TMGO
TULU MOYE GEOTHERMAL

CLIMATE CHANGE ASSESSMENT

I. PROJECT INFORMATION

Project name	Tulu Moye Geothermal
Project cost ($ million)	
Location	Ethiopia, Oromia Region, Iteya
Sector – Sub sector	Energy – Geothermal power
Theme	Project climate change assessment and mitigation
Brief description	Ethiopia has on of the largest geothermal potentials in Africa, the government of Ethiopia has prioritized the development of the sector to diversify the energy mix of the country and include intermittent power into the predominantly hydro generation (>97%). The Tulu Moye Geothermal project aims to add renewable baseload energy generation to reduce Ethiopia's reliance of climate dependent hydro energy. The project scope includes geothermal well development, power plant construction and transmission interconnection to the national grid. The geothermal field is located about 130 km southeast of Addis Ababa in the Main Ethiopian Rift (MER) and is part of the East African Rift System (EARS) running generally in NNE-SSW direction. The surface exploration has identified numerous indicators for the existence of a high-enthalpy (>260°C) geothermal system. A structural survey based on remote sensing (Lidar)followed by ground observations through field campaigns, i.e. soil flux and soil temperature survey, has demonstrated that the heat flow is strongly related to the complex fault system found within the area. Surface manifestations coincide with the caldera rim and the western most part of the Wonji Fault Belt (WFB), named the Salen Volcanic Ridge (SVR). Interpretations of gas geochemistry from fumarole sampling suggest a reservoir temperature in the range of 260 –300 °C, with maximum temperature in the southern section of the ring structure and proposed caldera. Within that structure the resistivity survey (MT/TEM) shows a low-resistivity clay cap covering a deeper high-resistivity zone, part of which is likely to correspond to a >260°Creservoir. The conceptual model analysis based on the current knowledge of the area proposes that the main heat source is a low resistivity body (possibly a magma pocket) about 2000 m below the base of the clay cap below the Gnaro obsidian dome. This magma heats up the deep ground water flowing primarily from the east and south and, after up flowing beneath Gnaro, the

	hot outflow is channeled to the WNW along the ring structure from Gnaro up to 6 km up dip towards the Werdea dome.

II. SUMMARY OF CLIMATE RISK SCREENING AND ASSESSMENT

A. Climate risk screening

Temperature evolution:
The mean annual temperature in the country is projected to increase by 0.84°C, 1.4°C, and 2.2°C for the 10th, 50th, and 90th percentiles for the RCP4.5 model ensemble runs. Similarly, the 10th, 50th, and 90th percentiles for the RCP8.5 ensemble project increases of 1.3°C, 1.8°C, and 2.6°C. [CCKP]. All projections indicate substantial increases in the frequency of days and nights that are considered "hot" in current climate. Annually, projections indicate that "hot" days will occur on 19-40% of days by the 2060s [UNDP].

Precipitation:
Ethiopia has a high degree of inter-annual variability and high degrees of uncertainty remain in future projections of Ethiopia's precipitation trends. Increases in the proportion of total rainfall occurring in 'heavy' events are expected; with annual increases up by as much as 18%.

Extreme events: Drought and flood are the extreme events considered.
The projected changes in precipitation are mostly uncertain across the country and that there is a substantial decrease over the central and northern parts of Ethiopia. Additionally, the length of dry and wet spells is projected to increase and decrease, respectively. According to the report of World Bank, the mean annual rainfall will decrease by 10–25% in the central highlands, by 0–10% in the south, and by more than 25% in the northern areas of the country in the coming periods. CDD, a measure of extremely dry conditions, shows an increasing trend in the coming periods over Ethiopia. Any changes in rainfall patterns are likely to increase the frequency of severe droughts and floods.

Climate Risk Classification: L*ow to Moderate Exposure*.

B. Climate risk and adaption assessment

Methodology: A literature review of climate impact in Ethiopia was used to assess the possible climate related issues. Key studies consulted include but is not limited to: -

- World Bank, Ethiopian Climate Risk Country Profile, World Bank Group, Washington, DC, USA 2020
- World Bank, Ethiopia: Economics of Adaptation to Climate Change, World Bank Group, Washington, DC, USA, 2010
- Asaminew Teshome and Jie Zhang; Increase of Extreme Drought over Ethiopia under Climate Warming, Hindawi Advances in Meteorology Volume 2019

Climate risk relevant to the project:

i. Impact of droughts leading to water shortages in the project area which already daces a water deficit. High temperatures and droughts related to climate change may affect the required 50l/s water required for future drilling activities.
Based on the hydrology studies undertaken by the project company, various options have been considered for water in consideration of local community usage, potential impact, and future trends.

ii. Another risk is the potential for high precipitation which may trigger landslides, this may affect the access road or activity areas.

Mitigation measures:

Mitigation measures adapted for this project include water storage facility, rainwater harvesting, wastewater treatment and reuse including geothermal wastewater. Improved design and construction of facilities and infrastructure and vigilant monitoring and evaluation of the climate condition. The project installed a weather station for such monitoring.

C. Climate risk screening tool and/or procedures used

Climate risk assessment on the project has been done using:

- CCKP = World Bank Climate Change Knowledge Portal
- USAID Climate Risk Screening and Management tool
- ThinkHazard

D. Appendix

- ThinkHazard – Arsi
- Tulu Moye Geothermal Climate and Disaster Risk Screening Report

Climate and Disaster Risk Screening Report for geothermal in Ethiopia

Table 1: Project Information

Project Title:	geothermal
Project Number:	2529
Project TTL:	Tulu Moye Geothermal
Assessment completed by:	Aynalem
Estimated timeline for PCN Year:	2020
Screening Tool Used:	In Depth Screening

The Climate and Disaster Risk Screening Tool provides high-level screening to help consider short- and long-term climate and disaster risks at an early stage of project design. The tool applies an Exposure–Impact–Adaptive capacity framework to characterize risks (Annex 1). Potential risks are identified by connecting information on climate and geophysical hazards with users' subject matter expertise of project components (both physical and non-physical) and understanding of the broader sector and development context.

The tool does not provide a detailed risk analysis. Rather, it is intended to help inform the need for further consultations, dialogue with local and other experts and analytical work at the project location to strengthen resilience measures in the course of project design.

[1] This is the output report from applying the World Bank Group's Climate and Disaster Risk Screening Project Level Tool (Global website:climatescreeningtools.worldbank.org; World Bank users: wbclimatescreeningtools.worldbank.org). The findings, interpretations, and conclusions expressed from applying this tool are those of the individual that applied the tool and should be in no way attributed to the World Bank, to its affiliated institutions, to the Executive Directors of The World Bank or the governments they represent. The World Bank does not guarantee the accuracy of the information included in the screening and this associated output report and accepts no liability for any consequence of its use.

Summary Climate and Disaster Risk Screening Report

1. Exposure of the project location : This step assesses the current and future exposure of the project location to relevant climate and geophysical hazards.

Exposure ratings for climate and geophysical hazards that are likely to be relevant to the project location both in the present and in the future:

	Climate Change Hazards						Geophysical Hazards		
	Extreme Temperature	Extreme Precipitation and Flooding	Drought	Sea Level Rise	Storm Surge	Strong Winds	Earthquake	Volcanic Erupation	Landslides
Current									
Future									

2. Impacts on the project's physical components: This step assesses the current and future impacts of identified climate and geophysical hazards on the project's physical components as currently designed under relevant subsectors.

	Impact
	Other Renewable Energy
Current	
Future	

3. Adaptive Capacity: modulating effect of the project's non-physical components and development context : This step assesses how the project's non-physical components, together with its broader development context, modulates potential impacts from climate and geophysical hazards. This step also considers particularly vulnerable groups, namely women, migrants and displaced populations.

Modulation of impacts by the project's soft components

↓

Reduce Risk

Feasibility, Design Studies

Data gathering, monitoring and Information Management Systems

Operations Support Capacity building, Technical Assistance and Outreach

Modulation of impacts by the project's energy sector context

↓

Reduce Risk

Modulation of impacts by the project's social, economic and political factors

↓

Reduce Risk

Women identified as particularly vulnerable to impacts from climate and geophysical hazards

✓

Components designed to help alleviate the risks to women from climate and geophysical hazards

✓

4. Risk to the outcome/service delivery of the project : This step assesses the level of risk to the outcome/service delivery that the project is aiming to provide based on previous ratings.

Outcome/Service Delivery

	Other Renewable Energy
Current	
Future	

Key for risk ratings:

Insufficient Understanding	No Exposure No Potential Impact No Risk	Low Exposure Low Potential Impact Low Risk	Moderate Exposure Moderate Potential Impact Moderate Risk	High Exposure High Potential Impact High Risk

Climate and Disaster Risk Screening Report for geothermal in Ethiopia

1. Introduction

Building resilience to climate and geophysical hazards is a vital step in the fight against poverty and for sustainable development. Screening for risks from these hazards improves the likelihood and longevity of a project's success. The project level Climate and Disaster Risks In-Depth Screening Assessment provides early stage screening for climate and disaster risks at the concept stage of project development. The tool uses an exposure - impact - adaptive capacity framework to consider and characterize risks from climate and geophysical hazards, based on key components of a project and its broader development context.

This report summarizes the results of the screening process for geothermal in Ethiopia, which was applied to the following selected subsectors:

 Other Renewable Energy

The potential risks flagged in this report were identified by connecting information on climate and geophysical hazards exposure with the user's subject matter expertise and understanding of the project components and sensitivity to rate the impacts. The in-depth screening assessment does not provide detailed risk assessments, rather it flags risks to inform consultations, enhance dialogue with local and other experts, and define further analytical work at the project location.

This early stage screening can be used to strengthen the consideration of climate and disaster considerations in key components of the project design, including the physical aspects (e.g., transmission lines, plants/facilities etc.).) and soft components (e.g., capacity building of energy managers,institutional strengthening, early warning systems, maintenance schedules, etc.).The broader sectoral (e.g., backups and system redundancy in place, strategic planning that considers how climate and geophysical hazards may affect key assets, system reliability, and demand, etc.) and development context conditions (e.g., influence on energy demand from population growth, legal enforcement of proper building codes and zoning regulations, etc.) could help modulate the risks to the delivery of the outcome/service level.

2. Exposure of the Project Location to Climate and Geophysical Hazards

The table below presents a summary description of exposure to climate and geophysical hazards at the project location for the Current and Future time frames. Exposure to climate hazards is evaluated in two time frames, because past records are not necessarily indicative of future conditions.

The descriptions provide a summary of the key characteristics and some indication of the trends in exposure from each hazard, drawing on global, quality controlled data sets from the Climate Change Knowledge Portal (CCKP). It is useful, for example to understand the temperature range and the rate of annual or decadal increase in a region; or precipitation patterns for historical and future time frames and seasonality shifts. Understanding the trends of hazards is important as they act individually and collectively on components/subsectors of the project. Because geophysical hazards (such as earthquakes, tsunamis, landslides, and volcano eruptions) do not have associated future projections, exposure for those hazards is assessed only in the Historical/Current time frame.

The following guiding questions were used to assess exposure:

- What have been the historical trends in temperature, precipitation and drought conditions?
- How are these trends projected to change in the future in terms of intensity, frequency and duration?
- Has the location experienced strong winds and/or geophysical hazards in the past that may occur again in the future?
- Will the location be exposed to sea level rise and storm surge in the future?

Summary of Exposure to Climate and Geophysical Hazards at Project Location

Hazard	Time frame	Description of hazards for the project location
Extreme Temperature	Current	
	Future	
Extreme Precipitation and Flooding	Current	
	Future	
Drought	Current	
	Future	
Sea Level Rise	Current	
	Future	
Storm Surge	Current	
	Future	
Strong Winds	Current	
	Future	
Earthquake	Current	
Volcanic Erupation	Current	
Landslides	Current	

Insufficient Understanding	Not Exposure	Slightly Exposed	Moderately Exposed	Highly Exposed

3. Impacts on the Project's Physical Components Under Relevant Subsectors

This section presents the detailed results of screening for relevant subsectors to the energy project, including the project's investments in physical structures. The impact ratings are based on the exposure ratings and the understanding of the project's sensitivity by the user. Understanding the contribution of risks from the subsectors, both individually and collectively can help inform the process of dialogue, consultation, and analysis during project design.

Other Renewable Energy

The potential impact of climate and geophysical hazards on the project's investments in renewable energy (other than hydropower) is rated based on exposure ratings for the location, and an understanding of the historical and future project sensitivity to these risks.

The following guiding questions were used to assess impact on Renewable Energy:

- Have recent trends and variability in climate hazards affected renewable energy production in your project location?
- Are the project designs appropriate for recent trends of climate and geophysical hazards?
- Do the investments in Other Renewable Energy projects "lock in" certain decisions for decades to come?
- How might projected changes in climate hazards affect those decisions?

The ratings are based on expert judgment and an understanding of the local development context.

	Potential Impact	
	Current	**Future**
Other Renewable Energy		
Description of impacts	No notes added	No notes added

Insufficient Understanding	No Potential Impact	Low Potential Impact	Moderate Potential Impact	High Potential Impact

4. Adaptive Capacity: modulating effect of the project’s soft components and development context

The potential impact on key components/subsectors due to exposure from hazards is modulated by the project's soft components (enabling and capacity building activities). The right kind of capacity building measures could increase preparedness and longer-term resilience and reduced the risks. An understanding of larger sector and development context with respect to key modulating factors helps to assess the climate risks in terms of adaptive capacity. For example, in the energy sector, policies to promote less centralized energy systems may help reduce risk; while a severe underfunding of the authority with oversight of the energy sector making the financing of activities to adapt to climate change impossible, may aggravate the risks.

In addition, vulnerable groups, namely women, migrants and displaced populations may be particularly affected by climate and disaster risks. Soft components can be designed to help alleviate the risks to women from climate and geophysical hazards.

The table below presents a summary description of the modulating effect the project’s soft components and broader development context, which includes the energy sector context and other social, economic and political factors.

Summary of Adaptive Capacity: modulating effect of the project’s non-physical components and development context

Adaptive Capacity		
Modulation of impacts by the project's soft components ↓ Reduce Risk Feasibility, Design Studies Data gathering, monitoring and Information Management Systems Operations Support Capacity building, Technical Assistance and Outreach	**Modulation of impacts by the project's energy sector context** ↓ Reduce Risk **Modulation of impacts by the project's social, economic and political factors** ↓ Reduce Risk	**Women identified as particularly vulnerable to impacts from climate and geophysical hazards** ✓ **Components designed to help alleviate the risks to women from climate and geophysical hazards** ✓

Description of modulating effects of non-physical components:

Description of modulating effects of the energy sector context: The energy sector in the country focused in diversifying the energy source. Solar, wind, and geothermal energy development priorities in recent years to change the country dependence on hydropower.

Description of modulating effects of social, economic and political factors in the project country:

5. Risk to the Outcome/Service Delivery of the Project

This section provides information on the level of risk to the outcome/service delivery that the project is aiming to provide based on previous ratings.

The following guiding questions were used to assess the Outcome/Service delivery of the project:

- Do the ratings you made under your physical components, soft components and development context interact in beneficial or harmful ways?
- Is there a single rating that is so influential that it outweighs the others?
- Do the risks to the outcome / service delivery threaten human health?

The actual ratings themselves, while instructive, should inform further consultations, dialogue, and future planning processes. Keep in mind that the greatest value of the tool is that it provides structured and systematic process for understanding climate and disaster risks.

5.1 Level of Risk by Subsector

Table a. below highlights the impact ratings on the project's components/subsectors, and the overall risk to the outcome/service level for both Current and Future time frames.

The ratings are derived on the basis of the hazard information, subject matter expertise, contextual understanding of the project, and modulated on the basis of adaptive capacity and the large development context of the energy sector and country. The results indicate what components are most at risk. The results indicate where risks may exist within one or multiple components and where further work may be required to reduce or manage these risks. An ongoing process of monitoring risks, refining climate and other information, and regular impact assessment may also be appropriate.

Table a. Summary of Risk to Outcome/Service Delivery by Subsector

Sub-sector	Potential Impact		Non-Physical Components		Devlopment Context				Outcome/Service Delivery	
					Energy sector		Broader Context			
Time Frame	Current	future	Current	future	Current	future	Current	future	Current	future
Other Renewable Energy			Reduce Risk		Reduce Risk		Reduce Risk			

Insufficient Understanding	No Risk	Low Risk	Moderate Risk	High Risk

5.2 Level of Risk by Time Frame

Table b. below highlights draws attention to how climate impacts and risks shift from the Current to the Future time frame. Potential impacts to the subsectors are evaluated separately for the Current and Future time frames to capture changes in the exposure from climate hazards over time. For example, projections might indicate that temperature are likely to increase significantly, and the dry season may become longer. Both of these changes would affect Other Renewable Energy quality concerns.

For investments with long operational lifetimes, such as physical infrastructure, considering future

climate variability and change is critical to avoid “locking in” designs and features that are only suited to current climate. For example, treatment facilities can be inundated from sea level rise and storm surge or experience damage from earthquakes. Treatment plants might be more easily flooded, distribution pipes corroded and cracked, and pumping stations can fail from loss of pressure. These impacts may influence the success of the water supply investments.

Table b. Summary of Risk to Outcome/Service Delivery by Time Frame

	Current					future				
Sub-sector	**Potential Impact**	**Non-Physical Components**	**Devlopment Context**		**Outcome/ Service Delivery**	**Potential Impact**	**Non-Physical Components**	**Devlopment Context**		**Outcome/ Service Delivery**
			Energy sector	**Broader Context**				**Energy sector**	**Broader Context**	
Other Renewable Energy		↓ Reduce Risk	↓ Reduce Risk	↓ Reduce Risk			↓ Reduce Risk	↓ Reduce Risk	↓ Reduce Risk	

Insufficient Understanding	No Risk	Low Risk	Moderate Risk	High Risk

5.3 Key Drivers of Risk

Table c. below highlights the key drivers of risk for each project subsector ratings, in terms of hazards that are likely to pose the greatest challenge.

The ratings for the potential impact for each subsector reflect the aggregate rating across multiple hazards, drawing on all of the exposure information and their own expert judgment.

Table C. Key Drivers of Risk

	Historical/Current Drivers	**Future Drivers**
Hazards & Location	Earthquake Volcanic Erupation Landslides	Drought
Physical Components	*	*
Outcome/Servicedelivery	*	*

Key High Risk Moderate Risk

* If a cell is blank it implies there is 'No high or moderate risks 'identified for this aspects of the project.

Specific consideration should be given to those hazards which have high ratings, or are moving from moderate to high ratings over time. For example, sea-level rise may not be a key risk driver in the Historical/Current time frame; but may emerge as a key driver across multiple sectors in the future time frame. Understanding which hazards are key drivers may help flag follow-on work to manage climate risks within the design and delivery of the project.

6. Guidance on Managing Climate Risks through Enhanced Project Design

By understanding which of your project components are most at risk from climate change and other natural hazards through initial screening, you can begin to take measures to avoid impacts by:

- Enhancing the consideration of climate and disaster risks early in project design.
- Using your risk screening analysis to inform follow-up feasibility studies and technical assessments.
- Encouraging local stakeholder consultations and dialogue to enhance resilience measures and overall success of the project.

Table 1 provides some general guidance based on the risk ratings for Outcome/Service Delivery, and Table 2 lists some climate risk management measures for your consideration. Visit the “Screening Resources" page of the tool for additional guidance and a list of useful resources.

Note: Please recall that that this is a high-level screening tool, and that the characterization of risks should be complemented with more detailed work.

Table 1: General Guidance Based on Risk Ratings for Exposure, Impact and Outcome/Service Delivery

Insufficient Understanding	Gather more information to improve your understanding of climate and geophysical hazards and their relationship to your project.
No/Low Risk	If you are confident that climate and geophysical hazards pose no or low risk to the project, continue with project development. However, keep in mind that this is a high-level risk screening at an early stage of project development. Therefore, you are encouraged to monitor the level of climate and geophysical risks to the project as it is developed and implemented.
Moderate Risk	For areas of Moderate Risk, you are encouraged to build on this screening through additional studies, consultation, and dialogue. This initial screening may be supplemented with a more detailed risk assessment to better understand the nature of the risk to the project.
High Risk	For areas of High Risk, you are strongly encouraged to conduct a more detailed risk assessment and to explore measures to manage or reduce those risks.

Table 2: Types of Climate Risk Management Measures for Typical Energy Projects

OBJECTIVE	EXAMPLES
Accommodate/Manage	• Develop redundant structures or services that can be relied upon if structures fail • Plan back-up power systems for treatment and pumping facilities • Increase inspection frequency to ensure structures are enduring climate change pressures • For transmission and distribution where higher winds are expected, adopting higher design standards for distribution poles; in the case of increased temperatures, putting in place of more effective cooling systems for substations and transformers • Setting up rapid emergency repair teams to repair damaged facilities quickly

Protect/Harden	• Upgrade existing cooling systems for thermal power • Designing facilities to be waterproofed where increased flooding is expected • Add reinforcements to walls and roofs • Build dikes to contain flooding • Incorporate structural improvements to transmission • For existing hydro infrastructure, operational changes to optimize reservoir management and improve energy output by adapting to changes in rainfall or river flow patterns • For hydropower, restored and better-managed upstream land, including afforestation to reduce floods, erosions and mudslides for a better protection of existing infrastructure • Increase drainage of energy facilities • Employ more robust specifications allowing structures to withstand more extreme conditions (such as higher wind or water velocity) • Design turbines and structures better able to handle increased wind speed and gusts
Retreat/Relocate	• Integrate sea level rise projections and storm surge in coastal siting • Relocate or refit extremely vulnerable existing infrastructure • For hydropower, where water flows changes are expected, consider diverting upstream tributaries, building new storage reservoirs and installing turbines better suited to expected conditions • For transmission & distribution, specifying redundancy in control systems, multiple T&D routes, relocation and underground distribution for protection against adverse conditions may be considered.
Build training and information systems	• Strengthen climate information systems, building on existing regional and national networks • For hydropower, strengthen hydrologic forecasting and coordinate power planning and operations with other water-use projects • For electricity end-use, putting in plirrigationace mandatory minimum energy performance standards for buildings, manufacturing facilities and energy-intensive appliances • Build capacity of national governments to harmonize data across regions • Putting in place more robust operational and maintenance procedures
Strengthen policies, planning and systems	• Integrate climate change and disaster management planning • Improve coordination of policies and programs across government agencies to address the additional pressures imposed by climate change • Foster integrated resource management with agriculture and water • Put in place policies and enforceable regulations to improve energy security, decentralized local planning and generation • Improve forecasting of demand changes and supply-demand with climate change • Improved land-use planning so future power infrastructure is in less vulnerable areas

Sources: USAID Climate Risk Screening and Management Tools: Infrastructure, Construction and Energy Annex
ADB Guidelines for Climate Proofing Investments in Energy

ThinkHazard!

Identify natural hazards in your project area
and understand how to reduce their impact

Arsi

Ethiopia , Oromia

Landslide | Volcano | Wildfire | Earthquake | Extreme heat | River flood

Urban flood | Cyclone | Water scarcity | Coastal flood | Tsunami

Report generated on 2020-09-01
from https://thinkhazard.org/en/report/149287-ethiopia-oromia-arsi

About ThinkHazard!

ThinkHazard! is a new web-based tool enabling non-specialists to consider the impacts of disasters on new development projects. Users of *ThinkHazard!* can quickly and robustly assess the level of river flood, earthquake, drought, cyclone, coastal flood, tsunami, volcano, and landslide hazard within their project area to assist with project planning and design.

ThinkHazard! is a simple flagging system to highlight the hazards present in a project area. As such, a user is only required to enter their project location – national, provincial or district name. The results interface shows a user whether they require high, medium or low awareness of each hazard when planning their project.

ThinkHazard! also provides recommendations and guidance on how to reduce the risk from each hazard within the project area, and provides links to additional resources such as country risk assessments, best practice guidance, additional websites. *ThinkHazard!* also highlights how each hazard may change in the future as a result of climate change.

The ThinkHazard! methodology is documented here.

Developed by

GFDRR
Global Facility for Disaster Reduction and Recovery

In partnership with

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Geoscience for a sustainable Earth

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The following organizations have contributed data and / or expert input to the development of this tool:

GNS SCIENCE
TE PŪ AO

VU UNIVERSITY AMSTERDAM
Faculty of Earth and Life Sciences
IVM Institute for Environmental Studies

FATHOM

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

The tool code is open source, to encourage other users to adapt the tool to their needs. The code can be found on Github.

Current instance version is .
Source of Administrative boundaries: The Global Administrative Unit Layers (GAUL) dataset, implemented by FAO within the CountrySTAT and Agricultural Market Information System (AMIS) projects.

The data was published for the last time on *Tue Jun 30 15:57:03 2020*.

Disclaimer

The hazard levels and guidance given in *ThinkHazard!* do not replace the need for detailed natural hazard risk analysis and/or expert advice. While *ThinkHazard!* does its best to scientifically determine the hazard level, there are still uncertainties in the data and analysis. Users of the tool should access more information by contacting relevant national authorities, reviewing the recommended resources, and through accessing detailed hazard data.

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Administrative boundaries are sourced from The Global Administrative Unit Layers (GAUL) dataset, implemented by FAO within the CountrySTAT and Agricultural Market Information System (AMIS) projects, with some amendment to administrative unit names.

Arsi

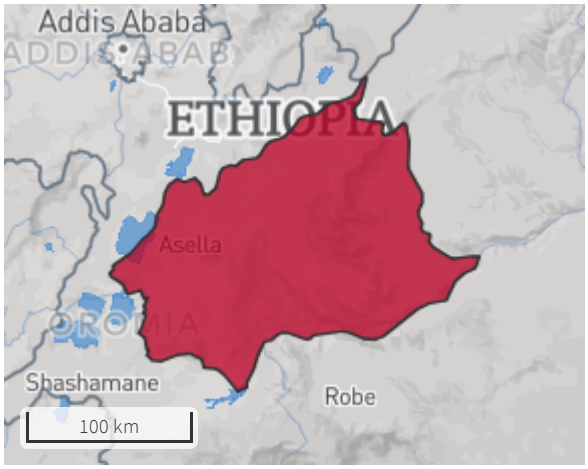
Ethiopia , Oromia

Landslide

Hazard level: ***High***

In the area you have selected landslide susceptibility is classified as high according to the information that is currently available. This means that this area has rainfall patterns, terrain slope, geology, soil, land cover and (potentially) earthquakes that make localized landslides a frequent hazard phenomenon. Based on this information, planning decisions such as project siting, project design, and construction methods, must take into account the potential for landslides. Further detailed information should be obtained to better understand the level of landslide susceptibility in your project area.

Climate change impact: Climate change is likely to alter slope and bedrock stability through changes in precipitation and/or temperature. It is difficult to determine future locations and timing of large rock avalanches, as these depend on local geological conditions and other non-climatic factors.



High Medium Low Very low

Data source: GFDRR

Further resources

- Country Adaptation Profile: Ethiopia
- Ethiopia Wereda Risk Profiles Database
- The Economics of Early Response and Disaster Resilience: Lessons from Kenya and Ethiopia
- Defining disaster resilience: a DFID approach paper
- EMDAT: Country Profile on Historical Disaster Events
- Global Assessment Report on Disaster Risk Reduction: Country Profiles
- Global Risk Patterns and Trends in Global Assessment Report
- Building Urban Resilience - Principles, Tools, and Practice
- Shock Waves : Managing the Impacts of Climate Change on Poverty
- Towards Safer School Construction
- Turn Down the Heat : Why a 4 Degree Centrigrade Warmer World Must be Avoided
- Understanding Risk in an Evolving World - Emerging Best Practices in Natural Disaster Risk Assessment

- Guidance on Safe School Construction
- Climate Change Knowledge Portal
- Community Based Landslide Risk Reduction

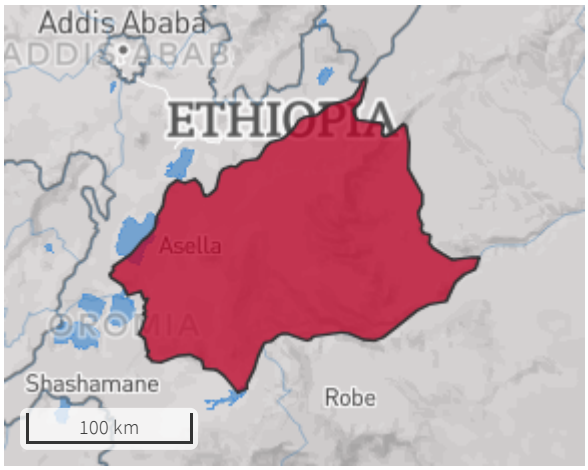
Arsi

Ethiopia , Oromia

Volcano

Hazard level: ***High***

In the area you have selected (Arsi) volcanic hazard is classified as **high** according to the information that is currently available. This means that the selected area is located at less than 50 km from a volcano for which a potentially damaging eruption has been recorded in the past 2,000 years and that future damaging eruptions are possible. Based on this information, **the impact of volcanic eruption must be considered in all phases of the project, in particular during project design, implementation and maintenance**. Further detailed information should be obtained to adequately account for the level of risk posed by individual volcanoes.



High Medium Low Very low

Data source: GFDRR

Further resources

- Ethiopia Wereda Risk Profiles Database
- The Economics of Early Response and Disaster Resilience: Lessons from Kenya and Ethiopia
- EMDAT: Country Profile on Historical Disaster Events
- Earthquake-report.com - Independent Earthquake Reporting Site
- Global Assessment Report on Disaster Risk Reduction: Country Profiles
- Guidance on Safe School Construction
- Guidelines on preparedness before, during and after an ashfall
- Living with volcanoes - The sustainable livelihoods approach for volcano-related opportunities
- The health hazards of volcanic ash - A guide for the public
- Database of Volcanoes - Global Volansim Program
- Understanding Risk in an Evolving World - Emerging Best Practices in Natural Disaster Risk Assessment
- Volcanic Ash impacts on critical infrastructure
- Volcanic Ash: What it can do and how to prevent damage
- Volcanic ash fall hazard and risk

- Volcanic gases and aerosols guidelines
- Volcanic hazards and their mitigation - Progress and problems
- Volcano Observatory database - World Organization of Volcano Observatories (WOVO)
- Towards Safer School Construction
- Defining disaster resilience: a DFID approach paper

Arsi

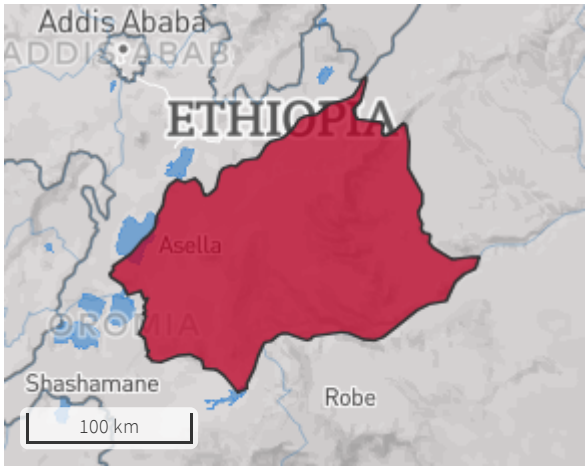
Ethiopia , Oromia

Wildfire

Hazard level: ***High***

In the area you have selected (Arsi) the wildfire hazard is classified as **high** according to the information that is currently available to this tool. This means that there is greater than a 50% chance of encountering weather that could support a significant wildfire that is likely to result in both life and property loss in any given year. Based on this information, the impact of wildfire **must be considered** in all phases of the project, in particular during design and construction. **Project planning decisions, project design, construction and emergency response planning methods should take into account the high level of wildfire hazard.** Note that damage can not only occur due to direct flame and radiation exposure but may also include ember storm and low level surface fire. In extreme fire weather events, strong winds and wind born debris may weaken the integrity of infrastructure. It would be prudent to consider this effect in the design and construction phase of the project. Further detailed information specific to the location and planned project should be obtained to adequately understand the level of hazard.

Climate change impacts: Modeled projections of future climate identify a likely increase in the frequency of fire weather occurrence in this region, including an increase in temperature and greater variance in rainfall. In areas already affected by wildfire hazard, the fire season is likely to increase in duration, and include a greater number of days with weather that could support fire spread because of longer periods without rain during fire seasons. Climate projections indicate that there could also be an increase in the severity of fire. It would be prudent to design projects in this area to be robust to increases in the severity and frequency of wildfire hazard. Areas of very low or low wildfire hazard could see an increase in hazard, as climate projections indicate an expansion of the wildfire hazard zone. Consider local studies on the impacts of climate change on wildfire trends, before deciding whether to design projects to withstand fire of greater intensity than those previously experienced in this region.



High Medium Low Very low

Data source: World Bank

Further resources

- Country Adaptation Profile: Ethiopia
- Building Urban Resilience - Principles, Tools, and Practice
- Shock Waves : Managing the Impacts of Climate Change on Poverty
- Turn Down the Heat : Why a 4 Degree Centrigrade Warmer World Must be Avoided

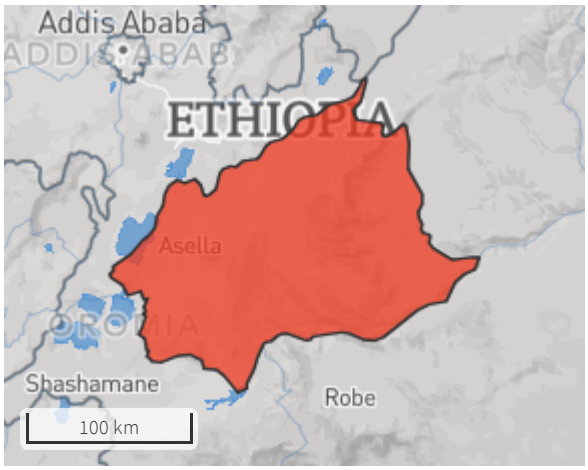
Arsi

Ethiopia , Oromia

Earthquake

Hazard level: ***Medium***

In the area you have selected (Arsi) earthquake hazard is classified as **medium** according to the information that is currently available. This means that there is a 10% chance of potentially-damaging earthquake shaking in your project area in the next 50 years. Based on this information, the impact of earthquake **should be considered** in all phases of the project, in particular during design and construction. **Project planning decisions, project design, and construction methods should take into account the level of earthquake hazard**. Further detailed information should be obtained to adequately account for the level of hazard.



High Medium Low Very low

Data source: GlobalEarthquakeModel

Further resources

- Ethiopia Wereda Risk Profiles Database
- The Economics of Early Response and Disaster Resilience: Lessons from Kenya and Ethiopia
- Global Earthquake Model - SSAHARA project
- Hospital Safety Index Guide
- Building Urban Resilience - Principles, Tools, and Practice
- Defining disaster resilience: a DFID approach paper
- EMDAT: Country Profile on Historical Disaster Events
- Global Assessment Report on Disaster Risk Reduction: Country Profiles
- Global Earthquake Model - GEM Foundation
- Global Risk Patterns and Trends in Global Assessment Report
- Guidance on Safe School Construction
- INFORM: Index for Risk Management
- Reducing Earthquake Risk in Hospitals
- Temblor

- Towards Safer School Construction
- Understanding Risk in an Evolving World - Emerging Best Practices in Natural Disaster Risk Assessment
- E-learning course: Understanding Risk (World Bank)
- Comprehensive Safe Hospital Framework

Arsi

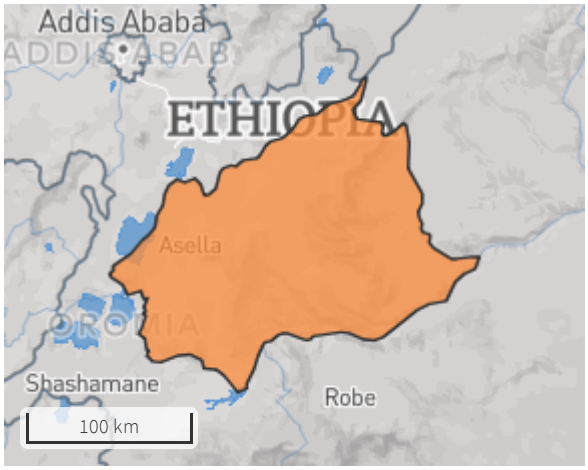
Ethiopia , Oromia

Extreme heat

Hazard level: ***Low***

In the area you have selected (Arsi) extreme heat hazard is classified as **low** based on modeled heat information currently available to this tool. This means that there is between a 5% and 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years. **Project planning decisions, project design, and construction methods should seek further information on whether the level of extreme hazard needs to be taken into account in the lifetime of the project**. The following is a list of recommendations that could be followed in different phases of the project to help reduce the risk to your project. Please note that these recommendations are generic and not project-specific.

According to the most recent assessment report of the Intergovernmental panel on Climate Change (IPCC, 2013), continued emissions of greenhouse gases will cause further warming, and it is virtually certain that there will be more frequent hot temperature extremes over most land areas during the next fifty years. Warming will not be regionally uniform. In the area you have selected, the temperature increase in the next fifty years will be slightly lower than the worldwide average, but still significant. It would be prudent to design projects in this area to be robust to global warming in the long-term.



High Medium Low Very low

Data source: World Bank

Further resources

- Country Adaptation Profile: Ethiopia
- Ethiopia Wereda Risk Profiles Database
- Heatwaves and Health: Guidance on Warning-System Development
- Building Urban Resilience - Principles, Tools, and Practice
- Turn Down the Heat : Why a 4 Degree Centrigrade Warmer World Must be Avoided
- Shock Waves : Managing the Impacts of Climate Change on Poverty
- Excessive Heat Events Guidebook

Arsi

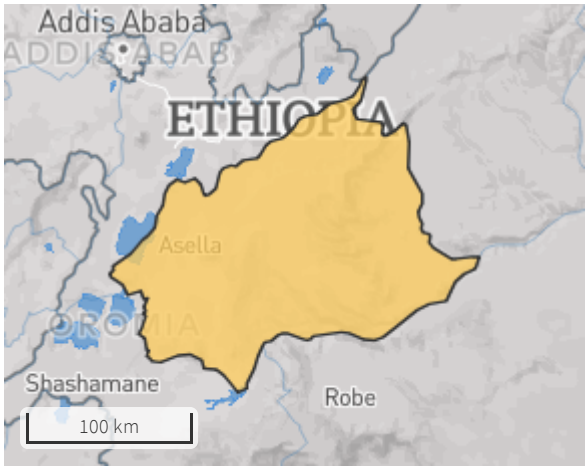
Ethiopia , Oromia

Water scarcity

Hazard level: Very low

In the area you have selected (Arsi) water scarcity is classified as **very low** or non-existent according to the information that is available to this tool. However, additional information may show some level of hazard. If local or additional information sources suggest that there is drought hazard, follow the recommendations below and seek expert guidance on additional recommended actions. In the area you have selected droughts will occur much less than once every 1000 years. Based on this information, **drought hazard does not need to be explicitly considered for your project**. Although the drought hazard is considered to be very low or non-existent in the project location, additional information may show some level of hazard. If local or additional information sources suggest that there is drought hazard, follow the recommendations below and seek expert guidance on additional recommended actions.

Climate change impact: Medium confidence in decreasing dryness. The present hazard level may decrease in the future due to the effects of climate change. However, this is uncertain and it may still be prudent to design projects in this area to be robust to increased drought hazard and water scarcity in the long-term.



High Medium Low Very low

Data source: IVM / VU University Amsterdam

Further resources

- Country Adaptation Profile: Ethiopia
- The Economics of Early Response and Disaster Resilience: Lessons from Kenya and Ethiopia
- Drought in the Horn of Africa: Preventing the next disaster
- Drought Risk Reduction: Framework and Practices
- EMDAT: Country Profile on Historical Disaster Events
- Global Assessment Report on Disaster Risk Reduction: Country Profiles
- Guidance on Safe School Construction
- INFORM: Index for Risk Management
- Building Urban Resilience - Principles, Tools, and Practice
- Shock Waves : Managing the Impacts of Climate Change on Poverty

- Towards Safer School Construction
- Turn Down the Heat : Why a 4 Degree Centrigrade Warmer World Must be Avoided
- Understanding Risk in an Evolving World - Emerging Best Practices in Natural Disaster Risk Assessment
- National Drought Management Policy Guidelines: A Template for Action
- Climate Change Knowledge Portal
- Defining disaster resilience: a DFID approach paper

Arsi

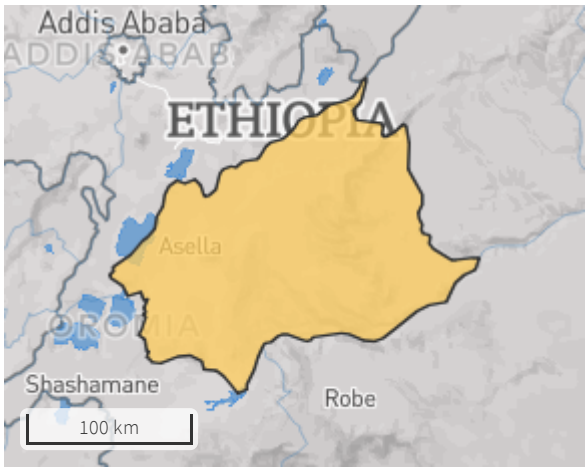
Ethiopia , Oromia

River flood

Hazard level: Very low

In the area you have selected (Arsi) river flood hazard is classified as **very low** based on modeled flood information currently available to this tool. This means that there is a chance of less than 1% that potentially damaging and life-threatening river floods occur in the coming 10 years (return period of c. 1 in 1000 years). Therefore, based on this information, **flood hazard does not need to be explicitly considered for your project**. Surface flood hazard in urban and rural areas is not included in this hazard classification, and may also be possible in this location. Please see 'Urban Flood' for consideration of urban surface and river flooding.Although the hazard is considered to be very low or non-existent in the project location based on the information available in *ThinkHazard!*, additional information may show some level of hazard. If local or additional information sources suggest that there is flood hazard, follow the recommendations below and seek expert guidance on additional recommended actions. It is recommended that local flood regulations and conditions possibly leading to highly localized water nuisance problems are considered. In particular, it is recommended to check the condition of and possible flaws in local water management systems, e.g. poorly dimensioned or maintained sewerage or drainage channels. Always consider taking no-regret measures.

Climate change impacts: High confidence in an increase in intense precipitation. The present hazard level is expected to increase in the future due to the effects of climate change. It would be prudent to design projects in this area to be robust to river flood hazard in the long-term.



High Medium Low Very low

Data source: GFDRR

Further resources

- Country Adaptation Profile: Ethiopia
- Ethiopia Wereda Risk Profiles Database
- The Economics of Early Response and Disaster Resilience: Lessons from Kenya and Ethiopia
- Climate Change Knowledge Portal
- Defining disaster resilience: a DFID approach paper
- EMDAT: Country Profile on Historical Disaster Events
- FLOPROS: A global database of Flood Protection Standards

- Global Assessment Report on Disaster Risk Reduction: Country Profiles
- Global Risk Patterns and Trends in Global Assessment Report
- Guidance on Safe School Construction
- Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century
- Shock Waves : Managing the Impacts of Climate Change on Poverty
- Towards Safer School Construction
- Turn Down the Heat : Why a 4 Degree Centrigrade Warmer World Must be Avoided
- Understanding Risk in an Evolving World - Emerging Best Practices in Natural Disaster Risk Assessment
- Understanding the Economics of Flood Risk Reduction
- Weather and Climate Resilience: Effective Preparedness through National Meteorological and Hydrological Services
- Weather and Climate Resilience: Effective Preparedness through National Meteorological and Hydrological Services
- INFORM: Index for Risk Management
- Building Urban Resilience - Principles, Tools, and Practice
- Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century

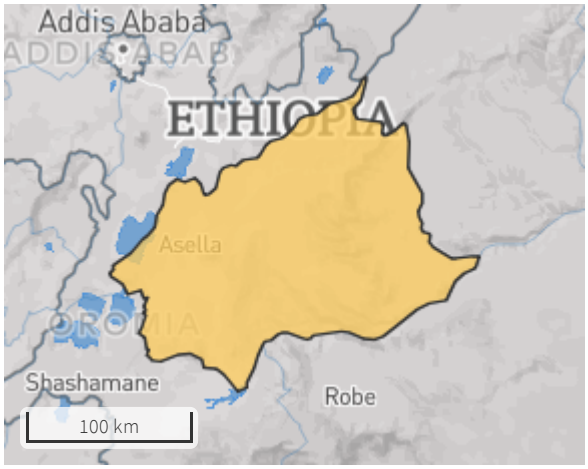
Arsi

Ethiopia , Oromia

Cyclone

Hazard level: Very low

In the area you have selected (Arsi) cyclone (also known as hurricane or typhoon) hazard is classified as **very low** according to the information that is currently available. This means that there is less than a 1% chance of potentially-damaging cyclone-strength winds in your project area in the next 10 years. Based on this information, the impact of cyclones does not necessarily **need to be** considered in different phases of the project, in particular during design and construction. Although the hazard is considered to be very low in the project location based on the information available in *ThinkHazard!*, other sources may show some level of cyclone hazard. If local or additional information sources suggest that there are cyclones, follow the recommendations below and seek expert guidance on additional recommended actions.



High Medium Low Very low

Data source: UNISDR

Further resources

- Country Adaptation Profile: Ethiopia
- The Economics of Early Response and Disaster Resilience: Lessons from Kenya and Ethiopia
- Defining disaster resilience: a DFID approach paper
- EMDAT: Country Profile on Historical Disaster Events
- Global Assessment Report on Disaster Risk Reduction: Country Profiles
- Guidance on Safe School Construction
- INFORM: Index for Risk Management
- Building Urban Resilience - Principles, Tools, and Practice
- Shock Waves : Managing the Impacts of Climate Change on Poverty
- Towards Safer School Construction
- Turn Down the Heat : Why a 4 Degree Centrigrade Warmer World Must be Avoided
- Understanding Risk in an Evolving World - Emerging Best Practices in Natural Disaster Risk Assessment
- Past Tropical Cyclones

Arsi

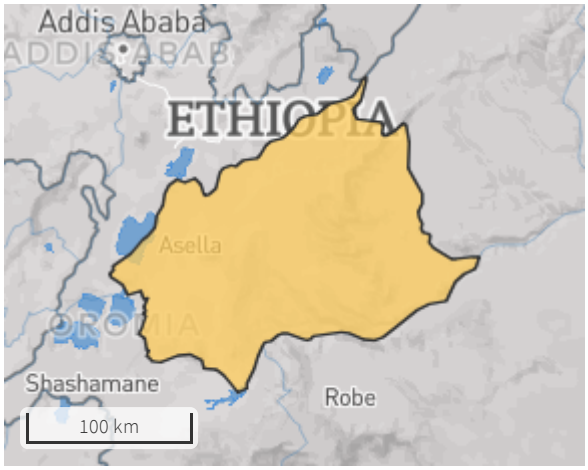
Ethiopia , Oromia

Urban flood

Hazard level: Very low

In the area you have selected (Arsi) urban flood hazard is classified as **very low** based on modeled flood information currently available to this tool. This means that there is a chance of less than 1% that potentially damaging and life-threatening river floods occur in the coming 10 years (return period of c. 1 in 1000 years). Therefore, based on this information, **flood hazard does not need to be explicitly considered for your project**. Although the hazard is considered to be very low or non-existent in the project location based on the information available in *ThinkHazard!*, additional information may show some level of hazard. If local or additional information sources suggest that there is flood hazard, follow the recommendations below and seek expert guidance on additional recommended actions. It is recommended that local flood regulations and conditions possibly leading to highly localized water nuisance problems are considered. In particular, it is recommended to check the condition of and possible flaws in local water management systems, e.g. poorly dimensioned or maintained sewerage or drainage channels. Always consider taking no-regret measures.

Climate change impacts: High confidence in an increase in intense precipitation. The present hazard level is expected to increase in the future due to the effects of climate change. It would be prudent to design projects in this area to be robust to river flood hazard in the long-term.



High Medium Low Very low

Data source: Fathom Global

Further resources

- Country Adaptation Profile: Ethiopia
- Ethiopia Wereda Risk Profiles Database
- Building Urban Resilience - Principles, Tools, and Practice
- FLOPROS: A global database of Flood Protection Standards
- Shock Waves : Managing the Impacts of Climate Change on Poverty
- Turn Down the Heat : Why a 4 Degree Centrigrade Warmer World Must be Avoided