CLIMATE CHANGE IMPACTS ON HYDROPOWER AND ELECTRICITY DEMAND IN SURINAME

Climate Change Division

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TECHNICAL NOTE Nº IDB-TN-02466

May 2022

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Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Climate change impacts on hydropower and electricity demand in Suriname / María San Salvador del Valle, Kepa Solaun, Gerard Alleng, Adrián Flores, Jordi Abadal.
p. cm. — (IDB Technical Note ; 2466)
Includes bibliographic references.
1. Climate change-Suriname. 2. Renewable energy sources-Suriname. 3. Water-power-Suriname. 4. Hydroelectric power plants-Suriname. I. San Salvador, María. II. Solaun, Kepa. III. Alleng, Gerard P. IV. Flores, Adrián. V. Abadal, Jordi. VI. Inter-American Development Bank. Climate Change Division. VII. Series.
IDB-TN-2466

JEL Codes: Q13, Q54.
Key Words: Suriname, Hydropower.

http://www.iadb.org

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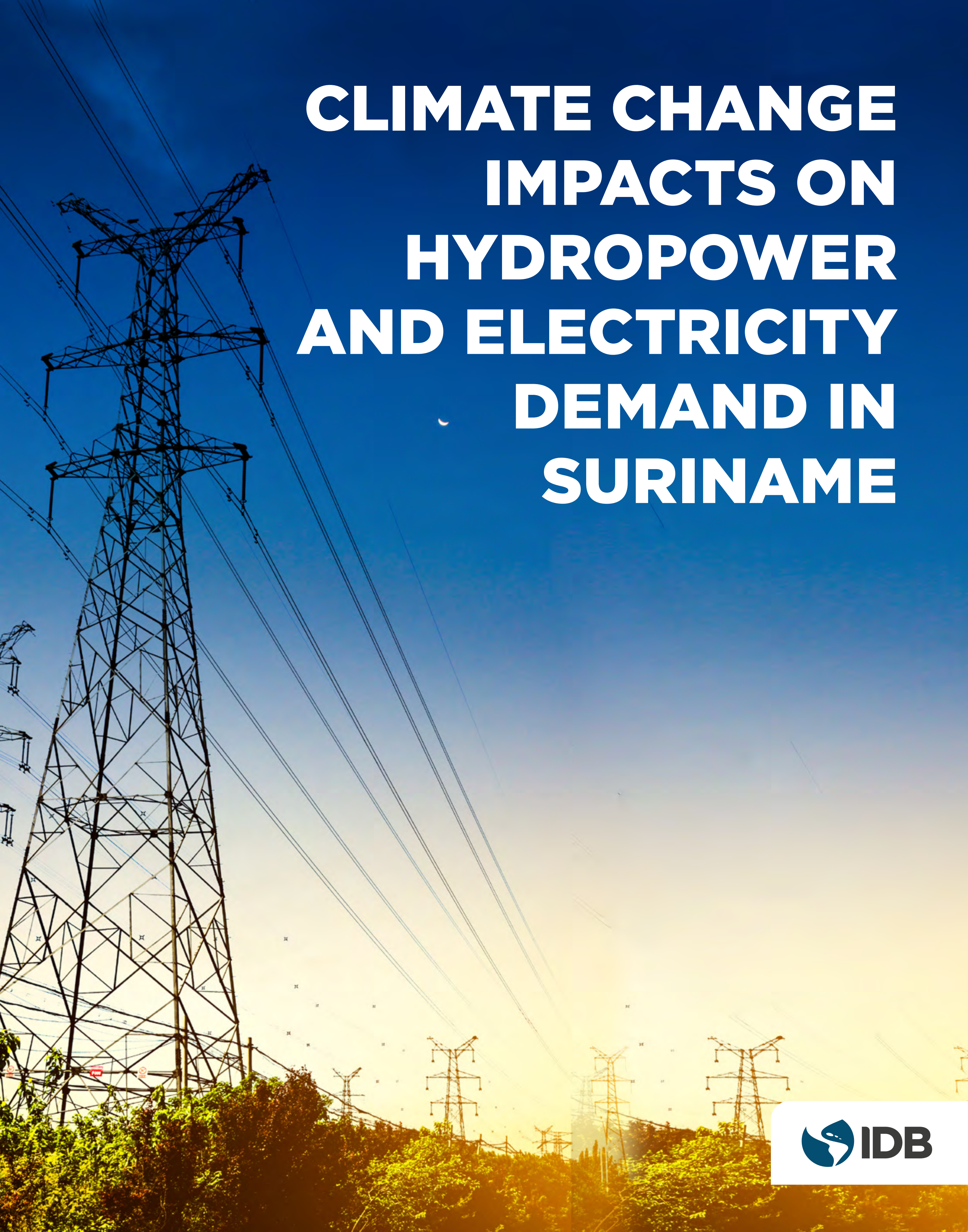

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SUMMARY

Climate change is expected to have significant impacts on electricity generation and demand in Suriname. Of all the generation technologies, hydroelectric energy will be the most affected. Research in this area has provided projections for variation in rainfall, water availability, and hydroelectric generation at the global, national, and local levels.

This report presents two case studies that analyze the impacts of climate change on the energy sector of Suriname, providing specific examples to understand and value these impacts. The first case focuses on the impacts of climate change on the Afobaka hydroelectric power plant. Specifically, it analyzes the historical correlation between rainfall, inflow, and generation. Results show that precipitation strongly influences water inflow at the hydropower plant, and the projection using various climate models under two scenarios shows a 9 to 14 percent reduction in inflow by the end of the century.

The second case addresses the impacts of climate change on electricity demand in the Paramaribo area. In this case, the correlation between cooling degree days and energy demand was examined. No significant correlation was found between comfort temperature and electricity demand. Thus, using the available data it does not seem plausible to estimate future electricity demand based on climate projections.

CONTEXT

Suriname's contribution to climate change is relatively small, as due to its large forest cover, the country's 2008 greenhouse gas (GHG) inventory demonstrated that it was a net carbon sink. However, Suriname is particularly vulnerable to the effects of climate change for several reasons: it is dependent on fossil fuels, it has forests vulnerable to decay, its ecosystems are fragile, and its low-lying coastal area contains 87 percent of the population and most of the country's economic activity. Suriname experience extensive coastal erosion, prolonged dry seasons, and frequent flooding. Today, many sectors are at risk of suffering losses and damage caused by gradual changes and extreme weather events related to climate change. However, the availability of in-depth studies about Suriname's climate projections and its impacts on different sectors is limited, and as a result evidence-based decision making is difficult.

For Suriname's development to be sustainable, the impacts of climate change and its effects into the country's legal and institutional frameworks must be considered. The Inter-American Development Bank (IDB) and the Government of Suriname decided to collaborate on the project "Mainstreaming Climate Change in Sustainable Decision-Making Tools," in order to integrate climate change mitigation and adaptation considerations in planning and decision making. Doing so enables evidence-based decision making that is inclusive, transparent, and considers the impacts of climate variability in multiple sectors. One of the project's products in this process is the State of the Climate (SOC) Report.

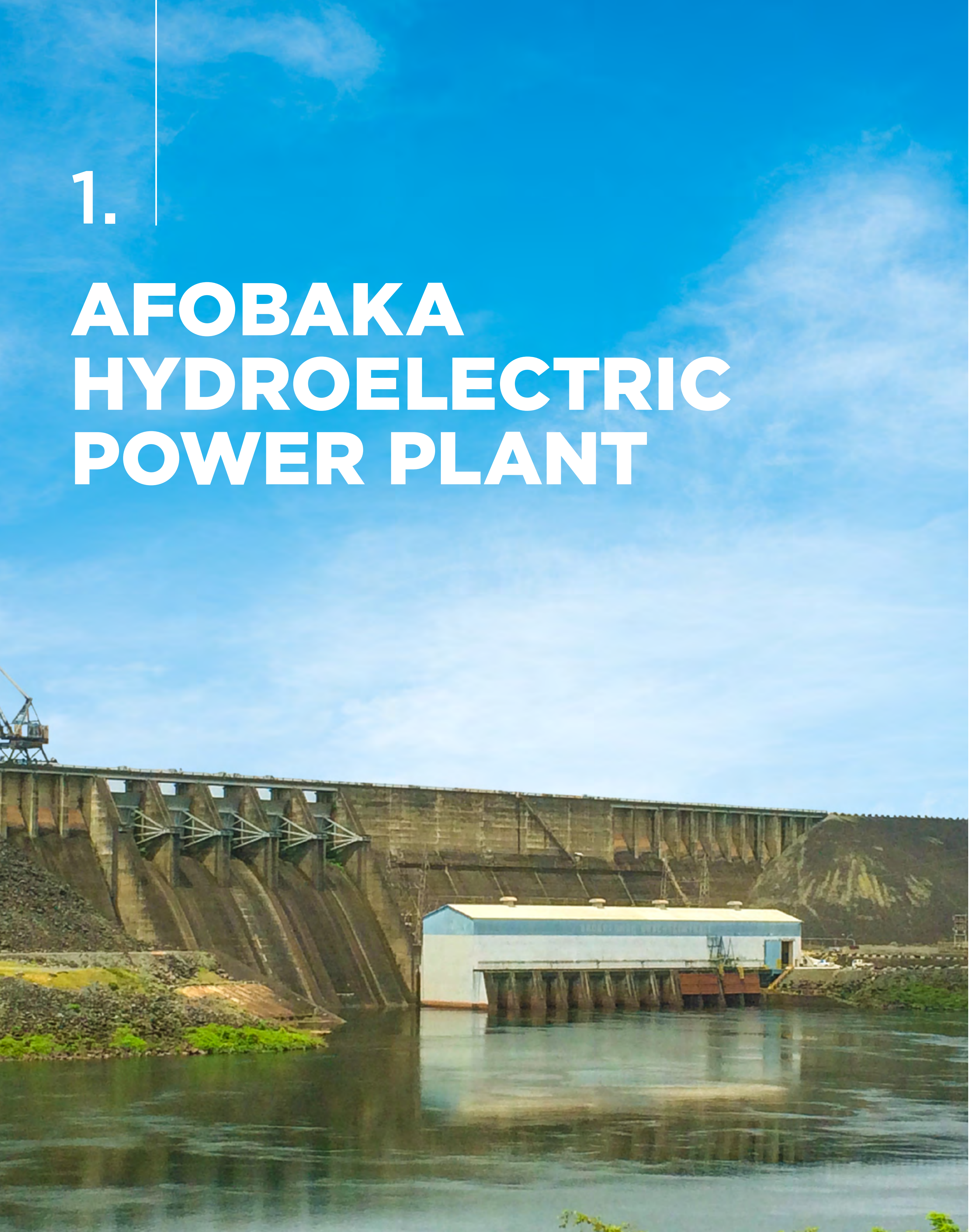
Suriname's SOC Report provides a comprehensive analysis of the country's climate risks and how it can mitigate them. The overall objective of the SOC Report is twofold: First, it comprehensively analyzes the likely impacts of climate change on several geographic areas as well as for the key sectors (agriculture, water, forestry, and infrastructure) through historic climatic trends. Second, it provides projections that include sub-country level details. The Non-Technical Summary provides the analyses, results, and recommendations of the SOC in non-technical language. The report serves stakeholders and policymakers in planning projects and investments. It also supports the country's efforts to fulfill its reporting obligations to the UNFCCC by providing up-to-date information on adaptation and vulnerability based on state-of-the-art climate projections.

The SOC Report analyzes Suriname's historical climate (1990-2014) and provides climate projections for three time horizons (2020-2044, 2045-2069, and 2070-2094) through two emissions scenarios (intermediate/ SSP2-4.5 and severe/ SSP5-8.5). The analysis focuses on changes in sea level, temperature, precipitation, relative humidity, and winds for seven subnational regions of Suriname (Paramaribo, Albina, Bigi Pan Multiple Use Management Area (MUMA), Brokopondo, Kwamalasamutu, Tafelberg Natural Reserve, and Upper Tapanahony).

The SOC Report shows similar trends throughout the timeframes, scenarios, and regions, with Suriname becoming hotter and drier in the coming decades. The average, minimum, and maximum temperatures are expected to rise significantly by the end of the century. Consequently, the number of hot days is expected to increase to 295 per year and nights to 364 per year by the end of the century, while cold days and nights disappear altogether. Rain is expected to decrease for all seasons, with precipitation episodes becoming more intense and rarer. Maximum wind speed is expected to increase moderately in all scenarios. Regarding the risk assessment, Paramaribo, Sipaliwini, and Wanica are the most exposed districts, and Coronie and Nickerie are the least at risk. Sipaliwini and Brokopondo are the most vulnerable districts due to their vulnerable agriculture and infrastructure sectors, while Coronie is the least vulnerable district.

The energy sector is particularly relevant in a changing climate. The sector is responsible for the highest GHG emissions due to the use of fossil fuels (Cambridge University Press, 2015). At the same time, the impacts of climate change can have a significant effect on electricity supply due to several threats to the generation and transmission infrastructure, particularly to the hydroelectric plants, as well as in the energy demand side, since they may vary the consumption patterns in different sectors (Wenz, Levermann, & Auffhammer, 2017). Climate change will also impact alternative renewable energies such as solar and wind, which can reduce emissions (Contreras-Lisperguer & de Cuba, 2008).

This assessment addresses and quantifies the impacts of climate change on the energy sector. First, it focuses on the Afobaka power plant to analyze the impacts of climate change in the hydropower facility through the historical correlation between rainfall, inflow, and generation has been analyzed. Then it addresses electricity demand in the Paramaribo area.



1.1 | INTRODUCTION

The share of hydropower generation in the world is expected to decrease by 2050, mainly due to the spike in energy demand that will be met by other renewable technologies. Still, total installed capacity is expected to increase from 1248 GW in 2015 to 1825 GW in 2050 (IRENA, 2018). Among the areas with the greatest potential for new hydroelectric plants are Asia, Latin America, and Central Africa (Zhou et al., 2015).

Climate change is expected to have significant impact on hydroelectric plants. However, defining this impact is complex due to the nonlinear and region-specific changes in precipitation and temperatures (Arent et al., 2014). Most of the studies on the impacts of climate change on hydropower analyze variations in water inflow due to variations in precipitation and temperature (Solaun & Cerdá, 2019). The main climate threats and impacts on hydropower are the following (Kepa Solaun & Cerdá, 2019):

Change in rainfall patterns

- Changing annual or seasonal patterns can impact river flows and water levels, affecting production.
- Changes in precipitation and temperature may affect the moisture levels of soil.
- Because of erosion, siltation can affect the soil and reduce power output.

Flooding and intense rain

- Flooding can damage infrastructure.
- Flooding may pose a significant risk to dam safety.
- Flooding can also transport debris and damage dams and turbines.

Air temperature

- Higher air temperature would increase surface evaporation, reducing water storage and power output.
- Melting ice can alter the seasonal water inflow to plants that rely on snowfalls or glaciers.
- An increase in temperature might increase operating costs and affect the efficiency of the equipment.

Others

- El Niño Southern Oscillation influences precipitation.
- An increase in sediment content in the water and suspended materials can affect the performance of gates.
- Landslides increase the level of sediments in water, which can cause other problems.
- Increased intensity and frequency of storms and extreme weather events may affect the plants.
- Conflicts with other uses may arise.

1.2 | METHODOLOGY

To evaluate whether climate change may affect hydropower generation and to quantify the potential impacts, the first step is to assess the correlation between rainfall patterns, water inflow to the plant, and generation[1]. If the correlation is high, a regression analysis can predict how the independent variable can affect the dependent one. This is summarized in the following steps:

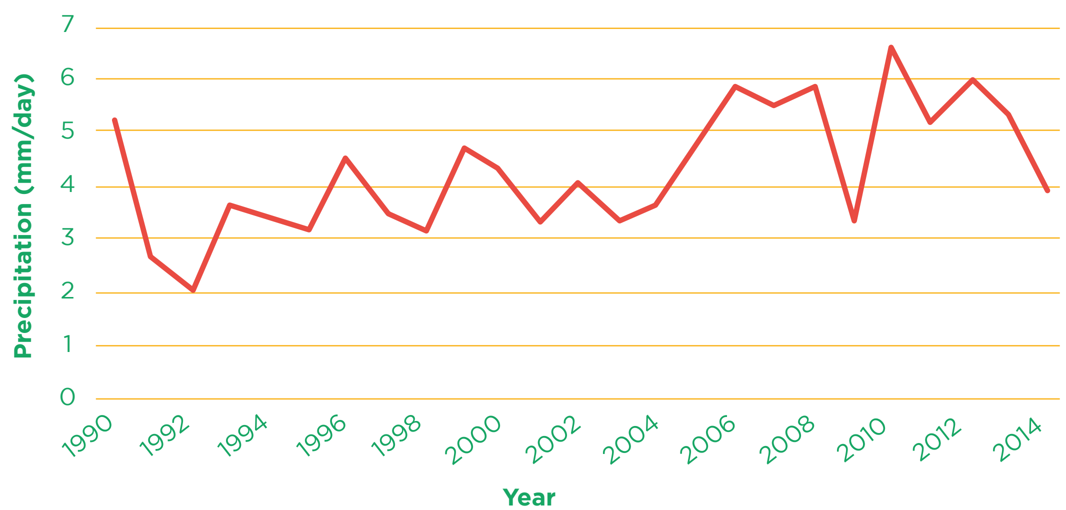
1.2.1 | Gathering of data on precipitation in the Brokopondo area

This project analyzed both historical and projected series of precipitation. Daily historical data from 1990 to 2014 were obtained, as were daily projected data from 2020 to 2094. The historical reference period selected is 1990-2014, since the models consider 2015-2019 to be part of the future (i.e., projected data). Historical and projected data are required since the models need to overlap to apply the Q-Q adjustments.

The historical precipitation series in mm/day is shown in Figure 1. The figure shows a decreasing trend in the first part (until 1992) and an increase in the last years (from 1992 onwards).

Figure 1 | Historical annual precipitation (mm/day)

Source: Report team based on project obtained data.



1.2.2 | Gathering of historical data on water inflow and generation in the Afobaka hydropower plant

Monthly historical data on the Afobaka hydropower plant inflow were gathered from January 1911 to November 2020, as shown in Figure 2. Figure 3 shows the historical annual generation in the Afobaka hydropower plant, supplied by Staatsolie Power Company Suriname (SPCS), from 2009 to November 2020. Those two series will be compared with the historical precipitation records to assess the influence of rainfall patterns on runoff near the plant and hydroelectric generation.

[1] Correlation measures the statistical relationship between various variables. If a high correlation is found, and there is information about the expected evolution of a variable, the evolution of others can be inferred, provided there is a casual relationship that connects them.

Figure 2 | Historical annual inflow (cfs)

Own elaboration based on EBS data.

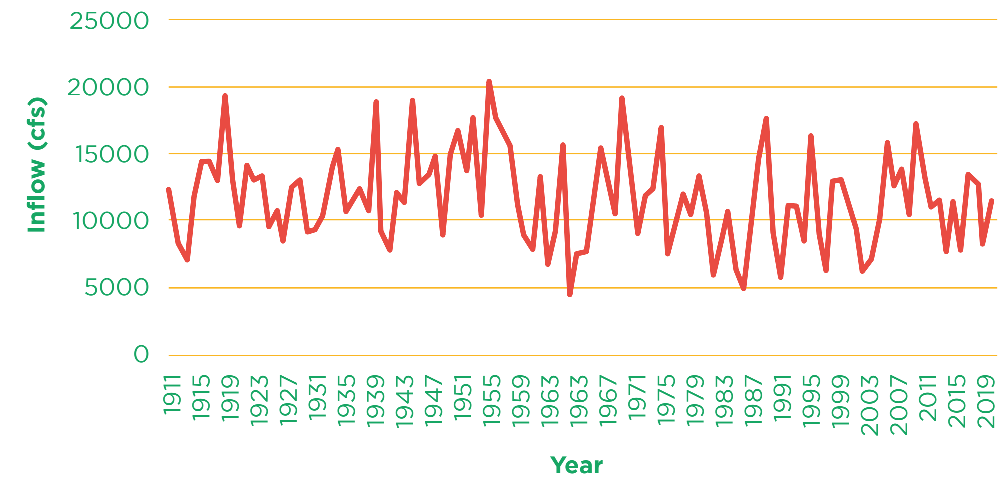
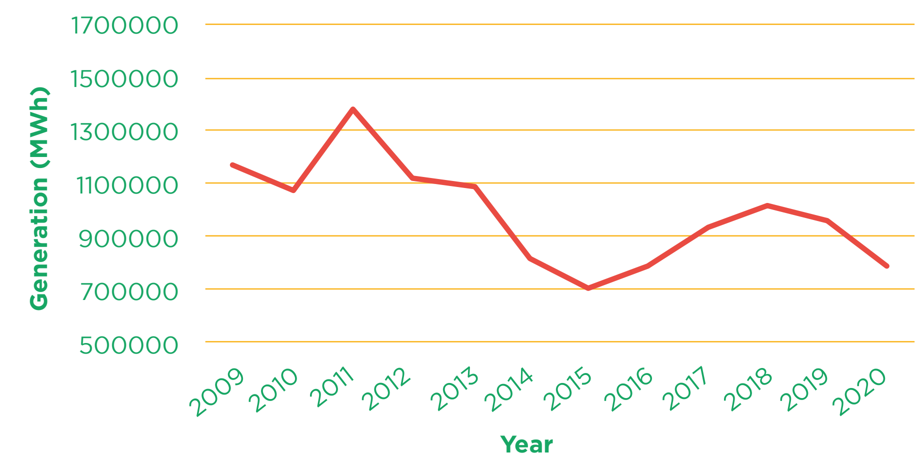


Figure 3 | Historical annual generation (MWh)

Source: Report team based on EBS data.



1.2.3 | Correlation and dependency analysis

a. Inflow and precipitation

An analysis was carried out using monthly data (1990 to 2014) to analyze the correlation between precipitation and inflow. Analyses based on daily data (2009-2020) and annual data (period 1990-2014) were also conducted. According to the results and the available data period, monthly data were considered to better represent the correlation between inflow and precipitation. Figure 4 shows monthly precipitation in mm/day (horizontal axis) and inflow in cubic feet per second (vertical axis) at the power plant.

Figure 4 | Precipitation vs. inflow for the 1990-2014 period (monthly basis)

Source: Report team based on project obtained data and EBS data.

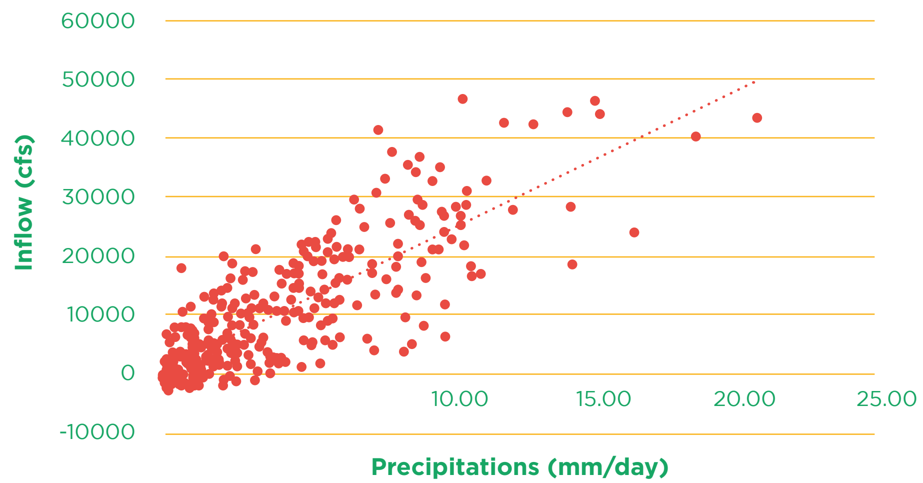


Table 1| Correlation between precipitation and inflow 1990-2014 (monthly basis)

Source: Report team.

Correlation between precipitation and inflow 1990-2014 (monthly basis)
0.799

As the Figure 4 suggests, a significant correlation between precipitation and inflow has been found and is displayed in Table 1. The next step is to find an equation that links both variables and allows the impact of one on the other to be quantified. A linear regression methodology[2] was used to project inflow (dependent variable) based on projected precipitation (independent variable).

b. Inflow and generation

According to the available data, the correlation between inflow and generation of Afobaka hydropower was calculated using daily, monthly, and annual data for 2009-2020. No long-term data for generation were found, which would be very relevant due to the interannual regime of the plant.

In this regard, Figure 5 shows inflow (horizontal axis) and generation in MWh (vertical axis). With existing information, no significant correlation was found. Table 2 shows the correlation between inflow and generation based on monthly data. Table 3 shows the correlation based on annual data.

Due to the weak correlation found, this study will not perform any projection on generation. If the evolution of these variables is not correlated, to project one based on the other will not produce representative results.

[2] A regression analysis is a set of statistical processes for estimating the relationship between various variables. The most common methodology is the ordinary least squares method.

Figure 5 | Inflow vs. generation for the 2009-2020 period (monthly basis)

Source: Report team based on EBS data.

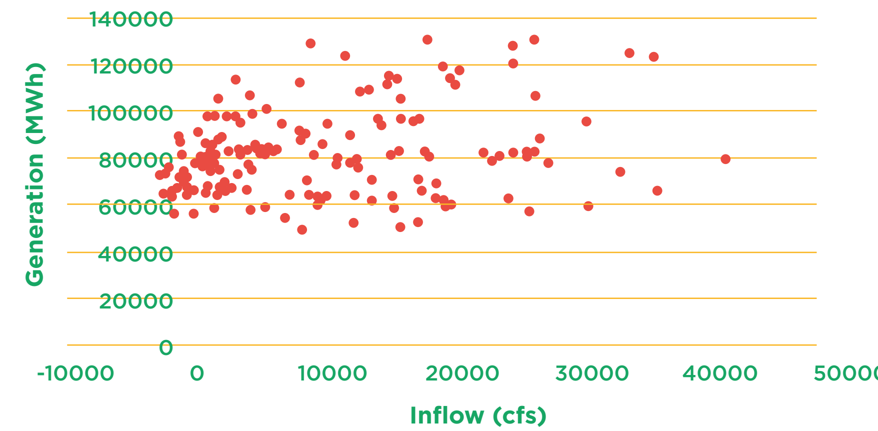


Table 2 | Correlation between inflow and generation 2009-2020 (monthly basis)

Source: Report team.

Correlation between inflow and generation 2009-2020 (monthly basis)
0.239

Table 3 | Correlation between inflow and generation 2009-2020 (annual basis).

Source: Report team.

Correlation between inflow and generation 2009-2020 (monthly basis)
0.397

1.2.4 | Projection of precipitation

The main project document, the SOC Report (K. Solaun, Alleng, Resomardono, Hess, & Antich, 2021), specifically Chapter 3, analyzes in detail historical and future climate projections in Suriname for different time horizons (1990-2014, 2020-2039, 2040-2069, and 2070-2099), scenarios (SSPS2-4.5 and SSPS5-8.5), and locations (Paramaribo, Albina, Bigi Pan MUMA, Brokopondo, Kwamalasamutu, Tafelberg Natural Reserve, and Upper Tapanahony).

General circulation models (GCM) were used to generate historical trends and future projections. GCM are numerical representations of the climate system that reproduce its components' (hydrosphere, cryosphere, and atmosphere) dynamics at different spatial and temporal scales. They include a complex group of processes based on each climate system component's physical, chemical, and biological properties, interactions, and existing feedback processes. In this way, each GCM can simulate responses to the radiative forcings (i.e., the total net radiation the system receives, which depends, among other factors, on the concentration of GHG) and scenarios (different reasons for different levels of radiative forcing to occur). Each GCM does so differently because of the way it models atmospheric processes and incorporates feedback. GCMs can thus be programmed to follow different scenarios and radiative forcings, thereby providing projections on how climate could evolve in the future.

An analysis of the scope and limitations of GCMs is conducted using the Coupled Model Intercomparison Project (CMIP), in which numerous internationally renowned climate modeling centers participate. The project is currently in its sixth phase (CMIP6). To produce climatic trends, the most recent and presently available climate models generated in the framework of the CMIP6 were used.

The models were selected based on the following criteria:

i. A renowned climate study conducted in the region used the HadGEM2-ES[3] and MIROC5[4] models (Almagro, Oliveira, Nearing, & Hagemann, 2017). The choice of these two models was based on their excellent simulation of precipitation and atmospheric circulation over South America. Our study used the new version of these models under CMIP6: HadGEM3-GC31 and MIROC6.

ii. IPSL-CM6A (the CMIP6 version of model IPSL-CM5A) was added to the multimodel analysis based on the suggestion of local experts from the Anton de Kom University (ADEKUS).

iii. The three models selected have undergone rigorous analysis and validation for the region.

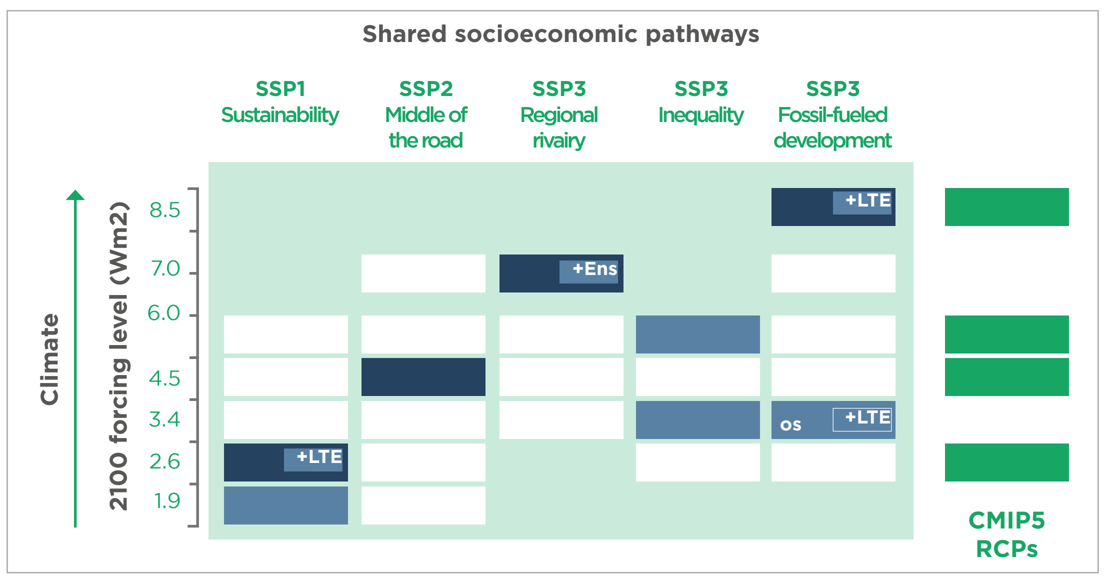
Several scenarios are used to carry out climate projections, as shown in Figure 6. In this study, the scenarios SSP2-4.5 (a combination of RCP4.5 and SSP2) and SSP5-8.5 (a variety of RCP8.5 and SSP5) were selected:

i. SSP2-4.5: This scenario represents the intermediate level in the range of future paths contemplated and updates the RCP-4.5 path (figure 6). It combines an intermediate society and forcing level.

ii. SSP5-8.5: This scenario represents the higher end of the range of future paths. It includes an update of the RCP8.5 trajectory (Figure 6) with increased CO_2 emissions after 2030. Since the RCP8.5 trajectory has very high expectations for other GHG that were not supported by observations, more CO_2 had to be released to reach 8.5 Wm-2 in 80 years. This is the only scenario with emissions high enough to produce a radiative forcing of 8.5 Wm-2 in 2100.

Figure 6| Matrix of SSP-RCP scenarios

Source: Rogelj et al., 2018



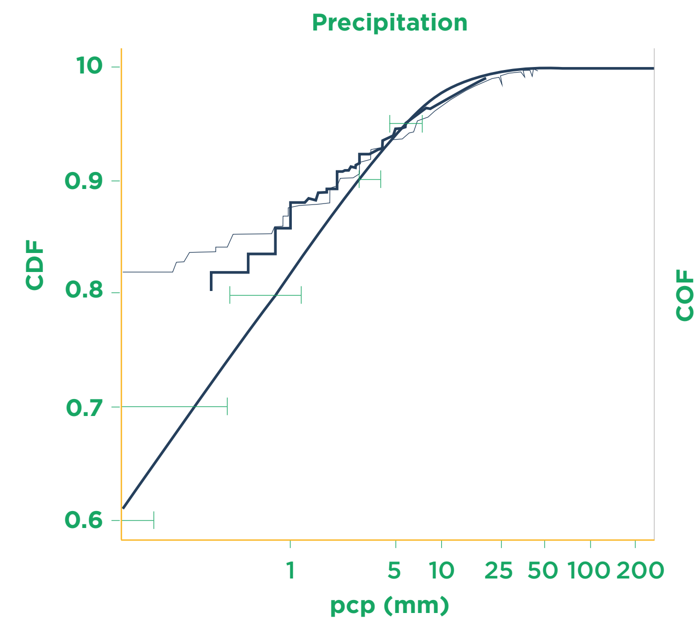
[3] The HadGEM2 model is the second iteration of the Met Office Hadley centre global environment model. https://catalogue.ceda.ac.uk/uuid/a9f7c9d7123b4c3f8e13382d66679d1a

[4] The MIROC5 is the Model for Interdisciplinary Research on Climate, developed by various organizations, led by the University of Tokyo.: https://data.globalchange.gov/model/miroc5

Several procedures for adjusting climate projections that consider regional or local forcings (a process known as downscaling) are currently available. A complex statistical downscaling method, the quantile-to-quantile method (Q-Q), was applied in this study (Amengual, Homar, Romero, Alonso, & Ramis, 2012). In the Q-Q adjustment, all climatic variables are adjusted to take regional forcings (Figure 7). The method considers the same historical period or baseline for the observed (black line) and simulated variables (dark grey line). It then determines the differences between the two series of data and corrects the variables for future periods, considering these differences (light grey line).

Figure 7 | Application of the quantile-to-quantile adjustment: Cumulative distribution function (CDF, i.e., the probability of the variable having a value equal to or smaller than x at each point) of precipitation in Palma de Mallorca, Spain

Source: Report team.



Under the World Meteorological Organization's (WMO) current technical regulations, climatological standard normals consist of averages of climatological data computed for successive 30-year periods. This period is long enough to filter out interannual variation or anomalies and short enough to show longer climatic trends. Averaging over shorter periods may lead to misleading interpretations of the results. Climatological standard normal periods should be adhered to whenever possible to provide a uniform basis for international comparison.

However, the analysis provided in this report was restricted by the current available future model periods, which sometimes only cover up to the year 2099. As this study aimed to analyze three future periods—near future, medium-term future, and long-term future—from 2020 onward, 25-year periods were defined. This was a good compromise between long periods to obtain robust results and covering three future periods. The following future 25-year periods were established: near future (2020-2044), medium-term future (2045-2069), and long-term future (2070-2094).

In line with this, a reference period of 25 years from January 1, 1990, to December 31, 2014, was used. This drew on the most recent observation data available in Suriname that still matches climate models (which end in 2014), thus allowing for Q-Q adjustments.

For the local study, the ERA5 (historical data provider) reanalysis data were used to analyze the current climate for each point of interest. Using the multimodel technique and applying the Q-Q statistical adjustment at the location of each point of interest, the future projections of all variables for each time horizon and the two scenarios were computed.

The main results regarding precipitation for the Brokopondo area are shown in Table 4. The selected variables are accumulated precipitation per year (mm/year), number of rainy days (days/year), highest 1-day precipitation amount (mm), and highest 5-days precipitation amount (mm).

Table 4 | Mean values and average days of precipitation indices and variations projected in each scenario and period in the Brokopondo area

Source: Report team.

	1990-2014	2020-2039		2040-2069		2070-2099	
Variables		**SSP2-4.5**	**SSP5-8.5**	**SSP2-4.5**	**SSP5-8.5**	**SSP2-4.5**	**SSP5-8.5**
Accumulated precipitation (mm/y)	1,556	1,457	1,387	1,397	1,387	1,379	1,306
Rainy days (days/year)	190	177.1	179	171.8	171.5	172.1	168.4
RX1day (mm)	68	68.3	73.1	75.8	82.8	78.3	82.3
RX5day (mm)	68	155.1	163	171	178.5	171.7	175.1

Figure 8 shows the annual average regime for precipitation for Brokopondo for the historical period (1990-2014) and climate projection in the SSP2-4.5 and SSP5-8.5 scenarios in the short-term future (2020-2039), medium-term future (2040-2069), and long-term future (2070 - 2099). The number of days without rain, weak rain, moderate rain, heavy rain, and very heavy rain is shown.

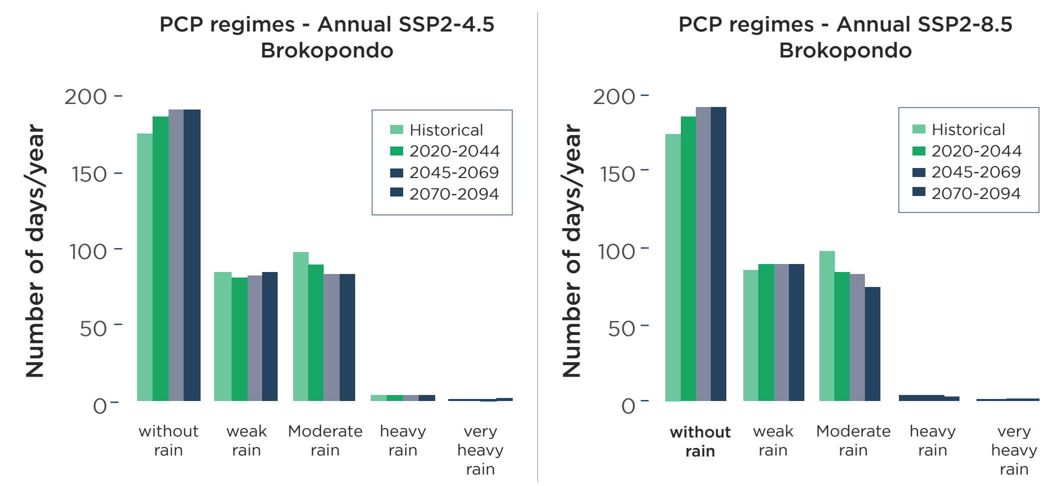


Figure 8 | Annual average regimes for precipitation for Brokopondo for the historical period and climate projection

Source: Report team..

Figure 9 shows the seasonal accumulated precipitation regime for Brokopondo for the historical period (1990-2014) and climate projection in the SSP2-4.5 and SSP5-8.5 scenarios in the short-term future (2020-2039), medium-term future (2040-2069), and long-term future (2070 - 2099). Results are provided for the rainy, short rainy, dry, and short dry seasons under both scenarios.

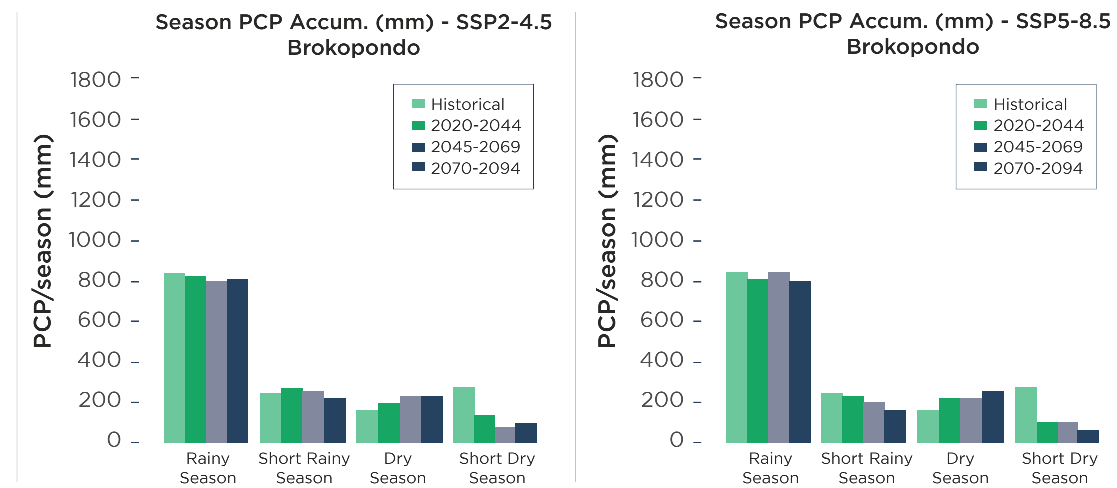


Figure 9 | Seasonal accumulated precipitation regime for Brokopondo, for the historical period and climate projection

Source: Report team..

Figure 10 shows future climate indices: rainy days and maximum precipitation in one and five days during the historical period (1990-2014) and climate projection in the SSP2-4.5 and SSP5-8.5 scenarios in the near-term future (2020-2039), medium-term future (2040-2069), and long-term future (2070 -2099).

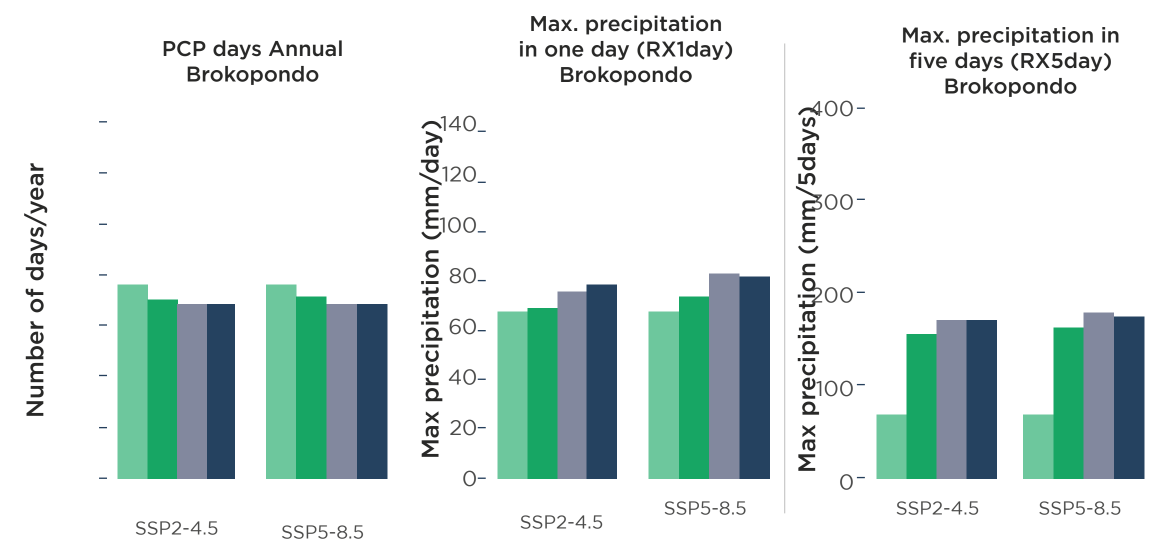


Figure 10 | Rainy days and maximum precipitation in one and five days Source: Report team.

Source: Report team.

This location shows a decrease in accumulated rain, but more importantly, a shift in its seasonal regime. Accumulated precipitation during the rainy season decreases slightly in all scenarios and periods, but it increases in the dry season and falls abruptly in the short dry season. Rainy days descend from 190 per year to around 170 per year in all periods and scenarios, while daily and five-day maximum precipitation increases (by 82.3 mm and 185.1 mm in the far-term future for SSP2-4.5 and SSP5-8.5, respectively).

1.2.5 | Projection of inflow

As there is a strong correlation between inflow and precipitation, the future inflow projection can be calculated based on the projected precipitation data obtained in the project by using linear regression. Projected precipitation is shown in Table 5 under both scenarios for the three time periods considered.

The future decrease in inflow in the Afobaka hydropower plant resulting from changes in precipitation was quantified. It is shown in Table 6 for the same scenarios and periods. Reductions in annual inflow start at 5-9 percent, depending on the scenario, and by the end of the century, they range from 10 to 14 percent. Therefore, reductions are higher under a more intense climate change scenario (SSP5-8.5) and in the long term.

Table 5 | Projected decrease in annual precipitation in Brokopondo area compared to the reference period (1990-2014)

Source: Report team.

	2020-2039 vs 1990-2014		2040-2069 vs 1990-2014		2070-2099 vs 1990-2014	
Scenario	Annual precipitation reduction (mm/y)	Reduction (%)	Annual precipitation reduction (mm/y)	Reduction (%)	Annual precipitation reduction (mm/y)	Reduction (%)
SSP2-4.5	99	6.4%	159	10.2%	177	11.4%
SSP5-8.5	169	10.9%	169	10.9%	250	16.1%

Table 6 | Projected decrease in inflow in Afobaka hydropower plant compared to the reference period (1990-2014)

Source: Report team.

	2020-2039 vs. 1990-2014		2040-2069 vs. 1990-2014		2070-2094 vs 1990-2014	
Scenario	Annual inflow reduction (cfs)	Reduction (%)	Annual precipitation reduction (mm/y)	Reduction (%)	Annual precipitation reduction (mm/y)	Reduction (%)
SSP2-4.5	634.63	5.7%	918.03	8.3%	1107.14	10.0%
SSP5-8.5	985.18	8.9%	1107.32	10.0%	1592.15	14.4%

The annual projected evolution of inflow in cubic feet per second is shown in Figure 11 (SSP2-4.5 scenario) and Figure 12 (SSP5-8.5 scenario). The decreasing trend is clear in both graphs.

Figure 11 | Projected annual inflow (SSP2-4.5 scenario)

Source: Report team.

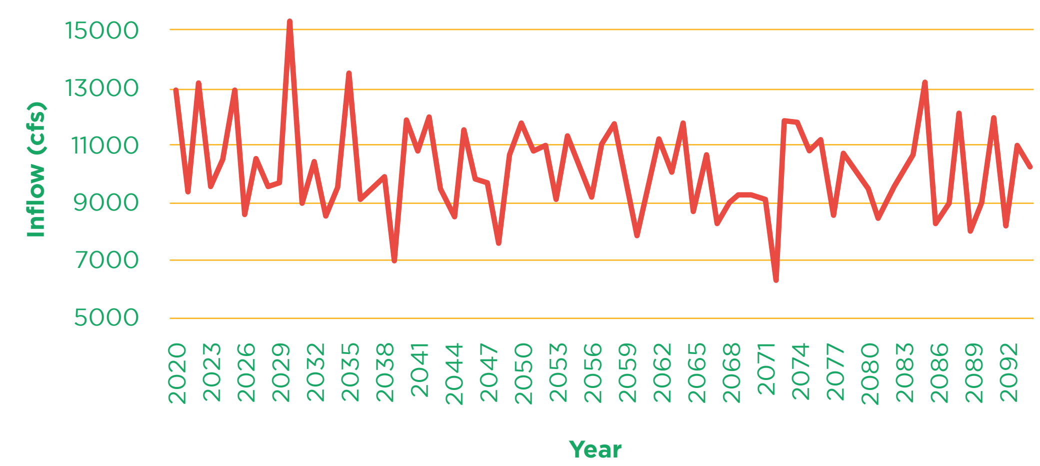
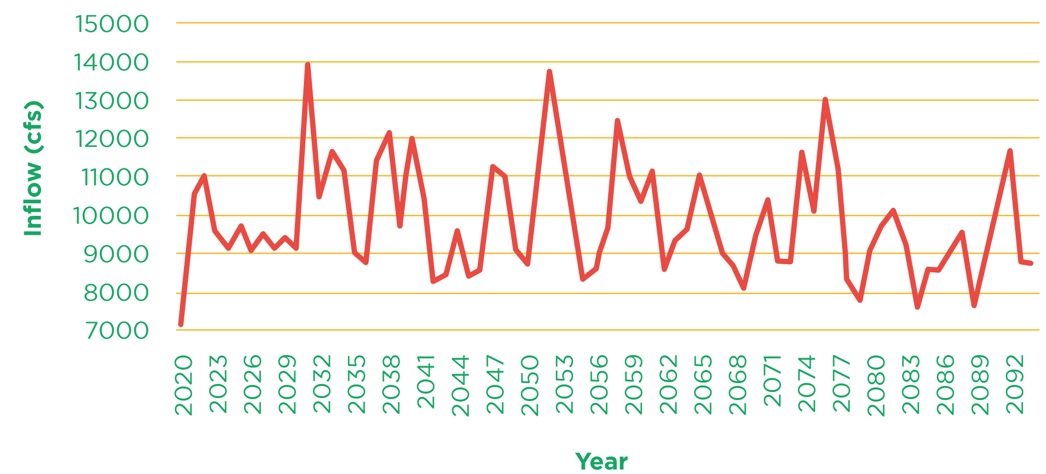
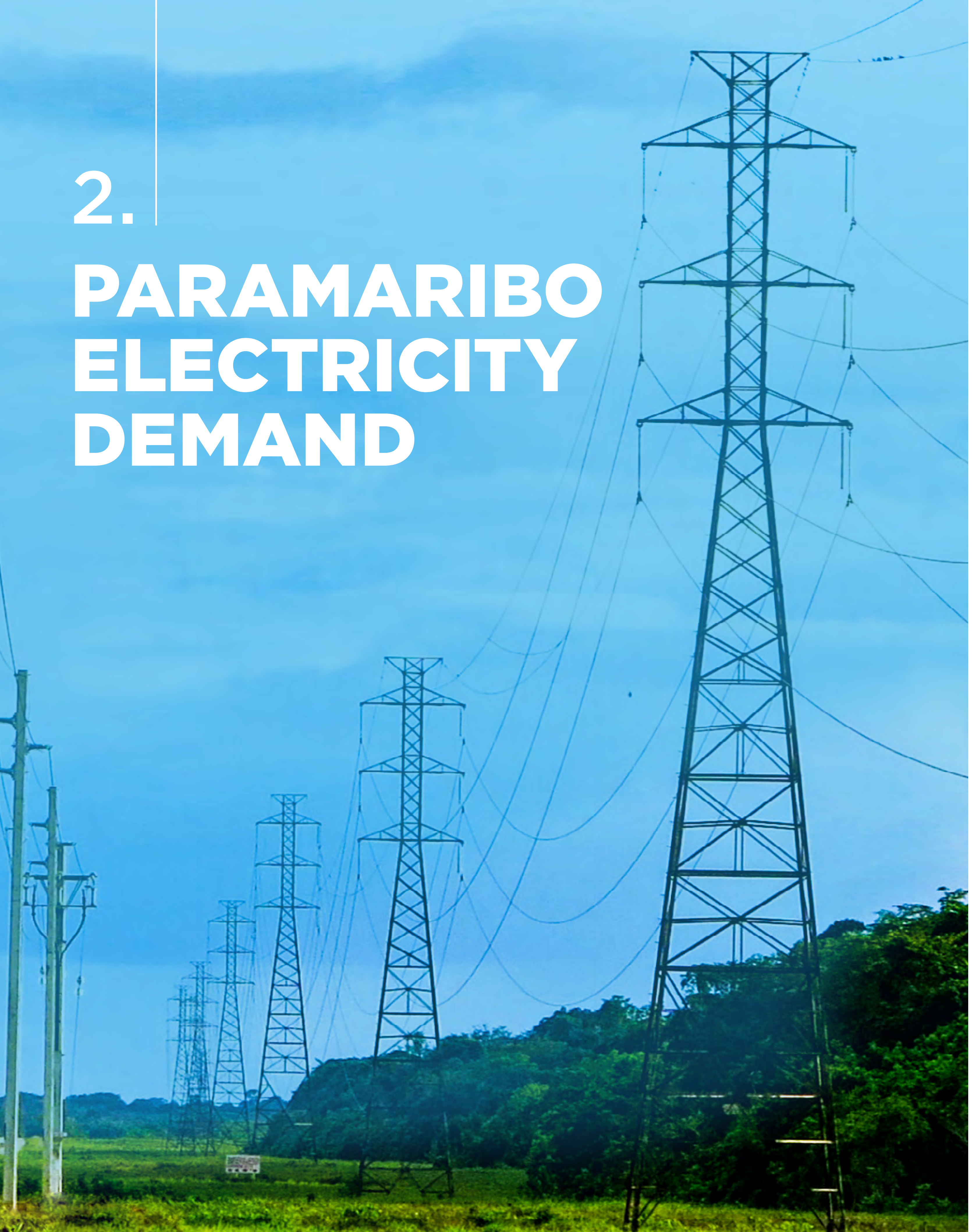


Figure 12 | Projected annual inflow (SSP5-8.5 scenario)

Source: Report team.





2. PARAMARIBO ELECTRICITY DEMAND

2.1 | INTRODUCTION

Multiple studies have shown that electricity demand is highly sensitive to variations in temperature and, therefore, climate change could bring significant changes in the future consumption (Sailor, 2001; Trotter, Bolkesjo, Féres, & Hollanda, 2016). Generally, the relationship between temperature and energy consumption is U-shaped, meaning that increases in consumption correspond to very low and very high temperatures (Ahmed, Muttaqi, & Agalgaonkar, 2012; Mirasgedis et al., 2007; Valor, Meneu, & Caselles, 2001; Wenz et al., 2017). However, few studies have been conducted on the influence of climate on energy demand in the Caribbean region, and the methodologies commonly used in other studies seem to be more appropriate for European or North American weather.

This analysis aims to correlate climate and energy data and analyze the extent to which electricity demand is vulnerable to variations in temperature in Suriname.

2.2 | METHODOLOGY

The methodology used in this case study can be summarized in the following steps:

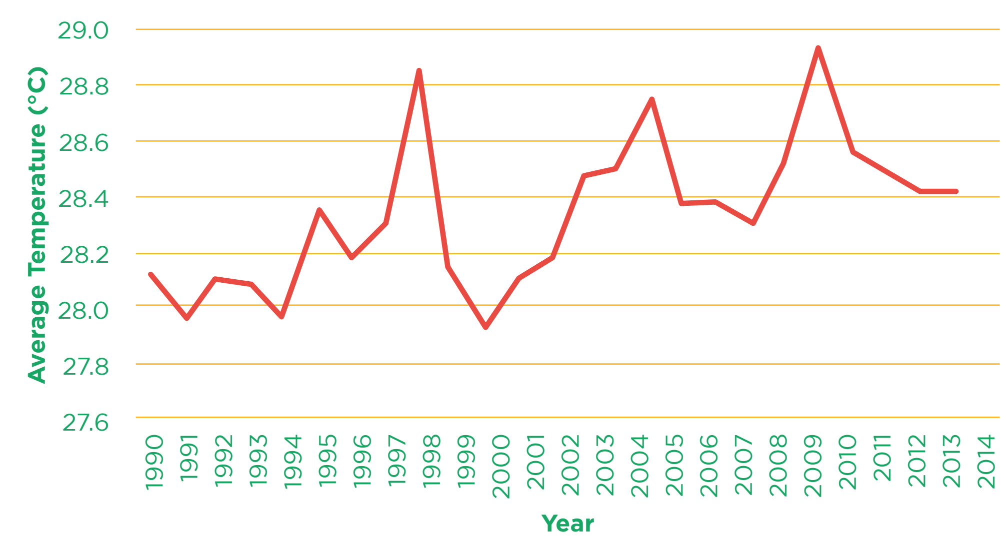
2.2.1 | Gathering of climate data in the Paramaribo area

Historical and projected series were produced. Daily historical data for temperature (in degrees Celsius) for the period 1990 to 2014 were obtained (Figure 13), and daily projected data 2020 to 2094 were compiled.

The historical reference period used is 1990-2014[5]. The models need the historical record and the simulated historical period to overlap to apply the Q-Q adjustments, which is why the period 1990-2014 has been finally used. The results using this reference period are as relevant as the proposed reference.

Figure 13 | Historical annual average temperature

Source: Report team based on project obtained data.



[5] The period 1995-2019 was initially proposed to use the most recent period as a reference. However, the available historical periods in the model cover only up to 2014. The models include 2015-2019 in future projections.

2.2.2 | Calculation of Heating Degree Days and Cooling Degree Days

Many resources in the literature analyze the relationship between climate variables and energy demand based on the calculation of deviations in temperature concerning what would be considered comfort temperatures. It provides better results than simply using average temperatures due to the non-linear relationship between changes in temperature and energy demand.

$HDD_{year} = \Sigma_{days} \max(0,(Ct-At))$	**HDD**: Heating Degree Days **Ct**: Comfort temperature expressed in °C **At**: Average daily temperature expressed in °C
$CDD_{year} = \Sigma_{days} \max(0,(At-Ct))$	**CDD**: Cooling Degree Days **Ct**: Comfort temperature expressed in °C **At**: Average daily temperature expressed in °C

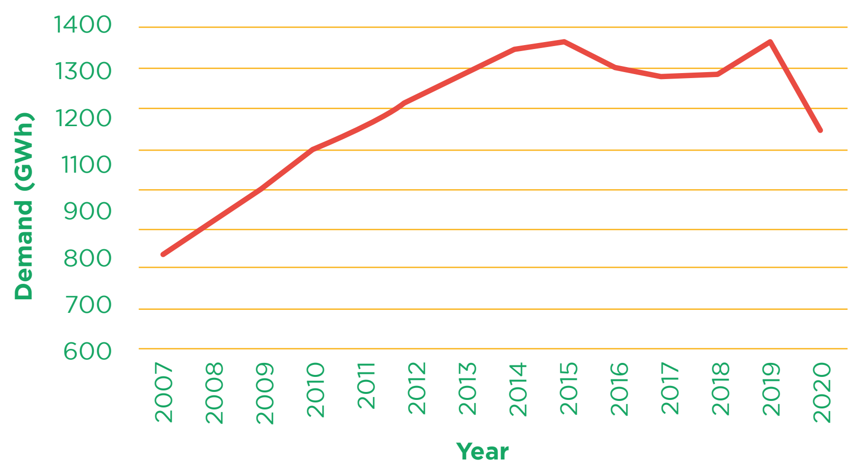
This analysis considers 18 °C and 26 °C for Ct since these are the thresholds commonly used (Kepa Solaun & Cerdá, 2020) for its projections. As HDD in Suriname are zero, for clarity purposes, only CDD will be used and be referenced in this analysis.

2.2.3 | Gathering of historical data on EPAR electricity demand in the Paramaribo area

Energie Bedrijven Suriname (EBS) have provided historical series of electricity demand. Monthly historical data are provided from January 2007 to October 2020 (Figure 14). These data obtained include the energy consumption for all sectors, which is a significant drawback since the correlation between HDD/CDD and electricity demand can differ depending on the sector (Kepa Solaun & Cerdá, 2020).

Figure 14 | Historical annual electricity demand

Source: Report team based on EBS data.



2.2.4 | Correlation and dependency analysis of CDD and electricity demand

According to the available data, a correlation analysis between the sum of CDD and monthly electricity demand was performed for 2007-2014. Figure 15 shows the relationship between CDD per month (x axis) and monthly electricity demand (y axis).

Figure 15 | CDD and electricity demand for the 2007-2014 period (monthly basis)

Source: Report team based on project data and EBS data.

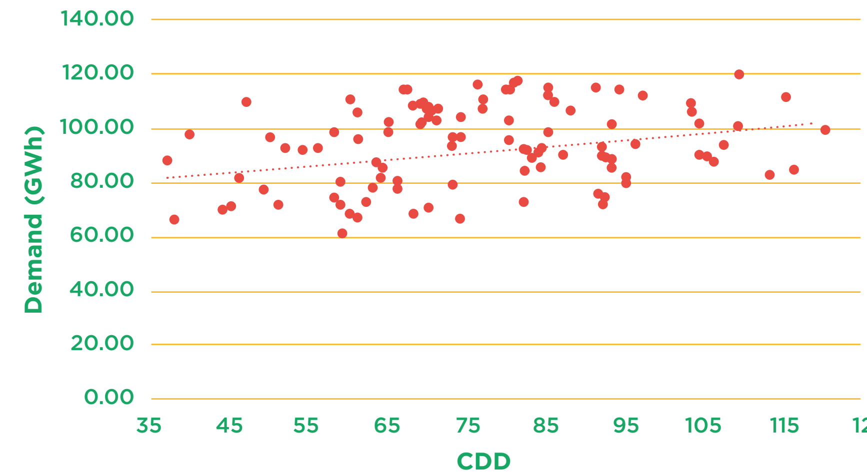


Table 7 | Correlation between CDD and electricity demand 2007-2014 (monthly basis)

Source: Report team.

Correlation between HDD and electricity demand 2007-2014 (monthly basis)
0.311

Results of the analysis show that no significant correlation was found between CDD and electricity demand (Table 7). A longer period or higher-resolution data may give more positive results and a better sectoral disaggregation. Also, other threshold temperatures were considered to calculate CDD, but they did not provide satisfactory results in terms of correlation. The results for other potential thresholds are shown in Table 8.

Some of the main limitations of the analysis are that there are no studies and data to assess the electricity consumption for cooling in buildings, which is the segment of the energy demand that is most affected by the climate. Other factors, such as the economic situation of the country, also highly influence demand for electricity.

Table 8 | Correlation between CDD and electricity demand 2007-2014 based on different thresholds temperatures

Source: Report team.

Temperature thresholds for CDD	Correlation
20 °C	0.338
22 °C	0.331
24 °C	0.323
26 °C	0.311

2.2.5 | Projection of CDD and electricity demand

No significant correlation has been found between temperature and electricity demand. Therefore, it was not possible to quantify future electricity demand projections based on the calculation of deviations in temperature concerning what is considered comfort temperatures.

3. CONCLUSIONS

The literature indicates that climate change may affect hydropower generation and electricity demand. An analysis was carried out in Suriname to assess the extent to which this impact can be quantified. One power plant—the Afobaka Hydroelectric power plant—and one geographic area—the Paramaribo area—were chosen as the subjects of the analysis.

Regarding the Afobaka Hydroelectric power plant, a strong correlation between precipitation and inflow was found, based on historical data. The future decrease in inflow was quantified from variations in precipitation. Short-, medium- and long-term analyses were carried out. The results were annual inflow reductions starting at 5 percent and, by the end of the century, ranging from 10 to 14 percent depending on the scenario. Reductions are higher under a more intense climate scenario and in the long term.

On the other hand, no strong correlation was found between inflow and generation or between precipitation and generation that allows future generation to be projected. The available data on generation were too limited to draw significant conclusions. Also, the fact that the plant has a very significant storage capacity and operates under a multiyear balancing regime can explain the lack of temporal correlation.

No significant correlation was found between temperature and electricity demand in the Paramaribo area. Therefore, it was not possible to quantify future electricity demand projections based on the calculation of deviations from what would be considered comfort temperatures.

However, the methodology used has been mainly applied to North America and Europe and therefore may not be fully applicable to Caribbean weather patterns. Further methodological developments may alter this analysis. Also, the lack of more specific data in Suriname about energy consumption in the buildings and on energy needed for cooling purposes is a significant limitation of this study.

In both cases, it seems likely that the lack of correlation in several analyzed variables might be more related to the lack of sufficiently disaggregated data than to the absence of a causal relationship. Therefore, further research and more robust data monitoring are recommended to improve this analysis over time, as it can be very relevant in energy planning and sectoral decision making.

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