Ceyhan Polipropilen Üretim A.Ş.Ankara, Turkey

Climate Change Risk Assessment (Update)

Ceyhan Propane Dehydrogenation-Polypropylene Production Project

Doc. No. P0031918-1-H1 Rev.2 – January 2023

Rev.	Description	Prepared by	Controlled by	Approved by	Date
3	Forth Issue	S. Zhu, S. Abd Alla, G. Bonvicini	A. Venturin,. D. Dilucia La Perna, I. Gulakov	R. De Laurentiis	March 2023
2	Third Issue	S. Zhu, S. Abd Alla, G. Bonvicini	A. Venturin,. D. Dilucia La Perna, I. Gulakov	R. De Laurentiis	January 2023
1	Second Issue	S. Abd Alla, R. Montesano, G. Bonvicini	A. Venturin, D. Dilucia La Perna, I. Gulakov	R. De Laurentiis	August 2022

0	First Issue	S. Abd Alla, R. Montesano, G. Bonvicini	A. Venturin, D. Dilucia La Perna	R. De Laurentiis	August 2022

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

CAT	Climate Action Tracker
CCKP	Climate Change Knowledge Portal
COVID-19	Corona Virus Disease
CPIR	Ceyhan Petrochemical Industrial Region
DHI	Diffuse Horizontal Irradiation
DNI	Direct Normal Irradiation
EC	European Commission
EU	European Union
ESIA	Environmental & Social Impact Assessment
ESWD	European Severe Weather Database
ETL	Electricity Transmission Line
GFDRR	Global Facility for Disaster Reduction and Recovery
GHG	Greenhouse Gases
GWP	Global Warming Potential
IFC	International Finance Corporation
IFI	International Financial Institution
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land-Use Change and Forestry
NCCS	National Climate Change Strategy
PDH	Propane Dehydrogenation
PP	Polypropylene Production
RCP	Representative Concentration Pathway
SPI	Standardized Precipitation Index
SSP	Shared Socioeconomic Pathways
TCFD	Task Force on Climate-related Financial Disclosures
TSMS	Turkish State Meteorological Service
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WEF	World Economic Forum
WMO	World Meteorological Organization
YEKA	By-Law on Renewable Energy Resource Areas
YEKDEM	Renewable Energy Sources Support Mechanism

1 INTRODUCTION

Ceyhan Polipropilen Üretim A.Ş. isplanning to develop the Ceyhan Propane Dehydrogenation-Polypropylene Production Plant, hereafter the Project, which will feature an annual production capacity of 472,500 tonnes in the Ceyhan Petrochemical Industrial Region (CPIR), Adana, Turkey.

With reference to the Project, RINA Consulting has prepared an update of the Climate Change Risks Assessment, CCRA, prepared as annex of the ESIA issued in December 2021.

This report addresses the comments shared by the lenders' consultant and it is elaborated considering Physical and Transitional Risks in line with the latest version of the Equator Principles (IV, dated October 2020) and the Recommendations of the Task Force on Climate-related Financial Disclosures.

The present document represents the CCRA report and it is articulated as follows:

- ✓ Chapter 1 constitutes the introduction to the document;
- ✓ Chapter 2 provides a brief overview of the project context;
- ✓ Chapter 3 describes the methodology applied to the analysis;
- ✓ Chapter 4 estimates the Greenhouse Gasses emissions;
- ✓ Chapter 5 focuses on the analysis of the climate patterns at the Project location, including observed trends for temperature, precipitations, wind and hazardous climate events over the last years and the projections for the upcoming decades, up to 2060;
- ✓ Chapter 6 is the core part of the analysis and includes the Climate Change Risk Assessment, describing the ongoing and expected changes in climate patterns and evaluating the climate-related physical and transition risks;
- ✓ Chapter 7 investigate the Climate Change Alternatives;
- ✓ Chapter 8 draws the conclusions of the analysis.

2 PROJECT CONTEXT

2.1 CEYHAN POLYPROPYLENE PRODUCTION PLANT

Ceyhan Polipropilen Üretim A.Ş. is planning to develop and operate Ceyhan Polypropylene Production Plant with an annual production capacity of 472,500 tonnes. The Project will consist of two separate processing units, which are PDH C3-Oleflex and Speriphol. In the process, liquid propane feedstock will be conversed to propylene, and then final product “polypropylene” will be produced by polymerizing the propylene.

Polypropylene has the second biggest share of national plastic raw material demand. It is anticipated that the Project will meet 19% of Turkey’s polypropylene demand. The overall demand in Turkey exceeds the production capacity of the existing petrochemical industries; therefore, the demand is mostly supplied by imports (~95% as of 2021). The Project will become “a petrochemical production hub” and it will have a key role in decreasing polypropylene import dependency. In the current situation, the only local producer is PETKİM having a capacity of 144,000 tons and corresponding 5% of the consumption.

Moreover, the Project will be in the Ceyhan Petrochemical Industrial Region in Adana, as reported in Figure 2.1, and it will create added value by:

- ✓ substituting imports with national production to contribute to Turkey’s current account deficit regarding polypropylene;
- ✓ creating qualitative employment;
- ✓ contributing to the development of Turkey’s plastics industry;
- ✓ contributing to Turkey’s development as a petrochemical hub.

Ceyhan Energy Specialized Industrial Zone (Ceyhan Petrochemical Industrial Region) was established among several initiatives with the primary aim of attracting potential investors in line with Turkey’s 2023, a government strategy aiming to increase the gross domestic product. Therefore, the Project will increase the industrial production capacity of the country.

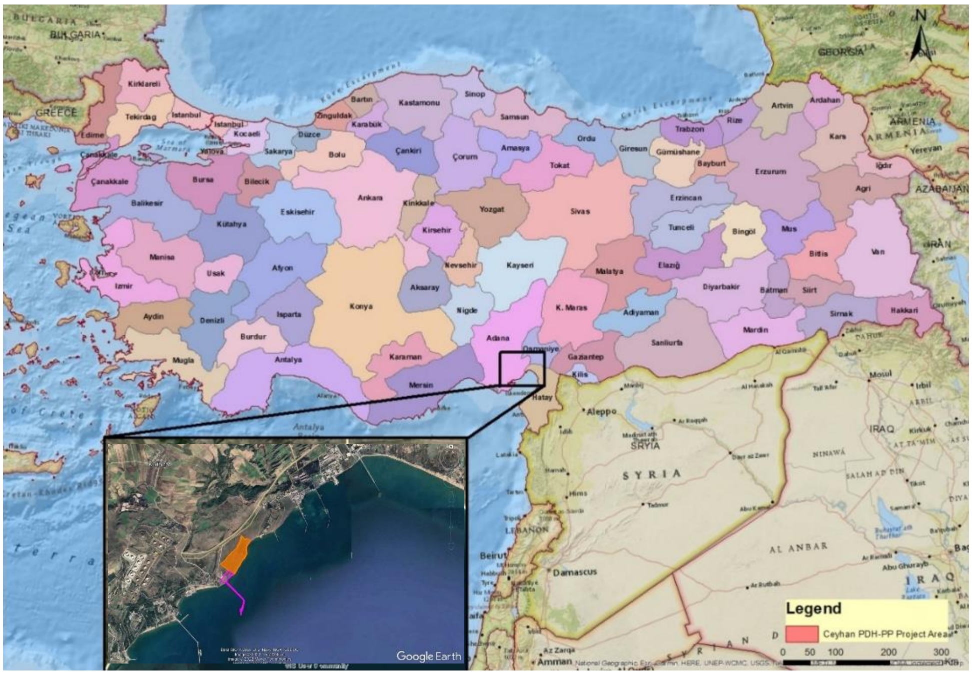


Figure 2.1: Project location

2.2 CLIMATE CHANGE POLICIES

The impacts of global climate changes in Turkey are confirmed by studies and have led to extreme weather events and gradual changes of climate conditions. According to the UNDP[1], Turkey is highly vulnerable to climate change and is already observing a warming trend in temperatures and a decreasing trend in precipitations. This is negatively impacting on water availability for food production and rural development, further exacerbating the social and regional disparities in a country characterized by a wide (and widening) gap between the Eastern provinces and the rest of the country.

Turkey is located between 36°- 42° north latitude and 26°- 45° east longitude in the Northern Hemisphere. Accordingly, there is a 76-minute local time difference between the west and east. Due to being in the mid zone, four seasons are experienced distinctively during the year.[2] According to Seventh National Communication[3], 11.4 % of Turkey surface area is made up of lakes and marshes, 28.8% is covered in forests, 35.8% is used in agriculture, 19% is grassland and 5% is used for habitation and other purposes.

The mid-year population of Turkey, while it was 55.1 million in 1990, it reached 80.3 million in 2017 with an increase of about 45.7% for the period 1990-2017. The population is estimated to reach about 104.8 million in 2050. [4]

The economic recession had directly caused reduction in total GHG emissions in 1994, 1999, 2001 and 2008. In these years, total emissions are decreased by 2.5%, 0.9%, 6.2% and 1.0% as compared to the previous year's emission respectively. Although there is no economic recession, total emissions were slightly decreased by 1.8% in 2013. The fluctuations in the emissions trends are mainly due to the GDP trends at market prices. [5] It could be concluded that GDP is the main driver of GHG emissions in Turkey.

Figure 2.2 provides a schematic of the Turkish efforts in terms of climate change. The signing of United Nations Framework Convention on Climate Change (UNFCCC) in 1992 was the most significant step to address the global warming effects brought on by human activities. When the Convention was adopted, Turkey was included among in Annex I and Annex II countries which bear most of the burden of the commitments made under the agreement. However, Turkey did not become actively involved in Convention implementation until 2001. In this year, thanks to negotiations, UNFCCC parties agreed that Turkey's "special circumstances" should be recognized and that it could invoke the "common but differentiated responsibilities" principle under the Convention. As a result of this decision, Turkey was removed from Annex II of the UNFCCC and States Parties were invited to recognize the special conditions which place Turkey in different position from Annex I countries.

In Turkey, Ministry of Environment, Urbanization and Climate Change (MoEUCC) is the National Focal Point of the UNFCCC and oversees developing policies and strategies related to climate change and air pollution. The Country established the Coordination Board on Climate Change (CBCC) in 2001 with the aim of determining climate change policies, measures, and activities. In 2013 the CBCC was restructured and renamed as Coordination Board on Climate Change and Air Management (CBCCAM). The CBCCAM is competent for taking decisions and measures related to climate change and air management.

The framework for Turkey's overall Climate Change policy includes several sectoral and cross-cutting policies, strategies, and action plans that are based on the applicable national legislation. The National Climate Change Strategy 2010-2023 (NCCS) and the National Climate Change Action Plan 2011-2023 (NCCAP) are the two main policy documents that are solely focused on Turkey's climate change policies. The NCCAP emphasizes "disseminating energy efficiency, increasing the use of clean and renewable energy resources, actively participating in the efforts for tackling climate change within Turkey's special circumstances and providing its citizens with a high quality of life and welfare with low-carbon intensity". NCCS and NCCAP identify short, medium, and long-term

****

[1] https://www.adaptation-undp.org/explore/europe-and-central-asia/turkey

[2] https://webdosya.csb.gov.tr/db/destek/editordosya/SixthNationalCommunicationofTurkey.pdf

[3] https://unfccc.int/sites/default/files/resource/496715_Turkey-NC7-1-7th%20National%20Communication%20of%20Turkey.pdf

[4] https://unfccc.int/sites/default/files/resource/TURKEY%E2%80%99S%20FOURTH%20BIENNIAL%20REPORT.pdf

[5] https://unfccc.int/documents/194819

goals under eight topics (energy, industry, forestry, agriculture, buildings, transportation, and waste and climate change adaptation). [6]

According to United Nations Development Programme (UNDP) [7], Turkey is highly vulnerable to climate change. The country is facing an observed warming trend in temperatures and a decreasing trend in precipitation. These conditions are causing negative effect on water availability for food production and rural development. In addition, it is projected that nearly 20% of the surface water in some basins will be lost by 2030. Furthermore, Turkey is vulnerable to natural disasters such as floods, increasing water stress in parts of country and land degradation. Economic losses from flooding and landslides as a proportion of GDP have historically been among the highest in Turkey compared to the other countries in Europe and CIS.

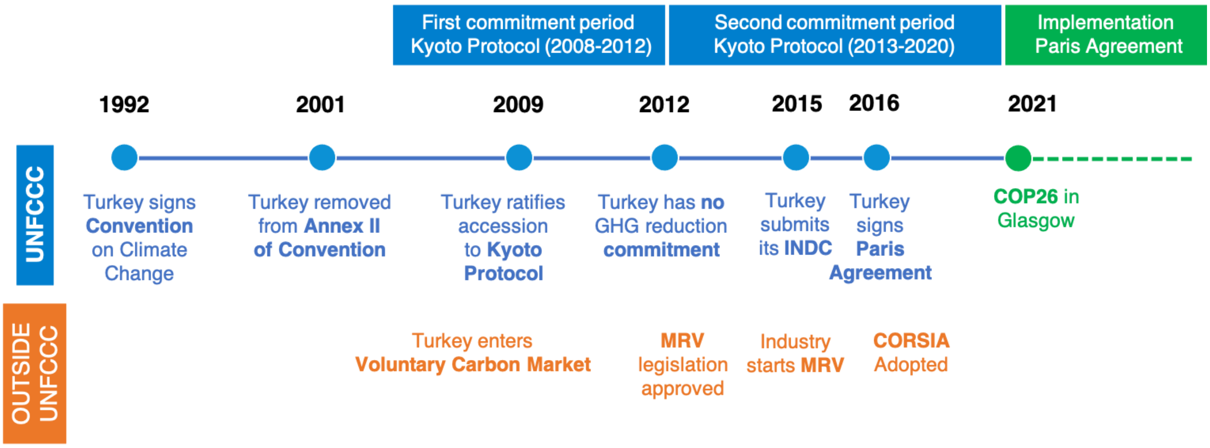


Figure 2.2: Timeline of climate policy developments

The Paris Agreement is a legally binding international treaty that aims to limit global warming to well below, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. At the 76th session of the UN General Assembly, it was announced that Turkey would have ratified Paris Agreement within October 2021. Moreover, Turkey signed Paris Agreement on April 22nd, 2016 and the approval was announced at the Official Gazette no: 31621 on October 7th, 2021.

In this context, Turkey's intended Paris Agreement target (INDC) [8] specifies emissions cuts of up to 21% by 2030, compared to a business-as-usual scenario as shown in Figure 2.3. Following a business-as-usual scenario, this target allows emissions growth (excluding LULUCF emissions) of up to 80% above 2018 levels. Such a trajectory is not yet aligned with a science-based approaches for keeping warming below at least 2°C. Moreover, projections indicate the Covid-19 pandemic to have had only a small impact on Turkey's emission trajectory, with emissions expected to have troughed at only 3-5% below 2019 levels by the end of 2020, and expected return to 2019 levels by 2021. As such, additional mechanisms – and significant financial resources from both national and international sources – will be needed to align Turkey's low carbon transition with global ambitions.

****

[6] https://unfccc.int/sites/default/files/resource/14936285_Turkey-NC7-2 Seventh%20National%20Communication%20of%20Turkey.pdf

[7] https://www.adaptation-undp.org/explore/europe-and-central-asia/t%C3%BCrkiye

[8] https://unfccc.int/sites/default/files/NDC/2022-06/The_INDC_of_TURKEY_v.15.19.30.pdf

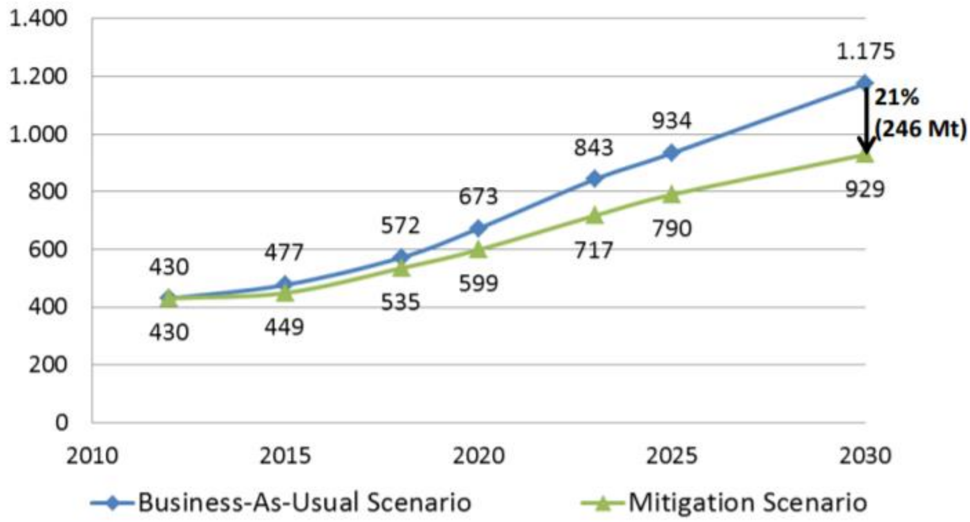


Figure 2.3: Trends for Total National GHG Emissions (Mt) for Turkey from INDC 2015

Despite these important commitments, Climate Action Tracker[9] (CAT) rates the climate commitments of Turkey up to 2019 as "Critically Insufficient", since if all countries were to follow Turkey's approach, global warming would exceed 4°C, thus not in line with Paris Agreement. The trends and forecasts carried out by CAT for 2030 and 2050, including the decrease in GHG emissions related to the COVID-19 pandemic are presented in Figure 2.4.

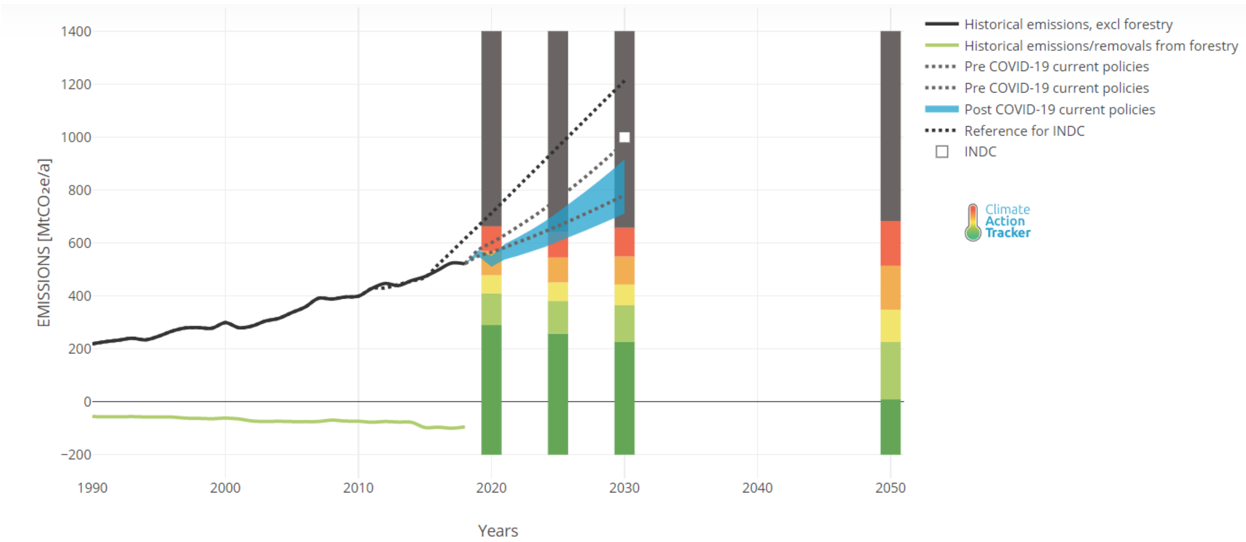


Figure 2.4: Trends for Total National GHG Emissions for Turkey from CAT 2020

****

9 https://climateactiontracker.org/countries/turkey/

In this context, Turkey is taking steps to prepare its economy for closer ties with EU legislation. One important step towards this integration has been the preparation of new legislation to monitor and verify emissions across a range of sectors. Regulation on “Greenhouse Gases Emission Monitoring“ entered into force on April 25th, 2012 with the publication of 28274 numbered official gazette, implements key parts of the EU Monitoring Mechanism Decision 280/2004/EC. Following some amendments on several articles, the regulation has been revised and republished on May 17th, 2014 on 29003 numbered official gazette. Within the scope of the legislation, industries mentioned in Appendix-1 of the regulation are subject to annual monitoring, reporting and verification processes. The monitoring plans, which are prepared within the legislation scope, are delivered to Ministry via Environmental Information System. The Project is subject to the following article in the Appendix-1 of regulation.

3 METHODOLOGY

International Financial Institutions (IFIs) are committed towards the contrast of climate change and the reduction of GHG emissions. For this reason, their covenants for project loans include requirements to adopt best practices to carry out GHG analyses and climate change risk assessments.

According to the UNFCCC[10], climate-related risks include different hazards, some of which occur gradually (e.g.: change in temperature and precipitations) and some suddenly (e.g.: extreme events like storms and floods). The same concepts are presented by the World Economic Forum (WEF) Global Risks Report 2020[11], which includes weather and climate risks among the top global risks, especially regarding the potential "failure of climate-change mitigation and adaptation" and "extreme weather events".

In order to increasingly account for climate-related aspects in the realization of new projects, the Equator Principles IV[12] published on July 2020 introduced the requirement to carry out a CCRA aligned with Climate Physical Risk and Climate Transition Risk categories as outlined in the Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD)[13]. Specifically, the Equator Principles state that a CCRA is required:

- ✓ for all Category A and - as appropriate - Category B Projects, to cover physical risks;
- ✓ for all Projects having combined Scope 1 and Scope 2 emissions greater than 100,000 tCO_2e/y, to cover climate transition risks and carry out a Climate Change Alternatives Analysis (which evaluates lower GHG alternatives).

Scope 1 indicates the direct emissions from owned or controlled sources. Scope 2 covers indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed. Whereas Scope 3 includes all other indirect emissions that might occur due to the project.

In light of these considerations, once estimated the Project's greenhouse gases emissions (GHGs), this CCRA investigates the physical and the transition risks and provides an evaluation of the adaptation measures to mitigate the climate change impact. In addition, the Climate Change Alternatives Analysis is elaborated to evaluate lower GHGs alternatives.

In order to calculate emissions from the project, the IPCC Guidelines for National Greenhouse Gas Inventories published in 2006, The European Bank for Reconstruction and Development (EBRD), The European Investment Bank (EIB), and UK GHG emission conversion factor by Department for Business, Energy & Industrial Strategy are used (IPCC, 2006; BEIS, 2020; EIB, 2020).

Moreover, the climate change risk assessment is structured on a bottom-up approach based on the following steps:

1. estimation of the GHGs emissions;
2. identification of climate pattern variation;
3. description of specific changes;
4. estimation of associated effects due to the changes;
5. assessment of the probability of such effects;
6. assessment of impact of such effects;
7. proposal of adaptation measures to be considered by the project to adapt to potential future climate scenarios (up to the year 2060);
8. assessment of residual risk; and
9. evaluation of the lower GHG alternatives.

Once the effect of the climate pattern variation and the adaptation measures are assessed, the residual risk is estimated. The residual risk represents the risk that remains after efforts to identify and eliminate some or all types of risk have been made.

****

[10] https://unfccc.int/topics/resilience/resources/climate-related-risks-and-extreme-events

[11] http://www3.weforum.org/docs/WEF_Global_Risk_Report_2020.pdf

[12] https://equator-principles.com/wp-content/uploads/2020/05/The-Equator-Principles-July-2020-v2.pdf

[13] https://assets.bbhub.io/company/sites/60/2020/10/FINAL-2017-TCFD-Report-11052018.pdf

4 GREENHOUSE GASSES EMISSIONS

The present Section focuses on the GHG emissions correlated with the Project; it provides an overview of international and national requirements in this field and, to conclude, presents the quantification of GHG emissions for the operation and construction phases of the Project.

4.1 APPLICABLE REQUIREMENTS

The following paragraphs present the requirements related to GHG emissions that are introduced by international organizations, international financial institutions, Turkish national policies.

4.1.1 International Requirements for Assessment of GHG Emissions

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 following an agreement between the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). The IPCC is an international scientific organization studying the variations of climate patterns and the impact that they can have on natural and economic systems and on human health, as well as the solutions to mitigate their effects. The latest report of the IPCC is the Sixth Assessment Report[14] published in 2022.

The IPCC Guidelines for National Greenhouse Gas Inventories were first published in 2006 with the aim of support the preparation of the national GHG inventories by the member countries, by providing default values of emission factors for various fuels and sectors, to allow the quantification of GHG emissions based on national data. The IPCC Guidelines were refined in 2019, when an updated version of the methodology[15] was issued.

4.1.2 Requirements of the International Financial Institutions

In addition to national and supranational authorities, also International Financial Institutions (IFIs) are committed towards the contrast of climate change and the reduction of GHG emissions. For this reason, their covenants for project loans include requirements to adopt best available techniques, to carry out GHG analyses and climate change risk assessments and to open carry out GHG emissions reporting. The main references for this are the Equator Principles IV, dated July 2020 and the IFC Performance Standards on Environmental and Social Sustainability[16], dated January 2012.

For projects expected to generate more than 25,000 tCO_2e/y of GHG emissions, a quantification of the direct and indirect emissions within the Project boundaries shall be carried out in line with an internationally recognized methodology.

Moreover, in accordance with Equator Principles IV, for projects with Scope 1 (direct) and Scope 2 (indirect) GHG emissions totalling more than 100,000 tCO_2e/y, a Climate Change Alternatives Analysis shall be carried out to evaluate possible options to reduce GHG emissions, and open reporting of GHG emissions must be published; moreover, for all Category A and - as appropriate - Category B projects, a Climate Change Risk Assessment shall be carried out to analyse physical risks (always) and transition risks (only for projects emitting more than 100,000 tCO_2e/y).

4.1.3 Regulation of Greenhouse Gas Emissions in Turkey

According to the 7th National Communication to UNFCCC, the climate-related policy of the Republic of Turkey is mainly framed by the National Climate Change Strategy (NCCS, 2010-2023) and the National Climate Change Action Plan (2011-2023); moreover, the 10th Development Plan for 2014-2018 introduced the concept of “Green Growth” in several areas (energy, industry, agriculture, transport, construction, services and urbanization), which

****

14 https://www.ipcc.ch/assessment-report/ar6/

15 https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/

16 https://www.ifc.org/wps/wcm/connect/c02c2e86-e6cd-4b55-95a2-b3395d204279/IFC_Performance_Standards.pdf?MOD=AJPERES&CVID=kTjHBzk

was confirmed in the 11th Development Plan (2019-2023). Since the energy sector has the highest GHG emissions share, the Intended Nationally Determined Contribution (INDC) issued in 2015 introduced clear renewable energy generation targets, particularly in power sector: to reach these targets, policy instruments like the Renewable Energy Sources Support Mechanism (YEKDEM) and By-Law on Renewable Energy Resource Areas (YEKA) have significantly contributed to investments in solar and wind power. Other relevant laws in the field are the National Renewable Energy Action Plan dated 2014 (target: to produce at least 30% electricity from renewables by 2023) and the Energy Efficiency Laws dated 2007 and 2012.

The INDC submitted by Turkey in 2015 aims at unconditionally reducing GHG emissions including LULUCF in 2030 by 21% with reference to a Business-as-Usual projection, as outlined in Figure 2.3.

4.2 GHG EMISSIONS ASSESSMENT

A review of the available data on the existing operations and proposed project has been undertaken. Information on the construction phase of the Project is limited as the development of designs is still at feasibility stage. Data for the operational phases has been taken from the most up-to-date information available at the time of writing and supplemented with assumptions where necessary.

4.2.1 Project Boundaries

The project boundary separates the entities (in other words, the facilities and operations) whose emissions are included in the assessment from those that are not. Construction phase emissions are normally not included in the assessment as they are typically not considered to be significant compared with operational emissions. However, construction related emissions were included in this assessment as they are greater than 5% of total emissions. The GHG emissions of the Project in Construction phase are assessed in terms of Scope 1, Scope 2 and Scope 3.

4.2.2 Construction Phase GHG Emissions

It is planned that construction phase will take 38 months after finalizing paper works with authorities. According to information supplied by the project owners, different types of machinery equipment will be used as reported in Table 4.1. While calculating GHG emissions from construction phase, UK Government GHG Conversion Factors for Company Reporting 2020 Version 1.0 were used (BEIS, 2020). It is estimated that the load factor is 0.5.

Table 4.1: Machinery lists from construction phase

Machinery	Capacity	Description	Quantity
Tower Crane	1000 - 1500 ton	Equipment Erec.	1
Crawler	600 - 800 ton	Equipment Erec.	1
Crawler	300 - 400 ton	Equipment Erec.	2
Crawler	160 - 250 ton	Equipment Erec.	2
Mobile Telescopic	150 - 200 ton	Pipe Fab. & Erection	5
Mobile Telescopic	60 - 100 ton	Pipe Fab. & Erection	12
Mobile Telescopic	25 - 50 ton	Pipe Fab. & Erection	10
Tower Crane	10 ton	Furnaces& Boiler	4
Trailer	10 - 60 ton	Transport	15
Boom Truck	10 ton	Transport	8
Forklift	5 ton	Pipe prafab, Civil & Steel Str.	5
Manlift	40mt	Piping&steel str.	15

The total fuel consumption for the machineries is 53,532 tonnes (1,036,800 kW) and total emissions from construction phase amount to 81,200 tCO_2e.

As all electricity requirement will be obtained from the grid (no construction works will be performed at remote locations) during the construction, no diesel generators will be used.

In terms of Scope 2 emissions, the approximate electricity requirement for peak months is estimated to be between 12 to 15 MW. Assuming an average total number of annual working hours of 2,080 and the emission factor of 0.484[17] tCO_2e/MWh, the total Scope 2 emissions amount to 12,080 – 15,100 tCO_2e.

Under the construction phase of the project, Scope 3 emissions from category 3 (Fuel- and Energy-Related Activities, Not Included in Scope 1 or Scope 2) and category 7 (Employee Commuting) defined in EPA (2021) were calculated as 8,863 tCO_2e (tonnes/year) (GHG Protocol, 2021).

Total GHG emissions (Scope 1, Scope 2 and Scope 3) from the construction of Ceyhan Polypropylene Production Plant were calculated as 102,143 – 105,163 tCO2e (tonnes).

4.2.3 Operation Phase GHG Emissions

4.2.3.1 Scope 1 Direct GHG Emissions

Scope 1 emissions are direct greenhouse (GHG) emissions that occur from sources that are controlled or owned by an organization (e.g., emissions associated with fuel combustion in boilers, furnaces, vehicles).

Within the scope of the project, there are two utility boilers, one 34 MW charge heater and three interheaters with a thermal power of 31, 28 and 28 MW, respectively. The utility boilers are in operation at 50% load each (34 MW). The PDH Off gas available is assumed to be used as fuel gas to both Heaters and Boilers. Since the combustion would be complete combustion, no CH_4 are foreseen in the flue gas streams. The PDH might be responsible for a small share of NOx (Nitrous Oxide), that the Company can include in the future GHG assessment. To the purpose of this CCRA, the NOx emissions are not estimated since they represent a very small share compared to the CO_2 emissions.

In order to calculate GHG emissions, "2006 IPCC Guidelines for National Greenhouse Gas Inventories the Default Emission Factors for Stationary Combustion in The Energy Industries" document was used. The projects emission sources and their yearly emission were given in Table 4.2.

Moreover, the total Scope 1 emissions, according to the data shared by the Company in March 2023, in the operation phase amount to 177,152 tCO_2/year.

Table 4.2: Calculation of boilers and heaters GHG emissions

Service	Thermal Power (MW)	Pollutant	Pollutant Flowrate (kg/h)	Working Hour/day	Working Day/year	Total CO_2 (tonnes/year)
Charge Heater (01-H-101)	27	CO_2	2,896	24	333	23,141
No 1 Interheater	30	CO_2	3,271	24	333	26,145
No 2 Interheater	28	CO_2	3,022	24	333	24,148
No 3 Interheater	23	CO_2	2,500	24	333	19,981

****

17 https://enerji.gov.tr/evced-cevre-ve-iklim-elektrik-uretim-tuketim-emisyon-faktorleri#:~:text=Son%20olarak%2C%20elektrik%20t%C3%BCketim%20noktas%C4%B1,2%2De%C5%9Fd.%20sera%20gaz%C4%B1%20emisyonu

Service	Thermal Power (MW)	Pollutant	Pollutant Flowrate (kg/h)	Working Hour/day	Working Day/year	Total CO_2 (tonnes/year)
NVIRO		CO_2	3,308	24	333	26,437
Flare purge gas		CO_2	892	24	333	7,131
Utility Boiler 1 (Assuming 29.45 MW Thermal Input)	29	CO_2	3,139	24	333	25,084
Utility Boiler 2 (Assuming 29.45 MW Thermal Input)	29	CO_2	3,139	24	333	25,084
					Emissions (tCO_2)	**177,152**

In addition, RINA was informed by Ronesans (13th March 2023) that the flare system that will be used during the normal operation will generate a limited amount of GHG emissions resulting only from flare header purge and fuel gas used for flare pilots. The actual flaring operation and the resulting GHG emissions to be generated from combustion from flares will be discontinuous and will emerge during rare emergency situations. Therefore, GHG emissions only from flare header purge and fuel gas used for flare pilots are included, and, emergency flaring are not included to the calculations

4.2.3.2 Scope 2 Indirect GHG Emissions

Scope 2 emissions are indirect GHG emissions associated with the purchase of electricity, steam, heat, or cooling generated from a fossil fuel source. It is planned that net electricity consumption in the project will be 667 GWh yearly. However, since the Project company has planned to cover electricity needs with energy from renewable sources, the Scope 2 emissions are null.

In addition, RINA received a further confirmation by Ronesans (13th March 2023) that the electricity consumption during the operation phase will be entirely from renewable energy. Ronesans highlighted their commitment to rely on renewable energy sources and availability to provide an official letter on demand. Besides, as per to the information received from Ronesans on 16th March 2023, contract with electricity supplier for renewable energy usage during operation will be completed in May 2023.

4.2.3.3 Scope 3 Indirect GHG Emissions

Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly impacts in its value chain. It has to be remarked that, the Scope 3 emissions estimation is not compulsory in the context of the CCRA, however the TCFD recommendations encourages the more virtuous companies to assess them appropriately.

The feedstock will be supplied by one of the project's partner, Sonatrach, and Propane (556,000 tonnes/year) will be transported from Algeria twice a month by sea tankers. The distance from Algeria to the project location is about 3,400 km per transfer. It is projected that transfer will be bimonthly, and emissions calculated for one way. Annual GHG emissions were given in Table 4.3.

Table 4.3: Calculation of transportation GHG emissions

Feedstock	Product (tonnes/year)	Number of shipments from Algeria per year	Distance One Way (km)	Emission Factor (kg CO2e/km)	CO_2e (t/year)
Propane	556,000	24	81,600	0.00943	770
				tCO_2e (tonnes/year)	**770**

**UK Government GHG Conversion Factors for Company Reporting 2020 Version 1.0 (BEIS, 2020)*

The Scope 3 Evaluator Tool (GHG Protocol, 2021) was used to calculate the Scope 3 emissions reported in Table 4.4. Emissions from category 3 and category 7 defined in EPA (2021) calculated as 673 tCO_2e/year.

Table 4.4: Scope 3 GHG emissions

Scope 3 Categories	CO_2e (t/year)
Category 3 Fuel- and Energy-Related Activities, Not Included in Scope 1 or Scope 2	460
Category 7 Employee commuting	213
tCO_2e /year	**673**

Moreover, the total Scope 3 GHG emissions amount to 1443 tCO_2e/year. However, the boundaries of Scope 3 emissions are very large since these are linked to the Project but not owned or controlled by the reporting organization. In future assessments, the Company might consider including the Scope 3 emissions also for: (1) the final use of the products, including the end of life; (2) the transport of all raw materials and products; and (3) the waste and waste-water treatment.

4.2.4 Annual Total Emissions (Construction and Operation)

GHGs emissions from the project were calculated under the Scope 1, 2, and 3 for both construction and operation phases. During the construction phase, that is planned to last 38 months, the total GHG emissions from the construction of Ceyhan Polypropylene Production Plant amount to 102,143 – 105,163 tCO_2e, respectively 81,200 tCO_2e for Scope 1, 12,080 – 15,100 tCO_2e for Scope 2 and 8,863 tCO_2e for Scope 3.

As concerns the operation phase, GHG emissions related to the PDH-PP amount to 178,595 tCO_2/year, which is higher than the threshold of 100,000 tCO_2e/y specified in the Equator Principles IV (July 2020). It is worth mentioning that the Equator Principles suggest reporting publicly on an annual basis on GHG emission levels (combined Scope 1 and Scope 2 Emissions) and GHG efficiency ratio, as appropriate, during the operational phase for Projects emitting over 100,000 tonnes of CO_2 equivalent annually.

The total GHG emissions from the construction and the operation phases of the project are reported respectively in Table 4.5 and Table 4.6. It should be noted that the construction phase duration is limited approximately to 38 months.

Table 4.5: Major GHG emissions related to the PDH-PP in the Construction Phase

Emissions		Activity	CO_2e
Construction Phase	**Scope 1**	Construction activities (trucks, forklifts, tower cranes etc.)	**81,200**
	Scope 2	Purchase of electricity, steam, heat, or cooling generated from a fossil fuel source	**12,080 – 15,100**
	Scope 3	Category 3 - Fuel- and Energy-Related Activities, Not Included in Scope 1 or Scope 2 Category 7 – Employee commuting	**8,863**
		tCO_2e	**102,143 – 105,163**

Table 4.6: Major annual GHG emissions related to the PDHPP in the Operation Phase

Emissions		Activity	CO_2e
Operation	**Scope 1**	Operational process (Boilers, Heaters, Flue Gas)	**177,152**

Emissions		Activity	CO_2e
Phase	**Scope 2**	Purchase of electricity, steam, heat, or cooling generated from a fossil fuel source	**0**
	Scope 3	Transportation and Distribution Category 3 - Fuel- and Energy-Related Activities, Not Included in Scope 1 or Scope 2 Category 7 – Employee commuting	**1,443**
		tCO_2e/y	**178,595**

5 CLIMATE CHANGE ASSESSMENT

The present section focuses on the analysis of the climate patterns at the Project location, including observed trends for temperature, precipitations, wind and hazardous climate events over the last years and the projections for the upcoming decades, up to 2060. The Project is located in the Yumurtalik district of Ceyhan city in the Adana Province of Turkey.

5.1 CLIMATE CHANGE BASELINE

This paragraph presents the climatic trends observed in the latest years in the Project location. The climate baseline is elaborated analysing temperature, insolation, precipitations and wind. Long-term statistical data are analysed to evaluate the baseline meteorological conditions.

5.1.1 Temperature

Turkey lies between latitudes 36-42°N and adjacent to the Mediterranean Sea and so might be expected to have a Mediterranean climate which does apply to the southern coastal areas where the project will be operated. In summer-time period, southern coastal areas are mostly dry and sunny. In general, Turkey is warm or hot in summer and cold or very cold in winter. In Ceyhan, a typical Mediterranean climate is observed, with very hot and dry summers, and warm and rainy winters. Figure 5.1 reports the minimum, mean and maximum average monthly temperature in Adana in 1991-2020. It can be noticed that January, February and December are the coldest months with nearly zero minimum temperatures and averages between 5°C and 7°C. The highest temperatures occur in July and August with maximum of 32°C and averages around the 25°C-26°C.

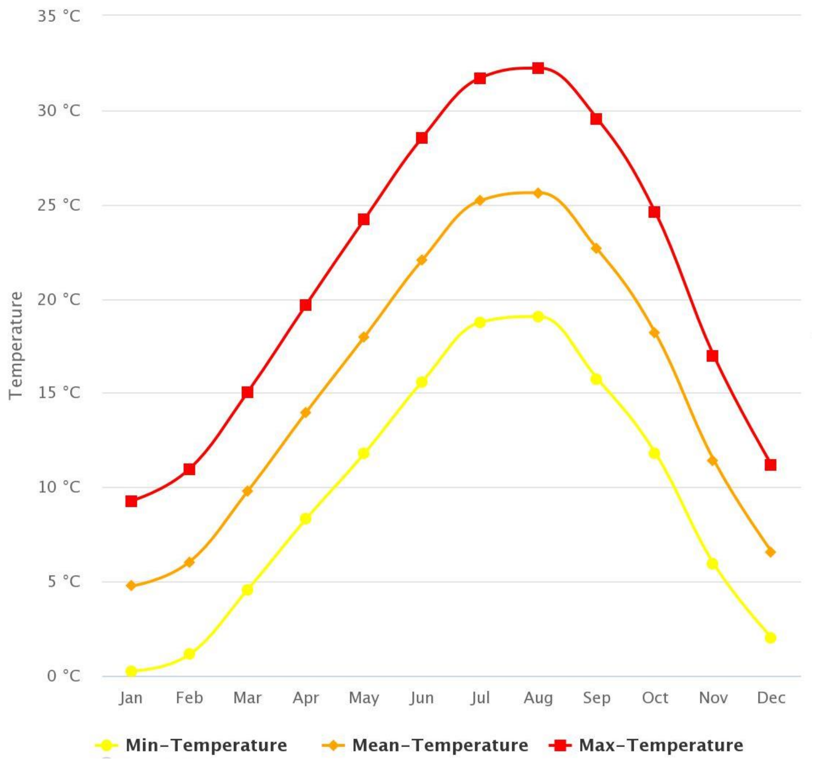


Figure 5.1: Minimum, Mean and Maximum Average Monthly Temperature in Adana in 1991-2020 (Source: World Bank[18])

****

[18] https://climateknowledgeportal.worldbank.org/country/turkiye/climate-data-historical

In Figure 5.2, it is clearly seen that between 1979 and 2019 the temperature shows an increasing trend in overall Turkey. The Southeast region where Ceyhan is located has clearly the hottest trends.

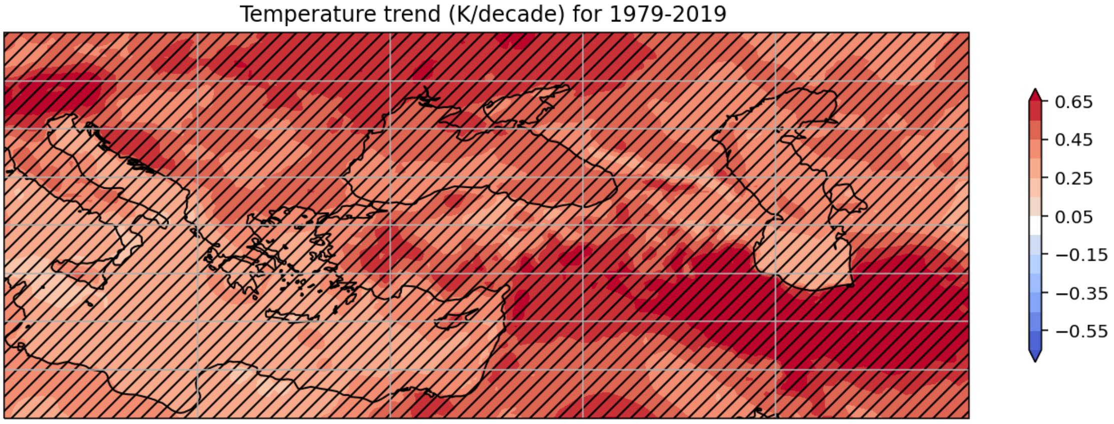


Figure 5.2: ERA5 Temperature Trends over Turkey from 1979-2019

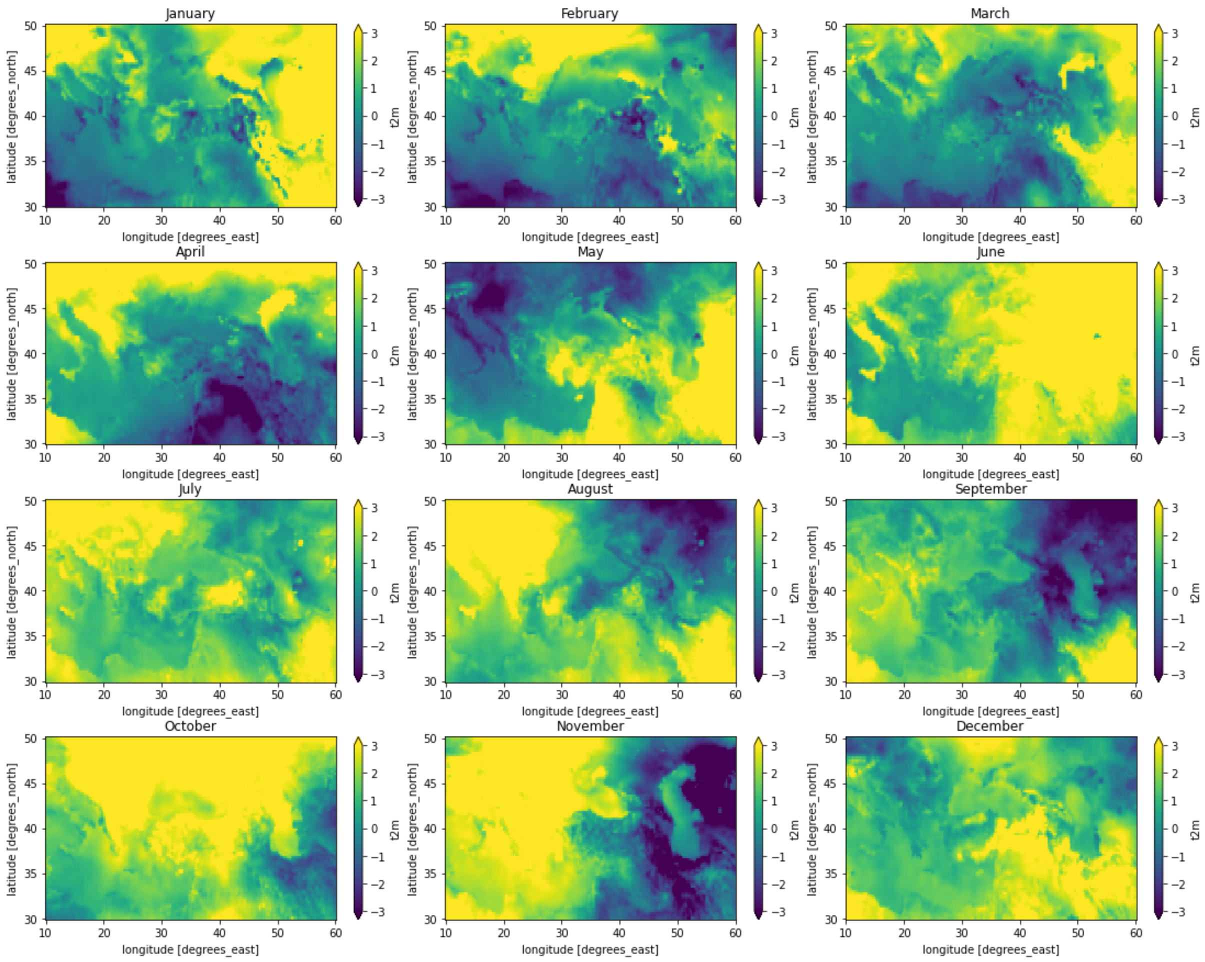


Figure 5.3: ERA5 monthly temperature trends over Turkey

In order to reveal temperature changes in detail, Figure 5.3 shows how monthly trends change over Turkey. While there are not much significant trends in winter, significant temperature increase is clearly seen towards the end of spring. In summer-time period, especially in June, the trend for increased temperature is very evident, and this is also true for October, November and December.

In addition, night-time temperatures (daily minima) show widespread decreases in the frequency of cool nights and increases in the frequency of warm nights with widespread higher confidence, especially for the increase in warm nights. Day-time temperatures (daily maxima) show a mixed signal in frequency of cool days but a spatially consistent signal for increasing warm days.

Moreover, many studies detected a long-term trend in terms of increase of annual number of summer and tropical days and nights in Turkey over the last decades.[19] In particular, a study found an upward trend in the number of tropical days (the annual number of days with maximum temperature ≥ 30 °C) over a 61 year study period from 1950 to 2010.[20] In this regard, Figure 5.4 shows inter-annual variations in the number of tropical days averaged from 97 stations in Turkey during the period 1950-2010. It could be noted that after 1976, a strong trend towards a higher number of tropical nights was detected, with 1994, 2007 and 2010 registering abnormally warm days at many stations of Turkey. This trend is confirmed by Figure 5.5 that reports the number of tropical nights (T-min > 20°C) between 1951 and 2020 extracted from the World Bank Climate Change Knowledge Portal.

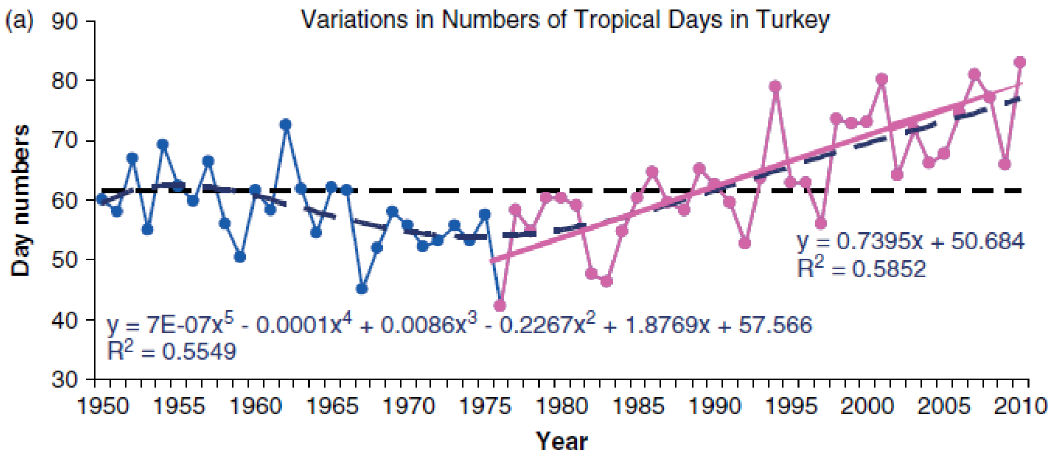


Figure 5.4: Variations in numbers of tropical days over Turkey for the period 1950-2010 (Source: Erlat & Türkeş, 2013)

****

[19] Erlat, E. and Türkeş, M. (2013), Observed changes and trends in numbers of summer and tropical days, and the 2010 hot summer in Turkey. Int. J. Climatol., 33: 1898-1908. https://doi.org/10.1002/joc.3556; Sensoy, Serhat & TÜRKOĞLU, Necla & AKÇAKAYA, Alper & Ekici, Mithat & ULUPINAR, Yusuf & Demircan, Mesut & Atay, Hakkı & TÜVAN, Arzu & DEMİRBAŞ, Hatice. (2013). Trends in Turkey Climate Indices from 1960 to 2010; Abbasnia, Mohsen & Toros, Hüseyin. (2018). Monitoring observed changes in warm-days extremes over Turkey. Natural Resources Conservation and Research. 1. 10.24294/nrcr.v1i3.869.

[20] Erlat, E. and Türkeş, M. (2013), Observed changes and trends in numbers of summer and tropical days, and the 2010 hot summer in Turkey. Int. J. Climatol., 33: 1898-1908. https://doi.org/10.1002/joc.3556.

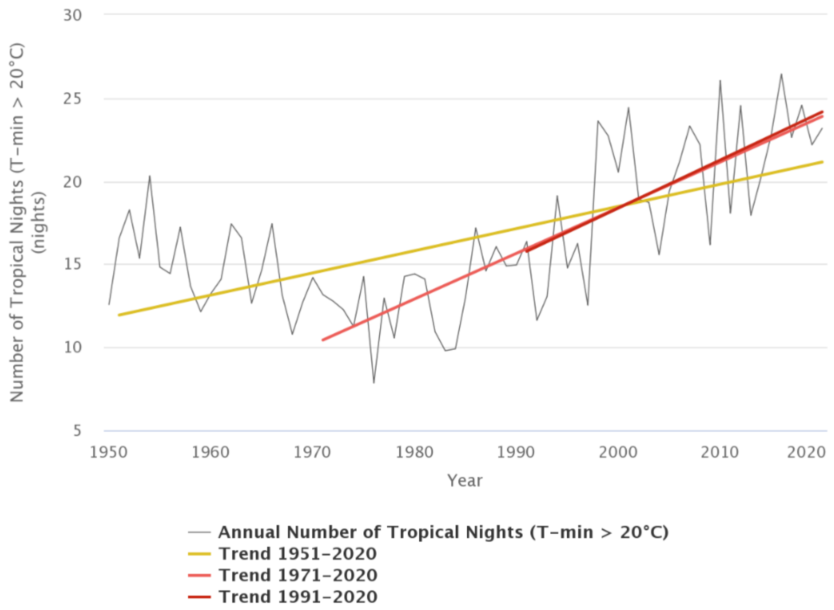
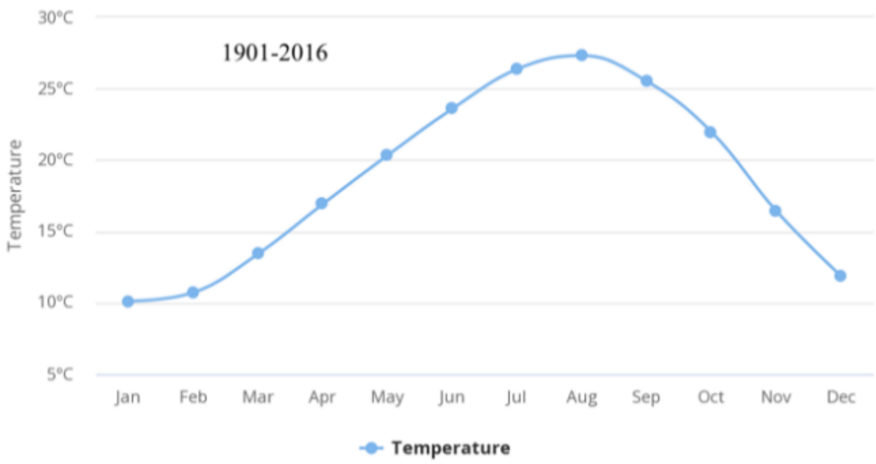


Figure 5.5: Number of Tropical Nights (T-min > 20°C) Annual Trends in Turkey. Source: Climate Change Knowledge Portal

In the project area, Figure 5.6 shows how monthly temperature averages change between 1901-2016 and 1991-2016. It is easy to say that there is warming trend in the project area through the year of 1991-2016 by about 1°C.

When looking at the January, it seems to be no temperature changes at first glance, but by looking in detail, there is an increase from 10,11°C to 10,56 °C. Higher changes can be seen in August by 1°C.



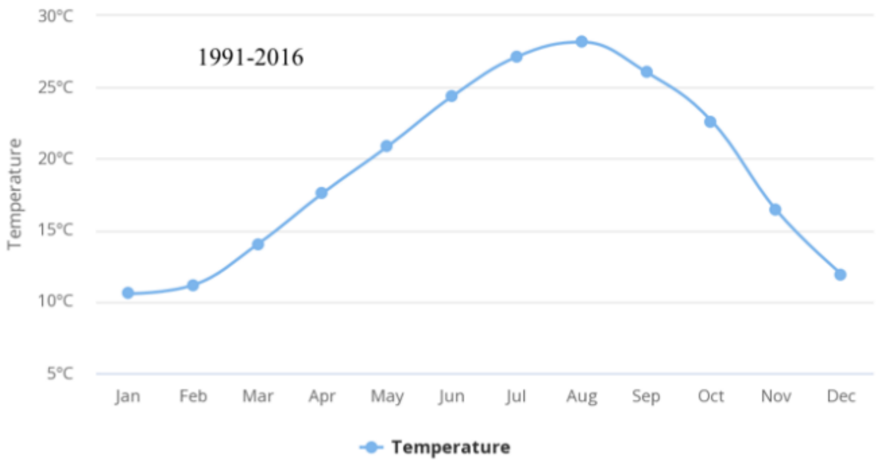


Figure 5.6: Monthly Temperature Averages in the Project Location, Ceyhan

Daily temperature means in Ceyhan from TSMS were given in Figure 5.7. It is possible to see the kind of extremes, and remarkable fluctuations in the project area. İn late April, there was a sharp decrease by 11 °C, average of wintertime in project area. A month later, in mid-May 27 °C were observed and this was the normal for summer averages.

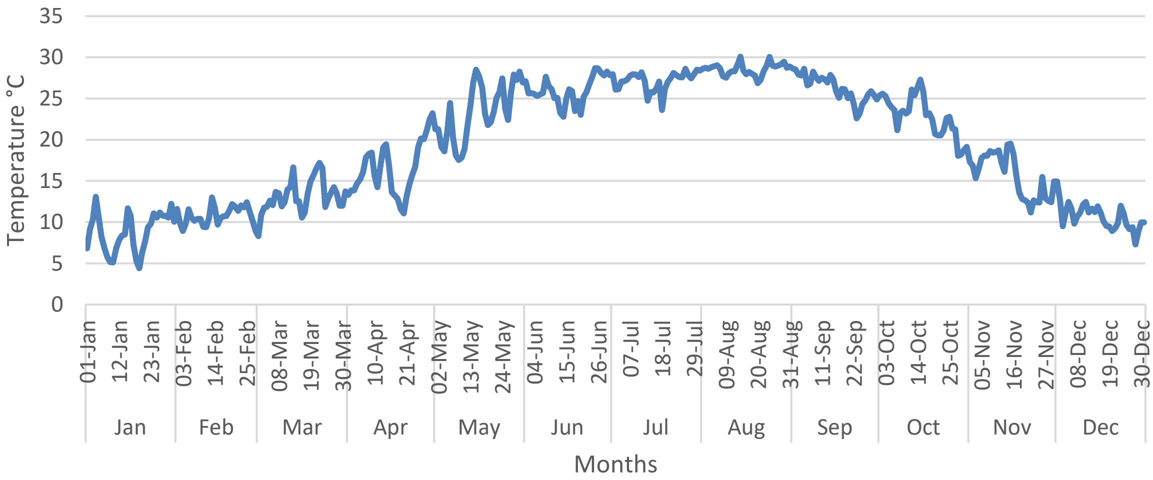


Figure 5.7: Daily Temperatures in 2019 (Ceyhan, Adana)

Figure 5.8 reports the Variability and Trends of Mean Temperature in Adana in 1971-2020 according to the Climate Change Knowledge Portal[21].

****

[21] https://climateknowledgeportal.worldbank.org/country/turkiye/trends-variability-historical

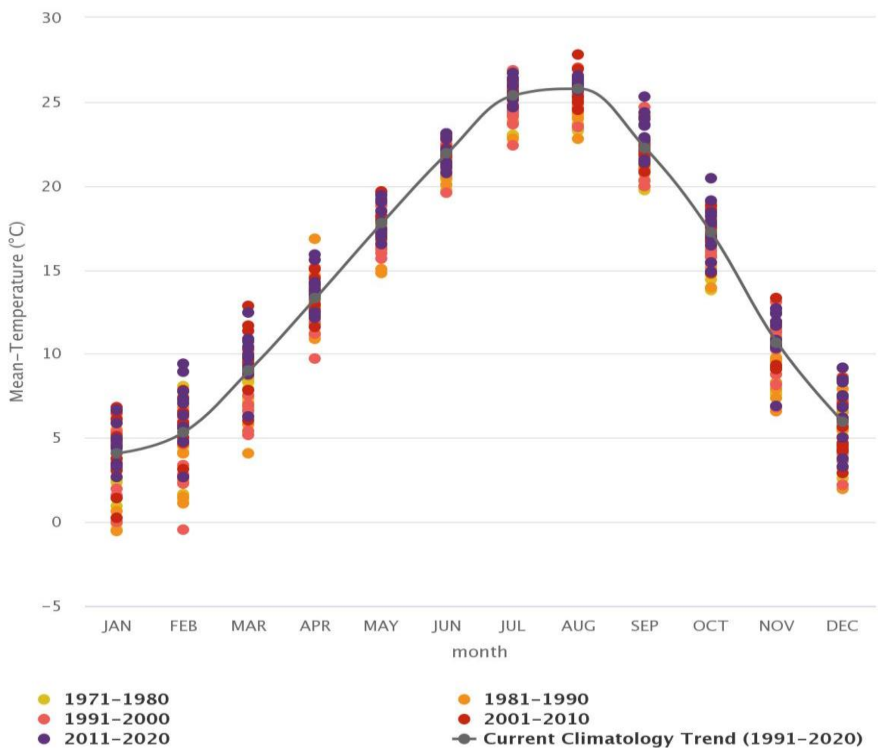


Figure 5.8: Variability and Trends of Mean Temperature in Adana in 1971-2020

5.1.2 Solar Irradiation

According to the Global Solar Atlas[22], Yumurtalik is characterized by an annual average Direct Normal Irradiation (DNI) that is around 1,865.4 kWh/m² and by an annual average Diffuse Horizontal Irradiation (DHI) that is around 646 kWh/m² as reported in Table 5.1. Direct irradiance is the part of the solar irradiance that directly reaches a surface; whereas the diffuse irradiance is the part that is scattered by the atmosphere.

Table 5.1: Main characteristics of solar radiation in Yumurtalik (Source: Global Solar Atlas)

	Value	Unit
Direct normal irradiation (DNI)	1,865	kWh/m²/year
Diffuse horizontal irradiation (DHI)	646	kWh/m²/year
Global tilted irradiation at optimum angle	2,050	kWh/m²/year
Air temperature	20	°C
Terrain elevation	8	M

****

22 https://globalsolaratlas.info/map?c=45.32727,9.406354,11&r=ITA&s=45.32727,9.406354&m=site

5.1.3 Precipitation

In Adana, the annual average precipitation was 58.8 mm/y over the last 30 years (1991-2020). The highest precipitations occur between December and January, while July and August registered the lowest average rate of precipitation. The monthly average rainfall is graphically presented in Figure 5.9: and the variability and trends of precipitation is shown in Figure 5.10. Moreover, as it could be noted in Figure 5.11, in the period 1951-2020 it was registered a decreasing trend in annual precipitation in Adana, a trend that was stronger in the decade 1991-2020 compared to the previous decades.

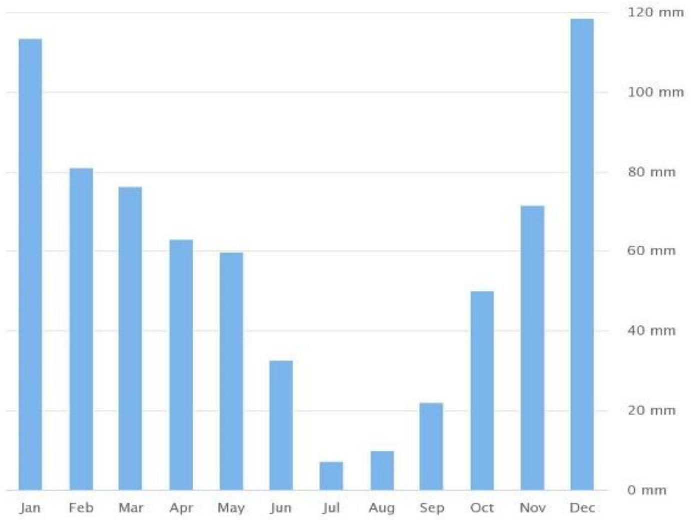


Figure 5.9: Monthly Average Rainfalls in Adana, 1991-2020

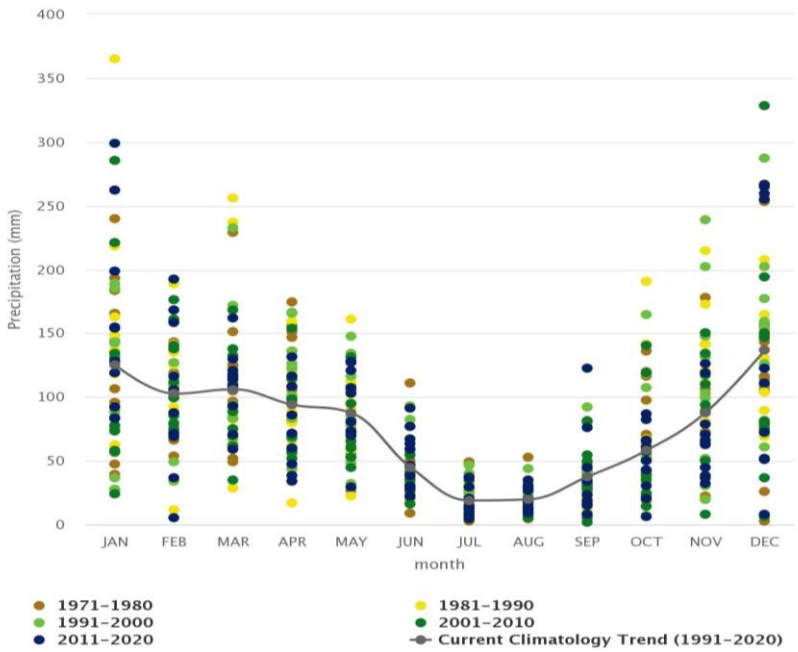


Figure 5.10: Variability and Trends of Precipitation in Adana in 1971-2020

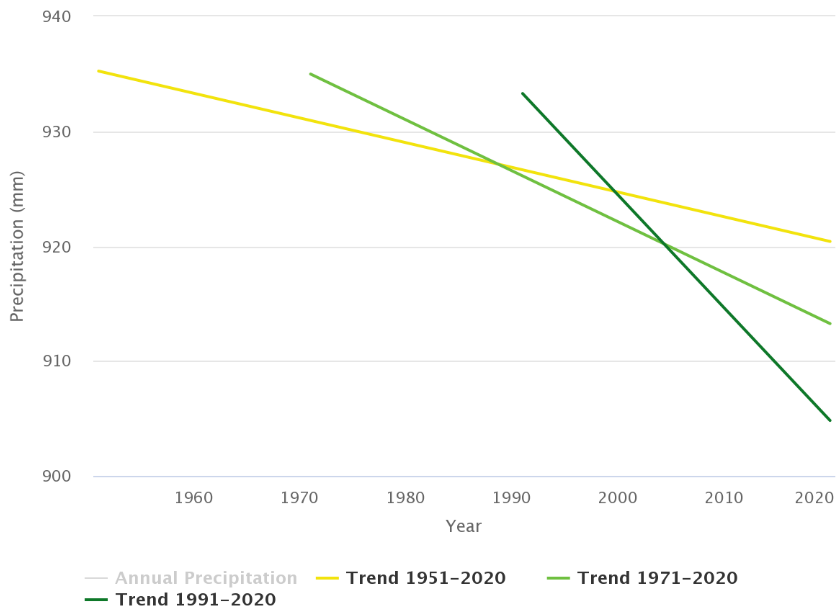


Figure 5.11: Precipitation Annual Trends in Adana in 1951-2020

5.1.4 Drought

Drought is a period of drier-than-normal conditions that results in water-related problems, an extended period of decreased precipitation and streamflow (USGS, 2021). Drought is a part of climate change, the frequency and intensity of droughts in several places have been increased recently.

According to the report by the UN Intergovernmental panel on Climate Change (IPCC), about 60% of Turkish land presents hydro climatological conditions favorable to desertification,[23] as confirmed by the high frequency of droughts occurred in the last decade,[24] and a study estimates that the intensity of drought condition is projected to increase as a consequence to climate change.[25] Figure 5.12 provides shallow groundwater storage levels as of January 11th, 2021, as measured by the Gravity Recovery and Climate Experiment Follow On satellites.[26]

****

[23] https://www.ipcc.ch/site/assets/uploads/sites/4/2022/11/SRCCL_Chapter_3.pdf

[24] Turkes, M. (2020). Climate and Drought in Turkey. In: Harmancioglu, N., Altinbilek, D. (eds) Water Resources of Turkey. World Water Resources, vol 2. Springer, Cham.

[25] Türkeş, M., M. Turp, T. An, N. Ozturk, and M.L. Kurnaz, 2019: Impacts of climate change on precipitation climatology and variability in Turkey. In: Water Resources of Turkey [Harmancioglu, N.B. and D. Altinbilek, (eds.)]. Springer International Publishing, New York, USA. Pages 467–491.

[26] https://earthobservatory.nasa.gov/images/147811/turkey-experiences-intense-drought

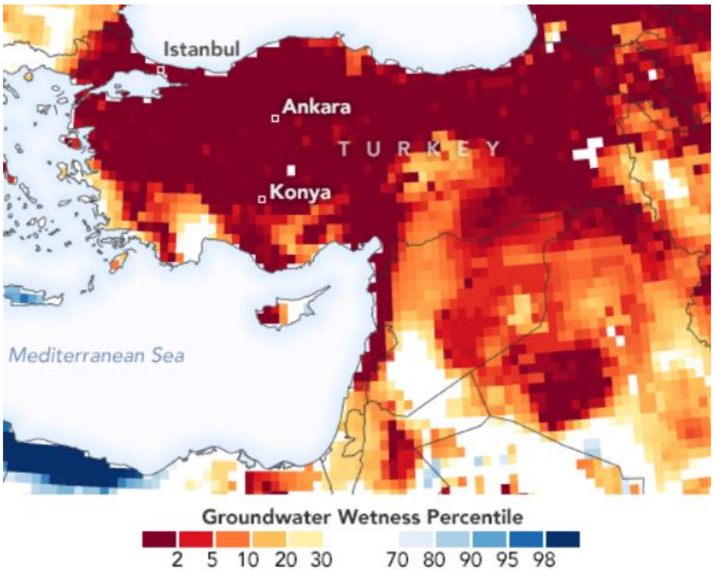


Figure 5.12: Groundwater storage in Turkey as of January 2021 (Source: NASA Earth Observatory)

The Standardized Precipitation Index (SPI) is a widely used index to characterize meteorological drought on a range of timescales. According to TSMS[27], the twelve-month standardized precipitation index shows exceptionally dry conditions in the Southeastern Anatolia Region, and severe and moderate drought in the Eastern Anatolia, and around Denizli and Burdur. Central and western Black Sea, Marmara and northern Aegean had a moist year as shown in **Error! Reference source not found.**. The Project will be located in Adana where no particular drought periods were recorded in 2021.

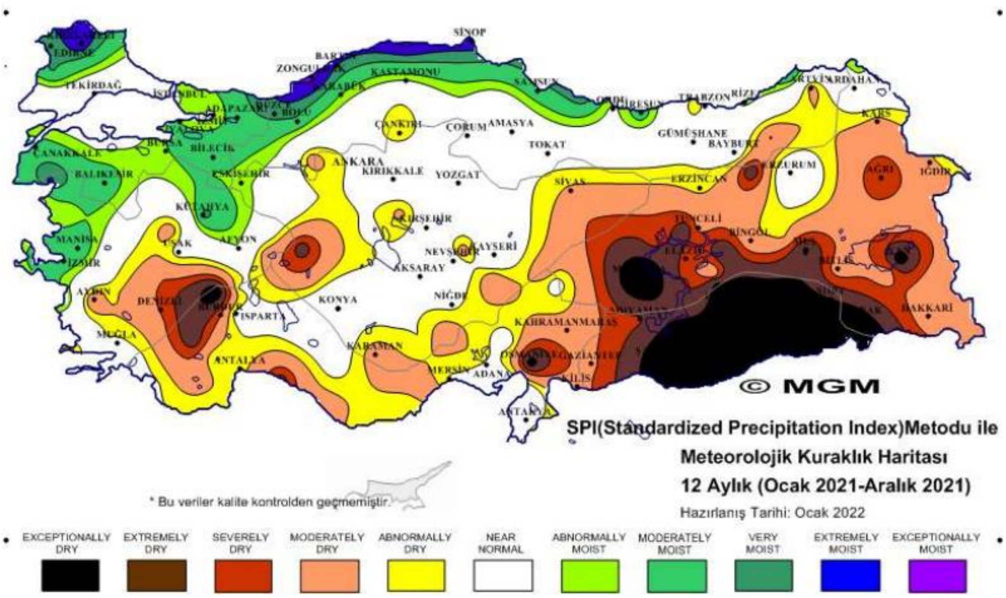


Figure 5.13: Twelve-month Standardized Precipitation Index in Türkiye in 2021 (Source: TSMS)

****

[27] https://mgm.gov.tr/eng/Yearly-Climate/State_of_the_Climate_in_Turkey_in_2021.pdf

5.2 HAZARDOUS WEATHER EVENTS

The studies carried out on climate change demonstrate the worldwide growth of damages caused by extreme weather events, with approximately 90% of most relevant economic losses due to extreme hydro-meteorological events such as floods, high-water, strong wind, storms, droughts. The ThinkHazard![28] Tool developed by the Global Facility for Disaster Reduction and Recovery (GFDRR) allows to investigate hazardous weather events in order to better understand and reduce countries vulnerability to natural hazards and climate change. The classification of hazard is based on the likelihood of the hazard exceeding predefined thresholds per each typology.

According to the ThinkHazard!, the most critical hazardous event in Yumurtalik are extreme heat and wildfire as presented in Table 5.2. It has to be remarked that coastal flood, earthquake and tsunami hazards in Yumurtalik are classified as medium implying that there is more than a 20% chance of potentially-damaging situation occurring in the next 10 years.

Table 5.2: Hazardous Weather Events likely to occur in Yumurtalik (Source: ThinkHazard!)

<table>
<tr><th>Hazardous Weather Events</th><th>Hazard Occurrence Level</th></tr>
<tr><td>Extreme heat</td><td rowspan="2">High
high levels of damage can be expected to occur within human lifetime</td></tr>
<tr><td>Wildfire</td></tr>
<tr><td>Coastal flood</td><td rowspan="3">Medium
potentially damaging effects can be expected to occur within the project or human lifetime</td></tr>
<tr><td>Earthquake</td></tr>
<tr><td>Tsunami</td></tr>
<tr><td>River flood</td><td rowspan="3">Low
potentially damaging events are less likely to occur within the project or human lifetime but are still possible</td></tr>
<tr><td>Landslide</td></tr>
<tr><td>Water scarcity</td></tr>
</table>

According to IPCC (2012), extreme events comprise a facet of climate variability under stable or changing climate conditions, which are defined as the occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends ('tails') of the range of observed values of the variable. Changing climate also leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather. These changes can be linked to changes in the mean, variance, or shape of probability distributions, or all of these.

When looking at the last five years' extremes in Turkey, as reported in Table 5.3, the highest number of extremes were observed in 2020, which almost doubled the 2016's extremes. While the average of the last ten years' extremes is 489,4 events/year, the last five years' average is 576,4 events/year. Changed average and 2020's extremes show the increased possibility and frequency of extremes.

Table 5.3: Last five years' extremes in Turkey (ESWD, 2021)

Years	2016	2017	2018	2019	2020
Number of Extreme Events	420	306	751	504	901

****
[28] https://thinkhazard.org/en/report/27459-turkey-adana-yumurtalik

For the geographical distribution of the extreme weather events observed in Turkey, the locations and types of extremes reported by the ESWD in 2020 were presented in Figure 5.14. It can be seen that heavy rainfalls and hails were highlighted over Turkey, and heavy rains and tornados were reported for the project areas.

Apart from the ESWD data, extreme events near the project area from 1975 to 2019 were obtained from six different meteorological stations operated by TSMS. As seen in Table 5.4, storms and heavy rainfalls were observed frequently near the project area, and many floods were also effective the urban areas.

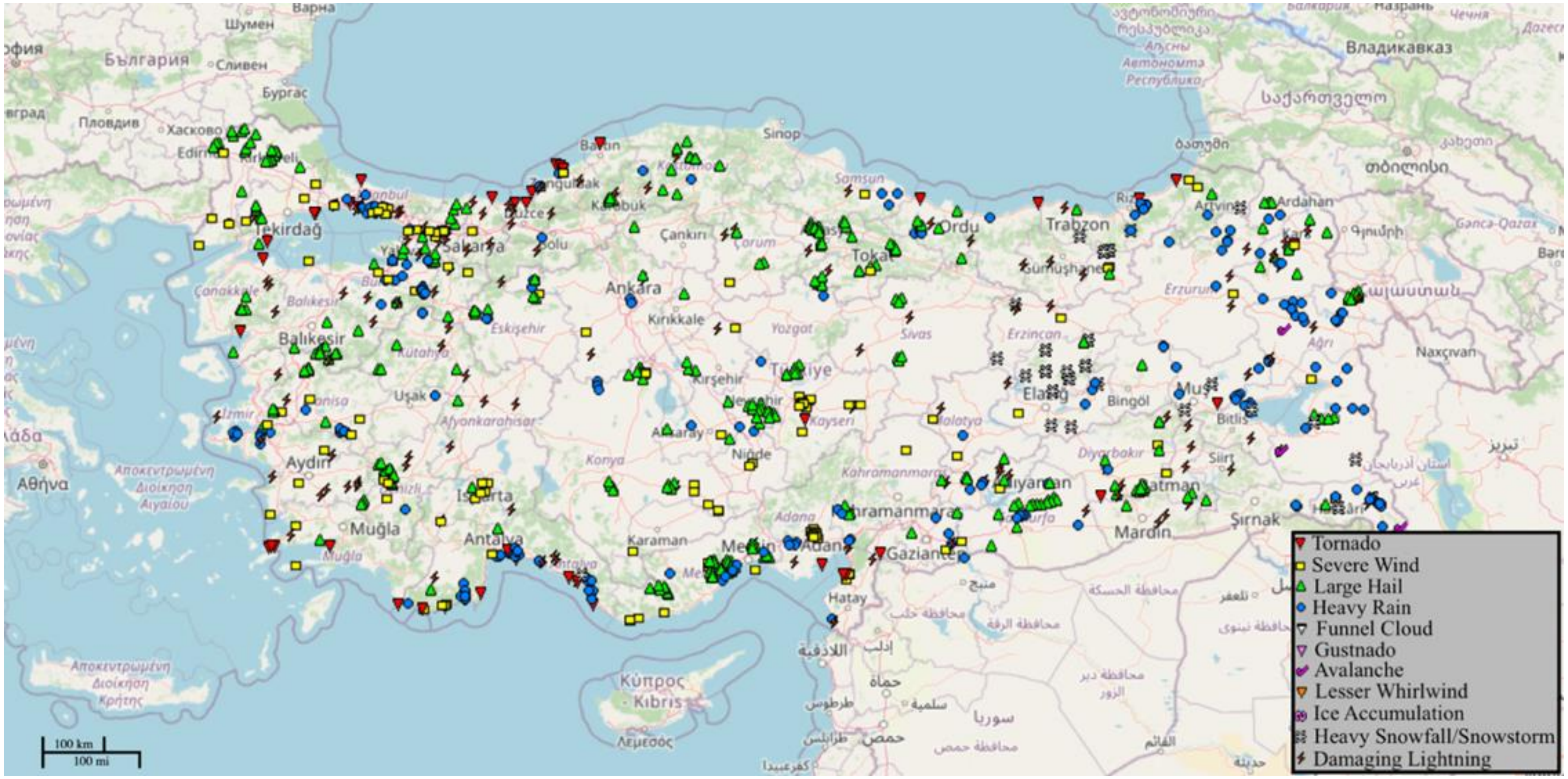


Figure 5.14: Locations of Extreme Weather Events Occurred in 2020, Turkey (ESWD, 2021)

Table 5.4: Extreme weather events near the project location from 1975 to 2019 (TSMS, 2021a)

Date	Location	City	Extremes	Date	Location	City	Extremes	Date	Location	City	Extremes
27/03/1975	Samandağ	Hatay	Rain, flood, and hail	**27/12/2006**	Ceyhan	Adana	Storm	**30/03/2014**	Adana	Adana	Storm and whirlwind
12/05/1975	Adana	Adana	Rain and flood	**24/03/2007**	Adana	Adana	Storm	**06/06/2014**	Adana	Adana	Heavy rain and flood
23/04/1976	Adana	Adana	Rain, flood, and hail	**08/04/2007**	Adana	Adana	Rain and flood	**20/07/2014**	İskenderun	Hatay	Rain and Flood
27/03/1980	Adana	Adana	Rain and flood	**29/04/2007**	Ceyhan	Adana	Rain and flood	**05/08/2014**	Adana	Adana	Lightning
02/04/1980	Adana	Adana	Rain and flood	**07/12/2007**	Samandağ	Hatay	Hail	**05/08/2014**	İskenderun	Hatay	Landslide
15/06/1981	Adana	Adana	Rain, flood, and storm	**04/04/2008**	Dörtyol	Hatay	Hail	**27/09/2014**	Adana	Adana	Storm and whirlwind
16/12/1981	Samandağ	Hatay	Rain, flood, and storm	**09/05/2008**	Adana	Adana	Rain and flood	**06/01/2015**	Adana	Adana	Storm and whirlwind
08/01/1982	Samandağ	Hatay	Storm	**10/05/2008**	Karataş	Adana	Hail	**19/03/2015**	Adana	Adana	Lightning
10/04/1983	Samandağ	Hatay	Rain and flood	**18/05/2008**	Ceyhan	Adana	Hail	**11/05/2015**	Adana	Adana	Hail
30/05/1983	Adana	Adana	Rain and flood	**24/08/2008**	Ceyhan	Adana	Storm	**26/06/2015**	İskenderun	Hatay	Rain and Flood
24/12/1983	Samandağ	Hatay	Rain and flood	**27/09/2008**	İskenderun	Hatay	Heavy rain	**21/09/2015**	Adana	Adana	Heavy rain and flood
16/02/1985	Samandağ	Hatay	Rain, flood, and storm	**22/11/2008**	Ceyhan	Adana	Rain and flood	**21/09/2015**	Adana	Adana	Storm and whirlwind
20/02/1985	Samandağ	Hatay	Storm	**29/01/2009**	Adana	Adana	Lightning	**14/03/2016**	Adana	Adana	Storm and whirlwind
27/02/1985	Samandağ	Hatay	Hoarfrost	**15/02/2009**	Dörtyol	Hatay	Hail	**18/05/2016**	Adana	Adana	Hail
10/10/1988	Adana	Adana	Rain, flood, and storm	**23/03/2009**	Karataş	Adana	Heavy rain and river flood	**19/05/2016**	Adana	Adana	Hail
10/10/1988	Samandağ	Hatay	Storm	**30/01/2010**	İskenderun	Hatay	Strom	**29/05/2016**	Adana	Adana	Heavy rain and flood
28/11/1988	Samandağ	Hatay	Storm	**03/03/2010**	Samandağ	Hatay	Hail	**30/06/2016**	Adana	Adana	Heavy rain and flood
27/02/1989	Adana	Adana	Frost-drought	**07/04/2010**	Adana	Adana	Hail	**17/08/2016**	İskenderun	Hatay	Rain and Flood
09/05/1992	Samandağ	Hatay	Rain and flood	**10/12/2010**	İskenderun	Hatay	Severe storm	**21/09/2016**	Adana	Adana	Storm and whirlwind

Date	Location	City	Extremes	Date	Location	City	Extremes	Date	Location	City	Extremes
03/01/1994	Adana	Adana	Rain and flood	**11/12/2010**	Karataş	Adana	Whirlwind	**14/12/2016**	Adana	Adana	Storm and whirlwind
12/02/1994	Samandağ	Hatay	Storm	**12/12/2010**	Karataş	Adana	Lightning	**14/12/2016**	İskenderun	Hatay	Storm and whirlwind
05/11/1994	Adana	Adana	Storm	**15/04/2011**	İskenderun	Hatay	Hail	**07/04/2017**	Adana	Adana	Heavy rain and flood
18/11/1994	Adana	Adana	Rain and flood	**12/05/2011**	İskenderun	Hatay	Hail	**23/05/2017**	Adana	Adana	Hail
21/05/1998	Samandağ	Hatay	Rain and flood	**11/06/2011**	Dörtyol	Hatay	Flood in urban areas	**14/06/2017**	Adana	Adana	Heavy rain and flood
18/02/1999	Samandağ	Hatay	Storm	**07/02/2012**	İskenderun	Hatay	Storm	**02/07/2017**	Adana	Adana	Severe cold and hot
19/02/1999	Adana	Adana	Storm	**12/03/2012**	İskenderun	Hatay	Severe storm	**28/10/2017**	Adana	Adana	Storm and whirlwind
19/02/1999	Adana	Adana	Storm	**16/04/2012**	Adana	Adana	Storm	**29/10/2017**	İskenderun	Hatay	Rain and Flood
19/02/1999	Ceyhan	Adana	Storm	**18/04/2012**	Adana	Adana	Storm	**03/01/2018**	Adana	Adana	Heavy rain and flood
03/06/2000	Ceyhan	Adana	Storm	**03/05/2012**	Adana	Adana	Rain and flood	**11/05/2018**	Adana	Adana	Hail
18/09/2002	Samandağ	Hatay	Waterspout	**21/05/2012**	Adana	Adana	Rain and flood	**05/06/2018**	Adana	Adana	Hail
16/12/2003	Ceyhan	Adana	Rain and flood	**28/02/2013**	Adana	Adana	Hail	**13/06/2018**	Adana	Adana	Heavy rain and flood
17/12/2003	Ceyhan	Adana	Storm	**03/03/2013**	Adana	Adana	Storm	**24/10/2018**	Adana	Adana	Heavy rain and flood
21/11/2004	Ceyhan	Adana	Storm	**03/03/2013**	İskenderun	Hatay	Storm	**26/12/2018**	Adana	Adana	Heavy rain and flood
08/02/2005	Ceyhan	Adana	Storm	**10/04/2013**	Adana	Adana	Heavy rain	**04/01/2019**	Adana	Adana	Heavy rain and flood
31/03/2005	Ceyhan	Adana	Storm	**14/05/2013**	Adana	Adana	Whirlwind	**14/01/2019**	Adana	Adana	Heavy rain and flood
26/10/2006	Adana	Adana	Rain and flood	**19/07/2013**	Adana	Adana	Flood in urban areas at high attitudes	**17/04/2019**	Adana	Adana	Heavy rain and flood
26/10/2006	Ceyhan	Adana	Rain and flood	**28/12/2013**	İskenderun	Hatay	Storm and whirlwind	**23/12/2019**	Adana	Adana	Heavy rain and flood

5.3 CLIMATE CHANGE SCENARIOS

5.3.1 Expected Climate Changes In Turkey

This analysis is based on the outcomes of the Fifth[29] (2013-2014) and Sixth[30] (2021-2022) IPCC Assessments. In the Fifth IPCC Assessment, four Representative Concentration Pathways (RCPs) are selected to represent the main scenarios of climate change projections up to 2100. All scenarios include time series of emissions and concentrations of the full suite of GHGs and aerosols and chemically active gases, as well as land use/land cover. At a global level, the IPCC projections indicate an expected increase in temperatures under all future climate scenarios, taking into account increasing GHG concentrations already in the in the atmosphere.

Regarding the different scenarios: in the "business as usual" scenario (RCP8.5) the expected temperature increase is in the range 2.6-4.8°C in 2081-2100 compared to 1986-2005 baseline, whereas in the intermediate scenario (RCP4.5) the increase in average temperatures is expected to be of 1.1-2.6°C and in the best case scenario (RCP2.6) with a significant reduction of GHG emissions, to keep global warming below 2°C; the projected increase in average temperatures is of 0.3-1.7°C in the same period.

The Sixth IPCC Assessment elaborated the associated socio-economic narratives for each RCP scenario called the Shared Socioeconomic Pathways (SSPs). The SSPs represent possible societal development and policy paths for meeting designated radiative forcing by the end of the century. SSPs include scenarios with high and very high GHG emissions (SSP3-7.0 and SSP5-8.5) and CO_2 emissions that roughly double from current levels by 2100 and 2050, respectively, scenarios with intermediate GHG emissions (SSP2-4.5) and CO_2 emissions remaining around current levels until the middle of the century, and scenarios with very low and low GHG emissions and CO_2 emissions declining to net zero around or after 2050, followed by varying levels of net negative CO_2 emissions (SSP1-1.9 and SSP1-2.6).

As mentioned in the Seventh National Communication to under the UN Framework Convention on Climate Change (2018)[31], Turkey is among medium-high risk countries in terms of both present climate, climate change and variability, and future climate, considering that Mediterranean Basin has been indicated as one of the most vulnerable regions in the world to the impacts of climate change (IPCC, 2007). Climate observations already confirm an increase of the average temperature as well as an upward trend in extreme temperatures. Furthermore, Turkey is prone to natural hazards and climate change is expected to increase its vulnerability to climate-related hazards over the next decades.

The Project's operational lifetime is expected to be 49 years, however, since most of the equipment lifetime is around 30 years, it is agreed with project company to analyse the climate change scenarios up to 2060. The following charts present the outcomes of simulations carried out for Turkey extracted from the World Bank Climate Change Knowledge Portal[32] (CCKP) with reference to SSP8.5 scenario:

- ✓ Figure 5.15 presents the projected variation of temperature for the period 2020-2039; it can be noticed that a slight increase of mean temperature between 0°C and 2°C is expected across all months, with potential decreases of up to -1°C in January and increases of up to 3.6°C in June;
- ✓ Figure 5.16 provides the projected variation of temperature for the period 2040-2059; it can be noticed that an increase of mean temperature between 1°C and 4°C is expected across all months, with potential decreases of up to -0.6°C in October and increases of up to 5.1°C in July;
- ✓ Figure 5.17 introduces the projected variation of rainfall for the period 2020-2039; it can be noticed that precipitation will experience small fluctuations all over the year, potentially significant variations are expected with decreases up to -30 mm and increases up to +36 mm;
- ✓ Figure 5.18 reports the projected variation of rainfall for the period 2040-2059; it can be noticed that precipitation will experience small fluctuations in the first four months and higher decreases in the second half all over the year, potentially significant variations are expected with decreases up to -32 mm and increases up to +34 mm.

****

[29] http://ipcc.ch/report/ar5/wg1/

[30] https://www.ipcc.ch/report/ar6/wg2/

[31] https://www.undp.org/turkiye/publications/seventh-national-communication-turkey-under-unfccc#:~:text=The%20Seventh%20National%20Communication%20is,the%20field%20of%20climate%20change.

[32] https://climateknowledgeportal.worldbank.org/country/turkiye/climate-data-projections

- ✓ Figure 5.19 provides the projected changes in rainfall distribution and precipitation with reference to SSP5-8.5 scenario for the period 2060-2079 and 2080-2099; it can be noticed that precipitation is estimated to experience a slightly decreasing trend compared to the 1995-2014 period;

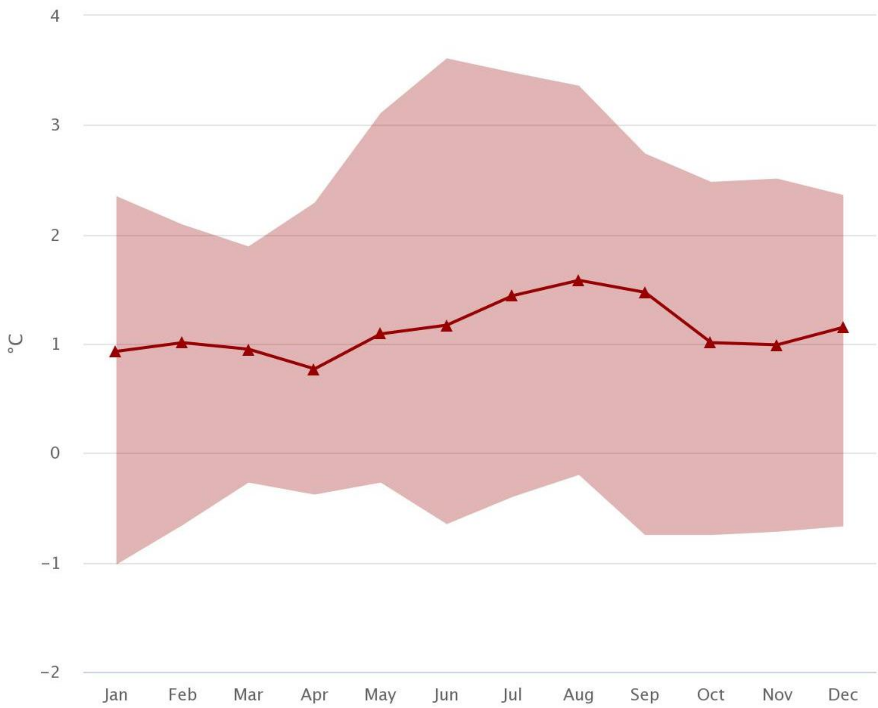


Figure 5.15: Projected Variation of Temperature in Turkey, 2020-2039

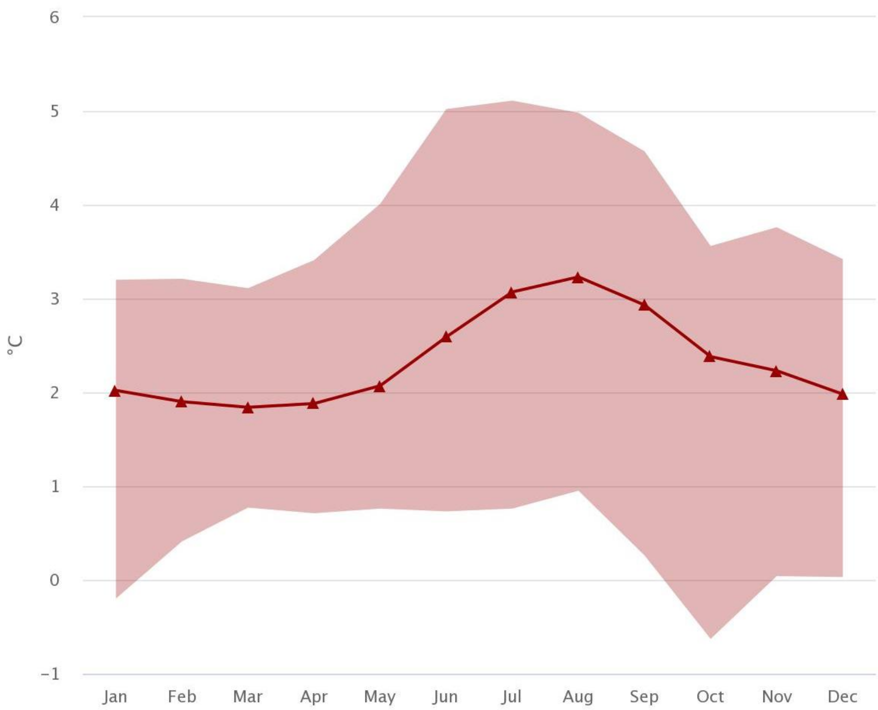


Figure 5.16: Projected Variation of Temperature in Turkey, 2040-2059

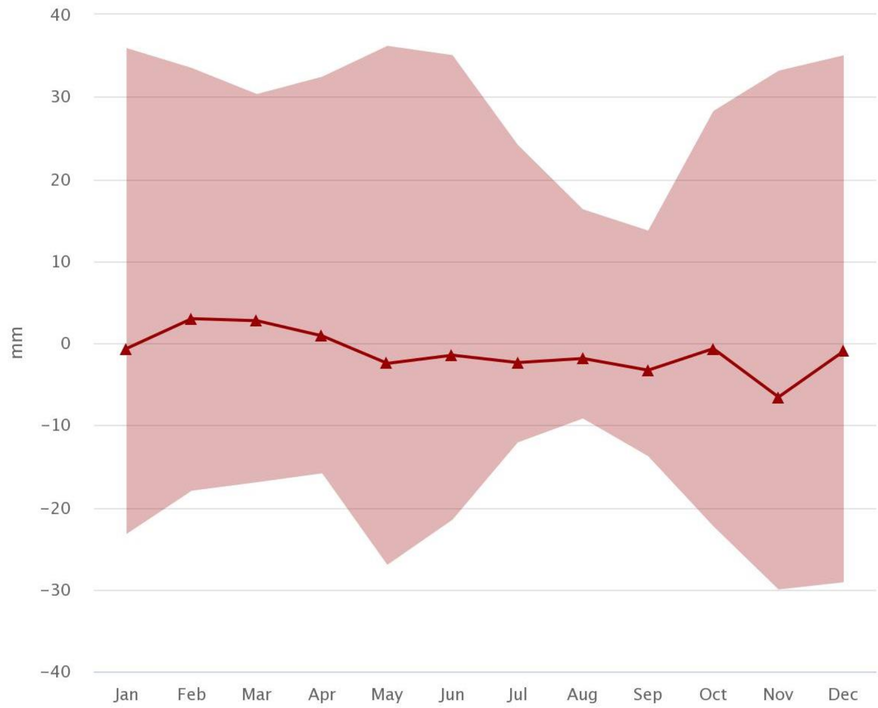


Figure 5.17: Projected Variation of Precipitation in Turkey, 2020-2039

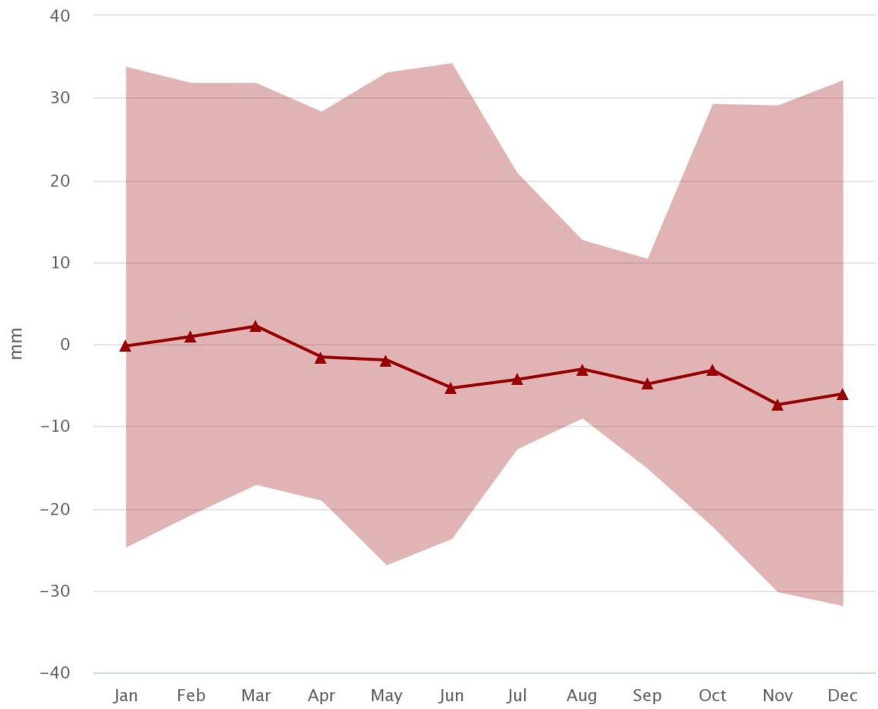


Figure 5.18: Projected Variation of Precipitation in Turkey, 2040-2059

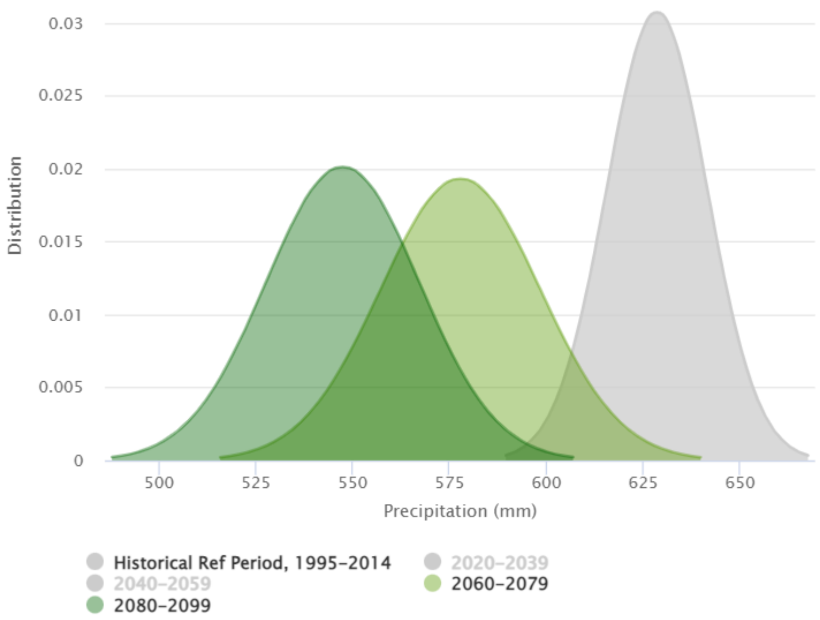


Figure 5.19: Projected Variation of Precipitation Distribution Turkey, 2060-2099 (Ref. Period 1995-2014)

5.3.2 Expected Climate Changes In Adana Region

With reference to the Project, a focus is made on the expected climate changes in the Adana Region. The following charts present the outcomes of simulations carried out for Adana Region extracted from the World Bank Climate Change Knowledge Portal[33] (CCKP) with reference to SSP8.5 scenario:

- ✓ Figure 5.20 presents the projected variation of temperature for the period 2020-2039; it can be noticed that a slight increase is expected across all months, with potential decreases of up to -2.2°C in December and increases of up to 3.8°C in June;
- ✓ Figure 5.21 provides the projected variation of temperature for the period 2040-2059; it can be noticed that an increase of mean temperature between 1°C and 3°C is expected across all months, with potential decreases of up to -1°C in January and increases of up to 5.1°C in July;
- ✓ Figure 5.22 introduces the projected variation of rainfall for the period 2020-2039; it can be noticed that precipitation will experience no significant variations with potential decreases up to -45 mm and increases +45 mm in November and January, respectively;
- ✓ Figure 5.23 reports the projected variation of rainfall for the period 2040-2059; it can be noticed that precipitation will experience no significant variations with potential decreases up to -47 mm and increases +43 mm in December and January, respectively.
- ✓ Figure 5.24 provides the projected changes in rainfall distribution and precipitation with reference to SSP5-8.5 scenario for the period 2060-2079 and 2080-2099; it can be noticed that precipitation might experience a slightly decreasing trend if compared to the 1995-2014 period;
- ✓ Figure 5.25 presents the projected annual variation in terms of humidity from 2015 to 2100 based on the reference period 1995-2014 as to SSP5-8.5 scenario; it can be noticed that a slight decrease is expected across the years.

****

[33] https://climateknowledgeportal.worldbank.org/country/turkiye/climate-data-projections

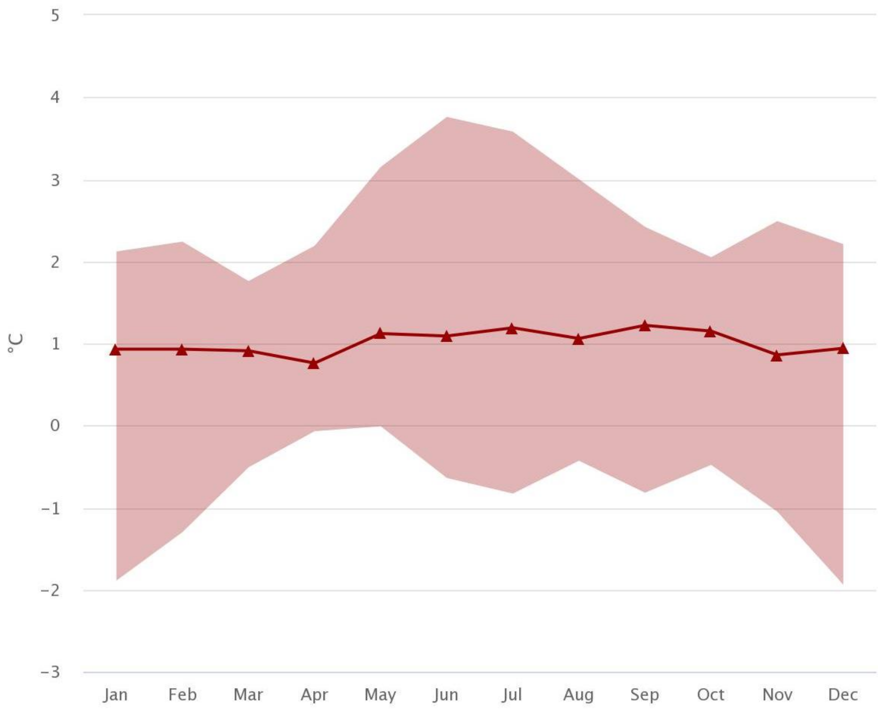


Figure 5.20: Projected Variation of Temperature in Adana Region, 2020-2039

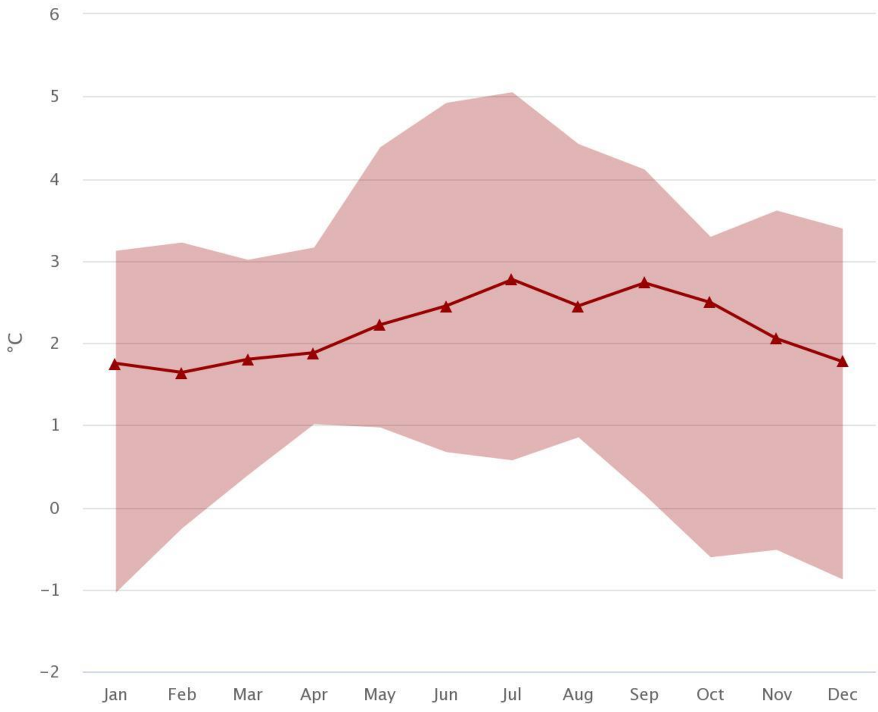


Figure 5.21: Projected Variation of Temperature in Adana Region, 2040-2059

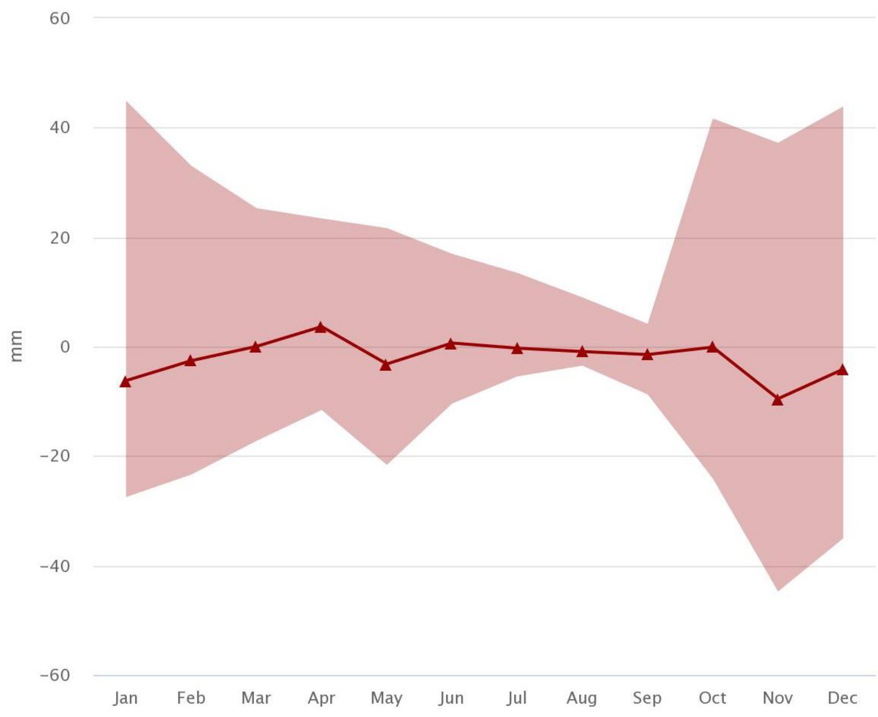


Figure 5.22: Projected Variation of Precipitation in Adana Region, 2020-2039

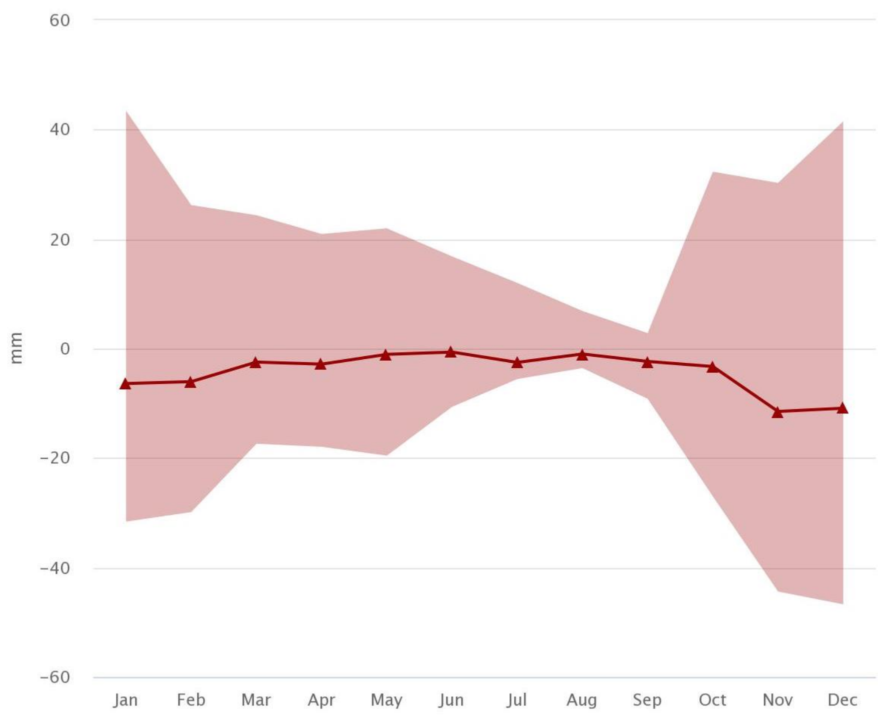


Figure 5.23: Projected Variation of Precipitation in Adana Region, 2040-2059

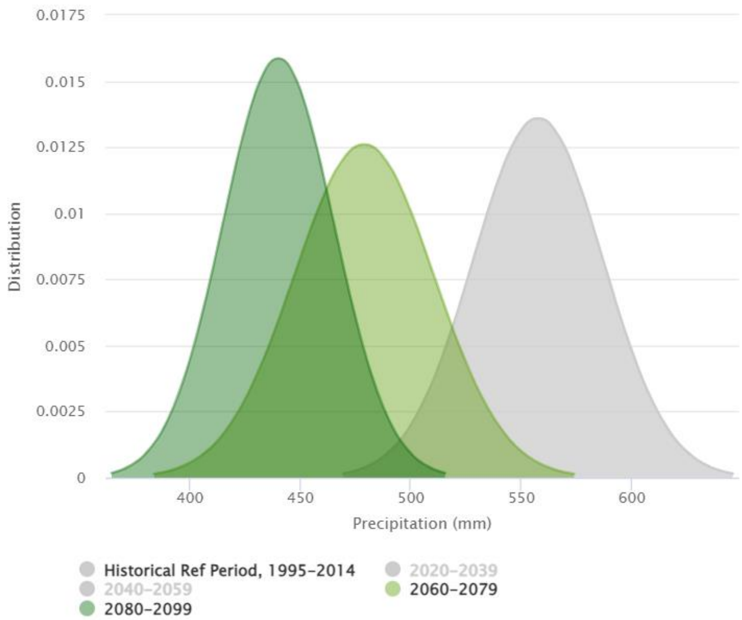


Figure 5.24: Projected Variation of Precipitation Distribution in Adana Region, 2060-2099 (Ref. Period 1995-2014)

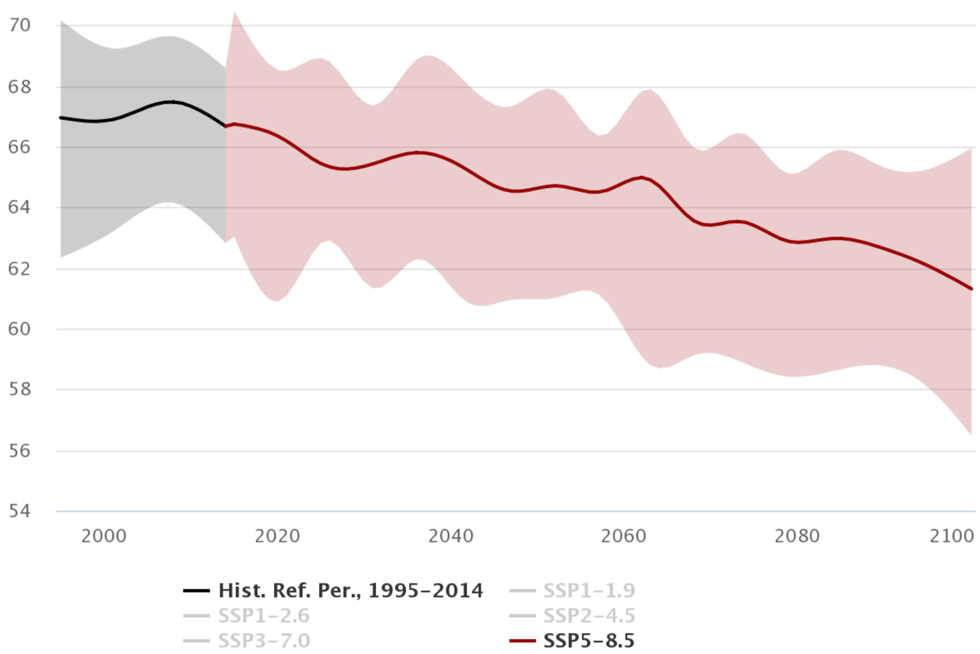


Figure 5.25: Projected Annual Relative Humidity in Adana Region, 1995-2100

5.3.3 Sea Level Rise

Changes in sea level are due to a complex interaction of climatic and geologic factors. Sea levels are rising largely because global temperatures are rising, besides this global trend, regional changes are also occurring in climate patterns affecting sea level. As the project will be established near the Mediterranean Area, any possibility of sea level rise might impact the marine part of the project.

Figure 5.26 reports the projected mean sea level rise of coastal Turkey for the period 2008-2100 extracted from the World Bank Climate Change Knowledge Portal[34] (CCKP) with reference to RCP8.5 scenario; it can be noticed that sea level will experience potential incremental rises up to 0.74 m in 2099.

Moreover, according to Climate Central Coastal Risk Assessment Tool, an interactive map showing areas threatened by sea level rise and coastal flooding affiliated to Princeton University, several coastal areas in Adana will be under the threat of being flooded by sea (Climate Central, 2021), as a province set in a low-altitude coastal area.[35] However, the Ceyhan Petrochemical Industrial Region in Adana will not be affected as shown in Figure 5.27. This forecast is confirmed by projections extracted from the World Bank Climate Change Knowledge Portal[36] (CCKP) with reference to RCP8.5 scenario, as shown by Figure 5.28, that reports the coastal areas under risk of inundation due to mean sea level rise in 2080.

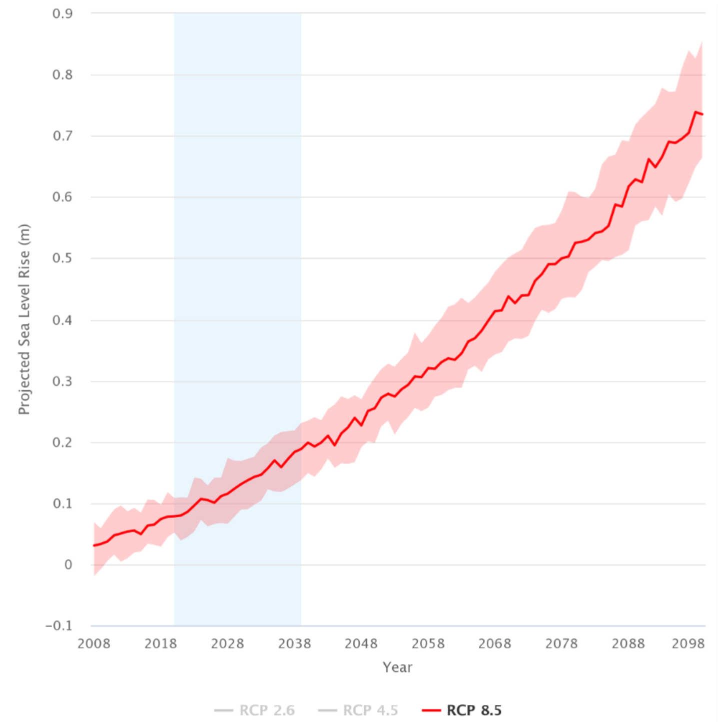


Figure 5.26: Projected Sea Level Rise of coastal Turkey 2008-2100 (Source: World Bank)

****

34 https://climateknowledgeportal.worldbank.org/country/turkiye/impacts-sea-level-rise

35 Kurt, S. and LI, X. (2020) Potential Impacts of Sea Level Rise on the Coasts of Turkey. 95 Journal of Environment and Earth Science, 10(5).

36 https://climateknowledgeportal.worldbank.org/country/turkiye/impacts-sea-level-rise

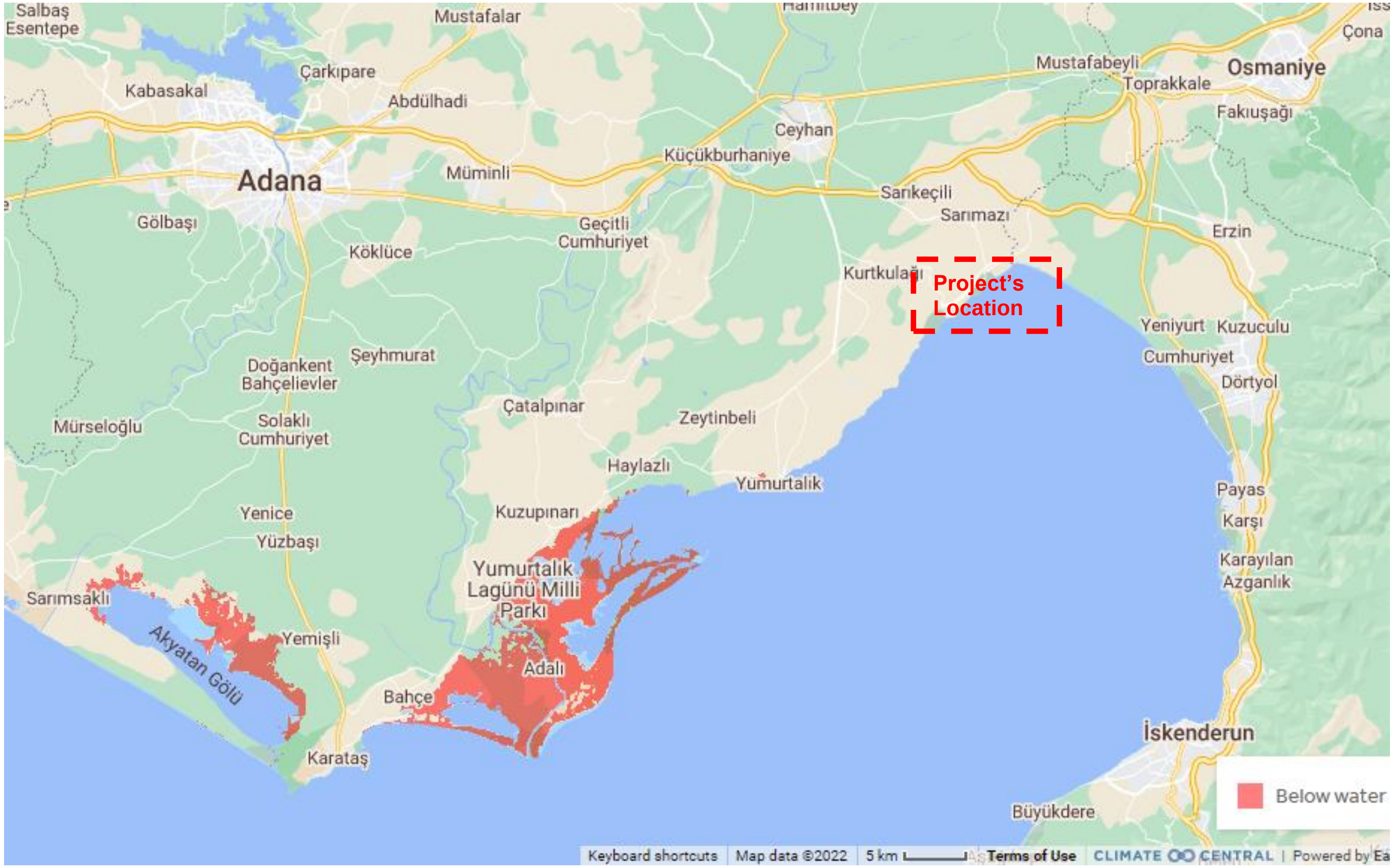


Figure 5.27: Sea Level Rise - Land Projected to be below flood level in 2050 (Climate Central – IPCC 2021)

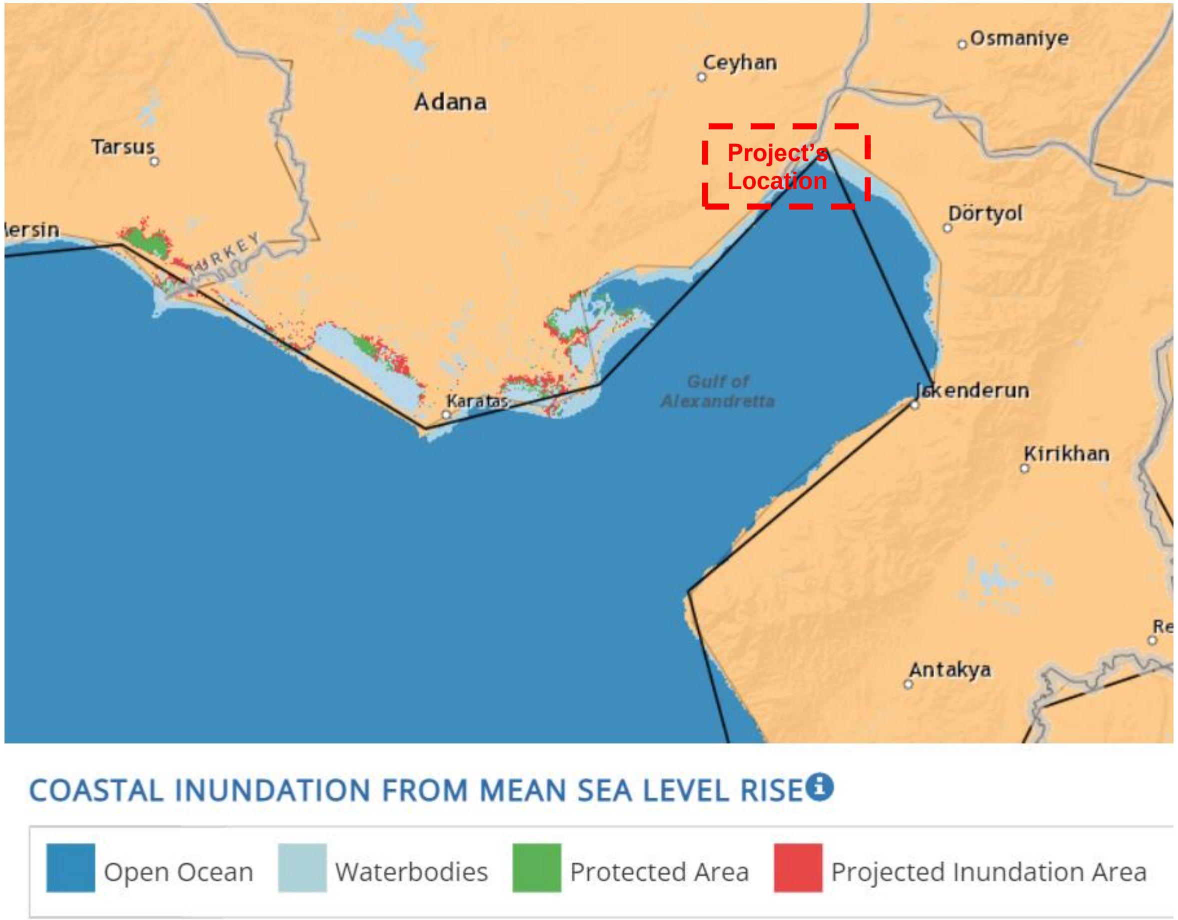


Figure 5.28: Sea Level Rise – Coastal Inundation from Mean Sea Level Rise in 2080 (Source: World Bank)

6 CLIMATE RISKS ASSESSMENT

Climate change-related risks are defined – in line with IPCC recommendations – as the potential negative consequences of climate change effects on human life, livelihood and health, for the ecosystems and biological resources, structures, infrastructure and services. Within the present report, climate change-related physical and transition risks for the Project are investigated.

In accordance with the Equator Principles IV and with the Recommendations of the TCFD, physical risks are evaluated considering the likelihood of occurrence of the hazardous trend or event and the magnitude of the effects of the trend/event. In addition, transition risks, i.e. business and financial risks arising in the frame of the global transition to a low-carbon economy, are also addressed in this section. Finally, the main climate related opportunities are identified, and the discussion of the results is presented.

6.1 PHYSICAL RISKS

Physical risks are related to physical changes of climate, which can be acute (due to a short-term extreme event) or chronic (due to slowly evolving climate patterns). According to TCFD, acute physical risks refer to those that are event-driven, including increased severity of extreme weather events, such as cyclones, hurricanes, or floods. While chronic physical risks refer to longer-term shifts in climate patterns (e.g., sustained higher temperatures) that may cause sea level rise or chronic heat waves.

The analysis of the observed historical weather data and of the climate projections, presented in the previous paragraphs, indicates that the changes in the climate pattern in the area under consideration are significant. In addition, it is worth mentioning that RINA agreed with Ronesans to analyse the climate change scenarios up to 2060 given that most of the equipment lifetime is around 30 years even if the Project's operational lifetime is expected to be 49 years.

Specifically, it has been found that in the long-term the Project may be affected by the projected increase in average annual temperatures as well as by the increase in the number and intensity of extreme events (in particular events with high and medium hazard level).

In order to assess the risks, a risk matrix approach is used. Risk matrix consists of two components: Probability and Impact. The Risk of a specific change is determined as a combination of these two components. Probability is defined as the expected frequency of damage assessed using the descriptions in Table 6.1 based on the analysis reported in Section 5.2 (Source: https://thinkhazard.org/). Impact is qualitatively assessed using the descriptions in Table 6.2. The Probability and Impact were combined to assess the Risk significance of effects on receptors as shown in Table 6.3. Finally, the Residual Risk is determined considering the implementation of the adaptation measures suggested.

Table 6.1: Definitions of Probability

Probability Level	Description
Very Low (VL)	The event may occur once during the lifetime of the project.
Low (L)	The event occurs occasionally during the lifetime of the project.
Medium (M)	The event occurs limited times during the lifetime of the project.

High (H)	The event occurs several times during the lifetime of the project.

Table 6.2: Definitions of Impact

Impact Level	Description
High (H)	Permanent damage and complete loss of service. Disruption lasting more than ten days but less than 20 days. Early renewal of infrastructure >90%. Severe health effects and/or fatalities. Very significant loss to the environment requiring remediation and restoration. Repairs cost 100% of reconstruction cost. Inability to reach raw material. Interruption of the distribution chain due to catastrophic meteorological conditions. Long-term disruptions in access to power and water.
Medium (M)	Limited infrastructure or asset damage and loss of service with damage recoverable by maintenance or minor repair. Disruption lasting more than one but less than three days. Adverse effects on health and/or the environment. Repairs cost 25% of reconstruction cost. Supply chain disruptions before raw material stocks run out. Disruptions in the distribution chain causing legal problems.
Low (L)	Localised infrastructure or asset disruption or loss of service. No permanent damage, minor restoration work required: Operation closure lasting less than one day. Slight adverse health or environmental effects. Repairs cost 2% of reconstruction cost. Supply chain interruptions up to 2 days, Disruptions in the distribution chain due to adverse weather conditions. Power and water cuts can be compensated by the company.
Negligible (N)	No infrastructure or asset damage, minimal adverse effects on health, safety and the assets. No operation closure. No financial loss. No transport difficulties, supply chain interruptions. No power outages. No water shortage.

Table 6.3: Criteria for Risk Evaluation

		Event Impact			
		Negligible	***Low***	***Medium***	***High***
Event Probability	***Very Low***	**Negligible**	**Negligible**	**Low**	**Medium**
	Low	**Negligible**	**Low**	**Medium**	**Medium**
	Medium	**Negligible**	**Low**	**Medium**	**High**
	High	**Negligible**	**Low**	**High**	**Critical**

A register of the physical risks identified for the Project, including their potential impacts, probability and adaptation measures is presented in Table 6.4 and graphically represented in Figure 6.1 to highlight the level of residual risk of the main effects on the project.

Table 6.4: Climate Change Physical Risks and Adaptation Measures

Variation of Climate Pattern	Specific Change	Effect	Probability	Impact	Risk	Adaptation Measure	Residual Risk
Increase of average annual temperature and of extreme maximum and minimum temperatures Increased intensity and frequency of extreme weather events	Temperature increase *(chronic risk)*	Accelerated material degradation. Increase of thermal loading on concrete components causing expansion, bleeding and cracking. Higher thermal induced stresses.	Medium	High	High	*PDH-PP and Jetty & Prophane Storage Facility:* ✓ Increase in concrete cover thickness; ✓ Improve quality of concrete (strength grade); ✓ Use protective surface coatings and barriers; ✓ Use of stainless steel, galvanized reinforcement, corrosion inhibitors, electrochemical chloride extraction.	**Low**
		Maintenance workers' health and safety risks due to overheating during working outdoors.				*PDH-PP and Jetty & Prophane Storage Facility:* ✓ Schedule repairs when temperatures reduce. ✓ Schedule maintenance out of hotter hours.	
	More frequent flooding episodes. *(acute risk)*	Faster loss of prestressing force. Less stable side-slopes.	Medium	Medium	Medium	*PDH-PP and Jetty & Prophane Storage Facility:* ✓ Protection by design, preservative treatment;	**Low**

Variation of Climate Pattern	Specific Change	Effect	Probability	Impact	Risk	Adaptation Measure	Residual Risk
	More violent storm surges and supercells. *(acute risk)*		Low	High	Medium	✓ Adequate slope stabilization measures; ✓ More frequent inspection and maintenance. *<u>Jetty & Prophane Storage Facility:</u>* ✓ Use of riprap; partially grouted riprap, concrete block systems, gabion mattresses, grout-filled mattresses. ✓ Upstream walls and obstructions, collars. ✓ Use of sacrificial embankments. ✓ Increased use of sonars to monitor soil movements. ✓	**Low**
	More frequent landslides *(acute risk)*						
	Wildfires *(acute risk)*	Electrical equipment damage and risks for the vehicles.	Medium	Low	Low	*<u>PDH-PP and Jetty & Prophane Storage Facility:</u>* ✓ Use of refractory electrical equipment.	**Negligible**
	Increase in solar radiation *(chronic risk)*	Accelerated material degradation. Higher thermal induced stresses.	Medium-Low	Medium-High	Medium	*<u>PDH-PP and Jetty & Prophane Storage Facility:</u>* ✓ More frequent inspection and maintenance. ✓ Increased use of sonars to monitor soil movements.	**Low**
	Changes in relative humidity *(chronic risk)*	Accelerated material degradation. Faster loss of prestressing force.	Medium-Low	Medium-High	Medium		**Low**

Variation of Climate Pattern	Specific Change	Effect	Probability	Impact	Risk	Adaptation Measure	Residual Risk
	Water scarcity *(chronic risk)*	Higher risk of consolidation settlement. Loss of buoyancy forces on underground structures.	Low	Medium	Medium	*PDH-PP and Jetty & Prophane Storage Facility:* ✓ Protection by design, preservative treatment. ✓ More frequent inspection and maintenance. ✓ Increased use of sonars to monitor soil movements.	**Low**
		Decreased water resource availability to cool the plant.	Low	Medium	Medium	*PDH-PP:* ✓ Move to more efficient and less resource consuming technologies as soon as they are available on the market.	**Low**
	Sea level rise *(chronic risk)*	Storm surge and/or sea level rise. Sea level rise inundation of the access jetty connection with the land. Sea level rise and/or storm surge inundation of the ancillary facilities. Wave overtopping of the breakwaters. Damage to the wharf / jetty due to wave uplift forces.	Low	High	Medium	*Jetty & Prophane Storage Facility:* ✓ Raise the level of the deck above the storm surge and/or future sea level. ✓ Extend the access jetty further landward, above the future sea level. ✓ Locate these assets above the future sea level and/or storm surge level. ✓ Raise the crest level of the breakwaters. ✓ Adopt permeable decking to dissipate wave forces. ✓ Adopt larger breakwater armour units.	**Low**

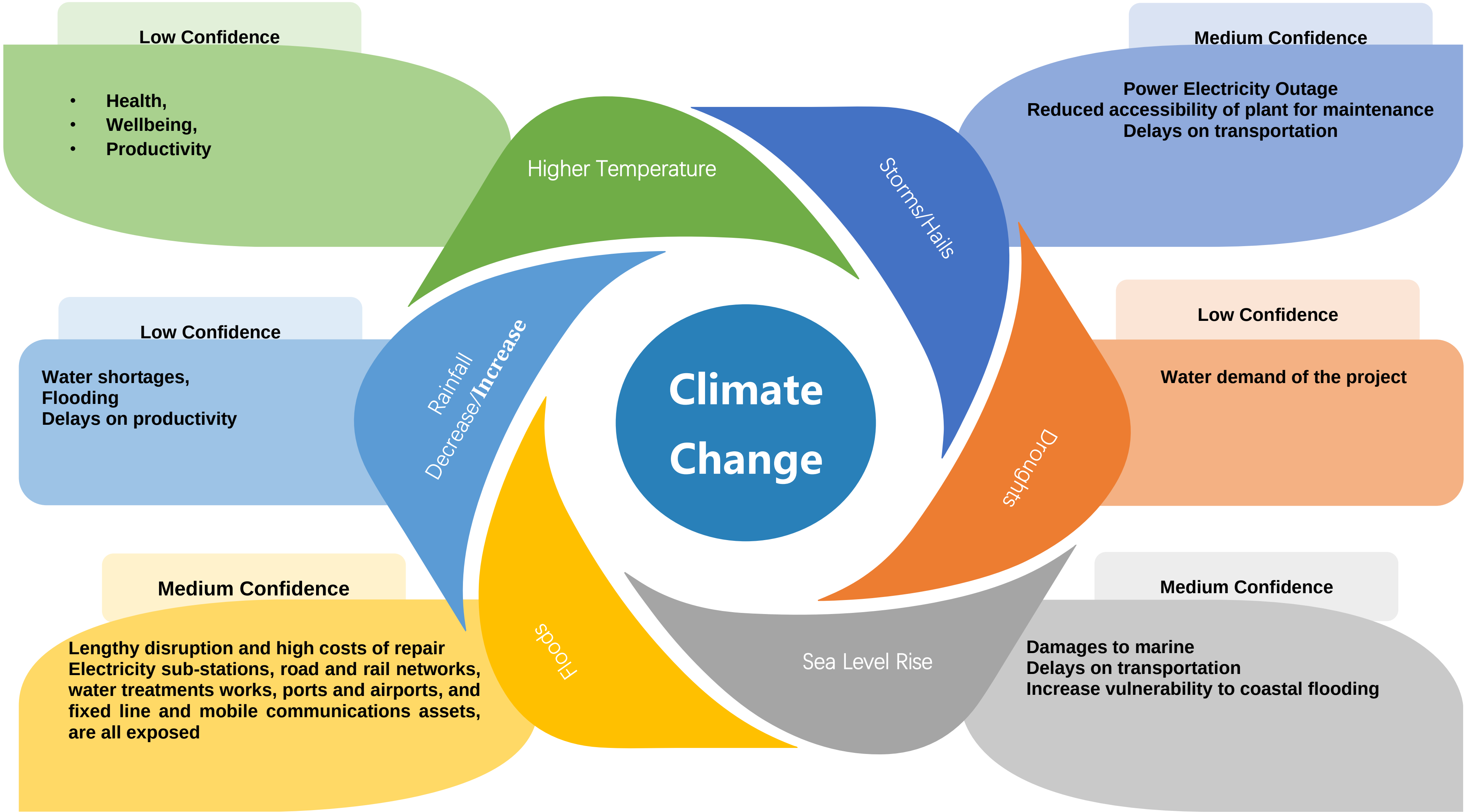


Figure 6.1: Main physical risks

6.2 TRANSITION RISKS

The Equator Principles IV introduced the requirement to carry out a Climate Change Risk Assessment in line with the Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). The Climate Change Risk Assessment shall cover physical risks for all Category A and - as appropriate - Category B Projects, whereas transition risks shall be covered only for Projects having combined Scope 1 and Scope 2 emissions higher than 100,000 tCO_2e/y.

Since the Project is responsible for around 206,013 tCO_2e/y of combined Scope 1 and Scope 2 emissions in the operation phase, the evaluation of transition risks is required.

In accordance with TCFD recommendations, the transition risks are evaluated under four main aspects: Policy and Legal, Technology, Market, Reputation. The following lines provide an overview of how the Project is located under these perspectives:

- ✓ **Policy and Legal**: a significant risk can be identified with reference to various policies being developed for the transition to a low carbon economy such as carbon-pricing mechanisms to reduce GHG emissions, shifting energy use toward lower emission sources, adopting energy-efficiency solutions by tighten embedded carbon intensity standards on packaging, appliances and other manufactured products, encouraging greater water efficiency measures, promoting product recyclability and/or extended producer responsibility, and promoting more sustainable land use practices. Indeed, in October 2021 Turkey ratified the Paris Agreement and published its first Intended Nationally Determined Contributions ("INDCs") including climate actions Turkey intended to take under the news international agreement. In this regard, Turkey's national climate change vision, as embodied within the National Strategy on Climate Change is to "become a country fully integrating climate change policies with its development policies, disseminating energy efficiency, increasing the use of clean and renewable energy resources, actively participating in the efforts to tackle climate change within its special circumstances and providing its citizens with a high quality of life and welfare with low-carbon intensity."[37] In case of stricter changes in the climate-related policies in the upcoming years, this may impact negatively on the operation of the Project. However, the Project is expected to monitor the GHG emissions annually in line with Regulation on "Greenhouse Gases Emission Monitoring" as mentioned in Section 2.2;
- ✓ **Technology**: the adopted technology is aligned with the best international standards but it is suggested to evaluate regular market studies for identification of new low carbon technologies or consumer preferences for different product and energy sources. It is evident that there will be a shift in demand for low carbon and circular materials such are Recycled PP as effort to keep the global warming above the thresholds established by Paris Agreement. At the meantime, it should be considered that plastic recycling in Turkey has been deemed harmful for the health workers and people living near recycling facilities.[38] Consequently, substantial research should be carried out in order to compare production costs, price trends, demand and social/environmental impact of virgin vs. post-consumer/recycled PP
- ✓ **Market**: variation in the polypropylene demand can impact negatively on the financial profitability of the Project in terms of reduced market for the product. However, ascending application of polypropylenes in fiber, raffia, and film and sheet, coupled with the growing trend of the application of polypropylene (PP) in the automotive sector to manufacture lightweight vehicles for increased fuel efficiency, might drive the market over the forecast period. Potential risks may also derive from competition with the demand for low carbon and/or circular (i.e. obtained by mechanical or chemically recycling of plastic waste) polypropylenes, or other alternative material such as bio-degradable polymers (high-polymer materials made of raw materials consisting of starch, sugar, or cellulose contained in plants).[39] In addition, international markets can be affected by climate change policies and cause disruption in the supply chain of imported products (such as propane imported from Algeria), the Company might consider varying the source of their raw materials.

****

37 Republic of Türkiye. 2021. 11th Development Plan 2019 – 2023.

38 https://www.hrw.org/report/2022/09/21/its-if-theyre-poisoning-us/health-impacts-plastic-recycling-turkey

39 https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC-sectoral-focus-Plastics_final.pdf

Reputation: a significant risk can be identified with reference to the change of community perceptions on the Project contribution to the transition to a polypropylene-free and low-carbon economy. Indeed, institutional investors and regulators are increasingly interested in the GHG emission profile of the companies they are dealing with. Companies which do not meet investor expectations as to carbon performance and disclosure, as well as adoption of sustainability-related initiatives may be negatively impacted in terms of access to capital or increased cost of capital.

The predicted extent of climate change impacts is very dependent on the scenario model applied. In this regard, the transition risk assessment is conducted based on the climate change scenarios under future time horizons (up to 2060, according to a long-term timeframe),[40] considering an aggressive mitigation scenario (< 2°C, RCP2.6) in alignment with the objectives of the Paris Agreement to limit global warming to well below 2°C, preferably to 1.5°C compared to pre-industrial levels. The choice was to adopt the most precautionary approach, which evaluates risks under the most impactful scenario for the Project operations.

A register of the transition risks identified for the Project, including their potential impacts, the project risk exposure in terms of materiality, adaptation measures and residual risks is presented in Table 6.5.

Materiality measures the severity of the Potential Impacts on the project before adaptation measures are undertaken, and it is based on exposure to risk and sensitivity to the risk, asdetermined using a combination of climate data and RINA subject matter expert judgement. The Residual Risk is determined considering the implementation of the adaptation measures suggested.

Finally, in line with Annex A of the Equator Principles, a list of on-going/planned adaptation actions is identified in the same table.

****

[40] As also defined by EIB, *Good practices for climate-related and environmental risk management*, November 2022.

Table 6.5: Climate Change Transition Risks and Adaptation Measures

<table>
<tr><th>Risk</th><th>Potential Impact</th><th>Materiality</th><th>Suggested adaptation Measures</th><th>Residual Risk</th><th>Ongoing/planned measures[41]</th></tr>
<tr><td colspan="6">Policy and legal risks</td></tr>
<tr><td>Incoming carbon pricing mechanisms such as carbon taxes and emission trading systems (ETS)[42].</td><td rowspan="4">Increased operational costs

Increased insurance costs

Increased fuel costs

Falling demand for polypropylene produced from non-renewable sources

Decline in the Company's revenues

GHG reporting preparation, verification and disclosure requirements

Reduction of Company's production</td><td>Medium - High</td><td rowspan="4">Make an allowance for potential introduction of GHG tax and insurance costs, and for falling demand, in the financial models for the investment efficiency estimation and planning of costs.

Timely identification of changes in regulatory requirements already at the stage of their preparation, also though participation in international working groups.

Periodic monitoring of energy consumption and updating of consumption forecasts.

Strategic planning and adequate control of GHG emissions at all stages of the</td><td>Medium</td><td rowspan="4">Regulatory changes are followed by the dedicated Environment & Sustainability responsible person of the Project, and also by the E&S management team of shareholders.

Energy consumption will always be monitored as a part of operational cost.

Operations will be fully performed using green energy and contract with electricity supplier will be completed in May 2023.

Verification and disclosure of GHG emission report is already provided as obliged in accordance with the national legislation, namely, Regulation for the Follow-up of</td></tr>
<tr><td>Potential climate-related lawsuits for high GHG emissions[43]</td><td>High</td><td>Medium</td></tr>
<tr><td>Regulation upon polypropylene production</td><td>Medium</td><td>Low</td></tr>
<tr><td>Reporting obligations</td><td>Medium</td><td>Low</td></tr>
</table>

****

[41] As communicated by Rönesans as of 16th March 2023.

[42] As of April 2022, about 47 jurisdictions adopted carbon pricing policies to fight climate change. In 2021, Turkey announced plans to establish an ETS through its draft climate change law. See https://carbonpricingdashboard.worldbank.org/map_data.

[43] There is no evidence of climate-related litigation cases filed in Turkey in the past years, but potential risk for future lawsuit should be taken into consideration.

Risk	Potential Impact	Materiality	Suggested adaptation Measures	Residual Risk	Ongoing/planned measures[41]
Import constraints on raw materials (such as propane)		High	Project (using all reasonable tools). Regular preparation, verification and disclosure of GHG emission reports. Vary sources of main imports such as propane.	**Medium**	the Greenhouse Gas Emissions.
Technology risks					
Falling demand for propane-based technologies due to increasing demand for other sources with lower GHG emissions such as low-carbon/circular/bio-degradable polymers	Declining market value of the Company Lower revenues due to falling demand for polypropylene produced from non-renewable sources Lower revenues due to lack of production capacity The installed equipment is getting obsolete rapidly Capital costs of transition to technologies with lower GHG emissions Process optimisation costs R&D costs	Medium - High	Phased implementation of the Project. Design for the use of best available solutions and techniques (implemented). Regular market studies for identification of emerging new technologies or consumer preferences for different energy sources and products. Building multifactor financial models for effective management of costs. Effective production management with control of improvement opportunities. Development of a new business related to the production of recycled polypropylene Consideration of research results in the Company management and planning.	**Medium**	FEED has been completed. The design has been further developed on top of FEED with EW1 and EW2 phases for a total period of 12 months. On top of these two phases of early works, the EPC Contractor is working on the procurement packages together with the completion of HAZOP/SIL and 30% 3D Model Review Meetings. BAT is implemented and already part of the ESIA. The plant configuration has been designed for lowest carbon configuration, for easy understanding, no natural gas consumption is required during normal operation; the fuel consumption and hydrogen produced as by-product produced from PDH-PP will be utilized as energy, Plans on carbon reduction will be considered/implemented
Need for transition to technologies with lower GHG emissions		Medium		**Low**	
Failed investments in new technologies and lack of expertise in alternative polypropylene production		Low		**Negligible**	

Risk	Potential Impact	Materiality	Suggested adaptation Measures	Residual Risk	Ongoing/planned measures[41]
			Development of in-house expertise R&D with preliminary assessment of costs and risks.		during the construction / operation period. Detailed financial models shared with lenders are adopted. ISO 9001 and production related quality / production management system licenses will be obtained. While selecting the technology, transition from grade during the production has been considered as one of the technology selection criteria (Spheripol vs Grace vs Novolen). In-house expertise development will be performed by SPIE oil and gas, who is the O&M Contractor.[44] Besides, Sonatrach, partner of the Project, will also use already existing in-house expertise and continue to develop it for the Project purposes. R&D with preliminary assessment of costs and risks has been performed.

****

[44] As an international subsidiary of the SPIE Group specialized in the energy sector, SPIE O&G has been working at the heart of energy production infrastructures for several decades, designing, installing, starting up and maintaining them, while ensuring the best possible conditions in terms of safety, costs, lead times and quality. SPIE O&G employs 3,100 staff of 70 different nationalities working in around 30 countries across Europe, Africa, Asia-Pacific and the Middle East.

Risk	Potential Impact	Materiality	Suggested adaptation Measures	Residual Risk	Ongoing/planned measures[41]
Market risks					
Uncertainty about market trends	Poor management efficiency due to inaccurate prediction of demand for polypropylene products	Medium - High	Regular market studies for identification of emerging new low carbon products and technologies or consumer preferences for different energy sources.	**Medium**	
Changes in consumers' behaviour	Falling demand for polypropylene products Decline in the Company's revenues	Medium		**Low**	
Reputation risks					
Negative attitude of stakeholders at unchanged level of GHG emissions	Tough requirements for disclosure of the Company's GHG management reporting Limited access to external investments Increased requirements for GHG emissions if external investments are involved	Medium	Planning and assessment of effective external investments Strategic planning and adequate control of GHG emissions (using all reasonable tools). Dialogue and promotion/advocacy with reference stakeholders, especially with institutional and financial representatives Regular preparation, verification and disclosure of GHG reports. Identification of emission reduction targets Publication of sustainability-related policies	**Low**	Operations will be fully performed using green energy and contract with electricity supplier will be completed in May 2023. The plant configuration has been designed for lowest carbon configuration, for easy understanding, no natural gas consumption during normal operation will occur; the fuel consumption and hydrogen produced as by-product produced from PDH-PP will be utilized as energy. PDH-PP and Terminal have an integrated and combined team which has members from all positions (including a dedicated Environment & Sustainability responsible
Negative public perception of polypropylene industry	Difficulties in recruiting personnel Falling demand for polypropylene products Higher costs in communication activities	Low		**Negligible**	

Risk	Potential Impact	Materiality	Suggested adaptation Measures	Residual Risk	Ongoing/planned measures[41]
			Adherence to the TCFD and publication of related documentation		person of the Project, finance, technical etc. and also the E&S management team of shareholders) who already engaged with stakeholders and will/can engage in the future to provide sustainable dialogue- and promotion/advocacy with reference stakeholders. GHG emission reporting is already provided as obliged in accordance with the national legislation, namely, Regulation for the Follow-up of the Greenhouse Gas Emissions. ISO 14001 is planned to be obtained and license will be published.

6.3 CLIMATE RELATED OPPORTUNITIES

Efforts to mitigate and adapt to climate change also produce opportunities for organizations, for example, through resource efficiency and cost savings, the adoption of low-emission energy sources, the development of new products and services, access to new markets, and building resilience along the supply chain.

In accordance with TCFD recommendations[45], several areas of opportunity are identified as described below:

- ✓ **Resource Efficiency**: the Company can reduce operating costs by improving efficiency across their production and distribution processes, buildings, machinery/appliances, and transport/mobility—in particular in relation to energy efficiency but also including broader materials, water, and waste management. The innovation in technology includes developing efficient heating solutions and circular economy solutions, making advances in LED lighting technology and industrial motor technology, offering water usage and treatment solutions, and developing electric transportation.
- ✓ **Energy Source**: same as per the consumption of electricity produced from renewable sources, the Company can transition a major percentage of their energy generation to low emission alternatives such as hydrogen and biofuels. The trend toward decentralized clean energy sources, rapidly declining costs, improved storage capabilities, and subsequent global adoption of these technologies are significant. Organizations that shift their energy usage toward low emission energy sources could potentially save on annual energy costs;
- ✓ **Products and Services**: the Company can innovate and develop new low-emission products and services may improve their competitive position and capitalize on shifting consumer and producer preferences. Some examples include consumer goods and services that place greater emphasis on a product's carbon footprint in its marketing and labeling and producer goods that place emphasis on reducing emissions (e.g., adoption of energy-efficiency measures along the supply chain);
- ✓ **Markets**: the Company can pro-actively seek opportunities in new markets or types of assets may be able to diversify their activities and better position themselves for the transition to a lower-carbon economy. New opportunities can also be captured through underwriting or financing green bonds and infrastructure (e.g., low-emission energy production, energy efficiency, grid connectivity, or transport networks);
- ✓ **Resilience**: the Company can develop adaptive capacity to respond to climate change to better manage the associated risks and seize opportunities, including the ability to respond to transition risks and physical risks. Opportunities include improving efficiency, designing new production processes, and developing new products. Resilience opportunities may be especially relevant for organizations with fixed assets or extensive supply or distribution networks; those that depend critically on utility and infrastructure networks or natural resources in their value chain; and those that may require longer-term financing and investment.

6.4 DISCUSSION OF THE ASSESSMENT RESULTS

In relation to physical risks, it has been found out that in the long-term the Project may be affected by the expected increase in average annual temperatures as well as by the increase in the number and intensity of extreme weather events (all events with medium-low risk factor). These changes may impact negatively on the plant mainly in terms of accelerated material degradation and potential damages to the infrastructures. However, since the Company has acknowledged the importance of the climate-related physical risks and is considering implementing several adaptation measures, the overall risk can be eventually assessed as low.

In the design documentation of the Project, it is considered that the Ceyhan Polypropylene Production Plant can operate in up to 43°C ambient temperatures and, according to the climate change projections, the temperatures increase in Adana might occasionally reach 37°C (32°C maximum in August 1991-2020 +5°C maximum increase 2040-2059 for SPP8.5) in during the project lifetime. Hence, the Project should not be affected by any disruption related to high temperatures by 2060.

In terms of equipment, the Company is suggested to plan the use refractory materials and to monitor continuously any changes in their performance.

****

[45] https://www.tcfdhub.org/Downloads/pdfs/E06%20-%20Climate%20related%20risks%20and%20opportunities.pdf

The maintenance and repairs shall be scheduled in the less hot hours when temperatures reduce.

The wildfire risk is low since the impact on the Project is minimal since the Ceyhan Petrochemical Industrial Region is an established industrial area with no forestry in the surroundings.

Since the risks from water shortages are rated as temporary and the precipitations are not expected to experience relevant reductions in the upcoming decades, the impact on the Project is not significant. However, the Company mentioned their willingness to investigate and adopt more efficient processes and technologies in the upcoming years in order to address also the transition technological risk. In the ANNEX-P BAT-BREF Evaluation, the measures reduce water consumption and the amount of contaminated wastewater discharged are analysed and compared to the BAT. It can be noticed that a Waste Water Treatment System is implemented in the Project in order to handle all the wastes from the plant units.

The transition risk assessment highlighted the importance of monitoring the national and international policies on polypropylene production and the public perception of the plastic industry. The costs of raw materials and changing consumer behaviour are risks that might impact the Company production rate and need to be addressed with regular market studies for identification of emerging new low carbon products and technologies or consumer preferences for different energy sources. In this regard, the Company has acknowledged the importance of the climate-related transition risks and is considering implementing several of the suggested adaptation measures, of which some have been already adopted/planned for the near future.

In line with this, the PDH-PP technology is on-purpose PP production technology that means there is not by product rather than Hydrogen. Hydrogen will also be consumed in the system which is a sustainable solution.

In this CCRA, the adaptation measures are identified for the PH-PP and the jetty and Prophane Storage Facility. However, even if the jetty and Prophane Storage Facility will be constructed by another private investor group formed by Rönesans Holding and a new partner, the Company will share suggestions with the management of Jetty & Storage Facility.

7 CLIMATE CHANGE ALTERNATIVES ANALYSIS

Modern society requires countries to guarantee security of supply of raw materials for the main industrial sectors. In the particular case of the polypropylene and petrochemical industry of Turkey, a major issue is, in spite of rapidly rising domestic demand, domestic production remains extremely low because of very limited investment. This, on the one hand, negatively affects the competitiveness of the sector against its competitors both within the country and around the world, while on the other hand, causes the added value of the petrochemistry sector, which is very high, to remain abroad.

In the period covering the years 2015-2020, the imports of plastic end products, which increased by 0.01% annually on amount and decreased by 0.2% on value basis, increased by 4.5% on amount basis and 10.6% on value basis in 2020 compared to 2019[46]. In 2020, polyethylene and polypropylene had the highest amount of imports in terms of amount and value. The imports of these two raw materials took a share of 56% on amount and 52% on value basis from the total plastic raw material imports. It is anticipated that the development of the Project will significantly decrease import dependency.

Given the importance of local production of plastic raw materials, particularly polypropylene, the Project needs to be implemented to secure local production to eventually meet 19% of the Country's polypropylene demand.

The main aim of the Project is to produce polypropylene by using propane as raw material. The production process will be composed of two main stages; namely, PDH and PP. The most used methods to produce polypropylene are the followings:

- ✓ Hydrocarbon slurry or suspension: Consists of using a liquid inert hydrocarbon diluent in the reactor;
- ✓ Bulk (or bulk slurry): Uses liquid propylene instead of liquid inert hydrocarbon;
- ✓ Gas phase: Uses gaseous propylene in contact with solid catalyst;
- ✓ Hybrid: Combination of the bulk slurry and gas phase.

In the design phase, the technological alternatives were analysed not only in technical, economic and financial terms but also taking into account the environmental impact (as reported in ESIA Chapter 2, Section 2.4.5). The following technology providers have been selected as a result of the assessment of alternatives: UoP Honeywell PDH C3-Oleflex™ Process Unit; and Lyondell Spheripol Process Unit. The chosen technology is well known worldwide and the UoP Honeywell has been awarded 42 out of 53 dehydrogenation Projects worldwide since 2011. In addition, there are a total of 16 commissioned facilities operating with C3 Oleflex Process worldwide.

Moreover, when the features of this Project are evaluated, the Oleflex features are more suitable than the other technologies in terms of its i) continuous operation, ii) high feedstock utilization, iii) catalyst change without shutdown and iv) ease of operation. The PDH C3-Oleflex Process is also advantageous in terms of its small environmental footprint due to i) low energy use, ii) low CO2, NOx, SOx, Volatile Organic Carbon (VOC) emissions and water usage, and iii) fully recyclable platinum based catalyst and non-toxic catalyst system helping to minimise its impact on the environment.

It has to remarked that Ronesans is also considering to implement several mitigation actions, highlighted in the ANNEX-P BAT-BREF Evaluation, that will allow to reduce more the environmental impact such as:

- ✓ Part of the propane dehydrogenation unit, for process furnace operation, it is envisaged, i.a., to control the process by measuring the amount of oxygen and CO in fuel gas and control of the air-fuel ratio;
- ✓ Process furnaces will be fed with residual (fuel) gas with addition of natural gas (if the residual gas stream is not sufficient). As part of the propane dehydrogenation unit for the operation of process furnaces, it is envisaged to use ultra- low NOx emission burners;

****

46 https://pagev.org/upload/files/Plastics%20Industry%20Report%202020%20%28%20REV%C4%B0ZE%20%29%20%281%29.pdf

- ✓ UOP has optimized the entire process by emitting the minimum concentration of pollutants (Vent gas treating system) H2 is recovered and used in the Polypropylene plant;
- ✓ the polypropylene plant has all the equipment for solid dust recovery; and
- ✓ a NVIRO Unit is included to avoid VOC emissions.

Additionally, platinum in the catalyst can be recovered and reused which avoid impacts and costs associated with its disposal. The independent reactor and regeneration design of the Oleflex technology helps maximise operating flexibility and onstream reliability.

Furthermore, the other well-known technology is the Lyondell Basell Spheripol Process technology more than 20 million tonnes of Spheripol process capacity licensed worldwide . The technology is advantageous given that i) no undesired by-products is resulting from the reaction and ii) leading resource consumption, monomer efficiency and emissions.

8 CONCLUSIONS

This report constitutes the updated CCRA of the Ceyhan Polypropylene Production Plant by Ceyhan Polipropilen Üretim A.Ş.according to comments of the Lender's consultant to the previous ESIA issued in December 2021. The Project will be located in the Ceyhan Petrochemical Industrial Region, Adana, Turkey.

The CCRA is elaborated considering Physical and Transitional Risks in line with the latest version of the Equator Principles IV (dated July 2020) and the Recommendations of the Task Force on Climate-related Financial Disclosures.

Moreover, within the present report the past trends for temperature, solar radiation, precipitations, wind and hazardous weather events likely to occur in Turkey, and in particular in Adana Region, are evaluated and the projected changes for the future decades, up to 2060, are considered.

The analysis of the observed historical weather data and of the climate projections indicate that the changes in the climate pattern in Adana Region are significant, in line with the average worldwide trends. These projected changes are an increase in temperatures, no significant variation of rainfall, and an increase in extreme weather event such as extreme heat and wildfire episodes.

In relation to physical risks, it has been found out that in the long-term the Project may be affected by the expected increase in average annual temperatures as well as by the increase in the number and intensity of extreme weather events (all events with medium-low risk factor). These changes may impact negatively on the plant mainly in terms of accelerated material degradation and potential damages to the infrastructures. Nevertheless, there are several reasons suggesting that the Company has acknowledged the importance of the climate-related **physical risks** and these can be eventually all assessed as **low**:

- ✓ the medium probability of these climate-related effects, as per the outcomes of this analysis;
- ✓ the commitment of the Company to undertake further adaptation measures according to the suggestions of this technical study and according to future evidence that might arise;
- ✓ the design options applied, not strictly inspired by the analysis of climate change effects, yet providing additional strength to the construction of the new plant.

Furthermore, this CCRA is carried out detailing the potential overall **transition risks** assessed as **low-medium**. The main potential areas for transition risks mentioned by TCFD recommendations (*policy and legal, technology, market, reputation*) have been screened and the main significant climate-related transition risks have been identified for the Project, together with suggested adaptation measures. Moreover, in line with Annex A of the Equator Principles, a list of on-going/planned adaptation actions is identified, together with a list of on-going/planned adaptation measured that have been undertaken by the Company to address the above-mentioned risks.

A significant *policy and legal* risk is identified with reference to various policies being developed for the transition to a low carbon economy such as carbon-pricing mechanisms to reduce GHG emissions, and promoting more sustainable land use practices. Similarly, the *reputation* risk is relevant considering the public perception of plastic products, however the current demand is very high and the Project will reduce the country reliance on imported goods. In this context, international markets can be affected by climate change policies and cause disruption in the supply chain of imported products (such as propane imported from Algeria), the Company might consider varying the source of their raw materials. Finally, the adopted technology is aligned with the best international standards and it is suggested to evaluate regular market studies for identification of new low carbon technologies or consumer preferences for different product and energy sources.

To conclude, a Climate Change Alternatives Analysis is elaborated considering that the Company has considered the environmental impact of the alternatives and the Project is aligned with current Turkey 2023 strategy for GDP growth. In terms of climate change mitigation, the environmental impact of the technologies was considered, and the Company is also relying on a large share of electricity from renewable sources.

Finally, the Company is embracing the Turkey's international obligations on climate change and efforts to align with the Paris Agreement by (1) adopting the most efficient technologies and production processes and (2) by planning to consume only electricity produced from renewable energy sources[47].

SZ001/SAB02/GIOBO/ALEVE/DDI01/RAIDE:irepa

****

47 https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Turkey/1/The_INDC_of_TURKEY_v.15.19.30.pdf

REFERENCES

BEIS (2020) Greenhouse gas reporting: conversion factors 2020. Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020 (Accessed: July 19th , 2022).

Climate Central (2021) Climate Central Coastal Risk Tool. Available at: https://coastal.climatecentral.org/map/10/35.7909/36.7219/?theme=water_level&map_type=water_level_above_mhhw&basemap=simple&contiguous=true&elevation_model=best_available&refresh=false&water_level=1.0&water_unit=m (Accessed: August 3rd , 2022).

EIB (2020) EIB Project Carbon Footprint Methodologies - Methodologies for the Assessment of Project GHG Emissions and Emission Variations. https://www.eib.org/attachments/publications/eib_project_carbon_footprint_methodologies_2022_en.pdf (Accessed: July 19th, 2022).

EPA (2021a) Scope 1 and Scope 2 Inventory Guidance. Available at: https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance (Accessed: July 19th, 2022).

EPA (2021b) Scope 3 Inventory Guidance. Available at: https://www.epa.gov/climateleadership/scope-3-inventory-guidance (Accessed: July 19th, 2022).

ESWD (2021) European Severe Weather Database. Available at: http://www.eswd.eu/cgi-bin/eswd.cgi#map_div (Accessed: July 19th, 2022).

Equator Principles, "The Equator Principles – October 2020", https://equator-principles.com/wp-content/uploads/2020/05/The-Equator-Principles-July-2020-v2.pdf (Accessed: July 18th , 2022).

GHG Protocol (2021) The Scope 3 Evaluator. Available at: https://quantis-suite.com/Scope-3-Evaluator/ (Accessed: July 19th, 2022).

Global Solar Atlas, https://globalsolaratlas.info/ (Accessed: July 18th , 2022).

IFC, "IFC Performance Standards on Environmental and Social Sustainability", https://www.ifc.org/wps/wcm/connect/c02c2e86-e6cd-4b55-95a2-b3395d204279/IFC_Performance_Standards.pdf?MOD=AJPERES&CVID=kTjHBzk (Accessed: July 15th , 2022).

IPCC, "2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories", https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/ (Accessed: July 15th , 2022).

IPCC, "Climate Change 2013: The Physical Science Basis", http://ipcc.ch/report/ar5/wg1/ (Accessed: July 15th , 2022).

IPCC, "Fifth Assessment Report", https://www.ipcc.ch/assessment-report/ar5/(Accessed: July 15th , 2022).

IPCC, "Sixth Assessment Report", https://www.ipcc.ch/assessment-report/ar6/(Accessed: July 15th , 2022).

TCFD, "Recommendations of the Task Force on Climate-related Financial Disclosures", https://assets.bbhub.io/company/sites/60/2020/10/FINAL-2017-TCFD-Report-11052018.pdf (Accessed: July 15th , 2022).

ThinkHazard!,, https://thinkhazard.org/en/ (Accessed: July 19th , 2022).

TSMS (2021a) MEVBIS - Turkish State Meteorological Service. Available at: https://www.mgm.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx?m=AKSARAY%0Ahttps://mgm.gov.tr/eng/forecast-cities.aspx (Accessed: July 17th, 2022).

TurkStat (2020) Greenhouse Gas Emissions Statistics, 1990 - 2018. Ankara, Turkey. Available at: https://data.tuik.gov.tr/Bulten/Index?p=Sera-Gazi-Emisyon-Istatistikleri-1990-2018-33624 . (Accessed: July 17th, 2022).

UNFCCC, Seventh National Communication, https://unfccc.int/sites/default/files/resource/14936285_Turkey-NC7-2 Seventh%20National%20Communication%20of%20Turkey.pdf (Accessed: July 15th , 2022).

USGS (2021) Droughts: Things to Know, US Geological Survey. Available at: https://www.usgs.gov/special-topic/water-science-school/science/droughts-things-know?qt-science_center_objects=0#qt-science_center_objects (Accessed: August 3rd , 2022).

WEF, "The Global Risks Report 2020", http://www3.weforum.org/docs/WEF_Global_Risk_Report_2020.pdf (Accessed: July 15th, 2022).

World Bank Group – Climate Change Knowledge Portal, https://climateknowledgeportal.worldbank.org/ (Accessed: July 19th, 2022).