



Dar es Salaam Climate Profile: Summary Version

Prepared by:
University of Cape Town



UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD



September 2017



Images: James Millington, landscapemodelling.net

For enquiries regarding this Climate Profile, please contact Lorena Pasquini (lorena.pasquini@gmail.com) or Lisa van Aardenne (lisa@csag.uct.ac.za)

Dar es Salaam's climate

Dar es Salaam has a tropical climate with relatively warm temperatures, high humidity, and annual rainfall over 1000 mm. Rainfall occurs all year round but mainly during two rainy seasons: the short rainy season from October to December (where roughly 350mm of rainfall falls on average) and the main / long rainy season from March to May (on average roughly 610 mm of rain falls during this period). Less rainfall occurs during January and February (the rainfall during this period averages around 110 mm), and there is a long and relatively dry season from June to September (there is less than 100 mm of rainfall during this period on average). The warmest time of year is during January and February and the coolest time of the year occurs during July and August. More details are provided in Figure 1 below.

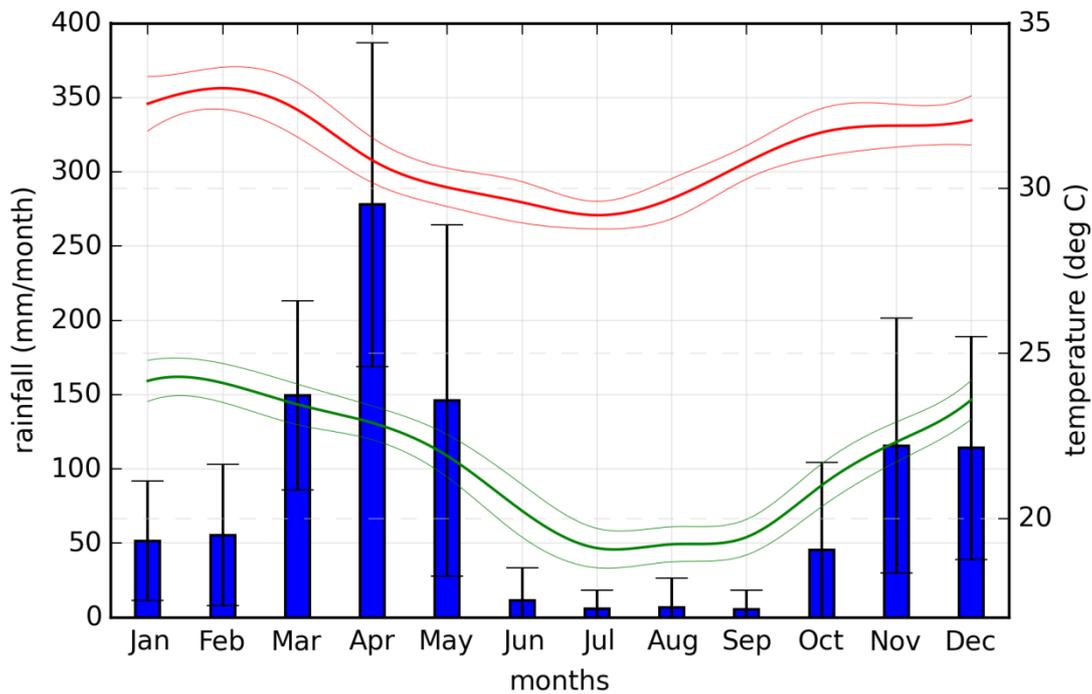


Figure 1: 1981 to 2010 historical averages for rainfall and temperatures over Dar es Salaam. Mean monthly total rainfall (mm/month) is shown as blue bars (the whiskers show ± 2 standard deviations). Monthly mean daily maximum and minimum temperature are shown by the red and green lines respectively. Lighter lines represent the ± 2 standard deviation around these means.

Rainfall patterns over time

- Rainfall normally happens during the late afternoon – early evening, although some storms may also develop over the ocean at night.
- From one year to the next, it is normal for the seasonal rainfall to be quite unpredictable. The average annual total rainfall is around 1,000mm, however some years recorded as little as 650mm while others recorded more than 1,300mm/year.
- Rainfall in Dar es Salaam has changed over time (i.e. from the period 1981-2013). The total annual rainfall has gone down over time¹. The number of days in which it rains has also gone down over time².
- However, the two rainy seasons have changed in different ways over time. The long rains (March to May) have shown an increase over time in the seasonal total amount of rainfall. This increase is because the daily intensity of rainfall (i.e. how much it rains in a day) in this season has gone up over time³. On the other hand, the frequency of rain days (the number of days in which it rains) has gone down over time⁴. In other words, over time, there are less rainy days during the long rains, but when it does rain, the rainfall is more intense.
- The short rains (October to December) show a different picture. Over time, the seasonal total amount of rainfall has gone down⁵. The number of days in which it rains has also gone down over time⁶.
- For both the long and short rains, the average wet-spell length (i.e. the number of back-to-back days in which it rains) has gone down over time, and at the same time the average dry spell length (i.e. the number of days between rainfall events) has gone up.

¹ The total annual rainfall has gone down over time by -26mm/decade, i.e. every decade, the average total rainfall for that decade goes down by 26mm.

² The number of days in which it rains has gone down over time by more than -6.5 days per decade, i.e. every decade, the average number of days in which it rains in that decade goes down by more than 6.5 days.

³ The average daily intensity of rainfall (i.e. how much it rains in a day on average), calculated over a decade, has gone up by nearly 6mm/day each decade

⁴ The number of days in which it rains during the long rainy season goes down by almost 4 days every decade.

⁵ There is a negative trend in the seasonal (short rains) total rainfall of -15 mm/decade, i.e., the average seasonal total rainfall, calculated over a decade, has gone down by 15mm each decade.

⁶ The average number of rain days within the short rains, calculated over a decade, has gone down by almost 2 days each decade.

Temperature patterns over time

- The average difference between the hottest and the coldest temperature within a day is just over 9 °C.
- The warmest temperatures take place during January and February (with an average daily maximum temperature of around 32.5 °C and an average daily minimum temperature of around 24 °C) and the coolest temperatures take place during the winter dry season (29.5 °C and 19 °C).
- From one year to the next, the average annual temperature does not change much.
- Over time, the most significant change in temperature patterns has been for average night-time temperatures. Over the period 1979-2014, average night-time temperatures have gone up in all seasons except during the long rains. The number of very hot nights (nights when the minimum temperature is more than 24.5 °C, which generally take place during December – March) has gone up over time⁷. The number of consecutive hot nights (the number of hot nights in a row) has also gone up slightly over time.

Future climate change

- The predictions for climate change in the future given here are taken from 15 different climate change models⁸.
- The future predictions for rainfall suggest that there will be no change in rainfall from the historical average (i.e. the average for the years 1986-2005) until the second half of the century. After that, some models predict an increase in rainfall, a couple predict a decrease in rainfall, and about half suggest that there will be no change in rainfall from the historical average up to the end of the century. *Please see Table 1 for details.*
- The future predictions for temperature suggest that both daytime and night-time temperatures will go up in the future. The number of very hot nights a year is predicted to go up much more than the number of very hot days. *Please see Table 2 for details.*
- The models suggest that this increase in temperatures is because of human activities that lead to climate change (i.e. it is not because of natural variability in the climate).

⁷ The average number of very hot nights, calculated over a decade, has gone up by more than 11 days each decade.

⁸ No single climate change model can predict the future accurately, so a number of models are used to give an idea of the worst-case and best-case predictions for future climate.

Table 1: Summary of predicted climate changes for key rainfall variables

Rainfall variable	Predictions from climate change models
Rainfall Totals [mm/year]	Most models suggest that there will be no change in average total rainfall from the historical average (i.e. the average for the years from 1986-2005) until the second half of the century. After that, some models predict an increase in rainfall, a couple predict a decrease in rainfall, and about half suggest that there will be no change in rainfall from the historical average up to the end of the century.
Rainfall daily intensity [mm/day]	Up to 2040, most models suggest that rainfall intensity will not change in the future from from the historical average. After 2040, a few models show that rainfall intensity will go up slightly.
Heavy rainfall frequency (over 10 mm in a day) [number of heavy rain days a year]	Up to 2040, most models suggest that the number of heavy rainfall days a year will not change, or will go up slightly, from the historical average. After 2040, more models predict that the number of heavy rainfall days a year will go up from the historical average, while a few predict that it will go down.
Extreme rainfall frequency (over 90 th percentile*, i.e. over 46.6 mm a day) [number of extreme rain days a year]	Up to 2040, most models suggest that the number of extreme rainfall days a year will not change, or will go up slightly, from the historical average. After 2040, more models predict that the number of extreme rainfall days a year will go up from the historical average, while a few predict that it will go down.

* The 90th percentile is used to show the frequency of extreme events through time, in other words the 10% of most extreme events - for example the 10% of days with the hottest temperature in the weather data record, or the 10% of days with the heaviest rain in the record. It is the historical threshold for extreme events.

Table 2: Summary of predicted climate changes for key temperature variables

Temperature variable	Predictions from climate change models
<p>Average Tmax [°C] [average daily maximum temperature]</p>	<p>By 2040 the average daily maximum temperature (the highest temperature in a day) may be between 0.5 – 1 °C higher (warmer) than the historical average (i.e. the average for the years from 1986 to 2005).</p> <p>By the end of this century, the average daily maximum temperature may be between 2 – 4 °C higher (warmer) than the historical average.</p>
<p>Average Tmin [°C] [average daily minimum temperature]</p>	<p>By 2040 the average daily minimum temperature (the lowest temperature in a day) may be between 0.75 – 1.75 °C higher (warmer) than the historical average.</p> <p>By the end of this century, the average daily minimum temperature may be between 2 – 4.5 °C higher (warmer) than it is now.</p> <p>However, it is expected that changes in the average daily minimum temperatures will be felt as early as the coming decade.</p>
<p>Frequency of daytime extreme heat events (over 90th percentile, i.e. the hottest daytime temperature is more than 34.6 °C) [number of extreme heat days a year]</p>	<p>By 2040 there will be more very hot days in a year (i.e. days where the highest temperature is more than 34.6 °C), compared to the historical average. However, there is a lot of uncertainty about how many more days a year there will be. At the moment, there are on average 36 days a year in which the highest temperature is more than 34.6 °C. By 2040, the average number of very hot days in a year could range from 50, to as many as 180. In other words, in the worst case scenario, half the days in a year could be hotter than 34.6 °C.</p> <p>By the end of the century, there is still a lot of uncertainty about how many more very hot days a year there will be. The average number of very hot days in a year could range from 80, to as many as every day in the year being hotter than 34.6 °C. In other words, in the worst case scenario, the highest daytime temperature could be hotter than 34.6 °C all year round.</p>
<p>Frequency of nighttime extreme heat events (over 90th percentile, i.e. the lowest night-time temperature is more than 24.5 °C) [number of extreme heat nights a year]</p>	<p>Up to the end of the century, the number of very hot nights in a year (i.e. nights where the lowest temperature is more than 24.5 °C) will go up steadily.</p> <p>Now, there are on average 36 nights a year in which the lowest temperature is more than 24.5 °C. By 2040 there could be on average between 100 and 200 of these very hot nights in a year.</p> <p>By the end of the century it is predicted that on average at least 220 nights in a year could be hotter than 24.5 °C, up to every single night in a year.</p>

A note on the climate change predictions

- These predictions for future climate change have been taken from global climate change models. Global climate change models cannot model what might happen at the local level very well: they give averages for large areas, and what might happen in a particular place might be quite different from these averages.
- There are different climate change predictions, called 'statistically downscaled projections', that try to predict what will happen at local levels.
- We have not given the results of these statistically downscaled projections here in detail, because we have more confidence in the results from the global climate change models.
- However, the results of the statistically downscaled projections are similar to those of the global climate change models for temperature:
 - By 2040 the daily maximum temperatures may be between 1 – 1.75 °C warmer than the current climate, and up to 2.75 – 4.5 °C warmer than the current climate by the end of the century. Changes in daily maximum temperatures may already be noticeable.
 - By 2040 the daily minimum temperatures may be between 1 – 1.5 °C warmer than the current climate, and up to 2.5 – 4.25 °C warmer than the current climate by the end of the century. Changes in daily minimum temperatures may already be noticeable.
 - The frequency of very hot days and nights (i.e. days where the minimum temperature is above 34.6 °C, and nights where the minimum temperature is above 24.5 °C) is expected to go up in the future. However, the number of very hot nights in a year is expected to go up more quickly than the number of very hot days, especially before the 2060s.
- The results of the statistically downscaled projections for rainfall are a bit different to those of the global climate change models:
 - For rainfall, most models suggest that up to 2040, there will be no change in average total rainfall, rainfall intensity, frequency of rainfall and frequency of extreme rainfall from the historical average.
 - By the end of the century, most models predict that average total rainfall, rainfall intensity, frequency of rainfall and frequency of extreme rainfall will all go down compared to the historical average.



The contents of this Working Paper reflect the views of the author only and not those of the UK Department for International Development or the Economic and Social Research Council.