meeting energy-efficiency standards ▪ Number of wells equipped with smart monitoring systems ▪ Number of staff trained / workshops conducted on climate-resilient design	▪ Once during installation and Annual verification

#	Defined Activity/ Interventions	Climate Risk	Risk Rating	How climate Risks are addressed	Opportunities to Strengthen Climate Resilience or Climate Mitigation	Responsibility	KPI	Frequency
					minimal energy use and avoiding over-pumping.			
2	Procurement, Construction, Installation, and Commissioning	▪ Extreme weather conditions (High temperature and heavy rainfall) may impact the transport, delivery, and installation of equipment. Thus, affecting the project timelines.	Low Risk (4)	▪ Develop flexible work schedules to adjust construction activities during high-temperature or heavy rainfall periods, minimizing weather-related delays. ▪ Use protective coverings and shelters for sensitive equipment to prevent weather damage during transport and installation. Install equipment during favorable weather conditions. ▪ Prepare contingency plans for extreme	▪ Design construction sites to include proper drainage and stormwater management systems to reduce the risk of flooding during heavy rains and ensure site access during extreme weather. ▪ Use equipment and materials designed to withstand extreme weather conditions, such as heat-	▪ Contractor	▪ % of sensitive equipment delivered and stored with appropriate protection. ▪ % of installations completed within safe weather windows. ▪ Availability of approved contingency plan with weather buffer. ▪ % of critical equipment and materials meeting climate-resilience specs	▪ Monthly during construction phase.

#	Defined Activity/ Interventions	Climate Risk	Risk Rating	How climate Risks are addressed	Opportunities to Strengthen Climate Resilience or Climate Mitigation	Responsibility	KPI	Frequency
				weather events, including buffer periods in the project timeline to accommodate delays due to weather disruptions.	resistant materials and corrosion-proof equipment that can better handle heavy rainfall.			
		Higher temperatures would increase the daily water demand for labor uses which would consequently increase the onsite wastewater storage.	Low Risk (4)	▪ Increase the storage capacity of the water and wastewater collection tanks.	▪ Implement programs for workers on water conservation practices to reduce unnecessary water use. ▪ Install water-saving fixtures (e.g., low-flow taps and showerheads) in onsite facilities to reduce water consumption, helping manage wastewater generation at the source.	▪ Contractor	▪ Average daily water consumption per worker (L/day) . ▪ % of wastewater storage used relative to capacity. ▪ % increase in storage capacity compared to baseline design. ▪ Number of training sessions conducted / % of workforce trained.	▪ Monthly
		Heavy rainfall/floods can disrupt drilling operations and	Medium Risk (9)	▪ Proper planning and weather forecasting. ▪ Changes in the timing or length of construction shifts	▪ Store and operate drilling equipment on elevated platforms or	▪ Contractor	▪ Number of shift changes due to weather conditions. ▪ Number of maintenance	▪ Quarterly

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		damage equipment. Accordingly, causes machinery malfunctions and increased maintenance costs.		and work seasons or changes in staff management plans may be required.	areas less prone to flooding to reduce the risk of water damage. ▪ Implement a maintenance schedule to check and repair equipment after heavy rainfall, minimizing long-term damage and repair costs.		inspections completed post-rain. ▪ % increase/decrease in maintenance costs related to weather events .	
		High temperatures could cause potential power outages and /or equipment overheating, delaying the construction operations.	Medium Risk (9)	▪ Install cooling systems such as air conditioning, fans, or heat dissipation units for equipment prone to overheating to ensure continuous operation during high temperatures. ▪ Ensure there are backup generators or alternative energy sources to maintain power during outages. Design workspaces with adequate shading or insulation to reduce heat buildup and	▪ Incorporate renewable energy sources, such as solar power, to reduce reliance on the grid, mitigate power outages, and lower the project's carbon footprint.	▪ Contractor	▪ % of critical equipment with active cooling systems. ▪ % of shaded/insulated areas in workspaces. ▪ Number of overheating incidents causing delays.	▪ Monthly

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				lower the overall energy demand for cooling systems, enhancing worker comfort and productivity.				
		Extreme weather conditions (storms) might halt drilling activities and delay project timelines.	Low Risk (4)	▪ Implement flexible work schedules that allow drilling activities to be paused during severe weather and resumed once conditions improve, reducing the impact of weather-related delays. ▪ Build extra time into project timelines to account for potential delays caused by storms, ensuring that minor setbacks do not significantly impact the overall project schedule.	▪ Use portable or mobile drilling units that can be easily relocated or secured during the storms, minimizing damage and downtime.	▪ Contractor	▪ Number of delay incidents attributed to heat-related power/equipment issues. ▪ % of energy supplied from renewable sources. ▪ % of implemented heat-related mitigation measures from the plan.	▪ Quarterly
		Higher temperatures would create aversive odors within waste storage areas.	Low Risk (6)	▪ Implement a regular schedule for waste removal to prevent prolonged storage that can contribute to odor issues. Proper sealing of storage	▪ Design waste storage areas with shading or insulation to prevent temperature spikes that	▪ Contractor	▪ Number of waste removal operations completed on schedule. ▪ Number of odor-related complaints logged.	▪ Monthly

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				containers will also help contain odors.	exacerbate odor production, thus improving climate resilience.		▪ % of measures implemented as per contractor's waste management plan.	
		Higher temperatures and droughts would cause fires for the chemicals and fuels stored within the construction sites.	Low Risk (6)	▪ Store chemicals and fuels in fire-resistant, temperature-controlled, and well-ventilated storage units to reduce the risk of combustion during high temperatures or drought conditions. ▪ Conduct routine inspections and audits of chemical and fuel storage areas to ensure compliance with fire safety standards and to identify potential hazards early.	▪ Improve waste management best practices. ▪ Design the construction site to include shaded areas and proper airflow around storage facilities, reducing heat buildup and enhancing the site's overall resilience to temperature extremes. ▪ Provide specialized training for workers on fire safety and prevention, focusing on the unique risks posed by high	▪ Contractor	▪ % of storage units meeting fire safety and ventilation standards. ▪ Presence of updated fire safety signage and drills conducted. ▪ % of compliance measures implemented as per HSE plan ▪ % of workforce trained / Number of refresher trainings conducted.	▪ Monthly

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					temperatures and the proper handling of hazardous materials.			
		Extreme weather conditions might deteriorate the structural integrity of wellheads, pipelines, and associated infrastructure.	Moderate Risk (8)	▪ Design and implement drainage systems, berms, and erosion control measures around wellheads and pipelines to manage excess water during heavy rainfall or floods, preventing infrastructure weakening or collapse. ▪ Construct wellheads, pipelines, and infrastructure with climate-resilient materials such as corrosion-resistant alloys, reinforced concrete, and flexible pipeline materials that can withstand harsh environmental conditions (e.g., heavy rainfall, strong winds, and extreme temperatures).	▪ Utilize advanced predictive models for extreme weather to inform proactive infrastructure management, such as adjusting operations or reinforcing critical structures before severe weather events. ▪ Design infrastructure with flexibility and adaptability in mind, such as using flexible pipelines that can absorb the stresses caused by soil shifting during extreme	▪ Contractor	▪ % of completed and functional drainage and erosion control features. ▪ % of materials used conforming to climate-resilient specifications ▪ % of pipeline sections using flexible/resilient materials. ▪ % of design measures implemented according to specifications	▪ Once (post-installation) and Quarterly inspection

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				▪ Design and install effective drainage systems to channel excess water away from pipelines and infrastructure, reducing the risk of erosion and water damage. This includes using ditches and culverts.	weather events, reducing the risk of pipeline breaks.			

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3	**Operation of Well Field**	**General Operation Activities**	▪ Extreme weather conditions (heavy rain/floods) might cause soil erosion increasing the risk of damaging of the pipelines /infrastructure.	Moderate Risk (8)	▪ Conduct regular inspections of pipelines and infrastructure, particularly after heavy rainfall or flood events, to identify and address any erosion-related damage promptly. ▪ Reinforce the foundations and supports of pipelines and infrastructure to withstand potential erosion and shifting soil. This may involve using retaining walls, riprap, or other stabilization techniques.	▪ Design pipelines and infrastructure with adaptive features that can accommodate or mitigate the impacts of soil erosion, such as adjustable supports or flexible joints that can adjust to changing soil conditions. ▪ Use erosion-resistant materials for pipeline coating and construction that can better withstand the effects of soil erosion and reduce maintenance needs.	▪ Project company and the O&M contractor ▪ The project company to ensure that such measures (to address the climate risk)are considered during the design phase.	▪ Number of inspections conducted / % of erosion issues identified and resolved.	▪ After each major rainfall event and quarterly

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			▪ Extreme temperatures can degrade road surfaces and building materials.	Medium Risk (9)	▪ Choose road surfaces and building materials specifically designed to withstand high temperatures. For roads, use asphalt mixtures with higher temperature tolerance, and for buildings, select materials with thermal stability.	▪ Design infrastructure to be adaptable to changing temperature conditions, incorporating features such as adjustable supports and temperature-regulating systems to handle extreme weather impacts effectively.	▪ The project company to ensure that such measures (to address the climate risk) are considered during the design phase.	▪ The degree of compliance with the Design specifications	▪ Semi-annually and after heatwaves.
		Energy Consumption	▪ Higher temperatures increase electricity loads leading to continuous blackouts that will affect wells operation.	Medium Risk (9)	▪ Use energy-efficient equipment and technologies to reduce the overall electricity load. This can help alleviate stress on the power grid and decrease the likelihood of blackouts.	▪ Incorporate renewable energy sources such as solar panels or wind turbines to reduce reliance on the grid and provide a stable power supply for well operations, even during high-temperature periods.	▪ The project company to ensure that such measures (adopted to address the climate risk) are considered during the design phase.	▪ % reduction in energy consumption / % of equipment upgraded. ▪ % of energy demand met by renewable sources.	▪ Annual

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					▪ Perform regular maintenance and testing of backup power systems to ensure they are operational and ready to support well operations during power outages.	▪ Conduct energy efficiency audits to identify and implement measures that reduce overall energy consumption, thereby easing the load on the power grid and decreasing the risk of blackouts. ▪ Adopt operational practices that contribute to overall sustainability and energy efficiency, such as optimizing well operation schedules to avoid peak electricity demand periods. This approach helps mitigate energy shocks by reducing	▪ Project company and the O&M contractor		

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						reliance on grid energy during periods of high demand.			
			▪ The increased energy consumption raises energy expenses that will be used.	Medium Risk (9)	▪ Use high-efficiency pumps and motors designed to reduce energy consumption ▪ Continuous maintenance to enhance pump efficiency and motors ▪ Wellhead orifice modifications	---------	▪ The project company to ensure that such measures (to address the climate risk) are considered during the design phase ▪ Project company and the O&M contractor	▪ % reduction in energy consumption	▪ Annual / performance review
			▪ The increased energy consumption would increase the indirect generation of CO2 emissions.	Medium Risk (9)	▪ Use high-efficiency pumps and motors designed to reduce energy consumption.	▪ Implement smart energy management systems that can optimize energy use and contribute to lower emissions.	▪ The project company to ensure that such measures (to address the climate risk) are considered during the design phase	▪ CO_2 emissions intensity (kg CO_2 per m^3 of water pumped). ▪ Operational efficiency of installed equipment (kWh/m^3).	▪ Annually

#	Defined Activity/ Interventions		Climate Risk	Risk Rating	How climate Risks are addressed	Opportunities to Strengthen Climate Resilience or Climate Mitigation	Responsibility	KPI	Frequency
					▪ Continuous maintenance to enhance pump efficiency and motors		▪ Project company and the O&M contractor		
		Biodiversity	Higher temperatures and scarcity of rain can exacerbate the degeneration of the area, limiting the natural regeneration of plant species and leading to habitat disturbances.	Medium Risk (9)	▪ Use heat-resistant plant species for revegetation and Landscaping	▪ Full implementation of the existing endangered plant species regeneration initiative .	▪ Project company and the O&M contractor	▪ % of disturbance areas rehabilitated. ▪ % of landscaping area covered with heat-resistant plant species ▪ Number of trees planted and maintained under the initiative. ▪ % of road protection planting completed. ▪ % of regenerated endangered plant species.	▪ Annual
			▪ Flash flood events might cause soil erosion increasing the	Low Risk (6)	▪ Conduct site inspections after the flash flood event to identify and address	------	Project company and the O&M contractor	▪ % of site areas inspected after flood events / % of identified erosion issues addressed.	▪ Post-flood event (As needed)

#	Defined Activity/ Interventions		Climate Risk	Risk Rating	How climate Risks are addressed	Opportunities to Strengthen Climate Resilience or Climate Mitigation	Responsibility	KPI	Frequency
			risk of habitat disturbances and vegetation loss.		any erosion-related damage			▪ % of erosion control measures applied.	

Institutional Responsibilities and Coordination

While the project company is responsible for implementing climate resilience measures, several responsibilities—particularly related to stakeholder engagement, integration of socioeconomic factors, and long-term monitoring—lie within the mandate of MWI. The ESIA outlines the Ministry's role in conducting stakeholder engagement and socioeconomic impact assessments, which are essential for supporting broader climate adaptation efforts.

To achieve the desired climate resilience outcomes, strong coordination between the project company and MWI is essential. While certain responsibilities fall outside the project's direct scope, their successful implementation—especially ongoing monitoring and stakeholder involvement—is crucial to ensuring the adaptive capacity of local communities and long-term infrastructure sustainability.

Conclusion

The CRVA for this project has identified key climate hazards—extreme drought, flash floods, heatwaves, and precipitation variability—that could significantly impact project infrastructure and operations, and long-term sustainability. By utilizing Jordan's NC4 projections, regional climate models, and spatial risk assessments, this study provides a data-driven approach to understanding climate risks and integrating resilience measures into project planning.

This CRVA is a foundational step in integrating climate resilience into the project's lifecycle. The findings will directly inform the engineering design, financial planning, and operational strategies, ensuring that the project is climate-adaptive, sustainable, and aligned with international best practices. Future phases should focus on refining adaptation measures, assessing cost feasibility, and strengthening institutional coordination for effective climate risk management.

Overall, the project's climate vulnerability is rated as ***Medium***. While many risks can be mitigated through design improvements, resilient material selection, and adaptive operational measures. However, the decline in groundwater poses a high long-term risk, this issue is considered an external risk managed at the national level by the (MWI). The project itself does not control the abstraction policy.