African Risk Capacity
Sovereign Disaster Risk Solutions
A Specialized Agency of the African Union

eXtreme Climate Facility (XCF)

SUMMARY

Index Design and Risk Modelling Policy Brief

AMIGO climate

SUMMARY

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1 Climate risk: extreme events and their impacts

The Extreme Climate Facility (XCF) is envisioned as a data-driven, multi-year financial vehicle that tracks the frequency and magnitude of extreme climate shocks in Africa, and provides additional financing for countries already managing their current weather risks through the African Risk Capacity Insurance Company Limited (ARC Ltd).

ARC ltd is a financial affiliate of the African Risk Capacity (ARC), a specialized agency of the African Union (AU) designed to improve current responses to climate-related food security emergencies. ARC's mission is to use modern finance mechanisms, such as risk pooling and risk transfer, to create pan-African climate response systems that enable African countries to meet the needs of people harmed by natural disasters. Since its launch in 2014, 8 countries have participated in the ARC Ltd insurance pool and secured drought coverage for their agricultural seasons. These countries are: Senegal, Niger, Mauritania, Malawi, Burkina Faso, Mali and The Gambia. Members of the ARC risk pool receive a payout when the rainfall deviation is sufficiently severe such that the estimated response costs cross a certain pre-defined threshold. When that threshold is crossed, qualified risk pool members receive a payout within 2 - 4 weeks of the end of the rainy season, once their final implementation plan is approved by the ARC Agency Board. The final implementation plans articulate how a government will spend a payout. This approach allows the affected governments to begin early and targeted intervention programmes to support vulnerable households before they begin engaging in negative coping actions.

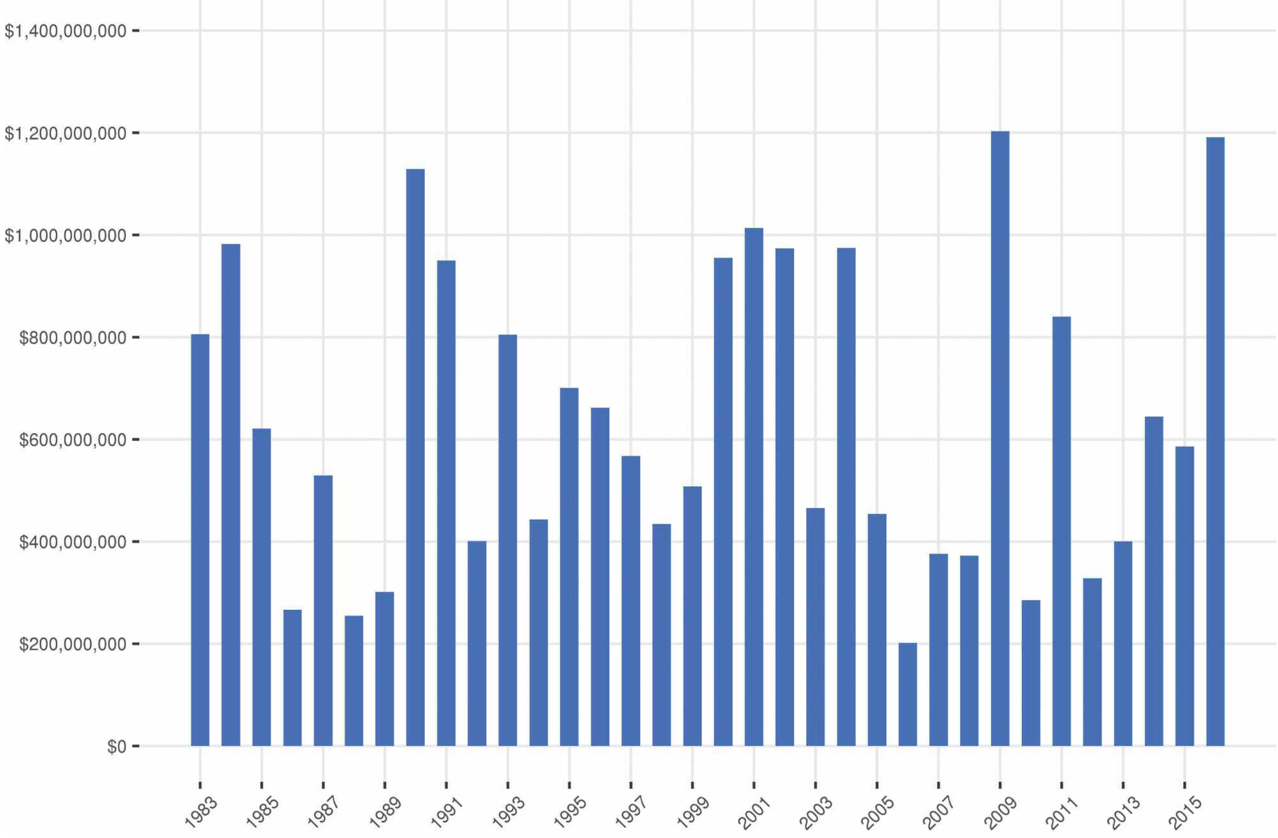


Figure 1. Total response costs estimated with Africa Risk View over a subset of qualified risk pool members which includes Burkina Faso, Gambia, Mali, Mauritania, Niger, Senegal, Chad, Kenya, Malawi, Zimbabwe, Madagascar, Ethiopia.

The frequency of extreme weather events such as drought, heatwaves and tropical cyclones is more and more uncertain due to climate change, and appropriate measures and investments are urgently needed to protect societies. In particular increasing droughts, intense rainfalls and heatwaves can have devastating impacts for many African countries.

Whereas ARC payouts are triggered in response to individual rainfall events, contracts issued by the XCF would trigger payments to all eligible countries in a region whenever an appropriate index measuring **the frequency of extreme events** exceeds a pre-defined threshold, thus indicating a changing climate in that area.

Droughts, for example, can affect a given area on different time scales. A few days without rainfall can have a catastrophic impact on agriculture if they occur during critical phases of the crop life cycle, such as germination or flowering. However, their impact on surface water reservoirs would be limited in this case. On the other hand, an entire season of less rainfall than usual can affect significantly the level of a lake or the discharge of a river.

The way a drought is perceived change also significantly from place to place. For example, while 700-800 mm of rainfall can be considered normal in Addis Ababa, a few hundreds of kilometers to the west the same level of annual accumulated rainfall would be considered low or extremely low.

Extreme droughts can have a dramatic economic impact for African countries.

For example, a 1-in-10 year drought event could have an estimated adverse impact of 4 percent on the annual GDP of Malawi, with even larger impacts for 1-in-15 and 1-in-25 year events[1]. Such decreased productivity detracts from economic growth, causes major budget dislocation, erodes development gains and resilience, and requires additional emergency aid from the international community in the future.

High temperatures also have an impact on the energy balance of any living organism and on the operational capabilities of critical infrastructures and specific sectors such as agriculture, health, wildfires, transport, power generation and distribution. Heatwaves occurring during critical phases of the crop cycle, for example during flowering, can lead to a complete failure of the cropping season. Heatwaves can amplify the effect of mild droughts, as it happened in Malawi during the winter of 2015. Furthermore, by increasing the energy demand and consumption linked to cooling, heatwaves have an impact on the electricity system, as well as on the efficiency of the energy transmission itself. Finally, persistently high temperatures have a direct impact on human health.

Overall, according to the World Food Programme[2], for millions of people across Africa, Asia and Latin America, **climate change means more frequent and intense floods, droughts and storms**, accounting each year for up to **90 percent of all natural disasters.** These can quickly spiral into full-blown food and nutrition crises. In the last decade, almost half of the World Food Programme (WFP)'s emergency and recovery operations have been in response to climate-related disasters, at a cost of US$23 billion.

2 The Extreme Climate Facility (XCF)

The XCF relies on a new specifically developed index called the Extreme Climate Index (ECI), which is capable of tracking changes in the frequency and/or magnitude of extreme weather events in African countries, thus indicating that a shift to a new climate regime is underway in a particular area.

The ECI: what it is and how it works

- is multi-hazard, i.e. a single index can be used to describe extreme temperatures, precipitations as well as additional hazards if needed. This way, it is possible to target the extreme events that are likely to have the gravest impact on Africa's vulnerable populations and economic growth potential;
- captures individual extreme events, and is suitable for monitoring changes in extreme climate event frequency and intensity over a 30-year or so time frame;
- is standardized, so that it can be aggregated and compared across larger geographical regions;
- reflects the large-scale climate regime picture of a region;
- is constructed from data with a consistent, long, high- quality historical record that will also be produced objectively and consistently in near real time going forward.

[1] African Risk Capacity – The cost of Drought in Africa http://www.africanriskcapacity.org/wp-content/uploads/2016/11/arc_cost_of_drought_en.pdf

[2] World Food Programme, "Climate Action". http://www1.wfp.org/climate-action

The ECI allows, first of all, to detect the **number of extreme climate events in a given area in a given period of time.**

The XCF also comprises **a strategy for detecting changes in the frequency of extreme events**. By using historical records of temperatures and precipitations along a *baseline period* of several decades, and relying on statistical methods, it is possible to calculate the maximum number of extreme events that would be compatible with the hypothesis of an unchanging climate. By comparing it with the number of extreme events actually observed in an area during, for example, the latest 5 years (the *assessment* period), it is possible to confirm or rule out that the local climate is changing, confidently distinguishing between the effect of climate change and the ordinary statistical fluctuations.

When the change in the frequency of events for a given area is considered virtually certain, a **payment** is triggered, in the form of a progressive lump-sum scheme (see section 5).

3 The Extreme Climate Index (ECI)

The first step towards defining an Extreme Climate Index that serves the purposes of the XCF is to define single-hazard indicators which can be integrated into a multi-hazard index. Well-established indicators exist in scientific literature and can be adopted or modified according to the needs of XCF. Among the many drought indices, the Standardized Precipitation Index (SPI) meets the requested properties of requiring a minimum number of input variables, so that it can be easily computed over large areas, and having a consistent definition over different geographical areas, so that critical threshold can be conveniently defined once for all.

The SPI is a measure of the deviations of cumulated rainfall from the expected normal, rather than a measure of the absolute values. For example, in a certain region, 400 mm of rain may be what is expected for the entire rainy season, while in another region the same value can be associated to an exceptional drought.

The computation of the SPI is constructed as follows:

- A monthly precipitation dataset is prepared, for a period of at least 30 years or more.
- For each month, the cumulative rainfall over a certain period (depending on the problem of interest it can typically be 3, 6, 12, 24 or 48 months) is computed.
- Each set of values of cumulative rainfall (for example, all the values of the July-August-September rainfall) is compared with statistical methods to the historical dataset, to establish a relation between each value of cumulative rainfall and its probability. The probability which corresponds to each value of the cumulative rainfall is turned into a value of the SPI index.

In the end, the values of SPI for each period is mapped out as a single bar chart (Figure 2) shows an example where each point represents a value of SPI referred to a 3-months period.

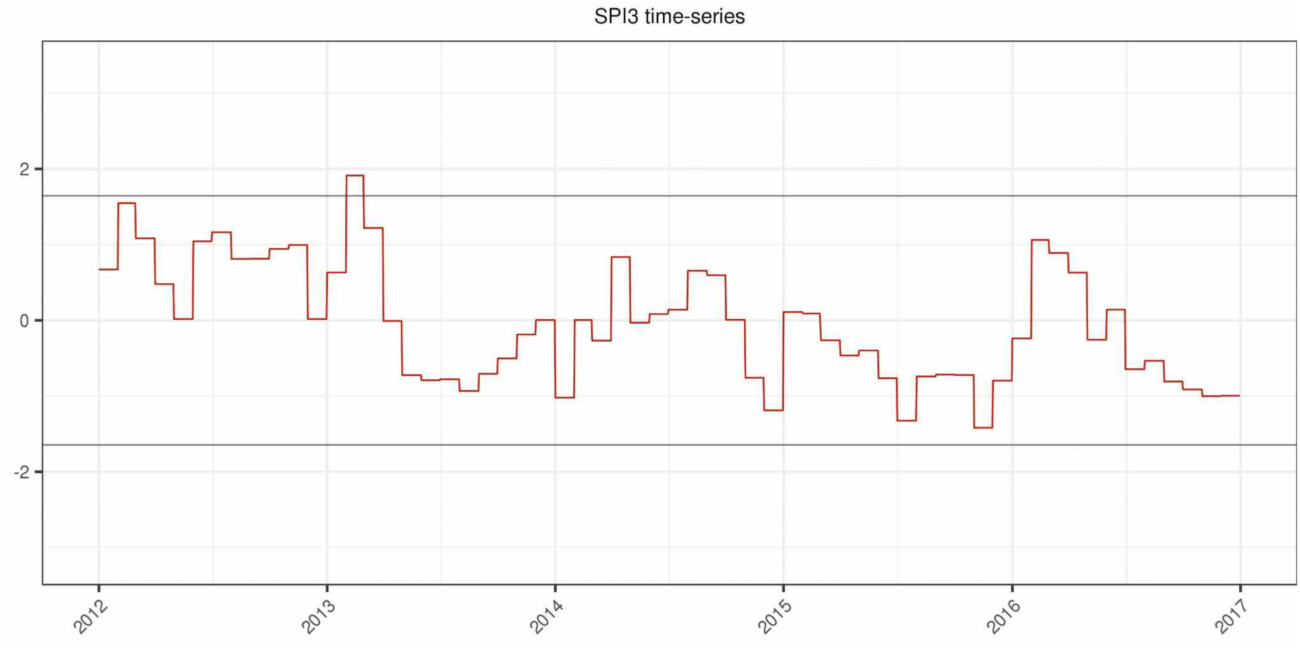


Figure 2 – SPI3 time-series for Region 1 (see Par. 5) on the assessment period 2012-2017, computed using ERA-INTERIM data. Each value of the time series is related to the probability of occurrence of the cumulated precipitation over the associated and the previous two months, computed with respect to the statistics of the historical dataset; as an example, the SPI3 value associated with Mar 2016 is related to the probability of occurrence of the cumulated precipitation over Jan, Feb and Mar 2016. The horizontal grey lines represent the 5^{th} (lower line) and the 95^{th} (higher line) percentiles of SPI3 values distribution over the historical dataset: SPI3 values crossing these lines indicate the occurrence of an extremely rare event or, equivalently, of an extreme event. In particular SPI3 values lower than the 5^{th} percentile and higher than 95^{th} percentile indicate, respectively, an extraordinary low and high amount of precipitation over the corresponding 3-months period.

The choice of the SPI time scale depends on the process of interest, since a lack or excess of rainfall have different impacts on the environment depending on their duration:

- A 3-month index reflects *short- and medium-term moisture conditions* and provides a seasonal estimate of precipitation, also relevant for cropping conditions. It is important to compare the 3-month SPI with longer time scales: as an example, a relatively normal 3-month period could occur in the middle of a longer-term drought, that would only be visible at longer time scales.

- A 12-month SPI reflects long-term precipitation patterns. It is tied to *streamflows, reservoir levels, and even groundwater levels at the longer time scales*.

For the purpose of the XCF, a combination of SPI3 and SPI12 was selected, so as to capture risks connected to both agricultural activities and depletion of water reservoirs.

Similarly, a Standardized Heat Wave Index (SHI) with the desired properties can be constructed with ad-hoc adjustments of existing heat wave indices, so that it not only allows the comparison of heat waves occurring under different climatic regimes, but also calculates their probability of occurrence and expected return period.

The computation of the SHI is similar to the one showed for SPI, and is based on measuring the probability associated with each observed value of temperature anomaly. In this case, the relevant time scale is of a few days, instead of months as for the SPI: this time scale is best suited to capture the impact of intense heat on living systems. As an example, most of the operational national Heat-Health systems worldwide, assume a duration of 2 or 3 days as the required threshold for the triggering of warnings[3].

The result is a bar chart showing a time series of SHI values, as shown in Figure 3.

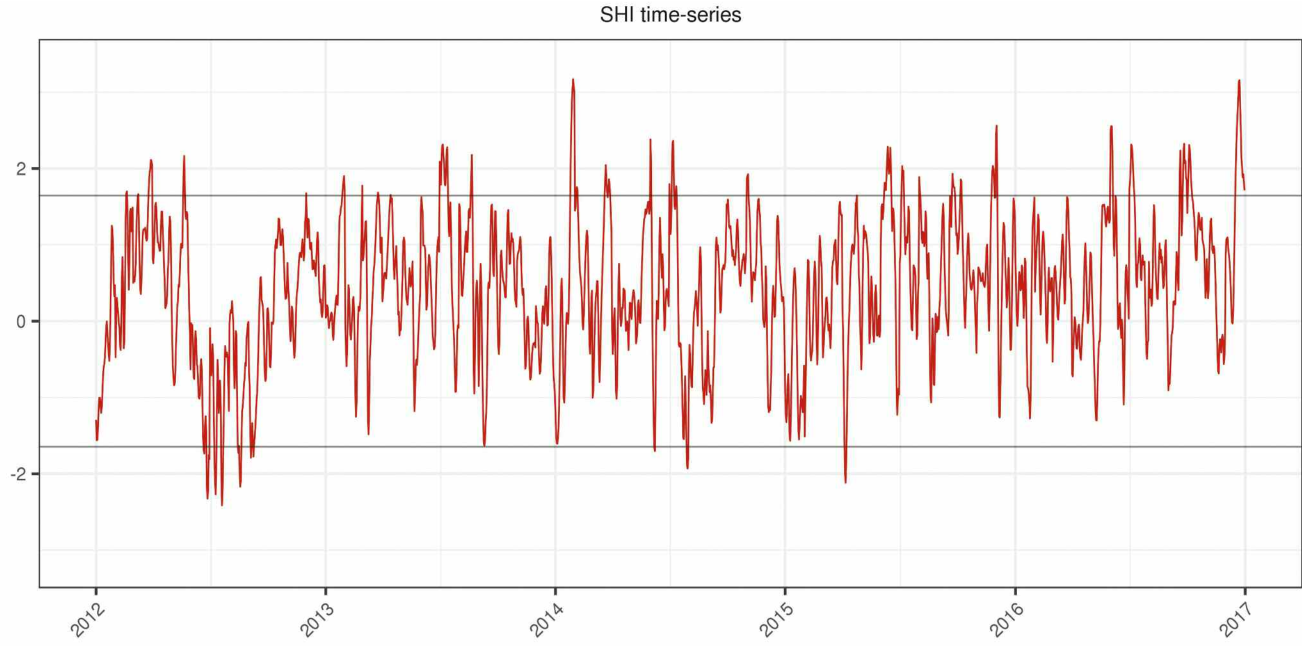


Figure 3 - SHI time-series for Region 1 (see Par. 5) on the assessment period 2012-2017, computed using ERA-INTERIM data. Each value of the time series is related to the probability of occurrence of the cumulated maximum daily temperature over the associated and the previous two days, computed with respect to the statistics of the historical dataset; as an example, the SHI value associated with 3 March 2016 is related to the probability of occurrence of the cumulated maximum daily temperature over 1, 2 and 3 Mar 2016. The horizontal grey lines represent the 5th (lower line) and the 95th (higher line) percentiles of SHI values distribution over the historical dataset: SHI values crossing these lines indicate the occurrence of an extremely rare event or, equivalently, of an extreme event. In particular SHI values lower than the 5th percentile and higher than 95th percentile indicate, respectively, extraordinary low and high temperatures over the corresponding 3-days period.

The values of the three single hazard indices (SPI3, SPI12 and SHI) for each point in time are then combined combined into a single value, the ECI.

[3] Heatwaves and health: guidance on Warning-System Development, WMO-No. 1142

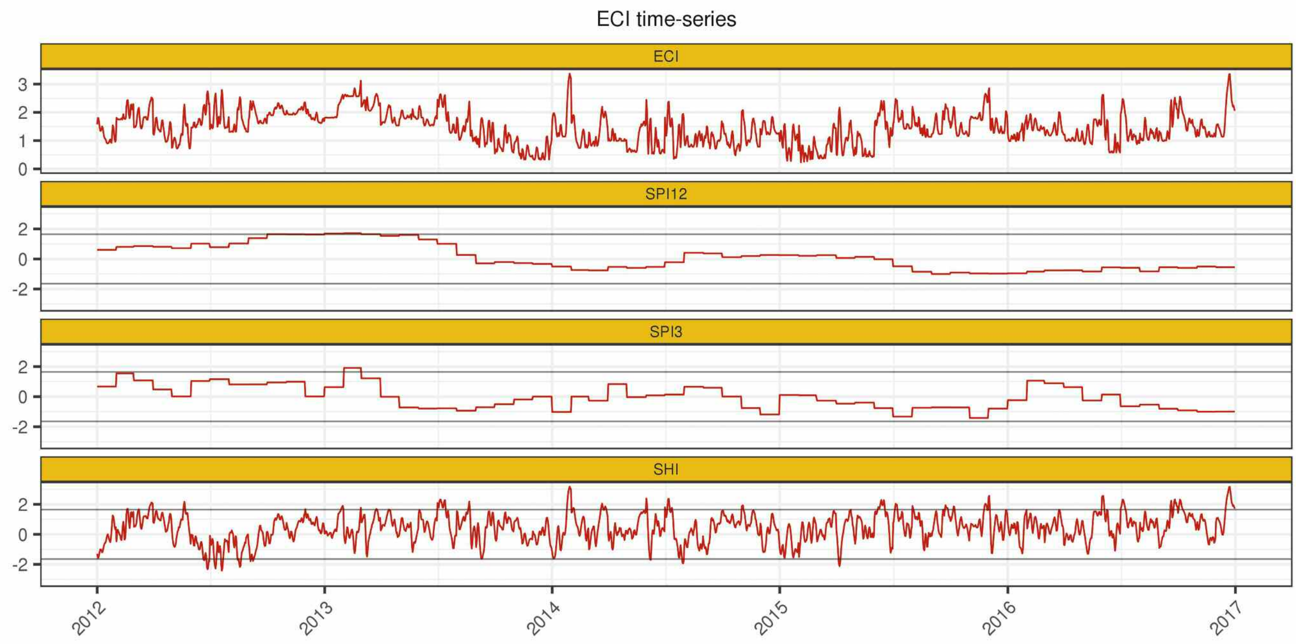


Figure 4 – SHI, SPI3, SPI12 and ECI time-series for Region 1 (see Par. 5) on the assessment period 2012-2017, computed using ERA-INTERIM data. SHI, SPI3 and SPI12 time-series are computed independently starting from the respective variables datasets. ECI time-series is given by the composition of the previously mentioned indicators.

After setting an appropriate threshold to define "extreme" events (typically defined as events that happen on average every 10 years), the ECI will highlight extreme conditions in the case of large anomalies of accumulated rainfall, of extreme temperature, and when both temperature and rainfall deficit are extreme.

4 Detecting changes in climate extremes

The algorithm for the detection of changes in the frequency of extremes - and hence for triggering the XCF payouts - is based on the comparison between the *observed* frequencies of extreme events over a given period, and the frequencies that are compatible with the hypothesis of an unchanging climate.

The ECI values for each day can be mapped out on a graph. Each day sits at a certain distance from the normal values of rain and temperature observed on the same day over the course of many years. One day could be very hot with almost normal rainfall, while another day may be very wet but with a normal temperature.

How does this index translate into targeted payouts? The method implies using a sufficiently long baseline period as a reference, and then calculating the maximum number of extreme events that would be compatible with stationary climate regimes. If, during a selected assessment period, the number of extremes exceed the allowed maximum, a change in climate regimes is detected and a payout is triggered.

For example, a decision to trigger or not trigger a payment for a certain geographical region in 2017 can be made as follows.

First, the number of extreme events over a period of 30 years, from 1982 to 2012, is counted. This is the *baseline* period. Based on this count, it is possible to derive the number of expected extreme events for the 5-year period from 2012 to 2017 (called the *assessment period*) under the hypothesis of an unchanging climate, and the maximum number of events that could still be attributed to statistical fluctuations (i.e. more than expected, but still not enough to discard the hypothesis of a stationary climate).

At this point, the number of observed extreme events can be compared to the threshold. In (Figure 5), the number of observed events is even below the number that would be expected, possibly because of statistical fluctuations. No payment is triggered in this case.

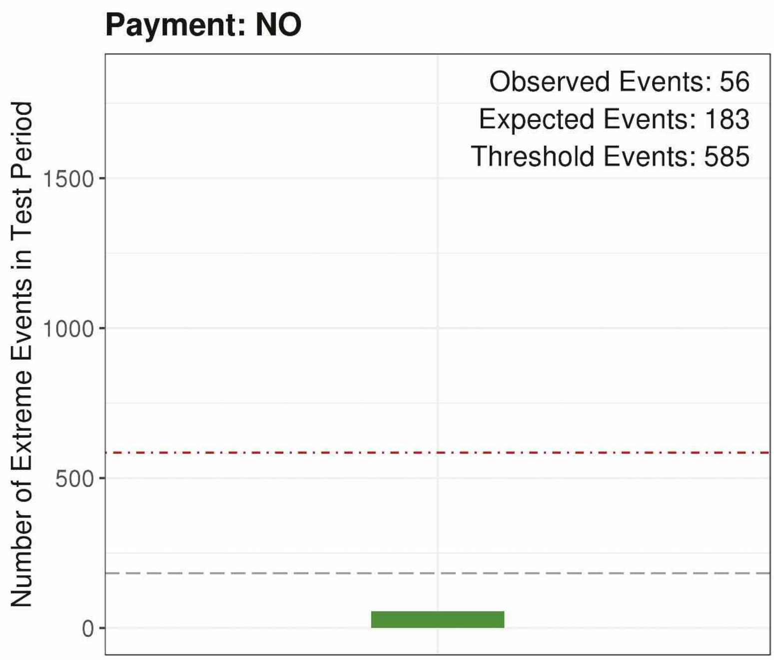


Figure 5 – Example of comparison between observed (green bar), expected (grey line) and threshold (red line) number of extreme events. In this case the observed number of extreme events is lower than the threshold number. As a consequence, no payment is triggered.

In Figure 6, the observed events are above the expected number, but still below the threshold that signals that climate is almost certainly changing. Again, no payout is triggered.

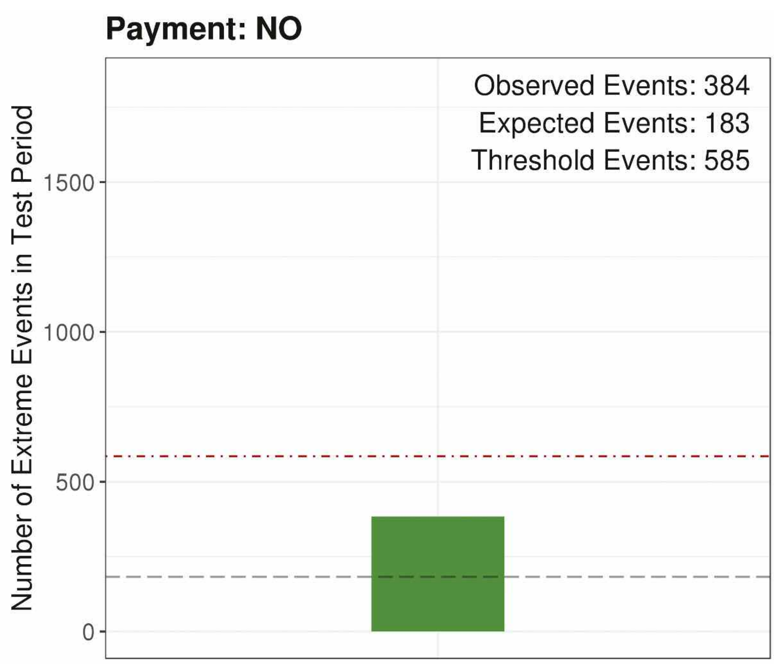


Figure 6 - Example of comparison between observed (green bar), expected (grey line) and threshold (red line) number of extreme events. In this case the observed number of extreme events is lower than the threshold number, even though it is higher than the expected number. As a consequence, no payment is triggered.

In Figure 7, the number of observed events is above the acceptable threshold, signaling that the probability of a changing climate is above 99,9 per cent. In this case, a payout is triggered.

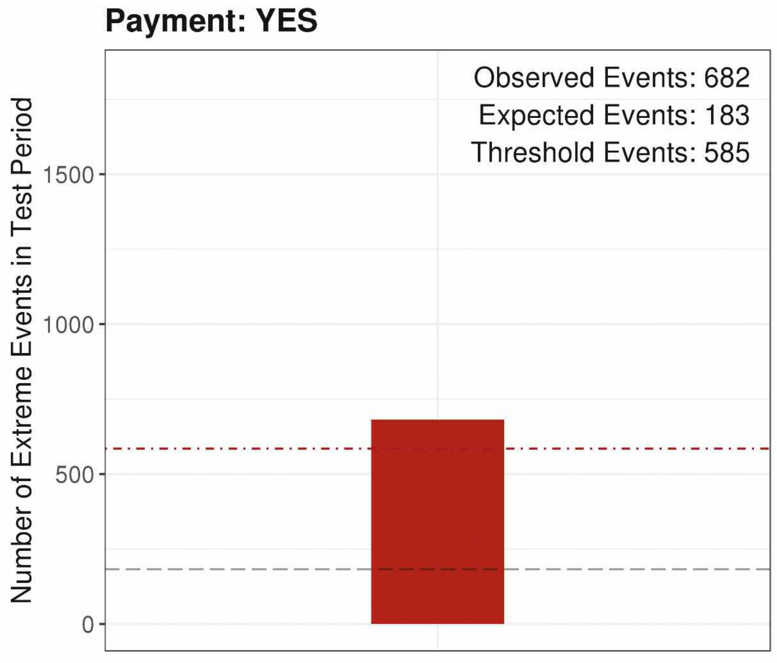


Figure 7 - Example of comparison between observed (red bar), expected (grey line) and threshold (red line) number of extreme events. In this case the observed number of extreme events exceeds the threshold number. As a consequence, a payment is triggered

The key parameters to define the maximum allowed number of extremes, and therefore the mechanism by which the ECI can be used to trigger XCF payouts are thus:

- **The duration of the *baseline period***. This parameter affects the definition of the reference probability distribution and hence of the value of the critical threshold above which extremes are assumed to occur. For the XCF, a baseline period of 30 years is suggested.
- **The threshold for the definition of extremes.** A common choice for the definition of extremes is to consider *extremes* those events whose intensity lies in the upper decile of the distribution and the expected return period is 10 years. A higher threshold implies that a lower number of extremes are detected over any time in terval, and the return time becomes correspondingly higher
- **The likelihood threshold** that changes in the frequency of extremes have occurred, i.e. the residual probability that, under the hypothesis of a stationary climate, a higher than expected number of extremes are detected during the *assessment period*.

The XCF payout scheme specifies a method for determining the amounts to be paid as well as the time of payment, and the relevant geographical entities to which payments are allocated.

The XCF adopts a *progressive* payout scheme, in which payouts are due only when changes in the frequency of extremes are *virtually certain.* However, the first payout would trigger only the disbursement of a selected fraction of the full payment, for example 25%. In the case of a second – consecutive – XCF payout, the full amount would be disbursed.

In the XCF, payouts are not awarded to individual countries, but rather to clusters of countries, which are defined according to the similarity in their historical series of the three-component ECI values, and on geographical criteria (for example, grouping countries that share the same river basins).

The regional clusters are as follows

Group 1	Nigeria, Niger, Liberia, Cote d'Ivoire, Ghana, Togo, Benin, Guinea, Sierra Leone, Senegal, Mali, Burkina Faso, Gambia, Guinea-Bissau;
Group 2	Chad, Sudan;
Group 3	Uganda, Ethiopia, Kenya, Somalia, Rwanda, Burundi, Tanzania, Eritrea, Djibouti;
Group 4	Mozambique, Malawi, Zambia, Madagascar;
Group 5	South Africa, Zimbabwe, Botswana, Lesotho, Namibia, Angola, Swaziland;
Group 6	Democratic Republic of Congo, South Sudan, Gabon, Congo, Central Africa Republic, Cameroon, Equatorial Guinea;

In Figure 8, an example of ECI time-series with associated fractions of full payment assigned to each 5-years assessment period using the progressive scheme is shown. The series shown are computed using CERA-20C[4] reanalysis data for Region 3.

[4] CERA-20C is the ECMWF climate reanalyses of the 20th century, from 1901 to 2010. It is based on the CERA assimilation system, which uses surface pressure and marine wind observations as well as ocean temperature and salinity profiles to reconstruct the global climate.

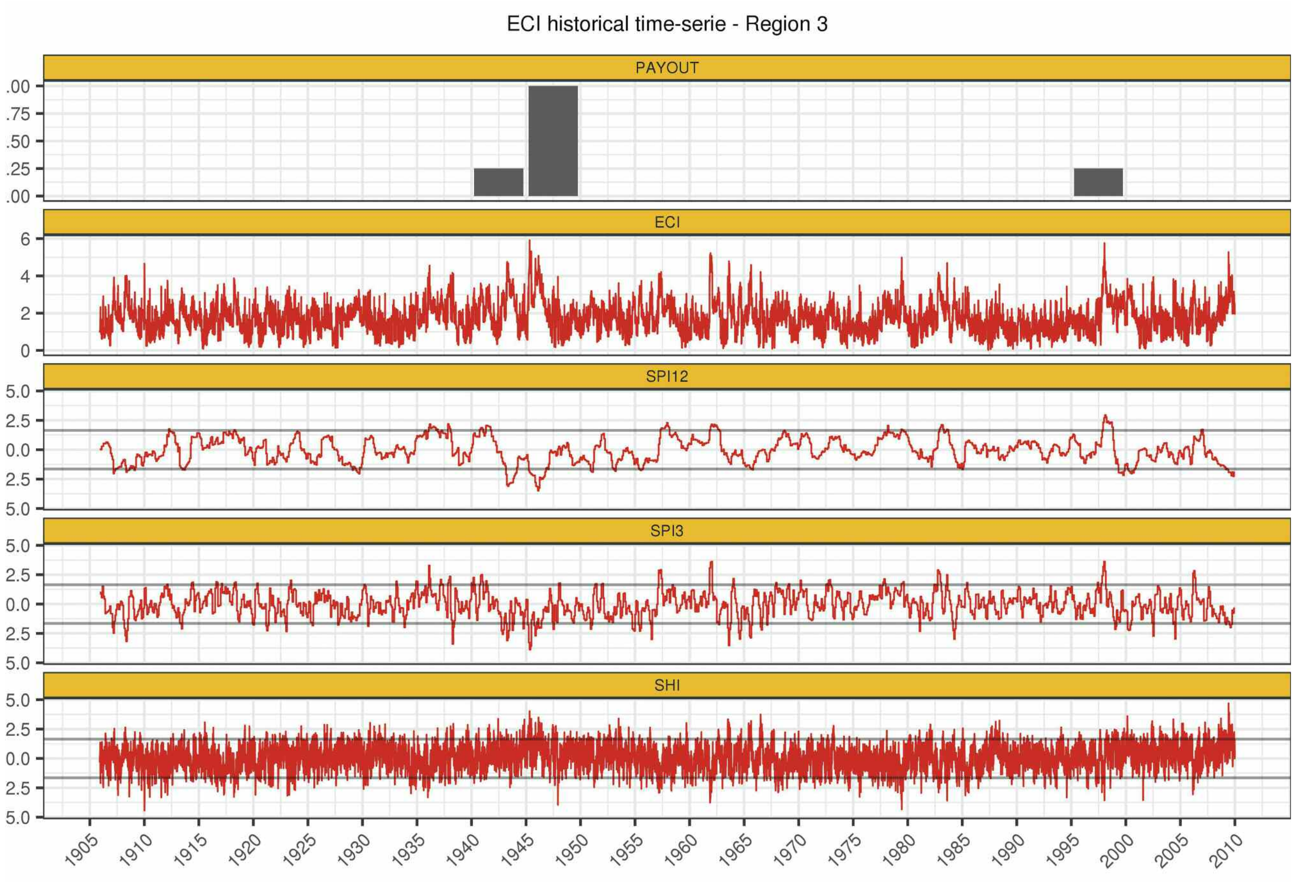


Figure 8 – SHI, SPI3, SPI12 and ECI historical time-series for Region 3, computed using CERA-20C reanalysis data. On the upper panel, the fractions of full payment triggered for each 5-years assessment period using the progressive scheme are shown. For all three periods in which a payment is triggered, the observed number of extreme events exceed the threshold level. For the periods 1940-1945 and 1995-2000, since no payment is triggered in the preceding periods, only 25% of the full payment is triggered. A full payment is assigned only to the period 1945-1950, since a payment is also triggered for the previous period

Two other payout schemes were considered but discarded: an incremental scheme where the amount of each payment varies according to the number of extreme events observed in a given area, *and a pure lump sum scheme, where the full amount is paid in one solution if changes are* virtually certain.

A risk modelling analysis (similar to the one outlined in the next chapter) shows that an incremental scheme produces a large number of small payouts and is not financially sustainable, both in the near-term and in the long-term. A simple lump-sum scheme produces a smaller number of payment than the incremental scheme. However, the the full amount is paid at each detected increase of climate extremes, thereby preventing the financial sustainability of this scheme.

The *progressive* payout scheme ensures that long term fluctuations (which have also implication from the point of view of adaptation) and trends are compensated with different payouts. Fluctuations would trigger smaller payouts with a *progressive* scheme, while persistent trends would receive progressively higher compensation as they consolidate over time.

Risk modelling is needed to make sure that the payout scheme chosen for the XCF is effective and financially sustainable. When it comes to modelling risk, a fundamental leap is required with respect to the approach that is usually adopted in the broader sector of weather-index based insurance.

The approach of weather-risk management applications is to assume a stationary distribution of weather events. As a practical approach, pricing relies on the analysis of historical data and their statistical distributions. The assumption that the probability distribution of the chosen index will not change in the future is a key step in the design of traditional weather- index based risk management approaches.

Instead, XCF focuses on the probability that a change *will occur* in the frequency of extremes exceeding a certain threshold. In this case, the investigation of the observed frequency is not sufficient, neither would the investigation of past changes in the frequency of extremes be sufficient: some information on the potential future changes in the climate system is necessary.

The analysis of risk modelling is thus based on 69 different simulations of future scenarios of climate change, under different hypothesis of future emissions of green-house gas concentrations. These are climate simulations considered in the Fifth Assessment Report of the IPCC[5], referred to as Representative Concentration Pathway (RCP). Currently, the main RCP scenarios considered for the simulation of future climate are RCP2.6, RCP4.5 and RCP8.5, which are representative of scenarios with increasing greenhouse gas concentration named after their radiative forcing[6] values in 2100 with respect to pre-industrial values (+2.6 W/m^2, +4.5 W/m^2, +8.5 W/m^2 respectively). The sustainability of XCF is assessed in terms of Expected Loss Cost (ELC), defined as the potential average losses that the XCF risk taker would face in the near and the long-term.

5.1 Near-term payout

To perform the risk modelling in the near-term, the ELC is evaluated for each country over the ten-year assessment period 2020-2029. All 69 climate scenarios, which encompass the RCP2.6, RCP4.5 and RCP8, are grouped together and the ELC is computed as the average payout over the entire set of climate models. In fact, in the near term, the green-house gas concentration for the different RCPs is very similar and the rate of increase in their concentration is also similar. The percentage of models which leads to full payout, according to the progressive payout scheme, is also evaluated. The resulting map is reported in Figure 9, which shows that, in the near term the, ELC is sufficiently low (less than 5%) over the entire African continent thus demonstrating that the scheme is financially sustainable in the short term.

[5] IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

[6] The rate of energy change per unit area of the globe as measured at the top of the atmosphere. (Rockström et al., Nature, 2009)

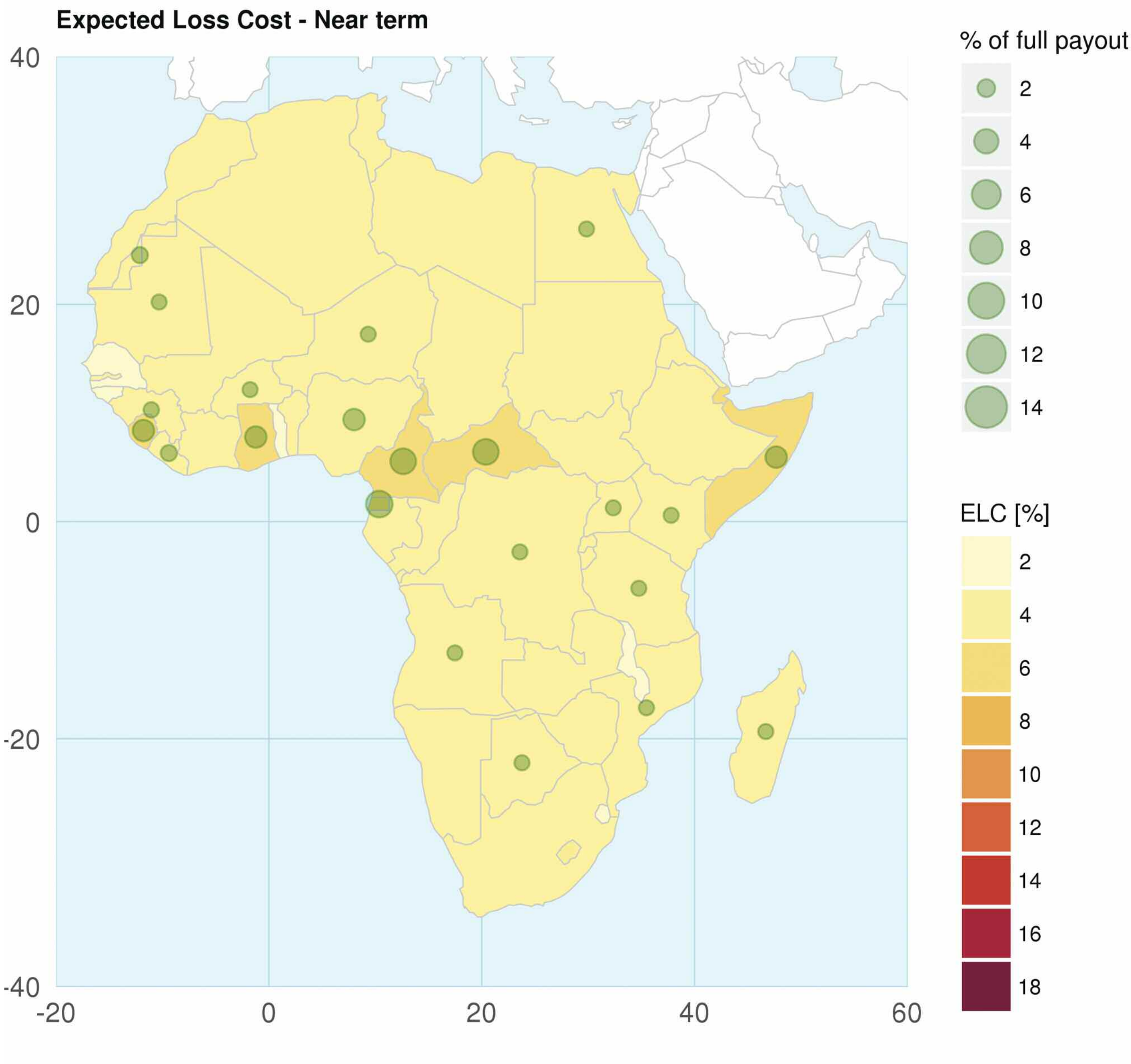


Figure 9 – Map of ELC over the ten-year assessment period 2020-2029 (near-term), based on 69 climate scenarios of RCP2.6, RCP4.5 and RCP8.5. Green circles indicate the percentage of models which leads to full payout, according to the progressive payout scheme

5.2 Long-term payout

The sustainability of XCF in the long-term is assessed by considering the period 2070-2079. In this case, the RCP scenarios are evaluated separately, provided that the different rates of change in greenhouse gas concentration leads to different climate regimes in the long-term. The resulting maps, for each scenario of changes, are reported in Figure 10. It is worth noting that climate scenarios are not meant to reflect the actual behaviour of the climate system during the corresponding calendar years. In fact, climate model simulations are not synchronized with the occurrence of specific climate conditions at specific times (for example the occurrence of El Niño events). Instead, they are meant to mimic the expected behavior of the climate system at a given concentration (and the corresponding

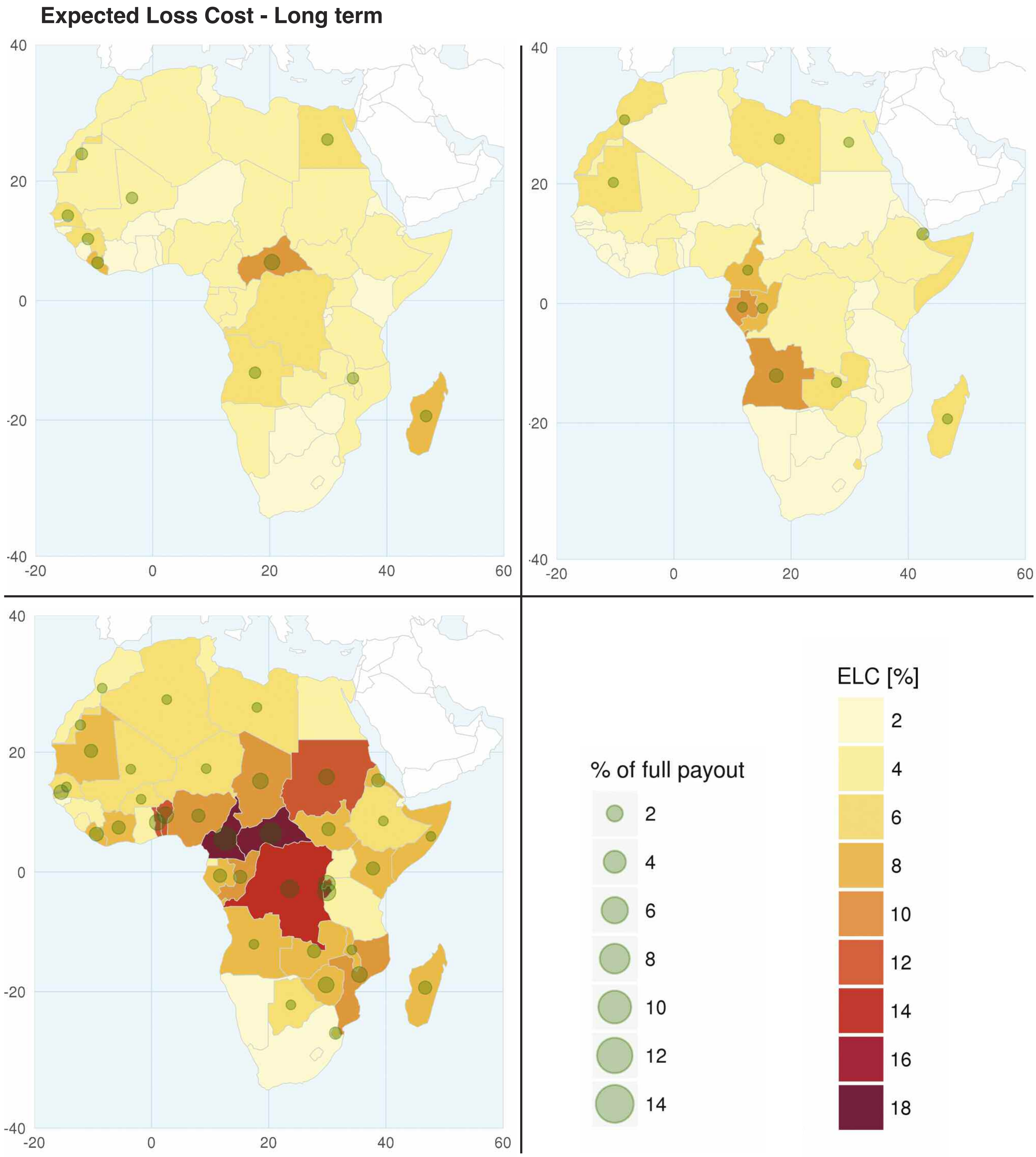


Figure 10 – Map of ELC over the ten-year assessment period 2070-2079 (long-term), based on separated climate scenarios of RCP2.6 (a), RCP4.5 (b) and RCP8.5 (c). Green circles indicate the percentage of models which leads to full payout.

rate of increase) of greenhouse gases. Therefore, the ELC should not be interpreted as the actual probability of a payout during the specific time frame, but rather as a measure of how much different climate scenarios could diverge in the long run in terms of expected payouts.

RCP2.6 and RCP4.5 show, in the long term, only a slight increase in ELC, which, however, remains mostly limited to values around 5%. Instead, RCP8.5 produces a more severe scenario, especially in central Africa, broadly corresponding to region 6, according to the clustering proposed for XCF countries in chapter 6. For the RCP8.5, all countries show a percentage of full payouts greater than zero, with values up to 18%, indicating that consecutive and persistent payouts are frequent. In the long-term, the sustainability and effectiveness of the XCF payout scheme - and of the corresponding adaptation actions - is thus ensured by the parallel implementation of effective mitigation policies.

6 Conclusion

XCF is a climate risk management facility which will enable the adaptation to structural changes in climate regimes over the coming century.

The Extreme Climate Index (ECI) is a fundamental building block of XCF and has been designed to cover an essential range of hazards, namely dry and wet periods over different time scales as well as extreme temperatures. The index is also designed with the possibility of extending its coverage to other natural hazards, as required.

The computation of the index requires access to publicly available datasets that are expected to remain consistent over the coming decades, such as climate reanalyses and satellite based rainfall estimates.

XCF entails a progressive payout triggering scheme with smaller payouts covering large, natural climate fluctuations and larger payouts in the case of persistent trends.

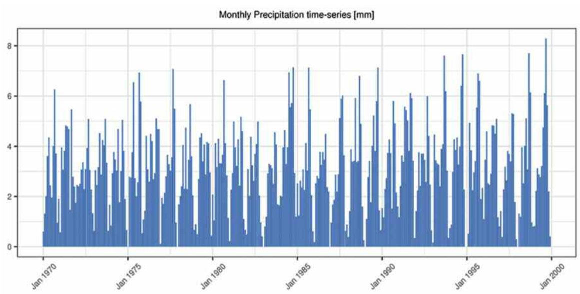
The risk modelling analysis shows that XCF is a financially sustainable facility for triggering adaptation funds in the short-term. In the long-term, the sustainability of XCF is ensured by the parallel implementation of effective mitigation policies.

A sample contract term-sheet is reported in the technical box, with the essential components of a possible contract based on ECI and on the XCF payout triggering scheme.

7. Technical box 1: sample termsheet

Effective Date:	January 1, 2020
Termination Date:	December 31, 2024
Climate Baseline:	30 years
Lowest ECI extreme:	2.80 (example)
Number of Extremes Strike Level:	500 (Example)
Premium:	USD 5,000,000 (Example)
Premium Payment Date:	December 31, 2019
Climate Index:	Extreme Climate Index ("ECI" as defined in Appendix I)
Climate Index Units:	A unit of the Extreme Climate Index.

Settlement Level and Payment Amount:	(i) The number (N) of ECI values above the lowest ECI extreme (L) is smaller or equal to the Number of Extremes Strike Level (T), no payment is due on the Payment Day. (ii) If N is larger than T, a lump-sum payment is due of the amount: 1) 0.25 * Maximum Transaction Payment Amount if, during the 5 years that precede the effective date, no payment has been settled, associated to this same term sheet except with different effective and termination dates or with a different climate baseline or with a different ECI extreme threshold, or with a different number of extremes strike level. 2) Maximum Transaction Payment Amount if, during the 5 years that precede the effective date, a payment has been settled, associated to this same term sheet except with different effective and termination dates or with a different climate baseline or with a different ECI extreme threshold, or with a different number of extremes strike level.



30 years of monthly data

The calculation of SPI-3 starts with a time series of monthly cumulated rainfall over a period of 30 years.

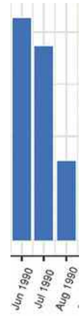
1

3-months values

The 3-month cumulated rainfall is computed and associated to the latest month in each group. For example, the cumulate value for August 1990 corresponds to the cumulated rainfall during June-July-August 1990.

June 1990 +
July 1990 +
August 1990 +

August 1990



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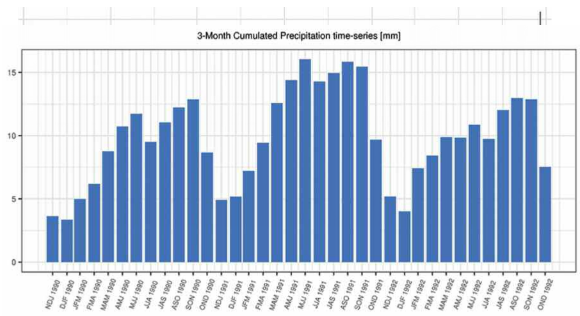


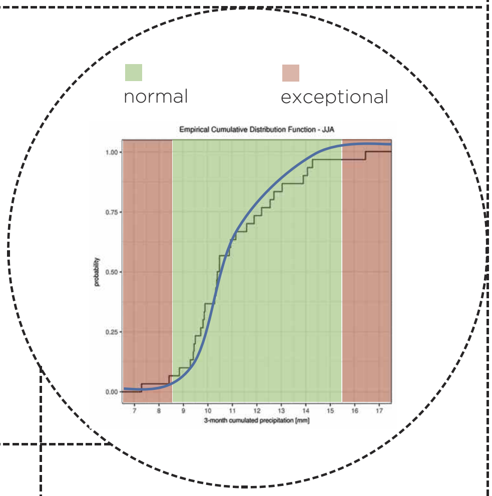
30 years of 3-month values

The 3-month cumulated rainfall values replace the monthly rainfall in the initial time series.

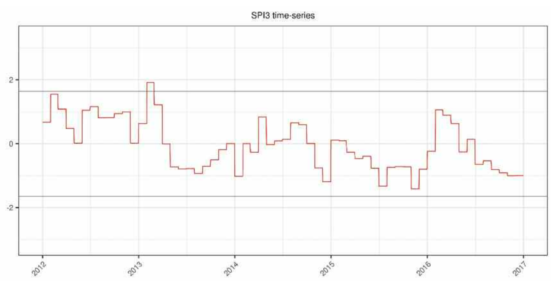
3

Probability distribution

For each month, the empirical distribution of the values of 3-month cumulated rainfall is fitted to a parametric probability distribution (usually a Gamma function). For example, the probability distribution for August is derived from the cumulated values of June-July-August for all years in the dataset.



4



Index

The computation of SPI-3 ends by replacing each of the 3-month cumulated rainfall values with the value of a normally distributed index that has the same probability of the corresponding cumulated rainfall. This index represents the standardized distance of each 3-month cumulated rainfall from the expected value.

5

The Extreme Climate Index (ECI) is obtained by combining two or more single-hazard indexes which measure precipitation, heatwaves and other climate-related parameters.

Though the measured variables and the time scale change, these single-hazard indexes are all based on a similar methodology. Each single-hazard index is made equivalent to a random variable that follows a normal (i.e. gaussian) distribution.

A brief illustration of this methodology is provided here, using to the Standardized Precipitation Index over a 3-month time scale (SPI-3) as an example.

The Extreme Climate facility (XCf) is envisioned as a data-driven, multi-yea financial vehicle that tracks the frequency and magnitude of extreme climat shocks in Africa, and provides additional financing for countries already managing their current weather risks through the African Risk Capacity Insurance Company Limited (ARC ltd).

The XCF relies on two distinct elements: a new and specifically developed index called the Extreme Climate Index (ECI), and a strategy for detecting changes in the frequency of extreme weather events in African countries, thus indicating that a shift to a new climate regime is underway.

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