Food and Agriculture Organization
of the United Nations

# Climate Rationale

*For the GCF-FAO Project "Forest Landscape Restoration for Climate Benefits and Resilience (Fiji FLR)"*

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# Climate Variables & Data Sources

## Climate Variables

This report aims to offer a thorough analysis of 18 climatic variables significant for characterizing the climate of Fiji. Table 1 outlines the variables used in this analysis, along with their respective definitions.

***Table 1 – Variable considered, and corresponding acronym and definition***

| VARIABLE | DEFINITION |
|---|---|
| Average Temperature (Tg) | *Average annual temperature.* |
| Minimum Temperature (Tn) | *Minimum annual temperature.* |
| Maximum Temperature (Tx) | *Maximum annual temperature.* |
| Accumulated Precipitation (P) | *Annually accumulated sum of precipitation.* |
| Maximum One-Day Precipitation (Pmax) | *Annual maximum precipitation occurring over one day.* |
| Precipitation Variability (Pvar) | *The annual precipitation variability was modelled as the standard deviation of the daily precipitation over the year.* |
| Accumulated Degree-Days (DD) | *Annually accumulated sum of degrees above 10°C for average temperature. As an example, if average temperature is 13°C during a given day, this day will yield 3°days. If average temperature is 8°C, this day will yield 0°days.* |
| Accumulated Wet Days (WD) | *Annually accumulated sum of days during which daily precipitation is above 1 mm.* |
| Accumulated Extremely Wet Days (WDext) | *Annually accumulated sum of days during which daily precipitation is above 35 mm.* |
| Maximum Wind Speed (WSmax) | *Annual maximum wind speed.* |
| Average Wind Speed (WS) | *Annual average wind speed.* |
| Reference Evapotranspiration ($ET_0$) | *Annually accumulated monthly reference evapotranspiration of a grass crop based on the original Hargreaves equation (Hargreaves 1994). However, a modified form due to Droogers and Allen was used (Droogers and Allen 2002) ; this equation corrects monthly reference evapotranspiration using the amount of rain of each month as a proxy for insolation, and the latitude and the month of the year as a proxy for the mean external radiation. This variable was calculated using the SPEI Package for R-stat (R Core Team 2023; Beguería and Vicente-Serrano 2023).* |
| Climatic Water Balance (CWB) | *Accumulated precipitation minus reference evapotranspiration. This variable can be understood as the accumulated excess/deficit of precipitation over a given year.* |
| Recorded Flood Events (FE) | *Annually accumulated flood events as recorded by Risk Frontiers (Mcgree, Yeo, and Devi 2010).* |
| Recorded Cyclonic Events (CE) | *Annually accumulated flood events as recorded by Fiji Meteorological Service.* |
| Sea Level (SL) | *Average sea level in above Tide Gauge Zero.* |
| Accumulated Dry Months (DM) | *Annually accumulated months during which the 3-months Standardized Precipitation-Evapotranspiration index (SPEI) is above 1. SPEI is a multiscalar drought index based on climatic data. It combines precipitation and evapotranspiration data to quantify drought and water surpluses severity and duration. It represents the difference between the observed precipitation and reference evapotranspiration, both standardized by their respective means and standard deviations over a given period. For the calculation of this metric, we used 3-months SPEI which represents meteorological droughts. The 3-months SPEI was calculated using the SPEI Package for R-stat R Core Team 2023; Beguería and Vicente-Serrano 2023).* |
| Accumulated Wet Months (WM) | *Annually accumulated months during which the 3-months Standardized Precipitation-Evapotranspiration index (SPEI) is below -1. See Accumulated Dry Months (DM) for more details on SPEI.* |

The variables used in this analysis were extracted or calculated based on the sources presented in Table 2.

***Table 2 – Data sources***

| DATA SOURCE | TYPE | USED TO CALCULATE… | DEFINITION |
|---|---|---|---|
| **Ministry of Forestry of the Republic of Fiji** | *Historical* | *All historical variables except Recorded flood events, recorded cyclonic events and Sea Level.* | *This report relies mainly on historical climatic data sourced from the Ministry of Forestry of the Republic of Fiji. The data was provided in a disaggregated format, station by station. The report integrates information from 21 distinct stations, namely Ba, Labasa, Lakeba, Lautoka, Matei, Matuku, Monasavu, Nabouwalu, Nadi, Nausori, Ono-I-Lau, Rakiraki, Rotuma, Savusavu, Sigatoka, Suva, Udu, Viwa, Vunisea, Yasawa, and Vanuabalavu. The locations of most stations are visually represented in Figure 5.* |
| **Risk Frontiers** | *Historical* | *Historical recorded flood events* | *The data was extracted from the report* "Flooding in the Fiji Islands between 1840 and 2009" *(Mcgree, Yeo, and Devi 2010), by Risk Frontiers.* |
| **Fiji Meteorological Service** | *Historical* | *Historical recorded cyclonic events* | *The data was extracted from the report "List of Tropical Cyclones Affecting Fiji Between 1969-70 to 2021-22 Seasons" by the Fiji Meteorological Service ('List of Tropical Cyclones Affecting Fiji Between 1969-70 to 2021-22 Seasons' 2022).* |
| **Commonwealth of Australia – Bureau of Meteorology** | *Historical* | *Historical Sea Level* | *The data was extracted from the web site of the* Commonwealth of Australia – Bureau of Meteorology: *http://www.bom.gov.au/oceanography/projects/abslmp/data/index.shtml* (Commonwealth of Australia – Bureau of Meteorology 2023) |
| **NASA NEX-GDDP** | *Projected* | *All projected variable* | *The evaluation of future climatic conditions in the Republic of Fiji relied on the NASA (National Aeronautics and Space Administration) Earth Exchange - Global Daily Downscaled Climate Projections (NEX – GDDP) dataset. This dataset encompasses 28 downscaled climate models, derived from the General Circulation Model runs executed within the framework of the Coupled Model Intercomparison Project Phase 6 (CMIP6 (Thrasher et al. 2012). Both RCP 4.5 and RCP 8.5 scenarios were analyzed for each model. The geographic data was aggregated spatially over the emerged lands of the country and temporally by year and month.* |

## Analytical Framework

The analytical framework used in this report will be presented in this section.

**Note:** Mount **Monasavu, situated in the highlands of Viti Levu, presents a distinctive microclimate due to its elevated altitude**. Consequently, in this report, the data from the Monasavu weather station will be presented separately from the remaining dataset in times series, to avoid presenting a skewed idea of the climate range in Fiji.

### Current Climate

To characterize the current climate of Fiji, only average temperature and the accumulated precipitation will be used. To illustrate this framework, we will use the accumulated precipitation.

## 1. Climate classification

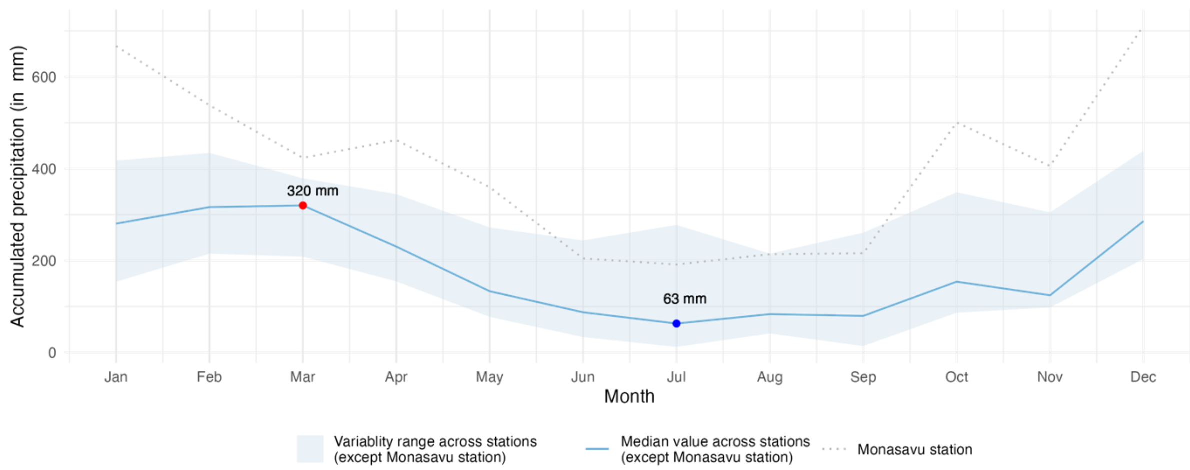
The current climate classification of Fiji was calculated using the average maximum, minimum, and average temperature, and annually accumulated precipitation. These data were calculated based on the median value of the annual averages of each of the 21 stations over the last 10 years (2012-2022).

## 2. Current seasonal variation

To analyze the current seasonal variation of monthly average temperature and monthly accumulated precipitation, we aggregated the daily data of all the stations provided over the last 10 years (2012-2022). We then calculated the median value of each variable over all the station provided, except Monasavu station (see note above), and presented the data in a chart (see Figure 1). In this graph the colored full line represents the median value across stations (except Monasavu Station), the lightly colored area represents the variability range across stations (minimum to maximum, excepting Monasavu Station), the red dot the maximum median value observed, and the blue dot the minimum median value observed. Finally, the dotted line represents the value of the variable for Monasavu Station (for comparison).

***Figure 1 - Accumulated precipitation: current monthly variation***

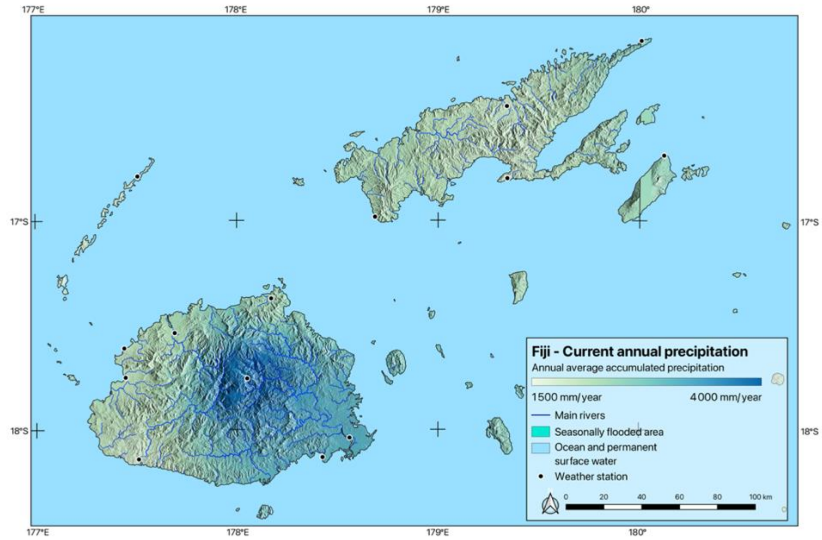
*Data averaged over the 2012-2022 period. <u>Data Source:</u> Ministry of Forestry of the Republic of Fiji*



**3. Current geographic variation**

to present the current geographic variation of the annual average temperature and annually accumulated precipitation, we presented a map of each variable aggregated annually and averaged over the last 10 years (2012-2022). This map was built using inverse distance interpolation between each station.

***Figure 3 - Accumulated precipitation: current geographic variation***
*Data averaged over the 2012-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




## Climatic trends

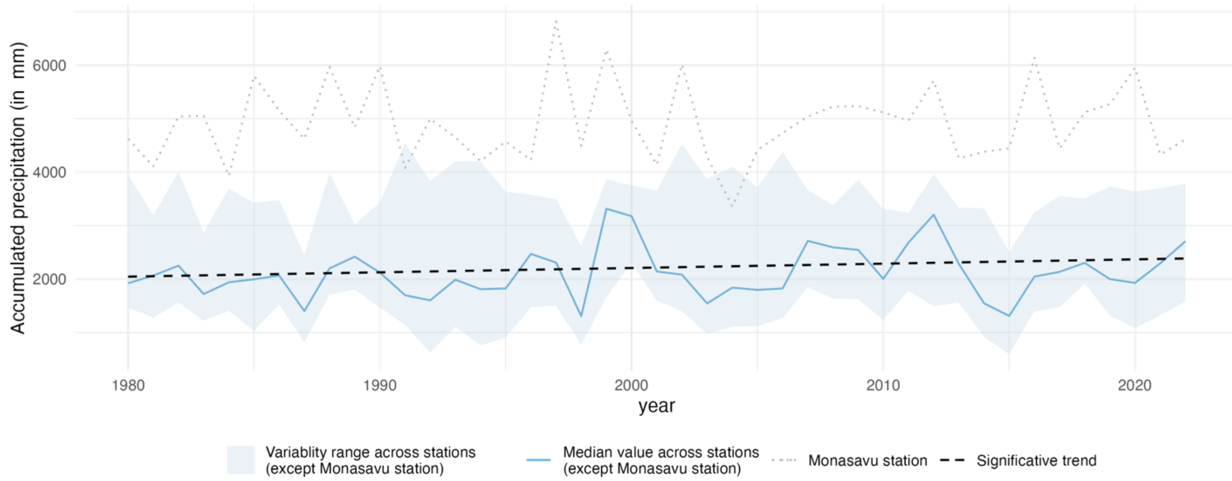
The climatic trends of all the variables mentioned in Table 1 were studied following the same analytical framework. to illustrate the framework, we will use the accumulated precipitation.

**1. Historical climatic trend**

Trends Statistical Significance: In this report, the trends were calculated by computing the linear regression trends of the times series and calculating the p-value of the F-Statistics corresponding to the regression. If the p-value was lower than an alpha of 0.05, the regression was considered statistically significant, and therefore reported. Otherwise, the trends were not considered significant, and no variation of the variable was reported.

The historical time series of the variable was presented in a chart (see Figure 10). In this graph the colored full line represents the median value across stations (except Monasavu Station) and the lightly colored area represents the variability range across stations (minimum to maximum, excepting Monasavu Station). If a statistically significant trend was observed for the median value during the period, the linear trend line was represented as a dashed black line. Finally, the dotted line represents the value of the variable for Monasavu Station (for comparison).

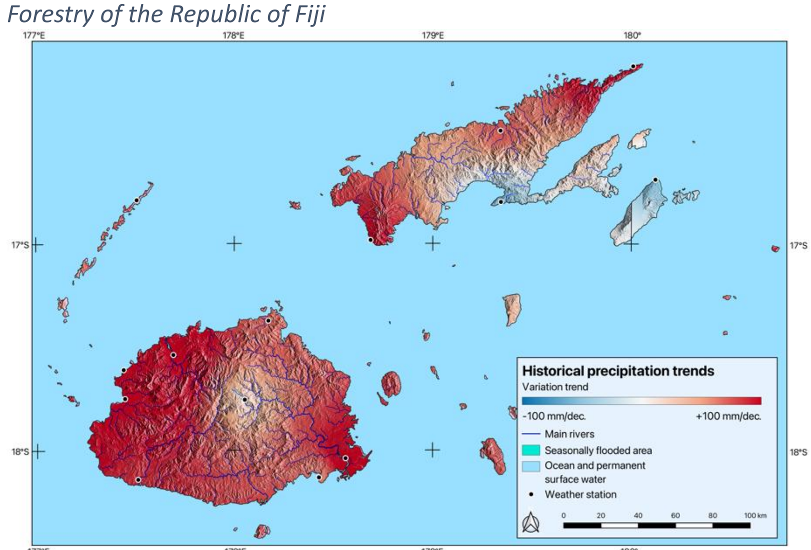
*Figure 2 – Annually accumulated precipitation: historical time series*
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




**2. Geographic variation of the historical trend**

If a statistically significant trend was observed for the median value during the period, we presented the geographic variation of this trend in a map for each variable. This map was built using inverse distance interpolation of the value of the variation trend for each station, at each station location.

***Figure 3 – Annually accumulated precipitation: historical geographic trends***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




### 3. Projected Models' Bias Correction

Each projected model for each variable was bias corrected using the median value of the local data provided by the Ministry of Forestry of the Republic of Fiji, by a non-parametric quantile mapping using empirical quantiles. This calculation was done using the qmap package for R statistics (R Core Team 2023; Gudmundsson et al. 2012)

### 4. Projected Models' Validation

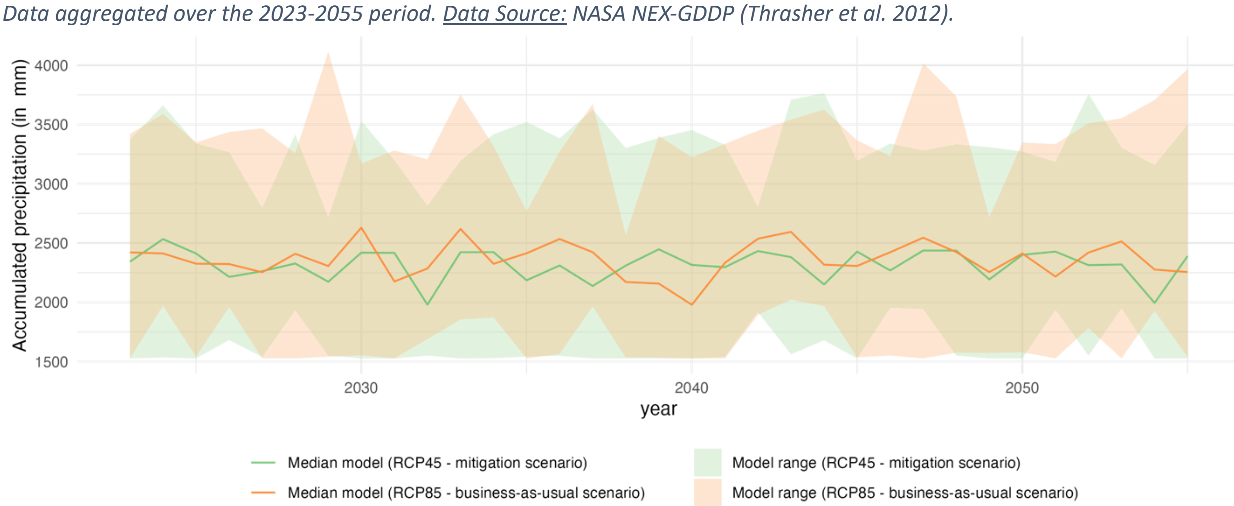
To validate the NEX-GDDP models, we used the 1980-2015 overlap period between the NEX-GDDP retrospective model run, and local data provided by the Ministry of Forestry of the Republic of Fiji. The data was compared model by model using the Mean Absolute Error (MAE) between observed and modelled data, standardized using the observed data range (RMAE). Only models presenting a RMAE lower than 0.25 were validated and used in this report.

### 5. Projected climatic time series

The annual time series of all the validated models under both scenarios (RCP4.5 and RCP8.5) is presented in a single chart. In these charts, the green line is the median value (over each validated model) of annual value of the variable under the mitigation scenario (RCP4.5) and the orange line is the median value (over each validated model) of annual value of the variable under the business-a-usual scenario (RCP8.5). The green shade is the range between the minimum and maximum value (over each validated model) of the annual value of the variable under the mitigation scenario (RCP4.5) and the orange shade is the range between the minimum and maximum value (over each validated model) of the annual value of the variable under the business-as-usual scenario (RCP8.5).

***Figure 4 – Annually accumulated precipitation: projected time series***

*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*




### 6. Projected climatic trends

Median our mean value of variable over a projected model ensemble can be misleading as models with asynchronous annual variation can cancel each other out and produce an artificial flat trend. Therefore, the trend analysis of the projected models was calculated model by model and scenario by scenario, to produce 28 trends under each scenario. A meta-analysis of these trends is presented in a table (see Table 7). In this table, the number of validated models is presented, along with the number of models presenting a statistically significant decreasing and increasing trends are presented. If there are statistically significant trends, the value of the average, highest, and lowest variation trend is also presented.

***Table 3 - Annually accumulated precipitation: projected time series metadata***

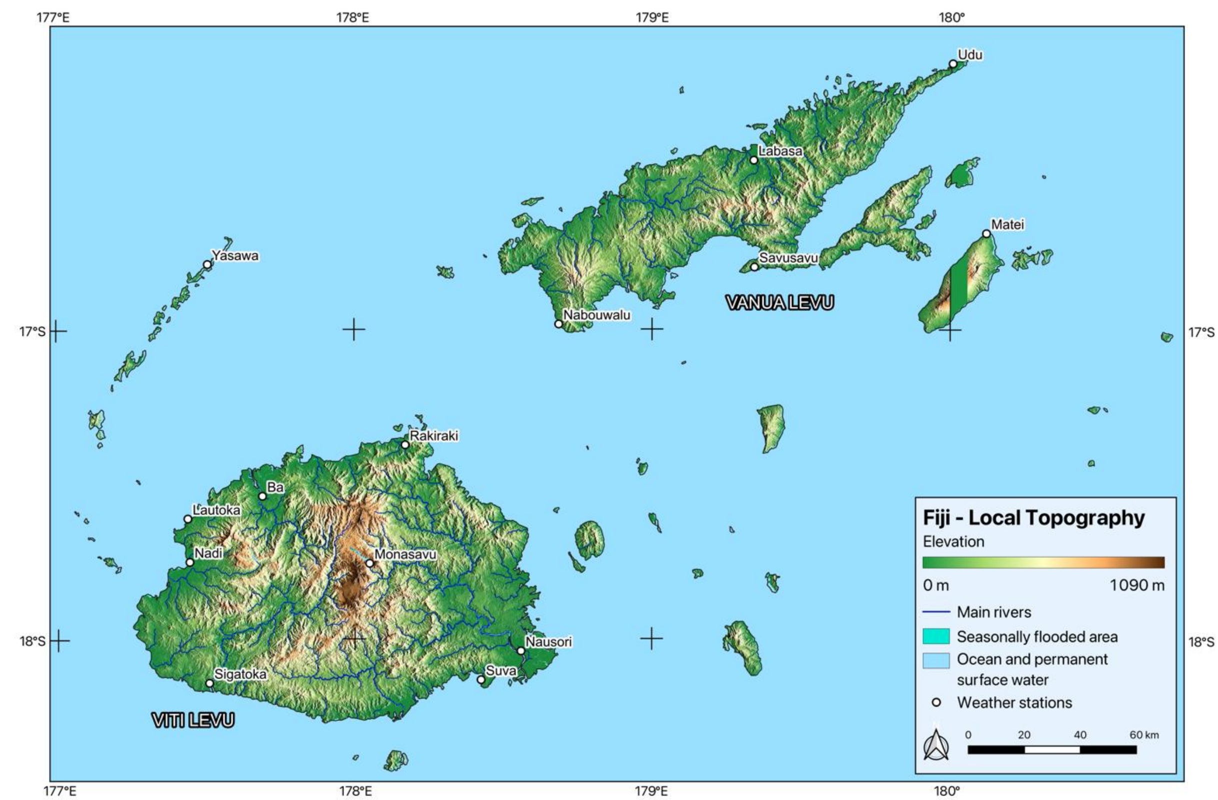
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 - RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **17** | |
| *Number of significative trends* | 2 | 2 |
| ***Number of significative increasing trends*** | **2** | **2** |
| *Average increasing trend* | +227 mm/dec. | +264 mm/dec. |
| *Highest increasing trend* | +246 mm/dec. | +274 mm/dec. |
| *Lowest increasing trend* | +209 mm/dec. | +255 mm/dec. |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Geographic & Current Climatic Context

Fiji is a small island nation in the South Pacific Ocean with an area of 18 000 km$^2$ spread over 332 islands, which form a broad range of ecosystems from reefs, mangroves, and coastal wetlands to a gradually elevating topography from fertile lowlands to grasslands, rocky hills, and volcanic mountains topped with unique rainforests. About 110 islands are inhabited but most of the population (87 percent of total population) lives on two large islands, **Viti Levu** and **Vanua Levu**, which comprise 80 percent of Fiji's landmass.

***Figure 5 – Topography of Fiji***
*Data Source: NASA / USGS / JPL-Caltech (Farr et al. 2007), JRC Yearly Water Classification History (Pekel et al. 2016), WWF HydroSHEDS Free Flowing Rivers Network v1 (Lehner, Verdin, and Jarvis 2008; Grill et al. 2019)*




The current climate in Fiji is classified as a tropical monsoon climate (Am) according to the Köppen-Geiger classification (Beck et al. 2018). This climatic profile is characterized by a monthly average temperature exceeding 18 °C throughout the entire year, along with a distinct dry season. It can be viewed as an intermediary between the more humid tropical rainforest climate and the drier tropical savanna climate.

***Table 4 – Current climate variables***

| Variable | Aggregation period | Annual average | Minimum | Maximum | Details on page… |
|---|---|---|---|---|---|
| ***Accumulated Precipitation*** | 2012-2022 | ± 2150 mm/year | 63 mm in July | 320 mm in March | 11 |
| ***Average Temperature*** | 2012-2022 | ± 27°C | 25.3°C | 29°C | 17 |

## Precipitation

Fiji's dry season, characterized by monthly precipitation levels below 200 mm, extends from May to November, while the rainy season (Monsoon) spans from December to April. February stands out as the wettest month, receiving an average of 320 mm of precipitation, while July is the driest month, with an average of 63 mm of rainfall. The annual average accumulated precipitation is around 2150 mm.

Spatially, the annually accumulated precipitation ranges from 1500 mm per year on Vanua Levu and the west coast of Viti Levu to more than 4000 mm per year on the highlands of Mount Monasavu on Viti Levu.

***Figure 6 - Accumulated precipitation: current monthly variation***
*Data averaged over the 2012-2022 period. <u>Data Source:</u> Ministry of Forestry of the Republic of Fiji*

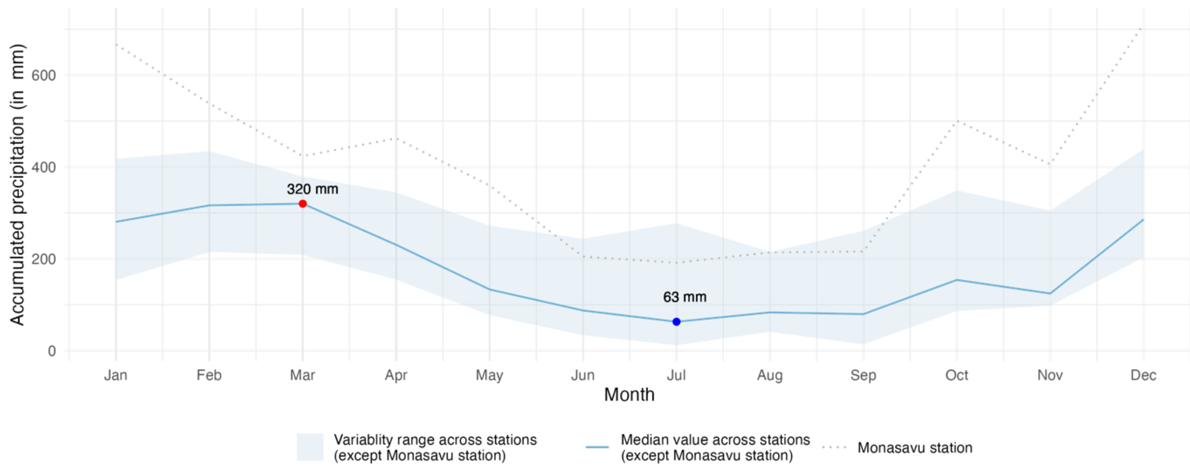
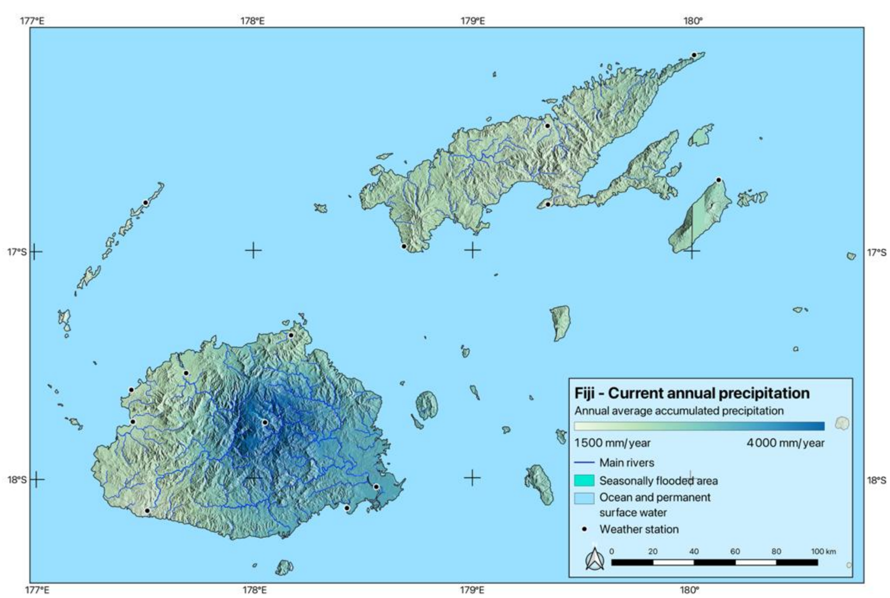



***Figure 7 - Accumulated precipitation: current geographic variation***
*Data averaged over the 2012-2022 period. <u>Data Source:</u> Ministry of Forestry of the Republic of Fiji*



## Temperature

The average temperatures in Fiji's follow roughly the same annual pattern than precipitation, showing only minor fluctuations. The average temperature decreases during the dry season, with a minimum around 25.3°C in July, and a maximum around 29.0°C in January, during the wet season.

Spatially, the annual average temperatures range from 25°C on the highlands of Mount Monasavu and southeast coast of Viti Levu to 27 on Vanua Levu and the northwest coast of Viti Levu.

***Figure 8 – Average temperature: current monthly variation***

*Data averaged over the 2012-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*

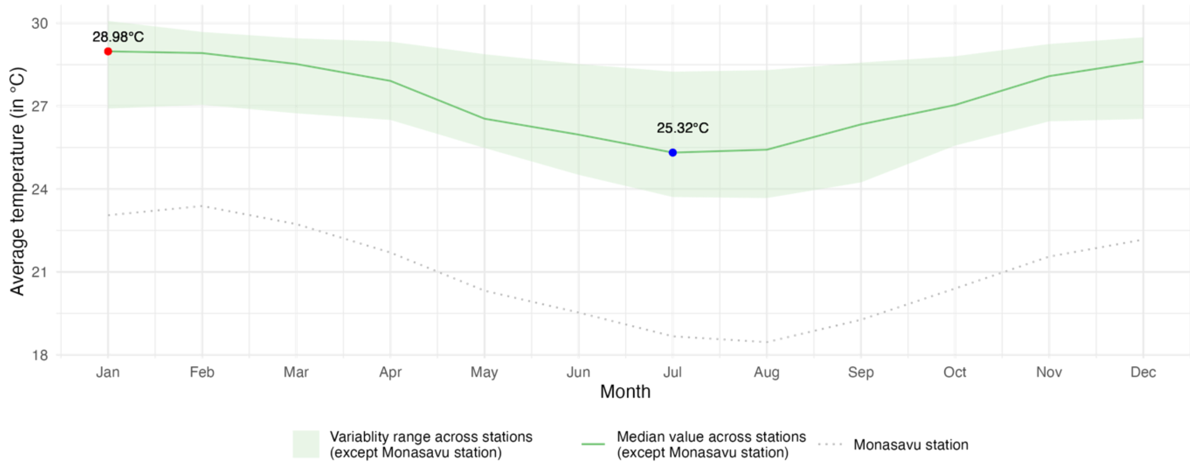
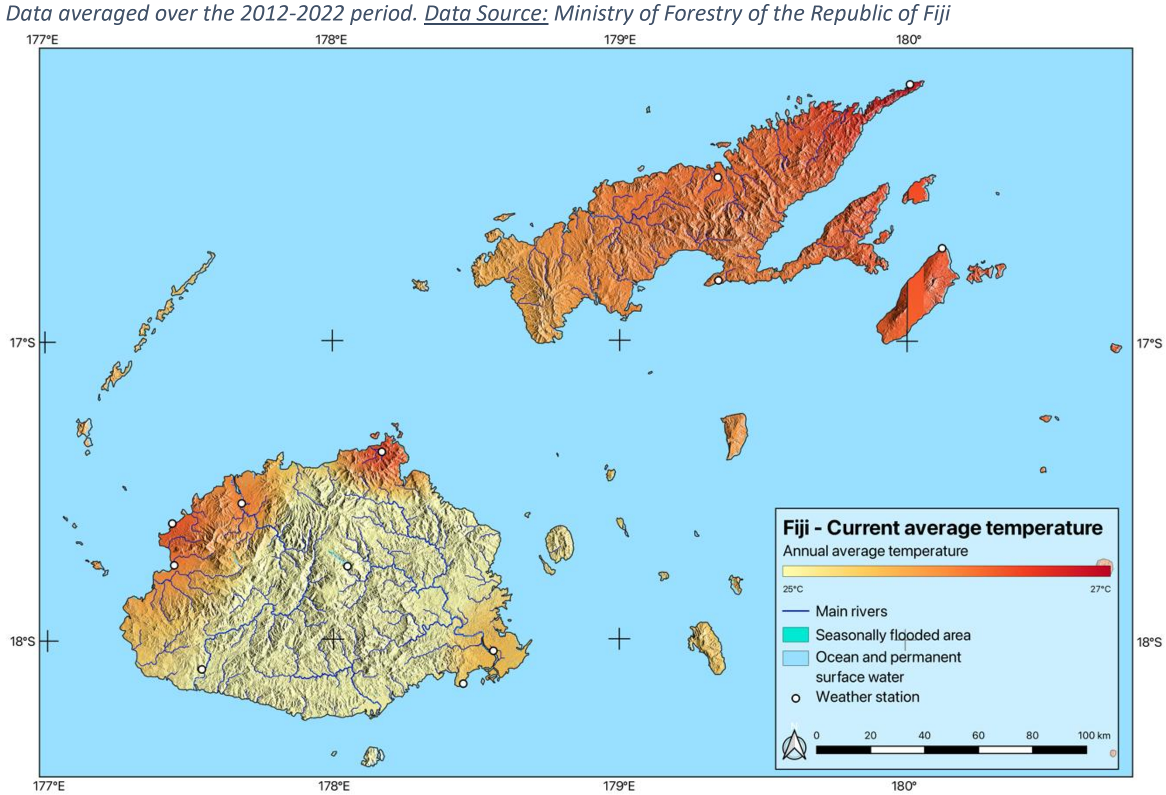



***Figure 9 - Average temperature: current geographic variation***

*Data averaged over the 2012-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*



# Climatic trends

*Table 5 - Trends in key precipitation, winds, and sea variables in Fiji*

| Variable | Aggregation period | Trend | Variation rate | Details on page… |
|---|---|---|---|---|
| ***Accumulated precipitation*** | *Historical (1980-2022)* | + | +81 mm/year per decade | 15 |
| | *Projected (2023-2055)* | + | +227 mm/year per decade under RCP4.5 (2 models)<br>+264 mm/year per decade under RCP8.5 (2 models) | |
| ***Maximum one day precipitation*** | *Historical (1980-2022)* | = | No statistically significant trend. | 17 |
| | *Projected (2023-2055)* | + | +14.42 mm per decade under RCP4.5 (1 models)<br>+12.87 mm per decade under RCP8.5 (1 models) | |
| ***Precipitation variability*** | *Historical (1980-2022)* | + | +0.35 mm per decade | 19 |
| | *Projected (2023-2055)* | = | Conflicting trends:<br>-1.13 mm per decade under RCP4.5 (1 models)<br>+1.28 mm per decade under RCP8.5 (2 models) | |
| ***Wet days*** | *Historical (1980-2022)* | + | +3.20 days/year per decade | 21 |
| | *Projected (2023-2055)* | + | +7.97 days/year per decade under RCP4.5 (1 models)<br>No statistically significant trend under RCP8.5. | |
| ***Extremely wet days*** *(P ≥ 35 mm/day)* | *Historical (1980-2022)* | + | +0.65 days/year per decade | 23 |
| | *Projected (2023-2055)* | + | Conflicting trends under RCP4.5. (1 model vs. 1 model)<br>+1.84 days/year per decade under RCP8.5 (1 models) | |
| ***Average wind speed*** | *Historical (1980-2022)* | = | No statistically significant trend. | 25 |
| | *Projected (2023-2055)* | = | No statistically significant trend. | |
| ***Maximum wind speed*** | *Historical (1980-2022)* | = | No statistically significant trend. | 26 |
| | *Projected (2023-2055)* | - | No projected model could be validated for maximum wind speed. | |
| ***Recorded flood events*** | *Historical (1980-2009)* | + | +2.01 recorded floods/year per decade | 27 |
| ***Recorded Cyclonic events*** | *Historical (1990-202)* | + | +0.30 recorded hurricanes/year per decade | 27 |
| ***Sea level*** | *Historical (1998-2022)* | + | +5 cm per decade in Lautoka<br>+10 cm per decade in Suva | 28 |

*Table 6 - Trends in key temperature variables in Fiji*

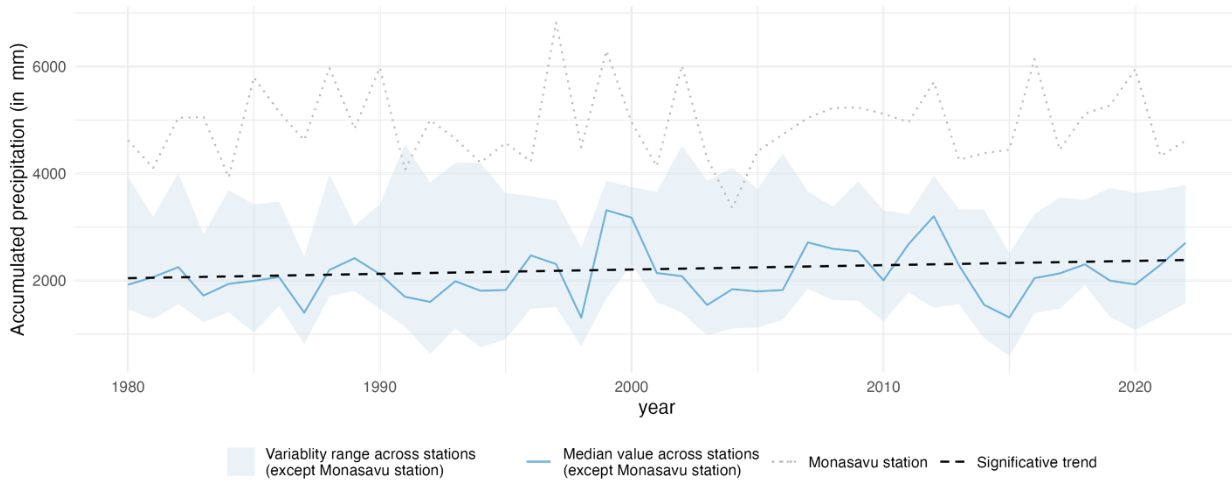
| Variable | Aggregation period | Trend | Variation rate | Details on page… |
|---|---|---|---|---|
| ***Average Temperature*** | *Historical (1980-2022)* | + | +0.27°C per decade. | 29 |
| | *Projected (2023-2055)* | + | +0.23°C per decade under RCP4.5 (23 models).<br>+0.34°C per decade under RCP8.5 (23 models). | |
| ***Minimum Temperature*** | *Historical (1980-2022)* | + | +0.29°C per decade. | 31 |
| | *Projected (2023-2055)* | + | No statistically significant trend under RCP4.5.<br>+0.40°C per decade under RCP8.5 (1 model). | |
| ***Maximum Temperature*** | *Historical (1980-2022)* | + | +0.33°C per decade. | 33 |
| | *Projected (2023-2055)* | + | +0.30°C per decade under RCP4.5 (11 models).<br>+0.42°C per decade under RCP8.5 (13 models). | |
| ***Degree Days*** | *Historical (1980-2022)* | = | No statistically significant trend. | 35 |
| | *Projected (2023-2055)* | + | +86°days per decade under RCP4.5 (11 models).<br>+128°days per decade under RCP8.5 (11 models). | |
| ***Reference Evapotranspiration*** | *Historical (1980-2022)* | − | -26 mm/year per decade. | 37 |
| | *Projected (2023-2055)* | + | No statistically significant trend under RCP4.5.<br>+0.31 mm/year per decade under RCP8.5 (1 model). | |
| ***Climatic Water Balance*** | *Historical (1980-2022)* | + | +102 mm/year per decade. | 39 |
| | *Projected (2023-2055)* | + | +245 mm/year per decade under RCP4.5 (1 model).<br>+315mm/year per decade under RCP8.5 (1 model). | |
| ***Number of Dry Months*** | *Historical (1980-2022)* | + | +0.15 months/year per decade. | 41 |
| | *Projected (2023-2055)* | + | +0.54 months/year per decade under RCP4.5 (1 model).<br>+ 0.71 months/year per decade under RCP8.5 (3 model). | |
| ***Number of Wet Months*** | *Historical (1980-2022)* | − | -0.17 months/year per decade. | 43 |
| | *Projected (2023-2055)* | = | No statistically significant trend. | |

## Accumulated Precipitation

The historical analysis of annually accumulated precipitation in Fiji shows a statistically significant increase in precipitation since 1980, to a rate of +81 mm/year per decade. Moreover, during the same period, Fiji experiences a large variability in precipitation levels from one year to the next, ranging from 1307 mm (in 1998) and 3315 mm (in 1999) over the 1980-2022 period. This variability can be linked to the influence of the El Niño effect contributing to lower precipitation values, and the La Niña effect associated with higher precipitation values.

***Figure 10 – Annually accumulated precipitation: historical time series***

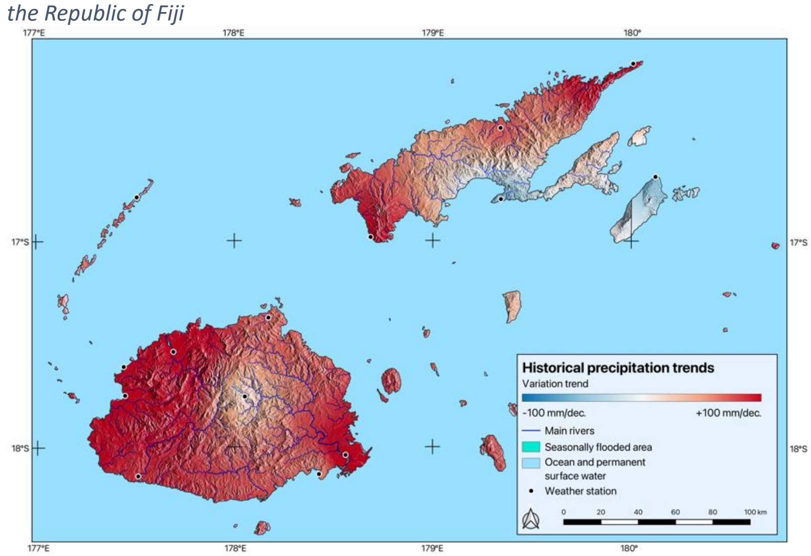
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




Spatially, the rise in precipitation is primarily observed along the coastal lowlands of Viti Levu and the northeastern coast of Vanua Levu. On Viti Levu highlands, specifically on the summit of Monasavu, the accumulated precipitation remained consistent and high since 1980. On the south coast of Vanua Levu, particularly around Savusavu Bay, and on Taveuni Island a slight decrease in precipitation rates has been observed over the last four decades, deviating from the overall trend observed in other areas.

***Figure 11 – Annually accumulated precipitation: historical geographic trends***

*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




While most models within the NEXX-GDDP ensemble passed the validation tests, a substantial proportion failed to manifest any variations, be it an increase or decrease. Upon closer examination, during the next three decades, under the mitigation scenario (RCP4.5), only 2 models showed statistically significant trends, both toward an increase, to an average rate of +227 mm per decade. The situation under the business-as-usual scenario (RCP8.5) is similar, with 2 models showing statistically significant increasing trends, to an average rate of +264 mm per decade.

***Figure 12 – Annually accumulated precipitation: projected time series***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

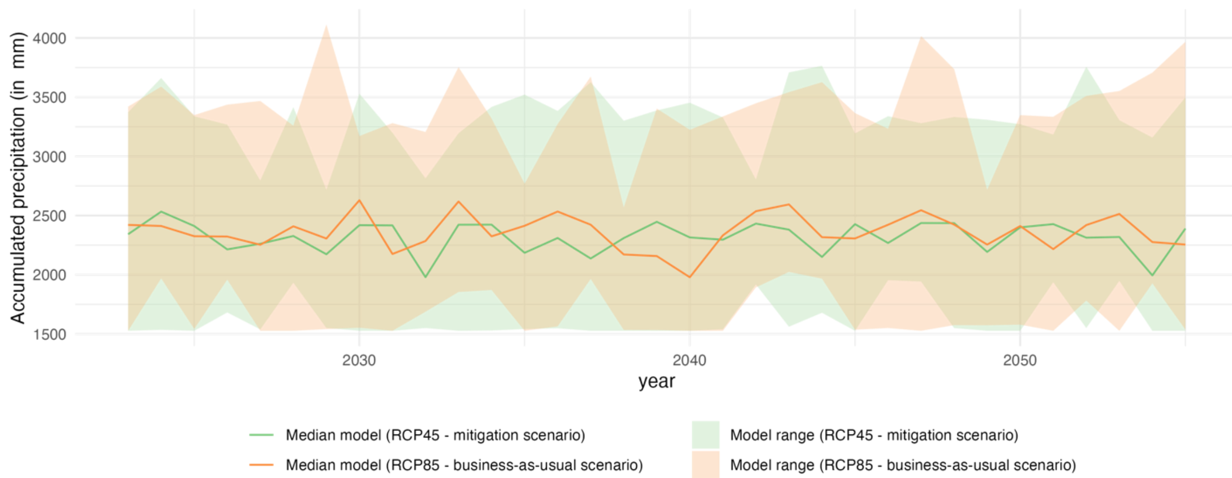


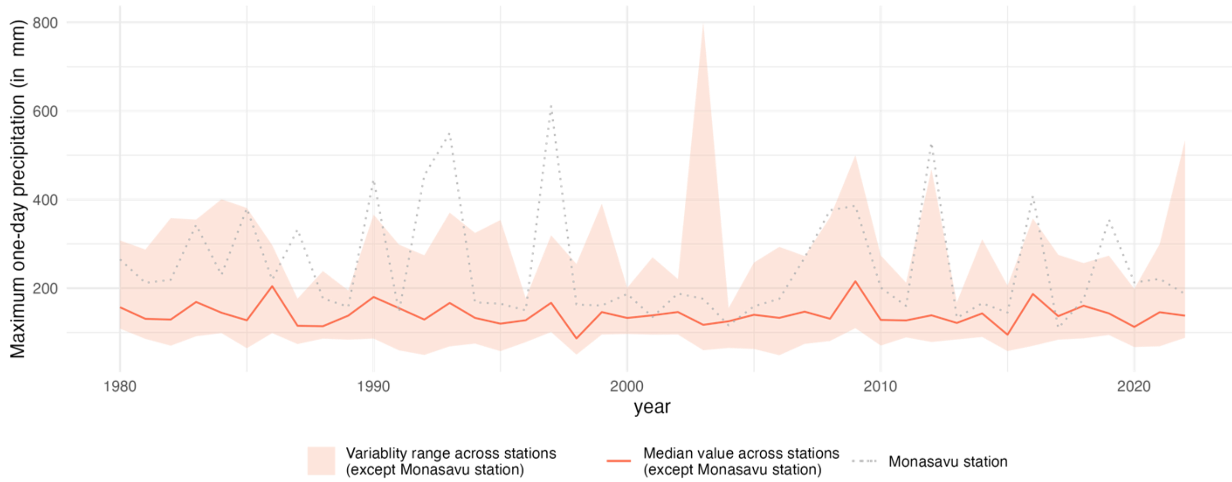

***Table 7 - Annually accumulated precipitation: projected time series metadata***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 - RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **17** | |
| *Number of significative trends* | 2 | 2 |
| ***Number of significative increasing trends*** | **2** | **2** |
| *Average increasing trend* | +227 mm/dec. | +264 mm/dec. |
| *Highest increasing trend* | +246 mm/dec. | +274 mm/dec. |
| *Lowest increasing trend* | +209 mm/dec. | +255 mm/dec. |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Maximum one-day precipitation

The historical analysis of the annual maximum one-day precipitation didn't show any significant trend, staying stable around 155 mm. Nevertheless, this value has often surge to significantly higher levels, frequently exceeding 300 mm of precipitation in a single day, depending on the specific year and station.

***Figure 13 – Annual maximum one-day precipitation: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




Although historical data didn't expect any statistically significant trends in maximum one-day precipitation, one model expected an increase under the mitigation scenario (RCP4.5), to a rate of +17.42 mm per decade. Under the business-as-usual scenario (RCP8.5), the same situation was observed, with one model expecting an increase in maximum one-day precipitation, to a rate of +12.87 mm/decade.

***Figure 14 – Annual maximum one-day precipitation: projected time series***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

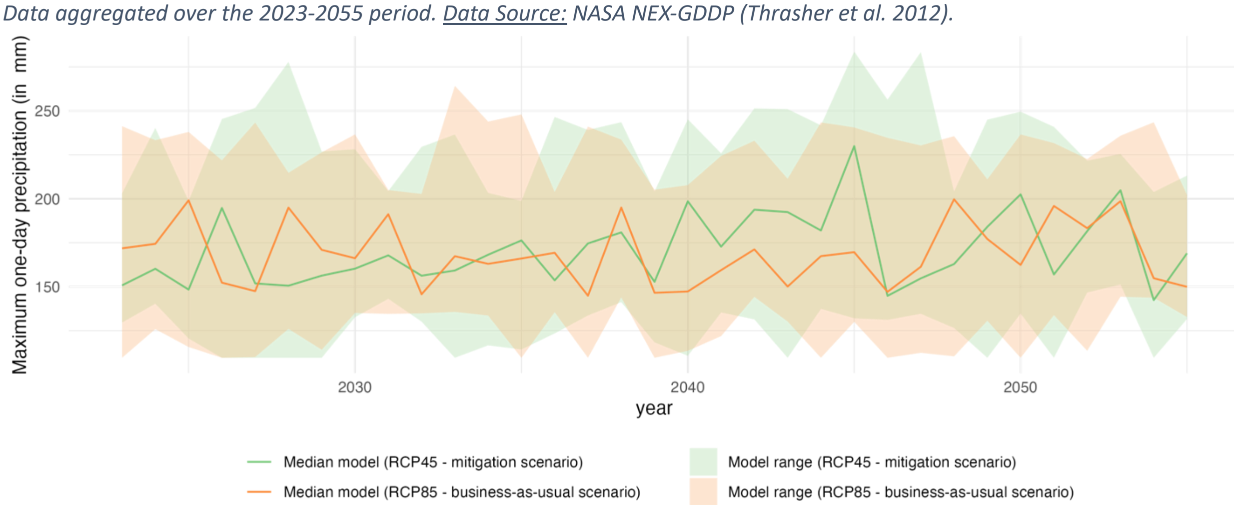


***Table 8 - Annual maximum one-day precipitation: projected time series metadata***

*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 - RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **11** | |
| *Number of significative trends* | 1 | 1 |
| ***Number of significative increasing trends*** | **1** | **1** |
| *Average increasing trend* | +17.42 mm/dec. | +12.87 mm/dec. |
| *Highest increasing trend* | +17.42 mm/dec. | +12.87 mm/dec. |
| *Lowest increasing trend* | +17.42 mm/dec. | +12.87 mm/dec. |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Precipitation Variability

The precipitation variability was assessed using the annual standard deviation of the one-day accumulated precipitation. This variable increased during the last 4 decades to a statistically significant rate of +0.35 mm per decade.

***Figure 15 – Annual standard deviation of the one-day accumulated precipitation: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*

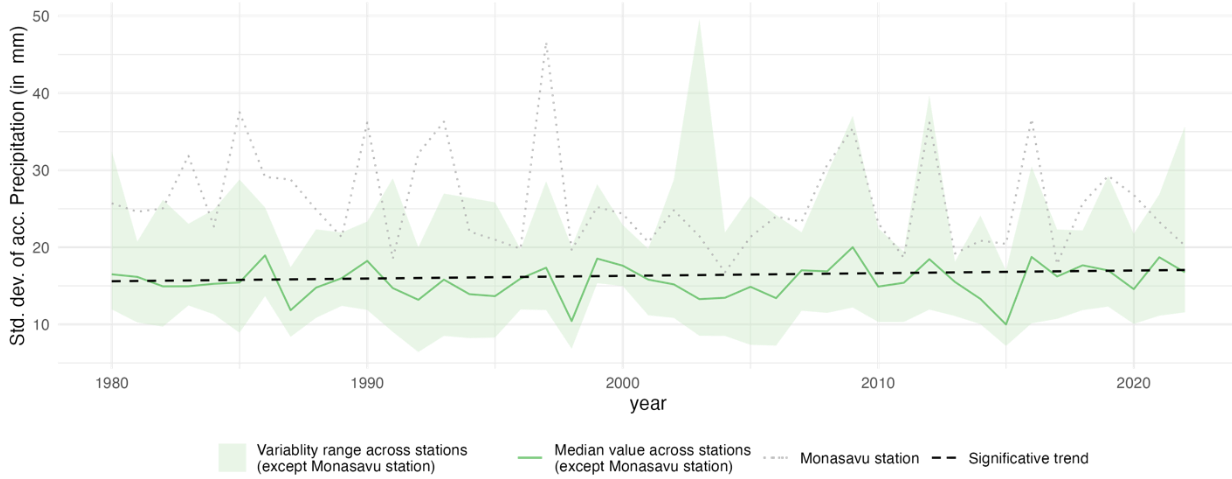
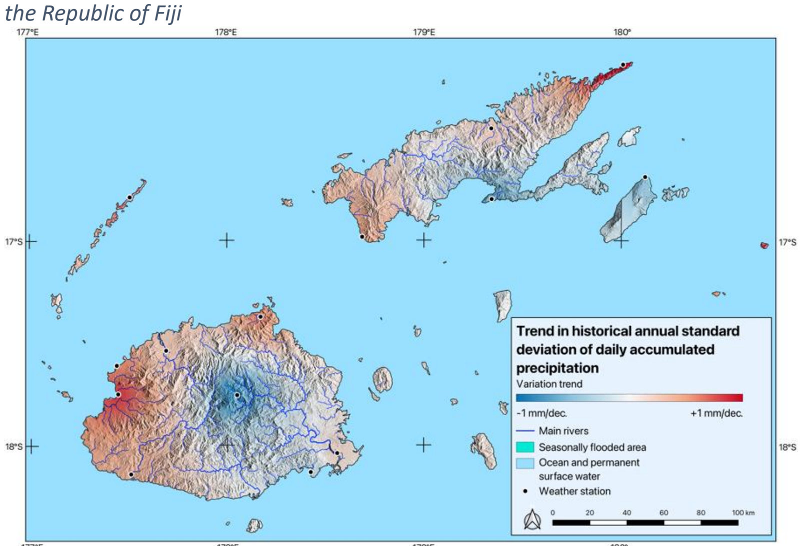



***Figure 16 Annual standard deviation of the one-day accumulated precipitation: historical geographic trends***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




Spatially, the rise in precipitation variability was primarily observed along the coastal lowlands of Viti Levu and the northeastern coast and western coast of Vanua Levu. On Viti Levu highlands, the precipitation variability seems to decrease since 1980. On the south coast of Vanua Levu, particularly around Savusavu Bay, and on Taveuni Island a slight decrease in precipitation variability rates has also been observed over the last four decades, deviating from the overall trend observed in other areas.

While most models within the NEXX-GDDP ensemble passed the validation tests, a substantial proportion failed to manifest any variations, be it an increase or decrease. Upon closer examination, during the next three decades, under the mitigation scenario (RCP4.5), only 1 model showed statistically significant trends, toward a decrease, to a rate of +1.13 mm per decade. The situation under the business-as-usual scenario (RCP8.5) is pushing the site trend in the opposite direction, with 2 models showing statistically significant increasing trends, to an average rate of +1.28 mm per decade.

***Figure 17 – Annual standard deviation of the one-day accumulated precipitation: projected time series***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

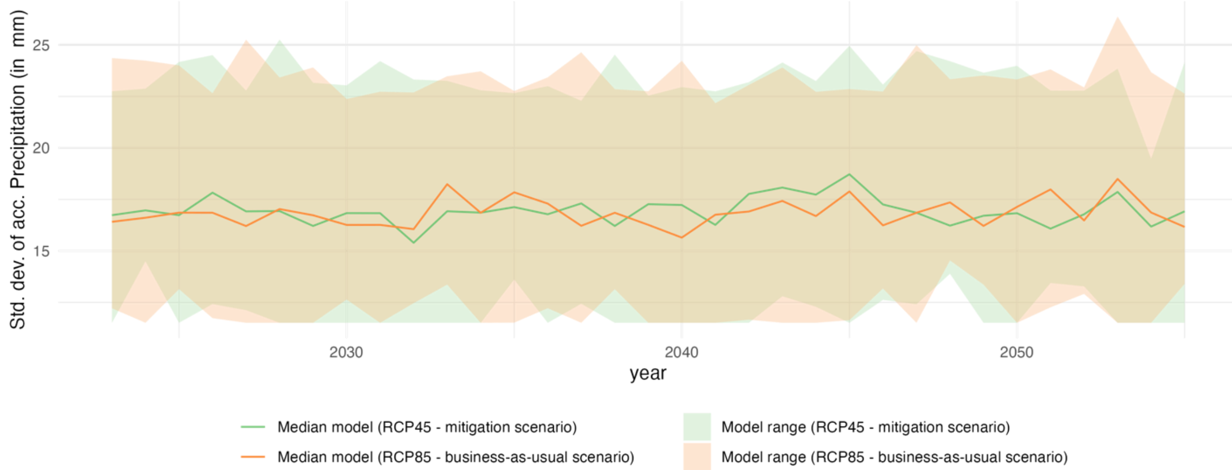



***Table 9 - Annual standard deviation of the one-day accumulated precipitation: projected time series metadata***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 - RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **25** | |
| *Number of significative trends* | 1 | 2 |
| ***Number of significative increasing trends*** | **0** | **2** |
| *Average increasing trend* | - | +1.28 mm/dec. |
| *Highest increasing trend* | - | +1.42 mm/dec. |
| *Lowest increasing trend* | - | +1.14 mm/dec. |
| ***Number of significative decreasing trends*** | **1** | **0** |
| *Average decreasing trend* | +1.13 mm/dec. | - |
| *Highest decreasing trend* | +1.13 mm/dec. | - |
| *Lowest decreasing trend* | +1.13 mm/dec. | - |

## Wet Days

The number of annually accumulated wet days in Fiji increased during the last 40 year, to a statistically significant trend of +3.20 days/year per decade.

***Figure 18 – Annually accumulated wet days: historical time series***

*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*

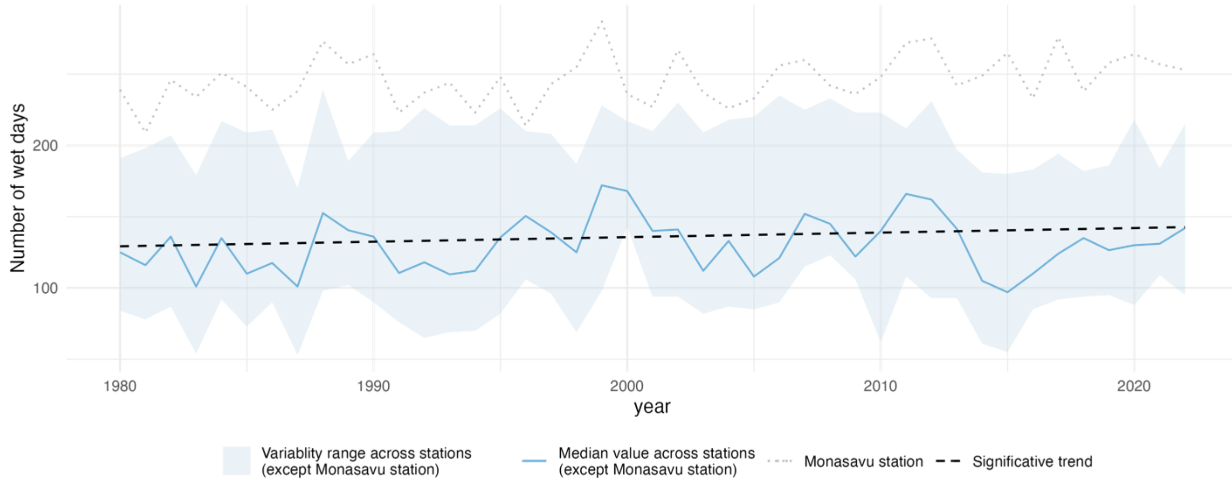
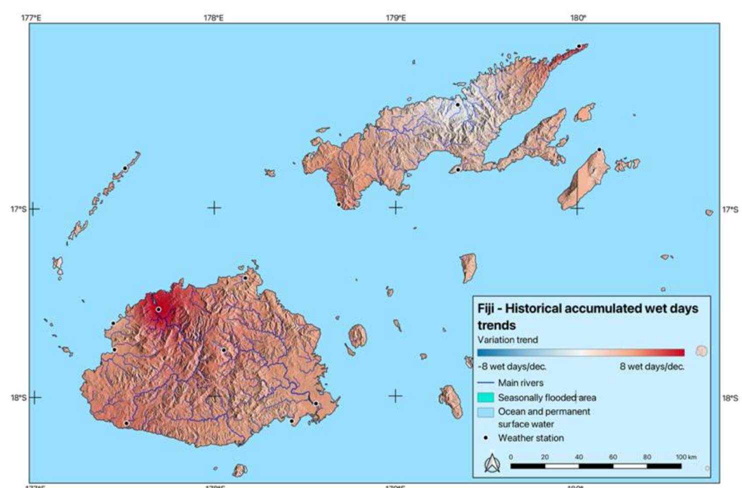



***Figure 19 – Annually accumulated wet days: historical geographic trends***

*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




Geographically, the increase in accumulated wet days is homogenous over Fiji, except around the town of Ba, in the Northeast of Viti Levu Island, where the increase is close to 5 days per decade, and around the town of Labasa, at the middle point of the northern shore of Vanua Levu, where the is almost no increase in the accumulated number of wet days.

Only one of the 6 validated models for accumulated wet days in Fiji showed a statistically significant trend, under the mitigation scenario (RCP4.5), to a rate of +7.97 days/year per decade.

***Figure 20 – Annually accumulated wet days: projected time series***

*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

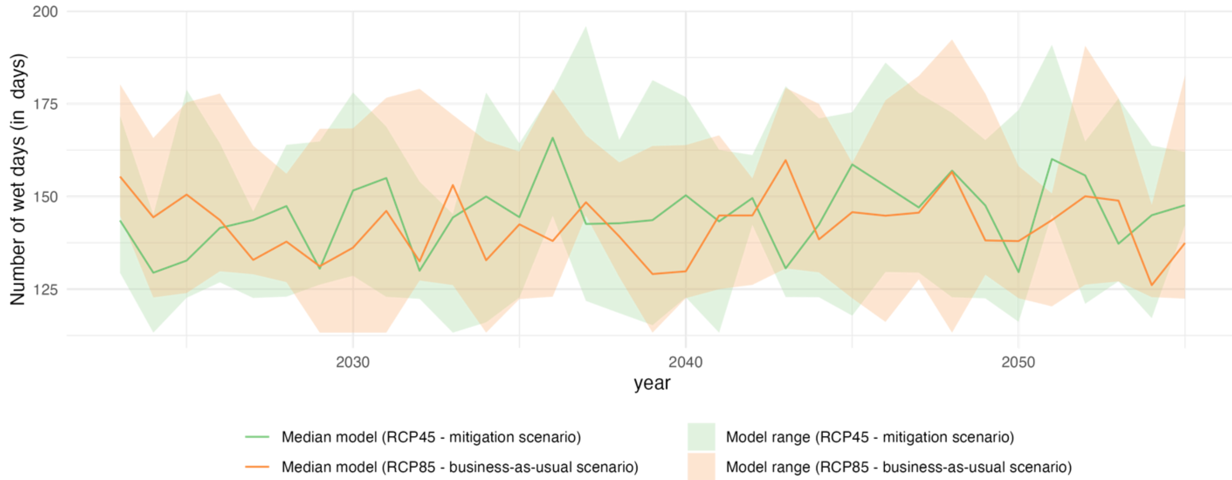



***Table 10 - Annually accumulated wet days: projected time series metadata***

*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 - RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **6** | |
| *Number of significative trends* | 1 | 0 |
| ***Number of significative increasing trends*** | **1** | **0** |
| *Average increasing trend* | +7.97 days/year/dec. | - |
| *Highest increasing trend* | +7.97 days/year/dec. | - |
| *Lowest increasing trend* | +7.97 days/year/dec. | - |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Extremely Wet Days

The number of extremely wet days in Fiji increased during the last 40 years, to a statistically significant trend of +0.65 days per decade.

***Figure 21 – Annually accumulated extremely wet days: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*

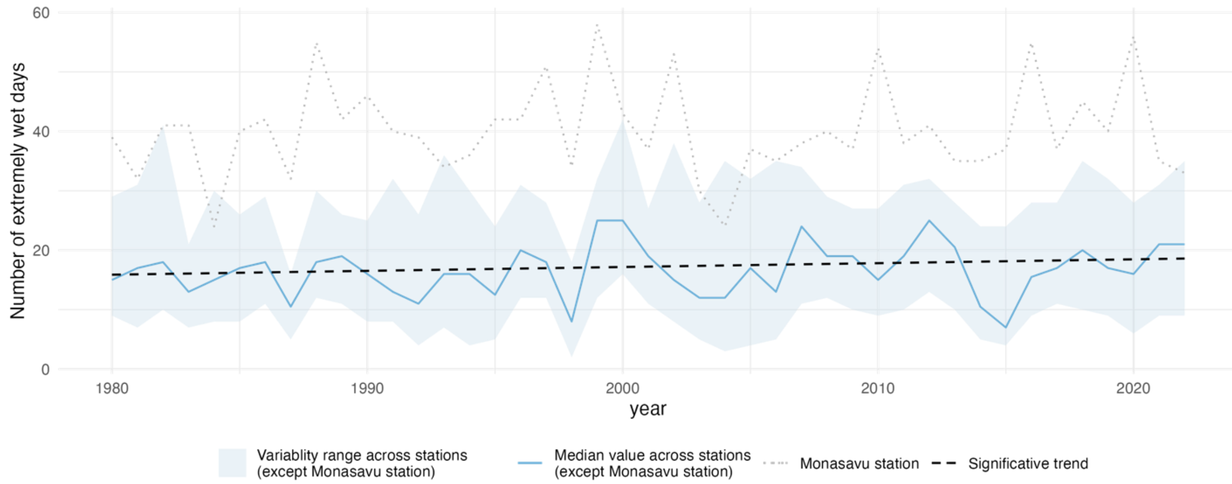
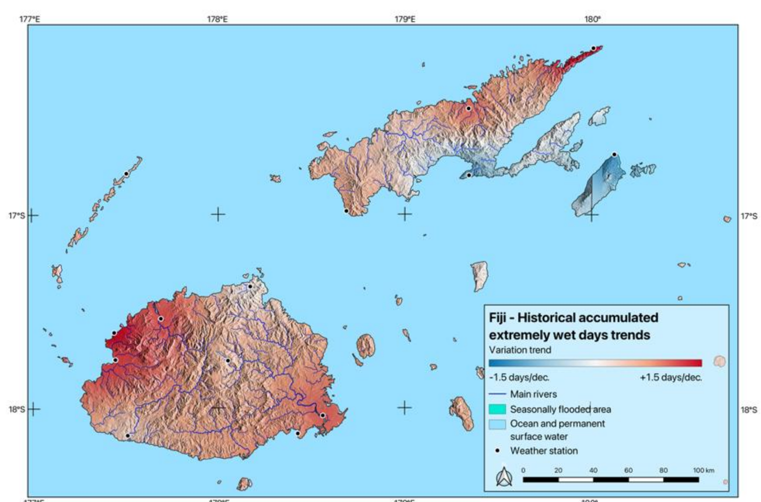



***Figure 22 – Annually accumulated extremely wet days: historical geographic trends***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




Geographically, the increase in accumulated extremely wet days is almost homogenous in Viti Levu Island, close to +1 day/decade, with slightly higher values on the northwestern part of the island. on Vanua Levu, the situation is more complex, with a slight increase (around +0.5 days/dec.) on the western part of the island, a decrease (around -0.5 days/dec.) to the southeast, and a marked increase on the northeastern part, close to Nambouono.

21 models were validated models for accumulated extremely wet days in Fiji. Under the mitigation scenario (RCP4.5), two of these models showed statistically significant trends, but in conflicting direction. Under the business-as-usual scenario (RCP8.5), the situation is clearer, with one model showing an increase in extremely wet days, to a rate of +1.84 days/year per decade.

***Figure 23 – Annually accumulated extremely wet days: projected time series***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

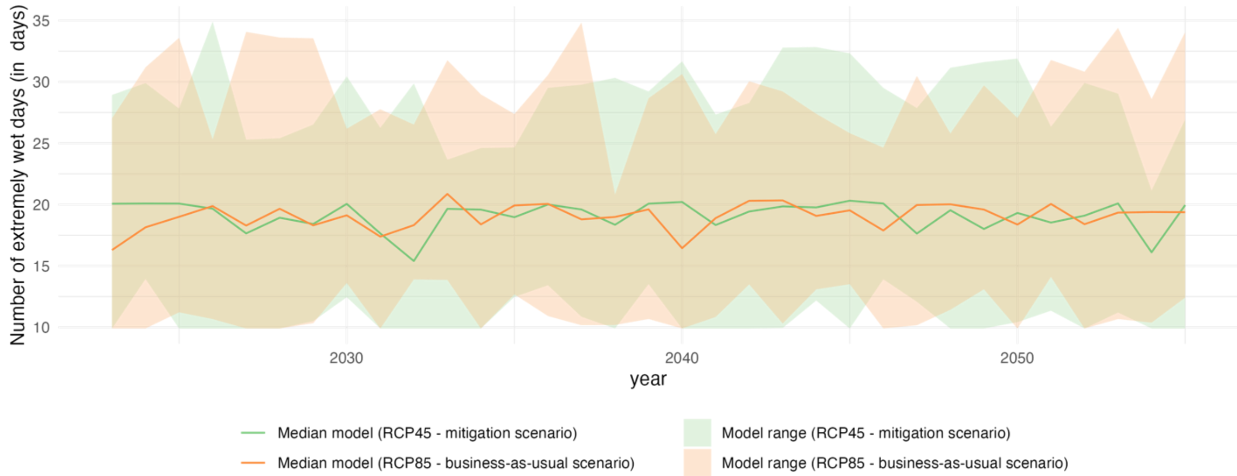


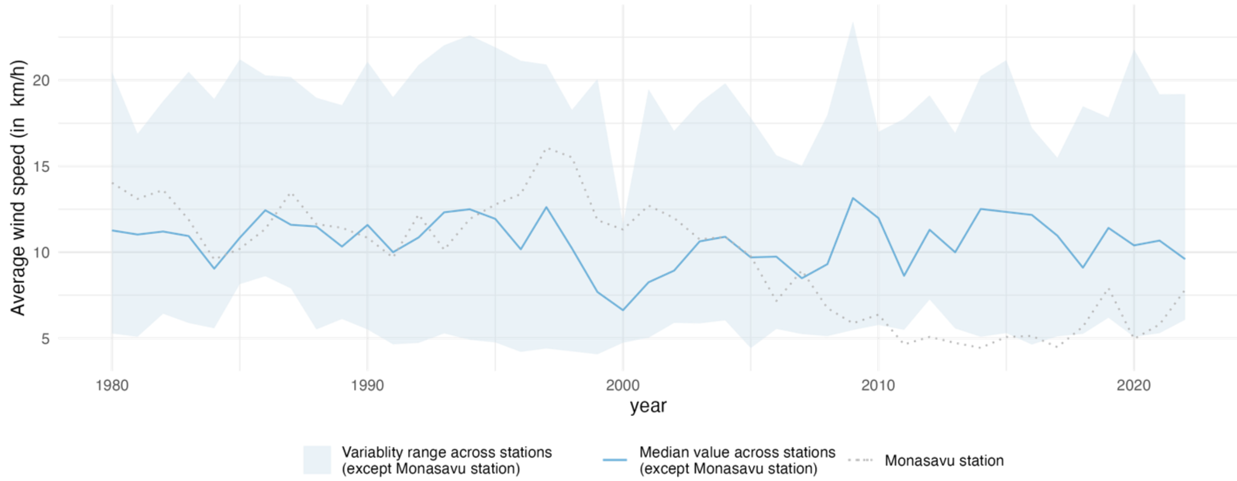

***Table 11 - Annually accumulated extremely wet days: projected time series metadata***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 - RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **21** | |
| *Number of significative trends* | 2 | 1 |
| ***Number of significative increasing trends*** | **1** | **1** |
| *Average increasing trend* | +1.77 days/year/dec. | +1.84 days/year/dec. |
| *Highest increasing trend* | +1.77 days/year/dec. | +1.84 days/year/dec. |
| *Lowest increasing trend* | +1.77 days/year/dec. | +1.84 days/year/dec. |
| ***Number of significative decreasing trends*** | **1** | **0** |
| *Average decreasing trend* | -1.75 days/year/dec. | - |
| *Highest decreasing trend* | -1.75 days/year/dec. | - |
| *Lowest decreasing trend* | -1.75 days/year/dec. | - |

## Average Wind Speed

The average wind speed in Fiji stayed stable around 11 km/h during the last 40 years.

***Figure 24 – Annual average wind speed: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




Although 16 projection models were validated for average wind speed in Fiji, none of them shown any statistical significative trends under either scenario. Therefore, the average wind speed is expected to remain stable for the next three decades.

***Figure 25 – Annual average wind speed: projected time series***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

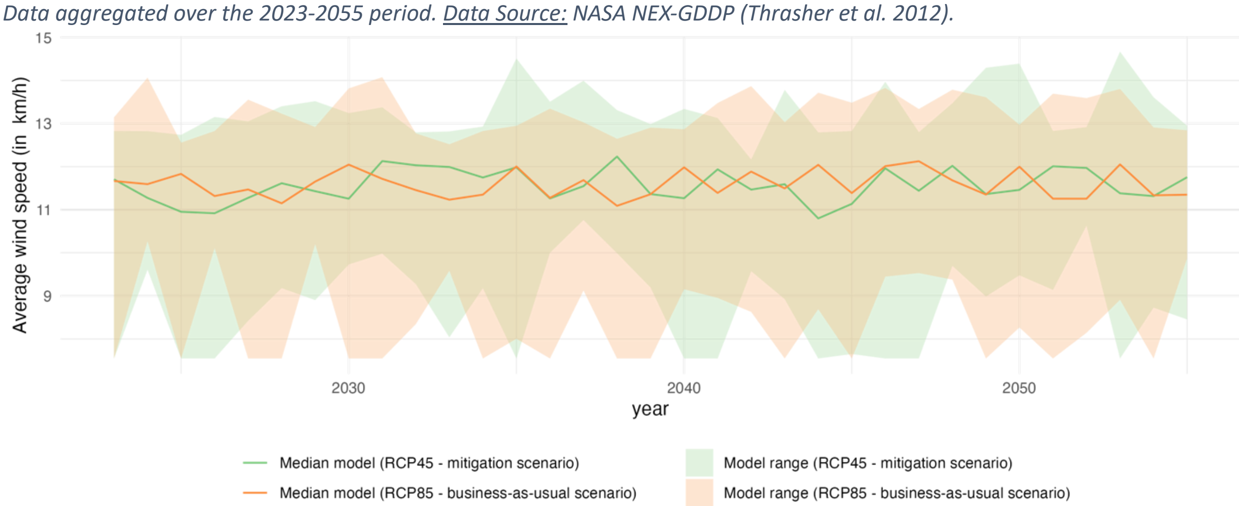


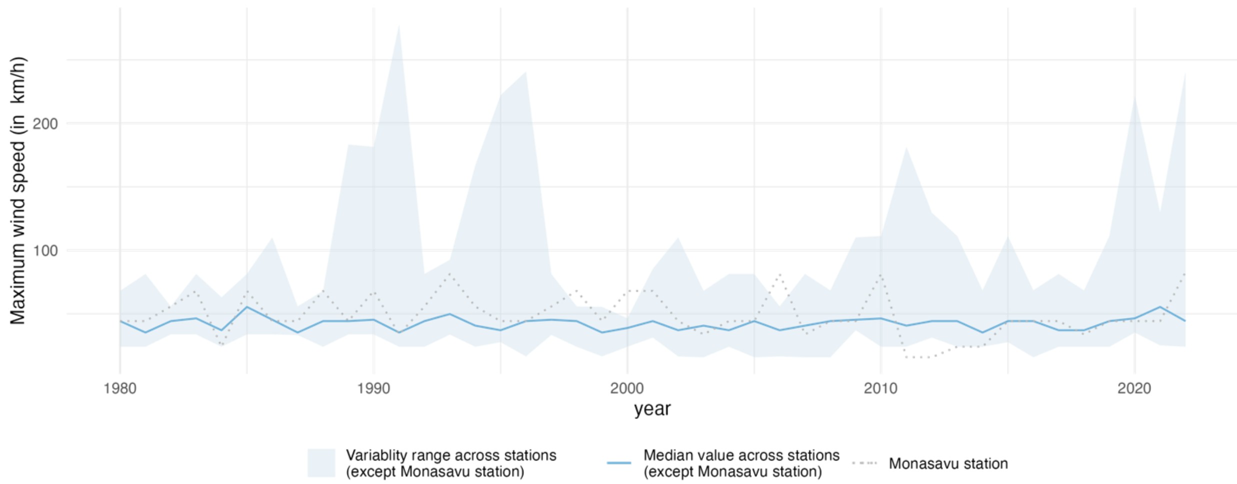
***Table 12 – Annually accumulated extremely wet days: projected time series metadata***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | Mitigation scenario (SSP2 – RCP4.5) | Business-as-usual scenario (SSP5 – RCP8.5) |
|---|---|---|
| ***Number of validated models*** | **16** | |
| *Number of significative trends* | 0 | 0 |
| ***Number of significative increasing trends*** | **0** | **0** |
| *Average increasing trend* | - | - |
| *Highest increasing trend* | - | - |
| *Lowest increasing trend* | - | - |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Maximum Wind Speed

The annual maximum wind speed in Fiji did not show any statistically significant variation during the last 4 decades, averaging around 48 km/h. Extreme events in specific locations can however be noted, with winds above 150 km/h and sometimes above 200 km/h.

***Figure 26 – Annual maximum wind speed: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*

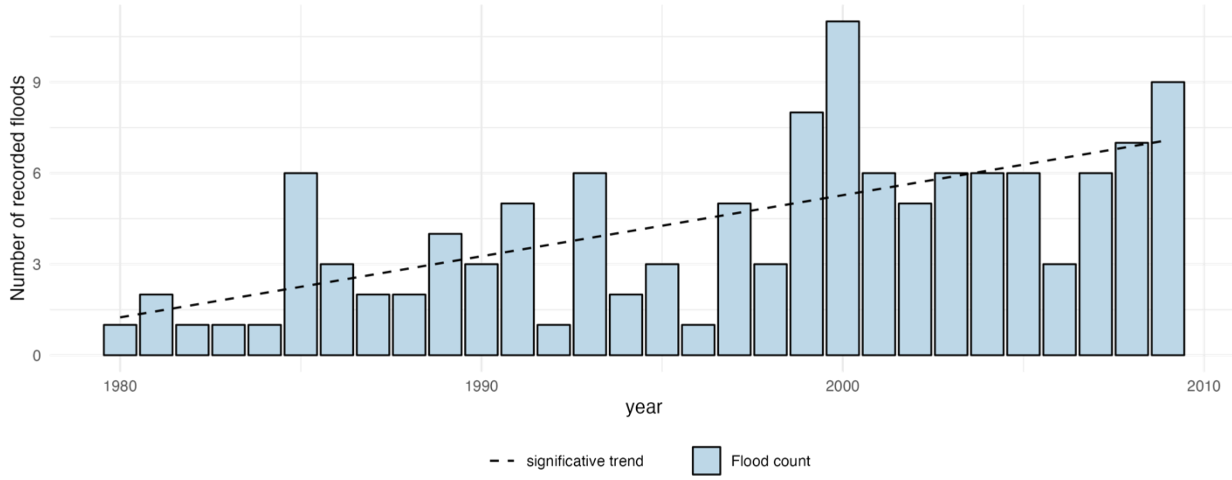



Unfortunately, of the 28 models selected to investigate Fiji future climate, none could be validated against local data.

## Recorded Flood Events

The number of floods reported in Fiji significantly increased in Fiji between 1980 and 2009, to a rate of +2.01 flood event reported/year per decade.

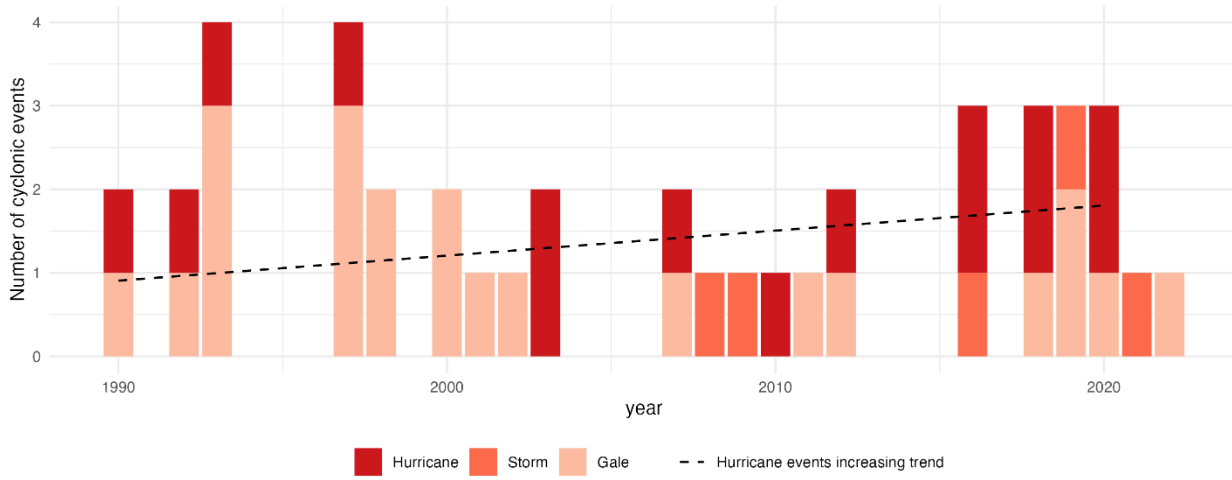
***Figure 27 – Annual amount of recorded flood: historical time series***
*Data averaged over the 1980-2009 period. Data Source: Risk Frontiers (Mcgree, Yeo, and Devi 2010)*




## Recorded Cyclonic Events

Although the number of cyclonic events remained stable in Fiji during the last 30 years, the number of Hurricane level events[1] increased, to a rate of +0.30 event per decade.

***Figure 28 – Annual amount of recorded cyclonic events: historical time series***
*Data averaged over the 1990-2022 period. Data Source: Fiji Meteorological Service*



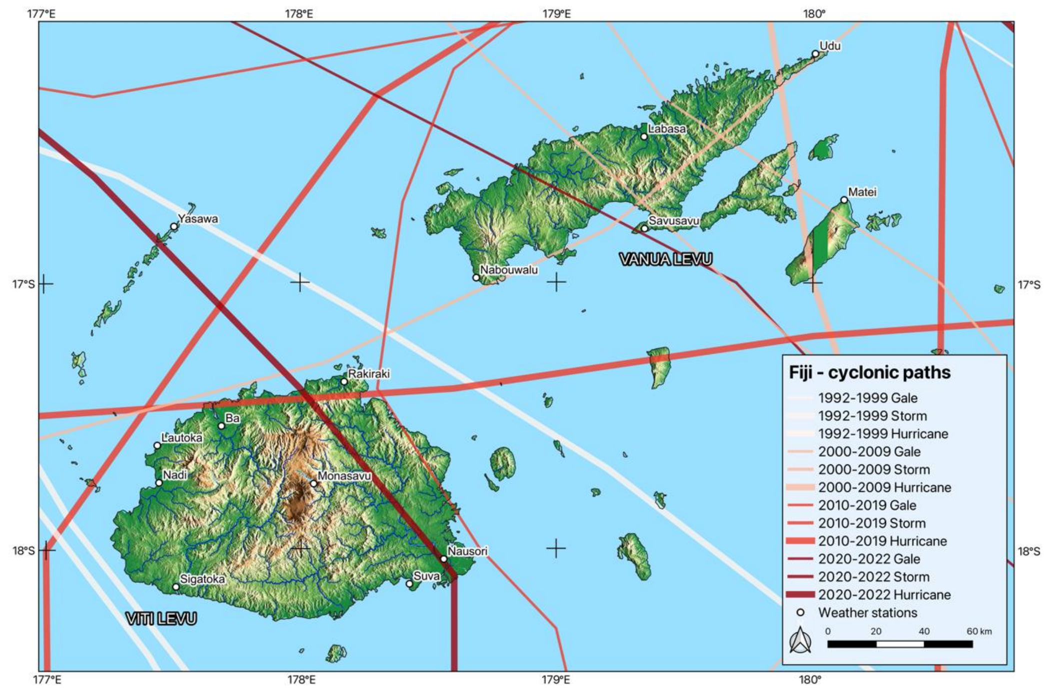

Geographically, most of the more intense and recent cyclonic events affecting Fiji passed through the coastal areas of Viti Levu, especially on the northern and eastern littoral area. Although Vanua Levu suffered the passing of multiple cyclonic events, especially during the 2000-2009 period, these events were Gales for the most part, which are less intense events that the Hurricanes that affected Viti Levu

[1] Cyclonic events presenting wind speeds higher or equal to 117 km/h (64 knots).

recently. However less intense, most of these events didn't stay on the coastline of Vanua Levu and crossed the full width of the island.

***Figure 29 – Recorded cyclonic events: historical paths***

*Data averaged over the 1992-2022 period. Data Source: Fiji Meteorological Service. Topological map background from Figure 5.*

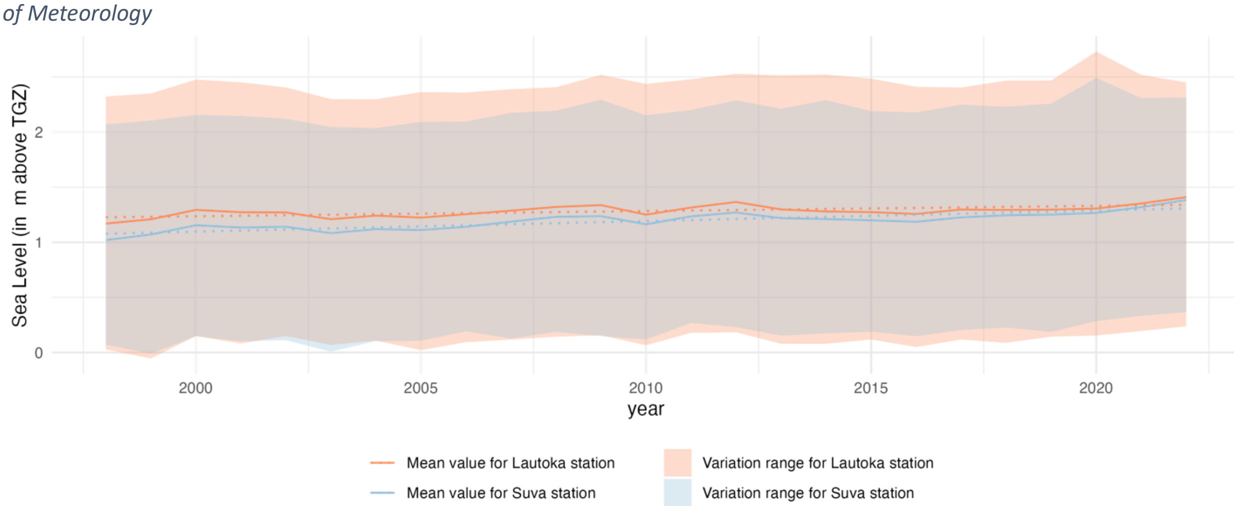



## Sea Level

During the last 30 years, The sea level rose consistently in Fiji, to a rate of +5 cm per decade in Lautoka, and +10 cm in Suva, both increase being higher than the global average (+4.5 cm per decade for the period 2013-2021 (World Meteorological Organization 2022)).

***Figure 30 – Sea level: historical time series***

*Data aggregated over 1998-2022. Sea level in in meters above Tide Gauge Zero. Data Source: Commonwealth of Australia – Bureau of Meteorology*



## Average Temperature

The average temperature in Fiji increased during the last 40 years, to a rate of +0.27°C decade.

***Figure 31 – Annual average temperature: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*

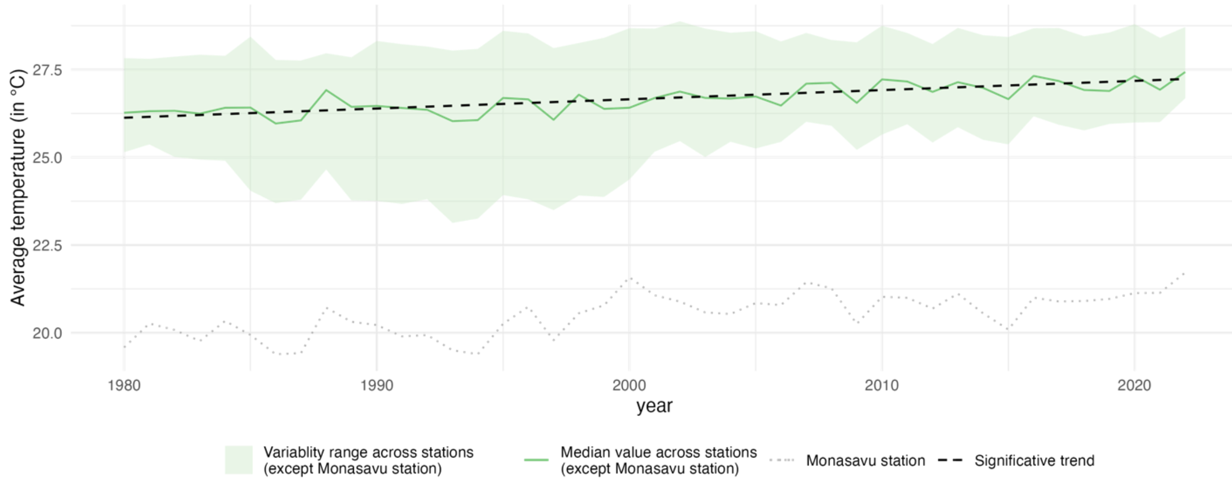
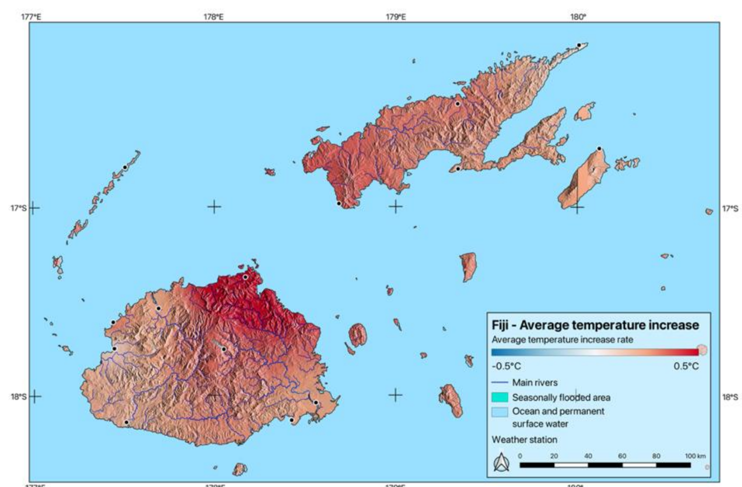



***Figure 32 – Annual average temperature: historical geographic trends***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




The increase in average temperature is ubiquitous and consistent through the islands. It is however slightly more marked on the North side of Viti Levu, around the town of Rakiraki.

All the 23 validated models concur that the increasing trend in average temperature is expected to continue over the next four decades, with an average rate of +0.23°C per decade under the mitigation scenario (RCP4.5) and +0.34°C under the business-as-usual scenario (RCP8.5).

***Figure 33 – Annual average temperature: projected time series***

*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

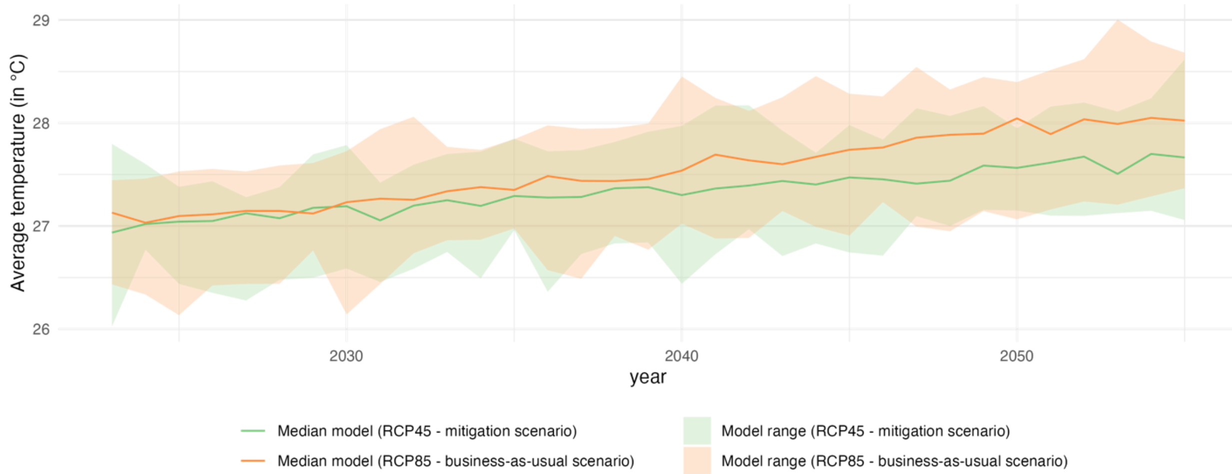



***Table 13 – Annually accumulated extremely wet days: projected time series metadata***

*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 – RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **23** | |
| *Number of significative trends* | 23 | 23 |
| ***Number of significative increasing trends*** | **23** | **23** |
| *Average increasing trend* | +0.23°C/dec. | +0.34°C/dec. |
| *Highest increasing trend* | +0.42°C/dec. | +0.50°C/dec. |
| *Lowest increasing trend* | +0.09°C/dec. | +0.14°C/dec. |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Minimum Temperature

As average temperature, the annual minimum temperature in Fiji has increased during the last 40 years, to a rate of +0.29°C per decade.

***Figure 34 – Annual minimum temperature: historical time series***

*Data aggregated over the 1980-2022 period. <u>Data Source:</u> Ministry of Forestry of the Republic of Fiji*

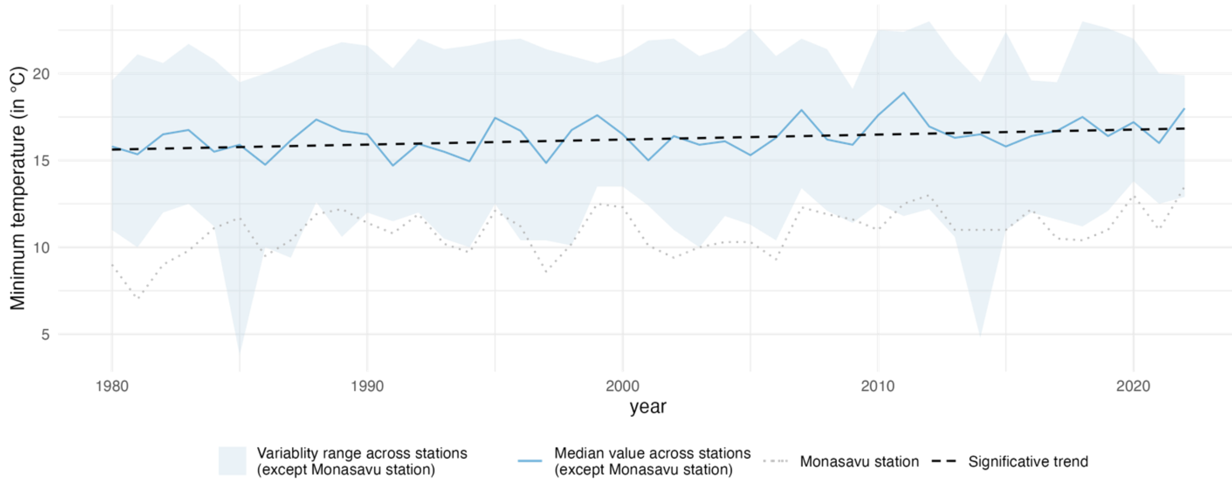
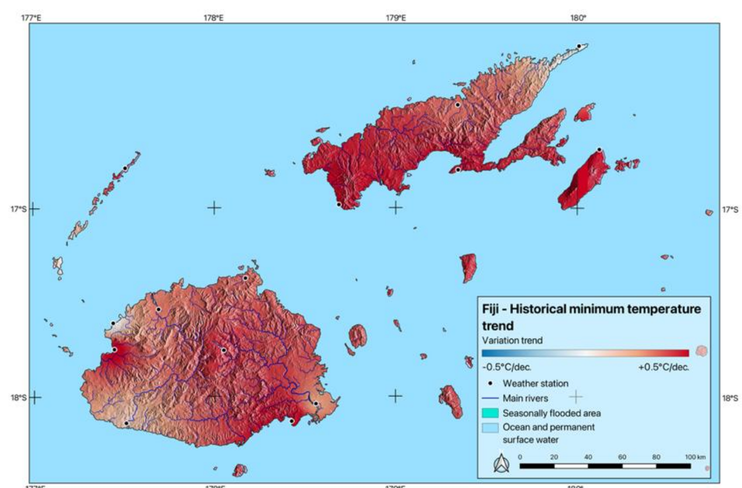



***Figure 35 – Annual minimum temperature: historical geographic trends***

*Data aggregated over the 1980-2022 period. <u>Data Source:</u> Ministry of Forestry of the Republic of Fiji*




The increase in annual minimum temperature is also spread out and consistent through the islands, with some slight differences: the increase in more marked on the northern shore of Vanua Levu, and on the East side of Viti Levu. On the west side of Viti Levu, the increase is less intense except in the bay of Nadi, where the increase is marked.

The expected increase in annual minimum temperature in Fiji is less clear than for average temperature, as only 1 model validated against local data. This model does however expect an increase in annual minimum temperature, to a rate of +0.40°C per decade under the business-as-usual scenario (RCP8.5).

***Figure 36 – Annual minimum temperature: projected time series***
*Data aggregated over the 2023-2055 period. Data Source:* NASA NEX-GDDP (Thrasher et al. 2012).

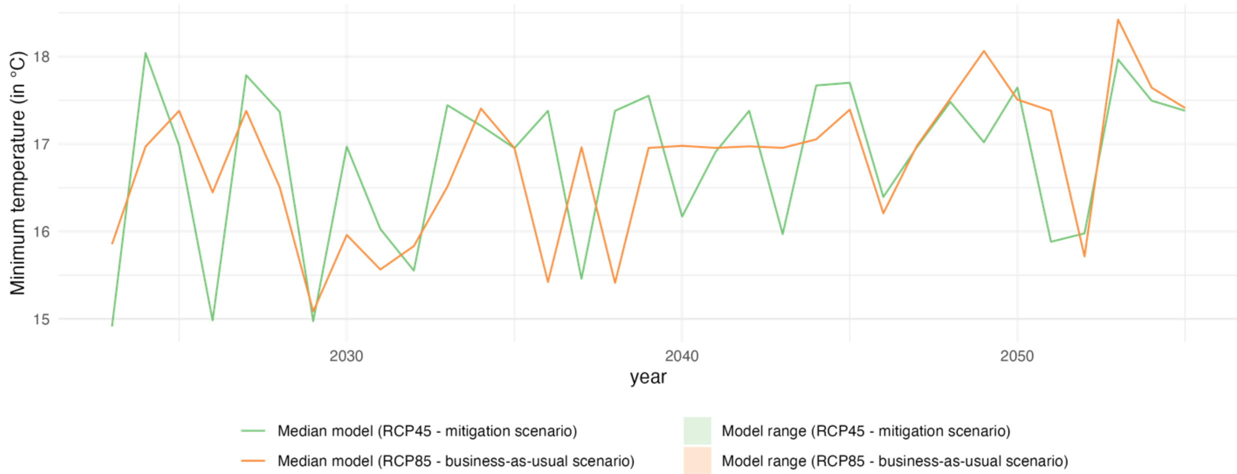



***Table 14 – Annually accumulated extremely wet days: projected time series metadata***
*Data aggregated over the 2023-2055 period. Data Source:* NASA NEX-GDDP (Thrasher et al. 2012).

| | **Mitigation scenario** *(SSP2 – RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **1** | |
| *Number of significative trends* | 0 | 1 |
| ***Number of significative increasing trends*** | **0** | **1** |
| *Average increasing trend* | - | +0.40°C/dec. |
| *Highest increasing trend* | - | +0.40°C/dec. |
| *Lowest increasing trend* | - | +0.40°C/dec. |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Maximum Temperature

As average temperature, the annual maximum temperature in Fiji has increased during the last 40 years, to a rate of +0.33°C per decade.

***Figure 37 – Annual maximum temperature: historical time series***

*Data aggregated over the 1980-2022 period. <u>Data Source:</u> Ministry of Forestry of the Republic of Fiji*

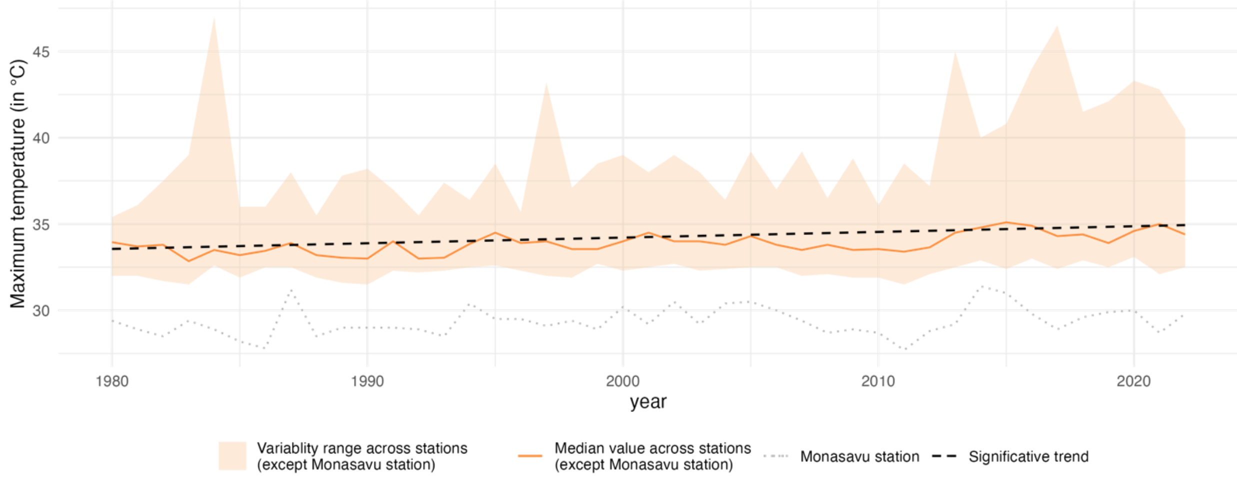
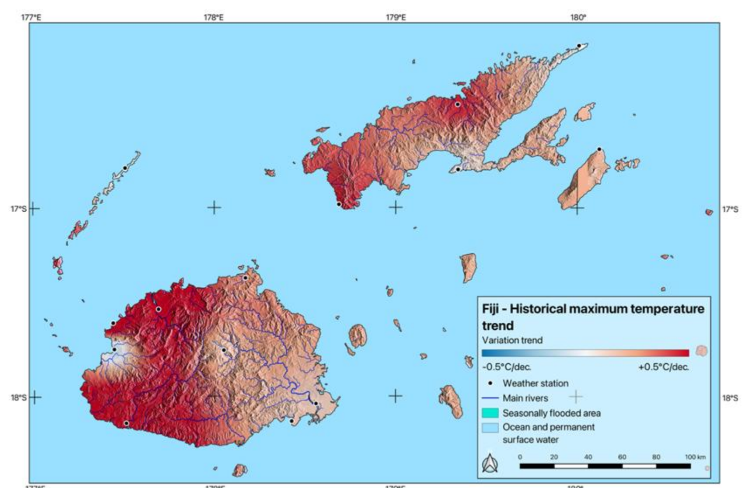



***Figure 38 – Annual maximum temperature: historical geographic trends***

*Data aggregated over the 1980-2022 period. <u>Data Source:</u> Ministry of Forestry of the Republic of Fiji*




The increase in annual maximum temperature is also spread out and consistent through the islands, with some slight differences: the increase in more marked on the West side of Viti Levu, except in the bay of Nadi, where the maximum temperature seems to be constant for the last 30 years.

The expected increase in annual maximum temperature in Fiji is quite marked, as more than 10 of the 14 validated models concur in the expected increase of maximum temperature, to a rate of +0.30°C per decade under the mitigation scenario (RCP4.5) and +0.42°C under the business-as-usual scenario (RCP 8.5).

***Figure 39 – Annual maximum temperature: projected time series***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

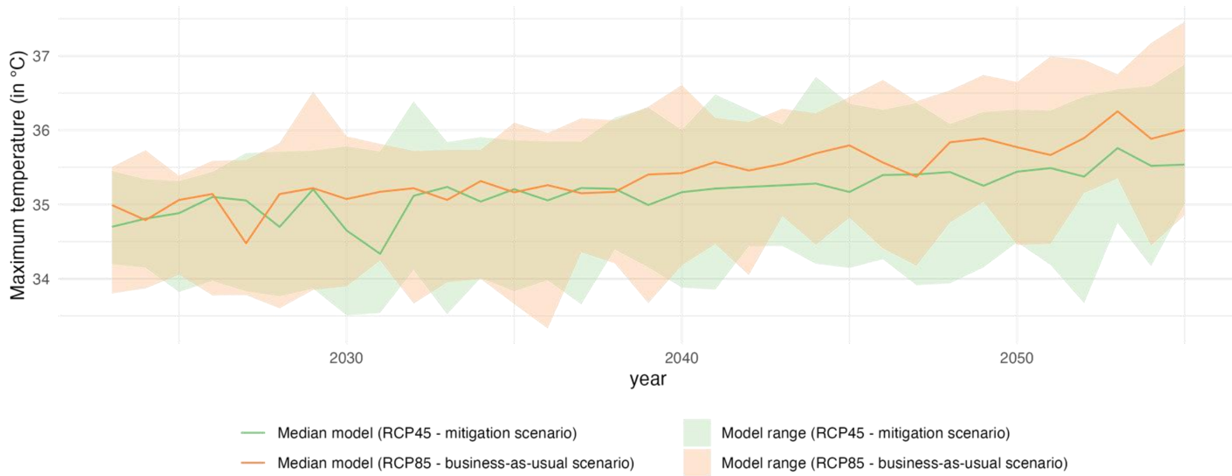



***Table 15 – Annually accumulated extremely wet days: projected time series metadata***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

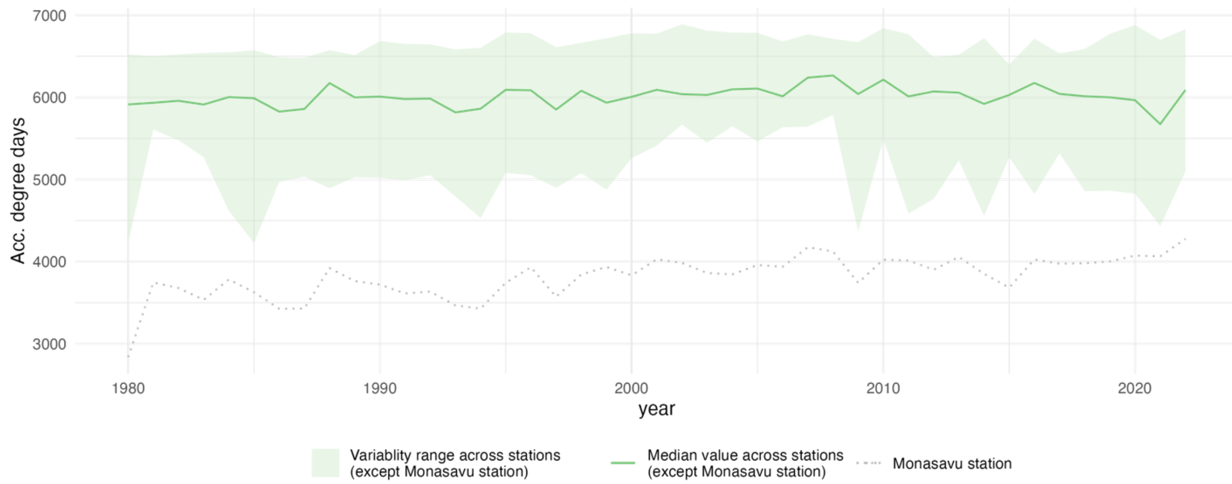
| | **Mitigation scenario** *(SSP2 – RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **14** | |
| *Number of significative trends* | 11 | 13 |
| ***Number of significative increasing trends*** | **11** | **13** |
| *Average increasing trend* | +0.30°C/dec. | +0.42°C/dec. |
| *Highest increasing trend* | +0.40°C/dec. | +0.62°C/dec. |
| *Lowest increasing trend* | +0.18°C/dec. | +0.25°C/dec. |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Degree-Days

Although the temperatures increased in Fiji during the last 4 decades, the annually accumulated degree-days in Fiji did not vary to any statistically significant trend, remaining around 6000°days per year.

***Figure 40 – Annually accumulated degree-days: historical time series***

*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




The annually accumulated degree-days are expected to increase during the next 40 years, as all the 11 models validated expect an increase, to an average rate of +86°days/year per decade under the mitigation scenario (RCP4.5), and +128°days/year per decade, under the business-as-usual scenario (RCP8.5).

***Figure 41 – Annually accumulated degree-days: projected time series***

*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

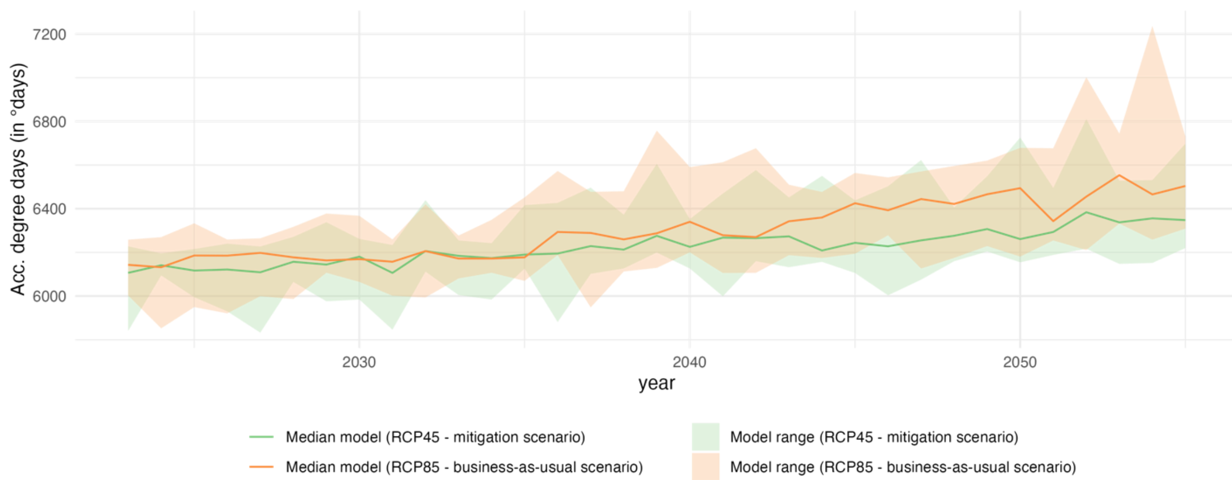


***Table 16 – Annually accumulated degree-days: projected time series metadata***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 – RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **11** | |
| *Number of significative trends* | 11 | 11 |
| ***Number of significative increasing trends*** | **11** | **11** |
| *Average increasing trend* | +86°days/dec. | +128°days/dec. |
| *Highest increasing trend* | +173°days/dec. | +196°days/dec. |
| *Lowest increasing trend* | +27°days/dec. | +57°days/dec. |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Reference Evapotranspiration

The reference evapotranspiration in Fiji has increased during the last 40 years, to a rate of -26 mm per decade.

***Figure 42 – Annually accumulated reference evapotranspiration: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*

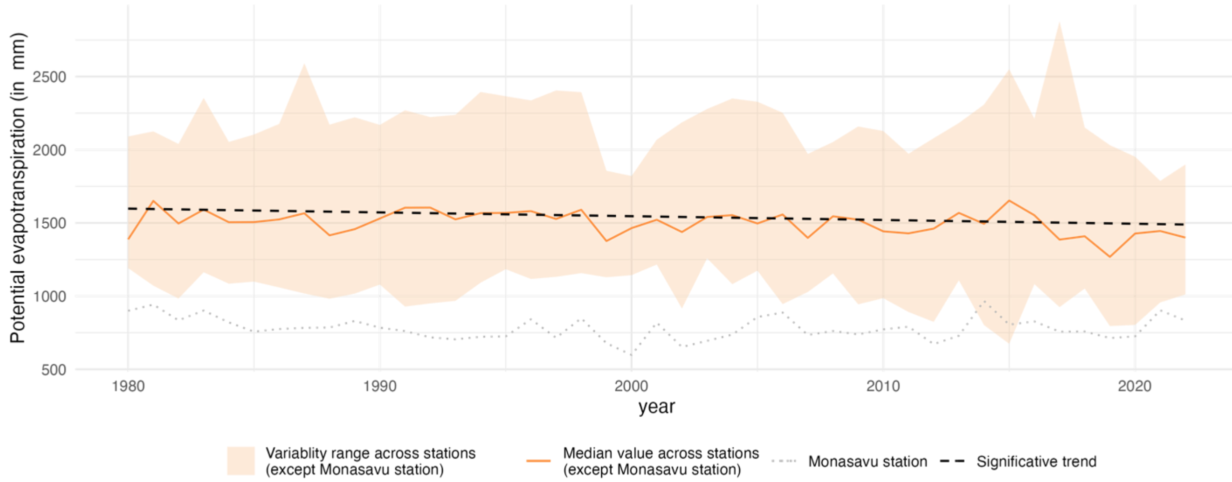
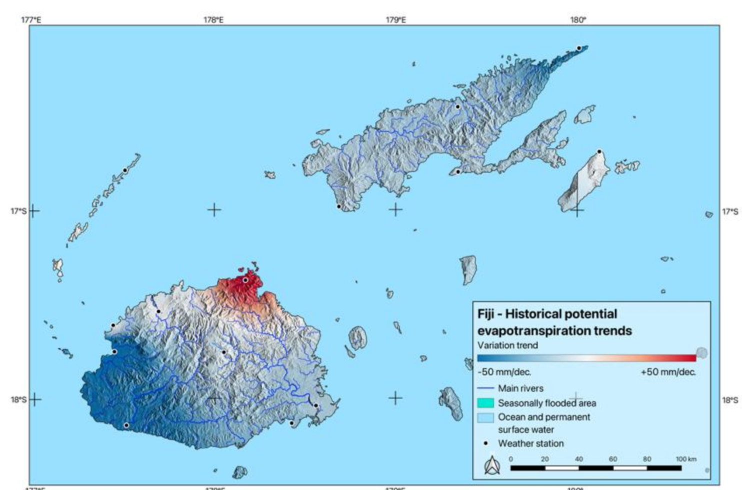



***Figure 43 – Annually accumulated reference evapotranspiration: historical geographic trends***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




The decrease in annually accumulated reference evapotranspiration is ubiquitous and consistent throughout Vanua Levu. On Viti Levu, while most of the island present a decrease in reference evapotranspiration, the northern tip of the island presents an increase for this variable. Moreover, the decrease in reference evapotranspiration is more marked on the southwestern side of the island.

Most of the validated model fail to present statistically significant trend for Reference Evapotranspiration in Fiji. Only one model presenting statistical significance was validated, under the business-as-usual scenario (RCP8.5), expecting an increase in reference evapotranspiration of + 31 mm/year per decade, which contradicts the historical trends.

***Figure 44 – Annually accumulated reference evapotranspiration: projected time series***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

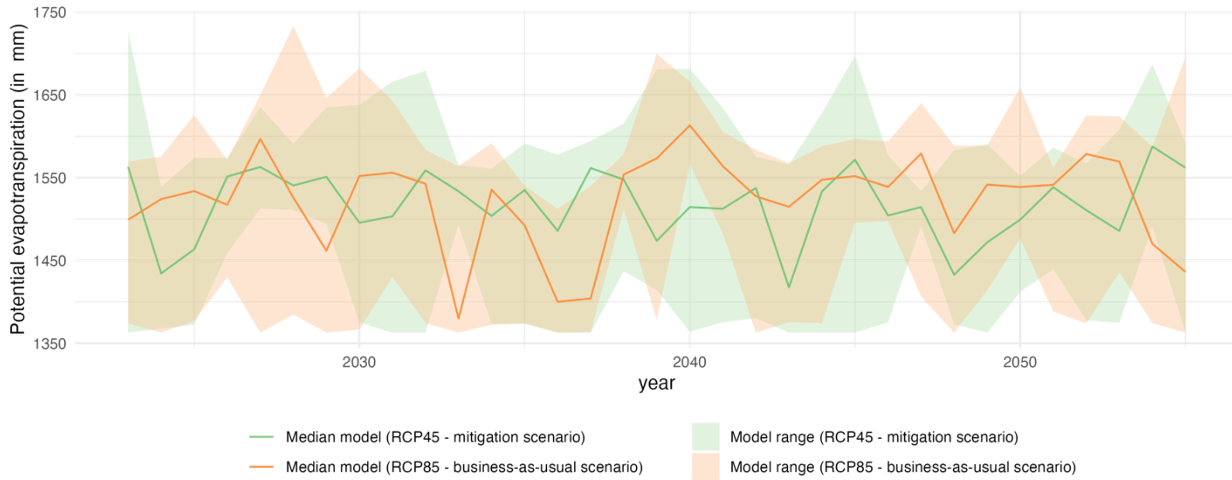



***Table 17 – Annually accumulated reference evapotranspiration: projected time series metadata***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 – RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **6** | |
| *Number of significative trends* | 0 | 1 |
| ***Number of significative increasing trends*** | **0** | **1** |
| *Average increasing trend* | - | +31 mm/year/dec. |
| *Highest increasing trend* | - | +31 mm/year/dec. |
| *Lowest increasing trend* | - | +31 mm/year/dec. |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Climatic Water Balance

The annually accumulated climatic water balance in Fiji has increased during the last 40 years, to a rate of +103 mm decade.

***Figure 45 – Annually accumulated climatic water balance: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*

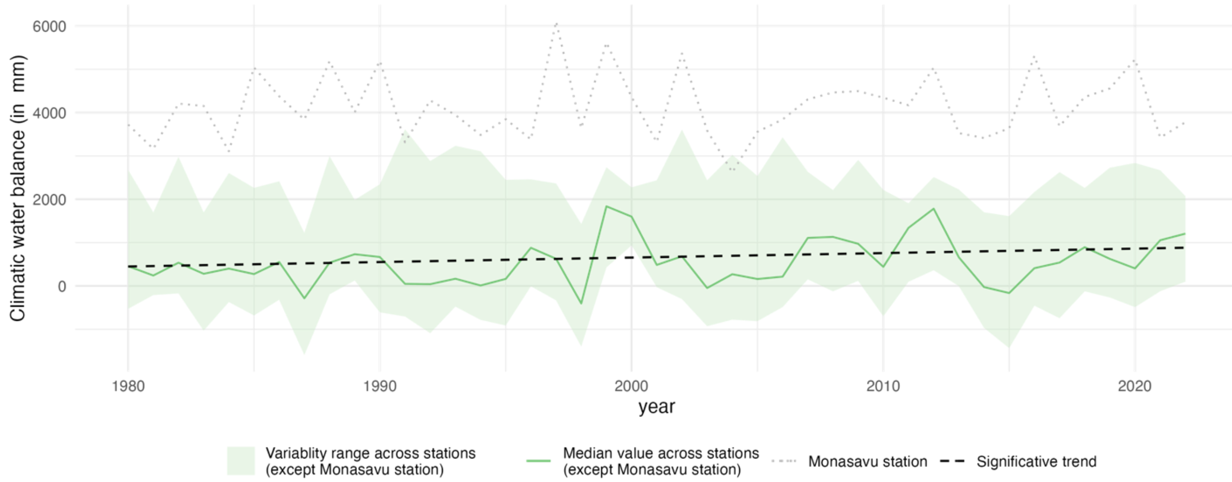
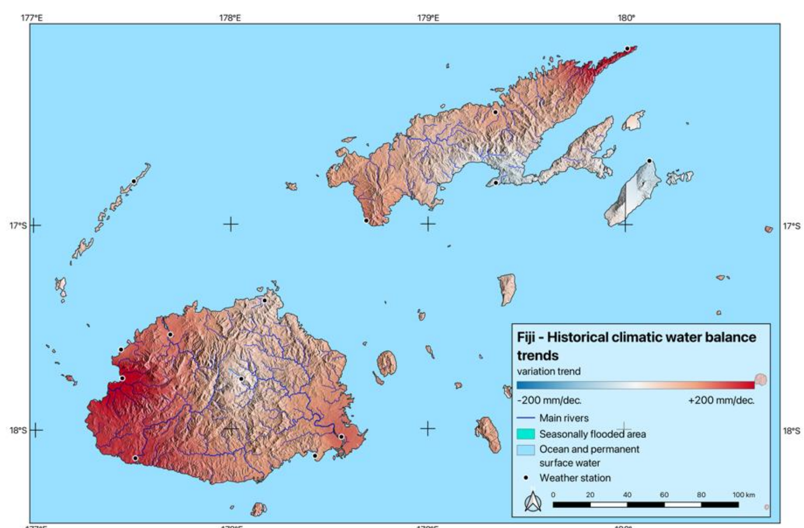



***Figure 46 – Annually accumulated climatic water balance: historical geographic trends***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




The increase in annually accumulated climatic water balance is spread out and consistent through the country, with some slight differences: the increase is more marked on the West side of Viti Levu, and on the northeastern tip of Vanua Levu. On Taveuni Island, there was almost no variation on climatic water balance during the last 4 decades.

Only one model of the 15 validated models for climatic water balance showed a statistically significant trend for both mitigation scenario (RCP4.5) and business-as-usual scenario (RCP8.5). In both case this trend was increasing, to a rate of +254 mm/year per decade under the mitigation scenario, and +315 mm/year per decade under the business-as-usual scenario.

***Figure 47 – Annually accumulated climatic water balance: projected time series***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

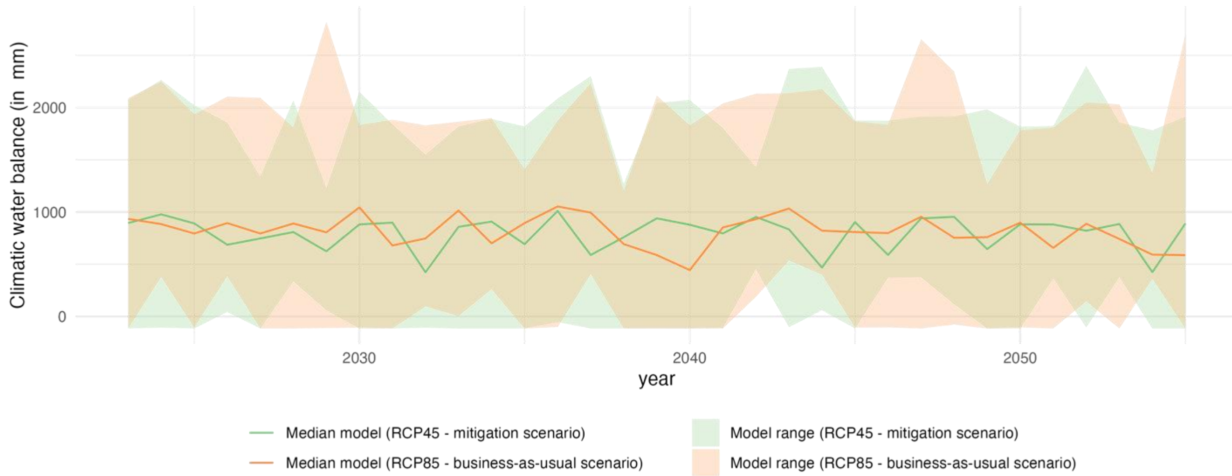



***Table 18 – Annually accumulated climatic water balance: projected time series metadata***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 – RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **15** | |
| *Number of significative trends* | 1 | 1 |
| ***Number of significative increasing trends*** | **1** | **1** |
| *Average increasing trend* | +254 mm/year/dec. | +315 mm/year/dec. |
| *Highest increasing trend* | +254 mm/year/dec. | +315 mm/year/dec. |
| *Lowest increasing trend* | +254 mm/year/dec. | +315 mm/year/dec. |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Accumulated Dry Months

The number of dry months has been increasing in Fiji during the last 40 years, to a rate of +0.15 months/year per decade.

***Figure 48 – Number of dry months per year: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*

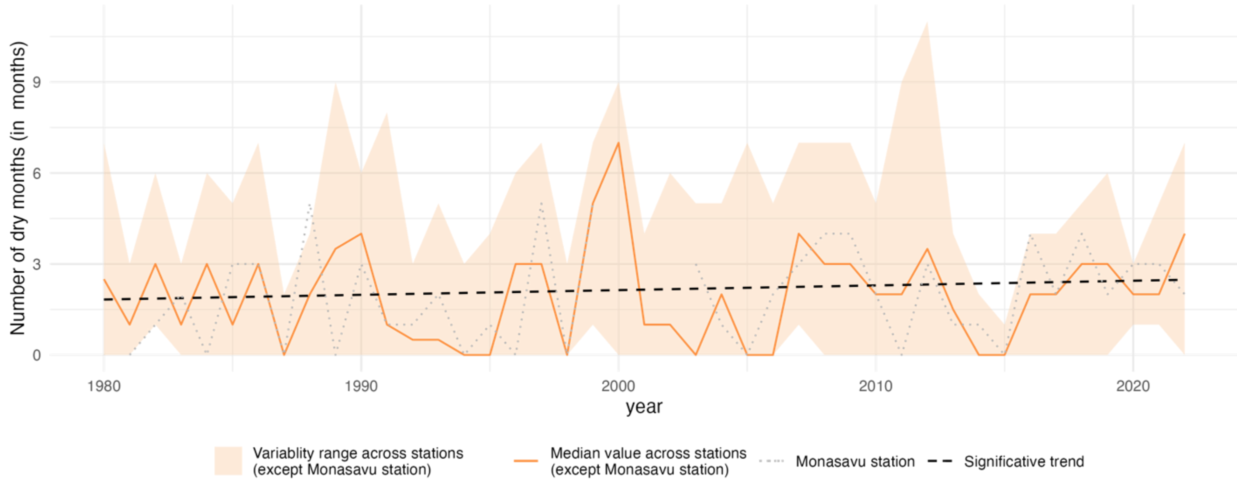
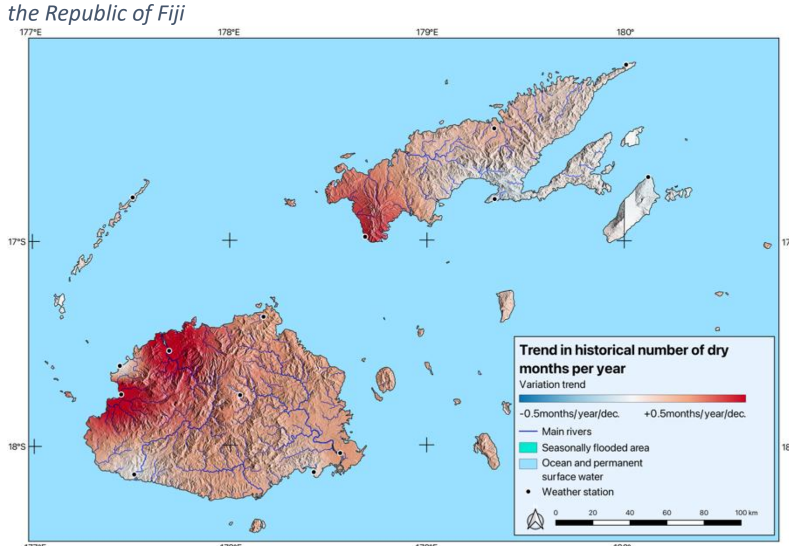



***Figure 49 – Number of dry months per year: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




The increase in the number of dry months per year (based on 3-month SPEI) during the last 40 years was concentrated in the northwestern Viti Levu, and on the southwestern tip of Vanua Levu.

19 models were validated for the number of dry months per year in Fiji and showed a general trend toward an increase in the number of dry months, under both scenarios. The trend is expected to increase at an average rate of +0.54 months/year per decade under the mitigation scenario (RCP4.5), and at an average rate of +0.71 months/year per decade under the business-as-usual scenario.

***Figure 50 – Number of dry months per year: projected time series***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

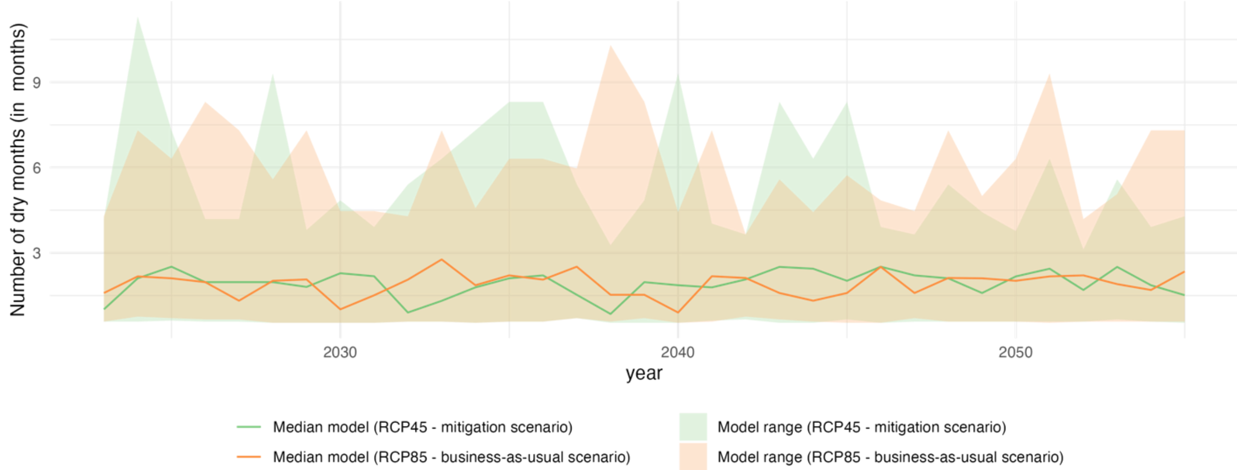


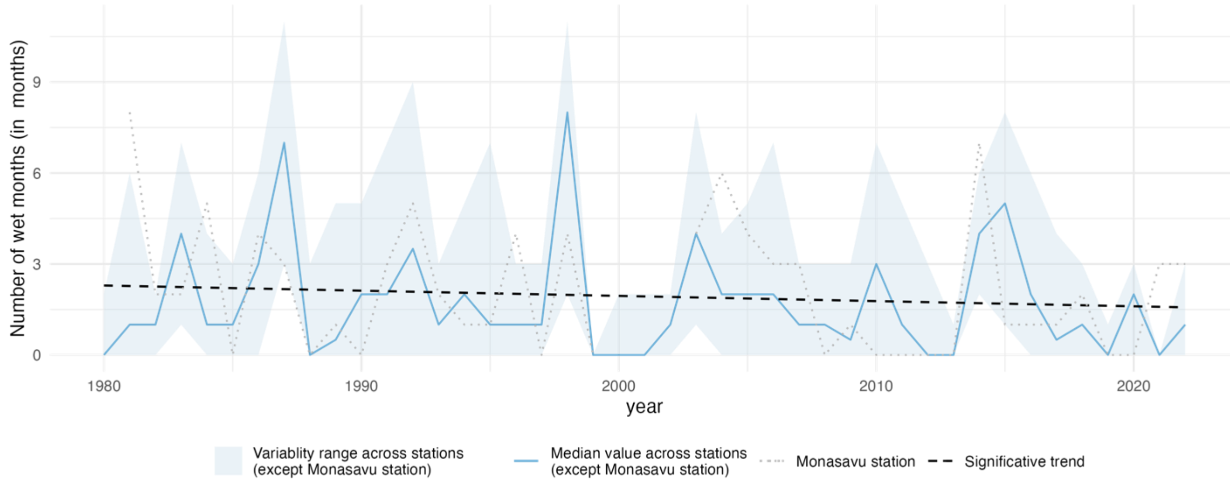

***Table 19 – Number of dry months per year: projected time series metadata***
*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 – RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **19** | |
| *Number of significative trends* | 1 | 4 |
| ***Number of significative increasing trends*** | **1** | **3** |
| *Average increasing trend* | +0.54 months/year/dec. | +0.71 months/year/dec. |
| *Highest increasing trend* | +0.54 months/year/dec. | +0.91 months/year/dec. |
| *Lowest increasing trend* | +0.54 months/year/dec. | +0.54 months/year/dec. |
| ***Number of significative decreasing trends*** | **0** | **1** |
| *Average decreasing trend* | - | +0.60 months/year/dec. |
| *Highest decreasing trend* | - | +0.60 months/year/dec. |
| *Lowest decreasing trend* | - | +0.60 months/year/dec. |

## Accumulated Wet Months

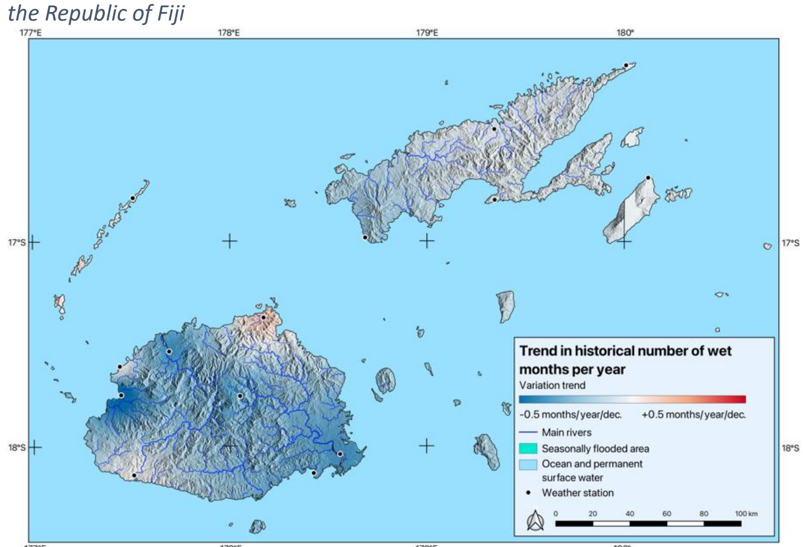
During the last 40 years, the number of wet months has decreased in Fiji, to a rate of -0.17 months per decade.

***Figure 51 – Number of wet months per year: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*




The decrease in the number of wet months per year (based on 3-month SPEI) during the last 40 years was spread out in Viti Levu, with some strong exceptions: areas around Sigatoka and Nadi didn't show any variation, while the area around Rakiraki showed a slight increase. In Vanua Levu, the decrease is present, but less marked.

***Figure 52 – Number of wet months per year: historical time series***
*Data aggregated over the 1980-2022 period. Data Source: Ministry of Forestry of the Republic of Fiji*



Although 23 projection models of the number of wet months per year were validated, none showed any statistically significant trend.

***Figure 53 – Number of wet months per year: projected time series***

*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

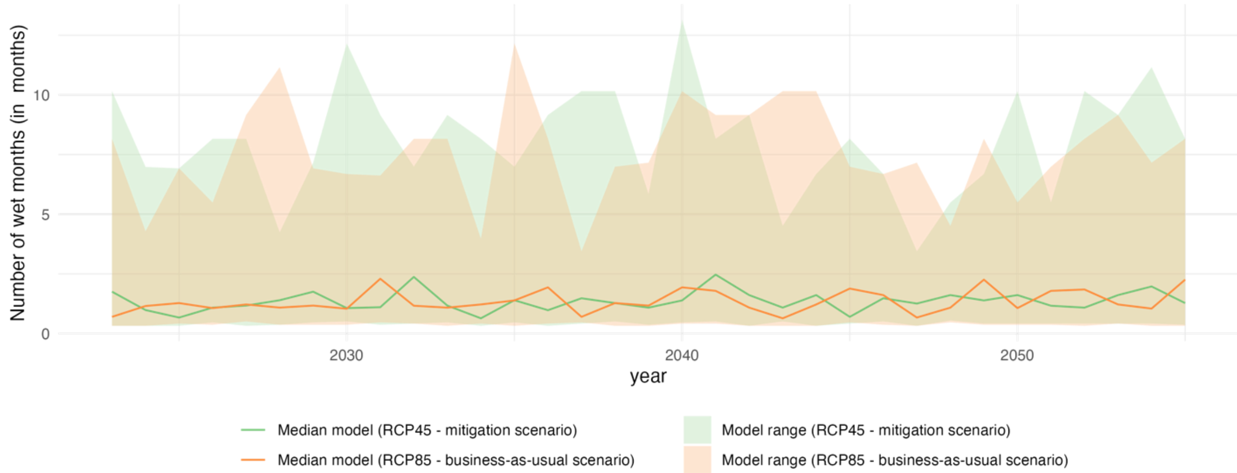



***Table 20 – Number of dry months per year: projected time series metadata***

*Data aggregated over the 2023-2055 period. Data Source: NASA NEX-GDDP (Thrasher et al. 2012).*

| | **Mitigation scenario** *(SSP2 – RCP4.5)* | **Business-as-usual scenario** *(SSP5 – RCP8.5)* |
|---|---|---|
| ***Number of validated models*** | **23** | |
| *Number of significative trends* | 0 | 0 |
| ***Number of significative increasing trends*** | **0** | **0** |
| *Average increasing trend* | - | - |
| *Highest increasing trend* | - | - |
| *Lowest increasing trend* | - | |
| ***Number of significative decreasing trends*** | **0** | **0** |
| *Average decreasing trend* | - | - |
| *Highest decreasing trend* | - | - |
| *Lowest decreasing trend* | - | - |

## Exposure analysis

### Fiji has experienced and is expected to continue experiencing significant and increasing exposure to floods.

**The rainfall is increasing and are expected to continue to increase.** Fiji receives a substantial and increasing volume of rainfall annually, with a rising frequency of extreme precipitation events. Over the last 40 years, its already high annual accumulated precipitation increased to a rate of +81 mm/year per decade, reaching a current average of ±2300 mm/year. This increase is expected to continue, to a rate between +227 mm/year per decade (RCP4.5) and +264 mm per year per decade (RCP8.5).

**The frequency of rain events and extreme rain days is also increasing and expected to increase.** The frequency of wet and extremely wet days has also increased, to a rate of +3.20 days/year per decade and +0.65 days/year per decade, currently reaching 140 days/year and 20 days per year respectively. The projected models on the future of Fiji's climate are however less clear. However, an increase in wet days can be expected under the mitigation scenario (RCP4.5), to a rate of +7.97 days/year per decade, while an increase in extremely wet days can be expected under the business-as-usual scenario (RCP8.5) to a rate of +1.84 days/year per decade.

**The average rainiest days in Fiji records more than 150 mm of rain in one day on average. This value is expected to increase, showing more intense extreme rain events.** While the value of the average annual maximum on day precipitation did not change over the last 40 years, it remained very high, 155 mm in a single day, with values above 300 mm in a single day being often recorded. What is more, this value is expected to increase during the next 30 years, to a rate between +14.42 mm per decade (RCP4.5) and +12.87 mm per decade (RCP8.5).

**The number of hurricanes affecting Fiji per year has increased.** Although the average and maximum wind speed during the last 40 years and the number of cyclonic events (Gale, Storms, and Hurricanes) affecting Fiji stayed constant during the last 30 years, the number of events classified as Hurricanes (cyclonic events featuring wind speeds greater than 117 km/hour (64 knots)) has increased, to a rate of +0.30 hurricanes/year per decade.

**The sea level in Fiji is rising 2 to 3 times faster than the global average.** Since 1998, the sea level rose at a steady rate of +7.5 mm per year on average, a rate almost double to the global average (+4.5 cm per decade for the period 2013-2021 (World Meteorological Organization 2022)). In Suva this increase was +10 mm per year. This rise in sea level can contribute to floods exposure as extremely high tides accompanied by strong winds can lead to coastal flooding.

**Causes leading to consequences, the number of recorded floods in Fiji increased.** The number of floods recorded in Fiji increased to a rate of +2.01 events/year per decade during the 1980-2009. In 2009, there was around 6.5 flood events per year in Fiji.

**The area mostly impacted by this increase in exposure is expected to be the coastal lowlands of Viti Levu.** The increase in accumulated rainfall, wet days and very wet days and hurricane paths are mainly observed along the coastal lowlands of Viti Levu[2].

[2] More details on the most exposed area in section XXX

## Fiji has experienced and is expected to experience an increase in temperatures

**Temperatures are increasing and are expected to continue to increase.** Fiji experienced a rise in average, minimum and maximum temperatures over the last 40 years, to a rate of +0.27°C, 0.29°C and 0.33°C per decade respectively. Except for minimum temperatures under the mitigation scenario (RCP4.5), This increase is expected to continue, to a rate between +0.23°C per decade and +0.42°C per decade depending on the variable and the scenario.

**The amount of accumulated degree days in Fiji is expected to rise during the next 30 years.** Although the amount of degree days stayed stable (around 6000°days per year) during the last 40 years, this variable is expected to increase during the next 30 years, to a rate pf +86°days/year per decade under the mitigation scenario (rCP4.5), and +128°days/year per decade under the business-as-usual scenario (RCP8.5).

**Although the reference evapotranspiration has been slightly decreasing during the last 40 years, this metric may increase in the future.** The reference evapotranspiration has been decreasing during the last 40 years, to a median rate of -26 mm/year per decade. This metric is, however, expected to stay stable under the mitigation scenario (RCP4.5), or even increase under the business-as-usual scenario (RCP8.5).

**Be that as it may, the climatic water balance has been increasing and is expected to continue to increase, driven by the expected increase in accumulated precipitation.** The climatic water balance increased during the last 4 decades to a rate of +102 mm/year per decade. This increase is expected to intensify during the next 3 decades, to a rate of +245 mm/year per decade under the mitigation scenario (RCP4.5), and +315 mm/year per decade under the business-as-usual scenario (RCP8.5).

**This general increase is however mitigated by an increase in observed and expected the number of dry months and an observed decreased number of wet months in Fiji.** The number of dry months in Fiji (as defined using the 3-months SPEI), has been increasing during the last 40 years, to a rate of +0.15 months/year. This increase is expected to continue to a rate of +0.54 months/per under the mitigation scenario (RCP4.5), and +0.71 months/year per decade the business-as-usual scenario (RCP8.5). The number of wet months, on the other hand, has been decreasing to a rate of -0.17 months/year per decade, but no statistically significative variations are expected during the next 40 years.

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