Bulgartransgaz EAD

Climate Change Risk Analysis

Chiren Gas Storage Facility Project - Bulgaria

Rev.	Description	Prepared by	Controlled by	Approved by	Date
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ABBREVIATIONS AND ACRONYMS

CAT	Climate Action Tracker
CC	Centrifugal compressors
CCGT	Combined Cycle Gas Turbine
CCKP	Climate Change Knowledge Portal
DHI	Diffuse Horizontal Irradiation
DNI	Direct Normal Irradiation
EIA	Environmental Impact Assessment
ESDD	Environmental and Social Due Diligence
EU	European Union
EU-ETS	European Union Emission trading system
FGPU	Fuel gas preparation unit
GFDRR	Global Facility for Disaster Reduction and Recovery
GHG	Greenhouse Gases
GTCUs	Gas turbine compressor unit
GTE	Gas turbine engine
HFL	Highly flammable liquids
IESC	Independent Environmental and Social consultant
IFI	International Financial Institution
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter Tropical Convergence Zone
KBDI	Keetch–Byram Drought Index
LULUCF	Land use, land use change and foresty
MOEW	Ministry of Environment and Water
NDC	Nationally Determined Contribution
RCP	Representative Concentration Pathway
SPEI	Standardized Precipitation Evapotranspiration
SPI	Standardized Precipitation Index
SSP	Shared Socioeconomic Pathways
TCFD	Task Force on Climate-related Financial Disclosures
TEG	Triethylene glycol
UGS	Underground gas storage
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WEF	World Economic Forum

1 INTRODUCTION

The Chiren Gas Storage Facility (the Project) is owned and operated by Bulgarstransgaz EAD (BTG or the Company), the state-owned enterprise of the Bulgarian government, and is the owner and operator of the existing Chiren natural storage facility.

The Project comprises the expansion of Chiren gas storage facility from 550 mcm to up to 1 bcm to satisfy the increased storage requirements associated with the flows of the new Greece- Bulgaria Interconnector Pipeline and the increase the national strategic reserve in response to geopolitical events. The Project comprises the following three main elements:

- ✓ Expansion of the gas handling facility;
- ✓ New interconnecting gas pipeline; and
- ✓ New exploitation wells, pipelines, and observation wells.

This report represents the Climate Change Risk Assessment of the Chiren Gas Storage Facility, and it is elaborated considering Physical Risks in line with the Equator Principles' Guidance Note on Climate Change Risk Assessment (EP IV) issued in October 2020[1], the latest update released in May 2023[2], and the Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD).

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 and climate change policies in Bulgaria;
- ✓ Chapter 3 describes the methodology applied to the analysis;
- ✓ Chapter 4 focuses on the analysis of the climate patterns at the Project location, including observed trends for temperature, precipitations, wind, drought and hazardous climate events over the last years. Moreover, it includes the projections of climate change for the upcoming decades, up to 2060;
- ✓ Chapter 5 is the core part of the analysis that includes the Climate Change Risk Assessment, describing the ongoing and expected changes in climate patterns and evaluating the climate-related physical risks;
- ✓ Chapter 6 draws the conclusions of the analysis.

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[1] Equator Principles, "The Equator Principles – October 2020: https://equator-principles.com/app/uploads/CCRA_Guidance_Note_Sept2020.pdf

[2] Equator Principles, "The Equator Principles –May 2023: https://equator-principles.com/app/uploads/Guidance-CCRA_May-2023.pdf

2 PROJECT CONTEXT

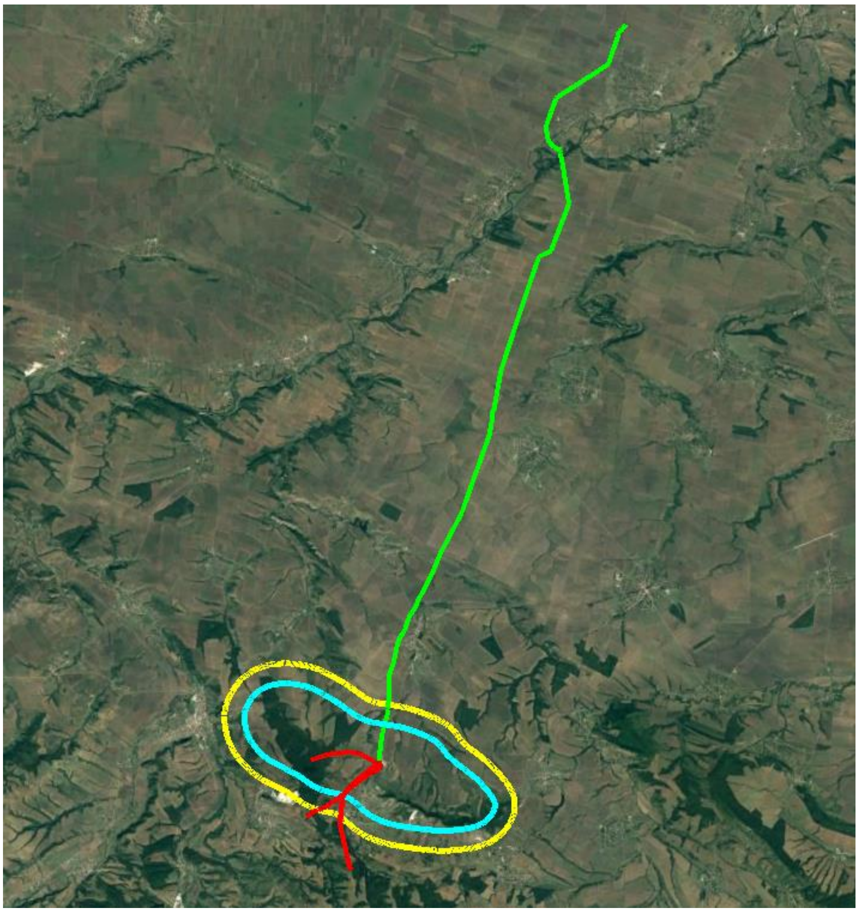
2.1 PROJECT OVERVIEW

The Project proposes the extension of the Chiren underground gas storage (UGS) facility from 550 mcm up to 1 bcm. The extension aims to boost the nation's strategic reserve in reaction to geopolitical developments and to meet the increasing storage needs brought on by flows through the new Greece-Bulgaria Interconnector pipeline.

The Project will be centered on the existing pipelines and comprises the following three elements:

- ✓ Expansion of the gas handling facility
- ✓ New interconnecting gas pipeline
- ✓ New exploitation wells and pipelines and observation wells

The Project is anticipated to start in Q2 2023, last for 600 days, and end in late Q4 2024. The location of the project is shown in Figure 2.1.



Key: Green: New Pipeline, Red: Existing Pipelines, Blue: limit of exploitation wells, Yellow: limit of monitoring wells

Figure 2.1: Project Location

The different project elements are described in the following sections.

2.1.1 Expansion of the gas handling facility

The above ground components contain the addition of four 18 MW gas turbine compressor units (GTCUs), including a gas turbine engine (GTE), driving two centrifugal compressors (CC), ancillary equipment to the GTCU, individual separation unit, Gas metering station (GMS), manifold, gas purification and heating, general separation, gas drying plant, triethylene glycol (TEG) regeneration plant, and formation fluids separation plant. In addition to the above equipment, a production and energy unit (PEU), a fuel gas preparation unit (FGPU), a flare, a tank with a fire-fighting pump station, access control point and a fence are also planned to be constructed.

The current Chiren site (see Figure 2.2) is 5.3 hectares in area and is situated around 1,000 m farther north than the town of Chiren (2,200 m from the center). There are several buildings on the 5,174 m^2 site, including an administrative building, a gas station, a compressor workshop, garages, warehouses, a service unit, fan cooling towers, a gas drying plant, a gas AVG and water-cooling plant, a wastewater plant, a storage tank for MC-20 oil and TEG, etc. The expansion area covers an area of approximately 8.2 hectares.

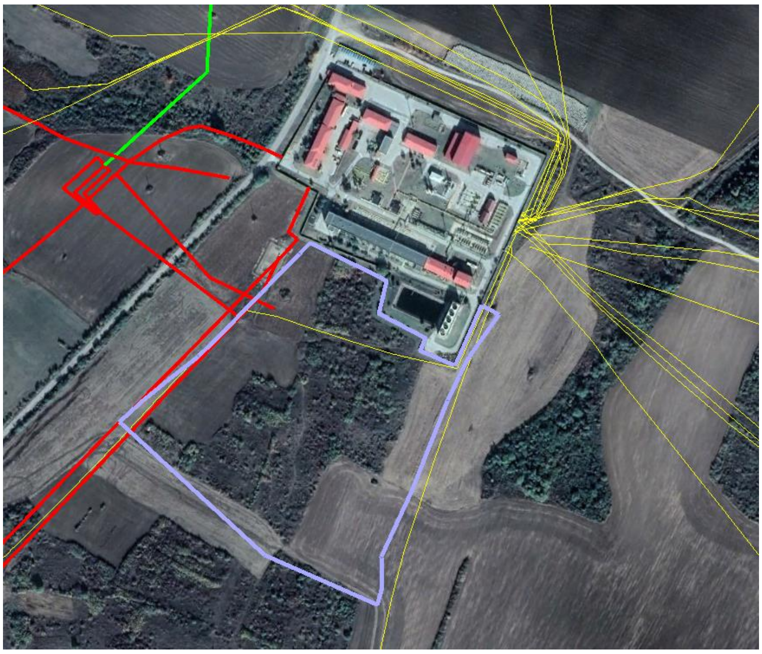


Figure 2.2: Current Chiren gas storage facility with the area of the expansion (purple) to the south

About 160 m to the north of the main site is a 290 m^2 storage space for highly flammable liquids (HFL). This contains a separate excise tax warehouse, a methanol tank, infrastructure, and modular offices for the gas condensate produced by the main plant.

The total installed thermal input of the currently site is 34.66 MW, as follows:

- ✓ Eight gas engine compressors with heat capacity 3.88 MW each;
- ✓ Three water heating boilers with rated thermal input 0.74 MW each and
- ✓ A tri-ethylene glycol regeneration unit with 1.4 MW power.

In addition, there is an emergency gas unit available at the site with a thermal rating of 1.67 MW.

On the current facility, there will need to be a temporary construction site during the building period. For the anticipated 10 construction workers, there won't be a need to set up a worker camp. Chiren Dam will provide hydrotest water through the current supply networks. The usage of hazardous materials is anticipated to be restricted to technical gases like acetylene, oxygen, argon, and carbon dioxide, as well as fuels (diesel, oils, etc.). All waste streams—construction, non-hazardous, hazardous, and municipal—should not have any problems with disposal because they will all be handled by regional garbage businesses.

The present 250 m^3 methanol tank will be supplemented by a new 30 m^3 tank during operations and recovered gas condensate will be kept in the current 525.5 m^3 tank. This will result in an increase in the volume of hazardous chemicals stored on the site. Additionally, TEG, lubricating oil, antifreeze, and an underground fuel tank are stored in bulk on the working site.

2.1.2 Interconnecting gas pipeline

The Chiren UGS will be linked to the current BTG gas transmission network in the vicinity of Butan village by the new interconnecting gas pipeline. The length of the 28" pipeline will be around 41.5 kilometers, and it will also be equipped with the following infrastructure:

- ✓ A fiber optic cable line parallel to the gas pipeline's axis within the easement region, extending from the Chiren UGS to the Pigging Facility (PF) at Butan (the gas pipeline's beginning point);
- ✓ Two Cathodic Protection Stations (CPSs) are envisioned in the design: one at the Line Valve Assembly (LVA) location near Manastirishte and the other at the Chiren UGS towards the end of the segment.
- ✓ Safety valve - located at the beginning of the new gas pipeline;
- ✓ Pigging Facility Near Butan (PF Butan): This launch/receive site has a total area of 2,146 m^2 and is situated next to the Botev Road, a municipal road that leads to the village of Butan in the south. The power supply is provided via the current 20 kV line of BTG;
- ✓ Pigging Facility (PF Chiren 3) next to the Chiren UGS: This new launch/receive site will be situated around 190 meters west of the Chiren UGS, right adjacent to PF Chiren 1/Vratsa 1, which will serve the Vratsa 1 for the current pipeline. Following the current Vratsa 1 gas pipeline easement, a low voltage link to the current Chiren UGS power supply will provide the PF Chiren 3 power supply; and
- ✓ LVA - This pipeline construction site is planned to be located on 155 m^2 of land in the Manastirishte village, Hayredin Municipality, and Vratsa Region. A 3.2-kilometre connection to the local electrical network is necessary for this.

According to BTG, the pipeline's route is based on a route that has previously been studied, approved, and the results of engineering, geological, and hydrological assessments have been issued. Along the pipeline's route, surveys have been conducted using visual materials, soil calculations, laboratory testing, sampling, and other methods. This data has not been reviewed by the IESC.

The new interconnecting gas pipeline primarily passes across agricultural land, with a few restricted parts crossing water bodies such as Ogosta river and forest/scrub, according to the paperwork supplied by BTG to the Competent Authority.

2.1.3 New exploitation and observation wells

The construction of 10 new high flowrate exploitation wells and 3 new observation wells, with the building of the required above ground facilities and pipeline infrastructure, will result in the increased underground gas storage inside the depleted gas condensate field. These will be added to the current 14 observational wells and 24 exploitation wells (see Figure 2.3). The contractors granted this contract shall evaluate the available seismic data and shall decide the placement of the additional exploitation and monitoring wells. After determining the well sites and pipeline routes, BTG will submit a request to the appropriate authorities to ascertain whether an EIA is needed to support this installation.

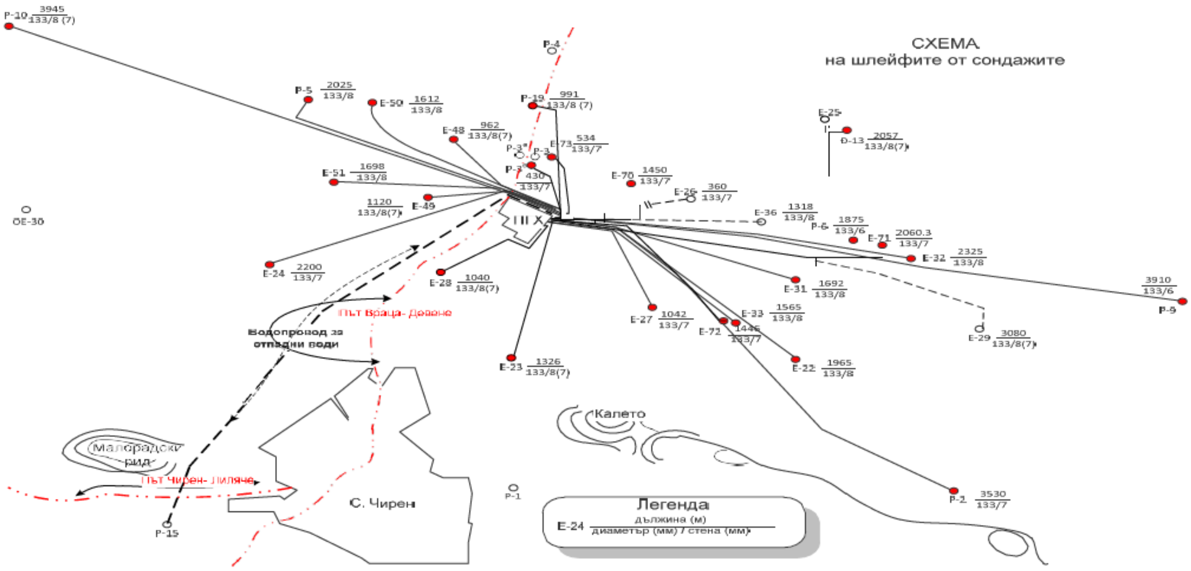


Figure 2.3: Layout of the existing borehole and pipeline network

The existing pipelines to the exploitation wells are buried, as will the new ones that are planned, and have an easement of 30 m centered on the pipeline within which there is a prohibition on any type of construction, soil cultivation (ploughing) of the soil to depths greater than 0.5m, additionally to the lighting of fires, planting perennial tree plantations, conducting drilling works, investigating and producing underground natural resources, parking of all types of vehicles, and storing any objects. The new pipelines will likely pass-through fields/cornfields, grassland, scrub/woodland, and vineyards which are within the vicinity of the Project.

2.2 CLIMATE CHANGE POLICIES

Bulgaria is susceptible to both the increased frequency of extreme climate change-related events, such as droughts and floods, and to temperature rise and excessive precipitation. The hazards brought on by climate change-related occurrences might result in human fatalities or significant property damage, which would have an impact on both national and international economic growth and prosperity. The two climate zones that make up Bulgaria are the continental climate in the north and the Mediterranean climate in the south. The country's Mediterranean climate is typically chilly in the winter and scorching and dry in the summer. The country's temperature is significantly influenced by the mountains that separate its northern and southern sections[3].

Bulgaria made progress in reducing GHG emissions as it has been reduced by about 51% between 1988 and 2019. Compared to the emissions of the previous year, emissions in 2019 were down 2.3%. Bulgaria's emissions level remains 15th in the EU in per capita terms. The primary source of GHG emissions in Bulgaria is the energy sector, which in 2019 accounted for 71.9% of all national GHG emissions (40,228 Gg CO_{2e} from energy sector of the total 55,955 Gg CO_{2e} excl. LULUCF) as shown in Figure 2.4, while industrial processes and product use (IPPU) ranked the second place with 11.4% and sectors Agriculture ranked the third place with 11.2% and Waste with 5.6% [4].

However, Emissions from the energy sector in 2019 decreased by 50.5% compared to the 1988 emissions that equal to 81,304 Gg CO_{2e} as shown in Figure 2.5. In 2019, emissions were 2.7% lower than in 2018 primarily because less power was produced from fossil fuels in the energy industries sector. The electricity and heating sector

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[3] Climate Risk Profile: Bulgaria (2021): https://climateknowledgeportal.worldbank.org/sites/default/files/2021-06/15848-WB_Bulgaria%20Country%20Profile-WEB.pdf

[4] Bulgaria. 2021 National Inventory Report: https://unfccc.int/documents/273453

made the largest contribution to the reduction. In contrast, emissions from transport sector have been gradually rising. On a subcategory level, the energy industries sector is the main source of emissions, accounting for 58.7% of the emissions from fuel combustion. Transport is the second-largest source of emissions, accounting for 26.0%, followed by manufacturing and construction, accounting for 10.7%.

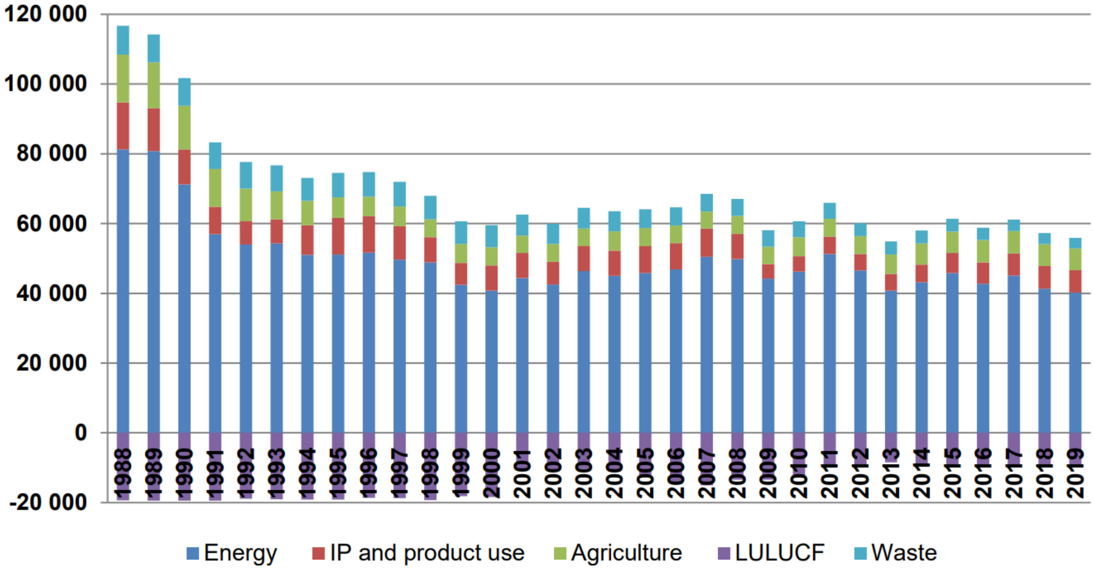

Figure 2.4: Total GHG emissions in $CO_{2\text{-eq}}$. per sector (Gg CO_{2e}), 1988-2019 (UNFCCC)

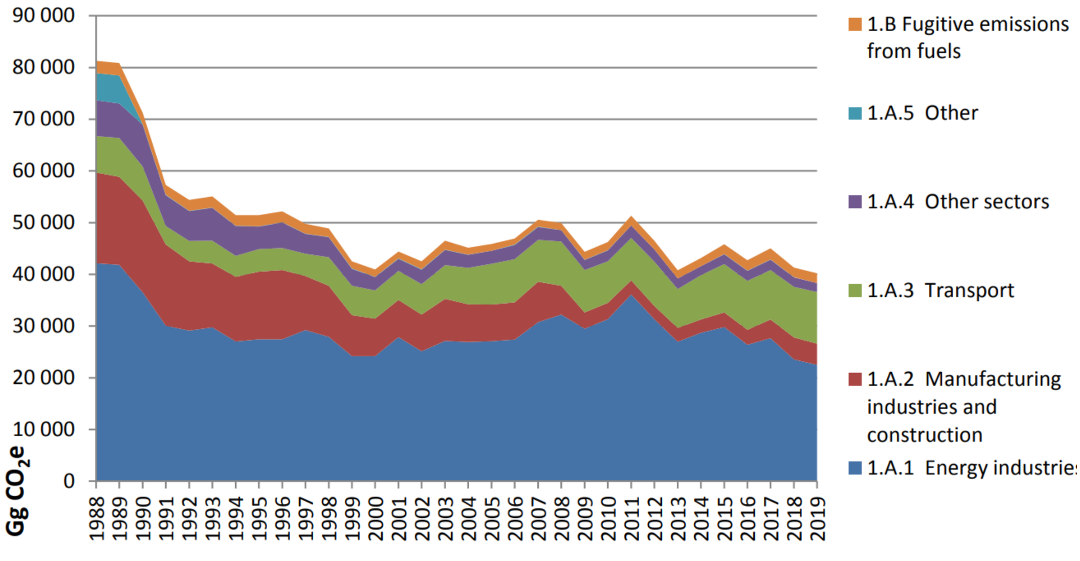

Figure 2.5: Historical GHG Emissions from energy sector by subcategory in CO_2 equivalent (Gg CO_{2e}), 1988-2019 (UNFCCC)

Bulgaria submitted its Nationally Determined Contributions to the UNFCCC in 2016 [5] as well as its Seventh National Communication to the UNFCCC in 2018 [6]. Climate change is acknowledged in the Bulgaria 2020 national

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[5] Nationally Determined Contribution (2016): https://unfccc.int/NDCREG

[6] Seventh National Communication (2018)

development program and plan, and the Third National Action Plan on Climate Change 2013-2020 includes an important section of the country's development agenda.

Using a vulnerability assessment, the Ministry of Environment and Water (MOEW) started its adaptation strategy in 2014. Although the nation created a National Climate Change Adaptation Strategy and Action Plan in 2019 [7], adaptation is included in the Third National Action Plan on Climate Change 2013-2020. The strategy covers the years through 2030 and looks ahead until 2050. The National Climate Change Adaptation Council and Expert Working Group, which are made up of several stakeholders from institutions, academics, industry, and NGOs, assist the implementation of the Strategy. Besides the ministry of the environment, 25% of all EU investments take climate change into account, which is reflected in sectoral policies.

Climate Action Tracker[8] (CAT) rates the climate commitments of Bulgaria as an EU member state up to June 2023 as "Insufficient" as EU climate policies and commitments need substantial improvements to be consistent with the Paris Agreement 1.5 °C temperature limit. This rating is for several elements of EU climate action such as climate targets, policies, and contribution to climate finance. The EU's 2030 emissions reduction target and its policies and action are consistent with 2°C of warming when compared to modelled domestic pathways. The EU is also not meeting its 'fair share' contributions to climate action. The EU should increase its 2030 target to at least 62% below 1990 levels (excl. LULUCF) in order to raise its rating, implement the necessary policies to achieve this objective, and substantially boost its support for climate action in developing nations. The trends and forecasts carried out by CAT for 2030, are presented in Figure 2.6.

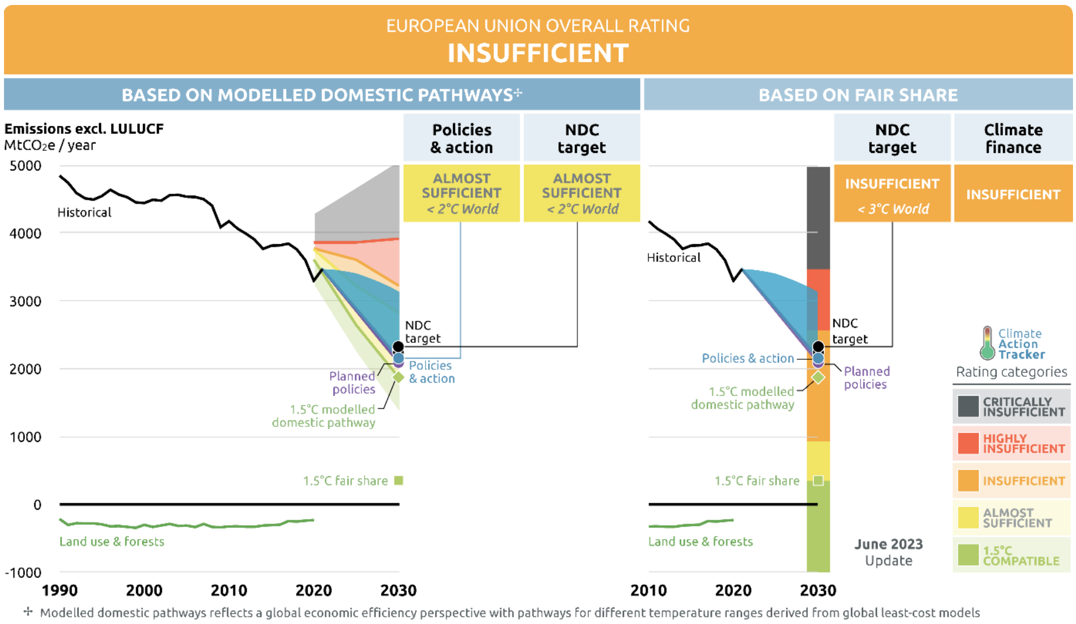

Figure 2.6: Trends for total GHG Emissions and the overall rating for European Union (Climate Action Tracker)

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https://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/0917254_bulgaria-nc7-br3-1-vii_nc_bulgaria_2018.pdf

[7]National Climate Change Adaptation Strategy and Action Plan (2019) https://www.moew.government.bg/en/climate/international-negotiations-and-adaptation/adaptation/

[8] Climate Action Tracker: https://climateactiontracker.org/countries/eu/

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[9], 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[10], 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[11] 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)[12]. Furthermore, this CCRA is based on the Equator Principles' Guidance Note on Climate Change Risk Assessment (EP IV) issued in October 2020[13] and the latest update released in May 2023[14]. 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, since the new Chiren Gas Storage Facility is a facility for gas storage including new interconnecting gas pipeline and new exploitation wells, pipelines and observation wells, the estimated GHG emissions from the project (combustion installations) are 87,050 tCO_{2e}/y ((based on calculations in annual GHG report for 2020) during the operational phase, therefore, the evaluation of transition risks is not required.

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

1. Identification of climate pattern variation;
2. Description of specific changes;
3. Estimation of associated effects due to the changes;
4. Assessment of the physical risk by considering three components: hazard, exposure and vulnerability;
5. Proposal of adaptation measures to be considered by the project to adapt to potential future climate scenarios (up to the year 2060);
6. Assessment of the residual physical risk and the potential financial risk.

This CCRA investigates the physical risks and provides an evaluation of the adaptation measures to mitigate the climate change impact. 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.

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

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

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

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

[13] https://equator-principles.com/app/uploads/CCRA_Guidance_Note_Sept2020.pdf

[14] https://equator-principles.com/app/uploads/Guidance-CCRA_May-2023.pdf

4 CLIMATE CHANGE ASSESSMENT

The present section focuses on the analysis of the climate patterns in the Chiren village which is part of Vratsa Municipality within the Vratsa Province in the North west of Bulgaria, the selected location, including observed trends for temperature, precipitations, drought, wind and hazardous climate events over the last years and the projections for the upcoming decades, up to 2060.

4.1 CLIMATE CHANGE BASELINE

This paragraph presents the climatic trends observed in the latest years in Vratsa region. The climate baseline is elaborated analyzing temperature, solar irradiation, precipitations, wind, and drought. Long-term statistical data mainly are analyzed to evaluate the baseline meteorological conditions.

4.1.1 Temperature

Bulgaria is characterized by two climatic regions: a continental climate in the north and a Mediterranean climate in the south. As the Chiren village which is part of Vratsa Municipality located at the North West of Bulgaria, the climate is humid continental. In Vratsa, the summers are warm and mostly clear, and the winters are very cold, snowy, and partly cloudy.

Figure 4.1 reports the minimum, mean and maximum average monthly temperature in Vratsa for the period 1991-2020. The maximum temperatures are usually recorded during the months which correspond to the summer season (the highest 29.6°C in August). The minimum temperatures are obtained in December, January, and February by about -1.6°C, -4.1°C and -2°C, respectively. The average annual temperature over the last 30 years is of 12.1°C.

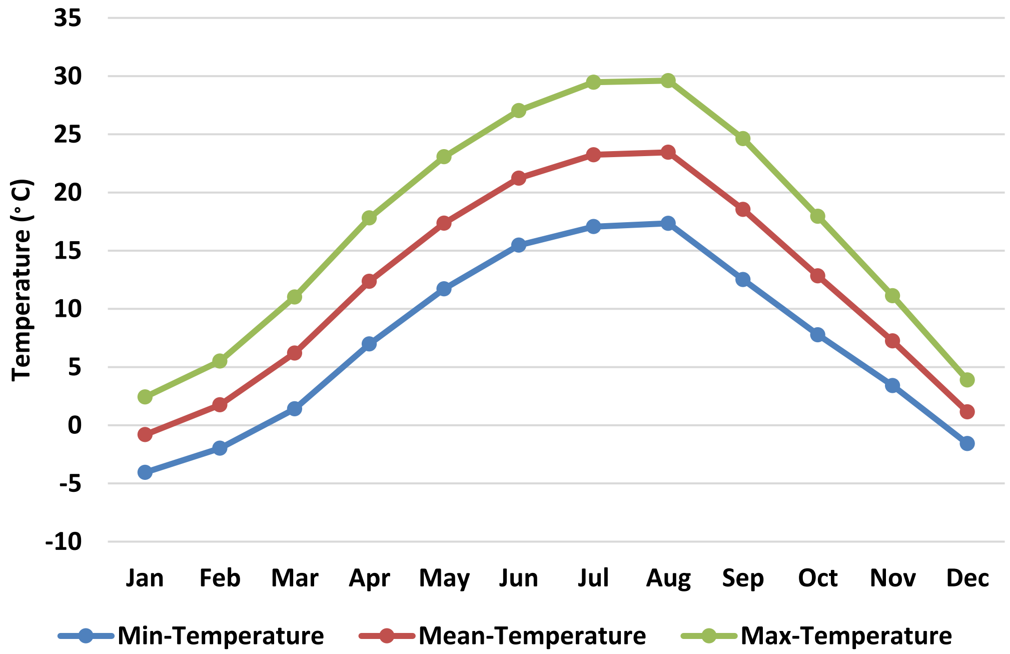

Figure 4.1: Minimum, Mean and Maximum Average Monthly Temperature in Vratsa region for period between 1991-2020 (Source: World Bank[15])

In relation to the Vratsa region, in Figure 4.2 it is clearly seen that between 1901 and 1929 the average annual mean temperature was quite constant while it fluctuated between 10 °C and 12 °C between the years 1930 and 1980. Also, the mean annual temperatures have increased steadily from around 11.2 °C in 1981 to 12.6 in 2021.

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[15] Climate Change Knowledge Portal "Bulgaria": https://climateknowledgeportal.worldbank.org/country/bulgaria/climate-data-historical

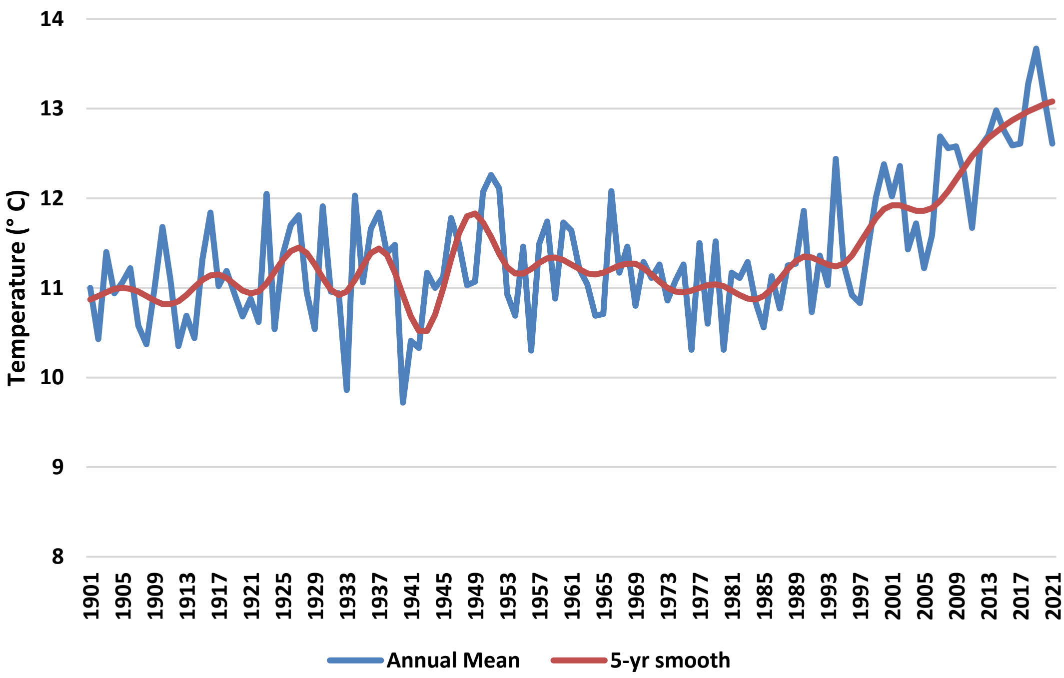

Figure 4.2: Annual average temperature in Vratsa region, 1901-2021 (Climate change Knowledge Portal)[16]

Figure 4.3 reports the variability and trends of mean temperature in Vratsa region in Bulgaria in 1971-2020 according to the Climate Change Knowledge Portal[17]. In order to reveal temperature changes in detail, Figure 4.4 shows how from 1950 to 2020 the number of frost days (minimum temperatures <0°C) decreased as it reaches to 70 days in 2020. Figure 4.5 shows an increasing trend regarding the number of tropical nights (minimum temperature >20°C) as it reaches to about 8 days in 2020 compared with 5 days in 1970.

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[16] Climate Change Knowledge Portal "Bulgaria" https://climateknowledgeportal.worldbank.org/country/bulgaria/climate-data-historical

[17] Climate Change Knowledge Portal "Bulgaria" https://climateknowledgeportal.worldbank.org/country/bulgaria/trends-variability-historical

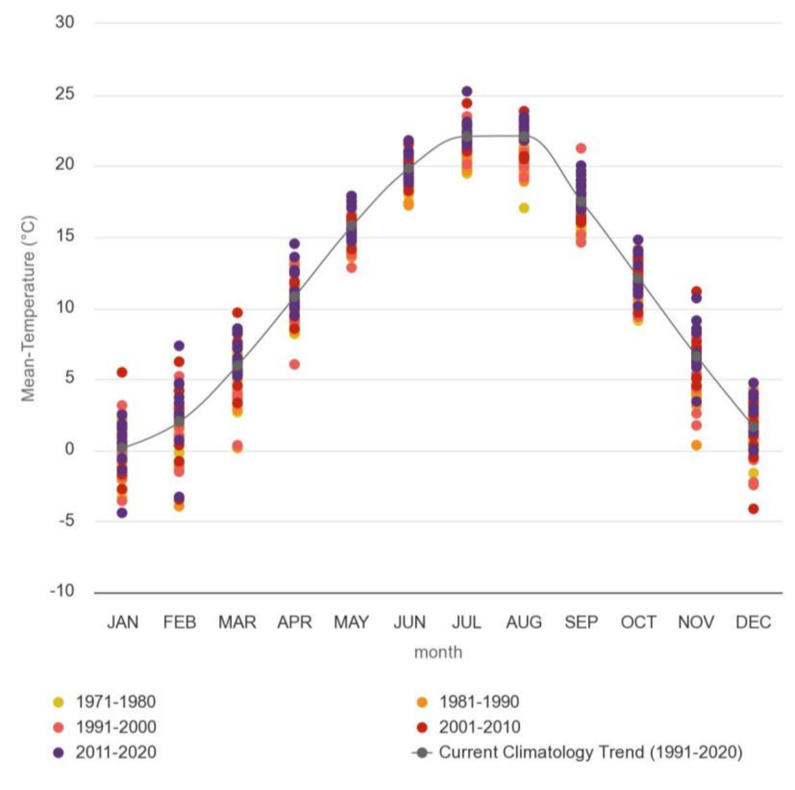

Figure 4.3: Variability and Trends of Mean Temperature in Vratsa, Bulgaria in 1971-2020 (Climate Change Knowledge Portal)

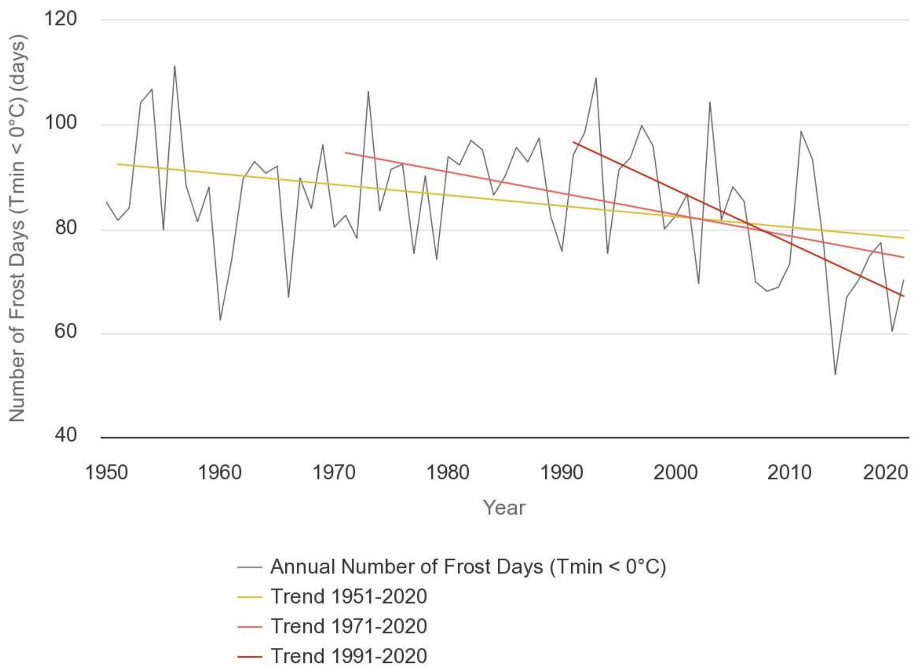

Figure 4.4: Number of Frost Days Annual Trends between 1950 and 2020 in Vratsa, Bulgaria (Climate Change Knowledge Portal)

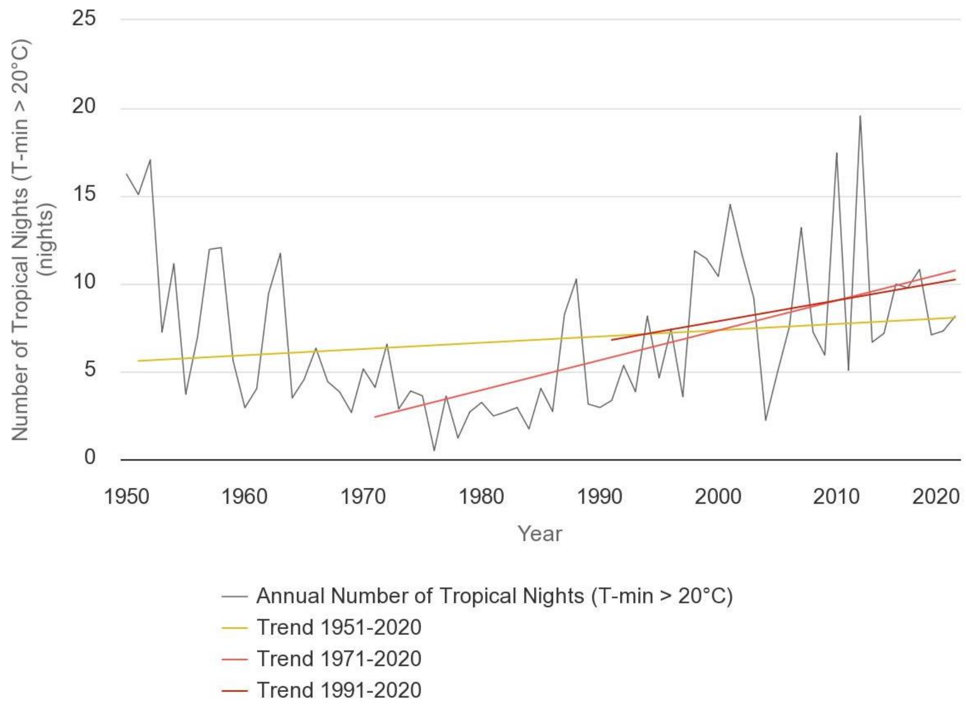

Figure 4.5: Number of tropical nights annual trends between 1950 and 2020 in Vratsa, Bulgaria (Climate Change Knowledge Portal)

4.1.2 Solar Irradiation

According to the Global Solar Atlas,[18] Vratsa is characterized by an annual average Direct Normal Irradiation (DNI) that is around 1,321.9 kWh/m² and by an annual average Diffuse Horizontal Irradiation (DHI) that is around 631.1 kWh/m² as reported in Table 4.1. 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 4.1: Main characteristics of solar radiation in Vratsa (Source: Global Solar Atlas)

	Value	Unit
Direct normal irradiation (DNI)	1,321.9	kWh/m²/year
Diffuse horizontal irradiation (DHI)	631.1	kWh/m²/year
Global tilted irradiation at optimum angle	1,625.8	kWh/m²/year
Air temperature	12.2	°C
Terrain elevation	211	m

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[18] Global Solar Atlas: https://globalsolaratlas.info/detail?c=43.399903,23.716534,11&m=site&s=43.399903,23.716534

Furthermore, Figure 4.6 [19] shows the number of hours of sunshine in Vratsa region that refers to the time when the sun is visible, without any obstruction of visibility by clouds, fog, or mountains. With 10.3 hours per day, July is the sunniest month in the region of Vratsa. While the sun shines the least in December with 2.4 hours per day.

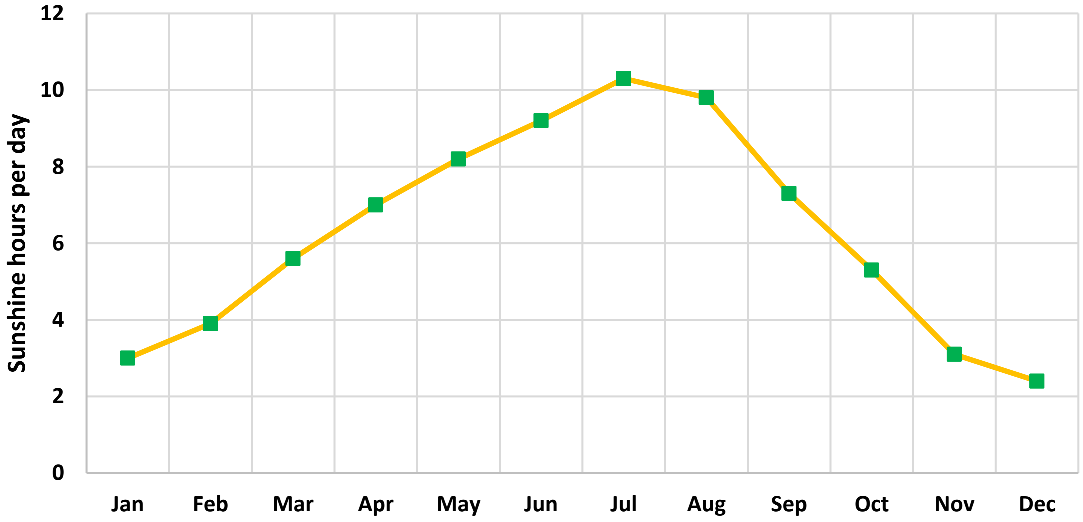

Figure 4.6: Sunshine hours per day in Vratsa (World Data)

4.1.3 Precipitation

In Vratsa region in Bulgaria, the annual average precipitation was 660 mm/y over the last 30 years (1991-2020). The highest precipitations occur between May and July, while February registered the lowest average rate of precipitation. The monthly average rainfall is graphically presented in Figure 4.7 and the variability and trends of precipitation is shown in Figure 4.8. Moreover, as it could be noted in Figure 4.9, in the period 1951-2020, it was registered constant trend in the annual precipitation in the Vratsa region of Bulgaria, but a decreasing trend was detected in the decade 1971-2020. On the other hand, the annual precipitation registered an increasing trend in the period of 1991-2020.

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[19] World Data, "Bulgaria" https://www.worlddata.info/europe/bulgaria/index.php

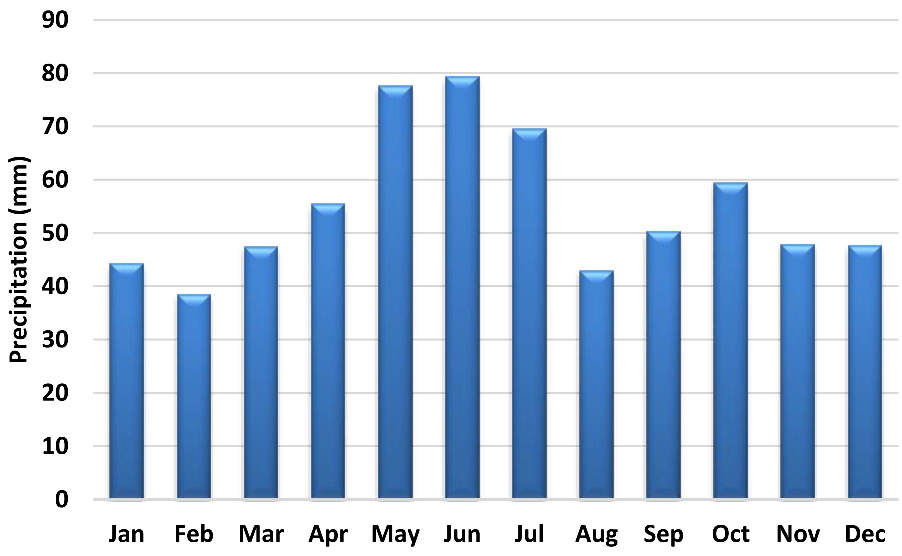

Figure 4.7: Monthly Average Rainfalls in Vratsa, Bulgaria, 1991-2020 (Source: World Bank[20])

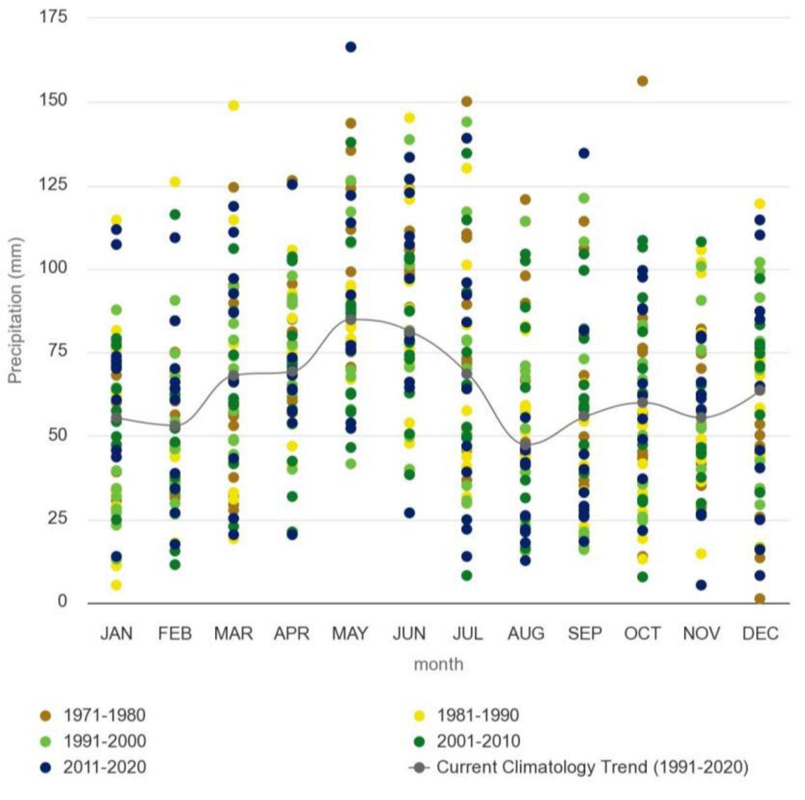

Figure 4.8: Variability and Trends of Precipitation in Vratsa region of Bulgaria in 1971-2020 (Climate Change Knowledge Portal)

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[20] Climate Change Knowledge Portal "Bulgaria": https://climateknowledgeportal.worldbank.org/country/bulgaria/climate-data-historical

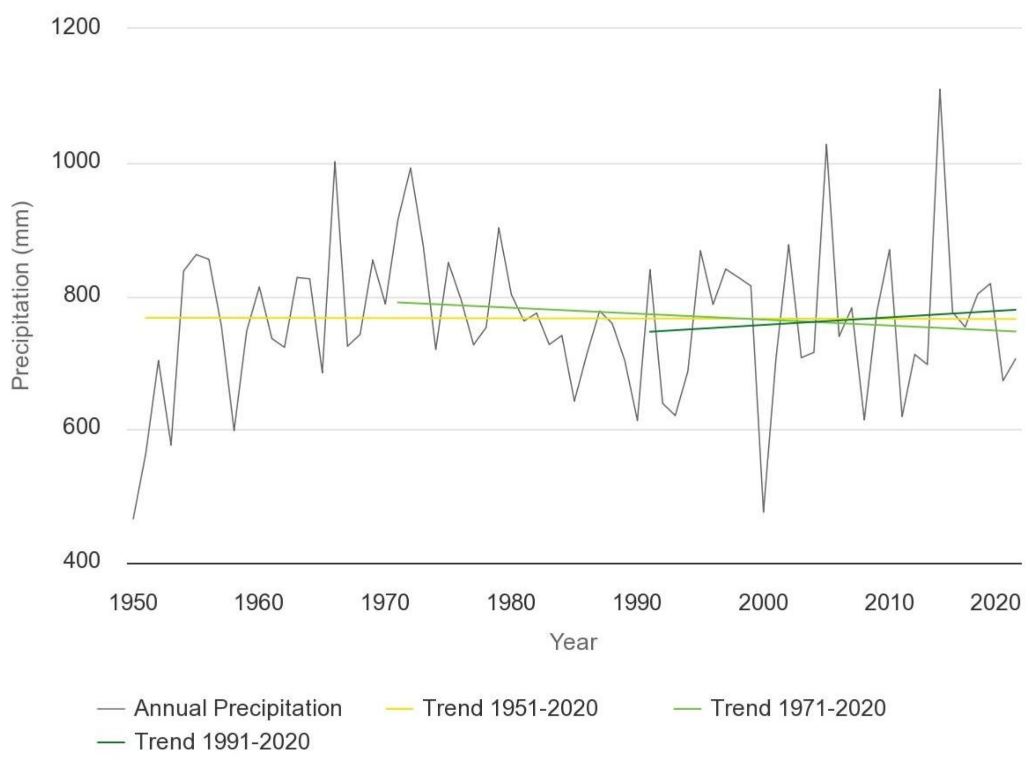

Figure 4.9: Precipitation Annual Trends in Vratsa region of Bulgaria in 1951-2020 (Climate Change Knowledge Portal)

4.1.4 Wind

In Vratsa region of Bulgaria, the monthly average wind speed over the period 2010-2020 is shown in Figure 4.10. The higher wind speed values are recorded between February and April by about 8.5 – 9.1 km/h. While the lowest wind speed recorded in the month of November by about 6.6 km/h [21].

According to Meteoblue data records[22] over the past 30 years for Vratsa, Figure 4.11 shows the distribution of wind rose for Vratsa region to evaluate how many hours per year the wind blows from the indicated direction. As shown in Figure 4.11, the prevalent wind direction is East/North-East (ENE) that is occurred for a total of 1,062 hours/year in which the wind speed is > 1 km/h for 233 h/year, >5 km/h for 465 h/year and >12 km/h for 256 h/year and > 19 km/h for 76 h/year and > 28 km/h for 15 h/year. While the wind direction is west (W) for about 1,005 hours/year.

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[21] Weather and climate: Vratsa: https://tcktcktck.org/bulgaria/vratsa

[22] Meteoblue: Vratsa: https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/vratsa_bulgaria_725712

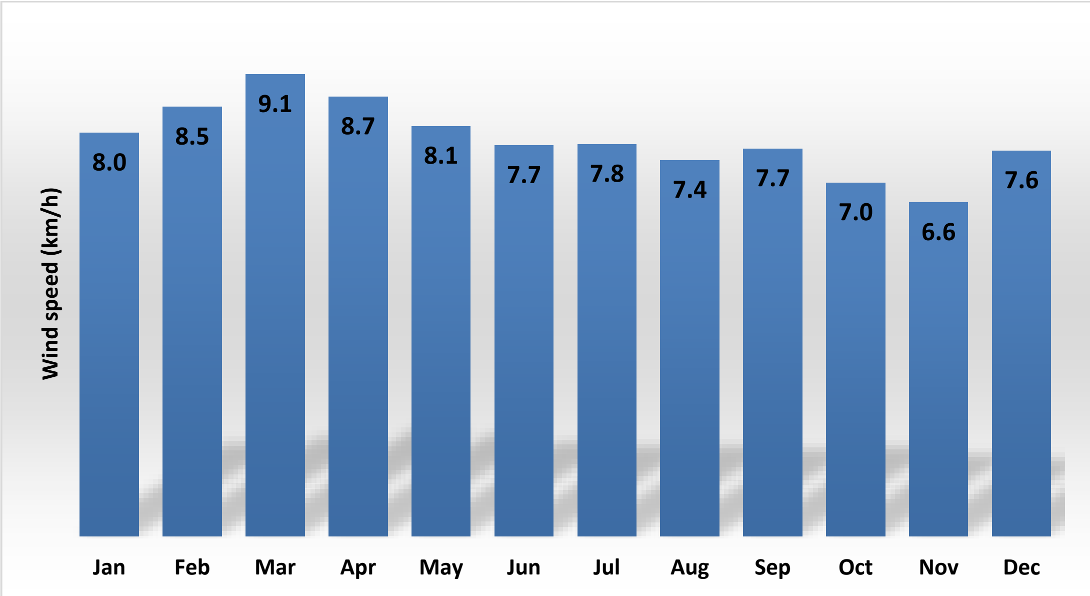

Figure 4.10: Average wind speed in Vratsa region of Bulgaria, 2010-2020 (Weather and climate)

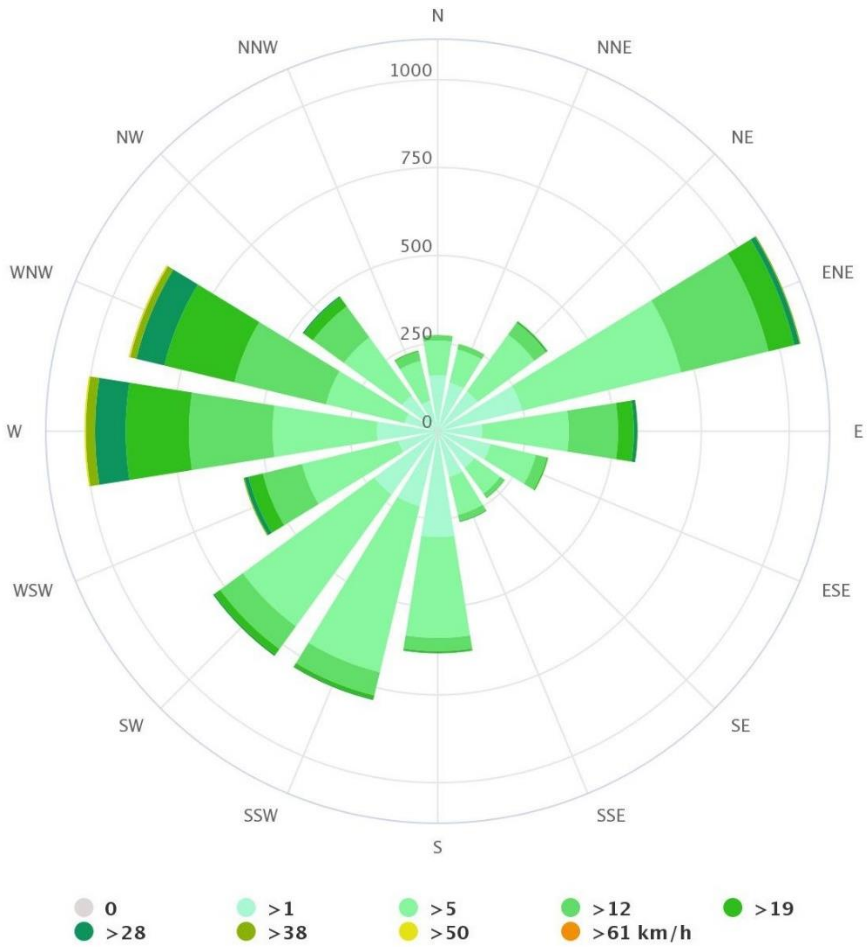

Figure 4.11: Distribution of wind direction in Vratsa region over the last 30 years (Meteoblue)

4.1.5 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 a Report by World Bank [23], Bulgaria's diverse territory renders it susceptible to a variety of natural hazards, including droughts. Droughts have occurred two times between 1900 and 2020 without affecting people or causing damage.

Figure 4.12 shows the projected annual Standardized Precipitation Evapotranspiration Index (SPEI) an index which represents the measure of the given water deficit in a specific location, Negative values for SPEI represent dry conditions, with values below −2 indicating severe drought conditions, likewise positive values indicate increased wet conditions. Bulgaria is projected to experience heightened dry conditions and with potential for increased drought severity, which will likely increase pressure on water resources for the country and region by mid-century and by end of the century. [24]

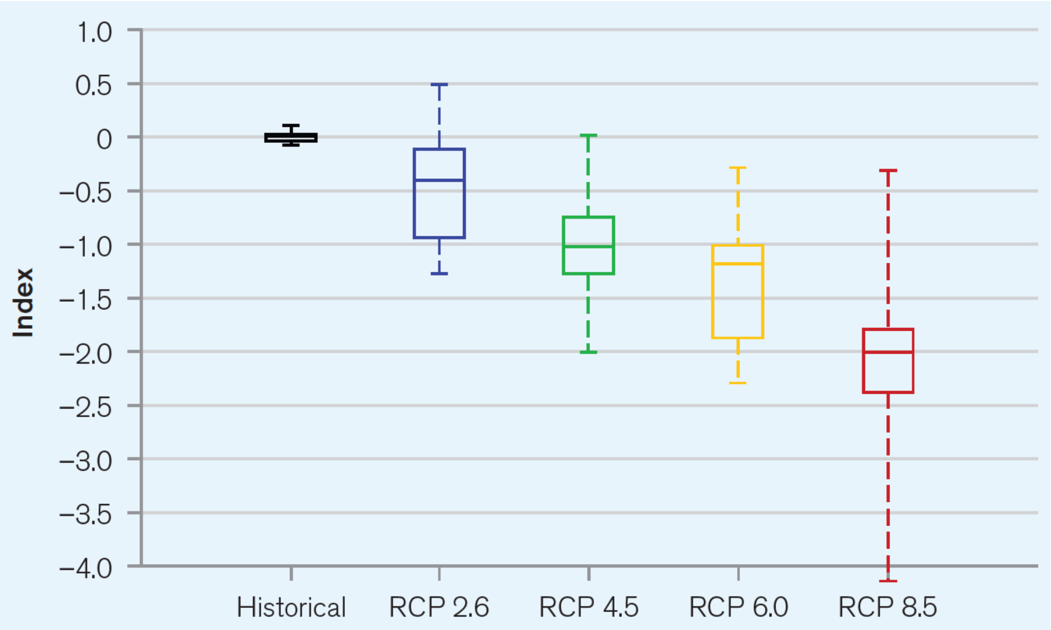

Figure 4.12: Projected annual SPEI Drought Index in Bulgaria (Reference Period, 1986–2005) (World Bank).

Figure 4.13 shows the maximum number of consecutive dry days annual trends with significance of trend per decade in the Bulgaria in 1951-2020. In the trend of 1951-2020, it was registered constant trend in maximum number of dry days that registered 23 days in Bulgaria, but an increasing trend was detected in the decade 1971-2020 (increasing from 20 days to 26 days) and 1991-2020 (increasing from 20 days to 27 days).

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[23] Climate Risk Profile: Bulgaria (2021):. https://climateknowledgeportal.worldbank.org/sites/default/files/2021-06/15848-WB_Bulgaria%20Country%20Profile-WEB.pdf

[24] Climate Risk Profile: Bulgaria (2021):. https://climateknowledgeportal.worldbank.org/sites/default/files/2021-06/15848-WB_Bulgaria%20Country%20Profile-WEB.pdf

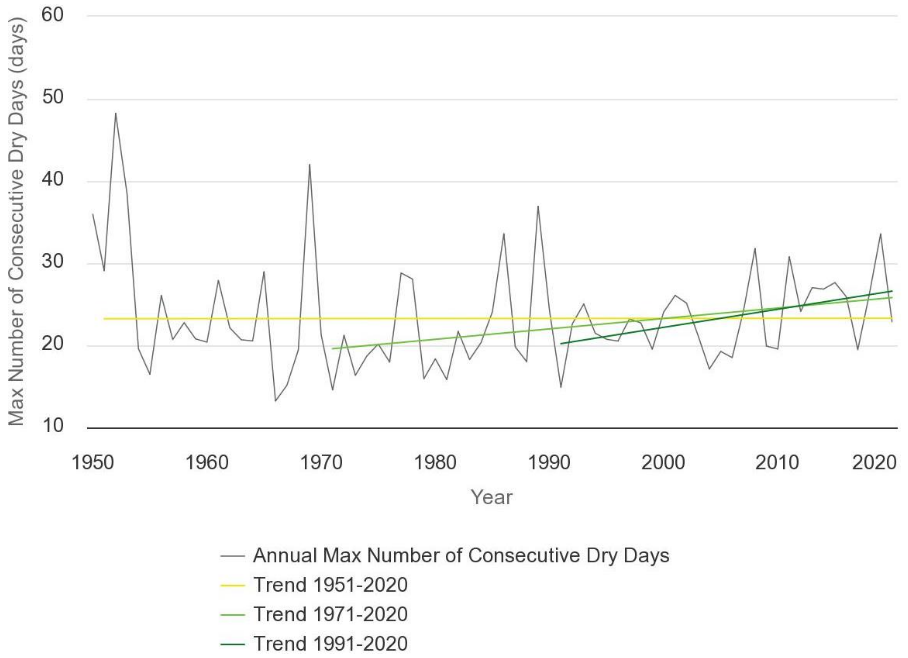

Figure 4.13: Maximum number of consecutive dry days annual trends with significance of trend per decade in Bulgaria in 1951-2020 (Climate Change Knowledge Portal)

4.2 HAZARDOUS WEATHER EVENTS

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.

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![25] 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 ThinkHazard! tool, the most critical hazardous events in Vratsa region of Bulgaria are river flood, urban flood, and wildfire, with “high” risk level, followed by earthquake, landslide, and extreme heat with “medium” risk level as presented in Table 4.2. In line with the average worldwide trends, the expected changes in the climate pattern in the area under consideration are significant.

Table 4.2: Hazardous Weather Events likely to occur in Vratsa (Source: ThinkHazard!)

Hazardous Weather Events	Hazard Occurrence Level
River flood	High
Urban flood	
Wildfire	
Earthquake	Medium
Landslide	
Extreme heat	
Water scarcity	Low

In relation to river floods and urban floods as shown in Figure 4.14, the high level of risk indicates that potentially damaging and life-threatening river/urban floods are expected to occur at least once in the next 10 years. High level of risk as to wildfire indicates that there is greater than a 50% chance of encountering weather that could support a significant wildfire that is likely to result in both life and property loss in any given year.

In the Vratsa region, earthquake hazard is classified as medium which means that there is a 10% chance of potentially damaging earthquake shaking in the area in the next 50 years. Landslide risk level is medium as well, which means that this area has rainfall patterns, terrain slope, geology, soil, land cover and (potentially) earthquakes that make localized landslides an infrequent hazard phenomenon. As to extreme heat hazard, this is classified as a medium, which means that there is more than a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years. While water scarcity is classified as low, this means that there is a 1% chance drought will occur in the coming 10 years.

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25 Think Hazard - Vratsa: https://thinkhazard.org/en/report/729-bulgaria-vratca

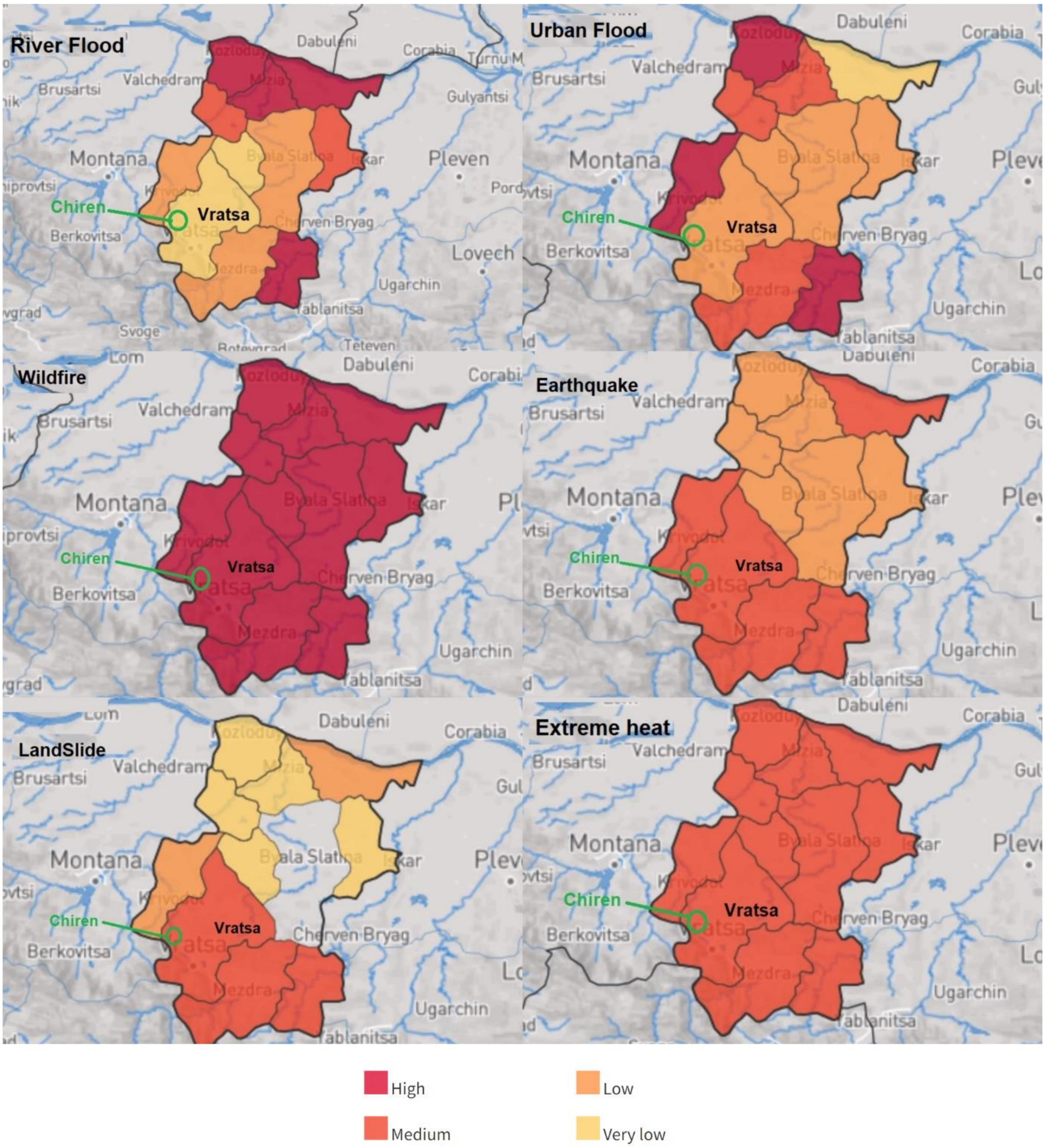

Figure 4.14: Risk of hazardous weather events in Vratsa region (Source: ThinkHazard!)

As reported in World Bank Climate Change Knowledge Portal [26], Figure 4.15 shows the average annual occurrence of natural hazard in Bulgaria between 1980 and 2020. While Figure 4.16 shows the number of people affected by each extreme weather events in the same period. Based on the statistics, the floods have the highest occurrence in Bulgaria between 1980 and 2020 by about 20 times which affected 60,400 people. Furthermore, extreme temperature has an average annual occurrence of 9 times and affected about 393 people in total between 1980

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[26] Climate Change Knowledge Portal “Bulgaria”: https://climateknowledgeportal.worldbank.org/country/bulgaria/vulnerability

and 2020. On the other hand, earthquakes occurred 4 times and affected about 3,800 people with a 131 people as a total death.

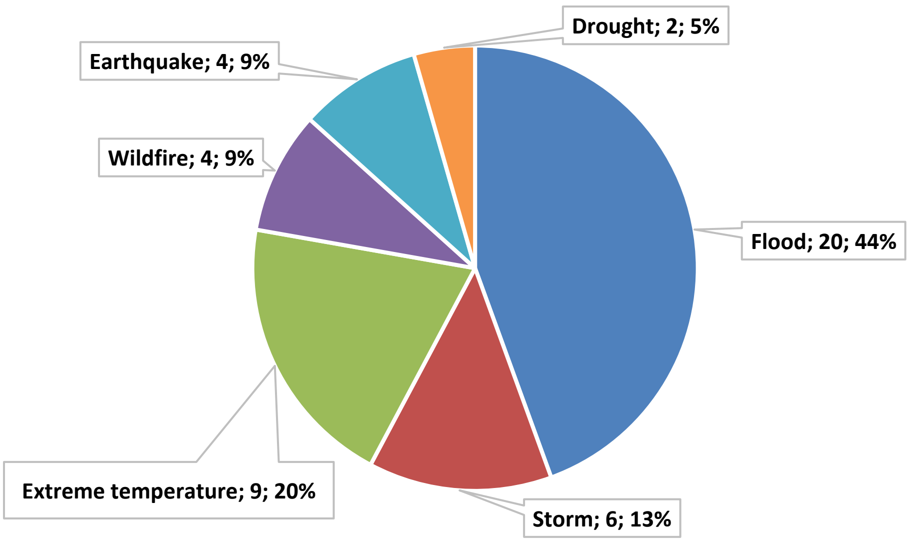

Figure 4.15: Average annual natural hazard occurrence in Bulgaria between 1980 and 2020 (Climate Change Knowledge Portal)

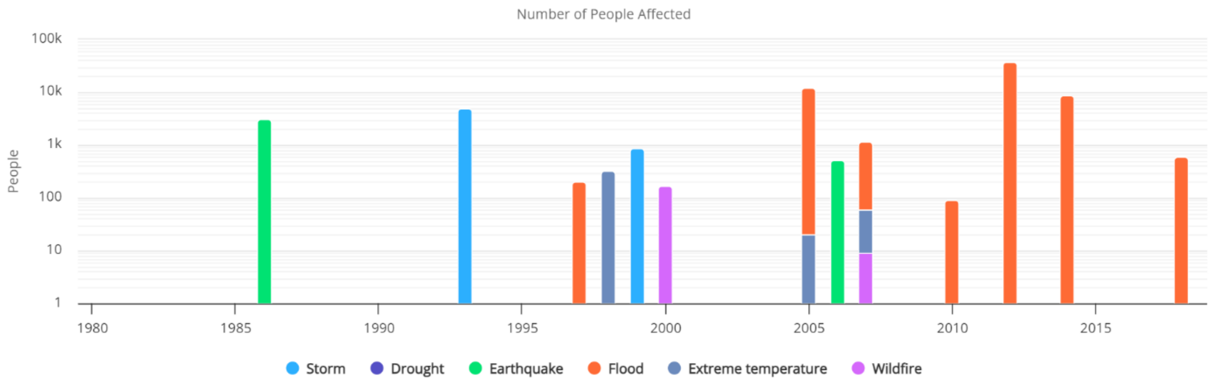

Figure 4.16: Number of people affected by extreme weather events in Bulgaria between 1980 and 2020 (Climate Change Knowledge Portal)

4.3 CLIMATE CHANGE SCENARIOS

4.3.1 Expected Climate Changes In Bulgaria

In the Fifth IPCC[27] 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 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 associated socio-economic narratives for each RCP scenario are called the Shared Socioeconomic Pathways (SSPs). They 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 CO2 emissions (SSP1-1.9 and SSP1-2.6).

As mentioned in the Seventh National Communication under the UN Framework Convention on Climate Change (2018)[28], the climate of Bulgaria is temperate continental with a transition towards a subtropical climate in its Mediterranean version (in the southern parts of the country), with four seasons. Climate observations already confirm an increase of the average temperature as well as an upward trend in extreme temperatures. Furthermore, Bulgaria is prone to natural hazards and climate change is expected to increase its vulnerability to climate-related hazards over the next decades.

The following charts present the outcomes of simulations carried out for Bulgaria extracted from the World Bank Climate Change Knowledge Portal[29] (CCKP) with reference to SSP8.5 scenario:

- ✓ Figure 4.17 presents the projected variation of temperature for the period 2020-2039; it can be noticed that a fluctuation of mean temperature between 0.8°C and 1.8°C is expected across all months, with potential decreases of up to -1°C in September and increases of up to 4.4°C in July;
- ✓ Figure 4.18 provides the projected variation of temperature for the period 2040-2059; it can be noticed that a slight increase of mean temperature between 1.8°C and 3.5°C is expected across all months, with potential decreases of up to -0.4°C in October and increases of up to 5.7°C in July;
- ✓ Figure 4.19 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 slight variations are expected in June with up to -32 mm or +36 mm in June;
- ✓ Figure 4.20 reports the projected variation of rainfall for the period 2040-2059; it can be noticed that precipitation is expected to decrease, with potentially slight variations up to -33 mm in June and +31 mm in June;
- ✓ Figure 4.21 shows the projected mean temperature in Bulgaria up to 2100 based on the reference period data 1995-2014 with reference to SSP8.5 scenario. It can be noticed an increase across the years from 11.7 °C in 2015 to about 14.2 °C in 2060 and 17.5 °C in 2100;
- ✓ Figure 4.22 shows the projected precipitations in Bulgaria up to 2100 based on the reference period data 1995-2014 with reference to SSP8.5 scenario. It can be noticed decrease trend across the years from 607 mm in 2015 to about 550 mm in 2060 and 489 mm in 2100.

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

[28] https://unfccc.int/documents/198224

[29] Climate Change Knowledge Portal “Bulgaria”: https://climateknowledgeportal.worldbank.org/country/bulgaria/climate-data-projections

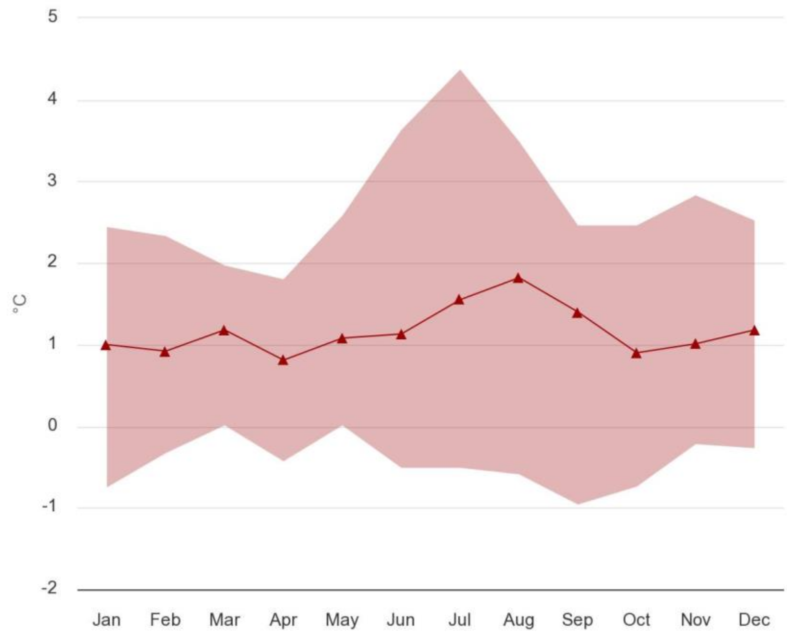

Figure 4.17: Projected Variation of Temperature in Bulgaria, 2020-2039

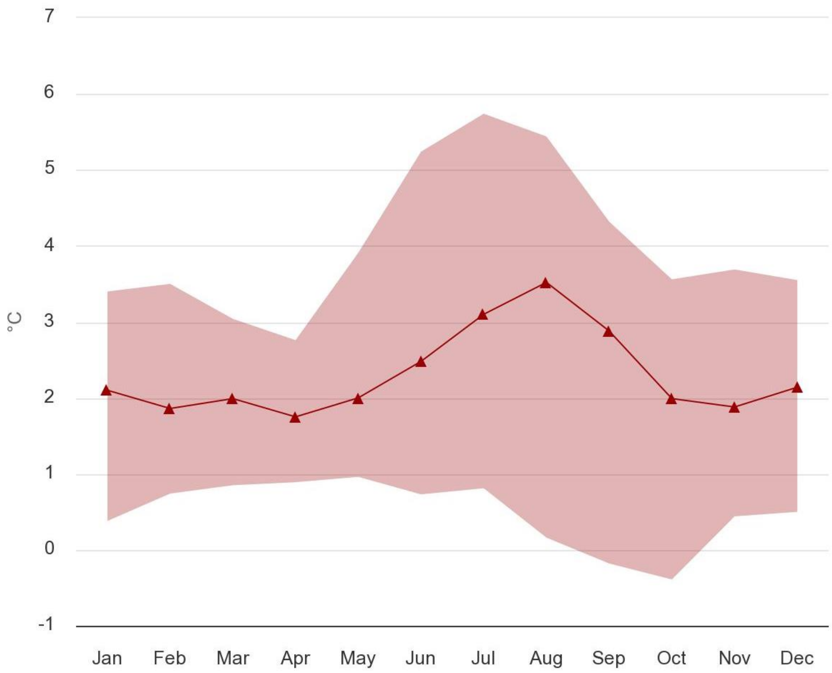

Figure 4.18: Projected Variation of Temperature in Bulgaria, 2040-2059

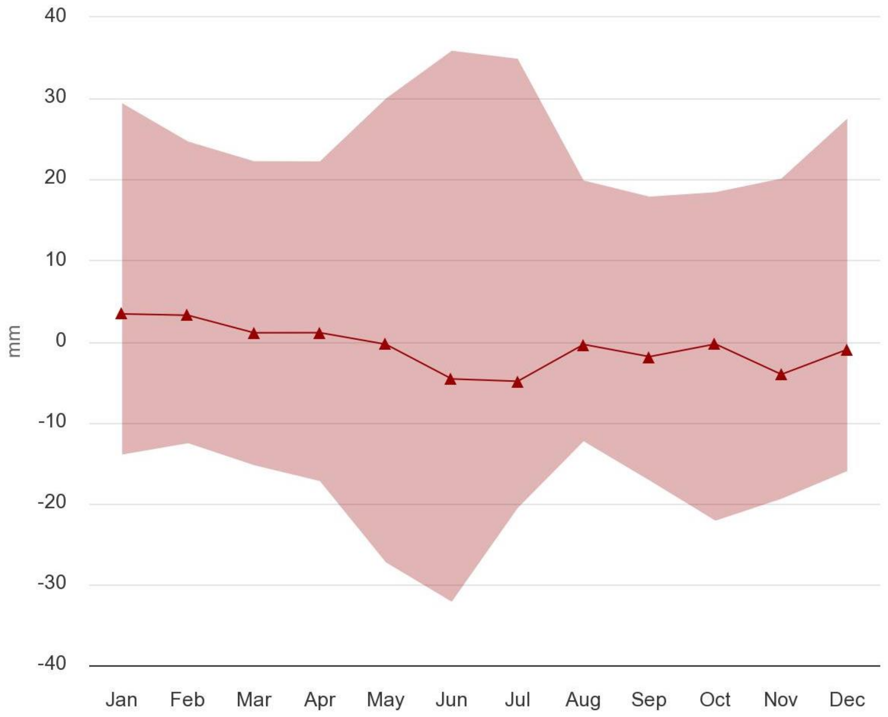

Figure 4.19: Projected Variation of Precipitation in Bulgaria, 2020-2039

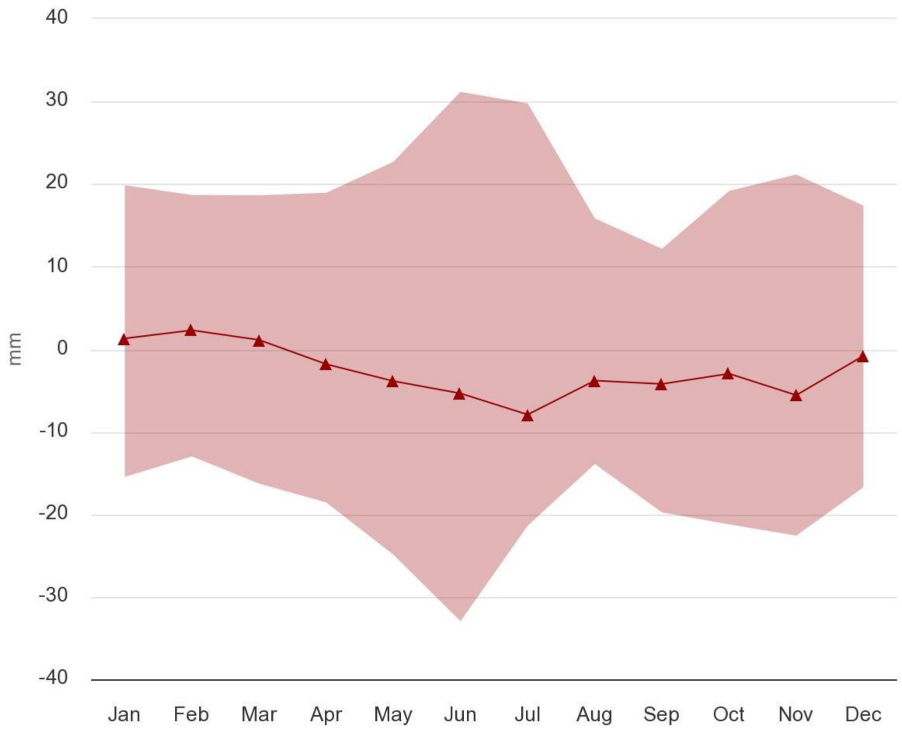

Figure 4.20: Projected Variation of Precipitation in Bulgaria, 2040-2059

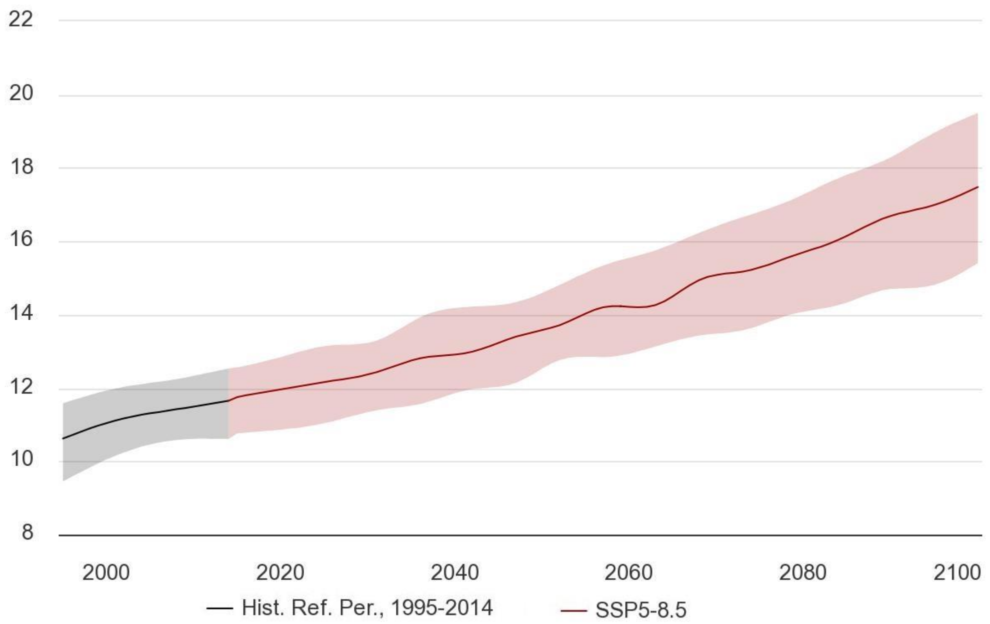

Figure 4.21: Projected mean temperature trend in Bulgaria up to 2100 with reference to SSP8.5 scenario

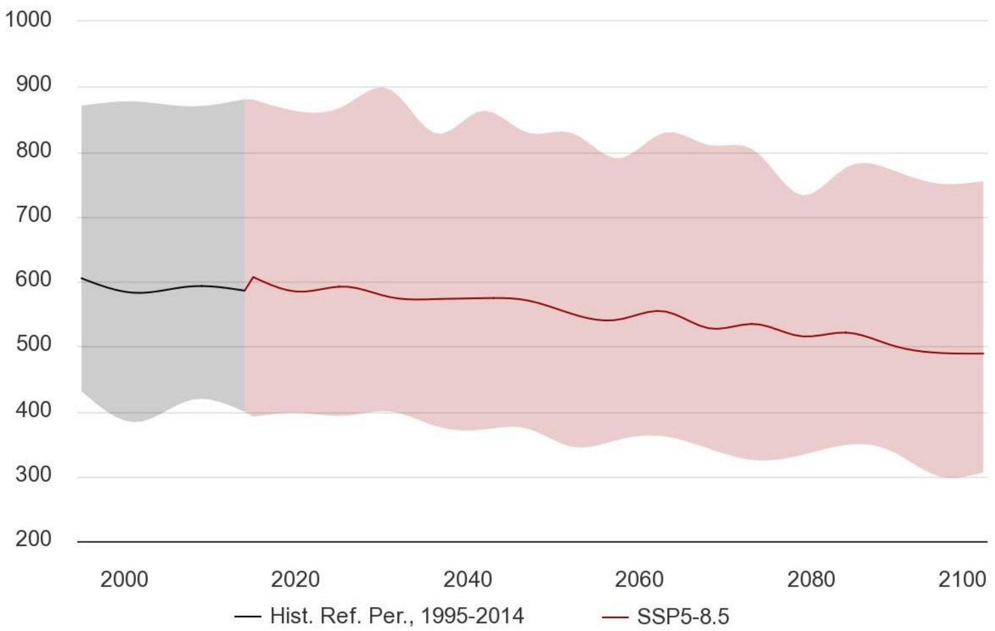

Figure 4.22: Projected mean precipitation measured in mm in Bulgaria up to 2100 with reference to SSP8.5 scenario

4.3.2 Expected Climate Changes In Vratsa Region

With reference to the Chiren Gas Storage Facility Project, a focus is made on the expected climate changes in the Vratsa Region. The following charts present the outcomes of simulations carried out for Vratsa Region extracted from the World Bank Climate Change Knowledge Portal[30] (CCKP) with reference to SSP8.5 scenario:

- ✓ Figure 4.23 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 -1°C in October and increases of up to 5°C in July;
- ✓ Figure 4.24 provides the projected variation of temperature for the period 2040-2059; it can be noticed that an increase of mean temperature between 1.5°C and 4.2°C is expected across all months, with potential decreases of up to -0.9 °C in October and increases of up to 6.5 °C in July;
- ✓ Figure 4.25 introduces the projected variation of rainfall for the period 2020-2039; it can be noticed that precipitation will experience slight variations with up to -42 mm in June or +40 mm in June and July;
- ✓ Figure 4.26 reports the projected variation of rainfall for the period 2040-2059; it can be noticed that precipitation is expected to decrease from May till December, with potentially slight variations up to -42 mm in June and +36/+40 mm in June/July, respectively;
- ✓ Figure 4.27 shows the projected mean temperature in Vratsa Region up to 2100 based on the reference period data 1995-2014 with reference to SSP8.5 scenario. It can be noticed an increase across the years from 10.3°C in 2015 to about 12.9 °C in 2060 and 16.3 °C in 2100;
- ✓ Figure 4.28 shows the projected precipitations in Vratsa Region up to 2100 based on the reference period data 1995-2014 with reference to SSP8.5 scenario. It can be noticed decrease trend across the years from 663 mm in 2015 to about 624 mm in 2060 and 542 mm in 2100.

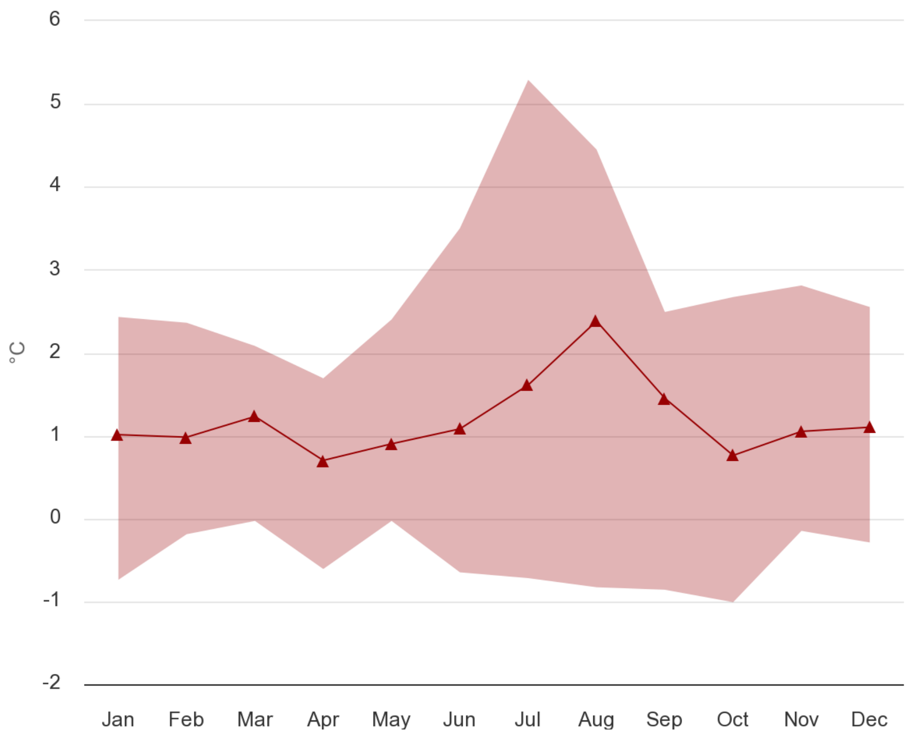

Figure 4.23: Projected Variation of Temperature in Vratsa Region, 2020-2039

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[30] Climate Change Knowledge Portal "Bulgaria": https://climateknowledgeportal.worldbank.org/country/bulgaria/climate-data-projections

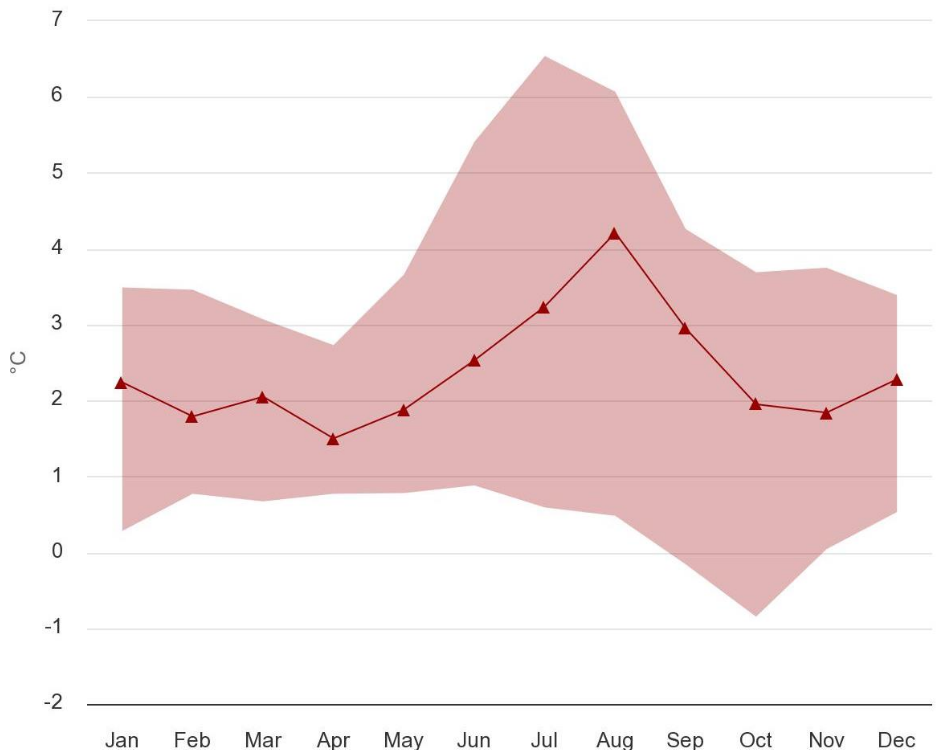

Figure 4.24: Projected Variation of Temperature in Vratsa Region, 2040-2059

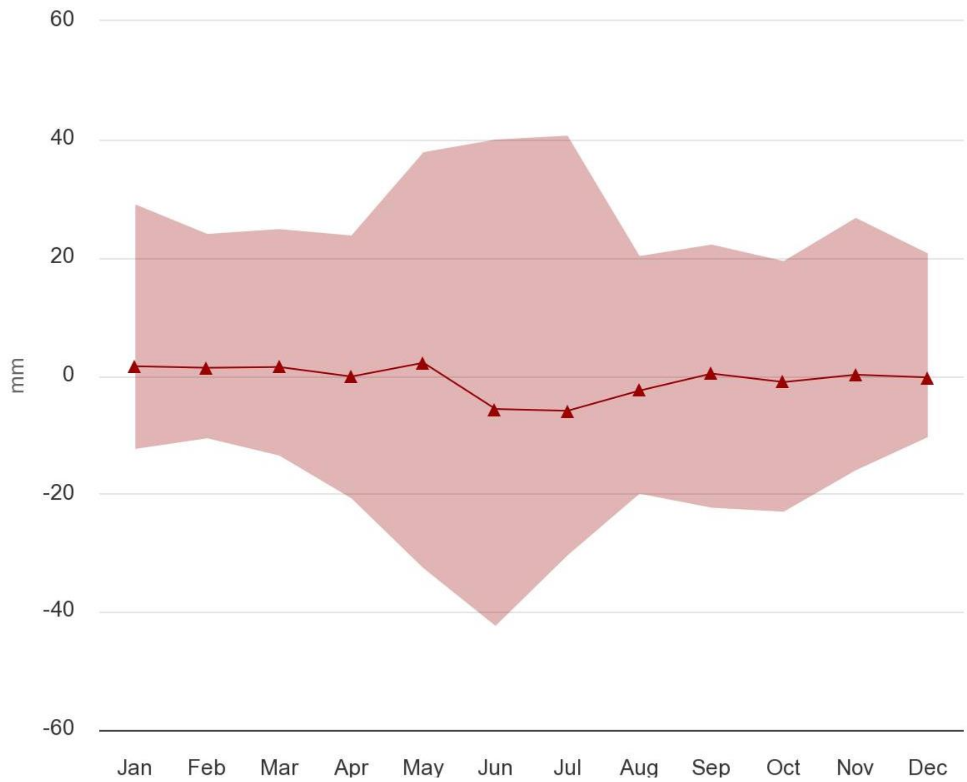

Figure 4.25: Projected Variation of Precipitation in Vratsa Region, 2020-2039

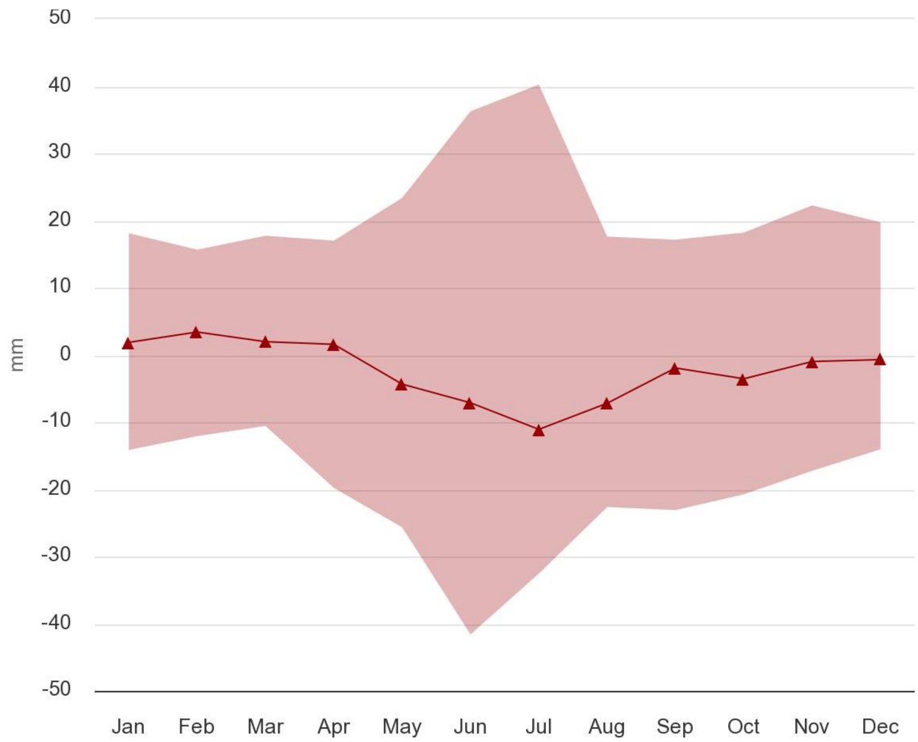

Figure 4.26: Projected Variation of Precipitation in Vratsa Region, 2040-2059

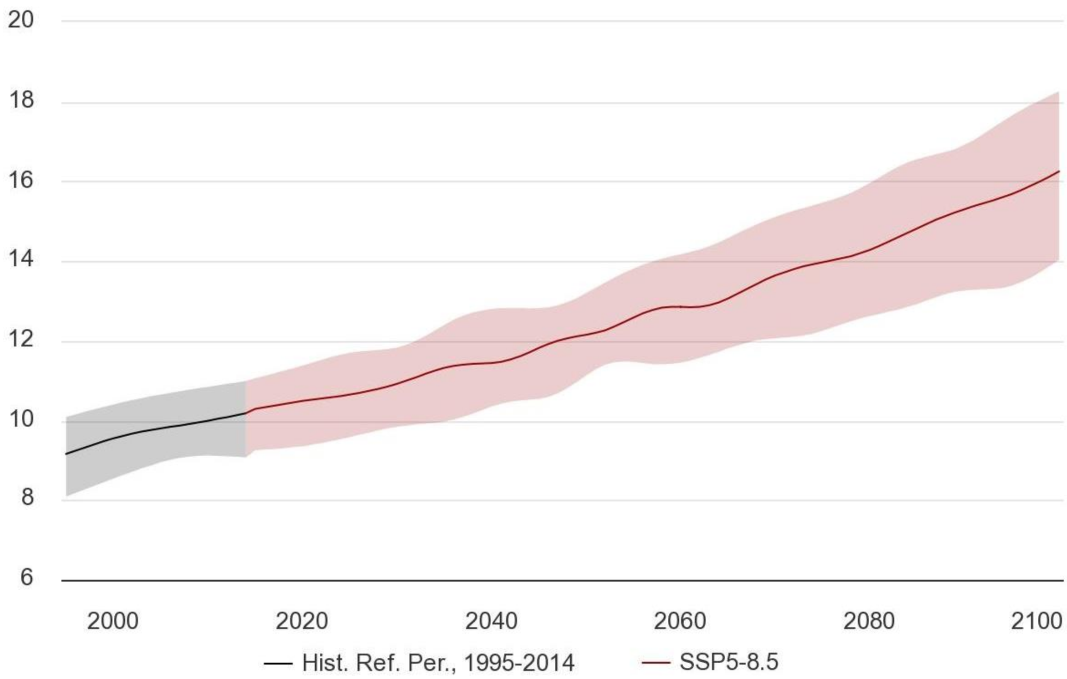

Figure 4.27: Projected mean temperature trend in Vratsa Region up to 2100 with reference to SSP8.5 scenario

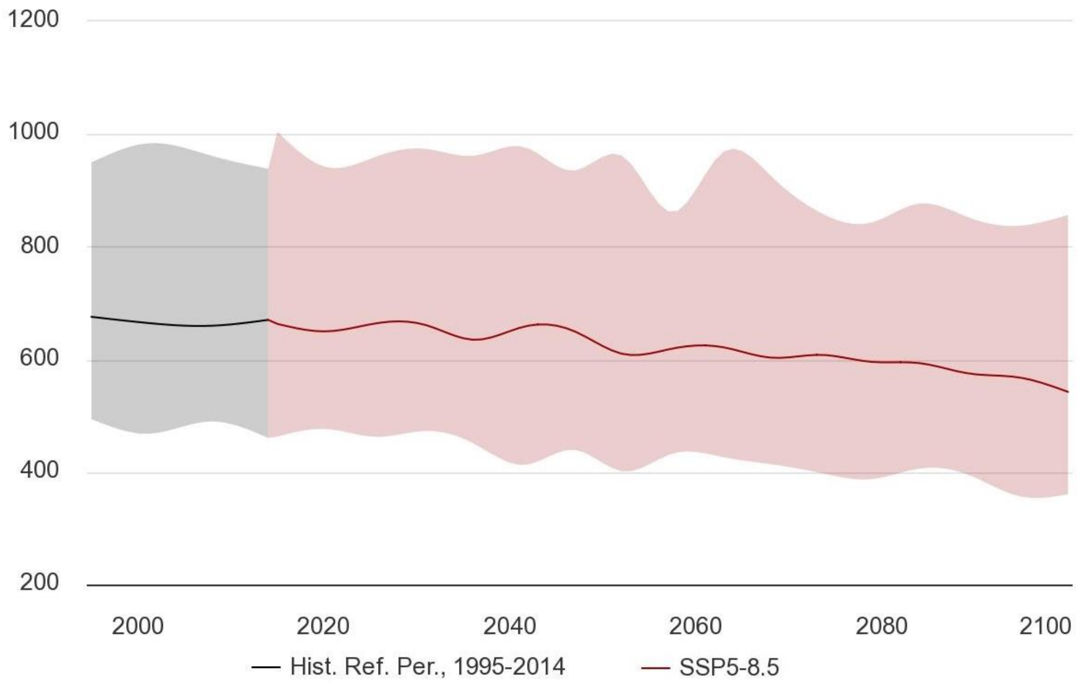

Figure 4.28: Projected mean precipitation measured in mm in Vratsa Region up to 2100 with reference to SSP8.5 scenario

5 CLIMATE CHANGE 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 Chiren Gas Storage Facility 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, an overview of the transition risks, i.e., business and financial risks arising in the frame of the global transition to a low-carbon economy, is also addressed in this section.

5.1 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 the analysis if performed considering the climate change scenarios up to 2060 in line with the Project's operational lifetime and the financial investment foreseen.

Specifically, it has been found that in the long-term the Project may be affected by the projected increase in average annual temperatures and decrease of precipitations 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. The risk matrix consists of three components: hazard, exposure and vulnerability.

Physical Risk = hazard * exposure * vulnerability.

The Physical Risk of a specific change is determined as a combination of these three components, reported in **Error! Not a valid bookmark self-reference.**. Finally, the Residual Physical Risk and the Potential Financial Risk are determined considering the implementation of the adaptation measures suggested. A register of the physical risks identified for Project, including their hazardous, exposure and vulnerability measures, as well as adaptation measures is presented in Table 5.2.

Table 5.1: Definition of risk components as per IPCC AR6[31]

Risk components	Definition
Hazard	The potential occurrence of a natural or human-induced physical event or trend, that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision and environmental resources.
Exposure	The presence of people, livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. For example, a community exposed to a drought hazard would have increased vulnerability if it lacked the capacity to bring in water resources from elsewhere or to adapt to reduced water availability.

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[31] IPCC, 2022: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844.

Table 5.2: Climate Change Physical Risks and Adaptation Measures

Category of climate hazard	Hazards	Effect on the Project	Hazardous Level	Exposure Level	Vulnerability Level	Physical Risk	Adaptation Measure	Residual Physical Risk	Potential Financial Risk
Acute									
Temperature related	Extreme heat event	Accelerated material degradation. Increase of thermal loading on concrete components causing expansion, bleeding, and cracking. Higher thermal induced stresses. Equipment failure for above ground components	Medium	Medium	Medium	Medium	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. Implementing a worker health awareness program to educate workers (and contractors) about the importance of drinking water and identifying the early signs of heat stroke/dehydration.	**Low**	**Low**
Water related	Extreme precipitati on events	Damages to storage facility components leading to lower productivity or out-of-service of the facility. Reduced accessibility to the project site for maintenance	High	Medium	High	High	Protection by design, preservative treatment. Insurance covering weather-related damages (including extreme events)	**Medium**	**Low**

Category of climate hazard	Hazards	Effect on the Project	Hazardous Level	Exposure Level	Vulnerability Level	Physical Risk	Adaptation Measure	Residual Physical Risk	Potential Financial Risk
	Drought	Decreased water resource availability for different processes required for the above ground components	Low	Medium	Medium	Medium	Availability of spare parts / components in sufficient amount Upstream walls and obstructions, collars. Use of sacrificial embankments. Increased use of sonar to monitor soil movements.	**Low**	**Low**
	Flood	Accelerated material degradation. Faster loss of prestressing force. Operation disruption	High	High	Medium	High		**Medium**	**Low**
Wind related	Extreme wind events *Storms, hurricanes, cyclones*	Damages to the storage facility components Reduced accessibility to the project site for maintenance Electrical equipment damage.	Low	Low	Low	Low		**Very Low**	**Very Low**
Solid mass related	Extreme mass movement *Landslide, avalanche, subsidence*		Medium	Low	Medium	Medium		**Low**	**Very Low**

Category of climate hazard	Hazards	Effect on the Project	Hazardous Level	Exposure Level	Vulnerability Level	Physical Risk	Adaptation Measure	Residual Physical Risk	Potential Financial Risk
Wildfires	Change in fire condition		High	Medium	Medium	High	Use of refractory electrical equipment. Ensure that emergency services receive adequate training on responding to wildfires.	**Medium**	**Low**
Chronic									
Temperature related	Mean temperat ure change	Accelerated material degradation. Increase of thermal loading on concrete components causing expansion, bleeding and cracking. Higher thermal induced stresses.	High	Medium	Medium	High	Develop emergency response plans specific to extreme heat events. This should include procedures for monitoring and forecasting high-temperature conditions, identifying triggers for action, and establishing communication protocols. Implementing heat-resistant materials, enhanced cooling systems Increase in concrete cover thickness, improve quality of concrete (strength grade), protective surface coatings and barriers, use of stainless steel, galvanized reinforcement, corrosion inhibitors, electrochemical chloride extraction.	**Medium**	**Low**

Category of climate hazard	Hazards	Effect on the Project	Hazardous Level	Exposure Level	Vulnerability Level	Physical Risk	Adaptation Measure	Residual Physical Risk	Potential Financial Risk
Water related	Mean precipitation change	Decreased water resource availability.	Low	Low	Low	Low	Move to more efficient and less resource consuming technologies as soon as they are available on the market. Procedures to minimize water consumption.	**Very Low**	**Very Low**
Wind related	Mean wind change	Damages to the storage facility components Reduced accessibility to the project site for maintenance	Low	Medium	Medium	Low	Implementation of wind monitoring systems and stay updated on weather forecasts to track changes in wind patterns and anticipate potential risks. Protection by design, preservative treatment. Insurance covering weather-related damages (including extreme events) Availability of spare parts / components in sufficient amount	**Very Low**	**Very Low**
Solid mass related	Erosion	Erosion of surface and subsurface layers, and damage to the infrastructure.	Very Low	Low	Low	Low		**Very Low**	**Very Low**

5.2 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. 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 Chiren Gas Storage Facility project is a facility for gas storage including new interconnecting gas pipeline and new exploitation wells, pipelines and observation wells, the assessment of transition risks is not required as the estimated GHG emissions from combustion installations is 87,050 tCO_{2e}/y during the operational phase (based on calculations in annual GHG report for 2020).

However, a general overview of the transition risks is provided under four main aspects in accordance with TCFD recommendations: Policy and Legal, Technology, Market, Reputation. The following lines provide an overview of how the Project can be investigated under these perspectives:

- ✓ **Policy and Legal**: underground gas storage (UGS) facilities contribute to the security of gas supply by providing additional gas in the event of high demand or supply disruptions. Moreover, UGS is important to boost the Bulgaria's strategic reserve in reaction to geopolitical developments. Even as the roles of biomethane and hydrogen expand over time, natural gas will continue to play a significant role as the primary dispatchable power source and a crucial energy source for the buildings and industrial sectors. In light of these considerations, no significant risk can be identified in the timeframe of this CCRA;
- ✓ **Technology**: the adopted storage technology is aligned with the best international standards, and it suggested to evaluate regular market studies for identification of emerging new storage technologies or consumer preferences for different energy sources;
- ✓ **Market**: no significant variation in the gas demand is expected that can impact negatively on the financial profitability of the Project in terms of the reduced market demand for the storage facility, especially, since it contributes to the reduction of the need to import additional gas and contributes to absorbing supply shocks. However, the potential strong increase in the market transition towards renewable sources and clean fuels such as hydrogen and biomethane could constitute a reduction of the market for natural gas;
- ✓ **Reputation**: no significant risk can be identified with reference to the change of community perceptions on the Project contribution to the transition to a low-carbon economy.

6 CONCLUSIONS

This report constitutes the CCRA of the new Chiren gas storage facility of Bulgarstransgaz EAD. The Project will be located in the Chiren village which is part of Vratsa Municipality within the Vratsa Province in the North-West of Bulgaria.

The CCRA is elaborated considering Physical Risks in line with the Equator Principles' Guidance Note on Climate Change Risk Assessment (EP IV) issued in October 2020 and the latest update released in May 2023, as well as 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, drought, and hazardous weather events likely to occur in Vratsa region in Bulgaria 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 the area under consideration are significant, in line with the average worldwide trends. These projected changes are an increase in temperatures, a slight decrease in rainfall, and an increase in extreme weather events such as river flood, urban flood and wildfire.

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 moderate-low risk factor) and by a reduction precipitation. These changes may impact negatively on the project 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 gas storage facility.

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