APPENDIX

Turning up the heat: West Africa faces rising climate hazards as adaptation gathers pace

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The below is supplementary material to "**Turning up the heat: West Africa faces rising climate hazards as adaptation gathers pace**."



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Here, we describe our approach to assessing the exposure of African countries and subnational governments to physical climate risks, including the input metrics and limitations.

Data sources

To estimate the direct exposure of African countries and subnational governments to nine climate hazards, we used the S&P Global Sustainable1 Physical Risk: Country, Subnational and Municipal dataset (S1 dataset). The dataset shows decadal averages from the 2020s through to the 2050s, averaged to country and subnational government administrative regions.

We also reviewed the climate hazard exposure data available for four of the shared socioeconomic pathways (SSPs) developed by the UN Intergovernmental Panel on Climate Change (IPCC).

Shared socioeconomic pathways defined

The IPCC's SSPs are a set of scenarios for projected greenhouse gas emissions and temperature changes. They incorporate broad changes in socioeconomic systems, including population growth, economic growth, resource availability and technological developments.

- **SSP1-2.6 is a low emissions scenario.** Under this, the world shifts gradually, but consistently, toward a more sustainable path. **This SSP aligns with the Paris Agreement's target** to limit the average increase in global temperature to below 2.0 degrees C by the end of the century. It projects a global temperature increase of 1.7 C (a likely range of 1.3 C-2.2 C) by 2050 or 1.8 C (1.3 C-2.4 C) by the end of the century.
- **SSP2-4.5 is a moderate emissions scenario.** This is consistent with a future with relatively ambitious emissions reductions but where social, economic and technological trends do not deviate significantly from historical patterns. **This scenario is close to countries' current pledges** but falls short of the Paris Agreement's aim of limiting the global temperature rise to below 2 C. It projects an increase of 2.0 C (1.6 C-2.5 C) by 2050 or 2.7 C (2.1 C-3.5 C) by the end of the century.
- **SSP3-7.0 is a moderate-to-high emissions (slow transition) scenario.** Under it, countries increasingly focus on domestic or regional issues, with slower economic development and lower population growth. A low international priority for addressing environmental concerns leads to rapid environmental degradation in some regions. This SSP projects a global temperature increase of 2.1 C (1.7 C-2.6 C) by 2050 or 3.6 C (2.8 C-4.6 C) by the end of the century.
- **SSP5-8.5 is a high emissions (limited mitigation) scenario.** This SSP sees the world place increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and where the development of human capital is a path to sustainable development. It projects a global temperature increase of 2.4 C (1.9 C-3.0 C) by 2050 or 4.4 C (3.3 C-5.7 C) by the end of the century.

Defining the sample

We analyze the 16 countries within West Africa, comparing climate hazard exposures with countries in the African continent (53 countries), as well as 371 subnational governments.

Breakdown of the 53 African countries used in our analysis

Region	Number of countries	Number of subnational regions	% of countries with subnational data
Central Africa	11	28	18%
East Africa	17	157	47%
North Africa	5	42	40%
Southern Africa	4	25	50%
West Africa	16	119	44%
Total	**53**	**371**	**40%**

Data accessed Aug. 3, 2026.

Coverage of African subnational regions within the Physical Risk: Country, Subnational and Municipal dataset.

Source: S&P Global Sustainable1.

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Applying climate scenarios

Climate data and scenario analysis can provide greater visibility into the long-term physical climate risks the companies in our sample may face (see "**Scenarios Show Potential Ways Climate Change Affects Creditworthiness**," July 25, 2024). However, there are various uncertainties around translating climate model outputs into specific potential impacts and gauging the financial materiality of climate events.

We consider countries' and subnational governments' exposure to climate hazards primarily using SSP3-7.0 through the 2050s. This is to reflect the lock-in of historical greenhouse gas emissions, which implies many physical climate risks may persist regardless of today's policy choices. SSP3-7.0 equates to a rise in temperature from preindustrial levels of about 2.1 C by 2050, the same time frame as the S1 dataset, or 3.6 C by the end of the century. This conservative scenario also reflects the uncertainties inherent in long-term projections.

We used the other SSPs to describe a broader range of possible outcomes, where appropriate. Countries' greenhouse gas commitments, if met, align with a global temperature increase of between 2.4 C and 2.6 C by 2100, according to the United Nations Environment Program. This is similar to SSP2-4.5. However, until the middle of this century, there is little difference in global temperature projections among the four climate scenarios due to a time lag of at least a decade in the climate system's response to greenhouse gas emissions, even as current emissions continue to warm the planet.

Climate hazards: Definitions and metrics

We applied definitions of the nine climate hazards, then used corresponding metrics to capture changes over time through values by decade.

The S1 dataset defines:

- **Extreme heat** conditions as temperatures exceeding the local daily maximum temperature for 5% of all days in 1950-1999. We assume that each location is adapted to its respective historical frequencies of extreme heat events, and that any future increase in temperature exceeds what would be expected due to natural variability.
- **Coastal**, **fluvial** and **pluvial flooding** as the annual frequency of days in excess of the historical 100-year flood level. This metric uses the annual probability of flooding, based on the decadal average.
- **Water stress** as the projected ratio of demand to basin-specific water supply (from both groundwater and surface water sources), expressed in absolute terms. This metric is reported using a range of 0 to 1.0 and describes the state of water availability (calculated using a decadal average) for the local water basin. A value of 0.4 or higher is defined as high water stress.
- **Wildfires** and **droughts** according to indexes that express, respectively, general fire intensity potential and climatic conditions favorable to drought. For wildfire, the index is enhanced by incorporating land cover that contains or is adjacent to burnable vegetation, urban areas or bodies of water. Both climate hazards are expressed as the absolute frequencies of extreme conditions annually.

Climate hazard metrics, definitions and spatial resolution for the 9 climate hazards

Climate hazard	Metric	Metric definition	Spatial resolution*
Extreme heat	Projected maximum temperature is warmer than the 95th percentile local baseline daily maximum temperature	Annual percentage of days with maximum temperature warmer than the 95th percentile local baseline daily maximum temperature	About 25 km x 25 km
Extreme cold	Projected minimum temperature is colder than the fifth percentile local baseline daily maximum temperature	Annual percentage of days with minimum temperature colder than the fifth percentile local baseline daily minimum temperature	About 25 km x 25 km
Coastal flooding (sea-level rise)	Frequency of 100-year coastal flood	Projected frequency of the historical baseline 100-year coastal flood depth	90 meters x 90 meters
Fluvial (river) flooding	Frequency of 100-year fluvial flood	Projected frequency and extent of the historical baseline 100-year flood depth	About 1 km x 1 km
Pluvial (rainfall) flooding	Frequency of 100-year rainfall event	Projected frequency of the historical baseline 100-year daily precipitation rate	About 25 km x 25 km

Climate hazard	Metric	Metric definition	Spatial resolution*
Tropical cyclones	Frequency of category 3 and higher storms	Projected annual frequency of category 3 and higher tropical cyclones	About 25 km x 25 km
Wildfires	Fire Weather Index	Projected frequency of days classified as high, very high or extreme based on the Fire Weather Index, adjusted for land cover/presence of burnable vegetation	About 25 km x 25 km
Water stress	Water Stress Index	Projected future ratio of water withdrawals to total renewable water supply in a given area	River basin
Drought	Standardized Precipitation-Evapotranspiration Index	Projected frequency of months classified as showing moderate drought, severe drought or extreme drought based on the Standardized Precipitation-Evapotranspiration Index	About 25 km x 25 km

Data accessed Aug. 3, 2026.

* Smallest distinguishable unit of area.

Source: S&P Global Sustainable1.

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Limitations

We describe some of the limitations and assumptions of our analysis below. This list is not exhaustive.

The climate hazard metrics capture only exposure to physical climate risks. This is separate from vulnerability, which can depend on asset type, the presence (and success of) adaptation and resilience measures, and supply chain, among other factors. The exposure hazard data is only a first step in understanding the factors that may contribute to (or offset) the climate-related credit impairment of an issuer/instrument, such as adaptation and resilience measures (e.g., levees, green roofs and managed retreats).

There are inherent uncertainties associated with climate science, as with any long-term estimate of future events. These include the crystallization and severity of climate risks (see "Model Behavior: How Enhanced Climate Risk Analytics Can Better Serve Financial Market Participants," June 24, 2021, which describes some of these uncertainties and potential mitigants). These uncertainties may include, but are not limited to:

- **Complexities associated with climate hazards.** For example, the cause of wildfires may be natural, such as lightning or ignition of dry vegetation by the sun, or human, such as unattended campfires. Many factors contribute to the number of wildfires in an area in any given year, including summer temperatures,

precipitation levels and wind conditions. Research suggests a strong relationship between temperature and fire extent, particularly in the US, with warmer years generally having more fires (principally due to fuel aridity) than cooler ones, since the early 1980s. The long-term change in climate may increase the risk of wildfires. However, it is not possible to precisely predict where and when specific wildfires will happen and what damage they may cause. By nature, wildfires (like heavy summer rainfall in many parts of the world) are highly localized. This notwithstanding, the potential for increased exposure over time highlights the importance of dialogue and learning how entities with assets in these areas assess these risks, and whether they have measures in place to reduce the risk of wildfires and other relevant hazards.

- **Greater uncertainty associated with projections of certain climate hazards**. Complexity and local factors — such as topography, hydrology and land use — can make modeling changes for some climate hazards (such as fluvial flooding or tropical cyclones) more difficult than for others (such as average temperature). Due to these uncertainties, projections of changes in tropical cyclones (for instance) are made through the 2040s, with subsequent decades held at the 2040s value.
- **Modeling highly localized events**. Projections of wildfires and other events are difficult because local conditions (including topography and wind patterns) are not easily replicated at scale in global climate models. Such limitations could obscure some of the likely changes in the intensity of climate events over the next 30 years.
- **Cascading and/or multiple climate hazards not being considered**. All hazards are modeled independently. The correlation or vulnerability associated with the co-occurrence of hazards is not specifically modeled. For example, the tropical cyclone hazard metric encompasses the frequency of associated wind risks, while the coastal flooding hazard metric independently includes storm surge flooding, likely capturing flooding associated with tropical cyclones.

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