Hydropower Project Sites; Climate Risk Assessment Using Historical Data in Zambia

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1. **Objective & Background**

Hydropower is highly sensitive to variations in weather and climate such as shifting rainfall patterns, increases in temperature, more frequent or intense incidence of droughts, floods and extreme weather events. These events can all affect hydropower generation capacity, damage infrastructure and cause disrupt to the service. Climate change and variability is set to bring more severe and frequent weather and climate related variations to most parts of the world increasing the Climate related uncertainties and risks to countries such as Zambia which rely heavily on hydropower. The study investigated the variability of extreme rainfall and temperature events on the basis of daily data from 26 hydro project sites in earmarked for the development of hydro power generation in Zambia under planning for the period 1981-2021.

1. **Method**

For this analysis the TAMSAT daily rainfall estimates for Africa at 4km resolution and the JRA 55 Reanalysis data for maximum and minimum temperature were used to extract historical long-term data at specific hydropower project site locations. All the data sets were validated using 42 Meteorological station data distributed across the Country. Climate Data Tool, an R based climate analysis tool was used to generate extreme values for daily and monthly rainfall and temperature values. Trends are associated with a significant change over time exhibited by a random variable, usually detectable by statistical parametric and non-parametric procedures. Long-term rainfall trend analysis was carried out for each of the project site using Climate Change Detection Indices (ETCCDMI) approaches in the Climate Data Tool. The trends are detected using a non-parametric Mann-Kendall test which is commonly employed to detect monotonic trends in series of environmental data, climate data or hydrological data.

1. **Principal Findings**

The risks identified in this analysis were drought, flooding, storm surge and heat stress. The level of risk increases both as the severity of negative impact increases and as the probability of negative impact increases. High climate risks; statistically significant test results, higher number of years of occurrence, high impacts and therefore high risk to the project sites a indicated in table 1.

Table 1; Project Sites; Risk Ratings adopted from the USAID Climate Risk Management project

	PROBABILITY OF NEGATIVE IMPACT (increases from left to right)		
SEVERITY OF NEGATIVE IMPACT (increases from top to bottom)	Low probability Low impact **LOW RISK**	Moderate probability Low impact **LOW RISK**	High probability Low impact **LOW RISK**
	Low probability Moderate impact **LOW RISK**	Moderate probability Moderate impact **MODERATE RISK**	High probability Moderate impact **MODERATE RISK**
	Low probability High impact **MODERATE RISK**	Moderate probability High impact **HIGH RISK**	High probability High impact **HIGH RISK**

Statistically significant increasing trends in the number of warm days (TX90p) were exhibited over most project sites at annual rates of about 14 to 18%. High probability, High impact and High risk in most of the project sites were mainly associated with Heat stress due to increasing temperature and storm surge.

1. **Conclusion (or Discussion)**

Increasingly investors, project planners and governments are realizing that climate risks could have very real implications, not only for the financial bottom line, but also for meeting objectives such as ensuring energy security; which is critical to helping countries in their economic development which is critical to helping countries in their economic development, as specified by the Expert Team of the World Meteorological Organization and Climate Variability and Predictability are derived for the past and future periods.