SMART SOLAR TECHNOLOGIES

Aliağa Solar Cell & Solar Module Integrated Production Factory

CLIMATE CHANGE RISK ASSESSMENT (CCRA)

FEBRUARY 2024

ANKARA

SMART SOLAR TECHNOLOGIES

Aliağa Solar Cell & Solar Module Integrated Production Factory

Climate Change Risk Assessment Report (CCRA) with Paris Agreement Alignment and Estimated Adaptation Finance

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1 INTRODUCTION

This assessment aims to comprehensively evaluate the potential risks and opportunities associated with climate change impacts on Smart Solar's operations, financial performance, and overall sustainability. By identifying and analysing these risks, Smart Solar seeks to enhance its resilience, transparency, and strategic decision-making processes, ensuring that it is well-equipped to navigate the challenges and capitalize on the opportunities presented by a changing climate.

1.1 Background

The Project encompasses the construction and operation of an integrated production factory for Solar Cells and Solar Panels facility within the Aliağa Organized Industrial Zone (ALOSBİ) in Çoraklar District, Aliağa district, Izmir province as provided in Figure 1-1. The production factory, located within ALOSBİ, occupies an area of 49,888 square meters and has a total enclosed area of 10,834 square meters. The land housing the project belongs to Smart Holding and is leased to Smart Solar Technology. While the project focuses on solar panel production in this space, construction for the cell production section in the adjacent building is also progressing rapidly. Smart Solar started test product preparation in March, with plans to increase module production capacity to approximately 2.2 GW/year upon completion of the neighboring construction.

The project activities involve the processing of intermediate products with glass and/or chemical production, surface coating of metal or plastic materials with metal, surface cleaning through electrolytic or chemical processes using tanks/pools with a volume of 5 m³ or more. Notably, the project does not include the vulcanization process of elastomer-based products, the production of batteries and/or accumulators, or the establishment of an industrial factory for electricity, gas, steam, and hot water production exceeding 20 MWt.

The details of the project, including description, components, and permits and management systems, are given in the Environmental and Social Due Diligence (ESDD) report prepared by 2U1K.

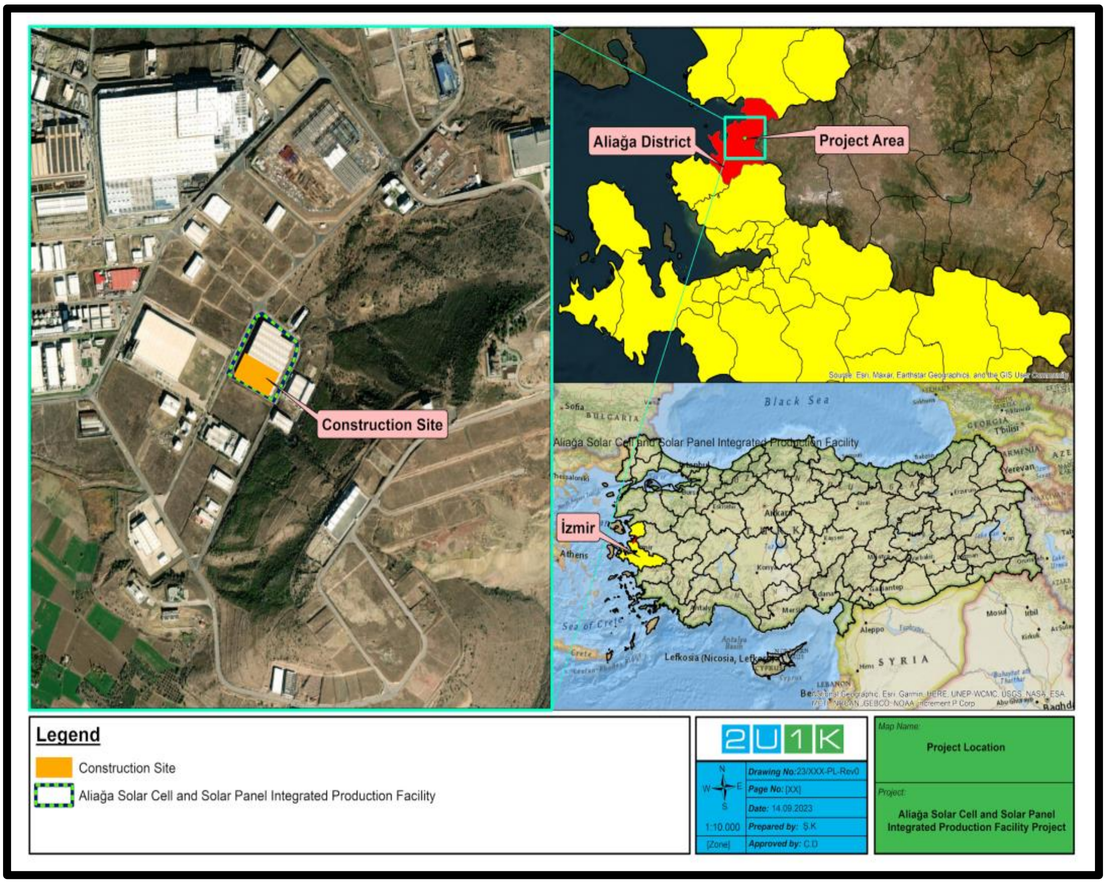

Figure 1-1. Project Location

1.2 Scope

The scope of this report is to conduct a comprehensive assessment of the physical climate risks associated with the proposed project and its components. The assessment will focus on identifying key climate hazards, including extreme temperature fluctuations, precipitation changes, and wind speed variations, as detailed in Section 3 of this report. The goal is to pinpoint vulnerabilities and potential impacts of these hazards on the project. The project design to incorporate physical climate risk reduction features will be examined and adaptation measures will also be proposed to address any remaining risks.

In addition to the risk assessment, the report will encompass an evaluation of the project's alignment with the adaptation and climate resilience objectives of the Paris Agreement on Climate Change. The proposed project's activities will be evaluated to sync with broader national or sectoral adaptation and climate resilience policies and priorities. Furthermore, the report will estimate the cost associated with adaptation measures recommended for integration into the project design, adhering to the joint methodology of Multilateral Development Banks (MDB) for tracking adaptation finance. This will provide a financial framework for the adaptation measures proposed.

2 METHODOLOGY

In this assessment, we employ a rigorous framework designed to gauge the alignment of the proposed project with the adaptation and climate resilience objectives set forth in the Paris Agreement. Our approach adheres to the Asian Infrastructure Investment Bank's (AIIB) methodology for Project Alignment (PA), providing a structured and comprehensive process for evaluation.

Initially, we undertake a meticulous examination of material physical climate risks that could potentially pose a threat to the project. These risks encompass a wide array of factors, including extreme weather events, sea-level rise, temperature variations, and other climate-related variables. These identified risks are then assessed in terms of their severity, likelihood, and potential impact on the project. This classification aids in prioritizing and addressing the most significant climate risks.

In response to these identified material climate risks, our methodology emphasizes the necessity of integrating adaptation measures into the project design. The adaptation measures are carefully selected to align with the specific climate risks and vulnerabilities identified. This integration process is a crucial step and involves the adjustment of project planning, design modifications, and resource allocation to ensure resilience in the face of climate challenges.

In accordance with the joint Multilateral Development Bank (MDB) methodology for tracking adaptation finance, this methodology outlines the systematic approach to estimating the financial resources required for integrating recommended adaptation measures into the project design.

The initial step involves the identification and specification of adaptation measures deemed necessary to enhance climate resilience. These recommendations are based on a comprehensive assessment of potential climate risks and vulnerabilities associated with the project under consideration.

All adaptation measures and recommendations have been discussed with Smart Solar in order to define a roadmap to minimize the impacts of climate change risks identified here.

Following the identification of these measures, the methodology adheres to MDB guidelines for categorizing adaptation costs. This classification encompasses various cost categories, including infrastructure, capacity building, technology transfer, ecosystem-based approaches, and more, ensuring that a comprehensive approach is adopted for estimating adaptation finance.

To derive accurate cost estimates, a structured approach is undertaken. This includes collecting relevant data from a variety of sources, such as project-specific information, local cost estimates, cost databases, and expert consultations. By utilizing a bottom-up cost estimation approach, individual adaptation measures are meticulously costed, encompassing labor, materials, technology, and other pertinent expenses.

The climate change scenarios used in the CCRA follow two shared socioeconomic pathways (SSP) scenarios for atmospheric greenhouse gas concentrations:

- SSP2-4.5 – stabilization scenario: Intermediate scenario leading to a warming at the end of the 21st century of more than 2°C relative to relative to the pre-industrial period (1850 – 1900).
- SSP4-8.5 – business-as-usual scenario: Most severe scenario leading to a warming at the end of the 21st century of probably more than 4°C relative to the pre-industrial period (1850 – 1900).

Climate projections have been predominantly provided for the period spanning 2040-2059, recognizing this timeframe as pivotal in the context of the global net-zero target. This specific period aligns with strategic milestones and commitments within international climate agreements, reflecting a critical juncture in efforts to mitigate climate change and transition towards a sustainable, low-carbon future.

3 PHYSICAL CLIMATE RISK ASSESSMENT

3.1 Observations

Turkiye lies between latitudes 36-42°N and adjacent to the Mediterranean Sea. The temperature (with an average of 13.3°C) in Türkiye can vary depending on the time of year and location. The country generally has a Mediterranean climate, with mild winters and hot summers. Coastal regions, where the Project, Smart Solar, is located in the Aegean Sea region (Izmir), tend to have hot and dry summers and warm and rainy winters. The fact that the mountains extend perpendicular to the sea and the plains extend to the threshold of Central Western Anatolia allow marine influences to spread to the interior.

The annual average temperature in Izmir varies between 16ºC (Bergama) and 17ºC (Bayındır). Considering the extreme values measured in Izmir, temperature varies between a maximum of 45.1ºC (Torbalı) and a minimum of -13ºC (Ödemiş).

Relative humidity in Izmir is low in the summer months when the temperature is high, and cloudiness is low. The values, which start to decrease starting from March throughout the year, reach their lowest rate in July.

The average annual precipitation is 700 mm. However, depending on the changes in the general atmospheric circulation, the total precipitation reaches 1000 mm in some years and falls to around 300 mm in some years. The amount of precipitation throughout the year increases starting from the mid-October and continues until May. The months with the highest average monthly rainfall are December, January and February.

3.1.1 Temperature

As noted in, Türkiye seems a transitive country from very hot southern areas reaching average of 30°C like Saudi Arabia, and Egypt, and very cold northern areas reaching average of 5°C like Ukraine and Russia. Figure 3-1 shows how 2m temperature of 1960-2022 changes over the Eastern Mediterranean areas (towards middle east) from ERA5 monthly averaged data (Hersbach et all., 2023).

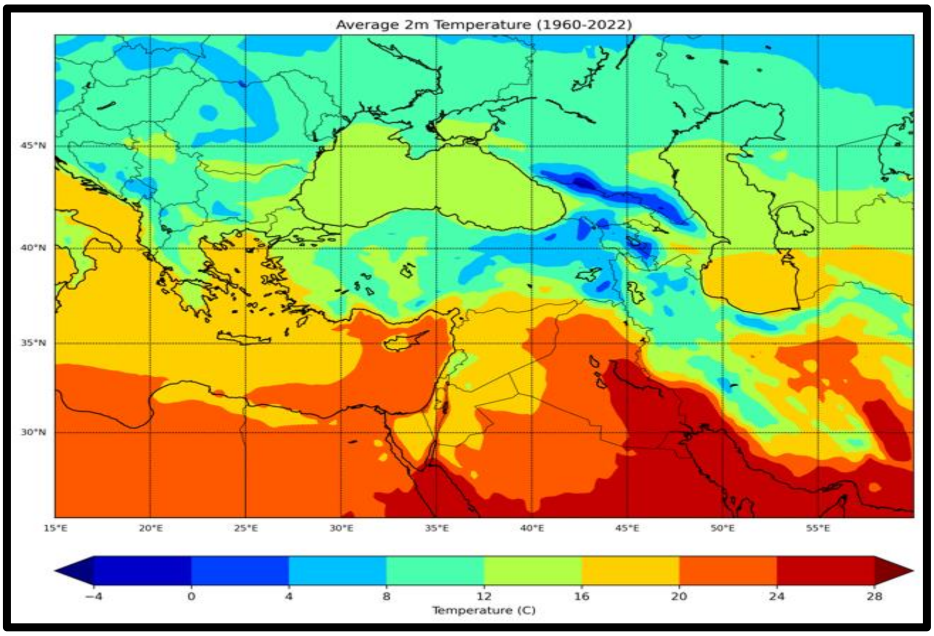

Figure 3-1. 2m Temperature for the Period of 1960-2022 (Hersbach et all., 2023).

Climate change is not only a challenge for the future, but it has already affected the many areas. Changes have been observed in Türkiye's climate with average temperatures having risen, and warmer winters and hotter summers trends. In Figure 3-2, it is clearly seen that between 1960 and 2022, the temperature shows an increasing trend over Türkiye and the Project location is under the increased trends.

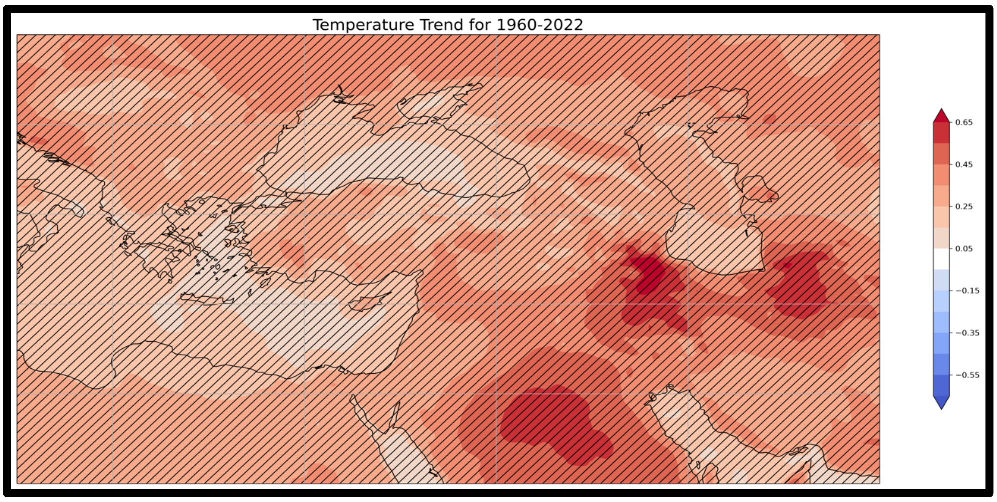

Figure 3-2. Temperature Trends over Türkiye for the period of 1960-2022 (Hersbach et all., 2023).

In order to reveal temperature changes in detail, Figure 3-3 shows how monthly trends change over Türkiye. All summer months (June, July, and August) and September shows significant increased all over Türkiye, and colder months do not show significant trends in some areas (mostly in eastern and northern parts).

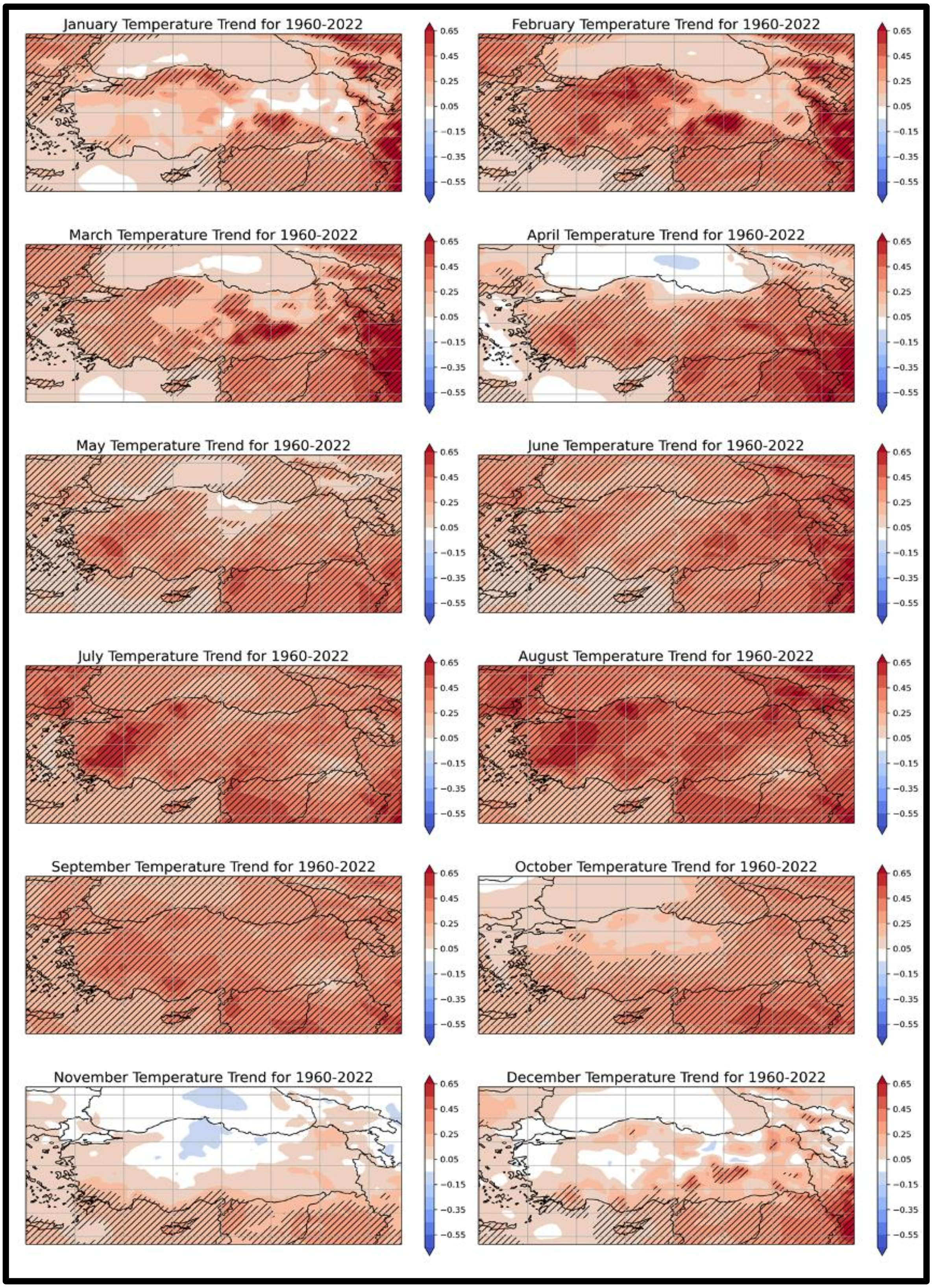

Figure 3-3. Monthly Temperature Trends over Türkiye (Hersbach et all., 2023).

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.

In the project area, Figure 3-4 shows how 2m temperature averages and total precipitation have changed since 1940. It is easy to see that there is warming trend in the project area through the year of 1940-2022 by about 2°C. When looking at the total rainfall values, it seems to be no rainfall changes at first glance, but by looking in detail, there has been a decrease in total precipitation below the average since 2000s.

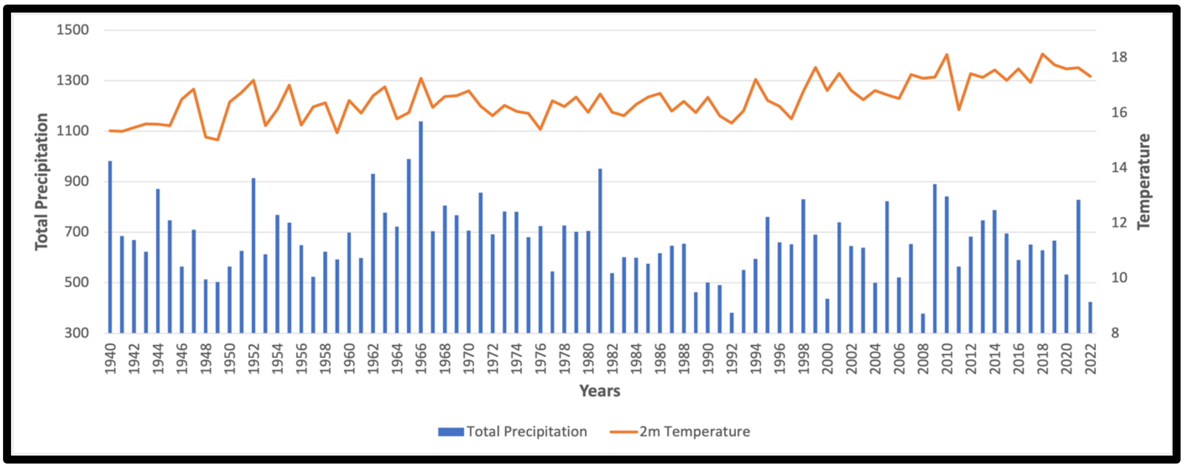

Figure 3-4. 2m Temperature and Total Precipitation in Aliaga from 1940 to 2022

To indicate how much warmer or cooler a certain area is compared to a historical baseline, temperature anomaly maps show the difference between an individual measured temperature and a reference, long-term average temperature. Aliaga temperature anomaly from 1940 to 2022 relative to 1970-1999 are shown in Figure 3-5. It shows clearly that the temperature in Aliaga has been rising steadily, most obvious in our plot since about the late-1990s.

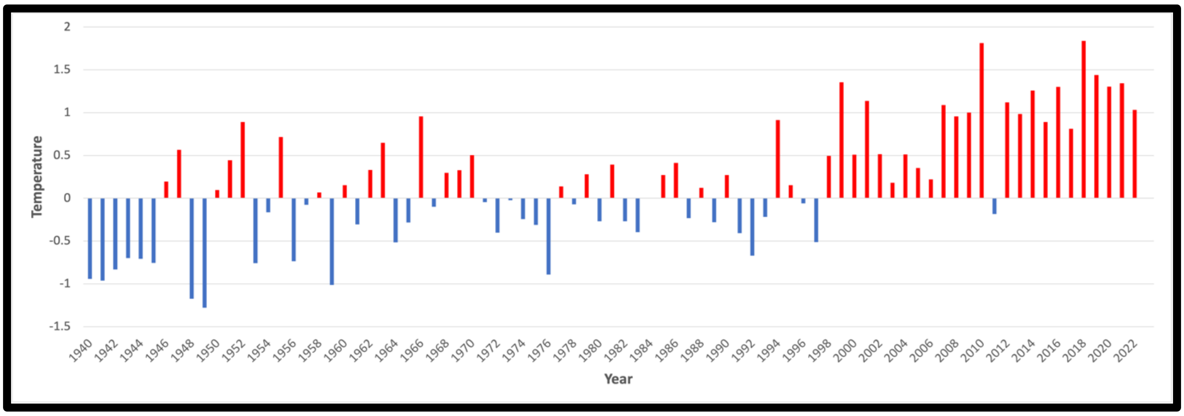

Figure 3-5. 2m Temperature Anomaly from 1940 to 2022 relative to 1970-1999.

3.1.2 Precipitation

Izmir, the Project location, is a coastal city located in the western part of Turkiye along the Aegean Sea coast, and it experiences a humid subtropical climate with significant precipitation throughout the year. 2022 monthly precipitation in Turkiye was above the normal of January, February, March, June, and August and was below the normal of other months (TSMS, 2023). Figure 3-6 shows how the precipitation changed in 2022 compared to 1991-2020's normal and it is noted that the project location was below the normal.

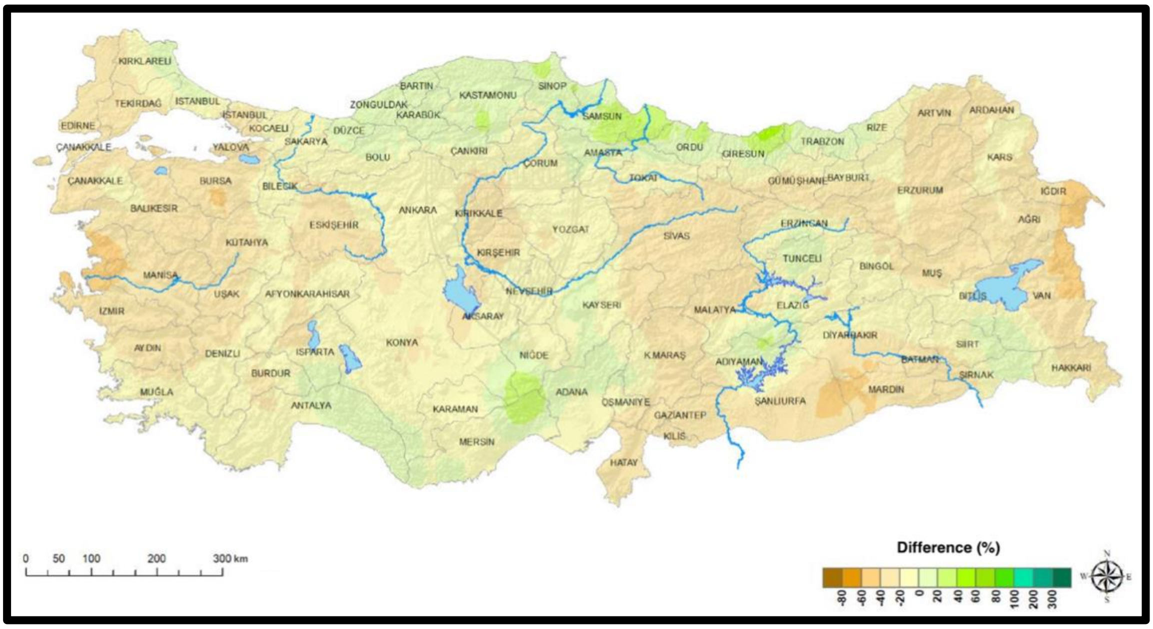

Figure 3-6. 2022 Total Precipitation Difference (%) Relative to 1991-2020.

Figure 3-7 and

Figure **3-8** depict the anomaly of total precipitation during summer and winter months in Aliaga from 1940 to 2022 relative to the baseline period of 1970-1999. Notably, the data reveals that total precipitation during winter months consistently fell below the established normal, while summer precipitation exceeded the anticipated levels. This observed trend may serve as an indicator of heightened extremes during the summer season.

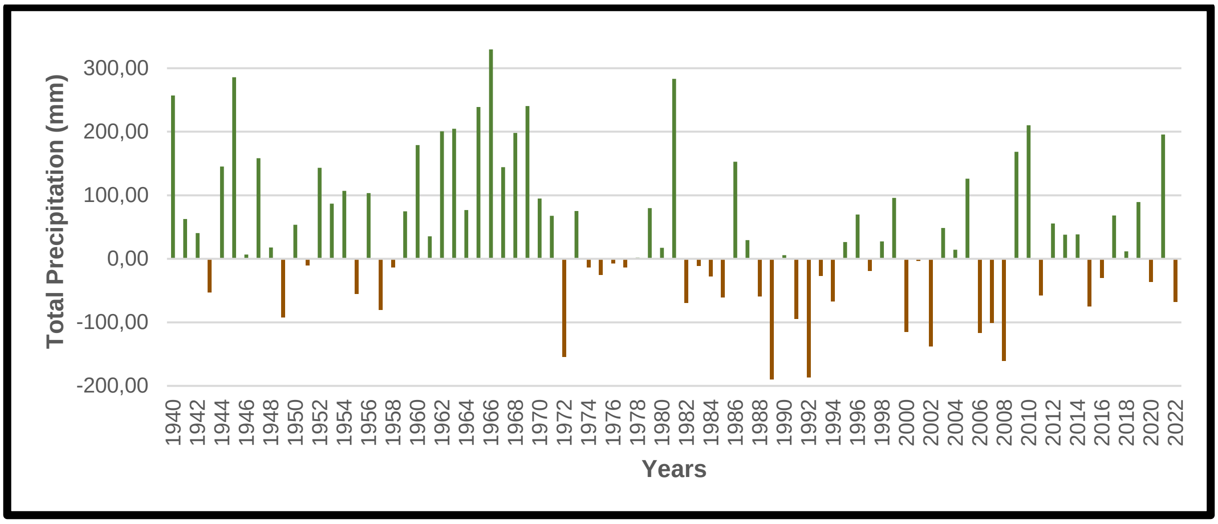

Figure 3-7. Winter Total Precipitation Anomaly (mm) Relative to 1970-1999.

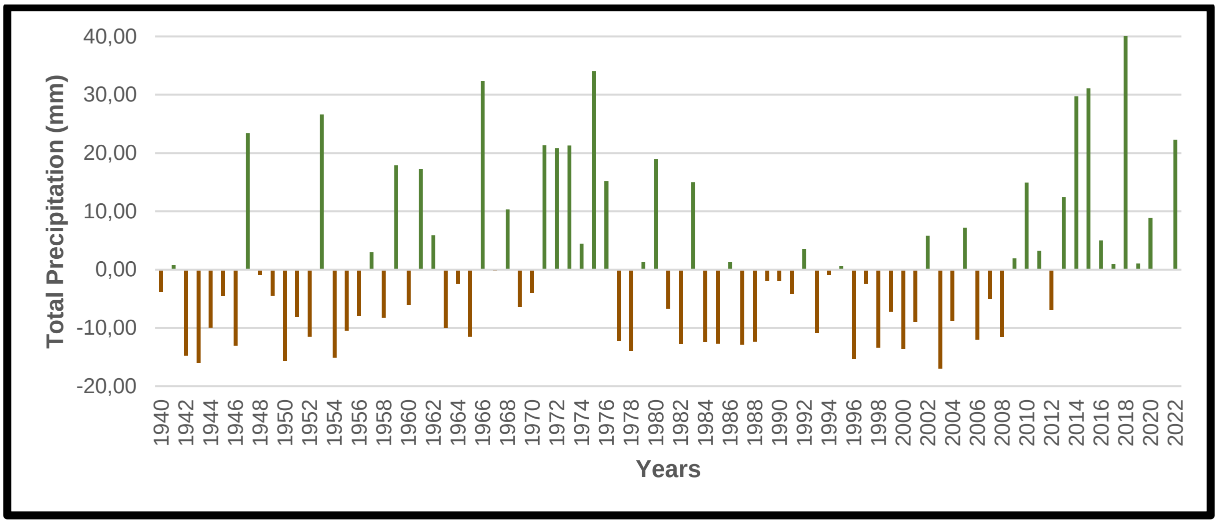

Figure 3-8. Summer Total Precipitation Anomaly (mm) Relative to 1970-1999.

3.1.2.1 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, 202). Drought is a part of climate change, the frequency and intensity of droughts in several places have been increased recently (Ebi et all., 2021; IPCC, 2021). The Standardized Precipitation Index (SPI) is a widely used index to characterize meteorological drought on a range of timescales. On short timescales, the SPI is closely related to soil moisture, while at longer timescales, the SPI can be related to groundwater and reservoir storage. According to TSMS, Figure 3-9 shows that the Project location was under abnormally dry conditions.

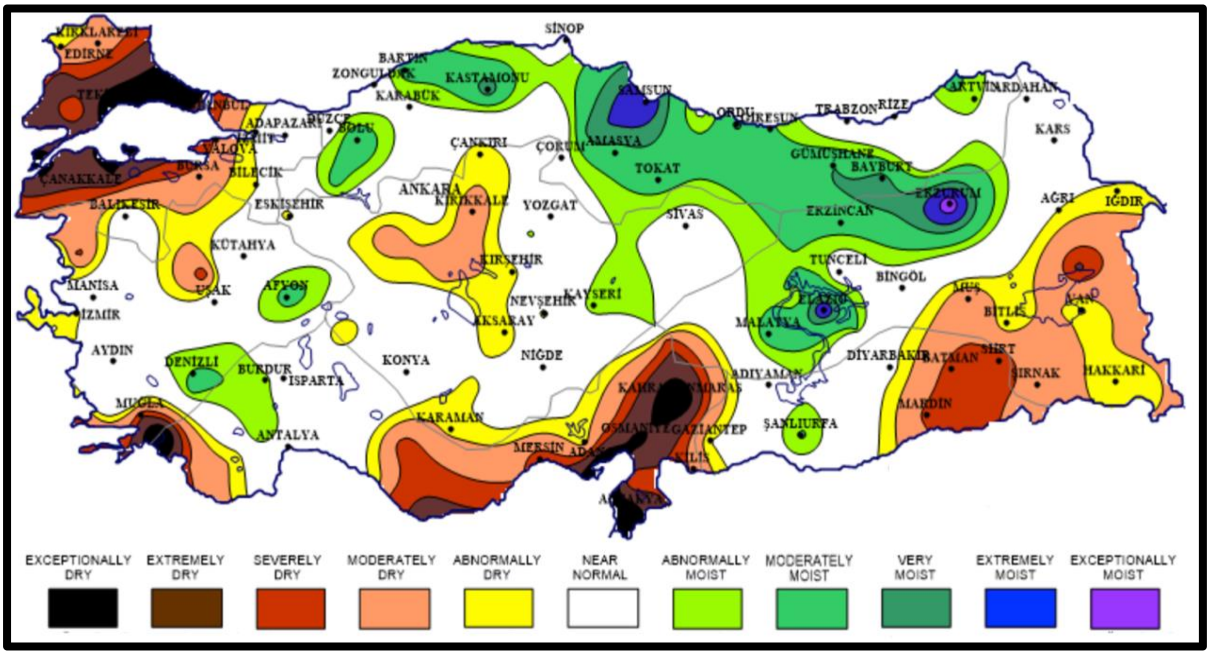

Figure 3-9. SPI drought map September 2022 – August 2023

3.1.3 Extremes

According to IPCC, 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 Türkiye (see. Table 3-1) 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 (2013-2022) is 578 events/year, the last five years’ average (2018-2022) is 772 events/year. Increased in average of extremes events and the number of 2022’s extremes show the increased possibility and frequency of extremes. It is also noted that even if extremes in 2023 are recorded until October, total number of extremes is above the average.

Table 3-1. Number of Extreme Events in Turkiye (ESWD, 2023)

Years	2016	2017	2018	2019	2020	2021	2022	2023
Extreme Events	420	306	751	504	900	818	891	1036

For the geographical distribution of the extreme weather events, the locations and types of extremes reported by the ESWD were presented in Figure 3-11. Heavy rains, large hails, tornados, and severe wind were reported near the project area.

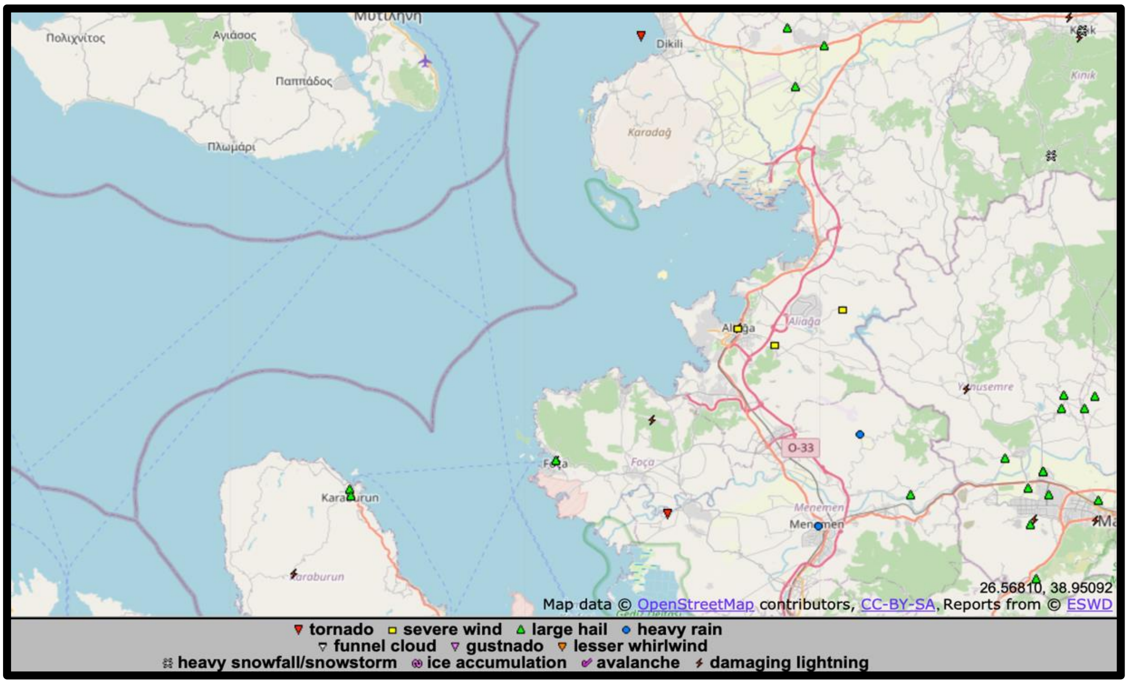

Figure 3-10. Extreme Weather Events near the Project Location.

Apart from the ESWD data, extreme events near the project area from 1978 to 2021 were obtained from four different meteorological stations (Bergama, Dikili, Izmir, and Manisa) operated by TSMS. There is a station near the project location called Aliaga, but the extremes were not available in this station. As seen in Table 3-2, storms and heavy rainfalls were observed frequently near the project area, and many floods were also effective near the project area.

Table 3-2. Extreme Weather Events Near the Project Location from 1978 to 2022

Date	Location	City	Extremes
22/10/1975	Bergama	Izmir	Hail
12/12/1976	Dikili	Izmir	Storm
15/04/1979	Manisa	Manisa	Hail
06/04/1981	Manisa	Manisa	Hail
19/04/1981	Izmir	Izmir	Storm
28/07/1981	Bergama	Izmir	Storm
30/11/1981	Izmir	Izmir	Rain and flood
05/12/1981	Izmir	Izmir	Rain and flood
31/12/1981	Bergama	Izmir	Storm

Date	Location	City	Extremes
15/09/1982	Bergama	Izmir	Storm
03/03/1983	Bergama	Izmir	Storm
22/12/1986	Bergama	Izmir	Storm
25/12/1986	Bergama	Izmir	Storm
28/02/1987	Dikili	Izmir	Frost
16/12/1990	Bergama	Izmir	Drought
10/06/1994	Bergama	Izmir	Drought
08/01/1997	Izmir	Izmir	Rain and flood
01/12/1997	Izmir	Izmir	Rain and flood
21/01/1998	Izmir	Izmir	Rain and flood
21/01/1998	Dikili	Izmir	Heavy rain and flood
22/01/1998	Bergama	Izmir	Rain and flood
16/11/1998	Izmir	Izmir	Rain and flood
21/11/1998	Izmir	Izmir	Rain and flood
01/02/1999	Manisa	Manisa	Heavy rain and flood
05/04/2000	Izmir	Izmir	Storm
28/12/2000	Izmir	Izmir	Storm
26/02/2001	Manisa	Manisa	Heavy rain and flood
14/11/2001	Izmir	Izmir	Rain
14/11/2001	Manisa	Manisa	Heavy rain and flood
24/11/2001	Izmir	Izmir	Storm
24/11/2001	Manisa	Manisa	Frost
28/11/2001	Izmir	Izmir	Rain
21/12/2001	Manisa	Manisa	Snow
31/01/2003	Izmir	Izmir	Storm, rain and hail
05/02/2003	Izmir	Izmir	Storm
09/10/2003	Izmir	Izmir	Storm
09/10/2003	Manisa	Manisa	Snow
09/10/2003	Bergama	Izmir	Rain and flood
04/04/2004	Manisa	Manisa	Storm and whirlwind
18/12/2004	Manisa	Manisa	Storm and whirlwind
25/01/2005	Manisa	Manisa	Storm and whirlwind
26/01/2005	Bergama	Izmir	Rain and flood
27/01/2005	Bergama	Izmir	Rain and flood
14/02/2005	Manisa	Manisa	Storm and whirlwind
05/03/2005	Manisa	Manisa	Storm and whirlwind
06/03/2005	Bergama	Izmir	Rain and flood

Date	Location	City	Extremes
01/04/2005	Bergama	Izmir	Rain and flood
21/05/2005	Manisa	Manisa	Storm and whirlwind
28/05/2005	Manisa	Manisa	Storm and whirlwind
01/06/2005	Manisa	Manisa	Storm and whirlwind
11/06/2005	Dikili	Izmir	Storm
17/12/2005	Bergama	Izmir	Fire and drought
28/09/2006	Izmir	Izmir	Rain and flood
23/06/2007	Izmir	Izmir	Heatwave
24/06/2007	Manisa	Manisa	Hail
24/07/2007	Manisa	Manisa	Hail
01/09/2007	Izmir	Izmir	Heatwave
10/11/2007	Dikili	Izmir	Storm
17/02/2008	Izmir	Izmir	Storm
24/03/2008	Dikili	Izmir	Storm
21/11/2008	Manisa	Manisa	Hail
22/11/2008	Izmir	Izmir	Storm
22/11/2008	Dikili	Izmir	Storm
22/11/2008	Dikili	Izmir	Storm
04/02/2009	Manisa	Manisa	Hail
07/02/2009	Dikili	Izmir	Rain and flood
07/02/2009	Bergama	Izmir	Lightning
08/02/2009	Manisa	Manisa	Hail
12/02/2009	Manisa	Manisa	Hail
21/03/2009	Izmir	Izmir	Rain and flood
18/05/2009	Izmir	Izmir	Hail
18/05/2009	Manisa	Manisa	Hail
18/12/2009	Izmir	Izmir	Storm
18/12/2009	Manisa	Manisa	Hail
31/12/2009	Izmir	Izmir	Storm
01/01/2010	Izmir	Izmir	Storm
25/01/2010	Manisa	Manisa	Hail
27/01/2010	Izmir	Izmir	Frost
01/02/2010	Manisa	Manisa	Hail
06/02/2010	Izmir	Izmir	Rain and flood
06/02/2010	Dikili	Izmir	Rain and flood
07/02/2010	Manisa	Manisa	Hail
27/02/2010	Dikili	Izmir	Hail

Date	Location	City	Extremes
17/03/2010	Manisa	Manisa	Heavy rain and flood
14/10/2010	Manisa	Manisa	Heavy rain and flood
18/10/2010	Manisa	Manisa	Heavy rain and flood
28/10/2010	Dikili	Izmir	Rain and flood
28/10/2010	Manisa	Manisa	Heavy rain and flood
26/12/2010	Dikili	Izmir	Rain and flood
24/01/2011	Izmir	Izmir	Storm
22/02/2011	Dikili	Izmir	Rain and flood
07/03/2011	Izmir	Izmir	Storm
12/04/2011	Manisa	Manisa	Heavy rain and flood
14/04/2011	Manisa	Manisa	Heavy rain and flood
19/05/2011	Manisa	Manisa	Heavy rain and flood
25/05/2011	Manisa	Manisa	Heavy rain and flood
26/05/2011	Izmir	Izmir	Rain and flood
27/05/2011	Izmir	Izmir	Rain and flood
27/05/2011	Manisa	Manisa	Heavy rain and flood
28/05/2011	Manisa	Manisa	Heavy rain and flood
28/05/2011	Manisa	Manisa	Heavy rain and flood
11/10/2011	Manisa	Manisa	Heavy rain and flood
06/01/2012	Izmir	Izmir	Storm
06/01/2012	Manisa	Manisa	Heavy rain and flood
18/04/2012	Dikili	Izmir	Storm
18/04/2012	Manisa	Manisa	Heavy rain and flood
19/04/2012	Izmir	Izmir	Storm
24/05/2012	Izmir	Izmir	Rain and flood
28/05/2012	Dikili	Izmir	Rain and flood
31/07/2012	Manisa	Manisa	Heavy rain and flood
01/10/2012	Manisa	Manisa	Heavy rain and flood
16/01/2013	Manisa	Manisa	Heavy rain and flood
18/01/2013	Manisa	Manisa	Heavy rain and flood
20/01/2013	Izmir	Izmir	Blizzard
24/01/2013	Manisa	Manisa	Heavy rain and flood
07/02/2013	Dikili	Izmir	Heavy rain and flood
08/02/2013	Manisa	Manisa	Heavy rain and flood
13/02/2013	Izmir	Izmir	Blizzard
12/03/2013	Manisa	Manisa	Heavy rain and flood
14/03/2013	Izmir	Izmir	Storm

Date	Location	City	Extremes
14/03/2013	Manisa	Manisa	Heavy rain and flood
18/03/2013	Manisa	Manisa	Heavy rain and flood
08/05/2013	Manisa	Manisa	Heavy rain and flood
08/05/2013	Manisa	Manisa	Heavy rain and flood
09/05/2013	Izmir	Izmir	Heavy rain and flood
23/05/2013	Izmir	Izmir	Storm
06/06/2013	Manisa	Manisa	Heavy rain and flood
12/06/2013	Manisa	Manisa	Heavy rain and flood
12/06/2013	Manisa	Manisa	Heavy rain and flood
17/07/2013	Manisa	Manisa	Heavy rain and flood
11/08/2013	Manisa	Manisa	Heavy rain and flood
17/08/2013	Izmir	Izmir	Hail
17/08/2013	Manisa	Manisa	Heavy rain and flood
16/09/2013	Dikili	Izmir	Storm and whirlwind
16/09/2013	Dikili	Izmir	Heavy rain and flood
16/10/2013	Dikili	Izmir	Heavy rain and flood
24/11/2013	Dikili	Izmir	Heavy rain and flood
25/11/2013	Izmir	Izmir	Heavy rain and flood
25/11/2013	Dikili	Izmir	Storm and whirlwind
28/01/2014	Izmir	Izmir	Heavy rain and flood
27/04/2014	Izmir	Izmir	Hail
08/06/2014	Manisa	Manisa	Frost
07/08/2014	Izmir	Izmir	Heavy rain and flood
07/08/2014	Manisa	Manisa	Frost
24/10/2014	Izmir	Izmir	Heavy rain and flood
20/11/2014	Izmir	Izmir	Heavy rain and flood
08/12/2014	Izmir	Izmir	Heavy rain and flood
26/12/2014	Izmir	Izmir	Snow
30/12/2014	Manisa	Manisa	Frost
06/01/2015	Izmir	Izmir	Frost
07/01/2015	Dikili	Izmir	Frost
12/01/2015	Dikili	Izmir	Storm and whirlwind
12/01/2015	Manisa	Manisa	Lightning
30/01/2015	Izmir	Izmir	Storm and whirlwind
30/01/2015	Dikili	Izmir	Storm and whirlwind
10/02/2015	Izmir	Izmir	Storm and whirlwind
10/02/2015	Dikili	Izmir	Storm and whirlwind

Date	Location	City	Extremes
06/04/2015	Dikili	Izmir	Heavy rain and flood
24/04/2015	Manisa	Manisa	Lightning
20/05/2015	Izmir	Izmir	Heavy rain and flood
03/06/2015	Manisa	Manisa	Lightning
09/06/2015	Manisa	Manisa	Lightning
22/06/2015	Izmir	Izmir	Hail
27/06/2015	Izmir	Izmir	Lightning
06/08/2015	Izmir	Izmir	Hail
06/08/2015	Izmir	Izmir	Storm and whirlwind
06/08/2015	Izmir	Izmir	Heavy rain and flood
06/08/2015	Izmir	Izmir	Lightning
06/08/2015	Manisa	Manisa	Hail
07/08/2015	Manisa	Manisa	Flood
20/09/2015	Manisa	Manisa	Hail
21/10/2015	Izmir	Izmir	Heavy rain and flood
22/10/2015	Izmir	Izmir	Hail
03/01/2016	Izmir	Izmir	Heavy rain and flood
17/01/2016	Izmir	Izmir	Heavy rain and flood
23/03/2016	Izmir	Izmir	Storm and whirlwind
18/05/2016	Izmir	Izmir	Heavy rain and flood
26/05/2016	Izmir	Izmir	Hail
26/05/2016	Izmir	Izmir	Heavy rain and flood
17/06/2016	Izmir	Izmir	Coldwave and Heatwave
29/06/2016	Izmir	Izmir	Hail
20/09/2016	Izmir	Izmir	Heavy rain and flood
08/11/2016	Izmir	Izmir	Storm and whirlwind
09/11/2016	Izmir	Izmir	Heavy rain and flood
28/11/2016	Izmir	Izmir	Heavy rain and flood
28/11/2016	Dikili	Izmir	Storm and whirlwind
28/11/2016	Dikili	Izmir	Heavy rain and flood
28/11/2016	Manisa	Manisa	Hail
28/11/2016	Manisa	Manisa	Hail
07/01/2017	Izmir	Izmir	Frost
10/01/2017	Izmir	Izmir	Snow
10/01/2017	Manisa	Manisa	Hail
03/05/2017	Manisa	Manisa	Hail
09/05/2017	Izmir	Izmir	Storm and whirlwind

Date	Location	City	Extremes
28/05/2017	Manisa	Manisa	Hail
29/05/2017	Izmir	Izmir	Heavy rain and flood
29/05/2017	Manisa	Manisa	Hail
04/06/2017	Izmir	Izmir	Hail
04/06/2017	Izmir	Izmir	Heavy rain and flood
04/06/2017	Dikili	Izmir	Lightning
08/06/2017	Izmir	Izmir	Hail
08/06/2017	Izmir	Izmir	Heavy rain and flood
09/06/2017	Izmir	Izmir	Heavy rain and flood
09/06/2017	Izmir	Izmir	Lightning
29/06/2017	Izmir	Izmir	Coldwave and Heatwave
21/07/2017	Manisa	Manisa	Hail
24/10/2017	Izmir	Izmir	Heavy rain and flood
20/11/2017	Izmir	Izmir	Hail
28/11/2017	Izmir	Izmir	Hail
18/01/2018	Izmir	Izmir	Storm and whirlwind
22/03/2018	Izmir	Izmir	Storm and whirlwind
25/03/2018	Izmir	Izmir	Storm and whirlwind
03/05/2018	Manisa	Manisa	Hail
05/05/2018	Izmir	Izmir	Heavy rain and flood
11/05/2018	Izmir	Izmir	Heavy rain and flood
24/05/2018	Manisa	Manisa	Frost
25/05/2018	Manisa	Manisa	Frost
26/05/2018	Manisa	Manisa	Frost
27/05/2018	Izmir	Izmir	Heavy rain and flood
27/05/2018	Manisa	Manisa	Frost
11/06/2018	Izmir	Izmir	Hail
11/06/2018	Manisa	Manisa	Frost
15/06/2018	Manisa	Manisa	Frost
22/06/2018	Izmir	Izmir	Heavy rain and flood
25/06/2018	Manisa	Manisa	Hail
26/07/2018	Izmir	Izmir	Hail
28/08/2018	Izmir	Izmir	Heavy rain and flood
29/09/2018	Izmir	Izmir	Heavy rain and flood
21/11/2018	Izmir	Izmir	Heavy rain and flood
10/12/2018	Izmir	Izmir	Heavy rain and flood
10/01/2019	Manisa	Manisa	Hail

Date	Location	City	Extremes
23/01/2019	Manisa	Manisa	Storm
25/01/2019	Manisa	Manisa	Storm
15/04/2019	Manisa	Manisa	Storm
15/04/2019	Manisa	Manisa	Storm
19/04/2019	Manisa	Manisa	Storm
19/04/2019	Manisa	Manisa	Storm
17/05/2019	Manisa	Manisa	Storm
17/05/2019	Manisa	Manisa	Storm
17/05/2019	Manisa	Manisa	Storm
17/05/2019	Manisa	Manisa	Storm
11/06/2019	Manisa	Manisa	Storm
11/06/2019	Manisa	Manisa	Storm
11/06/2019	Manisa	Manisa	Storm
11/06/2019	Manisa	Manisa	Storm
16/06/2019	Manisa	Manisa	Storm
16/06/2019	Manisa	Manisa	Storm
18/06/2019	Manisa	Manisa	Storm
18/06/2019	Manisa	Manisa	Storm and whirlwind
18/06/2019	Manisa	Manisa	Snow
18/06/2019	Manisa	Manisa	Frost
05/02/2020	Manisa	Manisa	Storm
05/02/2020	Manisa	Manisa	Hail
03/05/2020	Manisa	Manisa	Hail
01/06/2020	Manisa	Manisa	Heavy rain
12/06/2020	Manisa	Manisa	Heavy rain and flood
12/06/2020	Manisa	Manisa	Heavy rain and flood
12/06/2020	Manisa	Manisa	Heavy rain and flood
21/06/2020	Manisa	Manisa	Heavy rain and flood
23/06/2020	Manisa	Manisa	Heavy rain and flood
05/07/2020	Manisa	Manisa	Heavy rain and flood
05/07/2020	Manisa	Manisa	Heavy rain and flood
06/07/2020	Manisa	Manisa	Heavy rain and flood
09/08/2020	Manisa	Manisa	Heavy rain and flood
18/10/2020	Manisa	Manisa	Heavy rain and flood
12/01/2021	Manisa	Manisa	Rain
24/01/2021	Manisa	Manisa	Rain
31/01/2021	Manisa	Manisa	Rain and flood

Date	Location	City	Extremes
01/02/2021	Manisa	Manisa	Rain and flood
15/03/2021	Manisa	Manisa	Rain and flood
24/03/2021	Manisa	Manisa	Rain and flood
31/05/2021	Manisa	Manisa	Rain and flood
23/06/2021	Manisa	Manisa	Rain and flood
23/06/2021	Manisa	Manisa	Rain and flood
12/10/2021	Manisa	Manisa	Rain and flood
15/10/2021	Manisa	Manisa	Rain and flood
28/11/2021	Manisa	Manisa	Rain and flood
29/11/2021	Manisa	Manisa	Heatwave
30/11/2021	Manisa	Manisa	Heatwave

3.1.4 Flood

Floods are frequently observed in Türkiye, occurring when water rises in the same place or flows from another area, to cover an area that is generally dry. Floods can be classified into those that develop slowly, those that develop rapidly and flash floods, based on how fast they occur. A flood is referred to as slow if it develops over a week or longer, while a rapid flood develops over one or two days, and a flash flood occurs within hours. Floods are referred to as shore floods, city floods, dry stream floods, dam/pond floods, and stream (creek and river) floods, depending on the area in which they occur. Significant losses of property and even human life are witnessed every year in Turkiye as a result of illegal development of shantytowns on riverbeds, or as a result of the forestation, filling or rechannelling of riverbeds. Disaster Management and Natural Disaster Statistics in Turkey report published by AFAD (Disaster And Emergency Management Presidency) revealed that from 1950 to mid-2018, Izmir, the Project location, experienced 48 flood incidents, which is below the average when compared to other cities' flood incidents in Türkiye (see. Figure 3-11).

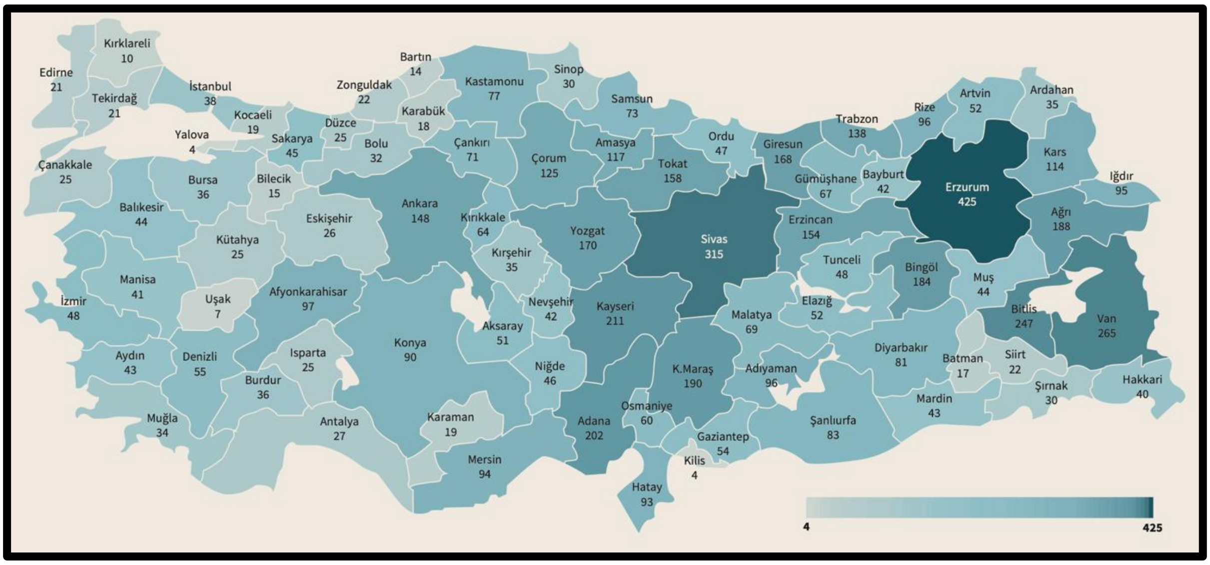

Figure 3-11. Numbers of Flood Incidents in Turkiye from 1950 to mid-2018

Notwithstanding Izmir's comparative position below the average of other cities by considering diverse flood data by the Disaster and Emergency Management Authority (AFAD), an analysis of station-based extremes reveals that the project location is susceptible to the hazards of flooding and intense rainfall.

3.2 Projections

3.2.1 Temperature

One of the problems from climate change over Türkiye is increased temperature especially in winter season. The increase in temperature may cause additional effects on rainfall patterns by turning the precipitation type from snow to rain during the winter (Demircan et al., 2017). The following charts present the outcomes of simulations carried out for the Project location, Izmir, Türkiye extracted from the World Bank Climate Change Knowledge Portal (CCKP) with reference to SSP2-4.5 and SSP4-8.5 scenarios (CCKP, 2023).

In Figure 3-12, it is noted that a slight increase of mean temperature between 1.4°C and 2.3°C mean-temperature in Izmir is expected: 18.4°C under SSP2-4.5 and 19.3°C under SSP4-8.5 by 2060.

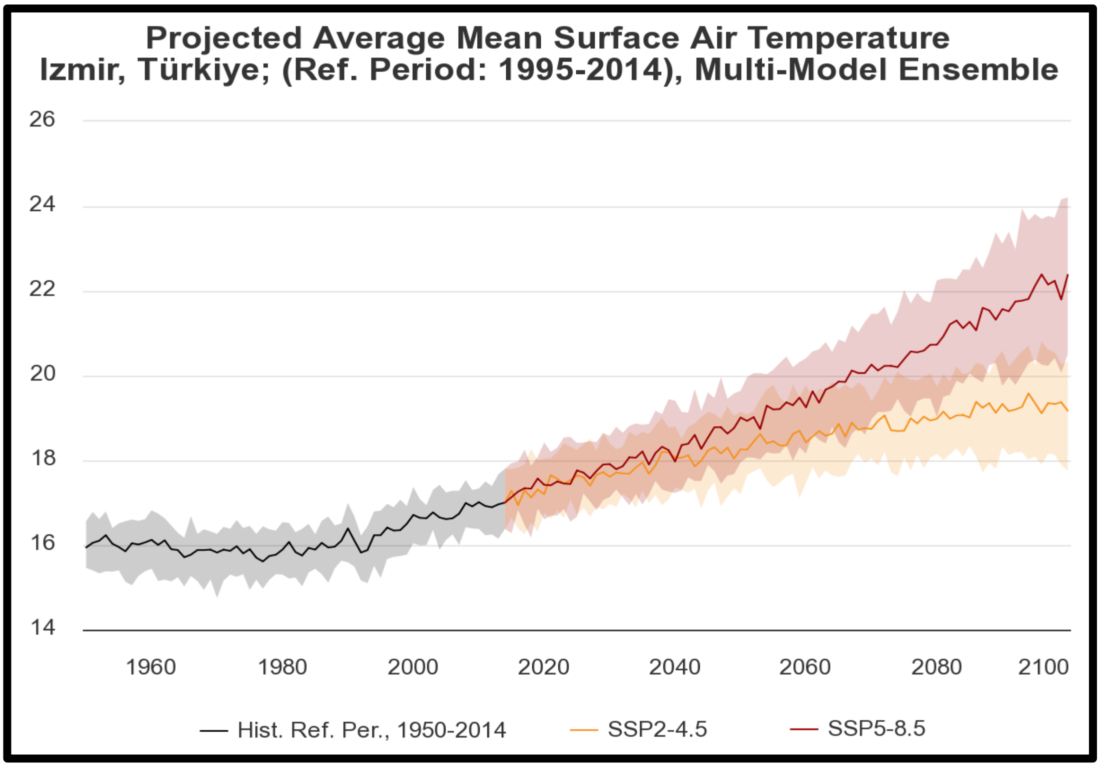

Figure 3-12. Projected Mean-Temperature in Izmir.

Figure 3-13 presents the projected variation of temperature under SSP2-4.5 for the period 2020-2039: it can be noticed that a slight increase of mean temperature between 0.5°C and 1.5°C is expected across all months, with potential increases of up to 2°C in September; and for the period 2040-2059; increase of mean temperature between 0.8°C and 2.1°C is expected across all months, with potential and increases of up to 3°C in July and August.

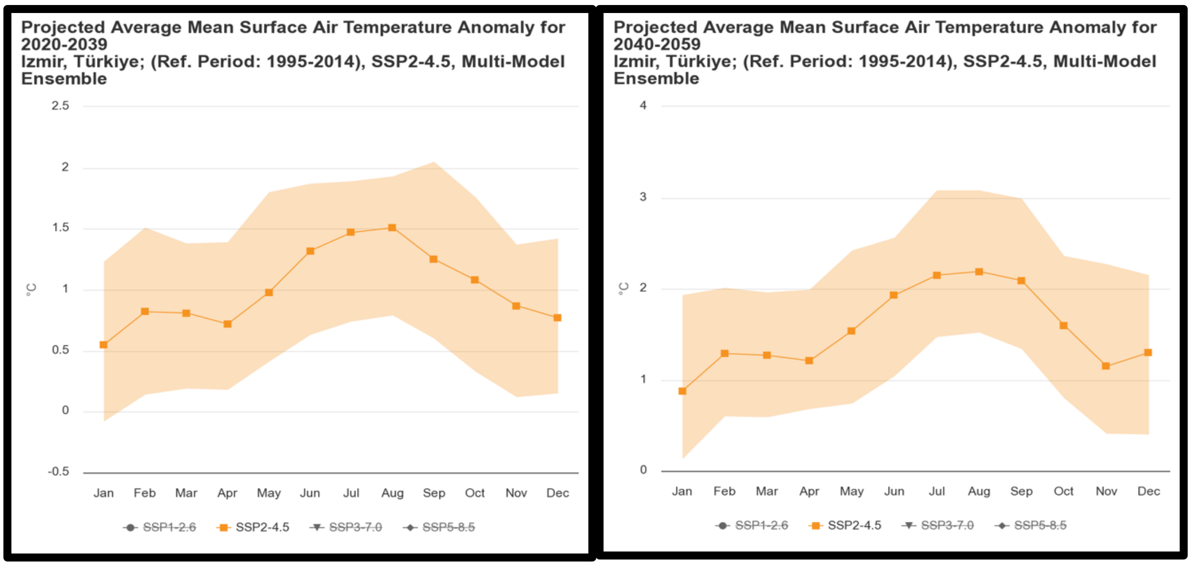

Figure 3-13. Monthly Projected Variation of Temperature in Izmir for the period of 2020-2039 (left) and 2040-2059 (right) under SSP2-4.5.

Figure 3-14 presents the projected variation of temperature under SSP5-8.5 for the period 2020-2039: it can be noticed that a slight increase of mean temperature between 0.7°C and 1.6°C is expected across all months, with potential increases of up to 2.5°C in August; and for the period 2040-2059; increase of mean temperature between 1.5°C and 3.1°C is expected across all months, with potential increases of up to 4°C in July and August.

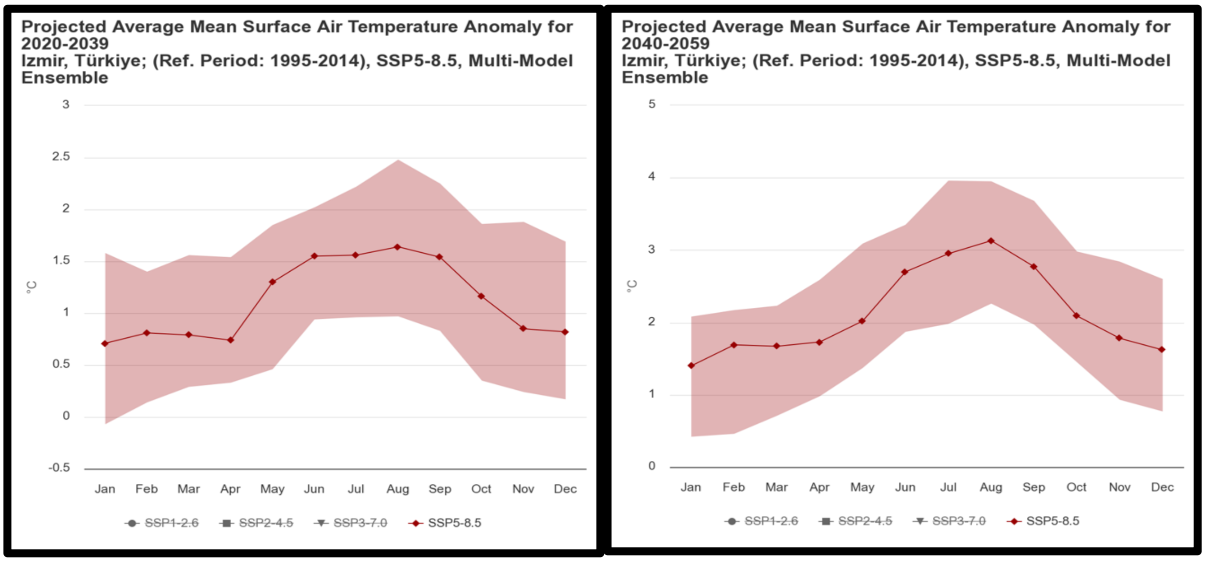

Figure 3-14. Monthly Projected Variation of Temperature in Izmir for the period of 2020-2039 (left) and 2040-2059 (right) under SSP5-8.5.

3.2.2 Precipitation

Findings from IPCC Sixth Assessment Report over the Mediterranean areas suggest that precipitation in the Project area is expected to decrease relative to 1850-1900 by around 8%, 12%, and 20% under simulated change at 1.5°C, 2°C, and 4°C global warming, respectively (Gutiérrez et all., 2021).

Figure 3-15 presents the projected variation of precipitation under SSP2-4.5 for the period 2020-2039: it can be noticed that precipitation will experience small fluctuations all over the year, potentially significant variations (mostly decreases) are expected with decreases up to 35 mm and increases up to 20 mm and 2040-2059; precipitation will experience fluctuations all over the year, potentially significant variations are expected with decreases up to 45 mm and increases up to 20 mm.

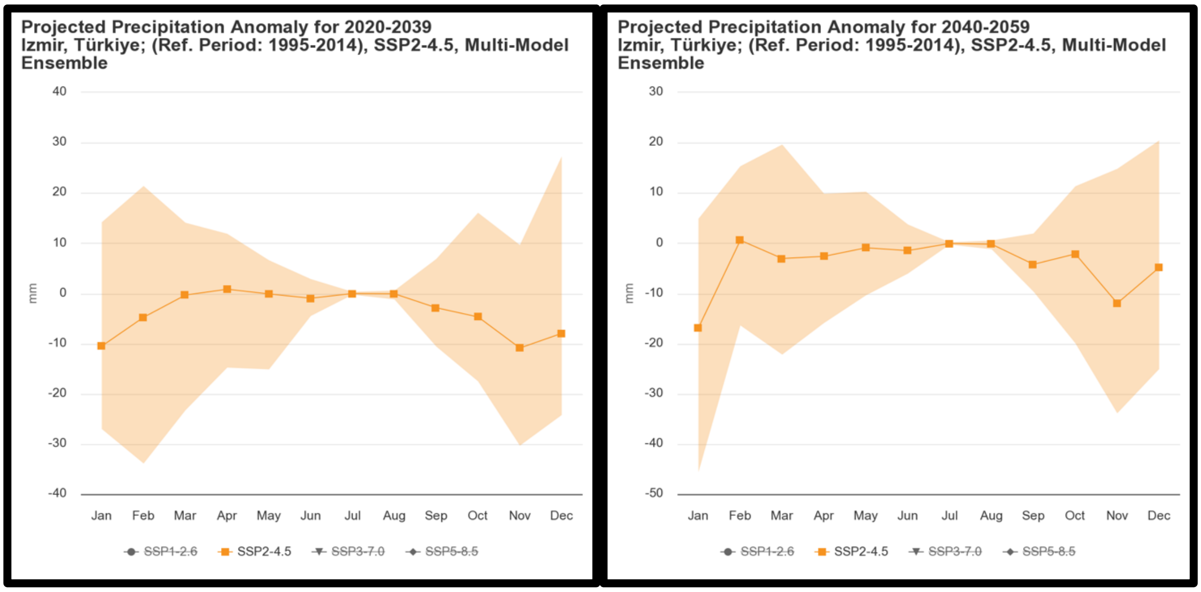

Figure 3-15. Monthly Projected Variation of Precipitation in Izmir for the period of 2020-2039 (left) and 2040-2059 (right) under SSP2-4.5.

Figure 3-16 presents the projected variation of precipitation under SSP5-8.5 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 32 mm and increases up to 22 mm and 2040-2059; precipitation will experience small fluctuations all over the year, potentially significant variations are expected with decreases up to 45 mm and increases up to 20 mm.

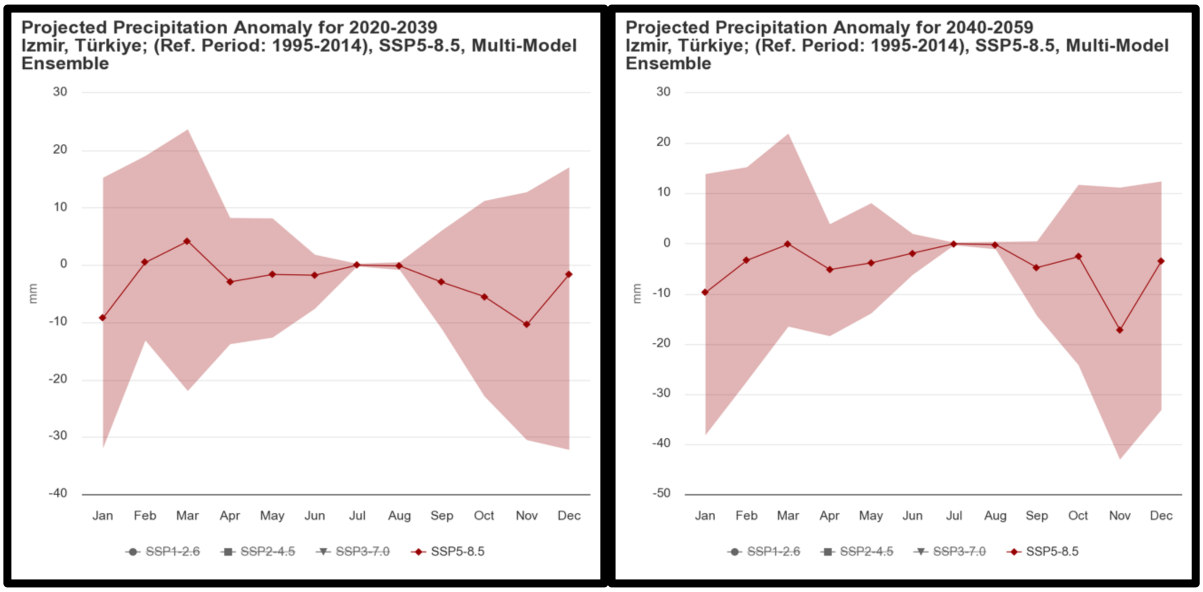

Figure 3-16. Monthly Projected Variation of Precipitation in Izmir for the period of 2020-2039 (left) and 2040-2059 (right) under SSP5-8.5.

Maximum 1- day Precipitation is expected to increase. The observed maximum 1-day precipitation value in Izmir in 1995 was 34.69mm and increased to 38mm in 2014. Projections specific to Izmir indicate that in 2050, the average largest 1-day precipitation will be 39.82mm under SSP2-4.5 and 36.94mm under SSP5-8.5 (World Bank Group 2023).

3.2.3 Other Climate Variables

Extreme Heat (Number of days above 35°C) is expected to increase. For the Mediterranean region, medium-term projections (2041-2060) indicate that extreme heat days (days above 35°C) will increase by 11.0 days under SSP2-4.5, and by 15.3 days under SSP5-8.5, from the 1995-2014 baseline (IPCC 2022)

Frost Days (<0°C) is expected to decrease. In Izmir specifically, in 2050, there is expected to be 7 frost days under SSP2-4.5 and 6 days under SSP5-8.5 and 14 days for the baseline of 1995-2014 (World Bank Group, 2023).

In the Mediterranean region, from the baseline of 1995-2014, by 2041-2060, there is expected to be a decrease in average surface wind speed by 1.4% under SSP2-4.5 and 1.9% under SSP5-8.5. There is expected to be an increase in extreme storm related precipitation, but a decrease in frequency of storm related precipitation in the Mediterranean (Gutiérrez et all., 2021).

3.2.4 Risk Descriptions – Exposure, Vulnerability and Mitigations

While assessing the physical risks from climate change, each climate patterns were considered, and potential risks were identified. In its “Sixth Assessment Report” published in 2022, the Intergovernmental Panel on Climate Change (IPCC) has already predicted that risks associated with extreme events will continue to increase as the global mean temperature rises. There is evidence that some extremes have changed because of anthropogenic influences, including increases in atmospheric concentrations of greenhouse gases. It is likely that anthropogenic influences have led to warming of extreme daily minimum and maximum temperatures at the global scale.

3.2.4.1 Heat stress (chronic) / Hot days (acute)

The deleterious effects of chronic heat stress and acute hot days on Smart Solar necessitate a comprehensive understanding of their potential ramifications. Chronic heat stress, stemming from prolonged exposure to elevated temperatures, presents formidable challenges. It not only jeopardizes the health and safety of factory workers but also has adverse repercussions on productivity. Heat-induced health concerns, such as heat exhaustion and heat stroke, demand meticulous management to avert life-threatening situations. Decreased work efficiency and heightened absenteeism are distinct outcomes of protracted heat stress, with the latter potentially resulting in labour shortages. Furthermore, the operational costs associated with alleviating heat stress can exert financial strain.

Conversely, acute hot days, characterized by sudden and extreme temperature spikes, can induce an array of immediate impacts. The abrupt onset of extreme heat may necessitate the temporary evacuation of workers from the factory floor, causing production interruptions. Machinery and equipment are rendered more susceptible to overheating, potentially leading to operational disruptions and downtime. Additionally, the augmented energy consumption required to maintain suitable working conditions during hot days can translate into increased operational costs.

To confront these challenges judiciously, the Smart Solar susceptible to heat stress or subject to heatwaves must adopt a multi-faceted approach. This entails the implementation of measures to mitigate heat stress among workers, including regular breaks, access to shaded areas, and education on heat stress recognition and management. Investment in climate-controlled facilities is paramount to ensure both workforce comfort and the preservation of equipment integrity. Routine maintenance and rigorous equipment monitoring are imperative to pre-empt overheating and machinery malfunctions. The formulation of emergency response plans, encompassing worker safety protocols and contingencies for production disruptions, is essential. Additionally, the exploration of energy-efficient cooling and ventilation solutions is integral to mitigating escalated energy expenditures during hot days.

Addressing the repercussions of chronic heat stress and acute hot days is pivotal not only for safeguarding the well-being of workers but also for upholding the quality of production and sustaining the overall efficiency and resilience of the factory.

3.2.4.2 Changing precipitation (chronic) / extreme rain events (acute)

In the context of chronic changing precipitation patterns, long-term alterations can disrupt water resource management within the Project. Extended dry periods may lead to water scarcity, directly impacting essential processes and necessitating adjustments in energy consumption to manage limited water resources efficiently. Furthermore, variations in precipitation can directly affect the availability and quality of raw materials such as silicon requiring a process that involves mining and purification which will be disrupted by excessive rainfall causing floods.

Conversely, acute extreme rain events present distinct challenges. These events can result in flooding, causing extensive damage to factory infrastructure, machinery, and raw materials. The aftermath often entails substantial repair costs and production delays. Ensuring the safety of factory personnel during these events is paramount, given the potential hazards associated with flooding and heavy rainfall. Additionally, transportation disruptions due to heavy rain may hinder the timely delivery of raw materials and the distribution of finished products, posing logistical challenges for the supply chain and business operations.

To effectively mitigate the impacts of changing precipitation patterns and extreme rain events on the project, an integrated approach is imperative. This approach encompasses efficient water management practices, diversification of raw material sources, comprehensive emergency preparedness, resilience of factory infrastructure, and adaptable supply chain strategies. By implementing these measures collectively, the Smart Solar can bolster their resilience, protect worker well-being, and ensure uninterrupted operations in the face of evolving precipitation patterns and extreme rain events.

3.2.4.3 Wind (chronic) / storms (acute)

The influence of wind, whether it persists as a chronic phenomenon or manifests acutely in the form of storms, can exerts significant ramifications upon the Smart Solar. These ramifications encompass a spectrum of operational aspects and warrant comprehensive consideration.

Prolonged exposure to chronic winds engenders the gradual degradation of factory infrastructure and machinery. Wind-driven particulates and debris contribute to surface erosion, thereby affecting the operational longevity of equipment and the structural integrity of the facility. Furthermore, the continuous prevalence of robust winds introduces air quality concerns within the factory premises, necessitating vigilance and potential mitigation efforts to maintain indoor air quality standards. Additionally, the elevated energy requirements to sustain optimal indoor conditions in regions prone to chronic wind pose an economic challenge, as heightened energy consumption corresponds to increased operational costs.

The advent of acute storms brings forth an array of critical considerations. Severe storms have the potential to disrupt production processes significantly, compelling temporary shutdowns to ensure worker safety or as a consequence of power outages. Structural damage inflicted upon factory buildings, roofs, and other critical infrastructure components necessitates immediate attention, often accompanied by delays in production schedules. The confluence of storm-induced power outages and machinery impairment underscores the need for resource allocation towards equipment recovery and system restoration, further adding to operational costs. Moreover, supply chain disruptions, precipitated by severe storms affecting the transportation of raw materials and the distribution of final products, can introduce bottlenecks in both production and distribution processes.

In the context of worker safety, paramount importance is attributed to safeguarding the well-being of factory personnel during storm events. The formulation and rigorous implementation of comprehensive protocols and contingency plans are imperative to protect employees from potential harm.

To effectively mitigate the aforementioned impacts of chronic wind and acute storms on the project, a strategic approach is warranted. This approach encompasses structural fortification to enhance resilience against wind forces, diligent emergency preparedness efforts, and investment in backup power systems to ensure continuity of critical operations during power outages. Furthermore, supply chain diversification serves to bolster resilience, rendering the factory less susceptible to disruptions arising from storm-related contingencies. Routine maintenance schedules, diligently adhered to for equipment and infrastructure, are pivotal for the early detection and rectification of issues stemming from chronic wind exposure.

In summation, adeptly managing the consequences of chronic wind and acute storms on the project mandates a proactive and holistic approach characterized by structural fortitude, stringent emergency preparedness, and supply chain robustness. These measures collectively serve to mitigate risks, safeguard the welfare of workers, and ensure the seamless continuity of factory operations.

3.2.4.4 Sea level rise (chronic) / flash floods (acute)

Changes in sea levels are affecting human activities in coastal areas, and rising sea level inundates low-lying wetlands and dry land, erodes shorelines, and contributes to coastal flooding. Higher sea level also makes coastal infrastructure more vulnerable to damage from storms. As relative sea level rises due to climate change, one of the most noticeable consequences is an increase in coastal flooding. Flooding typically occurs during seasonal high tides ("king tides") and storms that push water toward the shore. In recent years, however, coastal cities are increasingly experiencing flooding on days with less extreme tides or little wind, even on sunny days. Floods are happening more often as rising sea level reduces the gap between average sea level and the height of the land.

Projected changes in sea level by the end of this century (2100) under 2°C and 4°C scenarios (Strauss et al., 2021) were given below (Climate Central, 2023). According to sea level rise map, it is expected to the Smart Solar will be under the flood threat (especially under 4°C scenario), and as it is very close to coastal areas, it is important to follow the regulations from the government and local authorities.

Figure 3-17. Sea Level Rise by 2100 under 2°C Warming Scenario.

Figure 3-18. Sea Level Rise by 2100 under 4°C Warming Scenario.

As flooding caused by a short but very severe precipitation or sudden snow melt due to changes in climatic conditions, changes in the rainfall-runoff relationship and in the amount of runoff due to changes in land cover and land use in the basin, occurrence of hydroelectric power plants or dams, sand and gravel withdrawal from streams affect stream discharges will have direct or indirect impacts which can disrupt operations, damage equipment, and lead to financial losses.

The flood maps provide a detailed picture of flood risk for a range of flood event scenarios including climate change and are the essential tools for land use planning in flood-prone areas. The flood maps support planning and emergency response and allow the authorities to be prepared for possible flood events. The basic criteria for mapping are usually chosen according to flood return periods. Flood risk maps were obtained from the Turkish Flood Management Portal for the maximum flood discharges with return periods of 50, 100, and 500 years. Within flood risk maps, delineated by a red line extending from the coastal areas to the inland regions of Aliaga, water bodies and high-risk areas are demarcated, while blue areas denote zones susceptible to flooding within the district. A red star, accompanied by the label "Smart Solar," serves to pinpoint the location of the project on the map.

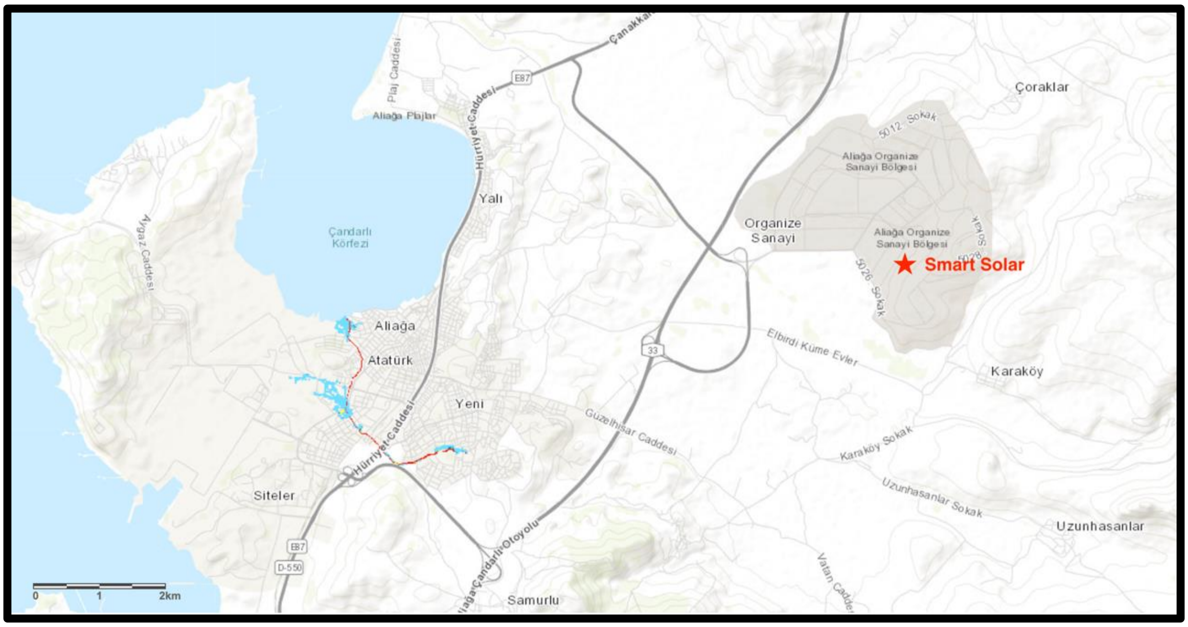

Figure 3-19. Flood Risk Map with return periods of 50 years**.**

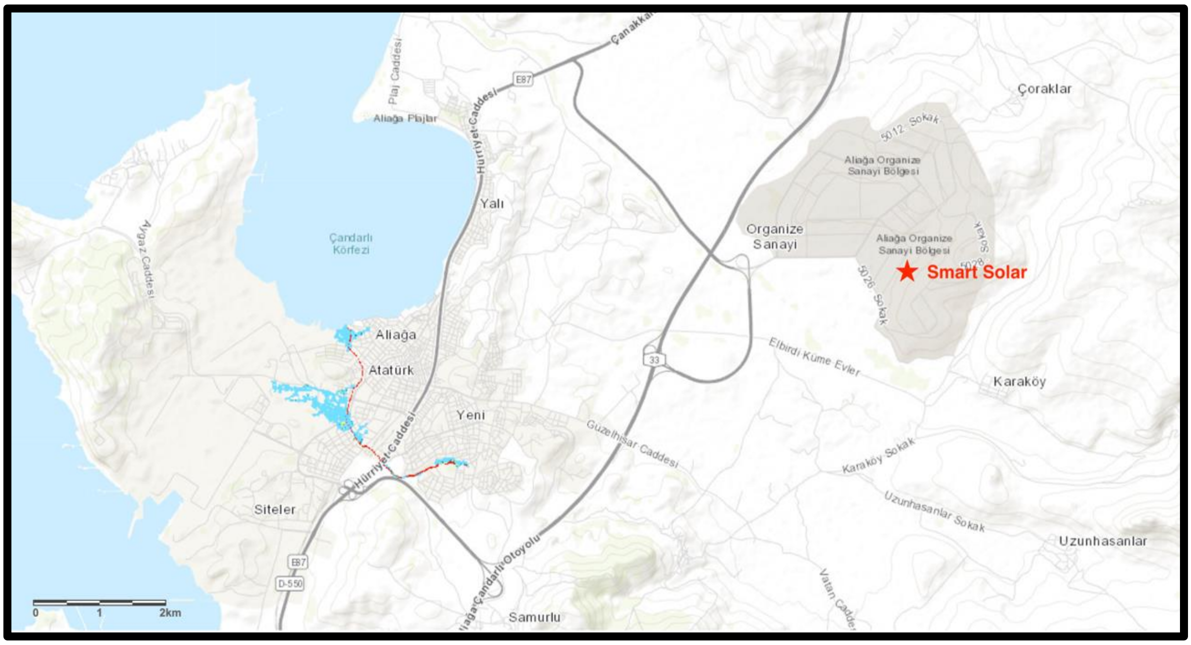

Figure 3-20. Flood Risk Map with return periods of 100 years.

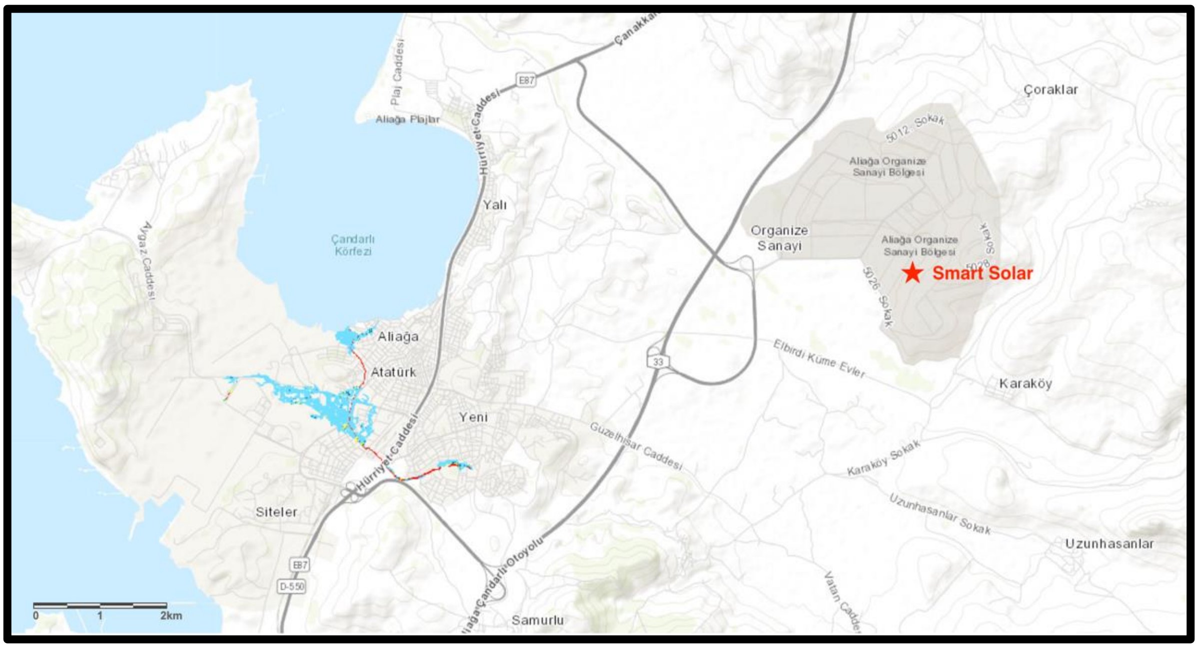

Figure 3-21. Flood Risk Map with return periods of 500 years.

The Project, Smart Solar, confronts a multitude of complex challenges when faced with floods. Floodwaters have the potential to inflict extensive damage upon the Smart Solar's infrastructure. This includes structural harm to buildings, vital equipment, and electrical systems. In the wake of a flood, extensive resources are often needed for rehabilitation and repair. The resultant downtime in production, as well as the costs associated with restoring the damaged infrastructure, can be financially burdensome for the project.

Floods can force a temporary cessation of manufacturing operations to safeguard the well-being of workers and protect the Smart Solar's assets. These interruptions can be considerable and may significantly disrupt production schedules, ultimately impacting the Smart Solar's ability to meet demand and fulfil orders on time.

Floodwaters frequently carry contaminants, sediments, and debris into the factory premises. These substances can infiltrate the manufacturing process and damage solar panel components. Cleaning and quality control procedures must be diligently applied, resulting in additional expenses and production delays.

The adverse impacts of floods are not limited to the Smart Solar itself; they extend to supply chains. Delays in the delivery of essential raw materials and components, due to disrupted transportation routes and logistics, can affect production schedules and potentially escalate operational costs.

Flood events present a clear threat to the safety of the Smart Solar's workforce. Ensuring the well-being of employees during such emergencies may necessitate emergency response and evacuation measures, further complicating the operational landscape.

If floodwaters lead to the release of hazardous materials or wastewater into the environment, the Smart Solar may face regulatory violations and environmental clean-up costs. Compliance with environmental regulations and remediation efforts may require considerable resources.

The destruction of inventory, including raw materials and finished products, can result from floodwaters. This leads to inventory losses and not only affects production but also has financial ramifications for the factory. The cumulative effects of production stoppages, infrastructure damage, clean-up and repair expenditures, and losses in inventory can have a significant financial impact on the Smart Solar's bottom line. Following a flood event, insurance premiums may increase, and insurance coverage terms and conditions may be altered, leading to higher operating costs for the factory.

Managing these challenges naturally leads to increased costs. These include not only the expenses associated with equipment repairs and infrastructure renovations but also higher insurance premiums due to flood-related claims. To navigate these financial challenges successfully, the Smart Solar must carefully assess its risk management strategies and financial preparedness for flood events.

To effectively address these multifaceted impacts, Smart Solar should proactively implement comprehensive flood preparedness and response plans, make strategic investments in flood-resistant infrastructure, and consider geographic location and flood risk mitigation as integral parts of its long-term business strategy.

3.3 Risk Evaluation

The methodology for conducting a Physical Risk Assessment under Climate Change Risk Assessment involves a systematic and comprehensive approach. It begins with scoping and understanding the organization's operations and geographical context. Historical climate data and future scenarios are analysed to identify potential hazards, such as flooding, sea level rise, and extreme weather events.

Exposure and vulnerability assessments are then conducted to evaluate the organization's assets' susceptibility and potential consequences. Risks are prioritized based on severity and impact. The assessment's findings are integrated into business processes providing transparent insights into identified risks and management strategies. Continuous review and refinement ensure the assessment remains current and informs ongoing decision-making. This methodology equips organizations to proactively manage physical risks arising from climate change, enhancing their resilience and aligning with sustainable strategies.

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 3-3, and it is assigned by referencing the historical data, climate projections and expert judgment in some cases, which also acknowledge uncertainty, specify time frames, and stakeholder perspectives. Impact is qualitatively assessed using the descriptions in

Table 3-4. The Probability and Impact were combined to assess the Risk significance of effects on receptors as shown in Table 3-5.

Table 3-3. 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 3-4. 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 3-5. Criteria for Risk Evaluation

Risk Evaluation		Event Impact			
		Negligible (N)	Low (L)	Medium (M)	High (H)
Event Probability	Very Low (VL)	Negligible	Negligible	Low	Medium
	Low (L)	Negligible	Low	Medium	Medium
	Medium (M)	Negligible	Low	Medium	High
	High (H)	Negligible	Low	High	Critical

The physical risks identified for the Project, including their potential impacts, probability and adaptation measures is presented in the following section.

3.4 Risks

A register of the physical risks identified for the Project, including their potential impacts, probability and adaptation measures is presented in Table 3-6.

Table 3-6. 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 Increased intensity and frequency of extreme weather events Decreased precipitation	Heat stress (chronic) / Hot days (acute)	Health and Safety Concerns	Medium	High	High	heat stress mitigation, climate-controlled facilities, maintenance and monitoring, emergency plans and energy efficiency	Low
		Reduced Worker Productivity	Medium	Medium	Medium		
		Higher Operating Costs	Low	Low	Low		
		Production Disruption	Medium	Medium	Medium		
		Equipment Overheating	Medium	Medium	Medium		
		Energy Costs	Medium	Medium	Medium		
		Quality Control Issues	Medium	Medium	Medium		
	Changing precipitation (chronic) / extreme rain events (acute)	Flooding and Infrastructure Damage	Medium	High	High	comprehensive emergency preparedness, resilience of factory infrastructure, and adaptable supply chain strategies	Low
		Worker Safety	Medium	Medium	Medium		
		Transportation Disruptions	Medium	High	High		
		Water Resource Management	Low	Low	Low		
		Raw Material Availability	Low	Low	Low		
		Energy Consumption	Medium	Medium	Medium		
	Wind (chronic) / storms (acute)	Equipment and Structural Wear	Very Low	Low	Negligible	structural fortification to enhance resilience against wind forces, diligent emergency preparedness	Low
		Air Quality	Very Low	Low	Negligible		
		Energy Consumption	Low	Low	Low		

Variation of Climate Pattern	Specific Change	Effect	Probability	Impact	Risk	Adaptation Measure	Residual Risk
		Production Disruption	Low	Low	Low	efforts, and investment in backup power systems to ensure continuity of critical operations during power outages.	
		Damage to Infrastructure	Low	Medium	Medium		
		Power Outages	Low	Medium	Medium		
		Supply Chain Disruption	Low	Low	Low		
		Safety Concerns	Medium	Medium	Medium		
	Sea level rise (chronic) / floods (acute)	Supply chain disruptions	Medium	High	High	implement flood preparedness and response plans, invest in flood-resistant infrastructure, and maintain appropriate insurance coverage. strategy	Low
		Energy supply interruptions	Medium	High	High		
		Worker safety	Medium	Medium	Medium		
		Increased costs	Medium	Medium	Medium		
		Environmental compliance	Low	Low	Low		
		Damage to the infrastructure	Medium	High	High		
		Contaminants into the raw materials	Low	Low	Low		

3.5 Key Climate-Resilient Design Features

Key climate-resilient design features for Smart Solar to mitigate climate change risks include:

Installing localized energy storage systems, such as battery storage or energy management systems, provides backup power during intermittent power supply or grid disruptions. This supports continuous operations and prevents downtime due to power outages caused by extreme weather conditions. Generators, which are already part of Smart Solar's procurement plan, will provide energy in the event of unforeseen situations.

As the project area is situated within an organized industrial zone, the water supply lines in Aliağa Organized Industrial Zone (ALSOBI) are available for use. However, ensuring a reliable water supply like bottled water or mobile water stations for the workforce is essential during extreme conditions. Daily drinking water needs of the workers are catered for in carboys purchased from licensed companies.

Investment in climate-controlled facilities is paramount to ensure both workforce comfort and the preservation of equipment integrity. As a part of the local legislation, Occupational Health and Safety Law (Law No. 6331), these design features have already been implemented in the factory.

The implementation of structural fortifications is paramount to fortify resilience against formidable wind forces. Additionally, it is important to make strategic investments in flood-resistant infrastructure. A comprehensive approach involves integrating considerations of geographic location and flood risk mitigation as integral components of the long-term business strategy. The warehouse loading platform has been designed to have the necessary elevation to minimise the impacts of extraordinary conditions, including flooding.

Developing a resilient supply chain strategy by diversifying suppliers, maintaining buffer stocks, and creating contingency plans for transportation disruptions due to weather events. This proactive approach ensures the continuous availability of essential raw materials even during weather-related disruptions. Smart Solar has a wide range of product suppliers and transportation methods to address transportation and supply issues in unforeseen situations.

Designing flexible and adaptable manufacturing layouts enables swift adjustments to changing climate conditions or disruptions. These layouts allow for efficient reconfiguration of production lines and storage areas, facilitating continuity in manufacturing processes during unexpected events or supply chain interruptions. Preventive measures have already been implemented to ensure uninterrupted manufacturing operations in the face of unforeseen circumstances, including the use of flexible and adaptive production layouts.

In Izmir Provincial Disaster Risk Reduction Plan (IRAP), some recommendations are considered and listed below:

H14-E21 Ensuring that water from all rainwater channels is collected at a single point within the Aliağa Organized Industrial Zone (2022-2026).

H14-E22 Increasing the number of water discharge pumps to prevent the gallery system within the borders of Aliağa Organized Industrial Zone from being affected by floods (2022-2026).

H14-E23 Ensuring that the companies that will make new investments within the Aliağa Organized Industrial Zone create the infrastructure that will enable the rainwater on their own land to be collected in a rainwater tank at a single point, at the building permit stage (2022-2026).

Implementation of all these recommendations of IRAP will be the responsibility of Aliağa Organized Industrial Zone, and Smart Solar will be in the position of helping ALOSBI.

As noted in Figure 3-22, storing solar panels (other waste disposal as well) in open areas exposes them to a range of climate-related risks, potentially impacting their efficiency and durability. However, during the preparation of risk assessment report and discussion with Smart Solar, it is noted that solar panels and other waste from the factory will be stored in warehouse. Since the production will be made according to demand, the waiting time of solar panels in the warehouse will not be too long. As noted in the Environmental and Social Due Diligence (ESDD) report, waste will also be stored in the waste storage area at the Project site and will be gathered in municipal receptacles and subsequently collected by Aliağa Municipality.

Figure 3-22. Panel Stacking (left) and Packaging Waste Storage (right)

Conducting regular training and educational programs for employees to increase awareness and preparedness for climate-related risks. Training sessions can cover emergency response protocols, risk mitigation strategies, and the importance of individual contributions to resilience efforts. As a part of Smart Solar's strategy, regular trainings and educational programs for employees will be conducted.

Implementing these advanced climate-resilient design features in the solar panel production factory strengthens its ability to confront and adapt to climate change risks, fostering a more sustainable and resilient manufacturing environment.

4 RECOMMENDATIONS FOR ADAPTATION MEASURES

Several recommendations for adaptation measures (as summarized in Table 3-6) that Smart Solar can implement to mitigate the risks associated with climate change are provided below. As discussed in previous section, all necessary recommendations will be implemented by Smart Solar in order to minimize the impacts and ensure that the project is at low risk.

Even if the residual risk from sea level rise and floods is low, the project should reinforce the factory's physical infrastructure to withstand extreme weather events. This includes flood barriers, elevation of critical equipment, and designing structures that can resist heavy rainfall. As the project is located in the Aliağa Organized Industrial Zone (ALOSBİ), ALOSBI is responsible for flood risk management. In addition to ALOSBI's responsibility, Smart Solar also considers the impacts of flooding and ensures the resilience of its structures and products (such as raised warehouse loading docks).

It is important to diversify suppliers and establish backup routes to ensure a steady flow of raw materials even during disruptive events. This should be provided by contingency plans for supply chain disruptions caused by extreme weather. Smart Solar's vast network of product suppliers and delivery alternatives, including the possibility of using cargo aircraft if necessary (instead of cargo ship which will affected by extreme weather event through the routes), ensures that the project is equipped to address any issues that may arise.

Considering integrating diverse energy sources is crucial for mitigating the impact of energy shortages due to changing climate conditions. Installing energy storage systems can help ensure a more reliable energy supply. This will be handled by using generator which are already part of Smart Solar's procurement plan.

Developing thorough emergency response plans that consider various climate-related scenarios is essential for ensuring minimal disruption to production and a swift recovery post-event. Establishing clear safety protocols and regularly training employees on emergency response plans during extreme weather events is crucial. Developing and practicing evacuation plans ensures the safety and well-being of the workforce.

Engaging in collaboration with governmental bodies and industry associations ensures alignment with national or sectoral adaptation and climate resilience policies. Staying informed about best practices and regulatory standards helps the factory remain proactive in its adaptation strategies.

Implementing these measures, which are already considered by Smart Solar, will significantly enhance the factory's ability to withstand and adapt to the challenges posed by climate change, ultimately ensuring continued operational resilience and stability in the face of unpredictable weather patterns and extreme weather events.

In Smart Solar's Environment and Climate Change Policy, it is stated that the main goal as the ("Company") is to support the creation of a climate-friendly, sustainable development-based ecosystem with low-carbon energy technologies and R&D-oriented products and services.

5 PA ALIGNMENT ASSESSMENT

Following the adoption of the Paris Agreement, the multilateral development banks (MDBs) started work on a joint methodological framework for Paris Agreement alignment (PAA). The framework defines six core areas of work, known as building blocks (BBs):

BB1 – Aligning with mitigation goals;
BB2 – Aligning with climate adaptation and resilience goals;
BB3 – Accelerating contribution to the transition through climate finance;
BB4 – Providing support for engagement and policy development;
BB5 – Characterizing, monitoring and reporting on the results of Paris-aligned investment operations;
BB6 – Aligning MDB internal activities.

5.1 Assessment for PAA under BB2 (climate adaptation and resilience goals)

The collaborative methodology developed by Multilateral Development Banks (MDBs) to evaluate the Paris Agreement Alignment (PAA) in direct investment operations primarily relies on the fundamental steps used to track adaptation finance in MDB initiatives. Three core assessment criteria are pivotal to this approach:

Criterion 1: The Climate Risk and Vulnerability Context is established. This requires an operation to identify any material physical climate risks that could adversely impact its activities, and assess the sensitivity, exposure, and overall vulnerability of the project to relevant climate- related hazards. Where risks have been identified as medium or high (i.e., material), a detailed climate risk and vulnerability assessment (CRVA) is required in order to support the consideration of suitable adaptation measures (see Criterion 2). If physical climate risks to the operation are considered low, Criterion 2 is not applicable and the PAA assessment proceeds to Criterion 3.

Criterion 2: Adaptation measures for managing material risks are identified and integrated into project design. This criterion seeks to ensure that the material risks identified have been managed by the inclusion of adaptation measures within the operation.

Criterion 3: The operation and its components are not inconsistent with the sectoral or national priorities for climate resilience. This requires an assessment of whether project activities are inconsistent with existing local, national, regional or sectoral policies and priorities for adaptation and resilience.

5.1.1 Establishment of climate risk and vulnerability context (Step 1)

The details of climate risks, key climate-resilient design features, adaptation measures were given in the Section 3 – Physical Climate Risk Assessment. By considering the recommendations and design features (some of them have already been implemented) which will be covered by Smart Solar to minimize the climate related risks, It is noted that the Smart Solar ***is not at medium or high risk***, and physical climate risks to the project are considered ***low***.

5.1.2 Definition of climate resilience measures (Step 2)

As the project is at low risk, this step is not applicable. However, it is suggested to take all key climate design features and adaptation measures into account.

5.1.3 Assessment of inconsistency with broad context for climate resilience (Step 3)

The Ministry of Environment and Urbanization (MoEU) is responsible for the formation and implementation of environmental policy in Turkiye and is also the focal point for the UNFCCC. In this context, climate change policies are determined and executed by Climate Change and Air Management Coordination Board (CCAMCB) under the coordination of the MoEU with the participation of relevant ministries and institutions.

Turkiye's main climate change policy documents (see. Figure 5-1 for timeline of climate policy developments in Turkiye) are 10th Development Plan, National Climate Change Strategy (2010-2023), National Climate Change Action Plan (2011-2023) and National Climate Change Adaptation Strategy and Action Plan (2011-2023).

The "Enhancing Adaptation Action in Turkey Project" report, which was co-financed by the European Union (EU) and Republic of Turkey in 2021 and implemented by the Ministry of Environment and Urbanisation via the United Nations Development Programme (UNDP), provides an exhaustive aggregation of all relevant stakeholders' efforts and studies on climate change adaptation in Turkey to date. Additionally, the report examines critical national policies, including Turkey's international initiatives.

The entire domain of climate change is not governed by a single legal code in national legislation. Upon closer inspection, the pertinent institutional regulations and legislation address climate change either directly or indirectly to an important extent. The legislation that contains the most straightforward provisions pertaining to climate change adaptation is the Environmental Law and the Law on Soil Conservation and Land Use.

Izmir Metropolitan Municipality, the project's location, commenced preparatory works for the "Izmir Green City Action Plan" as of 2019 as part of the Green Cities Programme of the European Bank for Reconstruction and Development (EBRD). This report specifies that investments in renewable energy will be encouraged in order to increase the capacity for solarpowered electricity generation. The Izmir municipality actively promotes the installation of solar panels by the private sector by utilising pre-existing national subsidies or financial initiatives.

The Paris Agreement is a legally binding international treaty aims to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. On 22 April 2016, Türkiye signed the Paris Agreement mentioned in its National Declaration as a developing country and ratified the Agreement on 7 October 2021 (deposited with the UN Secretariat on 11 October 2021) by completing the domestic law approval process. Therefore, climate change has now been considered seriously in Türkiye. In an amended version of Türkiye's Nationally Determined Contribution (NDC) presented at COP27, the Minister of Environment, Urbanization, and Climate Change declared the peaking of GHG emissions by 2038 and a new reduction target of 41% by 2030 (up from 21%).

Partnership for Market Readiness (PMR), launched by the World Bank in 2011, is a technical assistance program that aims to support the efforts of developing countries, which have an important place in the global fight against climate change, to reduce their greenhouse gas emissions, through the effective use of the market. A synthesis report outlining carbon market policy options for Turkiye was submitted to the Climate Change and Air Management Coordination Board in November 2018. The (PMR) First Phase Closure Meeting was held at the end of 2018 and the PMR Second Phase officially began in February 2019. With additional funding under the PMR Second Phase, Turkiye has developed draft legislation as well as improved technical and institutional capacity to prepare the groundwork for piloting a suitable carbon pricing policy.

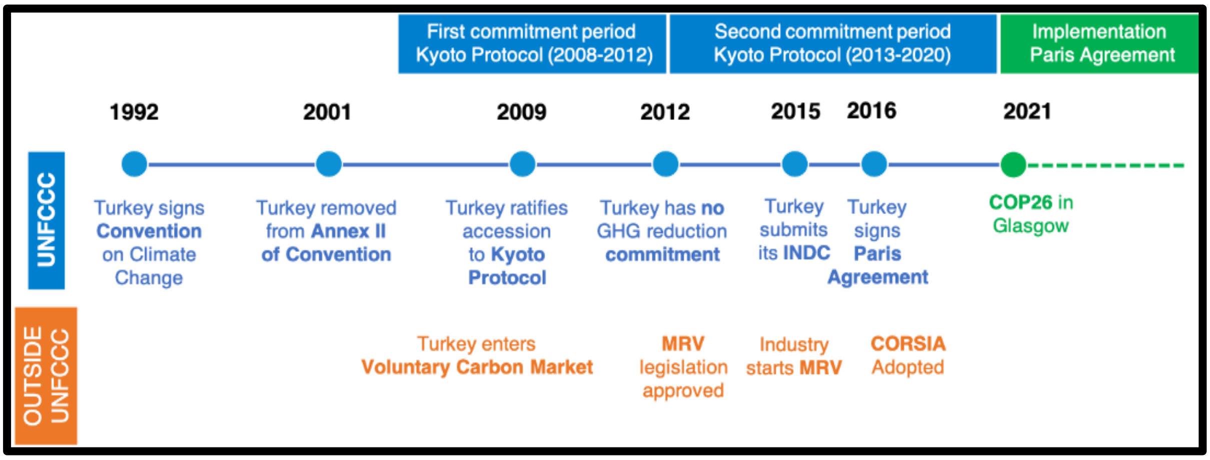

Figure 5-1. Timeline of climate policy developments.

Turkiye introduced its inaugural National Climate Change Adaptation Strategy and Action Plan (NASAP) in 2012, outlining objectives until 2023. The ongoing revision of NASAP involves a comprehensive assessment of impacts, vulnerabilities, and risks, particularly within the industrial and energy sectors. These evaluations aim to contribute to fulfilling the global adaptation goal set by the 2015 Paris Agreement.

Seven Regional-level Regional Climate Change Action Plans have been developed for distinct geographical areas. These plans outline priority measures across various sectors to combat climate change. At the local level, Turkish municipalities have committed to enhancing their climate resilience through dedicated local climate change action plans. Additionally, Turkey's Spatial Strategy Plan (2053) stands as a key policy document, laying the groundwork for the creation of sustainable, energy-efficient, and climate-resilient cities.

Regional Climate Change Action Plan of Aegean Region, where the project is located, addresses the following key points within the framework of regional climate change action plans:

Assessment of Potential for Energy Diversity: The aim is to evaluate the potential of wind and solar energy in the region to achieve diversity in energy production. Planning investments to make the best use of this potential will be a crucial step towards transitioning to sustainable energy sources for the region.

Industrial Planning Focused on Energy Efficiency: Anticipating an increase in electricity consumption in the industrial sector, climate change action plans target effective measures in enhancing energy efficiency. By concentrating on energy efficiency applications, the plans aim to control the rise in energy consumption and promote sustainable industrial practices.

Implementation of Alternative Energy Sources with Determination and Collaboration: Another significant aspect emphasized in the report is the implementation of alternative energy sources and energy efficiency measures with determination and collaboration. This requires a coordinated effort among stakeholders across the region. Establishing a joint action plan will enable the region to transition consistently to alternative energy sources and achieve successful applications in energy efficiency.

In Smart Solar Sustainability report, it is stated that environmental sustainability is an important component of Smart Solar’s sustainability strategy. Considering the environmental impact of its activities, the Company has been supporting a sustainable future with its products and services by developing green technology.

The Izmir Sustainable Energy and Climate Action Plan has set forth robust adaptation goals and within this framework:

Izmir aims to enhance the effectiveness of new water infrastructure networks by reviewing and updating existing design and implementation standards, ensuring the sustainability and efficiency of water systems.

Particularly in high-risk areas like industrial and residential zones, Izmir endeavours to create flood management plans, intending to implement effective measures against water inundations. These plans include strategies to enhance the region's preparedness for the impacts of climate change.

The action plan report aspire to incorporate climate projections and city resilience in the design and construction of future infrastructure. To achieve this, local policies, planning regulations, and principles will be reviewed and updated, serving as a crucial step in promoting infrastructure solutions resilient to climate change.

To address environmental impact, Smart Solar has established an Environment and Climate Change Policy, focusing on monitoring and continuously improving its environmental performance, minimizing its carbon footprint, efficiently utilizing resources, and complying with legal requirements.

Smart Solar aims to be net zero in 2040, in addition to its contributions to combating global climate change and reducing greenhouse gas emissions in energy production by providing clean technologies.

The company offers products and services focusing on green technology and low-carbon energy production to support the fight against climate change. Within the scope of environmental investments, the income obtained from climate-friendly energy production practices in 2022 increased by 160% compared to 2021 and reached approximately 2.2 Billion Turkish Liras.

In line with its sustainable development goals, the company uses green energy technologies with the principle of value engineering by focusing on optimum process efficiency. All activities of the Company are managed in accordance with national and international standards, as well as relevant environmental legislation and regulations.

In this context, Smart Solar is considered to be ***not inconsistent*** with the sectoral or national priorities for climate resilience.

5.2 Aligned or Not Aligned

By following three steps in the Methodology for assessing the alignment of AIIB investment operations with the Paris Agreement, the Project, Smart Solar, ***is aligned*** with the adaptation and climate resilience goal of the Paris Agreement.

6 ESTIMATED ADAPTATION FINANCE

As the cost of the adaptation measures identified through the CCRA will be covered by the client, not AIIB, in line with the joint MDB methodology for tracking adaptation finance, there will be no adaptation finance to be reported under this project.

7 CONCLUSIONS

This report provides a summary of the methods and information needed to perform a climate change risk assessment, specifically tailored to the project of Smart Solar. By following steps defined in the earlier section of this report, Climate Change Risk Assessment (CCRA) Report including the assessment of physical risks, PA alignment, and adaptation finance was prepared in line with the recommendations of the Task Force on Climate-related Financial Disclosures (TFCD), the Methodology for assessing the alignment of AIIB investment operations with the Paris Agreement, and the joint MDB methodology for tracking climate change adaptation finance.

Detail explanation of physical risks were identified here, and it is expected that higher temperature will likely affect workers and productivity and give extra pressures on electricity consumption, which may cause temporary shortages in electricity supply. Due to extremes near project location, delays in production, delivery etc will likely be occurred. Floods may be occurred due to heavy rainfalls, which will cause delays, lengthy disruption and high costs of repairs.

The Climate Change Risk Assessment considers infrastructure components for the operations phase of the Project. The site has in-design adaptation measures in places to reduce the impact of both current climate and projected changes to the future climate. Through the qualitative risk assessment, it is identified that the site is resilient.

By following three steps in the Methodology for assessing the alignment of AIIB investment operations with the Paris Agreement, the Project, Smart Solar, is aligned with the Paris Agreement. In line with the joint MDB methodology for tracking climate change adaptation finance, no adaptation finance will be reported under this project as all adaptation cost will be borne by the client.

Although the mitigation measures have the potential to reduce climate risks, the measures need to be monitored for their performance through an ongoing monitoring and surveillance process. As a part of this, a continual improvement process could be developed to integrate climate change risks and opportunities in this process. This continual improvement process could be used to outline the decision- making process for when action needs to be taken to improve climate resilience. The continual improvement process could be updated through an ongoing process over the lifetime of the Project. The results from the monitoring programs would be integrated to test the effectiveness of resilience and mitigation actions and manage the unexpected outcomes.

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