Lack of rainfall parametric cover for hydropower production

By

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Abstract

This product provides coverage to a hydropower company in Southern Africa for lost revenue when there is a cumulative lack of rainfall measured by satellite data and weather stations.

Overview

Peril/s	Lack of Rainfall
Geography/Region	Southern Africa
Years	2025 – 2027 within a Long-Term Agreement (LTA)
Exposure covered	Revenue loss & extra surcharge due to power purchasing
Trigger type/s	Pure parametric: cumulative rainfall index
Trigger mechanism/s	Gridded cumulative rainfall dataset integrating satellite measurements and observations from weather stations
Key information	Lack of rainfall targeting high frequency losses, impacting the balance sheet (goal: return period of 1-in-5 years). Linear payout structure (with agreed strike and exit)
Annual Limit	USD$ 70 million
Issuer	
Cedant	
Parties Involved	Local broker, utility company, local insurer, Descartes Underwriting for Pricing and Data Analysis, (re)insurance panel of MGA, weather data provider, weather data certification agent

DETAIL

Motivation

An international power company operates a few closely linked **hydro power plants** in Southern Africa that rely on rainfall and river inflows to fill their reservoirs. The power production of these plants is directly dependent on the water flow, which, in turn, is closely correlated with cumulative rainfall over the preceding months.

We observed the highest correlation between production and cumulative rainfall with a time window of 2 months.

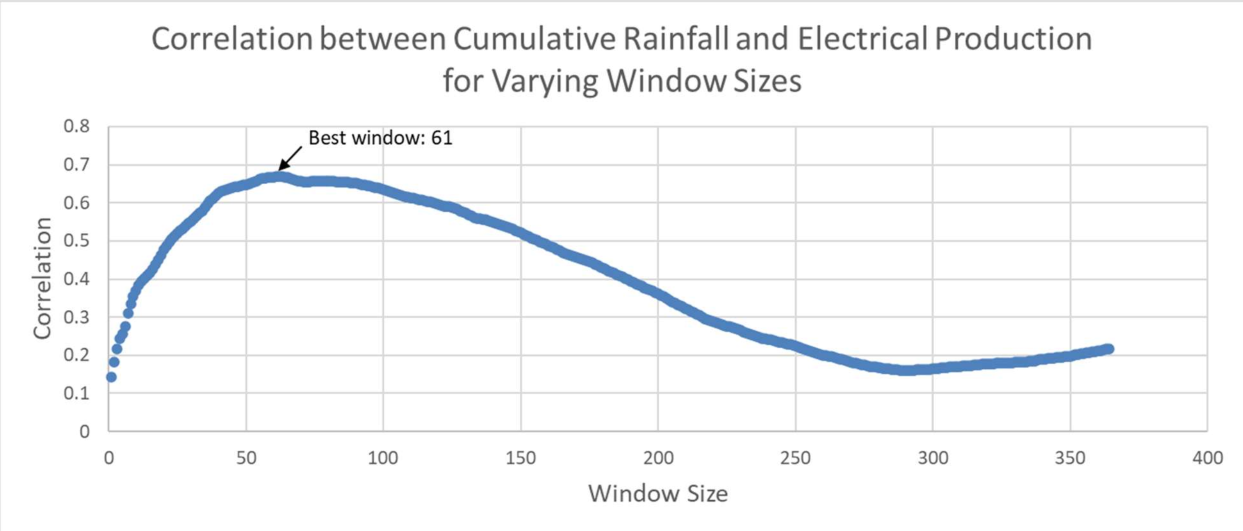

Figure 1: Correlation between Electrical Production and Cumulative Rainfall computed over varying Window Sizes of preceding days

When the rainy season is sparse, particularly from November to April, and the droughts are severe, water levels can drop to a fraction of their intended capacity. This is especially pronounced during El Niño years, significantly impacting net income, which has historically fallen by more than half during prolonged drought periods. With climate change intensifying annual rainfall variability, the energy security of hydroelectric power plants is at risk if they cannot adapt to extreme droughts and increasingly erratic rainfall patterns.

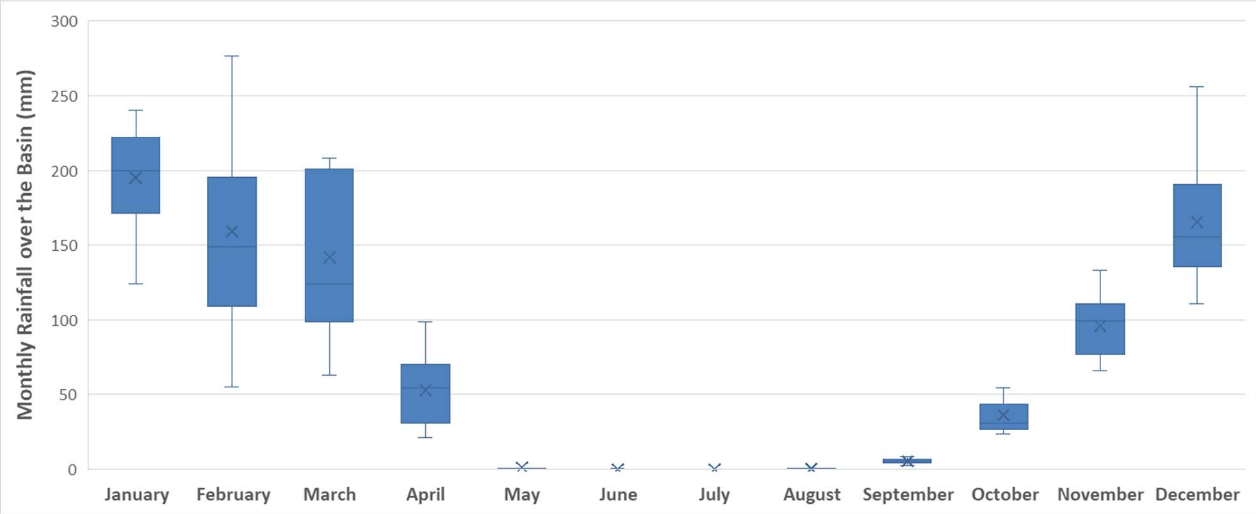

Figure 2: Boxplot of the cumulative monthly rainfall between 1981 and 2023 highlighting a rainy season (October to April) and a dry season (May to September).

As a result of insufficient water levels, the company has struggled with maintaining operations in the past, resulting in load-shedding, daily power cuts and a reduced power generation capacity. The company had to purchase power from other players to compensate for the power shortage, resulting in unforeseen costs inflated by a volatile energy market. Moreover, it has impacted its capacity to raise funds for further hydropower plant development and T&D line expansion, delaying the subsequent industrial development in sectors such as mining, manufacturing, and tourism in its affiliated regions.

Description of the Coverage

In response to these environmental and financial challenges, a **multi-year lack of rainfall solution** was envisioned to cover the **seasonal rainfall** based on a combination of satellite-based estimates and observations from a network of weather stations. The client looked to have a cover in place running for multiple years to increase the investor confidence and strengthen its financial risk management, knowing that investments are secured by a long-term underlying weather insurance product. Only under a parametric insurance approach with a long-term agreement was it possible for the energy company to hedge its risk of potential financial losses in the coming years with sufficient insurance capacity.

The power company and Descartes could pinpoint the most crucial weather stations and gauges to monitor **long-term historic water levels of the lakes** amid volatile conditions, thereby minimizing basis risk. The modelling of rainfall and subsequent water levels was strengthened by integrating **multiple data sources**, combining several data points of gauge and weather station with climate models and long-term rainfall satellite datasets.

The product also made sure that the latest scientific research and advanced local climate pattern modelling helped in the pricing and structuring of this cover across the envisioned multi-year timeframe to secure sufficient insurance capacity despite the recent loss events.

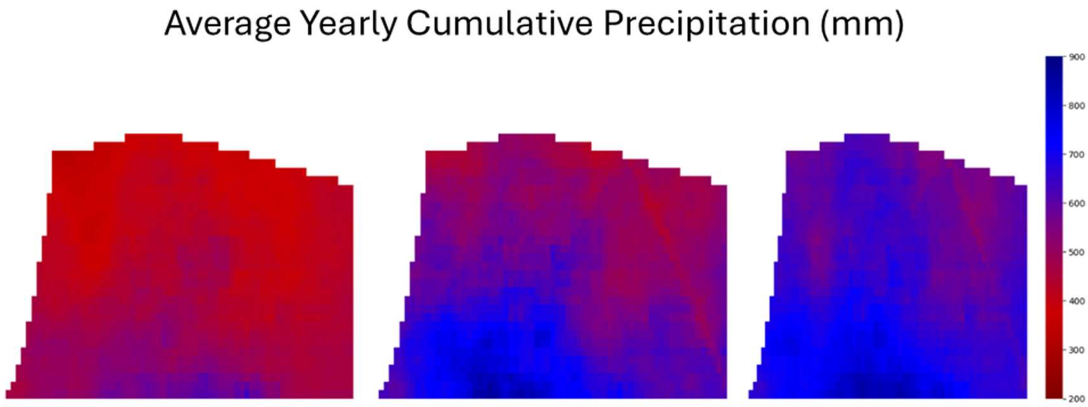

Figure 3: Comparison of average annual cumulative rainfall over different ENSO seasons (from left to right: *"El Niño", "Neutral", "La Niña")* based on CHIRPS data

Technical Modelling

Through in-depth discussions with the client and access to detailed technical information about the plant's production phases, Descartes was able to reconstruct an “as if” power generation scenario based on the current infrastructure. This was made possible by the client sharing critical data, including the exact architecture of the hydropower plant, the hydrostatic head, turbine specifications, and other key operational parameters. By validating our understanding against their infrastructure, we ensured that our assumptions aligned with real-world conditions. This rigorous approach allowed us to establish a strong link between the index performance and the client’s operational output, ultimately gaining their confidence in integrating the insurance solution into their risk management framework. With this foundation in place, we were then able to transition to our own rainfall-based modelling, leveraging hydrological data to further refine our assessment of production variability and risk exposure.

Utilizing the modelling and understanding of the client’s risk also allowed us to set up several pricing approaches tailored to the client’s risk appetite and show the necessary flexibility and openness to their various requests and requirements. Several interactions were needed to finetune the modelling and set the pricing approach, specifically also requiring the local broker’s support in communicating the modelling effectively to the client.

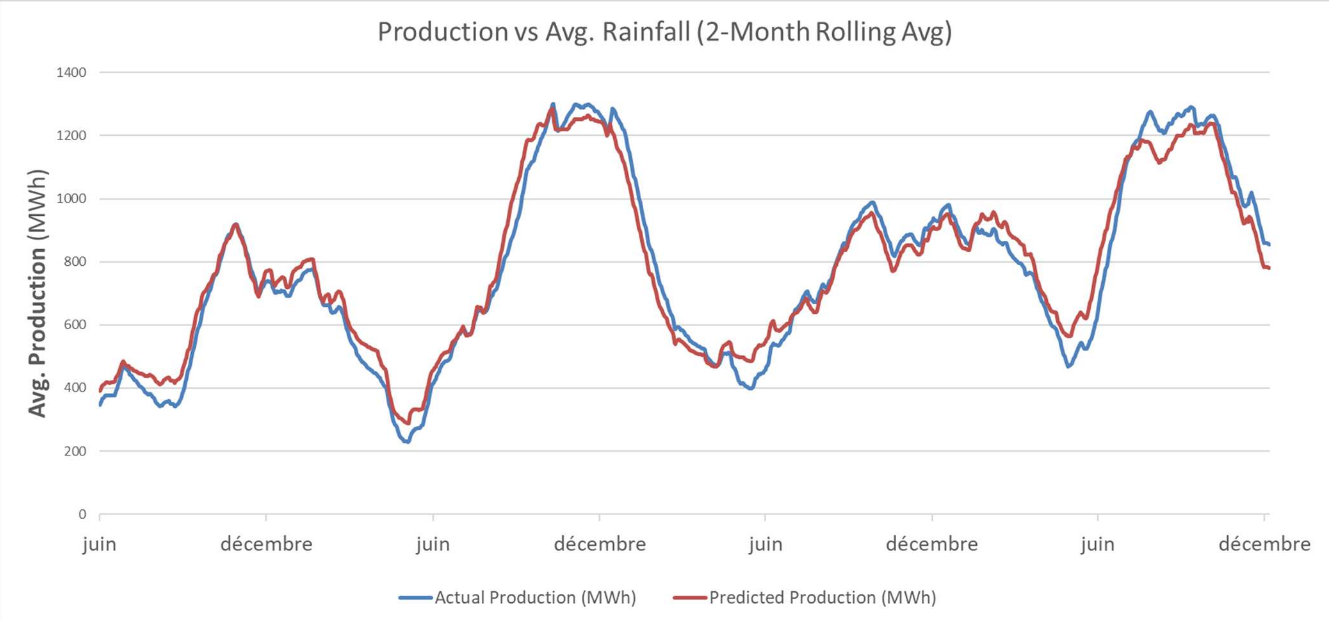

Figure 4: Comparison between the predicted production levels based on modelled data and the actual energy production.

Payout

The product was based upon a linear strike and exit payout structure with our rainfall index in aggregate as the single trigger for all hydro power plants. The attachment point was chosen based on the client's feedback and after presenting several options ranging from a 4 to 10-year return period.

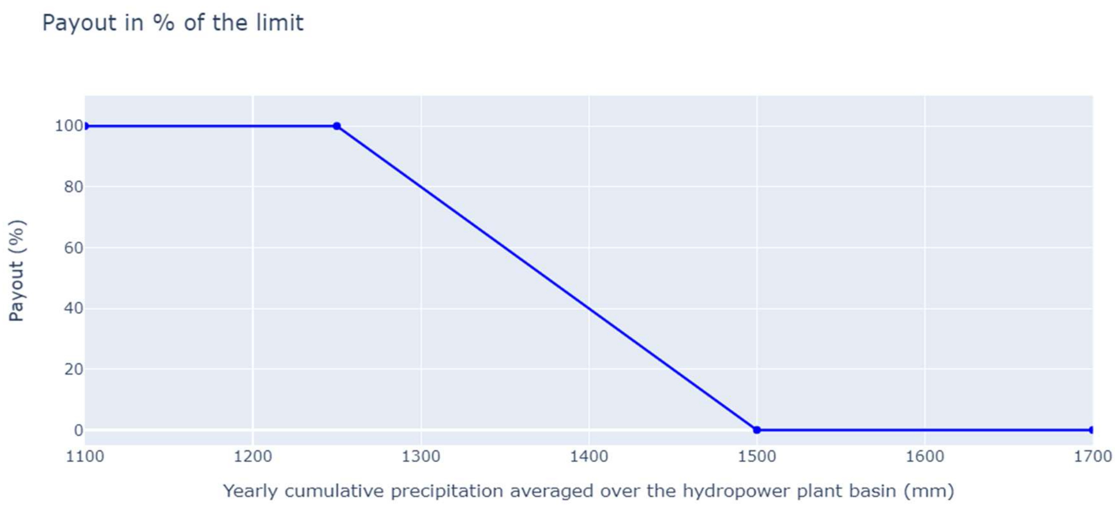

Figure 5: Graph of potential payout according to the mean precipitation

The performance of the **rainfall index** was backtested and presented to the client to guarantee a high level of transparency. The historical payouts along with their detailed calculation were shared to demonstrate the efficiency of the solution in case of severe drought.

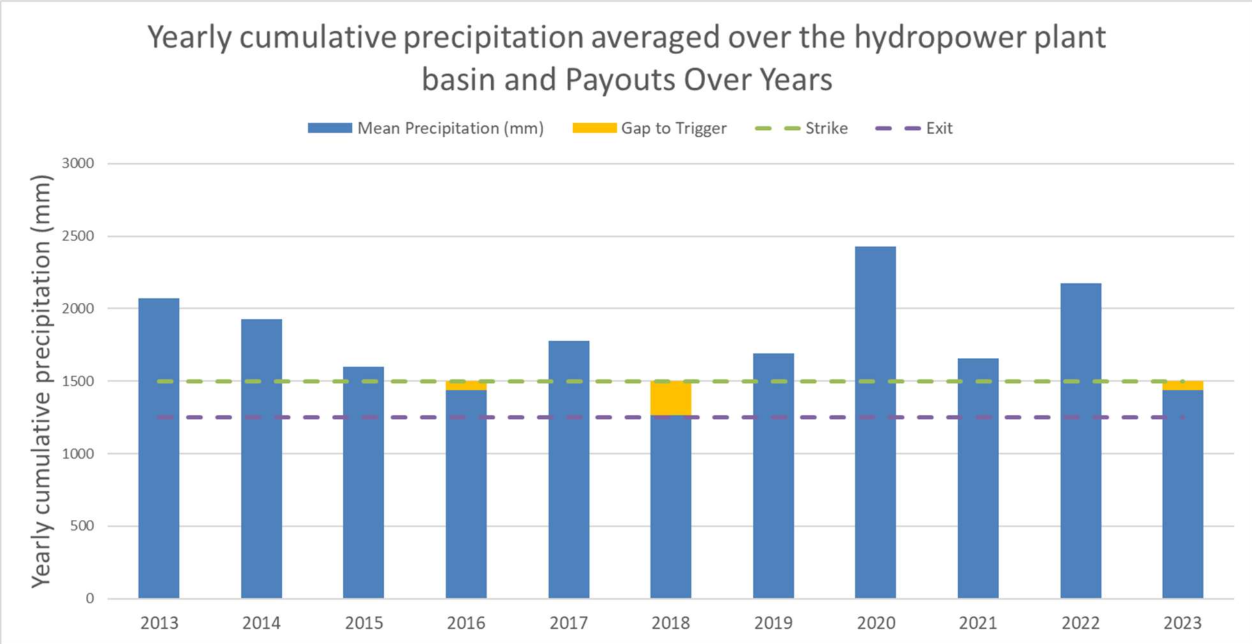

Figure 6: Histogram of payouts based on the mean precipitation over past 10 years.

The data reporting schedule is defined around the different rainfall seasons, allowing the client to quickly incorporate fresh event reports provided by the calculation agent and subsequent insurance insights into its quarterly reporting. The data is certified by an independent third party which provides the data within a few weeks, allowing enough time to blend satellite and weather stations observations. In case of severe data gaps or data errors identified by the certification agent, an appropriate fallback methodology based on alternative datasets is applied. This certification process guarantees continuity of the insurance coverage and allows for quick payouts within a pre-determined framework. The calculation agent then processes the data into a report containing the index and the payout. Once the data of the whole risk period has been released, the quarterly event reports are integrated into a yearly report done by the calculation agent, thus defining the final payout.

To stabilize the pricing, the structure operates with an **aggregate limit across the entire LTA**. This optimizes the premium to the client's budget and streamlines the placement, whilst still holistically enhancing the risk management practice of the client. Due to a strong panel of (re)insurers, potential payouts are processed within a few days following the final report of the calculation agent. The client aims to strengthen investor confidence — even during periods of high rainfall volatility — through transparent data reports and quick reimbursements. This approach not only protects current investments and capital reserves but also encourages future lending. At the same time, the prompt cash inflow improves liquidity, helping to settle outstanding accounts, especially those related to energy undersupply. It also covers the operational expenses incurred, safeguards the balance sheet, and ideally secures the company's profit margin.